iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IX **Month of publication:** September 2023

DOI: https://doi.org/10.22214/ijraset.2023.55622

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IX Sep 2023- Available at www.ijraset.com

Utilization of Solid Waste to Energy in India

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Abstract: ***With increase in population and advent of electric vehicles, electricity consumption in world will comprise an increasing portion of global energy demand in upcoming decades. In recent years, the increasing prices of fossil fuels and concerns about the environmental consequences of greenhouse gas emissions have renewed the interest in the development of alternative energy resources. Utilization of solid wastes as a renewable source of energy can achieve sustainable development and overcome shortage of other energy sources. We are highlighting the various routes of harvesting energy from solid waste into clean and sustainable way. Waste to energy concepts are techniques to address the growing menace of solid waste as well as to meet upcoming demands of energy in the form of biofuels. This concept provides environmental benefits and introduce a renewable energy source as well. Here, we discuss alternative technologies for enhancing renewable energy deployment and energy use efficiency from solid waste and also focuses the renewable energy scenario of India.***
Keywords: Biofuels, Energy demand, Solid waste, Sustainable development, Waste to energy.

I. INTRODUCTION

Nowadays it is a modern and fastmoving era where liberalization, privilization and globalisation are increasing continuously along with rapid population growth hence 1.5 lakh metric tons of solid waste generated every day from which 90% (1,35,000 MT per day) [ref: INDIA TODAY- India's trash bomb] of total amount is collected waste. And nearly 15000 MT of garbage remain exposed every day, resulting in almost 55 lakh MT of solid waste disposed in open areas each year and from the total collected waste only 20% (27,000 MT per day) is processed and remaining 80% (1,08,000 MT per day) [ref: INDIA TODAY- India's trash bomb] is dumped in landfill sides. The generated waste comprises a big portion of biomass materials such as paper, food, wood waste, clothes, plastic, vegetables, rubber and other daily used discharge materials this kind of waste is very hazardous for environment as well as human health. So, there is an urgent need to move to more sustainable solid waste management and this require new techniques or proper treatment. Now, on the other hand the conventional source of energy like fossil fuels and petroleum are depleting at rapid rate and whole nation is seeking for an alternative source. In this regards this solid waste can be an great opportunity as source of energy for power generation and fulfil the energy demand of the nation (mostly industrial and agricultural use) and by using this solid waste for energy generation we get two main things those are renewable and cost effective energy along with sustainable and clean environment and waste get reuse to generate energy. [16]

II. CLASSIFICATION OF WASTE IN INDIA

In India waste are generally classified as 4 types:

1) *Urban Waste:* urban waste is further classified as: -
a) *Municipal solid Waste:* This waste contains paper, glass, metal, manmade polymers (such as epoxy, polythene, nylon, gadgets, etc), pharmaceuticals waste (such as tablets, lotions, spray, etc), sanitary waste, etc.
b) *Sewage:* Sewage waste contain bulk excretory matters (such as urines), waste from body (like sweating, nails, etc), waste from laundary (residues from detergent and soaps).
2) *Waste from Biomedical:* biomedical waste contains pathological waste, waste from blood reports, surgical waste, etc.
3) *Waste from Biomass:* forestry residue, agricultural waste, animal waste and food processing waste are some kind of waste from bio mass.
4) *Waste from Industry:* industrial waste is further classified as: -
a) *Solid Waste:* Synthetic fibres, paper and pulp waste, brine mud, metallurgical slags, gypsum are some of the solid industrial waste.
b) *Liquid Waste:* Contaminants from dissolved organics, mixture of liquid with manure, cement/clay slurry, crushed liquid and solid, paint with emulsion, waste from oil, etc are some examples of liquid waste from industries. [2]

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A. Potential

The sector wise summary mainly covering urban and industrial areas for energy potential for India is given below:

Table 1: Sector of Solid waste in India

S.NO	SECTOR (SOLID WASTE)	ENERGY POTENTIAL (MW)
1	Urban solid waste	1247
2	Processing and preserving meal	13
3	Vegetable processing	3
4	Fruit processing	8
5	Fruit raw	203
6	Palm oil	2
7	Tapioca starch	15
8	Sugar press mud	200
9	Vegetable raw	579
10	Slaughter house	48
11	Cattle farm	862
12	Poultry	462
13	Chicory	1
14	Tanneries	10
	Total	3653

Source: Ministry of New and Renewable energy (https://mnre.gov.in/waste-to-energy/current-status till March 2021)

III. FEASIBILITY OF WASTE TO ENERGY IN INDIA

Policymakers in our country find a way just to burn it and generate electricity but it's not that easy just look like. Unless and until waste is not segregated it is not possible to make energy from it. In India contracts are given for segregation of waste. Policies that promote waste to energy: remaining waste is dumped or burned openly.

Now one of the major question arise in our mind that what should be done to manage this remaining waste?

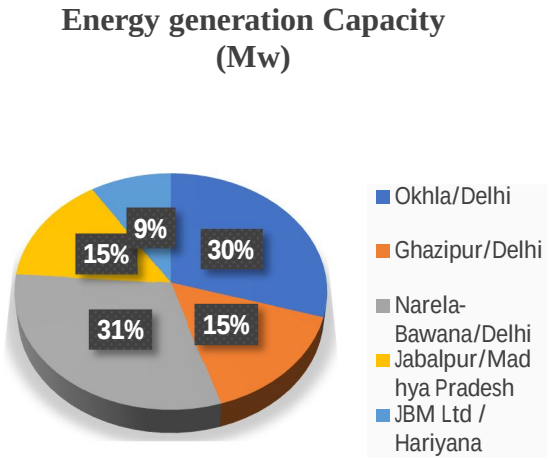
1) Niti aayog has set a target of constructing 511MW of waste to energy plants under Swachh Bharat Mission till 2017-18.
2) Government has also proposed formation of waste to energy corporation of India which would set up incineration plants through different models.
3) In 2017 National Thermal Power Corporation (NTPC) has invited developers and investors to set up 100waste to energy plants in India. Such policies have changed scenario and mind-set of people about waste to energy after this capacity of generating energy from waste have been increased rapidly and currently the total estimated energy generation potential from urban and industrial organic solid wastes in India is approximately 3653 MW till March,2021. [14]

IV. UTILIZATION OF SOLID WASTE TECHNIQUES

A. Incineration

Process of Controlled burning of Hazardous materials at the temperature sufficient enough to destroy contaminants is known as Incineration. For conducting Incineration an equipment known as incinerator which is a type of furnace is required. Incineration process include by-products such as fly ash with carbon, activated carbon. Fly ash can be used in agriculture and activated carbon can be used in sewage treatment, extraction of metals and purification of gold. Process of Incineration may take few weeks or sometimes years but this varies from site to site. Many undesirable materials like harmful chemicals, sludge and solvents can be destroyed by Incineration. No requirement of external fuel is one of the great advantages of Incineration and path of exhaust is through pollution control unit which releases only water vapour in the atmosphere. This led to reduction of groundwater pollution in residential areas. But the waste items such as plastics generate carbon dioxide and nitrous oxide when burned and it can harm the environment and health of people.

Table 2: Waste to Energy plants of in Incineration in India



S.no	Location of city	Energy generation (mw)	Garbage intake (Mt/day)
1	Okhla/Delhi	23	1950
2	Ghazipur/Delhi	12	1300
3	Narela-Bawana/Delhi	24	1300
4	Jabalpur/MP	11.5	600
5	JBM Ltd/ Haryana	7	500
	Total	77.5	5650

Source: Annual report 2020-2021 on implementation of solid waste management rules by Central pollution control board (cpcb)

B. Gasification

It is a technology that convert waste materials into renewable and alternative energy products. It converts carbon containing materials into syngas composed of hydrogen and carbon monoxide. This syngas can be used to produce electricity. It can gasify wide range and variety of waste- derived feedstock. This process uses very less amount of air and give higher energy recovery efficiency as an output. Gasification is advantageous as it is not harmful for the environment and is cost effective. Ammonia and urea which is necessary chemicals for production of fertilizers can be produced by gasification. Many techniques are used in gasification process and one such is Plasma gasification. We know plasma is an ionized gas formed when electrical discharge passes through it. Plasma gasification can make gasification more efficient. In India Municipal solid waste is generally gasified for generation of energy. Overall, we can say gasification is different from Incineration and is fruitful as it can be used to generate clean energy and is cheaper but the maintenance cost of plant is high. [1,13]

C. Pyrolysis

It is thermal decomposition of substance in a non - reactive atmosphere at high temperature. The material used for pyrolysis process are coal, animal waste, paper and plastic etc. Decomposition takes place just because of limited thermal stability of chemical bonds in the material which permits them to get disintegrated by using the heat. Pyrolysis based bio-refineries can also play crucial role in management of waste as they can convert plastic waste into energy and other valuable products which can bring economic and environmental benefits. In pyrolysis toxic components and pathogens are degraded by use of relatively high temperature. Only disadvantage in pyrolysis is that process is quite complex and requires high operational and investment costs. If we talk about India the new plants are setting up but this process is quite new and different for India as in India mostly other methods like Incineration and biomethanation are preferred.

Table 3: Waste to Energy plants of in Gasification and Pyrolysis in India

S.no	Location of city	Energy generation (Mw)	Garbage intake (Mt/day)
1	Pune/Maharashtra	10	700

Note: Waste To Energy Plant (Wte), Ramtekdi Pune is used both techniques pyrolysis and gasification.

D. Biomethanation

The process by which organic materials is micro biologically converted to biogas under certain anaerobic conditions. Microorganisms break down biodegradable material which can be normal kitchen waste in a bio- digester or reactor and this all happens in absence of oxygen.

Mainly in anaerobic digester biodegradable materials like food waste, sewage sludge, peels of vegetables are feed and can be stored in an oxygen free environment and under presence of anaerobic micro-organisms. In such environment reactions occur that convert biodegradable feedstock into biogas which is rich in methane. By- products of Biomethanation process are biogas and fertilizers. Raw biogas contains impurities such as carbon dioxide and hydrogen sulphide. There is wide range of applicability of biomethanation of wastewater, slurries and solid wastes.

This process requires different reactors and process conditions to obtain maximum energy output from waste. Biomethanation has capability of production of energy from solid waste and residues.

It can reduce carbon dioxide emissions and use of fossil fuels. In India biomethanation technology is highly preferred as we have to manage Municipal solid waste and different wastes generated daily due to high population. In India there had over 5 million biogas plants till year 2021.

Biomethanation is reliable and promising technology as it not only manages solid waste but provides biogas which is form of sustainable energy. [3,12]

V. WASTE MANAGEMENT SOFTWARE

1) Resourcify
2) Haul-IT
3) Trash-flow
4) Box tracker
5) Hack WIMS
6) IWS6
7) Waste manifest
8) I waste profile

VI. STATUS OF WASTE TO ENERGY IN INDIA

In India first waste to energy plant was set up in Timarpur, Delhi. This plant was developed with the ability to Incinerate 300 tonnes per day and generates 3.75 MW of electricity. But due to some reasons this plant shutdown soon after. After that nearly 14 plants of 130MW capacity have been installed. Of these ,7 plants with capacity of 66MW have been closed but other 7 plants are operational. As most of waste sent to plants is unsegregated it has high inert content which is not suitable for burning in waste to energy plants. For burning this additional fuel is required.

In India if subsidies are removed, the electricity produced from waste to energy plants will not be affordable. Waste to energy plants rejects almost 30-40% of waste which is dumped because it is either inert or too poor in quality to be combustible.

In developed countries there are various factors which lead to successful generation of energy from waste but this is not done in India because of lack of awareness among people regarding this. So, in this paper we will look such factors by implementing which in India energy can be generated with ease and in sustainable manner. [8,10]

VII. ELIGIBILITY CRITERIA FOR WASTE TO ENERGY PLANTS

1) Suitable management of Solid waste.
2) It should be mandatory to segregate the waste before sending to plants.
3) Complete ban should be applied on landfilling of organic waste.
4) Higher acceptance level for waste to energy plants from public.
5) Emission performance should be top priority.
6) Plants located near city cause lower transportation cost.
7) Most of the plants are owned by Municipality. All such criteria are generally followed in developed Nations such as countries in Europe but in India we are unable to follow or accept such criteria and it would be One of the major dilemma's for our country.

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VIII. CHALLENGES FOR WASTE TO ENERGY PLANTS IN INDIA

1) Lack of awareness on waste management.
2) We usually treat unsegregated waste.
3) High moisture content due to which calorific value is low.
4) Lack of acceptance level of waste to energy plants among people.
5) Lack of transparency of waste to energy plant management.
6) There is lack of enforcement of rules and regulations. There are many more challenges which our country daily faces but by overcoming these challenges we can create a much needed energy. Now, question arise in our mind how can we overcome these challenges? This concept of waste to energy plants is still a new concept for our Nation. Effective disposal of waste with keeping environmental measures can be done by importing technologies and also these technologies should be customized to be suitable for Indian conditions. Public participation should be done to segregate waste, door to door collection of waste in appropriate bin. This plays vital role in waste management and ensuring scientific waste disposal. Government also need to assure that people should be aware of all such activities and projects going on. One more thing government have to do is monitoring on waste to energy plants that these plants are following rules or not because public usually don't accept plants in nearby areas as they thought plants would cause environmental issues. So, this could be some ways by which we can overcome such challenges. Now, we should look some opportunities there exists potential of developing technology considering waste produced in India. With fair level of segregation plants should be installed to reduce load for collection and transportation of Municipal solid waste. India has potential for disposal of waste in distributed manner without long distance transportation which is suitable for towns which generate waste in smaller volume to avoid pollution. One important technology is Gasification, a proven choice for utilisation of biomass which can be explored in waste to energy sector and this technology is considered as expertise in Indian industry. In promoting in house techniques demonstration projects need to be setup. Demo scale plants helps in building confidence as well as in building cost effective technology. By analysing waste generation and its properties helps in choosing location specific appropriate solutions for waste disposal considering nature of waste. [11]

IX. DISCUSSION

In this review paper we have discussed the scenario of how waste can be converted to a must require sustainable energy in India and also about the status of India in accepting this challenge. There are different barriers also which should be overcome to achieve conversion of waste to energy. We had classified different types of solid wastes such as industrial wastes, medical waste, Municipal waste etc. Other than that we have talked about how much waste per year is generated in a particular state and total waste generation and its consumption in harnessing energy from it. We have talk about different techniques which are cost effective, suitable for particular conditions and environment these techniques include biomethanation which is one of most widely used and accepted technology for harnessing the energy other than this Incineration which is among one of the oldest technology for conversion of waste to energy than gasification which is one of the cost effective method than pyrolysis process which is new for India but can be used widely in upcoming years. Other than these techniques there are many more conventional methods also such as fermentation and anaerobic digestion. With the help of various graphs and tables we have explained the current status of India in achieving energy from waste and we have mentioned about different software's used for disposal of waste. Other than this feasibility of waste to energy in India is also discussed in detail that how much waste is dumped every year and how much utilized and also different policies which governments implemented to promote this plan to achieve sustainable growth. [9,5]

X. CONCLUSION

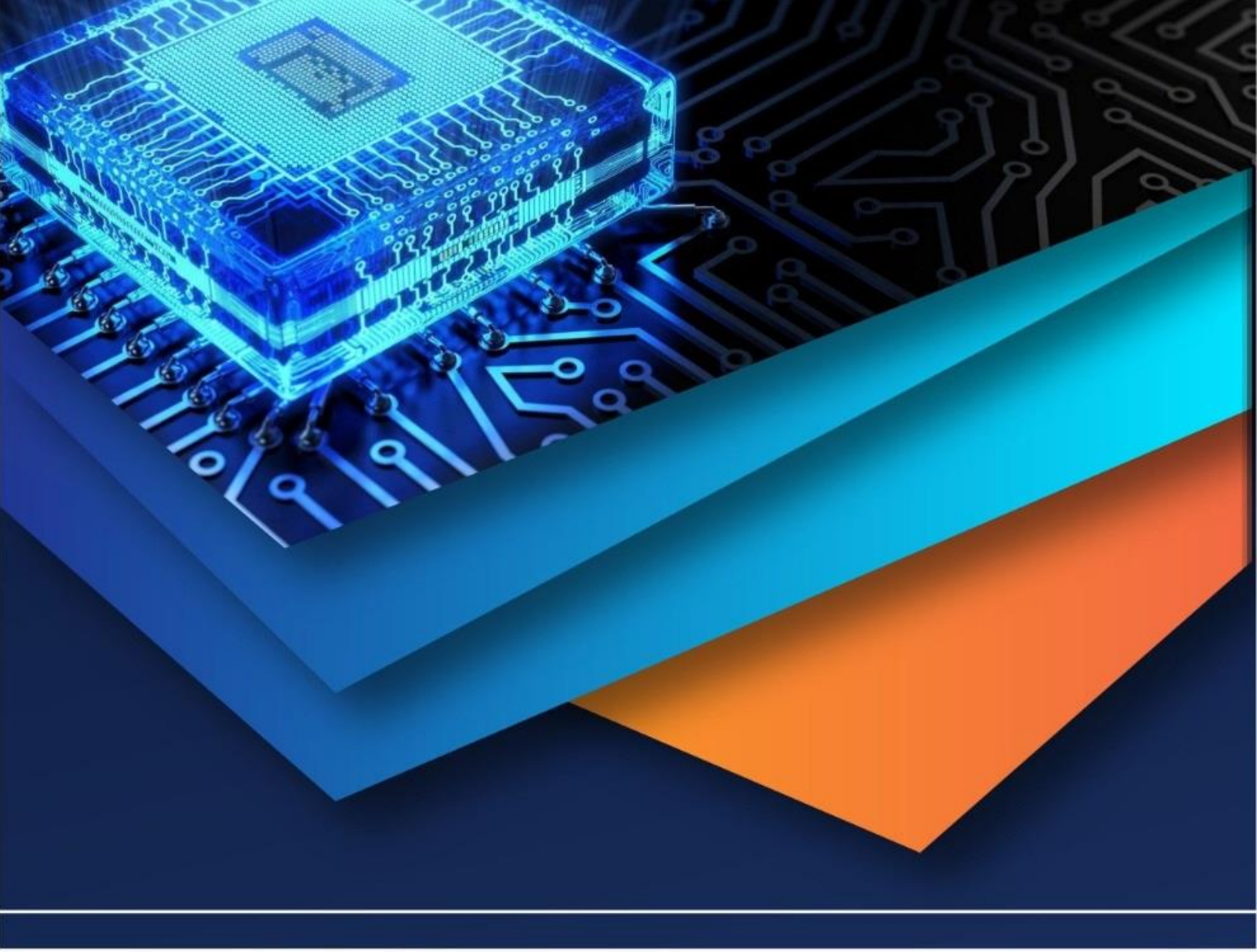
As per our point of view we have concluded that India is capable to generate energy from waste but requires to increase its potential. As we have concluded that we can use different conventional techniques as well different methods for accomplishing our target but we are currently only following traditional methods like Incineration and biomethanation which is cost effective as well as best suitable for our Indian conditions and environment so in this we need to look towards some other methods like pyrolysis and landfilling, composting and other different techniques so that we can compare which is better and best suitable for us as different type of waste can be handled with different techniques so it is necessary to review each and every approach towards our target. One major issue is lack of awareness among people toward waste disposal which can be overcome by creating awareness of disposal of waste in proper way and in this context Government and people need to take initiative that how proper waste management can be accomplished. In our review we have concluded status of India towards generation of energy from waste state wise and different graphs and table have been plotted in that for better explanation of current scenario.

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Different software's have also been mentioned for waste management such as waste manifest, Resourcify, Box tracker etc. with this software one can handle out problem of waste management. We have mentioned eligibility criteria for waste to energy plants by following that criteria one can achieve sustainable energy from waste. [7]

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