



Waste to Energy

(ENERGY REVOLUTION FROM MUNICIPAL SOLID WASTE)

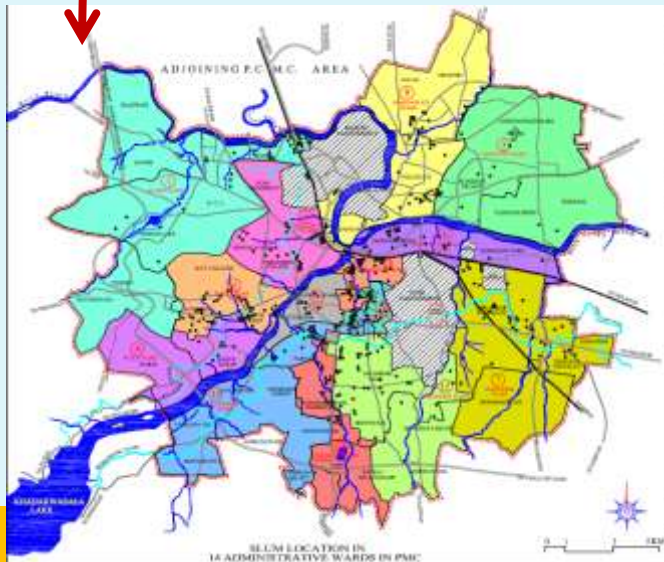
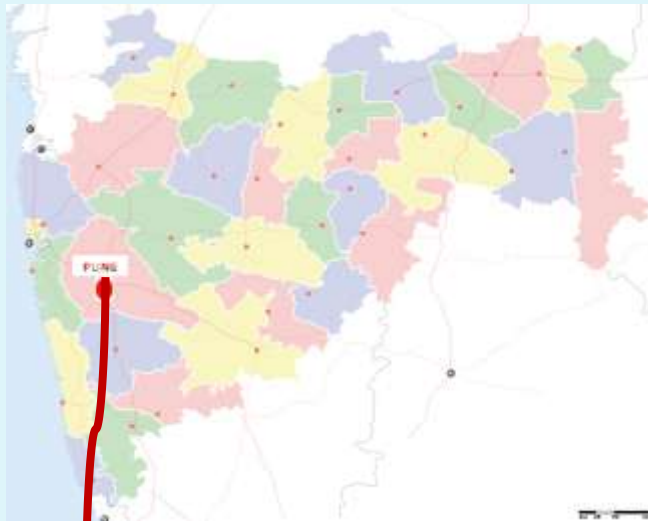
Dr. Ketaki Ghatge

Divisional Medical Officer , Pune Municipal Corporation





PUNE CITY



- Pune is the 8th largest city in India and the 2nd largest in the state of Maharashtra.
- Population ; about 4 million
- Households ; nearly 1 million
- Area of city is 250 sq. kms.
- 4 Zones ; 15 Administrative Ward Offices ; 76 Prabhags

BACKGROUND

Rapid urbanization
Changing consumer habits
Space constraints for processing

Change in quality and
composition of waste generated

Innovative and sustainable
solutions

Segregation at source and
decentralised processing of
waste



Sources and Composition of MSW

S N	Source of generation	Quantity(MT)	% of total
1	Household	950	69.1
2	Street sweeping & drainage cleaning	140	10.2
3	Hotels & restaurants	150	10.9
4	Markets / commercial area	50	3.6
5	C and D Waste	75	5.5
6	Fruit, vegetable, fish meat market waste	7.5	0.5
7	Biomedical waste	1.8	0.1

Description	Percentage
Organic Matter	45 to 50
Recyclables from Residential & Commercial	35 to 40
Inert Material	10 to 15
Other Parameters	• Density • GCV • C/N
	• 437 Kg/m³ • 937Kcal/Kg • 22.85

INTEGRATED SOLID WASTE MANAGEMENT



Vehicle Name	Nos.
Tipper Trucks	158
Compactors	12
Hotel Trucks	23
Tractors	10
Dumper Placers	89
Bulk Refuse Carrier (B.R.C.)	65

Year	Population	Waste Generation (TPD)
2011	3,115,431	1374
2021	4,487,573	2277
2031	6,211,404	3625
2041	8,597,417	5771

OVERVIEW OF WASTE MANAGEMENT



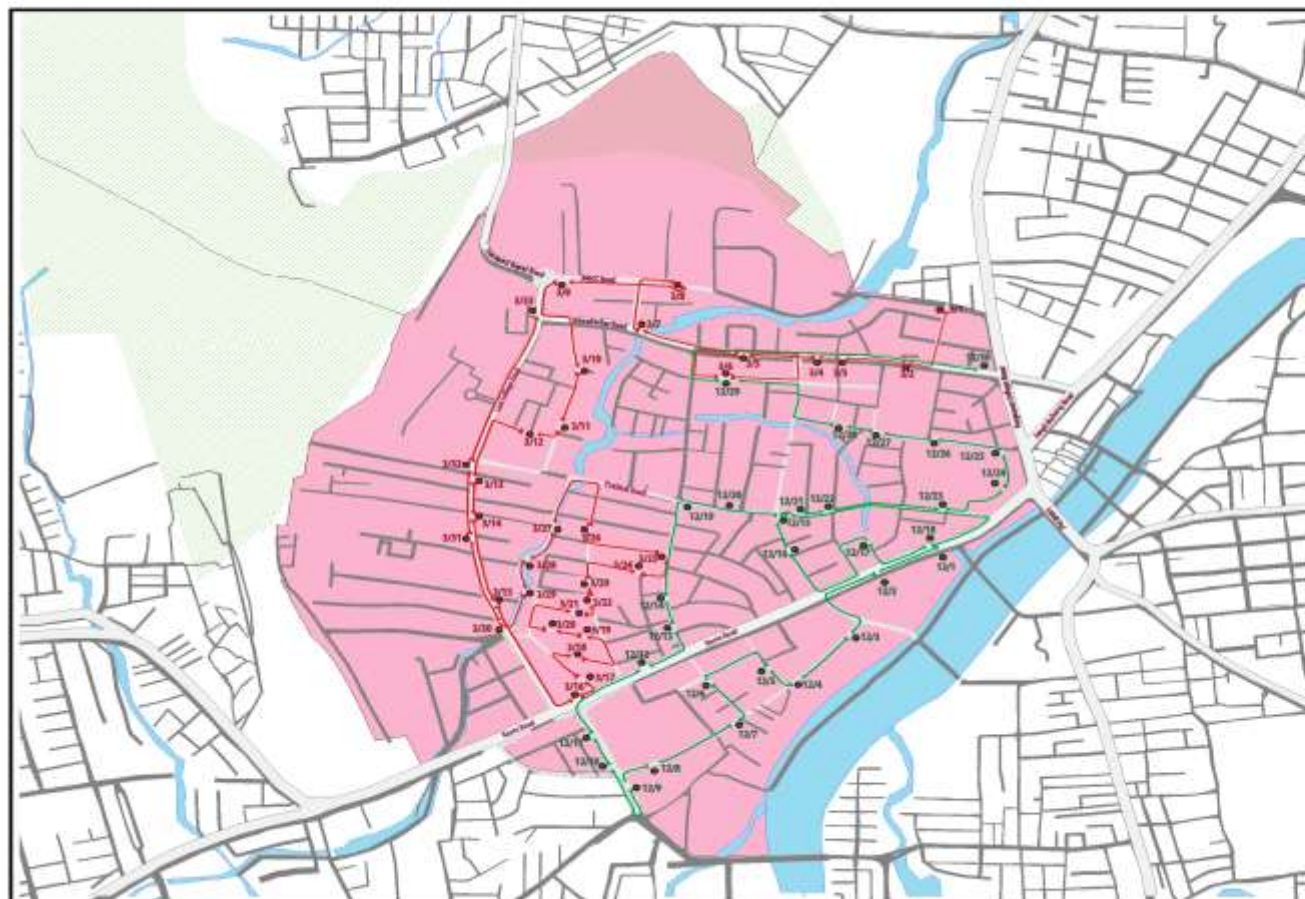
- Pune generates about 1600 tons of solid waste per day.
- 158 trucks collect waste door-to-door, collecting an average of 197 tons per day.
 - 60% of households have door-to-door coverage.
 - 44% of households provide segregated waste.
- 973 containers and 203 compactor buckets dispersed around Pune.
- SWaCH Cooperative, which is wholly owned by waste pickers, also provides services.
- Ward wise average- 350 to 750 gms per capita per day

PERFORMANCE BASED SLBS



Sr. No.	Performance Indicator	Expected	2010	2012	2014
1	Household level coverage of solid waste management services	100	52.70	54.50	60
2	Efficiency of collection of municipal solid waste	100	100.00	100	100
3	Extent of segregation of municipal solid waste	100	27.96	43.27	44
4	Extent of municipal solid waste recovered	80	85.00	85	85
5	Extent of scientific disposal of municipal solid waste	100	100.00	100	100
6	Extent of cost recovery in solid waste management services	100	60.88	80	80
7	Efficiency in collection of solid waste management charges	90	67.00	79.99	81
8	Efficiency in redressal of customer complaints	80	84.74	88.9	91

GHANTAGADI ROUTE MAP



No.	Feeder Point	Time
1.	Near Gupta Hospital	0800
2.	Near Balakrishna School	0815
3.	Near Virendra Mitra Mandir	0830
4.	Spencers Bldg, Bhanderkar Road	0845
5.	Near Quarters, Bhanderkar Road	0900
6.	Kanodia Park	0915
7.	Near Kala Path Container	0930
8.	Jala Hotel	0945
9.	NCC Headquarters	1000
10.	Near Lane 35 Container	1015
11.	Near Indradevi Path Container	1030
12.	Sw. Lefekar Chowk	1045
13.	Near Business Guild, Ram Mandir	1100
14.	Minor Apartments, Law College Road	1115
15.	Krishna Kunj Apartments, Law College Road	1130
16.	Vijay Apartments, Karve Road	1145
17.	Shiksha Apartments, Shanyale Lane	1160
18.	Kumpha Apartments, Kirloskar Path	1175
19.	Prabodhan Apartments, Raga Marg	1190
20.	Mahatma Bunglow, Raga Marg	1205
21.	Near Prabodhan Container	1220
22.	Sachin Bunglow, Ayakar Bhawan	1235
23.	Wardah House Society	1250
24.	Parthasarathi Sahakar Sadan	1305
25.	Anand Apartments, Throat Colony	1320
26.	Pragati Apartments, Ayakar Bhawan Road	1335
27.	Near Lalitlal Container, Teral Road	1350
28.	Near Hajar Kuchi Container	1405
29.	Hajar Kuchi, SMT	1420
30.	SMT College Gate	1435
31.	File and Television Institute	1450
32.	Hotel Banerji, Law College Road	1505
33.	Bhanderkar Institute	1515

No.	Feeder Point	Time
1.	Karve Road Post Paraswati Kuvda	0800
2.	Abhayareshwar Ganesha College	0815
3.	Central Mail Mailheadman	0830
4.	Khyatnadi Wasti number 35	0845
5.	Near Hall Margal Kuvda	0900
6.	Bhanderkar Wasti, Siddharth Hall	0915
7.	Hotel Kuvda	0930
8.	Near Agraharambhal Kuvda	0945
9.	Raja Mahesh Mahesh	1000
10.	Semadra Hotel	1015
11.	Mahadevi Panavale	1030
12.	Kanet Petrol Pump Karve Road	1045
13.	Nipravara Kuvda School, Bhonde Colony	1100
14.	Shantidul Kuvda Path, Bhonde Colony	1115
15.	Kachinadi Chowk	1130
16.	President Hotel Chowk	1145
17.	Maharaj Bhon Path, near Ganesha College	1160
18.	Sahyadri Hospital Chowk	1175
19.	Shiksha Chowk, Pratihag Road	1190
20.	Pratihag Road, Lane 20 and 21	1205
21.	Pratihag Road, Lane 6 and 7, near Lawman Hotel	1220
22.	Kolkar Nursing Home Lane 3, 4	1235
23.	Deccan Police Station	1250
24.	Wing Mahesh, near Post Office	1305
25.	Chitale Container	1320
26.	Near Deccan Sport Ground	1335
27.	Near PPC Ground	1350
28.	Near Mahadevi Container	1405
29.	Near Kanadia Path	1420
30.	Kuvda Chowk	1435

Serjany Inspector—Serjany Dhanwant
Mobile 94206-31879

Driver for route 12:—Dhanwant Tibkar
Driver for route 12:—Bharat Chavan

INTERMEDIATE TRANSFER STATION



BEST PRACTICES TO GENERATE WEATH OUT OF WASTE



- No open dumping and 100% scientific processing of waste
- Integrating Informal Sector in Municipal Solid Waste Management
- Pune's Trash Solution: A Zero Garbage City
- Biomethanation cum power generation plants
- Waste to energy – Plasma gasification
- Mandatory onsite disposal in post 2000 residential and commercial schemes

BEST PRACTICES (CONTIN)

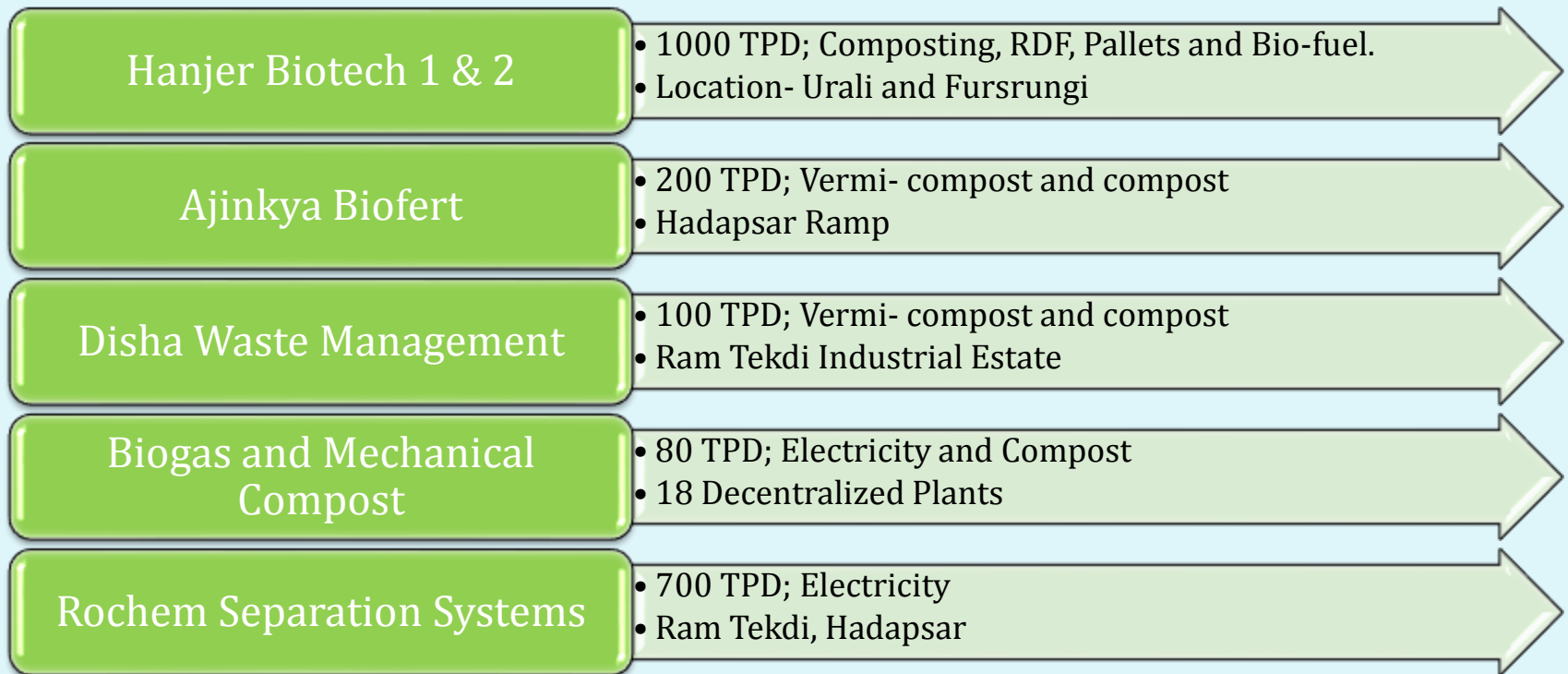


- Data collection for MIS using Mobile SMS and Biometric attendance
- ALERT G-Complaint Redressal through citizens participation
- Celebration of Ganesh Utsav in Eco friendly manner
- Sonia gram udyog prakalp for plastic recycling
- Shredding and composting of garden waste

CURRENT PROCESSING OF WASTE



- No open dumping since June 2010; scientific processing only.
- Decentralized waste processing plant.



THEORY OF SOLID WASTE MANAGEMENT



There are two aspects to the challenge, the

1. **Social Engineering (Segregation, Collection & Transportation).** - The social engineering deals with the ethics and efficiency for maintaining environment.
2. **Technology Application (Processing & Disposal)** - The technology application deals with the improvement of assimilative capacity as well as supportive capacity of environment.
3. **Waste Management** - In the case of waste management, it is, broadly, the practice of **Reduce, Reuse Recycle & Recover.**

TECHNOLOGY OPTIONS FOR MSW MANAGEMENT

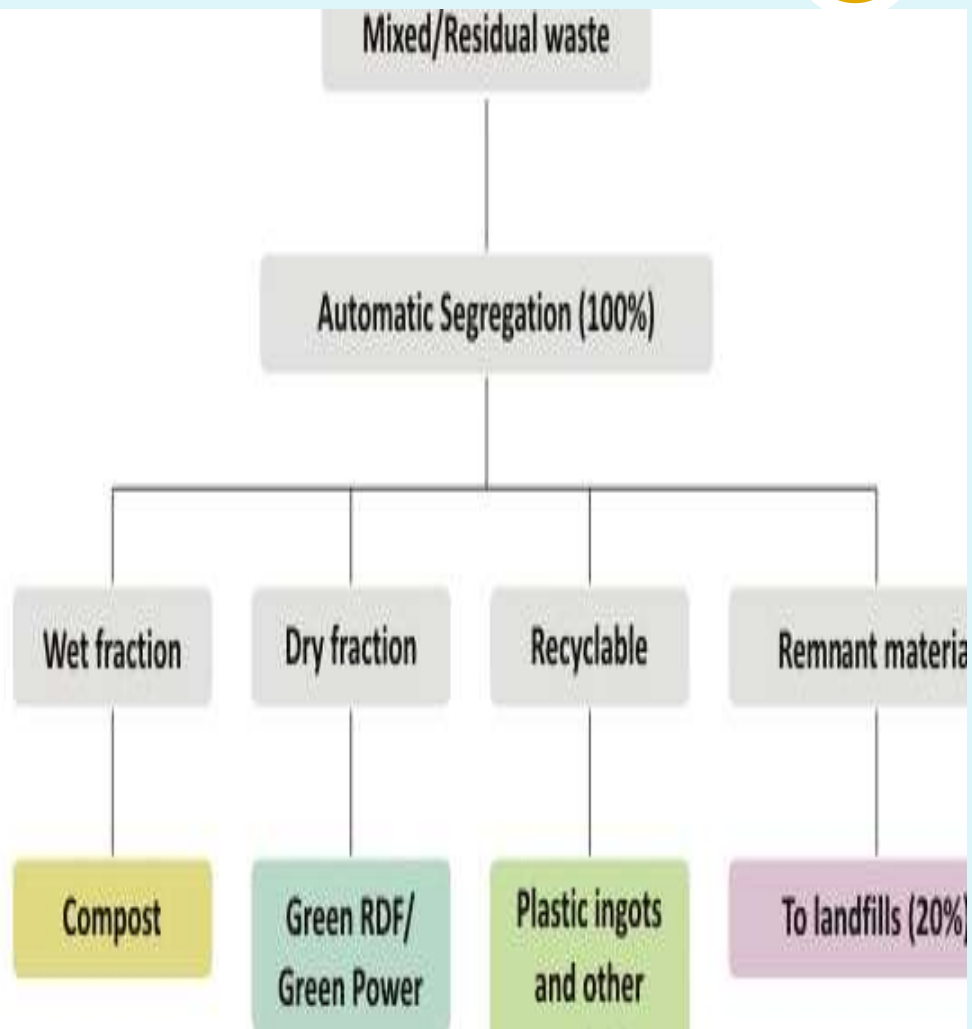


1. The technology options available for processing the Municipal Solid Waste (MSW) are based on either bio conversion or thermal conversion.
2. The bio- conversion process is applicable to the organic fraction of wastes, to form compost or to generate **biogas** such as methane (waste to energy) and residual sludge (manure).
3. Various technologies are available for **composting** such as aerobic, anaerobic and **vermi-composting**.
4. The thermal conversion technologies are **incineration** with or with out heat recovery, **pyrolysis** and **gasification**, **plasma pyrolysis** and **pelletization or production of Refuse Derived Fuel (RDF)**.



Refuse Derived Fuel

DETAILS OF HANJER PLANT



Capacity 1000 Tons per day
Bioorganic fertilizer from waste
Green fuel(RDF) from waste
Dry municipal solid waste is dried, crushed, screened and packed into brick form, used as substitute to conventional fossil fuels in boilers.

ADVANTAGES OF HANJER PLANT



- Proven and times tested technologies for Heterogeneous Indian Garbage.
- Suitable for the Indian cities generating more than 50Tpd MSW
- Reduces the consumption of land for scientific landfill with residue inert
- Reduces air pollution caused by unscientific dumping and burning of MSW
- Reduces health problems around the MSW dumping ground
- Avoids underground water contamination
- Reduces financial burden for MSW disposal on the Urban Local Bodies
- All product extracted and processed are eco friendly
- Minimum content of biodegradable matter in processed remnant reduces methane emission

RDF (Refuse Derived Fuel) Characteristics

- Calorific Value: 2500 – 3000 Kcal/Kg.
- High Volatile Matter (60%).
- Emission characteristics of RDF are superior compared to coal with less NOX, SOX, CO & CO₂.
- Bio fertilizer and the Fly ash are the useful by products

Proximate Analysis	in %
Moisture	7.2
Volatile Matter	64.6
Ash Content	21.9
Fixed Carbon	6.3
Carbon	36.7
Hydrogen	5.3
Nitrogen	1.21
Sulphur	0.32

HANJER BIOTECH – COMPOSTING & RDF



Disadvantages :

1. Least suitable for aqueous/ high moisture content/ low Calorific Value and chlorinated waste .
2. Excessive moisture and inert content affects net energy recovery; auxiliary fuel support may be required to sustain combustion.
3. Concern for toxic metals that may concentrate in ash, emission of particulates, SO_x, NO_x, chlorinated compounds, ranging from HCl to Dioxins.
4. Market availability for RDF
5. High Capital and O&M costs. Skilled personnel required. for O&M.
6. Overall efficiency low for small power stations .
7. Transportation costs to process in centralised manner



“Gasification”

What is “Gasification”?

“Gasification” is a process where waste is deposited in a closed container and burnt up at temperatures between 300 and 500 °C in an atmosphere with low oxygen content (approximately 6% in volume).

As a consequence, carbon bonds in complex molecules are broken and simpler chemical compounds are obtained. Thus, a “molecular dissociation” process is carried out, which brings to the formation of the so-called “Syngas”, mainly a mixture of

- Carbon Monoxide
- Hydrogen



ROCHEM SEPARATION SYSTEM (Plasma Pyrolysis Gasification)

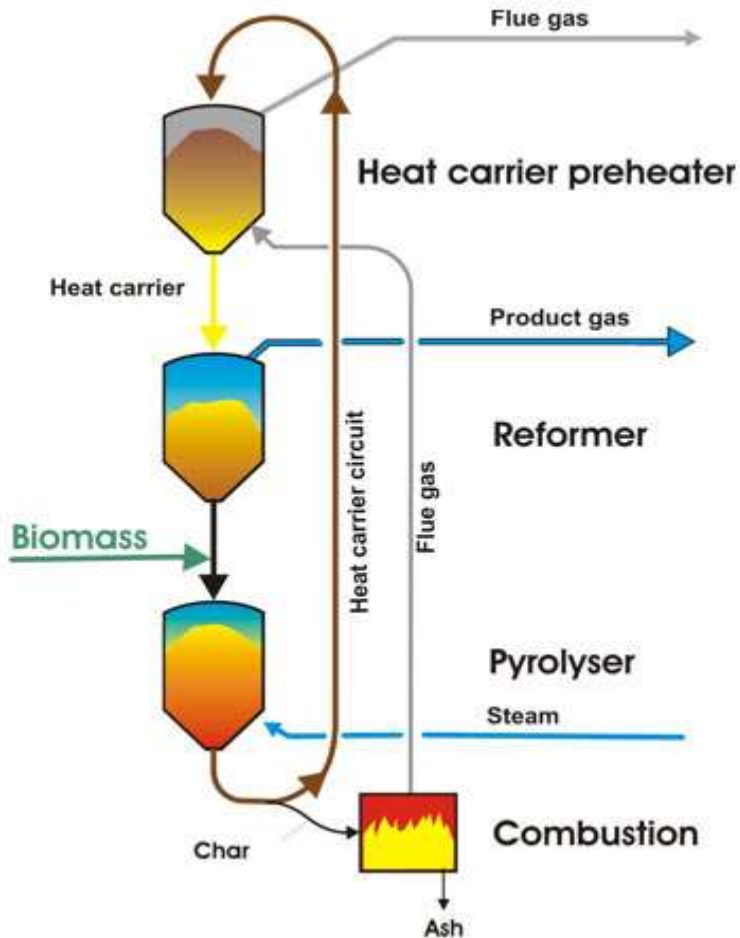


Pune is the **pioneering city** in the country to set up such plant for MSW treatment and electricity generation



Test Plant in Herten, Germany

DETAILS OF ROCHEM PLANT



1. MSW Processing plant of capacity 700 TPD
2. Technology: Gasification/Pyrolysis
3. Output: Electricity generation 10 MW.
4. DBOOT basis
5. Space Requirement: 10000 sq mts
6. Waste disposal in 48 hours
7. Less inert material after treatment

Rochem Separation System



ADVANTAGES OF ROCHEM PLANT



- From input of 250 MT MSW per day 2.5MW electricity .
- After Processing of 700 MT/ day MSW, Only 30 MT/ day of ash will be leave for disposal .
- Will stop methane emissions from that much MSW of 700 TPD & help to preserve the environment around the Pune city.
- Less space reuired and less inert material left after treatment

A unique advantage of the CB plant



Desired input and output can be changed as required, depending on the market economics of selling the following:

- High quality, high energy value Syngas: Can be used in gas powered electric generating motors or as a replacement or blender for natural gas.
- Hydrogen: is currently used in a multitude of industrial and manufacturing applications and holds great potential in automotive hydrogen fuel cell technology.
- Electricity: Turnkey system creates electricity via proprietary Syngas firing gas-motors.
- Bio Char: Is currently used in fertilizer and as a soil amendment, as well as its environmental value as a sequestered carbon.

Disadvantages of Rochem plant



- High Capital investments as well as O & M costs
- Quality of syngas to be maintained
- Tariff rate finalization for selling electricity
- Sanctions from MERC
- Net energy recovery may suffer in case of wastes with excessive moisture
- High viscosity of pyrolysis oil may be problematic for its transportation & burning



“Biomethanation”

WHAT IS BIOMETHANTION



- 40-45% urban solid waste is the organic can be easily treated by anaerobic digestion.
- Solid waste is treated in closed vessels where, in the absence of oxygen microorganisms break down the organic matter into a stable residue, and generate a methane-rich biogas in the process.
- It produces methane and carbon dioxide rich biogas suitable for energy production and hence, is a renewable energy source. The nutrient-rich solids left after digestion can be used as a fertilizer.

**Technical & Commercial Viability of Segregated Organic MSW Based
Decentralized Biogas Plants**

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Plant Capacity	5 TPD
Potential Sectors	Hotels / Resorts / Academic Institutions / IT Sector/ Industrial Canteens/Townships / Community Canteens etc.
Project Inputs	Area – 600 Sqmtr. Water – 5 Cum./day Electricity – 40 kWh/day
Project Output	Biogas – 250-300 Cum./day Manure – 500 Kg./day Liquid Manure – 7500 Liters/day Recirculation - 3000 Liters/day

Techno-commercial Viability of Decentralized Biogas Plants

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Project Economics - If Biogas is utilized for Thermal Application	
Plant Cost	Rs. 90.00 Lakhs
Biogas Generated	300 Cum./day
Equivalent LPG	126 Kg./day (@ 6 ½ Commercial LPG Cylinders / day of 19 Kg. each)
Annual Savings due to Biogas (Considering 330 operating days)	Rs. 38.61 Lakhs (6½ Cylinders X Rs.1800/- per Cylinder X 330 days)
Annual Savings due to Manure	Rs. 1.80 Lakhs (150 TPA X Rs.1200 / MT)
Savings to ULB in Transportation of Wastes to Landfill Site	Rs. 11.50 Lakhs (5 TPD X Rs. 700/- / Tone X 330 Days)
Savings (Electricity + Manure +Tr.)	Rs. 51.91 Lakhs
O & M Cost	Rs. 8.00 Lakhs / Year
Net Savings	Rs. 43.91 Lakhs
Simple pay-back period	2½ Years

Techno-commercial Viability Of Segregated Organic MSW Based Decentralized Biogas Plants

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Project Economics - If Biogas is utilized for Electricity Generation	
Plant Cost	Rs. 120.00 Lakhs
Biogas Generated	300 Cum./day
Electricity Generated	400 kWh /day
Auxiliary Consumption	@ 50 kWh/day
Annual Savings due to Biogas (Considering 330 operating days)	Rs. 7.50 Lakhs (350 kWh/day X Rs.6.50 /kWh X 330 days)
Annual Savings due to Manure	Rs. 1.80 Lakhs (150 TPA X Rs.1200 / MT)
Savings to ULB in Transportation of Wastes to Landfill Site	Rs. 11.50 Lakhs (5 TPD X Rs. 700/- / Tone X 330 Days)
Savings (Electricity + Manure + Tr.)	Rs. 20.80 Lakhs
O & M Cost	Rs. 9.50 Lakhs / Year
Net Savings	Rs. 11.30 Lakhs
Simple pay back period	8 Years

Techno-commercial Viability Of Decentralized Biogas Plants

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INDIRECT SAVINGS

Savings in Conventional Fuel - Coal to Electricity	100 Tones / Year
Stopping Release of Methane to the Atmosphere	54,000 Cum./Year
Generation of Employment	5 Persons
Volume saved at Landfill / Open Dumping Site	3000 Cum.
Stopping Ground Water Pollution at Open Dumping / Landfill site	

Decentralized Biomethanation Plants

Sr. No	Location of Biomethanation Plants	Capacity of Plant
1	Aundh Ward Office	5 TPD
2	Katraj Railway Musiam	5 TPD
3	Bavdhan	5 TPD
4	Hadpsar	5 TPD
5	Model Colony	5 TPD
6	Peshawe Park 1	5 TPD
7	Peshawe Park 2	5 TPD
8	Dhanori	5 TPD
9	Taljai Pathar 1	5 TPD
5	Taljai Pathar 2	5 TPD
11	Phule Nagar	3 TPD
12	K K Market	5 TPD
13	Katraj 1	5 TPD
14	Katraj 2	5 TPD
15	Katraj 4	5 TPD
16	Katraj 4	5 TPD

New Biogas Plants

Sr. No	Location of Biomethanation Plants	Capacity of Plant	Date of Project Starts	Expected Date of Complete Comissioning
1	Baner	5 TPD	01/04/2014	01/07/2014
2	Vadgaon Khurd	5 TPD	15/04/2014	15/07/2014
3	Vadgaon Khurd	5 TPD	15/04/2014	15/07/2014
4	Vadgaon Sheri	5 TPD	15/04/2014	15/07/2014
5	Yerwada	5 TPD	31/03/2015	01/07/2015
6	Wanawori	5 TPD	01/04/2014	01/07/2014



Disadvantages :

- 1. Unsuitable for wastes containing less organic matter.**
 - 2. Requires waste segregation for improving digestion efficiency.**
-
- 1. Longer Stabilization Time**

REDUCING CARBON EMISSION WITH ECOFRIENDLY TECHNOLOGIES



- The total CO₂ equivalent emissions could have been **5.58 times** the current emissions in case PMC had not installed the scientific technologies to process MSW in Pune city

POTENTIAL USING DIFFERENT TECHNOLOGIES



- Combined treatment for sewage and organic waste
- Vehicle fuel generation from biogas
- Compression of Biogas.
- Research on ethanol production from biomass / garden waste.



UNIQUE COMBINED TREATMENT (Organic waste and Sewage)



Particulars	Specifications
Capacity	Food Waste: 550 Kg/Day Sewage: 310m ³ / Day
Area Required For Biogas Plant	Approx. 200 sq.m.
Anticipated Biogas Generation	Approx 1,700 – 1,800 cum / month Equivalent to 765 Kg - 800 kg of LPG per month
Anticipated Bio-Manure Generated	Approx 20 ton/annum (bio-manure to be removed periodically)
Water Required	Approx.0.55 cum per day

Integrated Resources Management

WASTE LOOP



RENEWABLE ENERGY LOOP



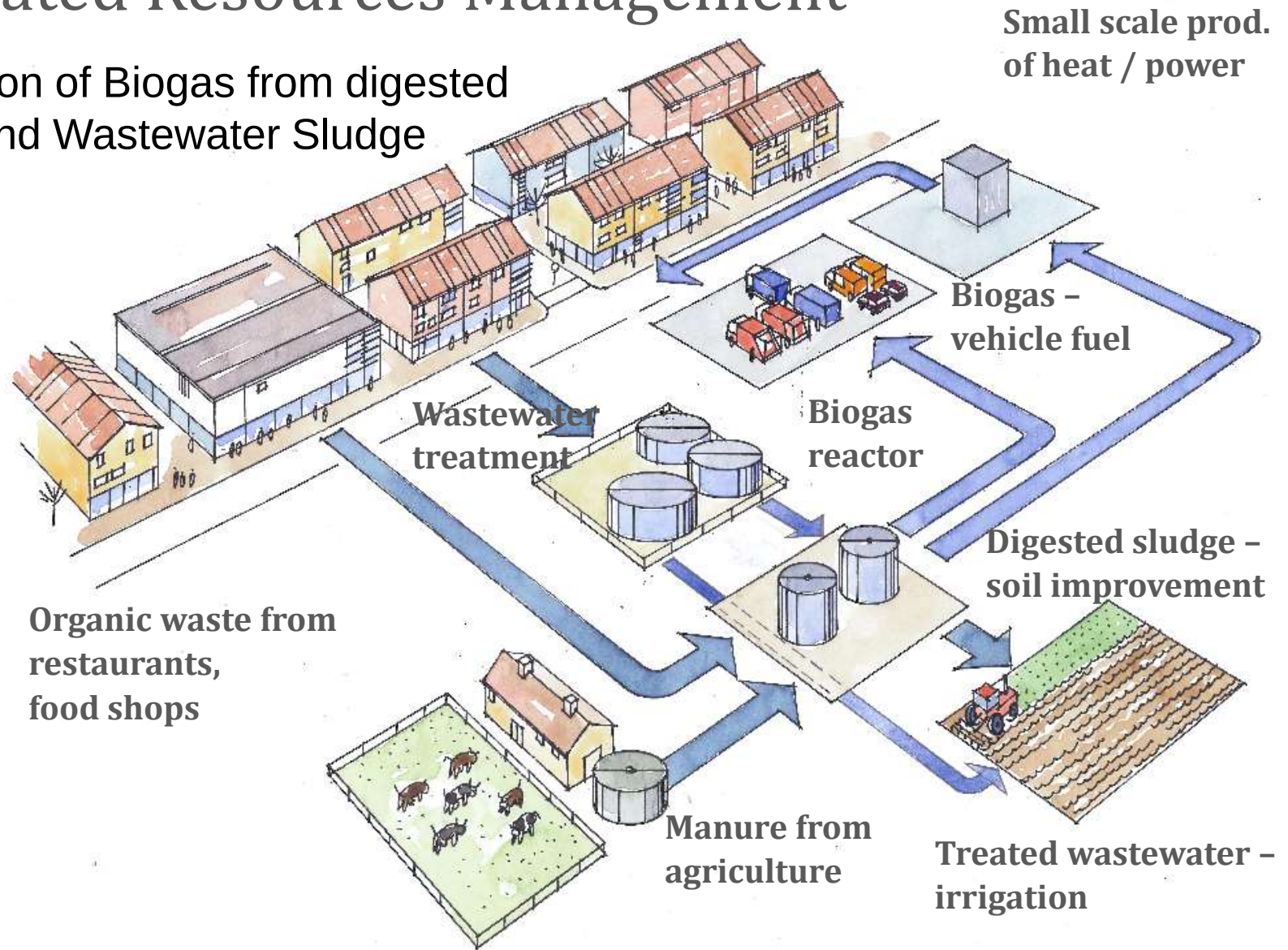
Principles for integrated approach on energy, waste and water into closed loop systems



WATER LOOP

Integrated Resources Management

Production of Biogas from digested
Waste and Wastewater Sludge



Synergies between WATER & SEWAGE, WASTE and ENERGY

MSWM: FUTURE SCENARIO AND CHALLENGES



- The land available for treatment & disposal shrinks everyday
- Lack of awareness among citizens and less political support resulted in limited community participation
- The limitations of the existing treatment processes will dictate implementation of more efficient treatment like plasma gasification & reduction in residues for landfill.
- Local waste management will form the centre-piece of MSWM strategy. This practice must continue zone-wise.
- Movement of waste will become problematic & costly.
- E Waste management will pose major challenge as the city is a major IT / ITES hub & the e-waste generation could reach over 4,000 to 5,000 MT per year.
- C & D waste would be over 35000 to 50000 TPY and shall need new locations for disposal.

VISION 2020 : FUTURE PLANS



- Build and operate higher capacity projects
- Land identification and acquisition
- Separate byelaws for MSW and debris
- Develop independent processing facility for e-waste
- Awareness generation for Reduce, Recycle and Re-use
- Provide incentives for recycling
- Decentralization of administrative power
- Encourage private and public participation
- Promote employment opportunities in wealth creation through waste
- Carbon credit
- Monitor progress at regular intervals using technology
- Work with state and central govt. to overcome bureaucratic hurdles

ACHIEVEMENT @ A GLANCE



- **SWaCH model :**
 - Saved more than Rs. 15 crores per annum in waste handling costs
 - Collect recyclable materials that amount to **20%** of municipal solid waste
 - They save Greenhouse Gas Emissions of **2,94,316 Metric Tonnes of Carbon Dioxide Equivalent (mtCO₂-eq)** per annum (2006)
- **Zero Garbage Ward**
 - Improved service delivery of DTDC and segregation of waste and reduced transportation cost.
 - ISO Certification for Decentralized Solid Waste Management System: Easy to transfer and replicate
- **Energy generation :** About 1 MW energy from 100 tons of organic waste using biogas (*Pay back period 5-6Years*)
- About 2.5 MW of energy from 250 Tons of waste by using plasma pyrolysis technology

Less space required, no capital cost, and share in Carbon credits.
- 100 percent scientific disposal since 2010 and no open Dumping - *Scientific land filling & Capping*

Recognition



- Vasundhara Award 2013 by Maharashtra Pollution Control Board for best practices
- Vasundhara film Award 2013 for - Awareness film '*Kachara Muktnichya Dishene*'
- HUDCO Awards for Best Practices to “ Improve the living Environment 2012-13”
- ICON SWM 2012- Award of Excellence in SWM.
-By International Society of waste management, Jadhavpur University & Karnataka Govt,2011-12.
- NagarRatna Award by JNNURM in 2010-2011.
- Skoch - Digital Inclusion Award:- The
-Benchmark of Best Practices 2013.
- APTDC award 2013 – Runner-up for SWaCH model and PMC best practices





Hon. Dr. Ishar Ahluwalia's visit to biogas plant



Hon. Shri Mahesh Pathak sharing Pune Biogas experiences with Hon. Dr. Montek Singh Ahluwalia



Hon. Dr. Montek Singh Ahluwalia's visit to biogas plant



Hon. Shri Arun Myra's and Shri Suresh Jagtap at Peshwe Park biogas plant



CONCLUSION



Pune Municipal Corporation has a head start in MSWM over other ULBs in India.

The ethos and working culture of the MSWM staff at all levels is conducive to up-gradation of the existing treatment and disposal options.

The 2043 horizon will require management of about 5000 TPD waste with state of the art reduction technologies for resource & energy recovery.

Higher degree of mechanization and enhanced monitoring techniques will need to be employed.

Emphasis will also shift to full consumption of treated waste products within the city limits.

Emphasis will also be on reduction of residues to go into landfill.

CONCLUSION



- The city has taken multi dimensional approach to overcome the challenges of urbanization.
- The solution lies in using different technologies tailor made to solve the specific needs of the problems at local level.
- Citizen and Governance have come together and mutually agreed to execute solutions.
- Pune- An Emerging ECO-Friendly City.



Thank You for patiently listening...



Pune Municipal Corporation, Maharashtra