



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

WASTE TO ENERGY CONVERSION

INTRODUCTION -1

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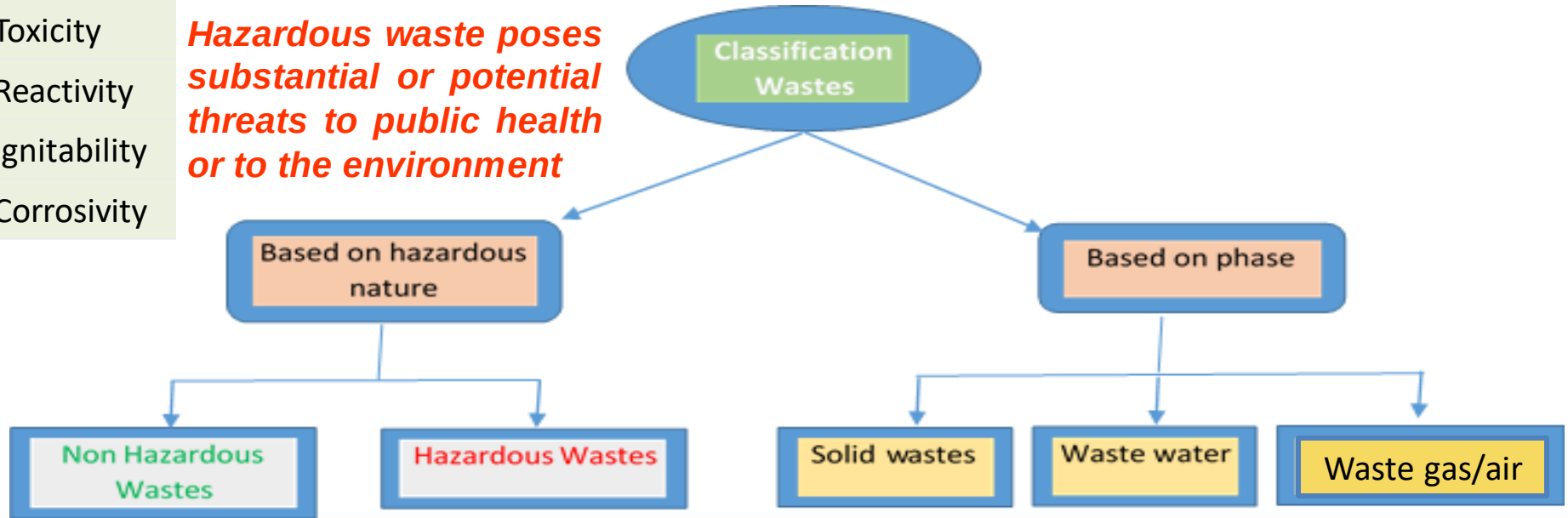
- Definition of wastes and their classification
- Important quality parameters of different types of wastes
- Wastes suitable for energy production
- Solid wastes and their classification
- Waste water and their classification
- Availability of agro based, forest, industrial and municipal solid wastes in India vis-a-vis world
- Availability of Wastewater in India, vis-a-vis world
- Routes for solid wastes management
- Need of energy production from wastes
- Energy from wastes, some scenario
- Routes for energy production from wastes

Definition of wastes and their classification

➤ Wastes are materials that are not prime products for a producer & has no further use in the process as such & is required to be discarded / recovered

❖ Classification of wastes

Hazardous waste poses substantial or potential threats to public health or to the environment



Important quality parameters of different types of wastes

Solid waste	Waste water	Waste gas/ air
Elemental composition (C,H ,N,S,O)	BOD, COD, TOC	Particulate matter
Moisture, volatile matter and ash content	pH	NOX, SOX, CO
Bulk density	TDS and TSS	Heavy metals
Heating value	Colour and odour	Hydrocarbons and other fuel molecules
Permeability or hydraulic conductivity	Cations and anions	Gas components
Particle size distribution	Bacterial count	

Wastes suitable for energy production

➤ Wastes which can be used for energy production are:

- Solid wastes with high carbon content and heating value
- Waste water with high BOD and COD value
- Waste gases with high heating value (However, in practice this option is not normally used).

(We will concentrate on solid wastes and waste water for further discussion)

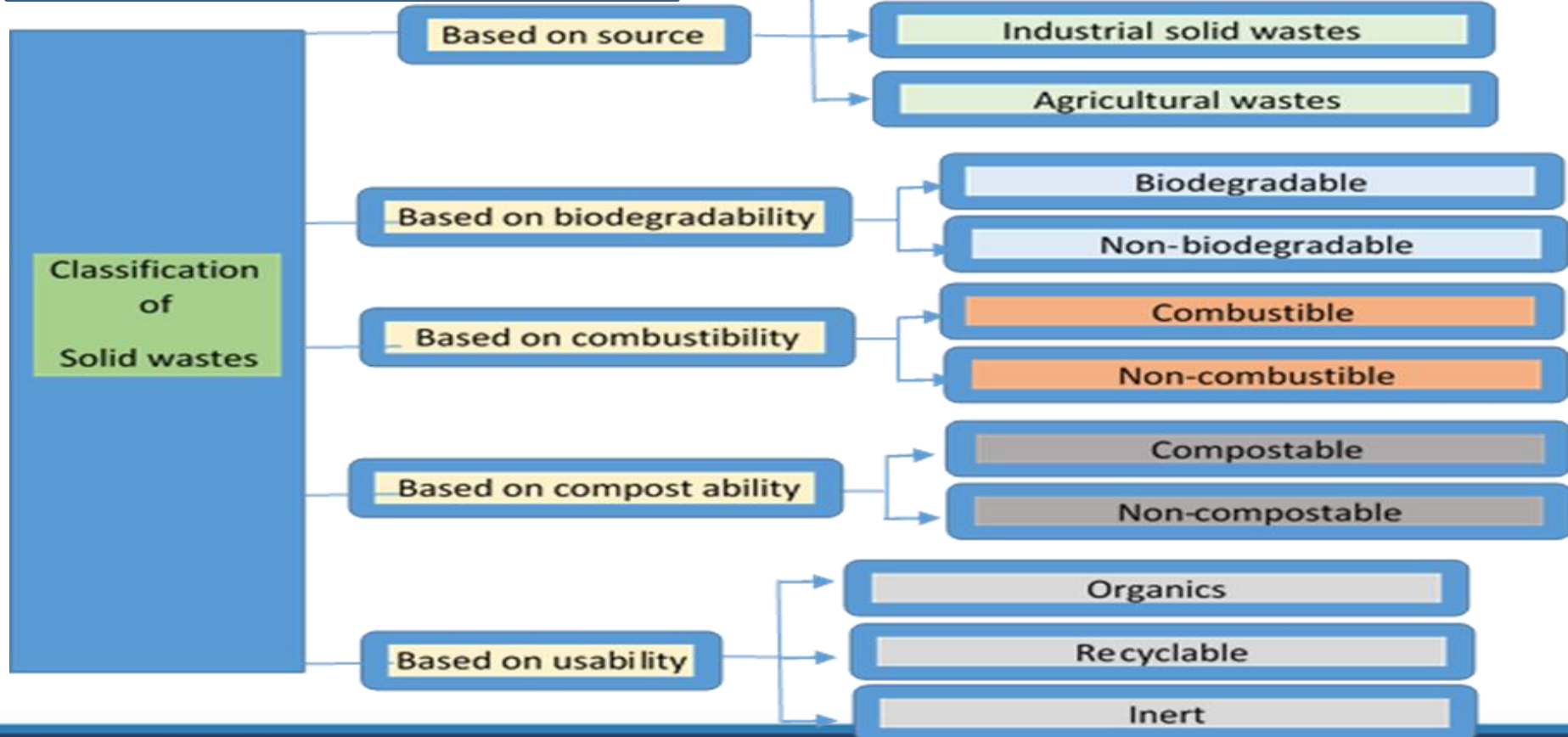


Solid wastes and their classification

Solid wastes comprise all the wastes arising from human and animal activities and are normally solid and that are discarded as useless or unwanted.



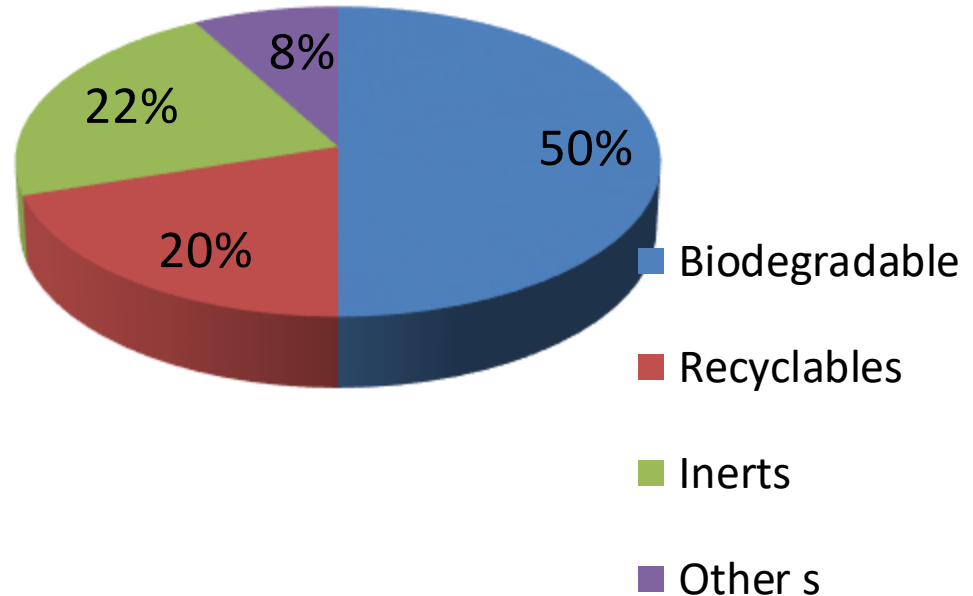
Classification of Solid wastes



Classification of Solid wastes contd.

Components	Example Materials
Biodegradables	Food stuffs, Landscape tree trimmings
Recyclables	Paper, tablets, plastics, glass, metals
Inerts	Stones, and slit and other inorganic material

Composition MSW in India



Source: <http://www.eai.in/ref/ae/wte/typ/clas/msw.html>

Classification of Solid wastes contd.

Composition & heating value of MSW in India

Region/City	MSW (TPD)	Compostable (%)	Recyclable (%)	Inert (%)	Moisture (%)	Cal. Value (MJ/kg)	Cal. Value (kcal/kg)
Metros	51,402	50.89	16.28	32.82	46	6.4	1,523
Other cities	2,723	51.91	19.23	28.86	49	8.7	2,084
East India	380	50.41	21.44	28.15	46	9.8	2,341
North India	6,835	52.38	16.78	30.85	49	6.8	1,623
South India	2,343	53.41	17.02	29.57	51	7.6	1,827
West India	380	50.41	21.44	28.15	46	9.8	2,341
Overall Urban India	130,000	51.3	17.48	31.21	47	7.3	1,751

Source: Ranjith Annepu Thesis 2012, Earth and Environmental Engineering, Columbia University. NJT



Classification of Solid wastes contd.

Moisture content and heating value of Municipal refuse components

Components	Moisture (%)	Heating value (MJ/Kg)
Paper, cardboard, bags	5	17.82
Wood crates, boxes, scrapes	7	18.20
Bush, branches	17	16.61
Leaves	30	11.40
Grass	50	8.89
Garbage	75	4.23
Green stuff	50	8.07
Greens	50	9.47
Rags, cotton, linen	10	14.98



Classification of Solid wastes contd.

Lignocellulosic agricultural residues

Grass



Corn Stover



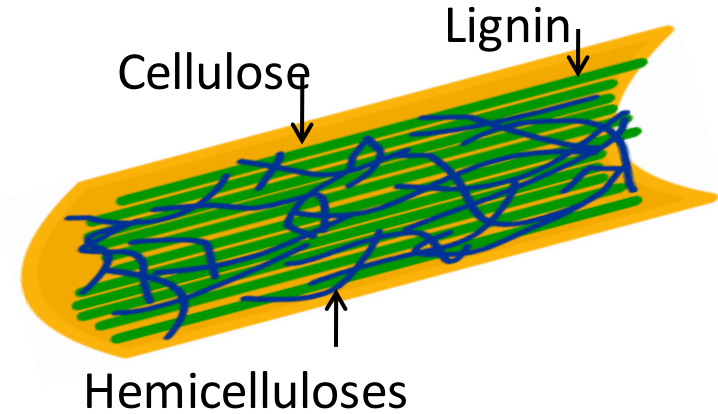
Bagasse



Wood chips



Component	Composition
Cellulose	38-50 %
Hemicelluloses	23-32 %
Lignin	15-25 %
Others	5-15 %



Waste water and their classification



11

Waste water and their classification contd..

Typical composition of untreated domestic waste water

Contaminants	Concentration		
	Low strength (mg/L)	Medium strength (mg/L)	High strength (mg/L)
Solids, total(TS)	390	720	1230
Dissolved, total (TDS)	250	500	850
Suspended solids(TSS)	120	210	400
BOD, 5 day,20°	110	220	400
TOC	75	140	290
COD	250	500	1000
Total nitrogen (as N)	20	40	70
Total Phosphorus(asP)	4	8	15
Chloride	30	50	100
Sulfate	20	30	50
Alkalinity (as CaCO ₃)	50	100	200
Grease	50	100	150
Total coliform	10 ⁶ –10 ⁷ (No/100 ml)	10 ⁷ – 10 ⁸ (No/100 ml)	10 ⁷ -10 ⁹ (No/100 ml)

Composition of some industrial wastewater

Industry type	Organic load (mg/l)	Typical composition of organic compound
Pulp and paper	COD: 32000 – 40000 BOD: 12 000–16 000	Soaps: 40-45% ; lignin: 35-45% Other organics: 10-15%
Distillery	COD: 110000–190000 BOD: 50000–60000 Melanoidin for colour	Reducing sugar (g/l): 0.5; Total sugar (g/l): 0.8 Total acids (g/l): 3.34; Free amino acids (g/l): 3.18 Total nitrogen (g/l): 11.0
Sugar	COD: 385 – 978 BOD: 112 – 225	Glucose Fructose
Oil refinery	COD:1965, BOD: 685	Oil contents , total solids, phenol
Petrochemicals	COD:1500; BOD: 350,	Octanol, HCHO, phenol, organic acid, petroleum



Parameter	Acidogenic phase		Methanogenic phase	
	Average	Range	Average	Range
pH	5	4.5 - 5.5	8	7.5 - 9
BOD ₅ (mg/l)	13000	4000-40000	180	20 – 550
COD (mg/l)	22000	6000-60000	3000	500 – 4500
BOD ₅ /COD	0.58	-	0.06	
Sulphate (mg/l)	500	70-1750	80	10 – 420
Calcium (mg/l)	1200	10-2500	60	20 – 600
Magnesium (mg/l)	470	50 - 1150	180	40 – 350
Iron (mg/l)	780	20 - 2100	1.5	3 – 280
Manganese (mg/l)	25	0.3-65	0.7	0.03 – 45

Availability of agro based, forest, industrial and municipal solid wastes in India vis-a-vis world

- Generation of municipal solid waste in India has gone up from 6 million tons in 1947 to 48 million tons in 1997 and it is expected to touch 300 million tones per annum by 2047
- Global generation of municipal solid waste is expected to rise by roughly 8% per year
- As per a report in 2011, around 1.7-1.9 billion tones of municipal solid wastes (MSW) are generated around the world per year
- Out of the 79.19 million tons of crop residues produced in Bangladesh in 2009, 41.56 million tons were available for energy use

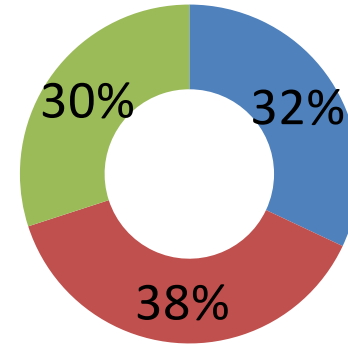


Availability of wastewater in India vis-a-vis world

- It is estimated that 38354 million litres per day (MLD) sewage is generated in major cities of India, but the sewage treatment capacity is only of 11786 MLD. Similarly, only 60% of industrial waste water, mostly large scale industries, is treated.

National level data on wastewater production, treatment and reuse in 181 different countries

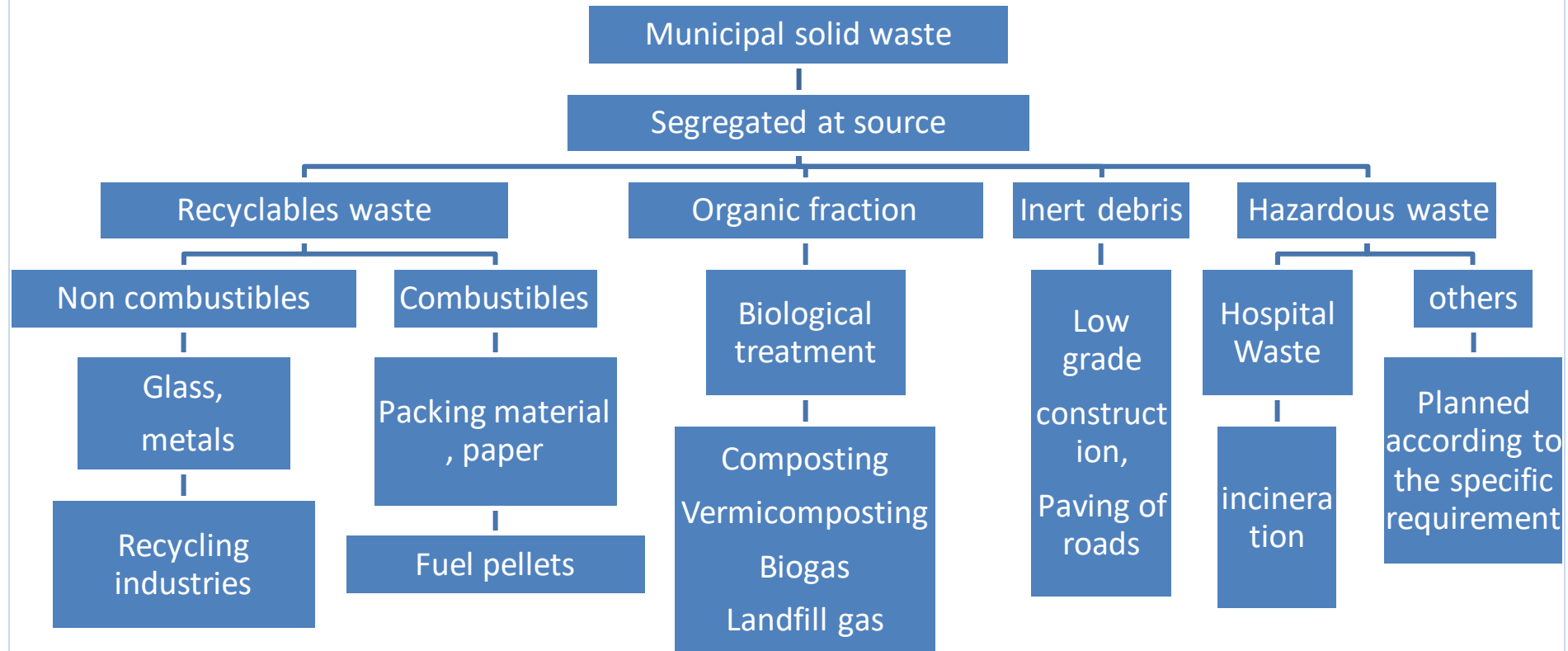
Only 30 % with complete data



Data source:
Sato et al., 2013
Agricultural
Waste
Management
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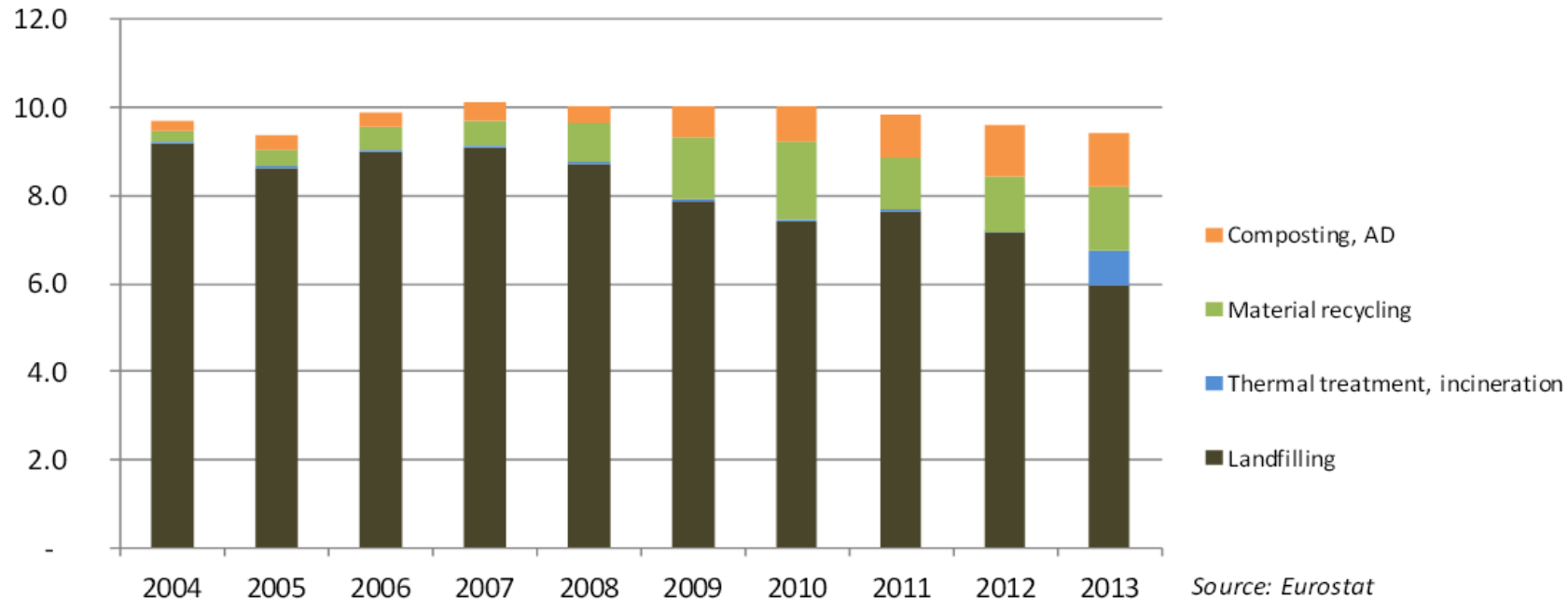
- no information
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Routes for Solid wastes management



Typical shares of different routes in Poland

million tonnes



Source: Waste to Energy 2015/2016 ecoprog GmbH, www.ecoprog.com :

Thanks...

