

# A Review on Production of Electricity from Waste Considering its Effect on the Environment

Sarang Agarwal<sup>1</sup>, Pawan Karan Deo<sup>2</sup>, Vishal Kumar Singh<sup>3</sup>, Jagdeep Singh Gautam<sup>4</sup>

B.Tech Student, Department of Power Engineering, NPTI, Badarpur, New Delhi, India<sup>1-4</sup>

**ABSTRACT:** Waste-to-energy (WtE) or energy-from-waste (EfW) is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste. WtE is a form of energy recovery. Most WtE processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels. . It contributes towards reducing carbon emissions and meeting renewable energy targets when used for electricity generation, these technologies have a steady and controllable output, sometimes referred to as providing “baseload” power. Promoting the integrated waste management system to reduce the landfill areas and generate the renewable energy. Endorsing public and private sectors to participate in waste management project.

**KEYWORDS:** Waste-to-Energy; Municipal Solid Waste; Renewable Energy; Incineration; Refused Derived Fuel; Biomethanation

## I. INTRODUCTION

Energy from waste is about taking waste and turning it into a useable form of energy. This can include electricity, heat and transport fuels (e.g. diesel). This can be done in a range of ways. Incineration is the most well-known. Burning waste reduces carbon dioxide emissions, thus reducing the greenhouse effect. The energy recovered from waste is used to generate electricity and for district heating, replacing the use of fossil fuels such as oil and natural gas. For example, you can recover as much energy from 3tonnes of waste as from burning one tonne of oil!

## II.WHY WTE

Waste-to-energy uses trash as a fuel for power generation. Similar to other power plants (just using trash rather than other fuels like coal, oil, or natural gas), the fuel is burned in a combustion chamber to heat tubes of water in boiler walls. The water is heated until it turns into steam, which is then used to drive a turbine generator that produces electricity. The electricity generated in this process is used to power the Facility and the remaining electricity is sold to National Grid, providing enough electricity for approximately 25,000-30,000 households. This beneficial reuse of the ash means that other finite materials, such as clean soil, do not need to be used for landfill cover. The Facility generates approximately 80,000 tons of ash residue annually. Metals that would otherwise have gone to a landfill are recovered from the Facility for recycling. The ferrous (magnetic) and non-ferrous (non-magnetic) metal recovery systems extract metal from the ash residue. Approximately 9,000 tons of metal are recovered annually.

Although reducing, reusing, and recycling are unquestionably preferable, the reality is that we still need alternatives for managing non-recyclable materials. To provide some perspective on the quantity of non-recyclables (or trash) generated in our community, if they were put into the Carrier Dome, the Dome would overflow in less than one year! Waste-to-energy facilities add a 4th “R” to “reduce, reuse, recycle” hierarchy – RECOVER. After maximizing reduction, reuse, and recycling, waste-to-energy facilities recover energy from the remaining trash and generate substantial amounts of electricity. Waste heat to electricity uses less fuel to produce a given energy output, and avoids transmission and distribution losses that occur when electricity travels over power lines. It also decreases the impact of outages when the power grid goes down. Waste-to-energy facilities reduce greenhouse gas emissions by reducing the

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

amount of organic material going to landfills, which in turn reduces methane emissions from landfills (methane is a potent greenhouse gas); recovering ferrous and non-ferrous metals from the waste stream for recycling, which is more energy efficient than mining virgin materials for the production of new metals; the electricity generated utilizing trash offsets electricity generated from fossil fuels; and only 10% (by volume) of the incoming waste is ultimately transported to an out-of-county landfill in the form of non-hazardous ash residue, which significantly reduces vehicle emissions.

WTE offering certain benefits at basic level too:

1. Fossil Fuel Dependence Is Reduced
2. Energy Is Produced Domestically
3. Stability in Availability and Pricing
4. The Local Community and Economy Benefit From These Facilities
5. More Space In Landfills Is Available
6. There Is An Unlimited Supply Of Municipal Waste
7. Greenhouse Gas Emissions Are Significantly Reduced
8. This Energy Generation Is Environmentally Friendly
9. Municipal Waste To Energy Promotes Recycling
10. Municipal Waste to Energy Plants are Strictly Monitored

## III. EMISSIONS

ACID EMISSIONS: Sulfur Oxides, Hydrochloric and Hydrofluoric Acids. The acid gases SO<sub>2</sub>, SO<sub>3</sub>, HCl and HF are all removed by the same kind of control equipment, i.e. dry or wet scrubbers. The design of scrubbers for WTE systems is largely based on experience obtained from coal-fired power plants.

SULFUR OXIDES EMISSION: Gaseous sulfur oxides from coal combustion are primarily sulfur dioxide (SO<sub>2</sub>), plus a much smaller quantity of sulfur trioxide (SO<sub>3</sub>) and gaseous sulfates. Emissions of sulfur dioxide from coal-fired plants were reduced from 13.8 million tons in 1990 to 9.6 million tons in 2000. With regard to WTE sulfur dioxide emissions, they were reduced by 87% from a pre-MACT emission estimate of 31 thousand tons to a post-MACT estimate of 4 thousand tons.

Table 1.

*Sulfur dioxide emission in coal-fired and WTE plants*

Year	Total Emissions (in 1000 tons)		% of Total SO <sub>2</sub> Emissions		Emission Factor <sup>d</sup>			
					lb/10 <sup>6</sup> Btu (g/MJ)		g/kWh	
	Coal-fired <sup>a</sup>	WTE	Coal-fired	WTE	Coal-fired	WTE	Coal-fired	WTE
1990	13,836	30.7 <sup>b</sup>	65.95	0.15	1.87 (0.81)	nd	8.7	nd
1995	10,548	nd	62.32	na	1.33 (0.57)	nd	6.2	nd
1998	11,335	nd	65.81	na	1.3 (0.56)	nd	6.1	nd
2000	9,625	4.076 <sup>c</sup>	64.88	0.03	1.05 (0.45)	0.031 (0.013)	4.9	0.21

Source: <sup>a</sup>EPA, (2003), Average Annual Emissions, All Criteria Pollutants (Table A-8)

<sup>b</sup>EPA, Docket A-90-45, Item VIII-B-7 (pre-MACT Emissions)

<sup>c</sup>EPA, Docket A-90-45, Item VIII-B3 (post-MACT Emissions)

<sup>d</sup>Data for energy input and energy output were taken from Energy Information Administration/Annual Energy Review 2001 (Table 2.1f and Table 8.2a) respectively

HYDROGEN CHLORIDE AND FLUORIDE EMISSIONS: Emissions of hydrogen chloride from WTE facilities reduced approximately 95% from 46,900 tons in 1990 to 2,670 tons in the year 2000.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

Table 2.

## Hydrogen chloride and Hydrogen fluoride emissions

	Emissions	Emission Factors			
		lb/10 <sup>6</sup> BTU	g/10 <sup>9</sup> J	lb/MWh	g/kWh
Coal-fired plants	Hydrogen Chloride <sup>a</sup>	0.04	17	nd	nd
	Hydrogen Fluoride <sup>a</sup>	0.005	2.2	nd	nd
WTE Plants	Hydrogen Chloride <sup>b</sup>	0.20	87	3	1.3

Source: <sup>a</sup>EPA, AP-42, Fifth Edition, Vol.1, September 1998, Table 1.11-15

<sup>b</sup>EPA, Docket A-90-45, Item VIII-B-3 (post-MACT Emissions);nd-no data

**NITROGEN OXIDE EMISSIONS:**Emissions of nitrogen oxides from coal-fired plants were reduced from 5.1 million tons in 1990 to 4.1 million tons in the year 2000; WTE facilities were reduced 17% from a pre-MACT emission estimate of 56.4 thousand tons to 46 thousand tons in the year 2000;Emission from post-MACT WTE facilities is lower at 0.35 lb/million BTU (0.15 g/MJ). However, NO<sub>x</sub> emission is slightly higher in terms of electric energy produced: 2.41 g/kWh compared to 2.1 g/kWh in coal-fired plants; this is attributed to the fact that coal fired plants have a higher thermal efficiency (30-33%) as compared to that of WTE facilities (17-20%).

Table 3.

## Nitrogen Oxides emission in coal-fired and WTE plants

Year	Total Emissions (in 1000 tons)		% of Total US Emissions		Emission Factor <sup>d</sup>			
	Coal- fired <sup>a</sup>	WTE	Coal-fired	WTE	lb/10 <sup>6</sup> Btu (g/MJ)		g/kWh	
					Coal-fired	WTE	Coal-fired	WTE
1990	5,129	56.4 <sup>b</sup>	22.1	0.24	0.69 (0.30)	nd	3.2	Nd
1995	5,072	nd	22.36	nd	0.64 (0.28)	nd	3.0	Nd
1998	4,942	nd	22.33	nd	0.57 (0.24)	nd	2.6	Nd
2000	4,124	46.5 <sup>c</sup>	19.55	0.22	0.45 (0.19)	0.35 (0.15)	2.1	2.4

Source: <sup>a</sup>EPA, (2003), Average Annual Emissions, All Criteria Pollutants (Table A-4)

<sup>b</sup>EPA, Docket A-90-45, Item VIII-B-7 (pre-MACT Emissions)

<sup>c</sup>EPA, Docket A-90-45, Item VIII-B3 (post-MACT Emissions)

<sup>d</sup>Data for energy input and energy output were taken from Energy Information Administration/Annual Energy Review 2001 (Table 2.1f and Table 8.2a) respectively, nd: no data

**PARTICULATE MATTER EMISSIONS:**PM emission from coal –fired power plant reached 240,000 tons in the year 1990 and has increased to approximately 570,000 tons in the year 2000. PM emissions from WTE facilities reached 7 thousand tons in 1990 and were reduced to 0.7 thousand tons in the year 2000.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

Table 4.

*Particulate matter emissions from coal-fired and WTE plants*

Year	Total Emissions (in 1000 tons)		% of Total Emissions		Emission Factor <sup>d</sup>			
	Coal- fired <sup>a</sup>	WTE	Coal- fired	WTE	lb/10 <sup>9</sup> Btu (g/GJ)		g/kWh	
					Coal-fired	WTE	Coal-fired	WTE
1990	241	6.93 <sup>b</sup>	0.95	0.03	33 (14)	nd	0.15	nd
1995	222	nd	0.95	nd	28 (12)	nd	0.13	nd
1998	179	nd	0.86	nd	21 (8)	nd	0.10	nd
2000	566	0.707 <sup>c</sup>	2.52	0.003	62 (27)	5(2.3)	0.29	0.037

Source: <sup>a</sup>EPA, (2003), Average Annual Emissions, All Criteria Pollutants (Table A-6: PM10)

<sup>b</sup>EPA, Docket A-90-45, Item VIII-B-7 (pre-MACT Emissions)

<sup>c</sup>EPA, Docket A-90-45, Item VIII-B3 (post-MACT Emissions)

<sup>d</sup>Data for energy input and energy output were taken from Energy Information Administration/Annual Energy Review 2001 (Table 2.1f and Table 8.2a) respectively

**COMBUSTION:** Combustion plants are often referred simply as EFW plants. They have a boiler to capture and convert the released heat into electricity and steam, and extensive air pollution control systems that clean the combustion gases to comply with regulatory emission limits before they are released to atmosphere through a chimney. Combustion is basically done by incineration method.

**INCINERATION:** -Combustion process basically known as incineration process in which MSW (Municipal Solid Waste) is heated at very high temperature above 850 C. Basically, Biomass combustion (incineration) refers to burning fuel in a boiler, furnace or stove to produce heat. The heat can be utilized as hot air, hot water, steam or electricity. Wood, agricultural residues, wood pulping liquor, municipal solid waste (MSW) and refuse derived fuel are examples of feedstock for combustion. Combustion (incineration) requires high temperatures for ignition, sufficient turbulence to mix all of the components with the oxidant, and time to complete all of the oxidation reactions.

**ADVANCE THERMAL TREATMENT:** Advanced Thermal Treatment technologies are primarily those that employ pyrolysis and/or gasification to process municipal solid waste (MSW). It excludes incineration of wastes which is already a mature and well established technology. The gasification and pyrolysis of solid materials is not a new concept. It has been used extensively to produce fuels such as charcoal, coke and town or producer gas. Charcoal and coke are produced by pyrolysing wood and coal respectively and producer gas is a combustible gas produced by the gasification of coke in the presence of air and steam. It is only in relatively recent years. It includes:

**PYROLYSIS:** -In pyrolysis, biomass is heated in the absence of air. The process results liquid, solid and gaseous fractions, mainly gases, bio-oil and char. The gases and the bio-oil are from the volatile fraction of biomass, while the char is mostly the fixed carbon component. In the first step, temperature is increased to start the primary pyrolysis reactions. As a result, volatiles are released and char is formed. Finally, after various reactions, pyrolysis gas is formed.

**GASIFICATION:** Gasification is a process by which solid waste (or fuel) is heated under closely controlled conditions to produce gases. The resultant gases are mainly carbon monoxide (CO) and hydrogen, commonly referred to as "syngas". Syngas is a desirable product because of its versatility. Both carbon monoxide and hydrogen can be used in a number of ways to produce heat and electricity and can also be compressed for later use. Additionally, syngas can be used to produce methanol using a Fischer-Tropsch process. Syngas as the following compounds: CO, H<sub>2</sub>, H<sub>2</sub>O, CO<sub>2</sub>, N<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>S, and HCl with lesser amounts of COS, NH<sub>3</sub>, HCN, elemental carbon, and trace quantities of other hydrocarbons. The reducing atmosphere within the gasification reactor prevents the formation of oxidized species such as SO<sub>2</sub> and NO<sub>x</sub>. However, unlike incineration, these supplementary fuels contribute primarily to the production of more syngas and not to the production of CO<sub>2</sub>.

**ANAEROBIC PROCESS:** -Anaerobic digestion (AD) is the only form of biological treatment of MSW. It creates the least amount of waste and is the most efficient conversion technology, yet has the smallest contribution to total energy output of WTE. Anaerobic digestion produces a biogas which can be used to produce electricity, process steam, or in the transportation sector. In this biological process, microorganisms are used to break down organic waste in the absence of oxygen in an enclosed vessel. Temperature, moisture, nutrient contents, and pH of the organic matter are



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

key factors in the process the biogas from AD consists of 60%-70% methane (CH<sub>4</sub>), 30%-40% carbon dioxide (CO<sub>2</sub>), and other trace chemicals. Biogas can be used to power a gas engine or turbine or it can be compressed and purified for use as vehicle fuels. Methane may also be extracted from the biogas for direct use.

Table 5.Comparison of capital cost of different processes

Technology	Plant capacity (tons/day)	Capital cost (M US\$)	O&M cost (US\$/ton)	Planning to commissioning (months)
Pyrolysis	70-270	16 – 90	80 – 150	12 – 30
Gasification	900	15 – 170	80 – 150	12 – 30
Incineration	1300	30 – 180	80 – 120	54 – 96
Plasma gasification	900	50 – 80	80 – 150	12 – 30
Anaerobic digestion	300	20 – 80	60 – 100	12 – 24

Waste Management Method	Energy Potential* (kWh per ton MSW)
Recycling	2,250
Landfilling	105
WTE Incineration	585
Gasification	660
Pyrolysis	660
Anaerobic Digestion	250

## V.WTE IN INDIA: QUESTION ARISING FOR PRESENT AND FUTURE

Every year, about 55 million tonnes of municipal solid waste (MSW) and 38 billion litres of sewage are generated in the urban areas of India. In addition, large quantities of solid and liquid wastes are generated by industries. Waste generation in India is expected to increase rapidly in the future. As more people migrate to urban areas and as incomes increase, consumption levels are likely to rise, as are rates of waste generation. It is estimated that the amount of waste generated in India will increase at a per capita rate of approximately 1-1.33% annually. The problems caused by solid and liquid wastes can be significantly mitigated through the adoption of environment-friendly waste-to-energy technologies that will allow treatment and processing of wastes before their disposal. These measures would reduce the quantity of wastes, generate a substantial quantity of energy from them, and greatly reduce environmental pollution. India's growing energy deficit is making the government central and state governments become keen on alternative and renewable energy sources. Waste to energy is one of these, and it is garnering increasing attention from both the central and state governments. While the Indian Government's own figures would suggest that the cost of waste to energy is somewhat higher than other renewable sources, it is still an attractive option, as it serves a dual role of waste disposal and energy production. The best way to handle mixed waste, as in India, is the conversion of waste to energy. However most of the attempts to install these in the country have collapsed down. A WTE project in 1980s, a large scale biomethanation project, and two RDF projects in 2003 have failed. An earlier WTE plant, which was built in Timarpur, New Delhi is not in operation anymore. The existing projects also hardly work. In fact, failure of WTE however raised enormous public opposition and has hindered any efforts in that direction. What perhaps is the reason for such recurring failures? Some of the possible causes for these failures are: (a) Improper Segregation (b) Logistical Errors (c) Lack of Funds

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

Table 7.State Wise Processing Facilities in India  
State-wise\* Status of MSW Processing Facilities in India (2011)

State	Composting	Vermi-composting	Bio-methanation	Palletization (RDF)	Waste to Energy
A & Nicobar	1	-	-	-	-
Andhra Pradesh	24	-	-	11	2
Assam	1	-	-	-	-
Chandigarh	Nil	Nil	Nil	1	Nil
Chattisgarh	6	Nil	Nil	Nil	Nil
Delhi	3	-	-	-	3
Goa	14	-	-	-	-
Gujarat	3	93	Nil	6	Nil
Himachal Pradesh	10	-	-	-	-
Jammu & Kashmir	1	-	-	-	-
Jharkhand	4	-	-	-	-
Kerala	21	7	10	1	1
Madhya Pradesh	7	-	-	2	-
Maharashtra	6	2	5	5	2
Meghalaya	1	1	-	-	-
Nagaland	1	1	-	-	-
Orissa	1	-	-	-	-
Punjab	1	3	-	-	-
Sikkim	1	-	-	-	-
Tamil Nadu	162	24	-	3	-
Tripura	1	-	-	-	-
West Bengal	13	7	-	-	-
Total	279	138	172	29	8

## VI. REPORTS REGARDING WTE IN INDIA

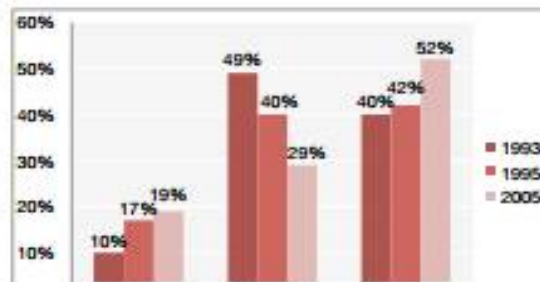


Fig 1.Comprison of materials of three different types: organic, recyclable and inert

State wise details regarding waste generation, collection and treatment (2012-13)

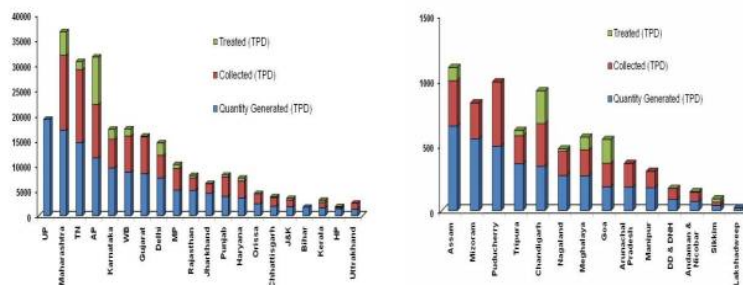


Fig 2. State wise Waste Generation

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

Table 8.Waste Energy Techniques in INDIA

WASTE TO ENERGY TECHNIQUES PRACTICED IN MAJOR CITIES IN INDIA			
City	MSW Generated (TPD)	Present Waste Handling Techniques	
		RDF / WTE (TPD)	Biomethanation (TPD)
Mumbai	11.645	80	Yes
Kolkata	12.060	Nil	Nil
New Delhi	11.558	825	Yes
Chennai	6.404	Nil	Nil
Chandigarh	509	500	Yes
Pune	2.724	600	Yes
TPD= Tonnes/ Day			
No Biomethanation quantity mentioned			

Table 9.Energy generated through WTE in past, present and future

POWER GENERATING POTENTIAL FROM MSW IN INDIA			
Period	MSW Generated (TPD)	Power Generation (MW)	Potential
2002	97.174	1.638	
2007	130.927	2.266	
2012	189.986	3.276	
2017	265.834	4.566	

## VII. FUTURE OF WTE IN INDIA

Waste to Energy (WtE) projects based on Municipal Solid Waste (MSW), installed in the country as of 31st March 2015 is just 154 MW. MSW is a heterogeneous mix of combustibles, organic matter, inerts and moisture. Energy generation through biochemical conversion or combustion will depend on the levels of segregation and collection efficiency of MSW. This is a key focus area of Ministry of Urban Development as well as Urban local bodies (ULBs) across the country and hence it is assumed under all scenarios that by 2047.

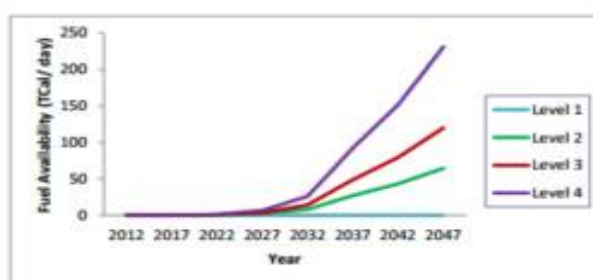


Fig 3.Fuel Availability

Level 1 assumes that there will be no capacity additions and hence MSW based WtE capacity will remain at a level of 96MW. There will be no capacity additions even beyond 2017, primarily due to lack of inter-agency coordination and favourable policies. Other key adverse factor will be limited understanding of technical issues involved in construction, operational and environmental aspects of MSW based WtE projects. Once these projects have lived their life, there will be no MSW based WtE projects, by 2037.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

Level 2 assumes that the capacity addition happen in line with 12th plan targets resulting in 153MW installed capacity by end of 12th Plan. Most of it will still be based on mixed MSW. With improving segregation levels and Government's focus on WtE, by 2047:

- 25% of segregated urban organic MSW will yield 0.36 Mtoe of biogas
- 20% of segregated rural organic MSW will yield 0.28 Mtoe of biogas
- 18% of total 'waste to electricity generation' potential will be realized resulting in approx. 3,550MW installed power generation capacity.

18% of segregated urban combustibles will be used as fuel yielding 2.36Mtoe of thermal energy.

3.6.3 Level 3. Level 3 assumes that Government and ULBs emphasize on MSW based WtE as a key resource recovery option. The policies and incentives get aligned. Rural areas adopt organic MSW based gas as a key energy option. However in urban areas, evolving technologies like combined heat and power still does not get any traction. By 2047:

- 50% of segregated urban organic MSW will yield 0.72 Mtoe of biogas
- 40% of segregated rural organic MSW will yield 0.55Mtoe of biogas
- 30% of total 'waste to electricity generation' potential will be realized resulting in approx. 5,850MW installed power generation capacity

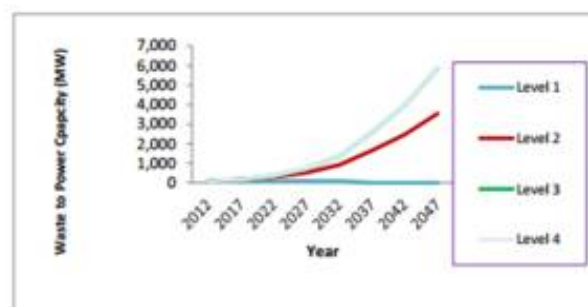
32% of segregated urban combustibles will be used as fuel yielding 4.4 Mtoe of thermal energy.

Level 4. In this scenario, there are absolutely no barrier (economic, social or technical) to the growth of MSW based WtE. Inter agency conflicts are also resolved. WtE gets enhanced attention coupled with significant increases in fossil fuel prices, especially coal. Fossil fuel externalities are priced. Energy security is consciously factored in energy planning. In this level, by 2047:

- 75% of segregated urban organic MSW will yield 1.09 Mtoe of biogas
- 60% of segregated rural organic MSW will yield 0.83Mtoe of biogas
- 30% of total 'waste to electricity generation' potential will be realized resulting in approx. 5,850 MW installed power generation capacity
- 63% of segregated urban combustibles will be used as fuel yielding 8.44Mtoe of thermal energy

30% of combustible urban waste will be used for combined heat and power applications yielding 4.35 Mtoe of energy.

Fig 4. Different Level of power Capacity



## VII. RESULT AND DISCUSSION

Interest in converting waste to energy has recently in Libya because this technology will reduce fossil fuel usage, greenhouse gas emissions, pollution, and landfill dumping. Advanced technologies can be used to generate fuel from waste, reducing the country's dependence on increasingly scarce and expensive non-renewable fossil-fuel resources. Using waste as a feedstock for energy production reduces the pollution caused by burning fossil fuels. Traditional incineration produces CO<sub>2</sub> and pollutants. We can observe that biogas from waste landfill contains 55% CH<sub>4</sub> that has a calorific value of 21.5 MJ/Nm<sup>3</sup>, while pure CH<sub>4</sub> has a calorific value of 35.8 MJ/Nm<sup>3</sup>; this is the reason to remove CO<sub>2</sub> from raw biogas. The energy balance of biogas is highly important, which can replace many other form of combustible gas, and the calorific value that can be replaced by methane. Advanced methods (e.g., gasification, pyrolysis, and liquefaction) have the potential to provide a double benefit: reduced CO<sub>2</sub> emissions as compared to



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

incineration and coal plants and reduced methane emissions from landfills. Landfills require large amounts of land that could be used for other purposes; the incineration of solid waste can generate energy while reducing the volume of waste by up to 80%.

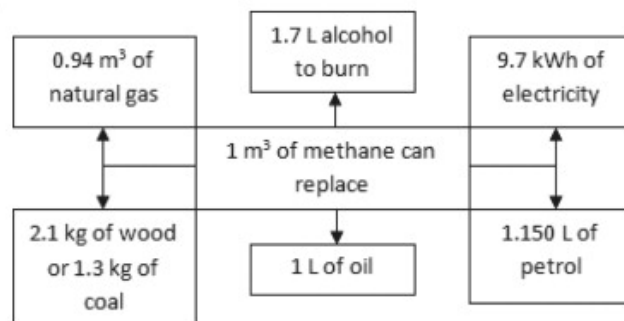


Fig 10. Energy Equivalence of methane

Additionally, the three scenarios provide a viable disposal option for MSW and, if implemented, will alleviate the landfills problem in the area. The decision to select among the three scenario will required further financial, social, technical, and environmental analysis. The decision to select between the two scenarios is crucial and should be taken at a political level based on the results of intensive research.

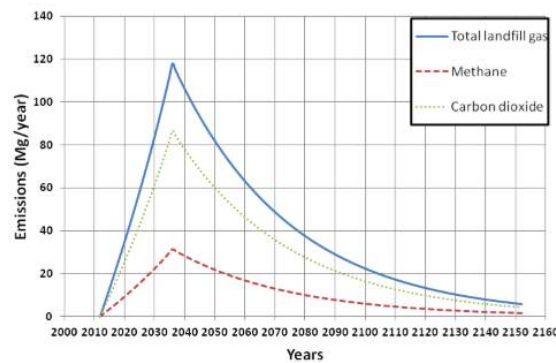


Fig 11. Emissions reduction (in Years)

## VIII. CONCLUSION

This paper presents an overview on solid waste that can be used as a source of bioenergy in world including MSW, ISW, and HSW as biomass sources. The management of solid waste and valorisation is based on an understanding of MSW's composition and physicochemical characteristics. Energy from waste is not a new concept, but it is a field that requires serious attention.

Various energy conversion technologies (thermochemical extraction, biochemical extraction, and mechanical extraction) can produce useful products (e.g., electricity, heat, and transportation fuel).

The dependence of world on fossil fuels will be reduced thereby significantly reducing both pollution and greenhouse gas emissions. Solid waste can be used as an energy source in world. The implementation of landfill disposal techniques should be encouraged for the valorisation of biogas.

It is essential to explore the potential of environment friendly technologies, like anaerobic digestion (AD), for the treatment of municipal waste because it holds the promise to address two highly important environmental concerns – waste management and renewable energy.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 7, July 2016

The ash that is transported to the landfill we describe in Delhi is one tenth the volume of the original MSW so the ash landfill will last ten times as long as the MSW landfill and, also, in the absence of organic substances there will be no acids formed to create toxic solutions that can contaminate the groundwater.

The truth of the matter is that WTE plants are environmentally much superior to landfills or waste dumps, and people interested in sustainable development should read about this subject because the only alternative to landfills is properly managed WTE plants that recover electricity and metals instead of using up land for landfilling (2.5 hectares per year). Municipal governments should practice caution in scoping projects, choosing private partners, and carry out transparent tendering processes by hiring reputed and knowledgeable consultants.

Meanwhile, the national government must design reasonable and strong regulatory framework for emissions monitoring, and policy for integrating the informal recycling sector. It should not hesitate to seek guidance from other Asian countries which have already passed through this phase of WTE development

### REFERENCES

- [1]. Ranjith Annepu is the India coordinator, for the Global Waste-to-Energy Research and Technology Council (WTERT).
- [2]. "National Energy Strategy," USDOE, 1991/1992, pages 181, 182.
- [3] Directive 99/31/EC, "Landfill of Waste, EEC policy.
- [4] C. Wiles and P. Shephard, April 1999 USDOE, 126 Pg. Booklet #BK-570-25841 "Beneficial Use and Recycling of Municipal Combustion Residues – A Comprehensive Resource Document" by the National Renewable Energy Laboratory.
- [5] Comparison of ecological effects and costs of communal waste management systems. Resources, Conservation and Recycling, 41, 83-102.
- [6] M. Chakraborty, C. Sharma, J. Paney, P.K. Gupta Assessment of energy generation potentials of MSW in Delhi under different technological options Energy Convers. Manage., 75 (2013), pp. 249–255
- [7] J. Frigon, S. Guioet Biomethanation production from starch and lignocellulosic crops: a comparative review Biofuels Bioproducts Biorefin., 4 (2) (2010), pp. 447–458