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## A Survey on Waste to Energy Potential in Odisha

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**ABSTRACT:** Urban human habitation discharges unwanted materials, refuses and waste of heterogeneous mixture. Collection and removal of these municipal wastes are the primary duties of the urban local bodies in order to make the urban life as well as the environment free from pollution. The Environment (Protection) Act, 1986 compels for management of this municipal solid waste effectively. Management of MSW involves the processes like collection, treatment and final disposal. Treatment of Municipal solid waste by way of waste to energy conversion has proved that the energy generated from solid wastes contributes substantially to the total energy demand of the country and source of renewable energy. As per the statistics from MNRE, as much as 62 million tonnes of municipal solid waste is generated annually in India. In Odisha the figure is 2239 tonnes per day (2012). As per data, 100 tonnes of raw MSW with 50-60% organic matter can generate about 1-1.5 MW power depending on the waste characteristics and accordingly as per MNRE estimates, an average of 1460 MW energy can be recovered from MSW generated in India. Likely the waste to energy potential in Odisha is calculated to be  $3.5 \times 10^{13}$  J per day.

**KEYWORDS:** Municipal Solid Waste, Solid Waste Management, Landfill, Gasification.

### I. INTRODUCTION

Human habitation discharges several unwanted materials and solid wastes which can neither flow into streams nor escape instantly into the atmosphere. In case of rural habitation, the human refuses and wastes lose their appearance by way of natural process like aerobic as well as anaerobic composting and thus needs little management of the same; but in case of urban areas, the wastes being a heterogeneous mixture of paper, plastic, cloth, metal, glass, organic matter, construction and demolition debris, leaves and other materials from market areas create problem for healthy living of the denizens. Different sources of solid wastes in a community are wastes from residence, places of commercial, institutional and industrial activities, animal wastes, dying & weaving, cookery wastes etc. To add to the woes, increase in the use of fossil fuels which produce huge amount of effluents and toxic gases such as carbon dioxide (CO<sub>2</sub>) and carbon monoxide (CO) results in the pollution of the environment. The situation is getting alarming day by day with rapid increase in the rate of urbanisation in India as well as in Odisha. It has become an urgent need for management of municipal solid wastes all over the world and particularly the developing countries like India. Hindrance in the smooth management of solid wastes occurs due to the lack of exact information about the generated waste quantities and the deregulation of powers at different levels thus leading to imposing improper policies for which the waste processing and the disposal capabilities often lag behind and the volumes of trash, garbage and the municipal refuse increase.[9,11]

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## 1.1 Municipal Solid Waste

As per Ministry of New and Renewable Energy [MNRE], twentieth Report on power generation from Municipal Solid Waste presented to Lok Sabha on 05.08.2016, in India, 62 million tonnes of Municipal Solid Waste is generated annually out of which 82% is being collected and out of the collected waste, only 28% is being treated and disposed. Population growth and rapid urbanisation makes cities bigger and denser which results in increased MSW generation in each city, 366 cities in India were generating 31.6 million tonnes of waste in 2001 and are currently generating 47.3 million tonnes of waste, a 50% increase in one decade. It is estimated that these cities will generate 161 million tonnes of MSW in 2041, a five-fold increase in four decades and at this rate, the total urban MSW would be 230 million tonnes per year.

## 1.2 MSW in Odisha

The corresponding figure in case of Odisha is as detailed below.

In Odisha, the waste generation in the year 1999-2000 was 646 tonnes per day which increased to 2239 tonnes per day in the year 2011-2012 and it is increasing every year. As per the total generated waste according to the population, different cities are categorised under various classes. From the total generated waste, 1837 tonnes per day of waste were collected and from those only 33 tonnes were treated.

Table 1: A relative comparison of increase in generation of MSW in some major cities of Odisha between 2001 and 2011 is detailed below [5]:

City	Class (2011 population)	2001 Population	2001 Per capita waste generation in kg/day	2001 MSW generated in TDP	2011 Population	2011 Per capita waste generation in kg/day	2011 MSW generated in TDP
Bhubaneswar	Class C	658,220	0.360	237	867,534	0.411	356
Cuttack	Class C	587,182	0.296	174	773,906	0.338	262
Rourkela	Class D	484,874	0.330	160	639,064	0.376	240
Berhampur	Class E	307,792	0.351	108	405,670	0.400	162
Puri	Class G	157,837	0.573	91	208,029	0.654	136
Balasore	Class G	156,430	0.347	54	206,175	0.396	82

## II. RELATED WORK

Several works are going on Waste to Energy transformation processes for realising the importance and significance of renewable sources such as Municipal Solid Waste. There are some of the ideas and approaches given by researchers and scholars.

Anyaeqbunam F. N. C [1] proposed a paper in American journal on Sustainable power generation by plasma physics.

H.D. Kumar, S.P. Adhikary [2] describes about different processes of waste management in the book A Text book on Environmental Engineering.

Advisory on Improving Municipal Solid Waste Management services, Central Public Health and Environmental Engineering Organisations (CPHEEO)[3] states about the ongoing processes on waste management in India.

RanjitKharvel, Annpu[5] gives the idea about the increasing population which thus possess a direct relation in increase in the area required for landfill.

CSIR, National Environmental Engineering Research, Nagpur, Annual report [7] gives the statistics about generation of Municipal Solid waste.

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KrishaniaMeena, Virendra Kumar, Vijay VK [13] in the article on Anaerobic Technology Harnesses Fully by Using Different Techniques: Review, gives the data about biomass availability in India and the efficiency of conversion process.

K M Rafi, MajidJamil, [14] in the article on Energy Potential & Generation through IRES in City of Faridabad- India, briefs about the amount of useful energy generated.

### III. MANAGEMENT OF MUNICIPAL SOLID WASTE (MSW)

The process of solid waste management is a complex one involving many technologies and disciplines. The technologies involve collection, handling, and transportation to the dumping yard, treatment and final disposal. Wastes when exposed in nonchalant manner pose a potential menace to human health and to the viability of natural and manmade ecosystems. Waste after generation in a co-mingled way is needed to be identified and separated into respective categories such as biodegradable and non-biodegradable. Collection of waste includes both the gathering of solid waste and recyclable materials and the activity of transport of these materials starting from the site of location to the place where the collection vehicle is emptied.

#### 3.1 Management of MSW by waste to energy conversion

Waste generation is increasing with the increase in population day by day and its management is of paramount importance as any sort of carelessness in handling the municipal wastes would endanger the life of the denizens and would not make the urban character of urban local bodies alive. Since solid waste is the renewable source of energy, its conversion to energy would stand as an alternative to non-renewable sources. The discarded materials usually considered to be useless can be made a source of energy. Wastes can be used as compost being a fertilizer for the agricultural crops or can be treated to produce energy. Treatment of wastes can be done in different ways such as Bio-chemical process, Thermo-chemical process, and landfill. In the biochemical process the energy content of the primary source can be converted through bio-decomposition of waste into energy rich fuels which can be utilised for different purposes.

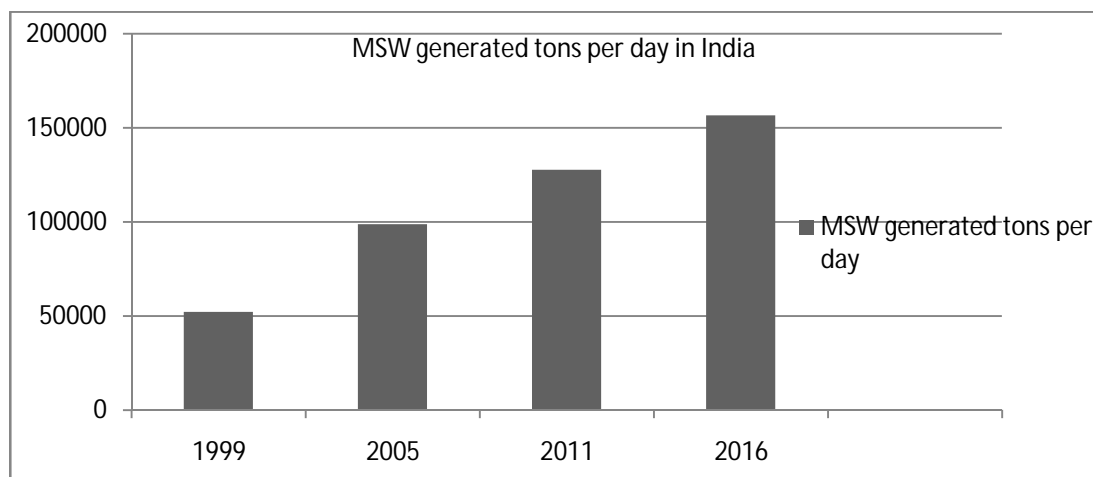


Fig 1: Increasing rate of MSW generated in India

#### 3.2 Process of waste to energy conversion

- Bio-Ethanol production:** Bio-ethanol can be produced by treating a range of organic fractions of waste. Separate stages involve hydrolysis by enzymatic treatment in which the complex polymers are broken down into simple monomers, fermentation by use of microorganisms and distillation.
- Biogas production from anaerobic digestion:** Anaerobic digestion process is carried out in absence of oxygen in which the wet biomass undergoes digestion process in wet and dark conditions and biogas is produced. The

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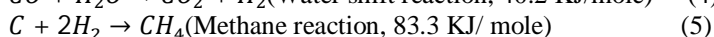
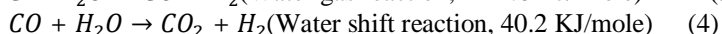
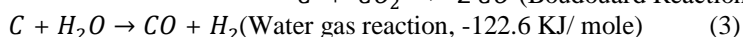
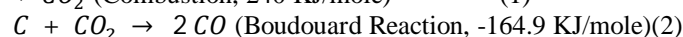
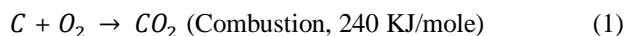
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obtained biogas can be used either to generate power and heat or to produce bio fuels. Several technologies utilising this process have been developed throughout the years but still they are considered to be immature and not economically competitive as compared to the other waste to energy conversion technologies.

- c. **Incineration:** The process of heating the waste quantities in open air is referred to as the process of incineration. This technique is usually considered for reduction of wastes generated to a volume. Incineration produces toxic gases such as polychlorinated dibenzo p-dioxins (PCDD) and polychlorinated dibenzo furans (PCDF) which are hazardous as cancer causing gases. The incineration plant behaves as thermal power plant.
- d. **Residual Derived Fuel (RDF) plant:** Residual Derived Fuel is used in order to achieve higher energy contents. Its high and uniform energy content makes it more attractive for energy production both by mono-combustion and co-combustion with MSW or coal. The Residual derived fuel is burnt in a furnace (at 1000<sup>0</sup>C) to produce steam in the boiler where the combustion process is enhanced by required amount of auxiliary fuel in case of RDF does not burn properly. The super-heated steam from the boiler is used in a steam turbine coupled to an alternator to produce electricity. In developing countries like India with MSW which has a low calorific value (7.3 MJ/ kg compared to greater values than 10 MJ/kg in Europe, Japan and US) and high percentage of inert, processing of waste is necessary to make it suitable as a fuel for which RDF becomes an important alternative to waste to energy combustion. RDF is an alternative to waste to energy and is a potential waste management technology. It needs lesser capital and is able to make use of existing infrastructure, compared to waste to energy.
- e. **Thermal gasification:** The term gasification means converting solid fuel into gaseous fuel by thermochemical method without leaving any solid carbonaceous residue. The process of gasification involves partial combustion that refers to the oxidation process in restricted amount of oxidant and the reduction operations of biomass. In gasification process, fuel is surplus and the products obtained are carbon dioxide, water vapour, nitrogen, carbon monoxide and hydrogen pass through the glowing layer of charcoal for the reduction process to occur.



f. Another process of waste to energy conversion is by landfilling. Landfilling refers to the disposal of solid wastes and solid waste residuals in the surface soils of the earth. Landfilling management involves the steps such as planning, design, operation, environmental monitoring, closure and post closure controls of landfills. Different landfilling techniques are excavated cell or trench method, area method, canyon method. Some other types of landfills used are Bioreactor type landfill that are designed for the construction and demolition wastes and the wastes generated by the tearing down of the buildings and the roadways. A bioreactor type landfill is designed in order to enhance the decomposition rate of the organic material within municipal solid waste. In a landfill the gas collection facilities are installed immediately upon the construction of the landfill cell so that methane gas can be recovered. Recycling of the city garbage and MSW poses a serious problem due to its enormous quantity. A large pit in the outskirts is prepared and a pipe system for the gas collection is laid. Then the MSW is buried under the earth and after two to three months, depending on the climate landfill gas can be extracted. The gas flows through the pipe in natural pressure and the gas having the calorific value of about 4500 Kcal/ m<sup>3</sup> can be used either for direct heating or cooking application or to generate power through the IC engines. One of the largest landfill gas plants in the world is 46 MW plant in California.[11]

### 3.3 Landfill Scenario in India and Odisha

According to the Annual report of Central pollution control board for 2010-11, there was record of 59 landfills constructed in the country, 376 landfills under planned and 1305 landfill sites were identified for future use. Presently,

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in India there are 72 landfill sites in total consuming an area of 1934 hectares of land. Amongst those 72 sites all over different cities of India, only 4 landfill sites are presently in action in Bhubaneswar, Odisha. And also there has been proposal for the new landfill sites.

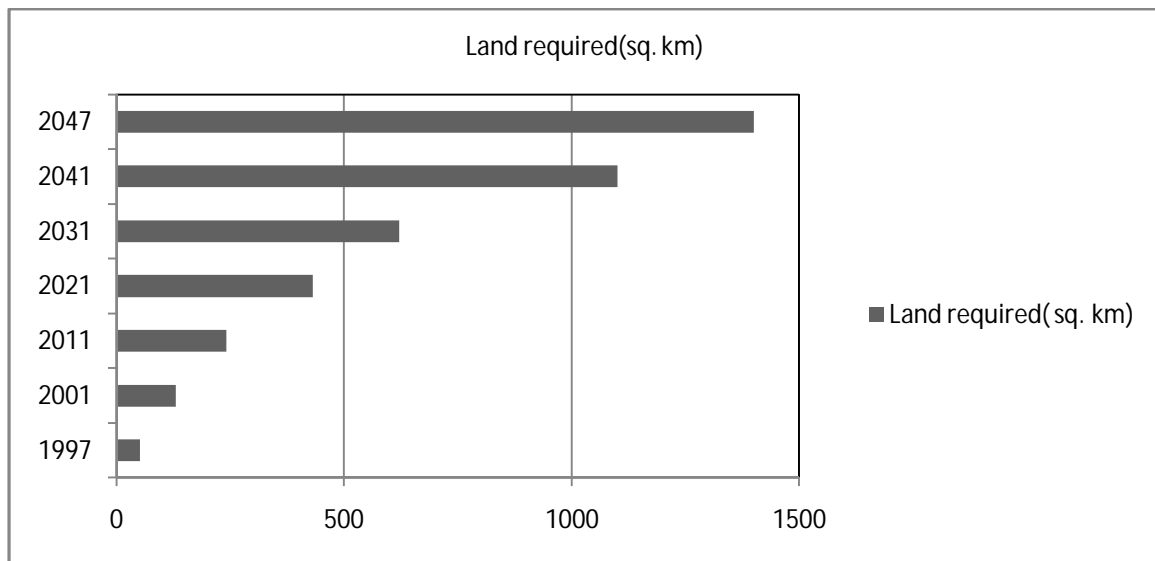


Fig 2: Land requirement for landfill

According to the above figure, the land required for landfilling is increasing day by day on a faster rate with the increase in population. Therefore it has been estimated that in the year 2047, the average land required for landfilling is about 1400 km<sup>2</sup>.

## IV. ENERGY OBTAINED FROM DIFFERENT CONVERSION TECHNIQUES

Biomass contributes to the world energy supply significantly for  $(45 \pm 10) \times 10^{18}$  J a year (9-13% of the world's energy supply; International Energy Report, WEC 1998. Major contribution from biomass on average between a 3<sup>rd</sup> and 5<sup>th</sup> is found in developing countries, comparing that with 3% in industrialised countries [WEC, 1994 b; IEA REWP, 1999]. In developing countries the traditional use of biomass is mainly dominated by the firewood for cooking and heating.

Modern use of biomass to produce electricity, steam and bio fuels is about  $7 \times 10^{18}$  J a year. In comparison of biogas and global carbon cycle, of the 590-880 million tons of methane released world-wide into the atmosphere through microbial activity every year nearly 90% of it comes from biogenic sources such as decomposition of biomass.

The gas produced in the gasification process is Syngas. Syngas is a mixture of CO, H<sub>2</sub> which is the result of the high temperature steam or gasification of organic material such as biomass. The syn gas produced can be used in different purposes such as hydrogen for oil refining, consumer products, substitute natural gas, transportation fuels or in generation of power.

### 4.1 Assessment of Energy Recovery Potential:

A rough assessment of the potential of recovery of energy from MSW through different treatment methods can be calculated from its calorific value and the organic fraction. In thermo-chemical conversion all of the organic matter, biodegradable as well as non-biodegradable contribute to the energy output.

In general, 100 tonnes of raw MSW with 50-60% of organic matter can generate about 1-1.5 Mega Watt power depending on the waste characteristics.

According to the MNRE Estimates, an average of 1460 MW energy can be recovered from MSW generated in India.

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## 4.2 Scenario in Odisha

In Odisha, the total energy demand up to 2016 as per report of Power Supply Position and Energy Management in Odisha is 3358 MW.

The generated amount of waste in Odisha on an average is 3740 TPD.

Net calorific value = 14.4 MJ/kg [According to IGNISS Energy]

As the wastes from the rural areas cannot be completely collected to be converted to energy, therefore wastes from the municipalities are converted into energy and an assumption has been made for converting waste into energy.

Let 65% of waste to be converted into energy.

Total energy available =  $3740 \times 10^3 \times 0.65 \times 14.4 \times 10^6 = 3.5 \times 10^{13} J = 405 \text{ MW}$

The total energy available after conversion into energy is 12% of the total energy demand.

Table 2: Energy available after different conversion processes

Different process	Efficiency of conversion	Energy available in Joules	Energy available in MW
Incineration	15-25%	$8.75 \times 10^{12}$	101.2
Gasification by Gas Turbine	10-27%	$9.45 \times 10^{12}$	109.3
Advance gasification by gas engine and gas turbine	30-40%	$1.4 \times 10^{13}$	162

## V. CONCLUSION

From the above fact and figures, it is estimated that effective management and treatment of municipal solid waste can generate energy and it can be treated as available source of renewable energy to a considerable quantity. Since the government at all levels are eyeing upon exploring the potential renewable sources of energy, the municipal solid waste generated in Odisha should be taken as a major source in this regard and the government should formulate plan and programmes by making adequate fund allocation for the projects of waste to energy conversion.

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