ENVIRONMENTALLY SOUND MANAGEMENT OF MUNICIPAL SOLID WASTE IN PUNE: POLICY ISSUES & SUGGESTED APPROACH - 2014 – 2017

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1.0 BACKGROUND

It is well known that the Pune city is facing severe problems with due to lack of proper management of municipal solid wastes (MSW) generated about 1600 MT per day. As a result, public health and environment protection has become serious concern and calls for immediate action by all concerned. Rapid urbanisation and growth of the city is certainly going to compound the situation unless proper systems are put in place and made systematically functional in a sustainable manner over period of time.

Pune is one such metro city which is growing at a colossal rate due to growth in the IT sector, educational sector, Industries and other services' sectors. With total city area of 243.84 km2 & having population of over 25 lakhs in 2001; currently, in 2014 the city has grown to 500 km2. due to addition of 34 fringe villages in the municipal corporation limits (UDD, GoM, 2014) and having current population of about 37.60 lakhs (Census, 2011).

A City Sanitation Plan prepared by the Pune Municipal Corporation, 2012 refers to a study undertaken by Gokhale Institute of Politics and Economics, Pune (2008) which has estimated that "the population of the city would reach 55.97 lakhs (Alternative II – realistic) by year 2026."

Table 1 – Pune City Population Projections (Adopted from PMC, 2012)

Year	2001	2006	2011	2016	2021	2026
				Projections		
Population	25,36,848	30,35,532	36,04,323	43,29,259	49,97,755	55,97,346

Table 2 – Pune city growth Rate (Adopted from PMC, 2012)

Year	Growth rate, %
2001-2006	3.59
2006-2011	3.43
2011-2016	3.67
2016-2021	2.87
2021-2026	2.27

The study also states that, the boost in the economy in the metro has attracted people from the surrounding villages as well as from across the country causing large migrations. Furthermore, the study by Gokhale Institute of Politics and Economics states that "[…..] the amount of in-migration towards the Pune city has increased significantly. The migration has become more male-oriented and the proportion of migrants from Uttar Pradesh /Bihar is increasing but still is at a lower level. The past trends imply that the migration is mainly due to economic reasons." (PMC, 2012) The following table shows the migration patterns:

Table 3 - Net In-migration (Adopted from PMC, 2012)

Year range	Net In-migration
1991-2001	3,66,983
2001-2006	2,91,410
2006-2011	3,64,265
2011-2016	3,60,430
2016-2021	4,32,925

The growth in urban population including migration has led to increase in load on existing environmental infrastructure of the municipal solid waste management of the city. There is no standard method of determination of the MSW quantities and hence the exact amount of the MSW in the city of Pune can't be determined. Different governmental agencies refer to different MSW quantities and accordingly reported at various levels.

The city population growth rate, migration rate and generation of municipal solid waste can't be matched. The precise estimation of Municipal Solid Waste in the city of Pune through a standard method of MSW estimation and accordingly the management plans need to be established. It is also necessary that all the governmental agencies need to follow same reporting mechanism in order remove any discrepancy.

The following table shows two nodal governmental agencies & their report MSW generation in the city of Pune from 2009 onwards.

Year	MSW generation (MT/day) as per MPCB reports	MSW generation (MT/day) as per PMC - ESR
2009 - 10	NA	1300-1400[5]
2010 -11	750[1]	1300-1400[6]
2011-12	750[2]	NA
2012	1600[3]	1300-1400 (as per draft CSP)[7]
2014	1500-1600[4]	NA

Legends: NA - Not Available, CSP- City Sanitation Plan- 2012, MPCB – Maharashtra Pollution Control Board, PMC – Pune Municipal Corporation

[1,2,3] - MPCB - Annual Report on Implementation of MSW (Management & Handling) Rules, 2000, for the State of Maharashtra for the years 2010- 2011, 2011-2012 & 2012 – 2013;
[4] - MPCB. 2014. Status of Municipal Solid Waste Management in Municipal Corporations (Maharashtra);
[5,6] - PMC – Environment Status Report, Pune City for the years 2009-2010, 2010-2011, 2012-2013
[7] - PMC. 2012. Pune City Sanitation Plan (Final Draft)

Due to such non-reliable estimations, the accurate assessment, planning & management of biodegradable and non- biodegradable waste is difficult that could lead to faulty planning for MSW treatment plants. Experts including Modak (2007) in his report to PMC has supported the argument by stating the same issue that "The inability to fully grasp the problems of waste generation and characterization have resulted in transforming Solid Waste Management as one of the most compelling problem of urban environmental degradation. Individual or fragmented approach is bound to become unsustainable in view of increasing complexity of the waste streams, increased urbanization and industrialisation."

Currently, the Pune Municipal Corporation is managing the MSW of the Pune city with the help of private & non private organisation. The current claims from the authority of managing up to 1200 MT/day stands incorrect. The following table shows that actual authorised capacity to treat the MSW in the city is more than that of the estimated MSW generation. The actual management of the MSW in the city is about 60 % and rest 40 % needs to be traced whether it is still being dumped at the Urali Devachi Site even after 2010 affidavit of 'No dumping at the stated site'. It is also important that the facts mentioned in the report are only about the MSW being collected and not about the piles of MSW that we see lying on the streets, curbs, etc.

Table 5 - MSW treatment Capacities & Present Status

S.No.	Name & Address of Operating Agency	Capacity	Method of Treatment	MPCB authorisation capacity	Remarks
1.	M/s. Hanjer Biotech Energy Urali Devachi Fusungi	500 TPD	Composting	500 TPD	♦ Operating only at 200 TPD
		500 TPD	RDF (Refuse Derived Fuel)	500 TPD	♦ Operating on at **200 TPD** ♦ Stack in demand of TDF ♦ Public complaints from Devachi Urali & Phurusungi. ♦ Biodiesel Project (4 T/Day) is not in operation
Total authorisation Capacity		**1000 MT/day**	**Actual Operation Status**		**400 MT/day**
2.	M/s. Rochem Separation System Pvt. Ltd., Mumbai Plot No.86, TPS-2, Hadapsar Ind. Estate, Pune	700 MT/Day	Pyrolysis/ Gasification [Waste to Energy]	700 MT/Day	1) 3 Phase Project capacity 700 MT/day but currently only one phase **in operation with 300 MT/Day capacity**
Total authorisation Capacity		**700 MT/day**	**Actual Operation Status**		**300 MT/day**
3.	M/s. Ajinkya Bio Fertiliser, Hadapsar MSW Ramp.	200 MT/Day	Vermi-compost	200MT/Day	Current operational capacity **200 MT/Day**

S.No.	Name & Address of Operating Agency	Capacity	Method of Treatment	MPCB authorisation capacity	Remarks
4.	M/s. Disha Waste Management Pvt. Ltd., Hadapsar Ind. No.87, Ramtekadi, Pune.	100 MT/Day	Vermi-compost	100 MT/Day	Presently is in **operation.** But **with low capacity.** ♦ Several Complaints from Ramtekadi Industrial Association. ♦ Court case No.4542 of 2012
Total authorisation Capacity - Vermicompost		**300 MT/day**	**Actual Operation Status**		**< 300 MT/day**
5.	Pune Municipal Corporation, Hadapsar Ramp -II	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified.
6.	Pune Municipal Corporation Rajiv Gandhi Udyan, Katraj Rap-II	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
7.	Pune Municipal Corporation Pesheve Park - Ramp 1	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
8.	Pune Municipal Corporation Pesheve Park - Ramp 2	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
9.	Pune Municipal Corporation, Aundh, Kachara, Ramp -1	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
10.	Pune Municipal Corporation, Ghole, Road	3 MT/Day	Bio-Methanation	**3 MT/Day**	Current operational capacity not specified
11.	Pune Municipal Corporation, Bawadhan Kh.	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
12.	Pune Municipal Corporation, Model Colony	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
13.	Pune Municipal Corporation, Parati, S. No. 67,68, Tuljai Pathar - I	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
14.	Pune Municipal Corporation, Parati, S. No. 67,68, Tuljai Pathar - II	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
15.	Pune Municipal Corporation, S.No.22. Dhanori	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified

S.No.	Name & Address of Operating Agency	Capacity	Method of Treatment	MPCB authorisation capacity	Remarks
16.	Pune Municipal Corporation, Katraj Ramp-III	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
17.	Pune Municipal Corporation, Katraj Ramp-IV	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
18.	Pune Municipal Corporation, Katraj Ramp-III	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
19.	Pune Municipal Corporation, Alandi Road	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
20.	Pune Municipal Corporation, Wadgaon Sheri	5 MT/Day	Bio-Methanation	**5 MT/Day**	Current operational capacity not specified
Total authorisation Capacity - Bio-Methanation		**78 MT/day**	**Actual Operation Status**		**< 78 MT/day**
21.	Pune Municipal Corporation, M/s. Excel Industry, Aundh.	2 MT/Day	Bio-Methanation	**2 MT/Day**	Current operational capacity not specified
22.	Pune Municipal Corporation, M/s. Save, Environment, Tamtekadi.	2 MT/Day	Mechanical Composting	**2 MT/Day**	Current operational capacity not specified
Total authorisation Capacity - Mechanical Composting		**4 MT/day**	**Actual Operation Status**		**4 MT/day**
Total Estimated MSW generation in the city of Pune in 2014					1600 MT/Day
Total authorisation Capacity to Manage MSW in Pune (All option included)					2082 MT/Day
Total Operational Capacity to Manage MSW in Pune (All option included)					982 MT/Day
Total MSW (Not managed)		**618 MT / Day (38.63% of the total MSW generated in the City of Pune)**			

Source : Adopted from MPCB, 2014.

Note: Here MSW quantity for 'Current Operational Capacity not specified' is assumed to be to the full capacity.

Additionally, the rapid urbanization and population growth has further made this problem critical due to the variations in the MSW characteristics at an alarming proportion. The household waste contains a mixture of biodegradable waste & non biodegradable materials such as plastics and hazardous material like used batteries, CFLs & E waste; thereby rendering it to be a complicated situation to handle. In addition to this household waste, the waste generated from commercial establishments and from industries adds a different dimension to the entire waste generation scenario. “The industrial hazardous wastes if mixed into Municipal Solid Waste (MSW) create unsafe conditions.” (Modak, 2007)

The table no. 5 shows that despite of the claims of becoming a ‘Zero Garbage City’, the ground scenario in Pune is actually becoming very grave. Many of the treatment plants don’t function to the full capacity due to financial and technical aspects. Public complaints have been filed against some of the projects on MSW due to improper management and environmental concerns.

It seems that the current methods, technologies adopted are reactive than proactive. They have been implemented without any strategic plan and methodical assessment of each component of the MSW management system. Hence it is utmost necessary to re-evaluate and assess the current procedures, technologies, methods, economical viability, environmental appropriateness and institutional mechanism for MSW so as to choose the appropriate model suitable for the Pune city.

2.0 APPLICABLE REGULATIONS

“The policy and legislative framework forms the backbone of any institutional and implementation system.” (Modak, 2007) Regulatory regime for waste management is provided by legislative apparatus as under:

(i) The Environment (Protection) Act, 1986, as amended, and Rules made there under;

(ii) The Municipal Solid Waste (Management and Handling) Rules, 2000;

(iii) The Bio-Medical Waste (Management and Handling) Rules, 1998, as amended in 2003 & 2011;

(iv) The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, as amended;

(v) Batteries (Management and Handling), Amendments Rules, 2001, as amended in 2010;

(vi) The Recycled Plastics Manufacture and Usage Rules, 1999, as amended in 2003;

(vii) The Maharashtra Non-Biodegradable Garbage (Control) Act, 2006;

(viii) The Maharashtra Plastic Carry Bags (Manufacture and Usage) Rules, 2006;

(ix) The Plastic Waste (Management and Handling) Rules, 2011

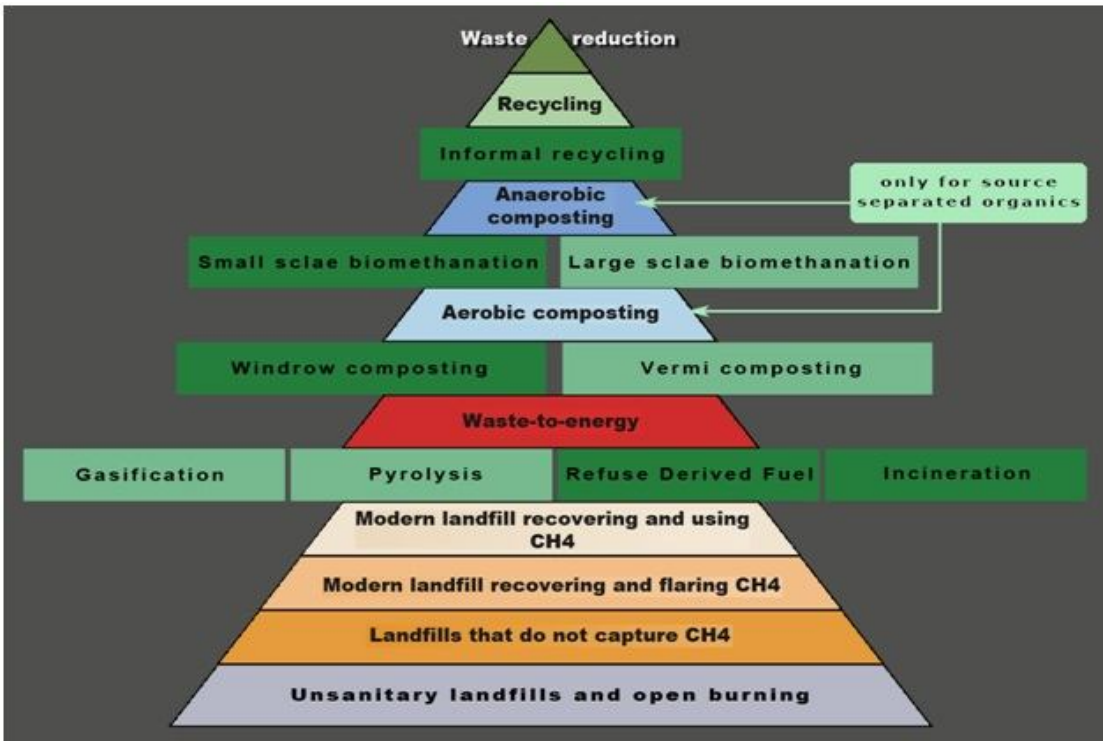
(x) E- waste (Management and Handling) Rules 2011

Even after having these regulations in place, the MSW situation in the city of Pune is not satisfactory due to tardy enforcement. The nodal agencies that are responsible for implementation MSW regulations are falling short in controlling the scene. Implementation of regulations for industrial and at times commercials establishments seems to be moving in right direction but when it comes to urban scenario in local civic bodies the entire management of MSW is not matching the requirements.

The Municipal Solid Waste (Management and Handling) Rules, 2013, provide directions about the implementation and responsibility of stakeholders. Construction and Demolition (C&D) wastes along with other wastes such as waste batteries, plastics, electronics and domestic hazardous waste in the urban areas can be found in the MSW making the waste management more difficult.

3.0 TECHNOLOGIES

The application & selection of technology for a particular area would generally depend upon the quantity, the composition of the solid waste & expected byproducts. A pyramid of different technology applications is presented below in Figure 1:

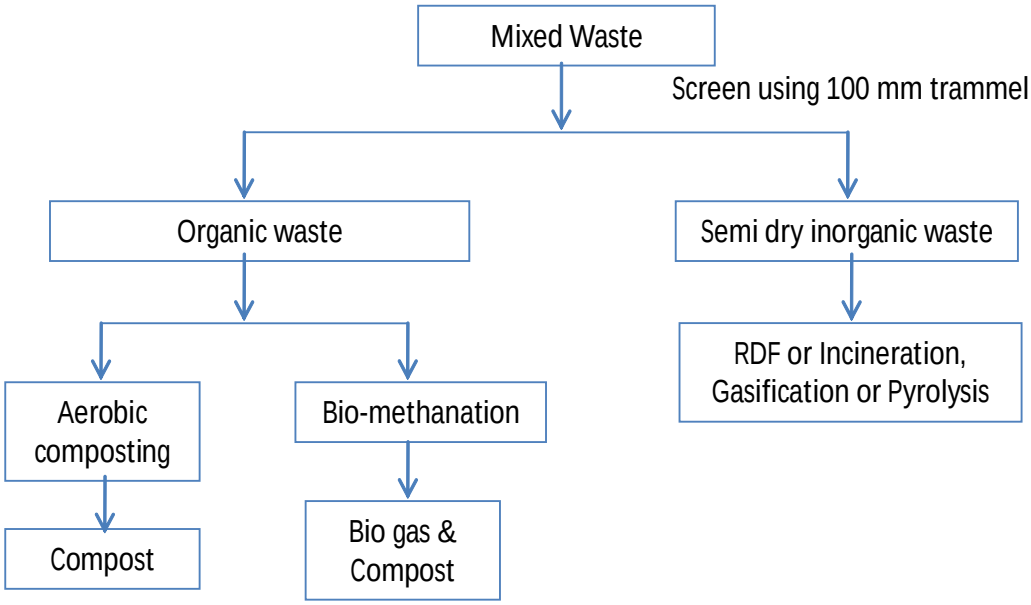


Other factors that influence the selection the waste treatment technology are follows:

(i) Applicable regulations;
(ii) Health & safety aspects;
(iii) Location of the facility
(iv) Available supporting Infrastructure i.e. land, electricity, water supply etc.;
(v) Capital investment & economical viability of the technology;
(vi) O & M costs; and
(vii) Salability & management of the byproducts

Furthermore, based on the characteristics of the solid waste the process flow shown in the adjoining flow chart can be adopted (Figure 2).

Figure 2 - Process flow chart for MSW management.



3.1 Composting

Composting can be carried out in two ways i.e., aerobically and anaerobically. During aerobic composting aerobic and thermophilic microorganisms micro-organisms oxidise organic compounds carbon dioxide (CO_2), water (H_2O), ammonium ($NH4^+$). Carbon from organic compounds is used as a source of energy while nitrogen is recycled. During decomposition of the organic waste the temperature of the mass rises. This stabilized compost material can be used as a mulch, soil conditioner and topsoil additive/ manure.

During anaerobic process, the anaerobic microorganisms break down the organic compounds by reduction. A very small amount of energy is released during the process and the temperature of composting mass does not rise much. The gases evolved are mainly methane (CH_4) and carbon dioxide (CO_2) etc.

There are two conventional composting methods are available namely, Indore and Bangalore methods of composting.

3.1.1 Bangalore Method

This is an anaerobic method conventionally carried out in pits. Initially, the waste is anaerobically stabilised in pits where alternate layers of MSW and night soil are laid. The pit is completely filled and a final soil layer is laid to prevent fly breeding, entry of rain water into the pit and for conservation of the released energy. The material is allowed to decompose for 4 to 6 months after which the stabilised material is taken out and used as compost.

3.1.2 Indore Method

In this method the pits are filled with alternate layers of similar thickness of waste. To ensure aerobic condition the material is turned at specific intervals for which a 60 cm strip on the longitudinal side of the pit is kept vacant. For starting the turning operation, the first turn is manually given 4 to 7 days after filling. The second turn is given 5 to 10 days thereafter. Further turning is normally not required and the compost is ready in 2 to 4 weeks.

In the urban areas, due to extensive provision of underground drainage system of sanitation, night soil is not available. Composting of MSW is hence often carried out. Aerobic composting of MSW is commonly carried out in windrows.

3.1.3 Vermicompost

The process involves decomposition of organic solid waste using earthworm which converts the organic material into worm castings. It is result of the combined activity of microorganisms and earthworms. Conditions unfavourable to aerobic decomposition result in mortality of earthworms.

Vermicomposting is relatively more stabilised and harmonised with soil system without any ill effects. Particle size of biomass and extent of its decomposition influences activity of worms due to temperature variation, anaerobic condition, toxicity of decomposition products etc. It has been used for agricultural waste and its adoption to municipal solid waste is of recent origin.

The worm species that are commonly considered are *Pheretima sp, Eisenia sp & Perionyx excavatus sp*. These worms are known to survive in the moisture range of 20-80% and the temperature range of 20-40^{0}C. The worms do not survive in pure organic substrates containing more that 40% fermentable organic substances. Hence fresh waste is commonly mixed with partially or fully stabilised waste before it is subjected to vermicomposting. The worms are also known to be adversely affected by high concentrations of heavy metals, such as Cd (Cadmium), Cr (Chromium), Pb (Lead) & Zn (Zinc). Due to the constraints of the temperature, moisture, Fermentable Organic Substances (FOS) and heavy metals use of vermicomposting on municipal scale has not been quite successful.

3.1.4 Mechanical Composting

A mechanical composting plant is a combination of various units which perform specific functions. Segregated waste is stored in a hopper of 8 to 24 hours depending upon transfer of the waste quantity from the collection areas. The waste is then fed to a slowly moving (5metres/minute) conveyor belt and the non-decomposable material such as plastics, glass; metals are manually removed manually or mechanically.

The compostable waste is thus subjected to size reduction for faster biological decomposition. Size reduction also helps in reducing fly breeding in the decomposing mass. This is commonly carried out either in Hammer-mills or Rasp mills.

The waste stabilisation is carried out by open windrows method. In this method, waste is placed well drained land in about 20 windrows with each windrow 3m long x 2m wide x 1.5m high.

Figure 3: Open Windrow

Figure 4: Static Pile Composting

Each windrow would be turned on 6th & 11th days outside to the centre to destroy insects' larvae and to provide aeration. On 16th day, windrow would be broken down and passed through manually operated rotary screens of about 25mm square mesh to remove the oversize contrary material.

The screened compost is stored for about 30 days in heaps about 2m wide x 1.5m high and up to 20m long to ensure stabilization before sale. (Urban India,?)

3.1.5 Factors affecting & the challenges of composting

Various natural factors affect the process of composting viz. microorganisms, temperature, moisture, C/N ratio, aeration etc. Deviation from the standard requirements of the above mentioned factors can hamper the composting process.

The challenges faced by the composting process are as below:

(i) Requires segregated organic waste (the segregation of MSW in Indian scenario is minimal);

(ii) Odour issues due to requirement of area open to the sky;

(iii) Long processing time may cause increase in insects, birds & other disease vectors;

(iv) Leachate formation;

(v) Health & safety issue to the staff;

(vi) High O & M costs; &

(vii) Salability of the byproducts i.e. the compost.

3.2. RDF (Refuse Derived Fuel)

A typical refuse derived fuel (RDF) can be produced from MSW through a number of different stages consisting of segregation of waste, size reduction by shredding, chipping and milling, separation and screening, blending, drying and pelletizing; packaging and storage.

Typically, the waste material is screened to remove the recyclable fraction (e.g. metals), the inert fractions (such as glass) and separate the fine wet putrescible fraction containing high moisture and high ash material before being pulverised.

The coarse fraction is either rejected or returned to the pulveriser. The medium fraction, consisting of paper, card, wood, plastic and textiles can either be burnt directly as coarse fuel (cRDF) or dried and pelletised into dense RDF (d-RDF). The decision of whether to pelletise the waste or not may vary depending upon different factors such as location of plan, economics involved, etc. There are technologies which produce RDF from MSW using its high calorific fraction.

3.2.1 Mechanical Biological Treatment plant

In a mechanical biological pre-treatment plant (MBT), metals and inerts are separated out and organic fractions are screened out for further stabilisation using composting processes, either with or without a digestion phase. It also produces a residual fraction which has a high-calorific value as it is composed mainly of dry residues of paper, plastics, textiles etc.

3.2.2 Dry Stabilisation Process

RDF can also be produced through a 'dry stabilisation' process, in which residual waste (minus inerts and metals) are effectively dried (and stabilised) through a composting process, leaving the residual mass with higher calorific value and suitable for combustion.

Packaging derived fuel (PDF) or process engineered fuel (PEF) is usually of higher quality than RDF as it is a source-separated processed dry combustible fraction which cannot be used for recycling, for example cardboard drink containers or PE/PET bottles contaminated by PVC." (RDF Information Source: EC, 2003). Currently, the market for the RDF in India is still emerging and will need longer time to gain a substantial share of the fuel market.

3.3 Pyrolysis

Pyrolysis is thermal degradation of materials in absence of oxygen or in vacuum. The thermal decomposition of organic matter occurs at about 900^0C. The process converts raw material into reactive intermediate products such as char, light molecular weight gases and heavy molecular weight compounds that condensed when cooled down. In conventional slow pyrolysis, a solid (char) is obtained; however, the rapid heating of a carbonaceous feedstock (fast pyrolysis) results in a liquid fuel.' (Kwon et. al. 2010) (Ramky,?)

The pyroligenous liquid has high heat value and is a feasible substitute of industrial fuel oil. Amount of each end-product depends on the chemical composition of the organic matter and operating conditions. Pyrolysis temperature, residence time, pressure, feed stock and other variables depend upon quantity and composition of the MSW.

There are different types of pyrolysis process:

(i) Garrets Flash Pyrolysis Process;
(ii) Slurry Carb Process, &
(iii) Plasma Pyrolysis Vitrification (PPV)/ Plasma Arc Process

3.4 Bio-Methanation

The Wet Process: In this process, the organic fraction of wastes is segregated and fed to a digester. Under anaerobic conditions, the organic wastes undergo bio-degradation producing methane-rich biogas and the sludge. The biogas production ranges from 50-150m^3/ ton of wastes, depending upon the composition of waste. The biogas can be utilised either for cooking/ heating applications, or through dual fuel or gas engines or gas / steam turbines for generating motive power or electricity. The sludge from anaerobic digestion, after stabilisation, can be used as a soil conditioner, or even sold as manure depending upon its composition, which is determined mainly by the composition of the input waste.

Fundamentally, the anaerobic digestion process can be divided into three stages with three distinct physiological groups of micro-organisms:

Stage I: It involves the fermentative bacteria, which include anaerobic and facultative micro-organisms. Complex organic materials, carbohydrates, proteins and lipids are hydrolyzed and fermented into fatty acids, alcohol, carbon dioxide, hydrogen, ammonia and sulfides.

Stage II: In this stage the acetogenic bacteria consume these primary products and produce hydrogen, carbon dioxide and acetic acid.

Stage III: It utilizes two distinct types of methanogenic bacteria. The first reduces carbon dioxide to methane and the second decarboxylates acetic acid to methane and carbon dioxide.

Anaerobic Digestion process can be influenced by temperature, pH, nutrient concentration, loading rate, toxic compounds and mixing. For start-up a good innoculum such as digested sludge is required. A temperature of about 35-38^{0}C is generally considered optimal in mesophilic zone (20-45^{0}C) and higher gas production can be obtained under thermophilic temperature in the range of 45-60^{0}C. Provision of appropriate heating arrangements and insulation may become necessary depending upon climatic conditions at the site.

Anaerobic Digestion (AD) of MSW offers certain clear advantages over the option of Aerobic process, in terms of energy production/ consumption, compost quality and net environmental gains:

(i) AD process results in net production of energy.
(ii) The quality of the digested sludge (compost) is better as Nitrogen is not lost by oxidation.
(iii) It is totally enclosed system that prevents escape of polluted air to atmosphere.

(iv) The net environmental gains are positive. (Urban India,?)

The Dry Process:

In this process, the mixed waste is placed in closed tunnels under anaerobic conditions & digested to release the biogas. The Digested material can further be treated using Windrow method to produce good quality compost

Wet Bio-methanation process	**Dry Bio-methanation process**
Higher gas production (approx. 20% higher)	Lower gas production
Segregated Organic Waste is required as a feed	Mixed solid waste can be used as a feed
Requires pretreatment to the segregated waste i.e. shredding, pulping, etc	No pretreatment is required
Involves mechanical parts for mixing resulting in increased O & M costs	Doesn't require major machinery inputs & hence lower O&M costs
Continues process & sensitive to the factors such as waste characteristics, moisture, temperature etc	Batch process & robust
O & M cost to Revenue is higher (25% of the revenue)	O & M cost to Revenue is lower (10% of the revenue)
Difficult to achieve success due to minimal segregation status in Indian Scenario	Workable solution in Indian Scenario due to the use of mixed solid waste

3.5 Gasification

Gasication transforms the solid fuel to a gaseous carrier, is also an attractive technology. This process is similar to Pyrolysis, involving some secondary/ different high temperature (>1000^{0}C) chemistry which improves the heating value of gaseous output and increases the gaseous yield (mainly combustible gases CO+H2) and lesser quantity of other residues. The resultant gas, or synthetic gas, is a mixture of primarily CO, CO_2, H_2, CH4, and non-methane hydrocarbons. It can be used directly as a fuel, or as feedstock for production of chemical such as hydrogen or methanol. (Kwon et. al. 2010) (Urban India,?)

The pyrolysisgasification technology has following advantages over the other available waste toenergy technologies:

i) Low Carbon footprint,
ii) Not land intensive,
iii) Low or no waste generation,
iv) Produce more power with less waste and
v) Maximum volume reduction. (Kwon et. al. 2010)

The challenges for Gasification process are as follows:

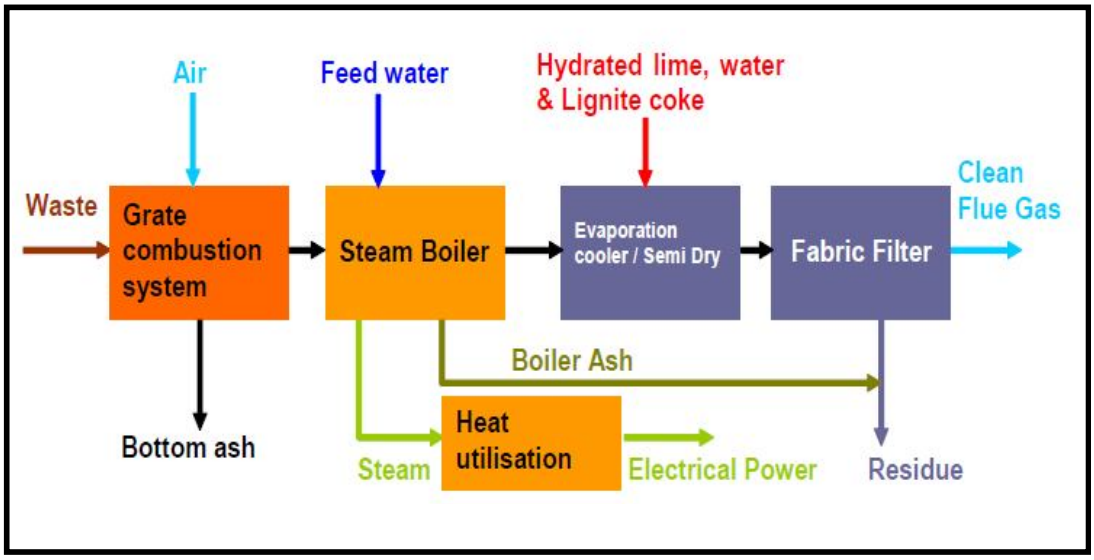
(i) The technology is still under development for scaled operations;
(ii) The optimum electrical efficiency is yet to be achieved; and
(iii) There are very few scaled gasification plants against incineration plants

3.6 Wastes to Energy (Mass Burning / Grate Chamber)

There are more than 1600 waste to energy plants all over the world using MSW as fuel. Power generation depends upon the volume of the waste and its calorific value. The first waste to energy plant in India is under construction at Jabalpur (Madhya Pradesh), having MSW processing capacity of 600TPD and producing 11.5MW thermal energy.

The technology for waste to energy is well established. MSW is used as fuel having calorific value of about 1100 to 2300 kcal. Waste to energy plant should not be viewed as conventional power plant. The grate surface area requirement for conventional fuel is 28 sq. m., whereas, for MSW it is 100 sq. m. for producing 56 MT steam generating 11.5 MW thermal out-put and accordingly refractory requirements would also be different. Therefore, MSW waste to energy project should not be assessed like that of the conventional thermal power plant in terms of financial closure and business model. There is an example in Taiwan, where waste to energy plant had 8000 hrs of non-stop operation in 2002 having capacity of 4x450 TPD with about 90% plant load factor (PLF). The oldest waste to energy plant set up in 1958 at Lausanne (Switzerland) is in operation till 2006 (48 years) now being replaced by larger and more efficient waste to energy plant having capacity of 750 TPD, producing 2x47MW thermal energy. Shanghai city in China has one of the largest Waste to Energy plants in the world having capacity of 3000 TPD producing 60MW of power. The Process Flow Diagram of typical waste to energy plant is presented below in Figure 7 :

Figure 7 - Process flow diagram of Waste to energy plant



Conceptually, a 600 TPD waste to energy plant using not-pre-treated / unsegregated MSW having LHV = 1100 – 2200 kcal/kg gives about 48MW gross thermal output and 11.5 MW gross power output with conversion efficiency of 25%. The plant operations are essentially secured and widely automatic. Stable combustion process gives constant flow of steam and flue gas. Turbo reactor for air pollution control provides proper mixing and long contact time of gas and absorbent. Fabric filter in air pollution control device separates solids efficiently without clogging. Typical emission from MSW based waste to energy plant confirms regulations as given in European Directive, 2000/76/ EC as well as India's MSW Rules, 2000, notified under The Environment (Protection) Act, 1986 as summarized below:

The area requirement for combustion plant is 5 acres and another 5 acres shall be required for ash utilisation and green belt development, however, this does not cover landfill requirement of rejects from the plant.

3.7 Expert Opinion on significance of the Waste to Energy

Experts view on the various aspects of a particular technology would differ based on the benefits as well as the shortfalls of the technology. Various parameters define the scope of a particular technology whether it can be implemented at a locality or not. The selection of the method will depend upon whether the MSW management is to be undertaken at centralized level or decentralized level. It will also depend upon the quantity and volume of the waste, techno-economic viability of that particular technology/ method to be used. In order to have a clear understanding of technologies, their advantages, limitations and applications, a decision matrix is presented below (Table No. 7). The exercise consists of mainly recording of opinion of the author in the form of scores in the range of 1 to 10 (1 being the least beneficial).

Table No. 7 - Decision Matrix for MSW Management

S.No.	Unit Operation or Step in MS Management	Attributes													
		Technical Feasibility		Managerial Feasibility		Social acceptability		Low Capital Cost Advantage		Low O&M Cost Advantage		recycling Potential		Possiblity of Minimum Externality	
		C	D	C	D	C	D	C	D	C	D	C	D	C	D
1.	Segragation at Source	3	5	3	3	5	5	6	4	7	5	5	8	4	2
2.	Transportation	5	9	6	6	7	7	5	7	5	7	4	7	6	4
3.	Pre-processing of Wastes	7	3	8	4	9	3	8	4	7	3	4	7	8	3
4.	W to E: Bio-methanation	5	7	4	8	8	4	4	7	7	4	5	8	8	3
5.	W to E: Conventional Composting	8	3	8	3	9	4	5	5	5	5	4	7	8	3
6.	Vermicomposting	3	5	3	5	9	4	5	5	5	5	4	7	7	4
7.	W to E: Mechanical Composting	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	W to E: RDF Production	8	3	8	3	9	4	7	4	7	4	4	7	9	4
9.	W to E: Incineration	10	2	10	2	9	3	5	5	5	5	0	0	8	5
10.	W to E: Pyrolysis / Gasification	4	6	4	6	6	6	4	2	4	2	0	0	8	4
11.	W to E: Plasma Arc Gasification	4	6	4	6	6	6	4	2	4	2	0	0	8	4
12.	Disposal of Road Sweeping and Construction Debris	7	2	8	2	8	4	8	4	8	4	7	3	9	3
13.	Engineered Sanitary Landfill	10	3	10	3	10	2	9	3	9	3	0	0	10	2
14.	Average	7	4	7	4	8	4	6	3	6	3	2	2	9	4
	Total	50	26	51	26	56	29	43	23	43	23	13	12	61	26

Average score for C = 45 and D = 24 where C is Centralised and D is De-centralised. [Adopted from Asolekar, S.]

4.0 SITUATION ANALYSIS

4.1 Actions Taken by MPCB during 2005-2014:

No.	Date	Sent to	Subject / Type of Action	Letter Information
1.	08.02.2005	Medical Health Officer, PMC	Non compliance under MSW (Managment & Handling) Rules, 2000.	1. Leachate collection and sampling by MPCB on 31.08.2004, parameters beyond prewscribed limits. 2. Submit Action Taken Report to MPCB
2.	10.02.2005	The Municipal Commissioner, Pune Municipal Corporation	Show cause notice under MSW (Management & Handling) Rule, 2000	1. Leachate disposal parameters beyond prescribed limits at Urali Devachi.
3.	15.07.2005	The Municipal Commissioner, Pune Municipal Corporation	Dumping of waste at Mantarwadi & Leachate	1. Leachate entering nearl\by Nalla thus polluting water course along with Mula & Mutha river. 2. Disposal of waste and leachate not according to MSW (Management & Handling) Rule, 2000. 3. Submit compliance report.
4.	13.09.2005	The Municipal Commissioner, Pune Municipal Corporation	Show cause notice under MSW (Management & Handling) Rule, 2000	1. Complaint from locals regarding improper MSW disposal at Urali Devachi 2. Submit reply within 15 days.
5.	21.10.2005	The Municipal Commissioner, Pune Municipal Corporation	Authorisation to process / dispose the MSW at Urali Devachi	Submit a time bound programme to MPCB 15 days regarding the proposal
6.	10.04.2006	The Municipal Commissioner, Pune Municipal Corporation	Show cause notice under MSW (Management & Handling) Rule, 2001	1. Time to time reminders to PMC about having the facility as per MSW (Management & Handling) Rule, 2000 2. Fire incidence on 08.04.2006 and air pollution occured. 3. Previous fire incidences at the site.

No.	Date	Sent to	Subject / Type of Action	Letter Information
7.	08.03.2007	Medical Health Officer, PMC	-------	1. Fly nuisance due to improper management of MSW 2. Recent fire incidence. 3. Take appropriate action.
8.	10.10.2007	Chief Health Officer, PMC	Regarding MSW Management & Handling	1. Unscientific management & handling of MSW 2. Complaints from locals 3. Site visit by MPCB field officer on 23.09.2007 4. Pollution due to leachate 5. To take appropriate action.
9.	02.09.2008	Chief Health Officer (MSW), PMC	Directions under section 33A of the Water (Prevention & Control of Pollution) Act 1974 and under section 31A of the Air (Prevention & Control of Pollution) Act 1981 read with MSW (Management & Handling) Rules, 2000	1. Complaints from locals 2. Show cause notices sent by MPCB 3. Site visits by MPCB field officer 4. Improper MSW transportation 5. Unscientific waste disposal 6. Inadequate infrastructure 7. ***International neglect towards compliance*** 8. Stop discharge of untreated leachate 9. Reply within 15 days.
10.	15.09.2008	Chief Health Officer (MSW), PMC	State Committee visit - 25.03.2008 & MPCB field officer visit - 11.09.2008	1. Unscientific waste storage & disposal 2. Nuisance due to fly & smell 3. Inadequate infrastructure 4. No fens & buffer zone around the site 5. No action by PMC until 6. Take appropriate action
11.	23.10.2008	The Municipal Commissioner, Pune Municipal Corporation	Notice under Environment Protection Act 1986 read with MSW (Management & Handling) Rule, 2000	1. Unscientific waste storag, leachate collection & disposal 2. Inadequate infrastructure 3. Improper MSW Transport 4. Need for scientific post closure activity 5. Provide proposal for above.
12.	06.04,2009	The Municipal Commissioner, Pune Municipal Corporation	Letter for scheduling personal hearing in front of Chairman, MPCB	1. Personal Hearing in front of Chairman, MPCB

No.	Date	Sent to	Subject / Type of Action	Letter Information
13.	12.05.2009	The Municipal Commissioner, Pune Municipal Corporation	Directions under section 15 of Environemtn Protection Act, 1986 & MSW (Management & Handling) Rule, 2000	1. To undertake capping of historical MSW dumps at Urali Devachi & to undertake scientific remediation 2. Provide sufficient infrastructure to cater the waste management 3. Complete the transition of bulk refuse transport to closed containers by Dec 2009 4. To get site clearance certificate from district collector under G.R. MSW/1003/matter no. 675/ws22 dated 26/08/03 issued by Water Supply & sanitation Department GoM 5. Submit bank guarantee of Rs.10 lakhs which will be valid for 2 yrs 6. To submit Concrete action plan for O& M of the facility
14.	26.08.2009	The Municipal Commissioner, Pune Municipal Corporation	Directions under MSW (Management & Handling) Rule, 2000	1. Unscientific leachate collection, treatment & disposal 2. No local committee formation & no site visits & its reports
15.	31.08.2009	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Directions under MSW (Management & Handling) Rule, 2000	1. Unscientific leachate collection, treatment & disposal 2. No local committee formation & no site visits & its reports
16.	04.09.2009	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Letter under MSW (Management & Handling) Rule, 2000	1. Unscientific disposal of MSW 2. Fly & smell nuisance 3. Smoke issue 4. No pollution control system at Hanjer plant
17.	30.04.2010	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Waste management	1. Unscientific leachate collection, treatment & disposal 2. No historical waste capping 3. No fens & buffer zone at the site 4. Unscientific dumping on the site 5. Water pollution in the nearby nalla due to leachate
18.	27.01.2011	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Site visit	Site visit on 27.01.2011 in presence of Sanitary Inspector of PMC.

No.	Date	Sent to	Subject / Type of Action	Letter Information
19.	08.03.2011	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Non Compliance under Air (Prevention & Control of Pollution) Act, 1981 read with MSW (Management & Handling) Rule, 2000	1. Site visit by MPCB field officer on 27/1/2011 & 28/01/2011 2. Hanjer Site ● Waste scattered all over the place ● improper leachate collection & treatment ● Fumes & fugitive emissions ● No fens and buffer zone provided ● No pollution control measures provided
20.	07.04.2011	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Waste Management	1. Fire incidence on 21/03/2011 2. Site visit by MPCB field officer on 21/03/2011 3. ***Warehouse RDF stock on fire*** 4. Take precautions & submit the report within 7 days
21.	17.06.2011	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Prosecution Notice under 43,33,24,25/26 of the Water (Prevention & Control of Pollution) Act 1974, Environment Protection Act, 1986 & MSW (Management & Handling) Rule, 2000	1. Unscientific leachate collection, treatment & disposal 2. Inappropriate BMW management
22.	23.12.2011	The Deputy Municipal Commissioner (MSW), Pune Municipal Corporation	Warning notice under MSW (Management & Handling) Rule, 2000	1. Site visit by MPCB field officer on 22.12.2011 2. Unscientific Storage and Disposal of rejects from Hanjer plant
23.	22.06.2012	The Pune Municipal Corporation - Garbate	Complaint about smell Nuisance due to poor maintenance and operations of Garbate processing plant.	1. Plant running under capacity, not treating expected capacity of waste on daily basis causing smell 2. Segregated plastic waste not sent to PMC site for further processing 3. Leachate collection & treatment not provided causing ground water pollution 4. Poor Housekeeping 5. Improve O & M 6. Submit compliance report on the above within 7 days from letter otherwise appropriate action

No.	Date	Sent to	Subject / Type of Action	Letter Information
24.	03.08.2012	-------	Water Sample Report dated 03.08.2012	-----
25.	21.08.2012	The Municipal Commissioner, Pune Municipal Corporation	Directions under section 33A of the Water (Prevention & Control of Pollution) Act 1974 and under section 31A of the Air (Prevention & Control of Pollution) Act 1981read with MSW (Management & Handling) Rule, 2000	1. Non Compliance & violation of MSW Rules, 2000 & take necessary improvements 2. Recurring Complaints from vicinity 3. Writ Petition No. 4542 of 2012 - Ramtekadi Industries Association & Ors. 4. Directions for ● Not to dump any waste in the vicinity ● Undertake waste segregation Appropriately ● Not to dump / landfill any waste at Plot no. 87, Ramtekadi Industrial area, Hadpsar ● Not to create any type of pollution & to maintain ambient air quality in the area 5. Submission of Compliance report on the above within 15 days of receipt of the letter ***In not***, then MPCB will take appropriate action
26.	09.10.2012	The Municipal Commissioner, Pune Municipal Corporation	Show cause Notice for non-compliance of the conditions of Authorisation granted by the board under the provisions of MSW Rules, 2000	1. Non submission of bank guarantee of Rs.5 lakh, as per previous authorisation application
27.	12.04.2013	Executive Officer, Solid Waste Management Divisiion, PMC Pune	Show cause Notice for violsation of the provisions of consent conditions.	1. Show cause asking ‘ why not to initiate action against the facility for non compliance 2. Reply within 7 days with time bound programme with compliance proposal otherwise actions will be taken

No.	Date	Sent to	Subject / Type of Action	Letter Information
28.	21.08.2012	The Municipal Commissioner, Pune Municipal Corporation	Compliance with provisions of 1. MSW (Management & Handling) Rule, 2000 2. Plastic Waste (Management & Handling) Rules 2011, as amended 3. Maharashtra Plastic Carry Bags (Manufacture & Usage) Rules 2006	1. Non provision of any effective arrangement of collection systems for plastic waste 2. Non working on the modalities of mechanism on Extended Producer's Responsibility with the manufacturers brand owners, etc. 3. Submission of concrete proposal for collection systems for plastic waste along with irrevocable bank guarantee of Rs. 50,000/- to be submitted to RO, within 15 days 4. ***If not*** provided then the name of the municipality will be informed to CPCB as defaulters & to initiate appropriate action
29.	30.12.2013	----	Leachate Sampling & report dated 20.12.2013	1. Leachate Sample collected from leachate tank at Hanjer Biotech plant
30.	18.01.2014	M/s. Hanjer Biotech, Fursungi	Fire incidence due to unscientific operation at the processing plant	1. Fire incident due to unscientific operations at the processing plant 2. Take necessary precautions to avoid such incidences 3. Report to RO, MPCB within 7 days
31.	02.01.2014	----	AAQM Report	Urali Devachi Site
32.	28.02.2014	----	AAQM Report	Urali Devachi Site
33.	19.03.2014	The Municipal Commissioner, Pune Municipal Corporation	Non Compliance under MSW (Management & Handling) Rule, 2000	1. A hearing notice between PMC, Hanger Biotech, Rochem & MPCB - MS at Mumbai Office on 21.03.2014
34.	15.04.2014	The Executive Officer (MSW), PMC	Monthly Status Report	----

No.	Date	Sent to	Subject / Type of Action	Letter Information
35.	11.06.2014	The Exeutive Officer (MSW), PMC	Minutes of Personal Hearing scheduled on 17.0-5.2014	**Hanjer Reply:** 1. No Demand for RDF & Compost 2. Company facing financial issues hence cant undertake O&M and run the plant to the fullest capacity 3. Electricity Bill pending for Rs. 40-45 Lakhs and hence plant processing has stopped 4. Already submitted alternative proposal for biogas generation & biofuel from plastic waste. Also proposal for tipping fees pending with PMC that need approval otherwise ***can't operate the plant*** 5. No project can run without tipping fees 6. Submitted proposal ***viability gap funding for Rs. 80Cr***. to PMC which needs approval 7. Minimum tipping fees should be Rs. 500/MT **PMC Reply** 1. ***There is opposition to run Hanjer project from the locals*** 2. Capping of historical waste to be completed by June 2014 3. Gap funding, Electricity bill, labour bills needs approval from general Body 4. Earlier agreement with Hanjer was without tipping fees and hence recent proposal of tipping fees is inconsistent with the previous & cant be considered 5. Electricity Bill of Rs. 40-45 lakhs to be borne by PMC 6. ***Out of 27 Plants by Hanjer, 20 plants are in non operation stage*** 7. ***PMC has serious concerns oer alternative proposal given by Hanjer about its feasibility*** **PMC reply to Rochem** 1. Company to ensure energy generation from the plant 2. PMC has pointed out serious problems in the operation of Rochem Technology

No.	Date	Sent to	Subject / Type of Action	Letter Information
35. *[continued]*		The Exeutive Officer (MSW), PMC	Minutes of Personal Hearing scheduled on 17.0-5.2014	3. out of 700MT/day capacity only 1/3 is in operations and only 400 kw trial run was made 4. To assess the Rochem Technology with the help of experts in the field **Other aspects** 1. Rochem technology with Rs. 300 tipping fees, RDF sale price, Transport, quality of syngas made - plant is not viable 2. Due to none functioning of Rochem & Hanjer the remaining waste is being dumped at Urali Devachi dumping ground 3. All these issues to be put in front of state committee for MSW 4. Total 17 new places identified by PMC but 3 of them viz. Tulapur, Vadhu & Sinthavane facing opposition due to historical sites 5. PMC to consider small land parcels of 5 acres in & around the city to be developed as secured landfills of 200 MT each **Conclusions:** 1. PMC & Operator companies to meet UDD for proposals 2. PMC & Rochem to appoint expert committee to check the operations 3. Forward the report to UDD/ State MSW committee for further decision 4. PMC to prepare DPR for non operations of Hanjer & its alternative with revised terms & conditions 5. PMC to constitute local area committee with MPCB, for monthly site visits, inspection & monitor capping progress 6. PMC to develop alternative sites plus small land parcels of 5 acres in & around the city to be developed as secured landfills 7. PMC to submit proposal for operations of all the above plants & its sites by 30/06/14
			Information Source: MPCB, RO, Pune	

4.1 Actions Taken by PMC during 2005-2014: *Following news items aptly describe the situation at Pune regarding management of MSW:*

Villagers stop trucks yet again, Pune stares at garbage problem: *[Umesh Isalkar, TNN | Aug 7, 2014, 12.49AM IST]*

PUNE: The PMC's dilly-dallying over finding a permanent solution to city's garbage disposal problem has once again put it at loggerheads with the residents of Uruli Devachi and Phursungi, the two villages used for indiscriminate dumping of garbage since 1981. On Wednesday, the residents stopped trucks carrying heaps of waste from entering their villages for the umpteenth time. They said they would continue their protest until the Pune Municipal Corporation treats all the garbage dumped so far and shuts down the sick processing unit permanently. Stopping of trucks outside Uruli and Phursungi would mean about 1,000 metric tonne of garbage piling up in dust bins across the city every day.

Villagers complain that dumping without processing has resulted in uncontrolled growth of leachate, a liquid toxic waste that seeps through garbage, in and around the depot. Incessant rains in the last few days have worsened the situation, increasing risk of health hazards for the villagers.

In February too, the villagers had blocked the trucks for two weeks resulting in waste accumulating everywhere. Sharad Pawar, who was the Union agriculture minister then, had succeeded in pacifying the villagers. They gave the PMC two more months to find a suitable place for shifting its processing units.

"The PMC has continued to dump around 900 tonne waste every day at the depot, which is unable to process even 100 tonne a day. Hence, we have blocked the garbage containers from entering the village from Wednesday. We want the PMC authorities to shut down the Hanjer processing plant permanently and stop bringing trash to our village," said Bhagwan Bhadale, president of Kachara Depot Hatao Sangharsh Samiti. Ranjeet Raskar, a member of the Phursungi gram panchayat, said, "Heavy downpour has increased generation of leachate in and around the depot. The health risk is grave as the PMC continues with dumping in violation of all environment norms." "We want the civic authorities to first process the openly dumped mounds of garbage and bring the entire trash under capping. Finally, we want them to shut down the Hanjer processing plant," Raskar added. Despite repeated attempts, Suresh Jagtap, head of PMC's solid waste management department could not be contacted.

The Issue:

- The garbage depot at Uruli started in 1981. Only 43 acres of land was under the depot then. Another 120 acres in the adjoining Phursungi village was brought in 2003.
- In 2000, villagers sought the high court's intervention to stop dumping. The HC directed the PMC to take immediate steps to segregate waste at source
- Villagers formed the Kachara Depot Sangharsh Samiti.

- On June 1, 2011, the PMC declared it had stopped open dumping
- Biogas plants set up at different locations in and around Pune contained the problem of foul smell at Uruli Devachi as hotel waste was taken care of
- The problem of open dumping, however, remained unresolved. The issue came alive every time the Hanjer processing plant at the depot developed snag. Once that happened, waste would pile up at the depot and the villagers would take to streets Corporators want action against villagers

All party leaders in the Pune Municipal Corporation (PMC) on Wednesday asked the civic administration to take tough stand against the residents of Urali Devachi who have threatened to block garbage processing in their villages. “We discussed the issue and asked the civic administration to take help of police if villagers stop garbage vehicles from entering their villages,” said mayor Chanchala Kodre on Wednesday.

News Item appeared on Wednesday, August, 6th, 2014: **Subject: PMC approves two new waste processing plants**

In a bid to find a viable solution to the city’s ever-growing problem of garbage disposal, the Standing Committee (SC) of Pune Municipal Corporation (PMC) has recently approved two new waste processing plants to decentralise the process of waste management. The authorities maintain that these new plants are estimated to process an additional six hundred metric tonnes of waste every day.

Talking to Mirror, Bapusaheb Karne, Standing Committee Chairman, said, “The technical Committee duly scrutinised all the companies and awarded the contract to two companies Nobel Exchange Environment Solution and Organic Recycling System. Both these companies will each process 300 metric tonne of waste every day. Around seven acres of land will be required to set up the processing units. Nobel will charge Rs 360 per tonne as tipping fee along with an 8 per cent hike in the rate every year. Organic Recycling System will having two units and the tipping charges will be fixed at Rs 360 per tonne. Both the plants will be constructed on a Build-Operate-Transfer (BOT) basis.”

PMC had earlier planned to develop smaller solid waste processing units, with an idea to contain the garbage situation in the city and prevent it from spiraling out of control. To this purpose, the civic body issued a tender and invited local and international companies specializing in solid waste management to submit their bids.
Starting April, a special technical committee was formulated to shortlist the company to set up the waste processing unit. Five companies — Nobleexchange Environment Solution, Creative Eco Recycle Port, Organic Recycling System, Degremont Limited JV Suez Environment India and Essel Infraprojects — were approached to undertake the project. In the run up to the finalisation of a contractor, the technical committee appointed by PMC had made presentations in order to explain the nature of the job and the current garbage disposal problem being faced by the city.

Suresh Jagtap, head of the Solid Waste Management department, said, “At present, the city generates more than 1,500 metric tonne of waste everyday. This figure stood at 900 metric tonne in 2010. The proportion of waste has been increasing by the day. As per a recent decision by State government, 34 villages will be included in the PMC limits soon. Given the impending increase in PMC limits, the decision to add new waste processing plants was a

crucial one. In the development plant (DP), various areas have been earmarked for the setting up of the new garbage processing units."

As per the DP, land in the city limit areas of Baner, Wadgaon Khurd, Ambegaon Budruk, Kondhwa Budruk and Hadapsar, has been reserved for the plants and will soon be finalised after getting a final approval from the General Body (GB).

Currently, Hanjar and Rokem are the two major garbage processing plants servicing the city. According to the contract signed by it with the civic body, Rokem was scheduled to run to full capacity from September 2012, processing 700 metric tonne of garbage every day. However, the processing unit has not been running to full capacity, owing to financial and technical issues. The Hanjar plant located in Uruli Devachi also has two processing units with a daily capacity of 1,000 metric tonne each. However, this plant too is struggling to process a paltry 300 metric tonne of garbage daily.

S.No.	Date	Sent to	Sent by	Subject / Type of Action	Letter information
1.	June-10	PMC, Pune	II & FS	Report	Report on '**Environmental Assessment of existing dumping ground and its proposed scientific closure at Urali Devachi'**
2.	12.06.13	Hanjer Biotech	Registration Authority cum Director (inputs/ Quality Control), State of Maharashtra	Show cause notice for violation of 1985 Act Section 12, 13-1(c), 19(A), 19(c) - 1,3, 19(c)-5, 19(7)-c	1. Wrong Content information on compost packaging 2. False information about percent content of various compounds such as N, P, K, C:N ratio, etc, 3. Cobalt & Nickel content not as per prescribed standards; 4. Reply given by Hanjer was not satisfactory on the above 5. No further permission for sale of compost; 6. Consent / Authorisation to sale compost got cancelled automatically due to expiry of validity
3.	17.01.14	MPCB	Statement by Urali Devachi Villagers	Fire Incidence at Hanjer Biotech, Urali Devachi site	1. Fire incidence occured 2. Smoke and smell covering the village areas
4.	NA	---	---	Starred question (No.6666) by MLA Shri Shivtare on MSW situation at Urali, Devachi	N.A.

Legend: NA - Details not available
(Information Source : MPCB, RO, Pune)

5.0 SUGGESTED TECHNOLOGY OPTIONS

The quantity of the MSW generation in cities depends upon the population. Based on the experience of the author as a regulator and considering the variation of the quantity of the MSW generation in different cities & towns technology options can be worked out as under:

- For cities generating MSW < 150 TPD
  - Option 1
    - Landfilling with gas recovery
  - Option 2
    - Dry Methanation
    - Compost recovery
    - Landfilling
- For cities generating MSW 150-400 TPD
  - Option 1
    - Mixed waste to dry methanation
    - Aerobic process to recover compost & RDF
    - Landfilling
  - Option 2
    - Screening
    - Organics to composting
    - Others to drying & RDF
- For cities generating MSW > 400 TPD
  - Option 1
    - Mass burn incineration
  - Option 2
    - Screening
    - Organics to dry methanation
    - Residues to incineration
- For cities generating MSW > 1000 TPD
  - MSW mining for dumps
  - Mass burning for Waste to Energy
  - Landfilling
  - Centralised facility

6.0 BUSINESS MODEL & COST ECONOMICS

In order to ensure institutionalization of environmentally sound management of the MSW as envisaged in the MSW Rules, 2000, the techno-economic viability of the project important. Revenue generation depends on the technology application and so does the capital cost requirements. Possible revenue generation per ton of MSW processed and technology application has been worked out and presented in the table No. 9 and Capital cost requirements in table no. 10

Table No. 8 - Appropriate Revenue / Ton

Technology revenue	Output	Assumption	Units of output	Units/ton	Price in Rs./unit	Total
Composting + RDF	Compost	7% of input material	Kg	70	0.7	124
	RDF	15% of input material	Kg	150	0.5	
Wet Metha-nation + RDF	Biogas	70 m^3/ton	Kwh	140	5	824
	RDF	15% of input material	Kg	150	0.5	
	Compost	7% of input material	Kg	70	0.7	
Dry Metha-nation + RDF	Biogas	50 m^3/ton	Kwh	100	5	
	RDF	15% of input material	Kg	150	0.5	624
	Compost	7% of input	Kg	70	0.7	
Incineration	Power	350 units/ton	Kwh	350	5	1750

Table No. 9 - Revenue Capital Cost

Technology	Output (Rs.)	Opex/Ton Opex	Total Ton	Capex/ Ton (Rs.)	Revenue/ Capex Normalised	Revenue
Composting + RDF	Compost	330	470	8 lakh	124	1.0
	RDF	140				
Static composting + RDF	Compost	320	460	7 lakh	124	1.1
	RDF	140				
Static composting + RDF	Compost	320	460	7 lakh	124	1.1
	RDF	140				
Dry methanation + RDF	Biogas	35	475	12.2 lakh	624	3.3
	RDF	290				
	Compost	140				
Incineration	Power	520	520	33.3	1750	3.4

Note : here Opex includes Leachate treatment cost, Landfill construction & disposal rent.

Keeping in view of the information presented in Table no 9 and 10, an attempt has been made to work out capital cost requirements for a city generating MSW @ 1000 MT/day as shown in the table no 11.

Table No. 10 - Approximate Capital Cost @ 1000 TPD

Technology	Output	Civil cost (Rs.in Cr.)	Vehicles & Machinery (Rs. in Cr.)	Landfill (%)	Total Cost (Rs.)	Revenue/ Ton (Rs.)
Composting + RDF	Compost	23	17	30-40%	65	124
	RDF	9	16			
Static composting + RDF	Compost	14	21	30-40%	59	124
	RDF	9	15			
Dry methanation + RDF	Biogas	17	23	25-35%	65	624
	RDF	9	15			
	Compost	15	21			
Incineration	Power	280		20%	280	1750

Note : Assumed plant operating only in 2 shifts, Plant capacity @ 30% excess capacity & completely closed plant.

Factors for selecting Technology:

- Technology selection for Indian waste be driven by (in descending order)
  - Operational ease
    - Quantity of the waste to be treated
    - Stability & reliability of the system
  - Sale of Product
    - Proximity of Agriculture belt and cement industries
    - Proximity to grid
    - Need to evaluate DISCOM's credit rating before building the plant & entering to PPA
  - Cost of OPEX to revenue from sale of products should be < 1
    - Multiple revenues can offset the problem with tipping fee delays during period of disagreement
  - Project cost
    - Technologies if not robust will not sustain
    - Availability of capital grants

Key things to consider:

- Evaluate and conclude selection of the technology during bidding stages
- Don not bid for a project that does not make practical sense
- Opt for optimum capacity to sustain inevitable consequences (e.g. Strikes, serge in volumes, etc.)
- Module based preferred so capacity can be increased at later stages.
- Opt for automation and say NO to vehicle/low skilled driven operations
- Prefer capital grant projects
  - That makes the ULB liable
  - Tipping fee will be lower and the project is less dependent on the revenue from municipality.

7.0 ISSUES TO BE ADDRESSED FOR PUNE MSW

It is not a case that nothing has been done in Pune for management of MSW, several efforts were made by the local body but all that was without much success. It is therefore important to address issues leading to the dismal situation as on today. The major issues that required to be considered are as under:

7.1 Waste Estimations [unrealistic]

The estimation of waste generation in Pune Municipal Corporation does not provide the extent of the level of socio-economic change, consumerism, development and implication of merging new villages in to the corporation limits.

To gauge the extent of waste generation there is data published by the World Health Organization which states that 0.3kg/person/day is the waste generated in developing nations. According to 2011 census Pune has a population of 50, 49,968, which transpires its waste generation at 1515Tonnes per Day

However the data published by Central Pollution Control Board, New Delhi provides data which not only covers cities across India but also sub-classifies the MSW generation in class-I & II cities. This classification provides a more realistic data on waste generation.

According to CPCB, the average MSW generation is 0.376kg/person/day in Class-I cities which includes the city of Pune. As per the 2011 census Pune has a population of 50, 49,968; hence the total waste generation of MSW in Pune is estimated at 1898Tonnes per day.

The precise MSW estimation is a critical point based on which entire management is dependent. It has been observed that in the city of Pune, the estimations have never been precise and nodal agencies that should manage and monitor the waste are following different MSW figures. Due to such unrealistic and non-dependable MSW figures have given rise to a chaotic situation where no one exactly knows what is to be done about MSW in Pune. The waste generated and haphazardly disposed by slums/ unauthorized is often goes unaccounted.

Considering the facts above it can be stated that irrespective of accuracy of data, higher limit of waste generation as per CPCB should be considered for developing

MSW management strategy of Pune, as Pune is a rapidly developing city will achieve1898Tonnes/Day estimate sooner rather than later.

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7.2 Infrastructure [deficient]

Pune Municipal Corporation suffers from the unclear policy on solid waste management due to the multiple stake holders in its development which includes bureaucracy and politicians. Since MSW management is a back end support function of any ULB, it is critical to understand the critical issues related to its enormous scale of operations from financial as well as technical aspects.

Due to lack of such knowledge various entity/persons (Private Sector) with vested interests have been guiding the corporation with concepts of waste management which are half learnt and not implemented anywhere. Expert guidance from regulatory authorities is required to take the MSW management in right approach.

Due to public and political pressure PMC has been driven to solutions of MSW management which were impractical such as the infamous “ZERO TIPPING FEE” model. Wherein the by-products of MSW management using composting and RDF processing could provide revenue to not only sustain the operations but also earn profits. Such type of proposals not only created honey trap of PMC in believing its waste being wealth but also looking at it as a revenue earner as bidders started bidding with a premium payment to PMC.

The issue with such type of proposals is that there is no focus on waste management or compliance or environment protection but only revenue generation. In addition while making such proposal there is not impetus given to identifying who the compost and RDF user is or if there is any facilitation by PMC in selling these products. Hence all such plants could not take off and when they did the realization of aforesaid facts caused them to cut corners and end up without a proper processing and disposal facility.

The above stated facts have severe implications which are linked. The selection of technology and waste management systems are at times vendor driven. Regulatory agencies are not involved in the decision supporting systems of the local bodies. Infrastructure deficiency is also due to unrealistic and/or faulty business model provided by the vendor. In one instance, the vendor offered very low tariff which was not only impracticable but also uneconomical. As a result, vendor got into in to losses and had to shun the operations leaving local body in to lurch. This situation led to the violations of the environmental regulations by the local body. MSW collection was disrupted causing concern for protection of public health and environment. In spite of intensive public agitation and judicial interventions perceptible improvement is not seen. The infrastructure is deficient even by design and does not operate efficiently. Rapid growth of the city is further compounding the situation. No one in the planning department can

accurately inform the concerned people about infrastructure requirements with regards to segregation, collection, transportation, treatment & the disposal of MSW. Most of the facilities available in Pune are deficient and can't cater the needs of the city.

Space availability is another such aspect that can't be ignored. No new treatment site is acquired even though such grave issue standing at the door.

Because of the unrealistic MSW figures and lack of administrative as well as political will no real time solution for the MSW can be found out. The selection of technology and waste management systems are at times vendor driven. Regulatory agencies are not involved in the decision supporting systems of the local bodies. Infrastructure deficiency is also due to unrealistic and/or faulty business model provided by the vendor. In one instance, the vendor offered very low tariff which was not only impracticable but also uneconomical. As a result, vendor got into in to losses and had to shun the operations leaving local body in to lurch. This situation led to the violations of the environmental regulations by the local body. MSW collection was disrupted causing concern for protection of public health and environment. In spite of intensive public agitation and judicial interventions perceptible improvement is not seen. The infrastructure is deficient even by design and does not operate efficiently. Rapid growth of the city is further compounding the situation. No one in the planning department can accurately inform the concerned people about infrastructure requirements with regards to segregation, collection, transportation, treatment & the disposal of MSW. Most of the facilities available in Pune are deficient and can't cater the needs of the city.

Space availability is another such aspect that can't be ignored. No new treatment site is acquired even though such grave issue standing at the door.

7.3 Institutional Capacities for Governance [weak]

The MSW management needs to be institutionalized. In many parts of India, the MSW is been looked at by the health department but now MSW problem has grown to such an extent that it needs a separate department with all administrative support that it needs. The health department on its own should not be handling the MSW issue. This requires a fleet of experts and the service providers that need to work round the clock to have check on this issue. To make the problem worse, the bureaucrats and political will power is lacking in case of city of Pune.

The existing infrastructure is not even enough to handle 1/4th the waste generated in the city. The service providers or experts needs to have a strong background on source segregation, collection & transportation and processing & disposal. However as on date there is no support for such activities which can be technical or commercially evaluated.

It is imperative that a Independent Engineer be appointed whenever a new concession agreement is being signed for MSW processing and disposal, the IE can not only monitor the implementation of concession agreement but also the EC condition and Consent to Operate conditions. IE can ensure proper infrastructure is in place for scientific processing and disposal of waste and also certify the work done at site and it can provide performance standards for making payments to concessionaire without any bias and prejudice.

7.4 Strategic Planning [not considered]

A lot of work had been undertaken and reports have been generated over the years including report from Experts such Dr. Modak, but no consideration was given to inputs from various experts. Schemes such as JNNURM had given a chance to Pune city to solve MSW problem but no serious work was done until now. The planning of MSW management in Pune has failed at multiple levels and needs serious interventions at all levels.

The strategy for development of Pune and the waste management solution needs to be in sync with its waste generation from various sources. Pune being an economic hub which covers industrialization to Information Technology hence the waste classification is from Hazardous Waste, Biomedical Waste, E-waste to Municipal Solid Waste. These aspects were covered by Dr. Prasad Modak in his strategic action plan for solid waste management in Pune.

To address the environment degradation due to solid waste, an Integrated Approach in line with Rules for each category of waste is required. In case of Hazardous Waste, Biomedical and E-waste there are dedicated facilities and treating waste scientifically. However the strategy for waste management requires a strong impetus on legal enforcement which is successfully achieved by regulatory authorities except for MSW.

PMC instead of relying on MPCB which has in past acted as PMC to ULB's for Bio-medical waste facilities, industrial waste management etc., relies on private consultants. The strategic plan for waste management of Pune does provide the road map for capacity building of not only PMC but also pollution control boards for better monitoring of MSW projects. The strategic action plan also micro plans for collection & transport of MSW with guidance to processing and disposal technologies of MSW based on practical experiences.

7.5 Adopted Use of Treatment Technologies

Bespoke solution to manage the MSW in city of Pune is required. The MSW problem should not be treated a common / superficial issue. Selection and implementation of the technology which is appropriate and is able to cater the quantities of MSW is necessary. A blind fold approach of technology selection has worsened the MSW issue in Pune.

MSW processing and disposal technology as per the MSW Rules, 2000 provides some guidance of the kind of technology that can be used; however local conditions, market etc. need to be considered before finalizing the technology. PMC has been advocated technologies of MSW processing using composting and RDF; however the both the byproduct do not have a feasible market especially RDF. The nearest cement industry for RDF sale from Pune in Maharashtra is in excess of 800kms and outside it is 300kms. RDF consumption requires NOC from home state.

Each technology may also need a PESTLE analysis Political Economic, Social, Technical, and Legal & Environmental.

While finalizing the treatment technology the following should be taken in to consideration:

- Waste characterization so as to know whether waste has more quantity of organics, in-organics, plastics, recyclables, inserts etc.
- Land availability and requirement
- The social acceptability of the technology or its mitigation mechanism
- Whether there is a market for the by-product such as compost, RDF, Power, Gas etc.

It is pertinent to not that a particular type of technology successful in one country cannot be made successful in another country. Similarly, each city in India requires a strong overview of local conditions before finalizing the technology based on and not restricted to the criteria mentioned above.

Technologies which have not been successful should not be introduced on commercial basis as there far too many unknown factors which can cause more damage than benefit. The selection and application of technology should be done after proper due diligence with the help of experts.

7.6 Economic Viability

While selecting and implementing a particular method or system of MSW management, a critical assessment of its economic viability including CAPEX & OPEX should be done. The existing systems in Pune fail the economic viability test and most of them are not fully functional or improperly managed due to financial reasons. Looking at the current situation, it can be inferred that the approvals to these systems were given without such financial assessment resulting in the failure of the system.

PMC should not look at economic viability only from the perspective of its own savings but also from the sustainability of the project over a long period. The selected developer should get reasonable tipping fee for covering the debt, interest, depreciation, salaries and other operating cost. The tipping fee should also be paid considering post closure maintenance of the landfill after completion of concession agreement.

The economic viability of project is of utmost importance, conserving money today by not providing sustainable waste processing and disposal will result in very high environmental liability for PMC. Given all these years nothing has been done, the environmental liability cost is piling up.

7.8 Tendering Process

This is one of the administrative procedures that may cause a delay or faulty system implementation. The tender document should be such that it should bring in the best and suited technology/system so that no further faults or mismanagement should occur. It should include and satisfy the needs of the environment & community without compromising on the economic viability to the vendor or to the administrative office of the government. The tender evaluation procedure should not only evaluate the financial parameters but also the technical parameters in terms of how the technology will be able to meet the environmental compliance.

7.9 Social Acceptance

Community or societal acceptance of a particular technology is very much important for the proper functioning of the system. Due improper handling of MSW aspects by local government, now there are litigations that have been filed against the existing MSW management systems in Pune, many of them are from individuals.

Urali Devachi has been the waste dumping ground for Pune for over 20 years. The local community was not taken in confidence whilst proposing then the dumping and now the treatment site. To make matter worst, the improper handling waste has created serious environmental & health concerns.

Looking at this scenario, the communities from newly proposed waste treatment sites including Tulapur, & Vadhu near Pune are protesting against these proposed waste treatment plants.

8.0 CONCLUSION

The Pune city is growing rapidly. Proper planning and strategic assessment is required for control over the population growth and migration of rural to urban areas resulting in the increased pressure on urban infrastructure including water supply, sanitation and municipal solid waste management. The cities are estimated to grow at high rate and by 2036 about 50% of population would be living in the city or urban conglomerations. Pune may not be exception.

Over the years, the regulatory authorities have promulgated various legislations/ regulations that are meant to control various types of pollution as well as for safe disposal of the wastes arising from various activities. Rules including The Municipal Solid Waste (Management and Handling) Rules, 2000, have directed the state governments to achieve various targets within specific time frame but its implementation and target achievement has not been done.

Situation analysis of Pune city with regard to MSW indicated that the regulatory compliance has not been satisfactory over the years. Since 2005, there have been several public agitations protesting against the mismanagement of the MSW in Pune. Legal actions, show cause notices and directions from MPCB have not yielded much success. Administrative actions by Pune Municipal Corporation (PMC) and spending lot of money could not successfully put in place an environmentally sound management regime for about 1600 MT of garbage generated daily in the city. The entire system of city waste management especially processing and disposal need through overall and a fresh look for protection of public health and environment. It high time that the PMC takes up this issue with systematic and scientific approach that should yield results in a time bound manner.

Information from various reports shows that currently Pune city generates about 1600MT/day of MSW but the MPCB's recent report on The Municipal Solid Waste (Management and Handling) Rules, 2000 suggests that only 60% of the city's MSW is being treated at various treatment sites & balance 40% of the MSW is still being dumped at the Urali Devachi site. Other information collected from MPCB suggests that not all treatment plants in Pune are running to the fullest capacity as well as not producing quality byproducts due to inefficient performance. Failure of these treatment plants is,

among other things, due to technology failure, economic un-viability, social rejection due to system mismanagement, passive approach of the regulatory agencies, wrong choice of technology applications, etc. High level bureaucratic and political willingness is essential to solve the issue.

This paper describes various technologies that are available but selection of the technology should be done with the help of strategic assessment whilst considering local conditions, environmental benefits, and economic viability for the stakeholders and social acceptance. Business model can be considered based on cost implications and treatment capacity of the plant.

Attempt has been made to identify various issues and problem areas which would have caused failure of MSW management in Pune city. Among other things, unrealistic MSW estimations, deficient infrastructure, weak institutional capacities, absence of strategic planning, choice of treatment systems which may not be appropriate to local conditions, social rejection, economically un-viable tariff, faulty tendering processes and mismanagement of MSW at various levels could have added to the failure of the system

Integrated planning, MSW estimations, suitable treatment technology with recovery & recycling options are utmost necessary in overall MSW management in Pune city. Thus, it is felt that the process of solid waste management needs critical review and a life cycle assessment of the entire system should be undertaken. A paradigm shift seems to be necessary while choosing new system for treatment & disposal options which should be environmentally sound, socialy acceptable, and economically viable. Performance of the technology applications must be ensured and guaranteed by the vendor.

9.0 RECOMMENDATIONS

Wherever time frame for taking action has not been fixed the action is recommended and shall be taken as per schedule hereunder:

S.No.	Activity	Time Frame	Agency
1.	M/s Hanjer Biotech Energy, at Urali Devachi, Fursungi may be continued with existing 200TPD operation with improved performance as per the contract, till new system is put in place. Thereafter, the agreement with M/s Hanjer shall be terminated. All efforts must be made to produce bio-composted manure and RDF.	4 months	PMC/MPCB
2.	M/s Rochem Separation System Pvt. Ltd. at Pune may continue with existing Phase 1 operation of 300TPD based on pyrolysis, gasification. The operations shall be stabilized so as to confirm to the performance standards and environmental regulations as given in agreement within 4 months, failing which, contract agreement shall be terminated. All efforts must be made to produce waste to energy based on pyrolysis and gasification.	4 months	PMC/MPCB

S.No.	Activity	Time Frame	Agency
3.	Vermicomposting plants of 200TPD operated by M/s Ajinkya Bio Fertiliser at Hadapsar and 100TPD by M/s Disha Waste Management Pvt. Ltd at Hadapsar shall be continued with improved performance as per the contract, till proposed new system is put in place. After which, the existing contracts shall be terminated.	4 months	PMC/MPCB
4.	Vermicomposting plants of 200TPD operated by M/s Ajinkya Bio Fertiliser at Hadapsar and 100TPD by M/s Disha Waste Management Pvt. Ltd at Hadapsar shall be continued with improved performance as per the contract, till proposed new system is put in place. After which, the existing contracts shall be terminated.	4 months	PMC/MPCB
5.	Realistic estimation of existing waste generation and future forecast for at least 20 years shall be carried out by engaging services of an expert agency of National / International repute. This will form a basis for capacity estimation of new system.	4 months	PMC
6.	i) Infrastructure for collection and transport of MSW shall be reviewed by engaging expert agency and action plan shall be prepared for daily collection of MSW in the city. ii) Secondary Collection mechanism should be based on compactors and bins. iii) Transfer stations should be modernized to ensure no re-handling of waste	3 months	PMC
7.	Approval of action plan for collection and transport of MSW and its implementation. Financial institutions can fund based on PPP model.	1 year	PMC / State Govt. / Financial Agency(s)
8.	Institutional Capacities for Governance: i) 2 weeks training program for 15 officers (High and Middle level) of PMC (10), MPCB (2), State Environment Department (2) and Directorate of Local Self Govt. (1) including field visits shall be arranged which will include 1 week in India and 1 week abroad to study waste to energy plants based on mass burning. MPCB shall prepare the Course content in consultation with experts in the field. ii) Standard Operating Procedures (SOP) shall be prepared and implemented by PMC for collection, transport, treatment and disposal operations of MSW and its web based public reporting.	6 months	PMC / State Environment Department / Directorate of Self Govt.

S.No.	Activity	Time Frame	Agency
9.	iii) Schedule and procedures of monitoring of MSW management shall be prepared and implemented by MPCB in a transparent manner Strategy : i) It is experienced that MSW treatment and disposal based on composting, bio-methanation, gasification / pyrolysis has failed due to obvious reasons and therefore, waste to energy operations based on mass burning using grate technology should be used. ii) The capacity suggested is 2 x 600 TPD plant producing about 48MW gross thermal energy and 11.5 MW gross power output with conversion efficiency of 25% or more. There are at least 8 to 10 companies across the world that can provide such technology in a competitive manner. iii) Electrical energy produced shall be fed into power transmission grids iv) Secured landfill shall be provided for disposal of ash and other inert material, if any.	Immediate	PMC
10.	i) Treatment technologies to be adopted for Waste to Energy based on Mass Burning shall be as under or equivalent: ii) Low capital cost expected, say, about Rs.12Cr (2014 price) with standardized design and “chute to stack” technology as well as material handling iii) Technology is based on low calorie MSW input in the range of 1100 to 2200kcal/kg iv) Air cooled Grate type furnace v) Energy recovery with boiler and turbine vi) Flue gas treatment to meet emission standards as per European Directives, 2000 (Minimum) vii) MSW capacity 2x600 TPD in phase 1 viii) Net calorific value 6.9 MJ/kg ix) Thermal capacity 2 x 48 MW x) Steam 2 x 57 t/h (46 bar, 410°C) xi) Gross Power 2 x 11.5 MW xii) Corporate Guarantee from Technology Supplier	Immediate	PMC
11.	Economic Viability: i) In order to ensure institutionalization of environmentally sound management of the MSW as envisaged in the MSW Rules, 2000, the	Immediate	PMC

S.No.	Activity	Time Frame	Agency
	techno-economic viability of the project important. Revenue generation depends on the technology application and so does the capital cost requirements. Possible revenue generation per ton of MSW processed and technology application should be worked out, for example:· ◆ Capital Cost (Capex Rs./T):· ◆ Revenue generation(Rs/T):· ◆ Operating cost (Opex Rs./T):· ◆ Revenue / Capex normalized:· ◆ Payback Period (years): ii) User fee for collection and transport shall be charged for households, commercial establishments, offices, etc.		
12.	Social Acceptance: Wide public consultation and elucidation of public opinion shall be carried out by the project proponent as envisaged in the Environment (Protection) Act, 1986, and Rules made thereunder.	Immediate	PMC/Project Proponent
13.	Tendering Process: i) The project operator shall be selected based on International / National competitive bidding process. ii) Detailed Project Report (DPR) and Bid document shall be prepared by an expert agency iii) Project Management Consultant (PMC) shall be appointed to facilitate the implementation of the project under the overall guidance and supervision of the Steering Committee. iv) A Steering Committee comprising of a group of experts under the Chairmanship of an eminent environmental scientist shall be appointed for overall implementation of project. v) PMC shall report to the Steering Committee and concerned department in the PMC shall provide required ministerial and administrative support.	Immediate	PMC/Steering Committee/ Project Management Consultant.

10.0 REFERENCES

- *Asolekar, S. 2014. Expert Opinion on Significance of Waste to Energy Technologies. Decision Matrix for Comparison of Centralized and Decentralized Management of MSW.*
- *Census India.2011. URL: http://censusindia.gov.in/*
- *European Commission (EC) – Directorate General Environment. 2003. Refuse Derived Fuel, Current Practice And Perspectives (B4-3040/2000/306517/MAR/E3). Final Report*
- *Kwon, E., Westby, K. J. and Castaldi, M.J.2010. Transforming Municipal Solid Waste (MSW) into Fuel via the Gasication/Pyrolysis Process. Proceedings of 18th Annual North American Waste to Energy Conference. NAWTECH18-3559.*
- *Maharashtra Pollution Control Board (MPCB). 2014. Status of Municipal Solid Waste Management in Municipal Corporations (Maharashtra). URL: http://mpcb.gov.in/ereports/pdf/Mumbai%20Booklet%20Final%20All%20171%20Pages%20new%2085%20to%20126%20New.pdf (accessed on 16/06/14)*
- *Ministry of Urban Development (MoUD). 2011. URL: http://indiagovernance.gov.in/files/urbandemographictransition.pdf*
- *Modak, P. 2007. Strategic Action Plan for Integrated Solid Waste Management Plan, Pune (Vol. I). Prepared for UNEP, DTIE, IETC & Pune Municipal Corporation*
- *National Institute of Urban Affairs (NIUA). 2011. India's Urban Demographic Transition. The 2011 Census Results (Provisional).*
- *Pune Municipal Corporation (PMC). 2012. Pune City Sanitation Plan, 2012. URL:http://www.urbanindia.nic.in/programme/uwss/CSP/Draft_CSP%5CPune_CSP.pdf (accessed on 100314)*
- *Urban Development Department, Government of Maharashtra (UDD, GoM), 2014. Draft notification to alter the limits of the city of Pune. Gazette of Government of Maharashtra dated 29/05/2014.*
- *Urban India. URL; http://urbanindia.nic.in/publicinfo/swm*

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