

SUSTAINABLE DEVELOPMENT THROUGH WASTE MANAGEMENT

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Abstract—In a modern rising world, where the standard of living of people in our country is increasing day by day along with high paced industrial development, basic forms of energy are on the verge of extinction as well as they are donating generously to global apprehensions like the greenhouse effect, global warming & other environmental issues. The need to revolutionize and employ substitute energy sources has become critical for the existence of upcoming future generations. World is moving towards sustainable development & sustainable utilization of energy resources. India also suffers from inefficient, ineffective & insufficient waste infrastructure & increasing rates of waste generation. Waste management is one of the ways to cater sustainable development. Problems of service quality & waste quantity need to be handled together in a systematic way. Proper waste management infrastructure along with latest technological processes and setup are needed to be developed. Using emerging technology, various methods can be employed to reduce and dispose waste. These methods in turn can help in energy generation in the form of heat and electricity, thus creating alternative to standard energy resources.

Keywords: Municipal solid waste (MSW), Sustainable development, Waste management, Waste to energy.

1. INTRODUCTION

India generates huge amount of solid wastes every day, which is comparatively higher than many countries' total daily waste generation taken together. India tussles to provide effective and efficient waste management service due to lack of financial resources, proper infrastructure & advance technologies. One more reason is lack of awareness in general public about waste management. People think that it is the sole duty of government to handle the waste generated by human activities. But actually it is the duty of the people to reduce, reuse & recycle things so that waste generation can be minimized. 'Swachh Bharat Abhiyan', biggest social media movement, started three years ago by the Hon'ble Prime Minister of India, Shri Narendra Modi was also concerned about creating awareness in the general public about cleanliness & waste management. Segregation of waste at the starting level would help the concerned authorities to deal with the waste effectively. Waste, in fact can be used to generate energy using various conversion processes. Moreover, the

high instability in fuel costs and the subsequent turbulence in energy markets have constrained to search for substitutes of energy, for both financial and ecological reasons. With developing mindfulness about sanitation, and with expanding concern of the government and urban local bodies to manage waste produced more proficiently, the Indian waste to energy sector is ready to develop at a quick pace in the years to come. The double squeezing needs of waste administration and solid sustainable power development, making alluring market or opportunities for investors and engineers in this sector. Indian Government is also focusing greatly in this direction. Governments & other environmental firms have now started realizing that the need of the hour is to work in this field[1-2].

2. BRIEF FACTS ABOUT WASTE GENERATION AND WASTE MANAGEMENT IN INDIA

- Our urban cities generate 62 million tonnes of solid waste annually. In a country of 1.25 billion population, each one of us contributing to the waste piles but only few are working to manage and mitigate the problem.
- Out of this 62 million tonnes of solid waste generated only 43 million tonnes is collected & out of that only 11.9 million is properly treated, rest is just dumped. Even if the waste is collected it is very difficult and costly to process it because it is not segregated. Every individual should work on the ground level so the waste is collected in segregated form.
- Class 1 cities (urban centres with population of 0.1 million or more) are responsible for 80% of country's total municipal solid waste generated. Metropolitan city such as Delhi alone produce over 9000 metric tonnes of waste each day.
- It is just waste is the common Perspective of people. But the fact is this "JUST WASTE" has a huge potential. It can provide employment to 5 lakh rag pickers.
- About 80% of the total waste generated in Delhi & other Indian cities can be recycled, if it is segregated properly from the source. Sunita Narian, Director General of Centre for Science & Environment (CSE), stated "We can't do

waste management without segregation. But there is no incentive for segregation.” Swati Sambyal, program officer, sustainable industrialization, CSE, said “We need to learn from Sweden, which is a zero waste country. We need to learn from countries like Sri Lanka or Bhutan where everybody is conscious to not pollute their land.”

- According to a study conducted, this generated Municipal Solid Waste (MSW) has potential of developing power, which is estimated to be 5200MW in 2017. This waste to energy conversion can be a boon for Indian states which are still suffering from power shortage.
- A study taken by PRICEWATERHOUSECOOPERS & ASSOCIATED CHAMBERS OF COMMERCE OF INDIA (ASSOCHAM) reveals that by 2050, the quantity of urban waste would reach to a limit that a land fill of about 88 square kilometres will be required to dispose the waste. The study states that this is roughly the area currently under Delhi MCD administration.
- It is expected that by 2050, 50% of India’s population will live their life in cities. With this trend, the study estimates that the expected waste generated by 2021, 2031 and 2050 will be 101, 164 and 436 million metric tonnes (MMT) per year respectively.

The MSW composition (Percentage of waste) of India is shown in Figure 1.

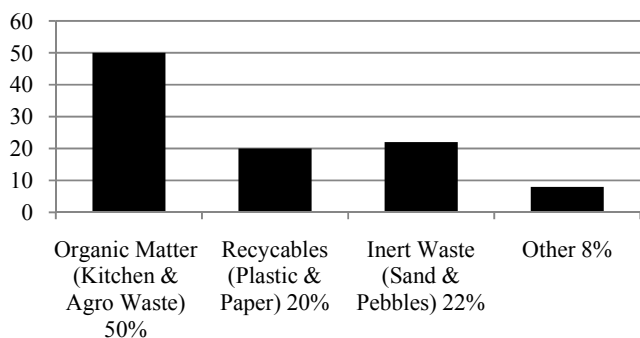


Figure 1

50 % of the MSW is organic or biodegradable matter that can be converted into fertilizer & biogas energy using appropriate anaerobic techniques & processes. 20 % can be easily recycled. The only problem is segregation, which can be eliminated by strategically collecting waste & creating proper awareness among people[3-5].The waste generation from various sources is shown in Figure 2.

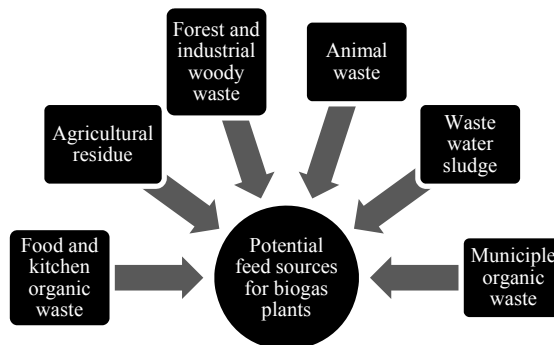


Figure 2

3. WHY WASTE TO ENERGY IS THE NEED OF THE HOUR?

Major portion of waste that is produced find its way into land and water bodies without legitimate treatment, triggering extreme water and air contamination leading to severe environmental complications that would in turn lead to transformation of our earth into a waste land that will no longer sustain healthy life forms. The issues initiated by solid and liquid waste can be significantly diminished by accepting environment friendly waste to energy advancements that will allow treatment & handling of waste before their allocation or disposal.

The regular advantages of waste conversion into energy are clear and convincing as compared to landfills and other traditional methods of waste disposal. Waste to energy produces spotless, reliable energy from a sustainable or renewable fuel source, therefore decreasing reliance on petroleum products (fossil fuels), the ignition of which is a noteworthy sponsor to Greenhouse gases.

4. ADVANTAGES OF UTILIZING WASTES

In addition of energy generation, waste to energy can bring huge economic advantages. A portion of the strategic and financial advantages from this waste conversion are as follows:

- **Lucrativeness:** If all segments of waste are utilized to value with proper utilization of innovation along with ideal technological procedures, waste to energy could be a profitable business. It is actually the untouched market in India.
- **Government Enticements:** Indian government as of now is giving noteworthy motivation to waste to energy ventures, by providing favorable policies, capital endowments & feed in rates. With increasing concerns about environmental changes, waste management and proper sanitation are on expansion in urban & rural areas; a consequence of this growing concern is that recently a ministry is framed exclusively for Drinking Water and

Sanitation. Various other government departments also are paying attention in this direction. The administration incentives for this sector are just set to increase in upcoming future.

- **Associated Waste Opportunities:** Attainment of proper management & disposal of municipal solid waste could prompt opportunities in other wastes, for example, sewage waste, hazardous waste & industrial waste. Any waste can be converted into energy or useful products with help of emerging technologies & research work in this direction. Depending upon the innovative technology utilized for energy recovery from waste, eco-friendly & green co-products, such as - bio-oil, charcoal, compost or supplement manure can also be obtained.
- **Emerging Opportunities:** New technological advancements in this field would not only help us to cater environmental problems related to waste but it will create job opportunities for engineers & researchers. Private firms can also benefit from this untouched market. Competition between firms & government departments would create a new business sector that would help to control & manage wastes.

5. WASTE MANAGEMENT HIERARCHY

The waste management hierarchy is shown in Figure 3.

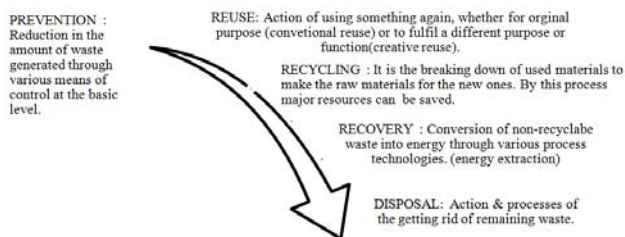


Figure 36. Process of Waste to Energy Conversion

The process of energy extraction from wastes is basically the recovery of energy from non-recyclable materials through different processes and techniques, which includes various thermal and non-thermal advancements made in this direction.

The energy produced as heat or fuel using combustion, gasification, fermentation or anaerobic digestion, is a clean & sustainable power source, having diminished carbon discharges & insignificant environmental effects. The widely accepted, recognized and most prevalent technique for conversion of waste into useful energy is 'Incineration'. Actually, this process is an exceptionally debated invention, due to the concerns it raises with respect to safety & ecological effects. A few nations on the planet, particularly in Europe are trying different things with incineration as a substitute methods for energy creation; Sweden, Germany, and Luxembourg to give some examples.

6.1. Thermal Technologies

- *Depolymerization*, also called *hydrous pyrolysis*, utilizes thermal disintegration where organic compounds are heated in presence of water at very high temperatures. Depolymerization has its own particular arrangements of advantages and confinements.
- *Gasification* is another alternate procedure, utilized to convert wastes into energy. It changes carbonaceous substances present, mainly into carbon dioxide (CO₂) and carbon monoxide (CO) with little amount of hydrogen.
- *Pyrolysis*, another waste to energy process, is utilized significantly in modern procedures. It is similar to hydrous pyrolysis, with no use of oxygen. It utilizes organic wastes from industries and other sources.
- *Plasma circular segment gasification* utilizes plasma technologies to acquire synthesis gas or syngas. The gas is then ionized using a plasma torch, to obtain union gas. The procedure produces electricity while compacting or reducing the waste volume.

6.2. Non-Thermal Technologies

- *Anaerobic digestion* is a time taking process, in which microorganisms are utilized to degrade the biodegradable substances in the absence of oxygen. This simple process is used locally as well as commercially to tap the release of energy during the process and utilize it. Anaerobic technologies are viewed as great operators to diminish environmental concerns caused by greenhouse gases. Also it is a commendable substitution to petroleum products.
- *Microbial fuel cell (MFC)*: An MFC is a electrochemical system in which microorganisms change chemical energy produced by the oxidation of organic/inorganic chemical compounds into ATP by successive reactions in which electrons are conveyed to a terminal electron acceptor to produce an electrical current [6-8].

7. Major Challenges Concerning Waste Management in Delhi

- **Infrastructure for seclusion:** Presently miscellaneous waste is collected & sent to various dump sites, compost plants & waste energy conversion plants. Effective systems are required for proper & structured collection, transportation & disposal of waste at various stages.
- **Waste management in unapproved slum areas:** Delhi has 1634 unapproved colonies in three MCDs' administrative region. These unapproved settlements are not created as per the city planning standards. These colonies pose problems in waste collection & transportation.
- **Inventorization of waste:** Delhi is generating huge amount of waste annually & there are no clear figures. No

crisp values can be provided due various unrecognised waste generating factors.

- **Awful position of dumpsites in Delhi:** The three prevailing landfills in Delhi - Okhla, Bhalswa and Ghazipur are oversaturated; they have completely surpassed their capabilities of waste disposal, in 2008. The dumping locations present in Delhi don't have any mechanization or gasifiers system to regulate the methane that is formed routinely by the decomposition of bio degradable waste. Also there are no prominent fire protection standards and frameworks at these disposal destinations, along these lines making them a potential flammable area.
- **Availability of land:** Delhi authorities do not have proper lands and infrastructure for handling & disposal of solid waste.
- **Lack of public awareness:** People are unaware of proper waste management norms. In fact, few are having ignorant and irresponsible behavior towards waste management and cleanliness in the city.
- **Absence of consistent implementation:** Absence of administrative staffs is one the biggest challenges in enforcing the effective implementation of solid waste management operations and procedures. Additionally, no nodal officer is assigned by the local establishment experts to check the growth and progress of waste management, for example, manage separation, proficient collection and effective transportation (C&T) frameworks, handling of segregated waste and appropriate disposal according to the SWM rules[9].

8. Existing Infrastructure for Waste Management

The existing capacity of waste management infrastructures in Delhi is shown in Figure 4.

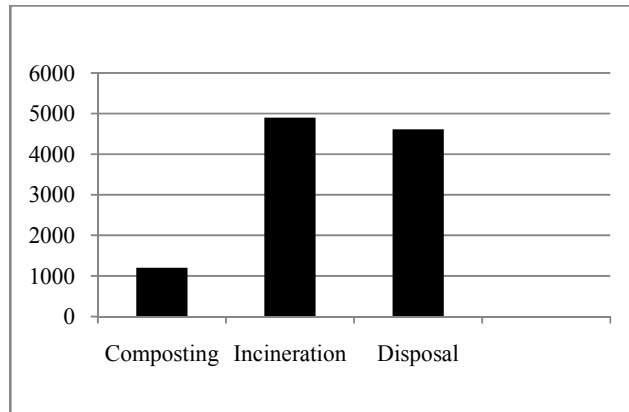
Composting sites	Waste to energy	C&D facility	Landfills/Dumpsites
<ul style="list-style-type: none"> • Okhla (200 tonnes) • Bawana (1000 tonnes) 	<ul style="list-style-type: none"> • Okhla (2000 tonnes, 16MW) • Ghazipur (1300 tonnes, 14MW) • Narela-Bawana (2000 tonnes, 24MW) 	<ul style="list-style-type: none"> • Shastri Park (500 tonnes) • Burari (2000 tonnes) 	<ul style="list-style-type: none"> • Ghazipur (70 acres, Oversaturated) • Okhla (56 acres, Oversaturated) • Bilasawa (40 acres, Oversaturated) • Bawana (100 acres)

(Source: According to the information delivered by MCDs in committee gathering, held on 17th & 20th July, 2017.)

Figure 4

9. Processing Capacity of Waste in Delhi (TPD- tons per day)

The processing capacity of waste is shown in Figure 5.



(Source: According to the information delivered by MCDs in committee gatherings, July, 2017.)

Figure 5

10. Proposals to Reinforce the Present Waste Management System in Delhi

- Minimizing waste generation by reusing & recycling things at ground level. Moving through waste management hierarchy.
- Segregation at source is of utmost importance: Different sources of waste or waste generating segments must realize their responsibility & must keep their premises clean. There must be set of rules for every segment of society for amount of waste generation & segregation procedures.
- Local establishments must reinforce their structures for collection, conveyance and effective handling of the segregated waste using advance technologies & information systems.
- Public- private partnerships need to be developed for proficient waste management. We need to be updated in terms of technologies & processes for waste management.
- Recognition of candidates & NGO's who are working in this direction.
- Creating awareness among general public: Cleaning societies, campaigning, cleanliness awards to the workers & people who are working in this direction would create a sense of motivation.
- Provisions for litter bins in public areas (blue for disposing dry waste & green for disposing wet or organic waste).
- Proper training should be provided to waste collectors (Informal or formal collectors).

- Development of Management Information System (MIS) for increasing visibility in waste management network.
- Use of GPS Tracking systems & RFID for waste collecting & transporting trucks & cleaning vehicles for effective working.
- Recognition of defaulters: Local Authorities that are taking care of proper waste disposal should install CCTV surveillance systems at all public places and prominent black spots/illegal dumping points in the city, to capture defaulters who create nuisance and do not follow the set standards of waste disposal.
- Penalties for dropping litter & for refusal against cleanliness rules: Revision of littering fine under the prevailing DMC Act, 1957 & setting up of new penalties for ignoring cleanliness rules is the need of hour. At present, fine of Rs. 50/- is imposed for littering. This needs to be revised to Rs. 500 to 1000 or more, depending upon the case.
- Use of Leaf Plates: Using plates made up of leaf for food distribution, at gatherings instead of plastic plates would help Delhi in dealing with plastic waste, moreover they are cheap & biodegradable. This concept is currently applied by a company Leaf Republic, it's a company in Germany. It has taken inspiration for ancient Indian culture. World is accepting our traditional ideas, why not we.
- Development of mobile application or any other system to resolve complains & issues related to waste management. This can also be used to identifying & removal of the black spots or points of problem in the city. Instant action systems [9].

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