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Presentation on

Characterization of Combustible Fraction of Legacy Waste: Exploring the Impact of Landfill Depth and Quantifying Energy Recovery Potential

By

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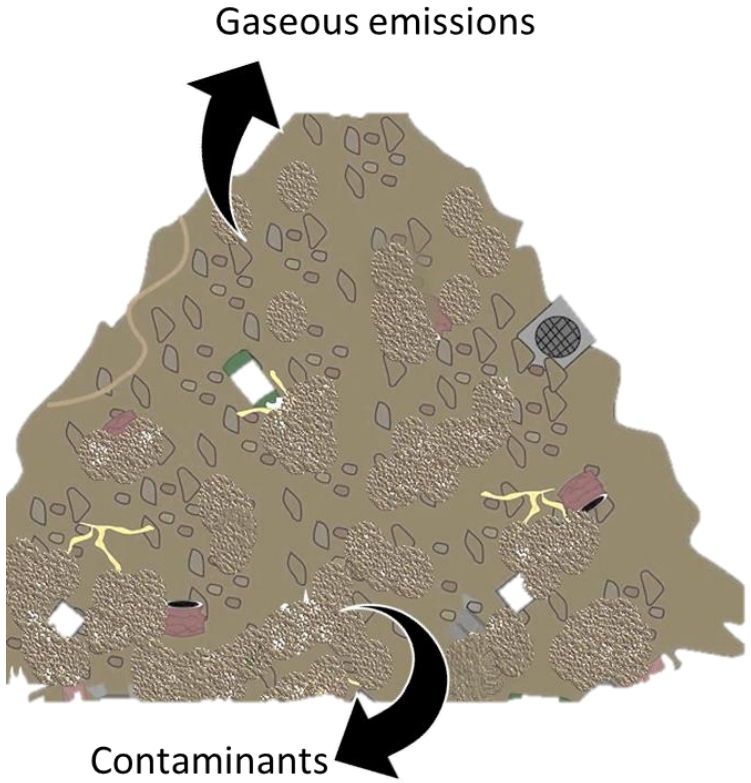
Background

- In India, **~77%** of the MSW generated ends up in landfills and dumpsites[1].
- Most of these sites are **open dumps** with no provision of proper cover and lining layer.
- Ticking time-bombs causing **negative impacts** on human and environment.
- After implementation of SWM Rules 2016, push from the government to rehabilitate those dumpsites.
- Landfill mining is the promising solution to tackle the negative impacts.



Landfill Mining Process

Waste Excavation → Drying & Stabilization → Screening → Fine fraction, Combustibles & Inerts

1. World Bank, *What A Waste 2.0* (2018)

Need of the Study

- Numerous landfill mining projects are underway in India and tonnes of legacy waste is being excavated.

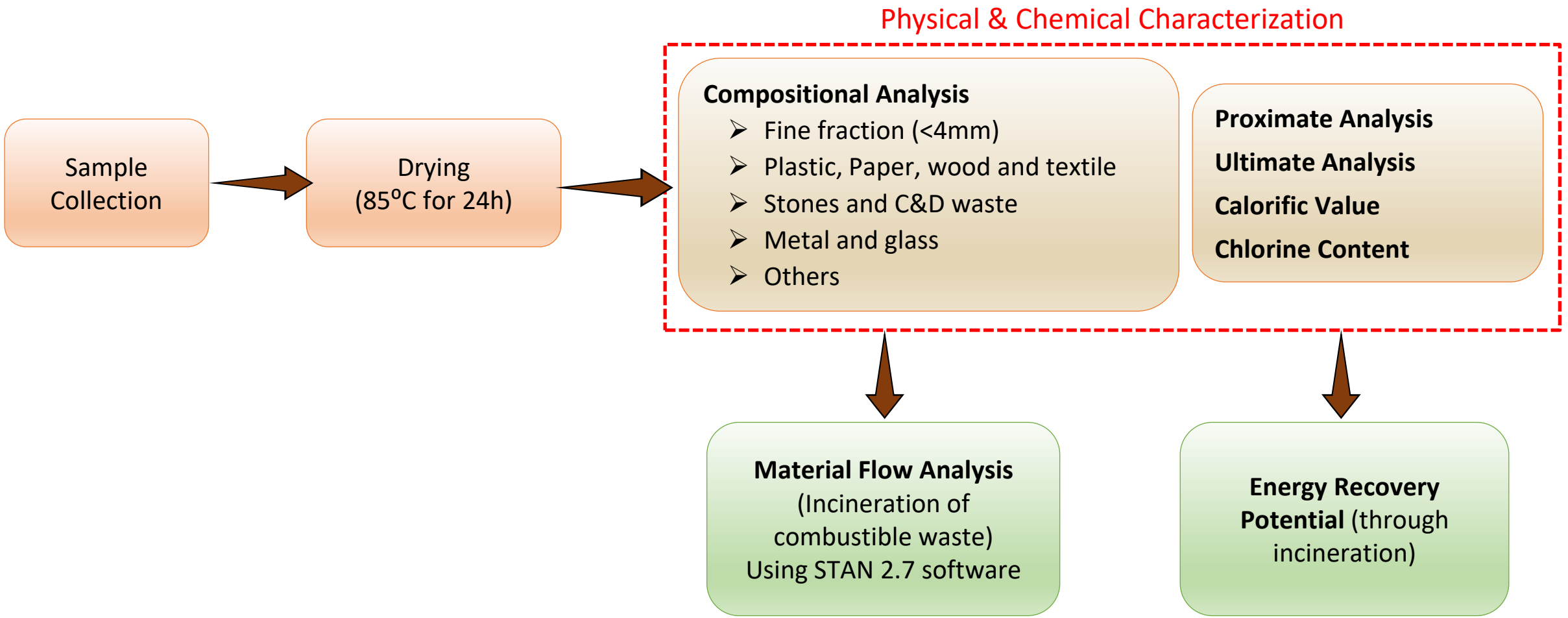
- Lack of knowledge on possible valorization options

- Site-specific investigations are required

Objectives of the Study

- Study the influence of landfill depth on characteristics of legacy waste
- Quantify the energy recovery potential of the combustible fraction of legacy waste.

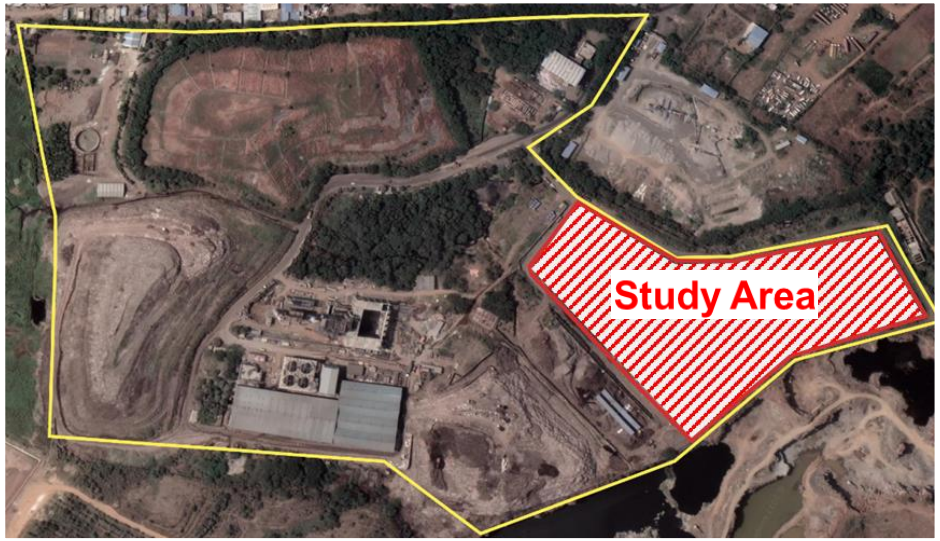
Methodology



Analysis Methods

Analysis		Procedure	Equipment
Proximate Analysis	Moisture Content	-	Hot Air Oven
	Volatile Matter	ASTM D3175-20 (2020)	Muffle Furnace
	Ash Content	ASTM D3174-12 (2018)	
	Fixed Carbon	-	
Ultimate Analysis	Carbon, Hydrogen, Nitrogen, and Sulfur	-	Elemental Analyzer (FlashSmart, Thermo Fisher)
	Oxygen	By Difference	
Calorific Value		ASTM E711 (2002)	Bomb Calorimeter
Chlorine Content (in form of chloride)		Bomb Combustion and Ion Chromatography	Bomb Calorimeter Ion Chromatograph (Metrohm IC 732)

Sampling

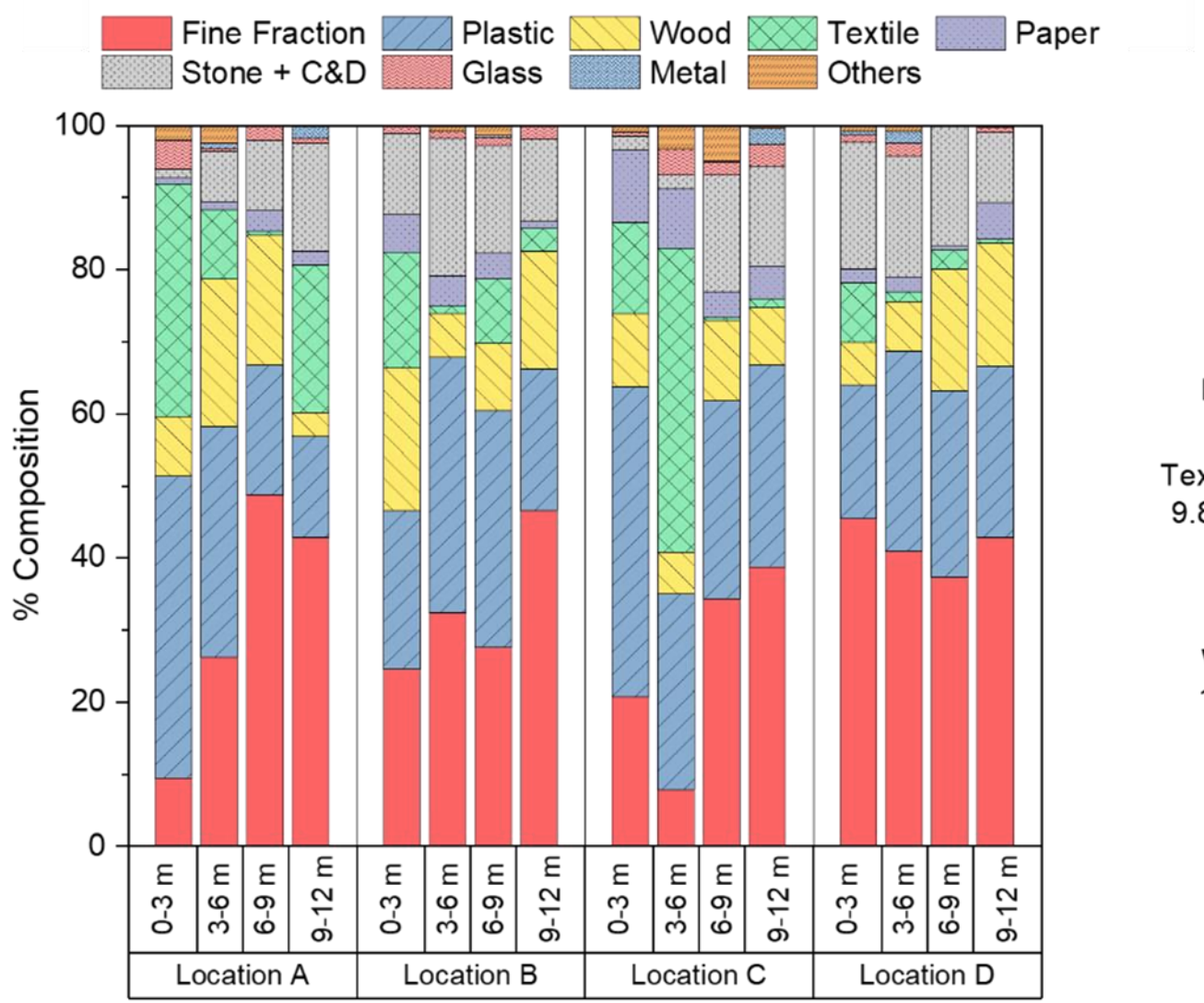


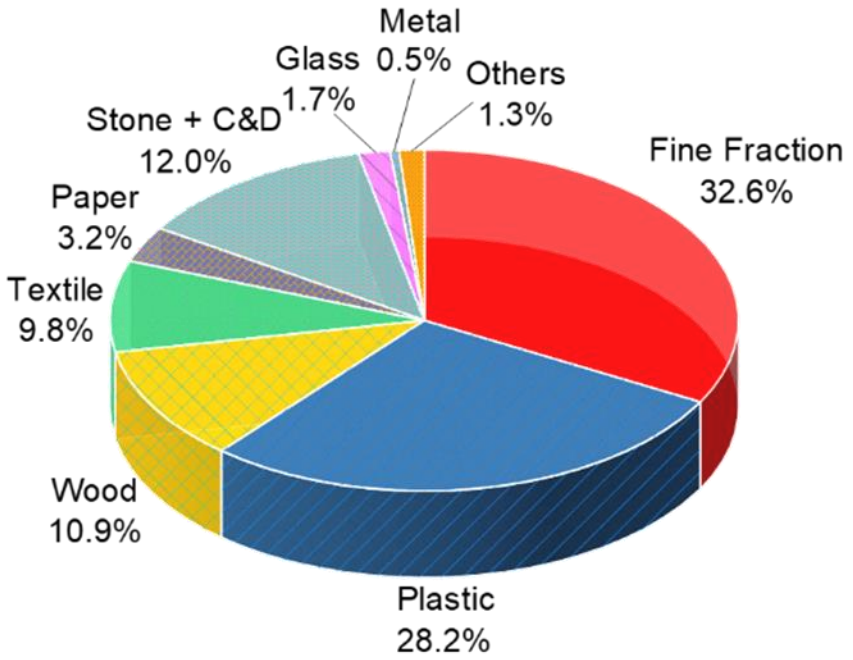
- Sampling Locations: 4
- Depth Interval: 3m
- Total Depth: 12m

Samples Collected: 16

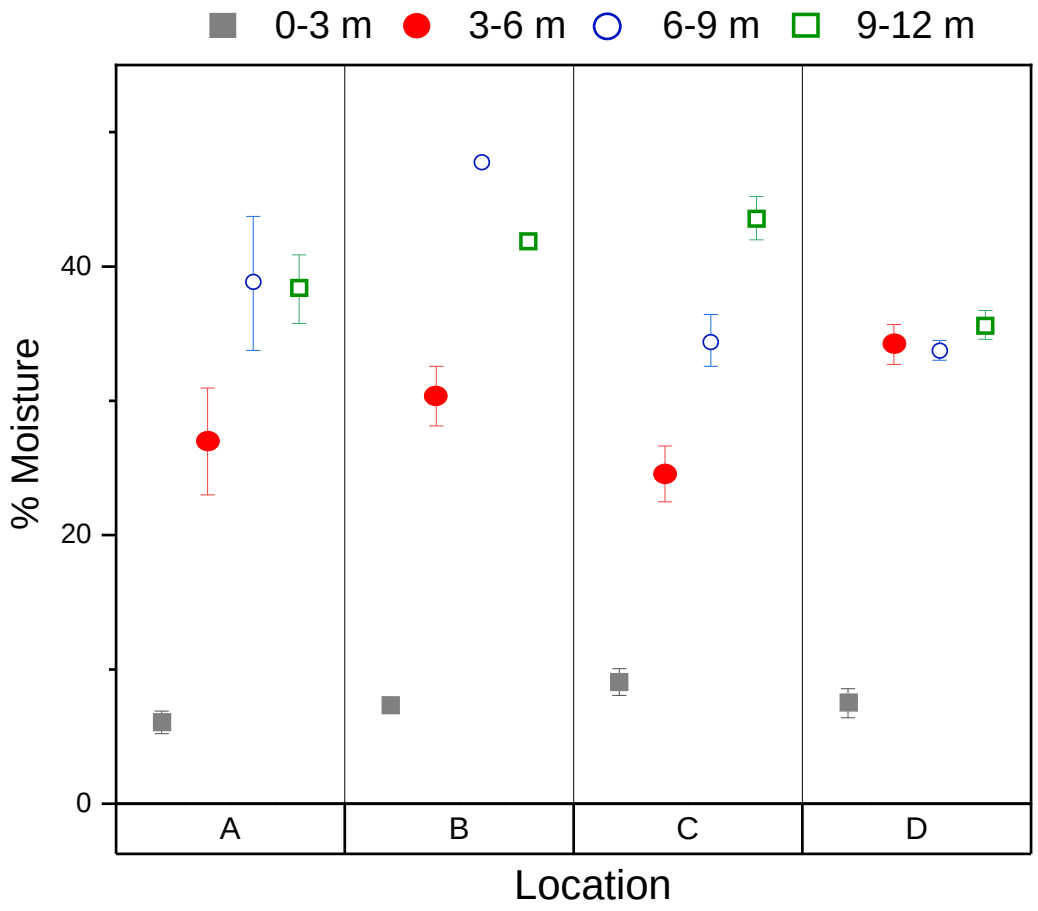
Marked sampling locations (Moshi dumpsite, Pimpri Chinchwad, Pune)

Composition of Legacy Waste



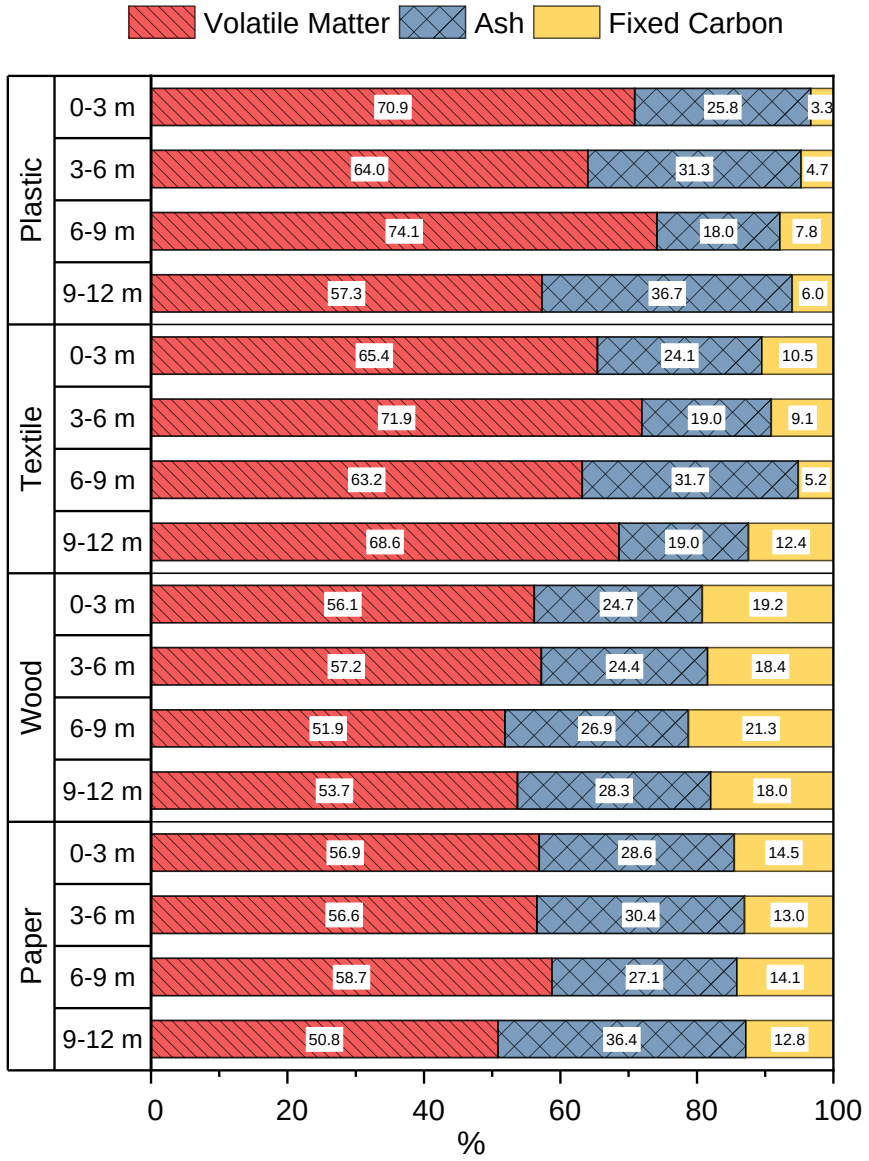


Moisture Content



Average Moisture Content = 28.7 %

Volatile Matter, Ash Content, and Fixed Carbon



Parameter	Dry Basis	Wet Basis*
Volatile matter (%)	63.9	51.1
Ash content (%)	27.4	21.9
Fixed Carbon (%)	8.7	7.0

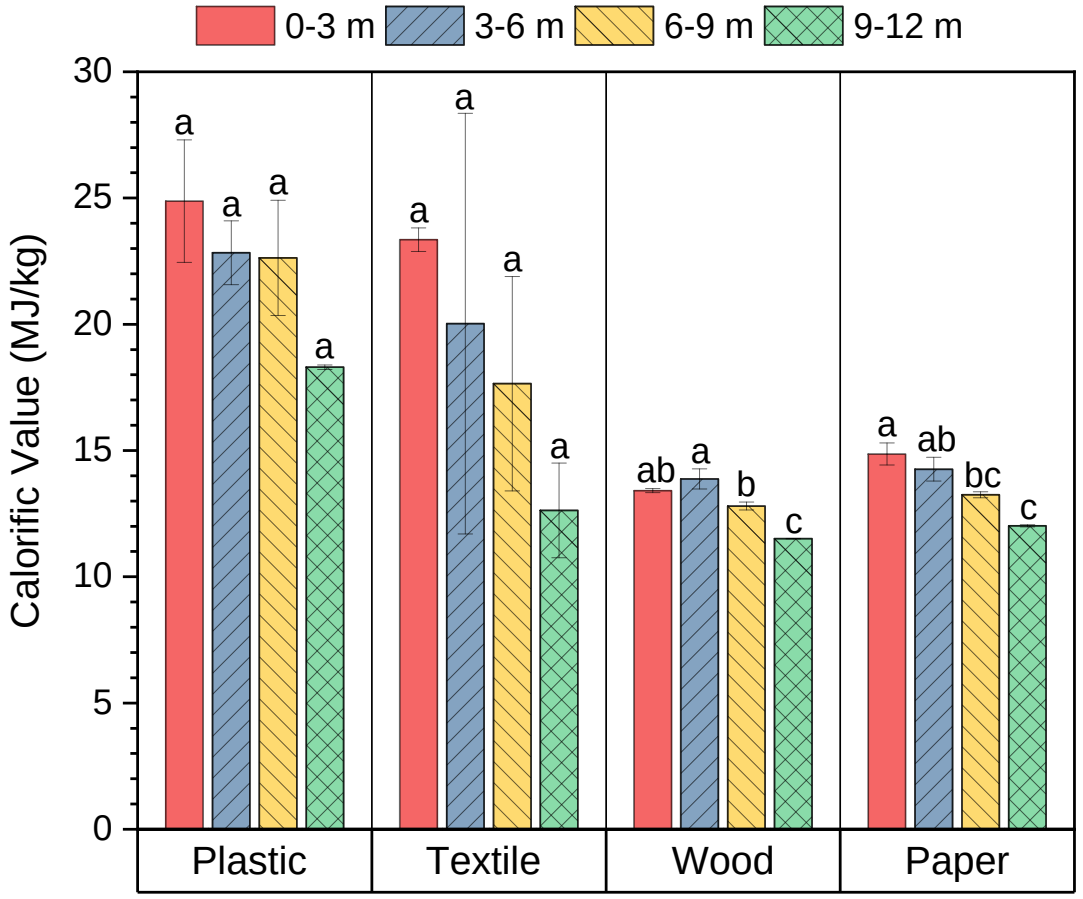
*Assuming residual moisture content of 20% after sun-drying

Requirements for incineration of combustible waste[1]

- ✓ Volatile matter: >40%
- ✓ Ash content: <35%
- ✓ Fixed carbon: <15%

1. Selection criteria for waste processing technologies. Central Pollution Control Board, Ministry of Environment, Forests and Climate Change New Delhi, India.

Calorific Value



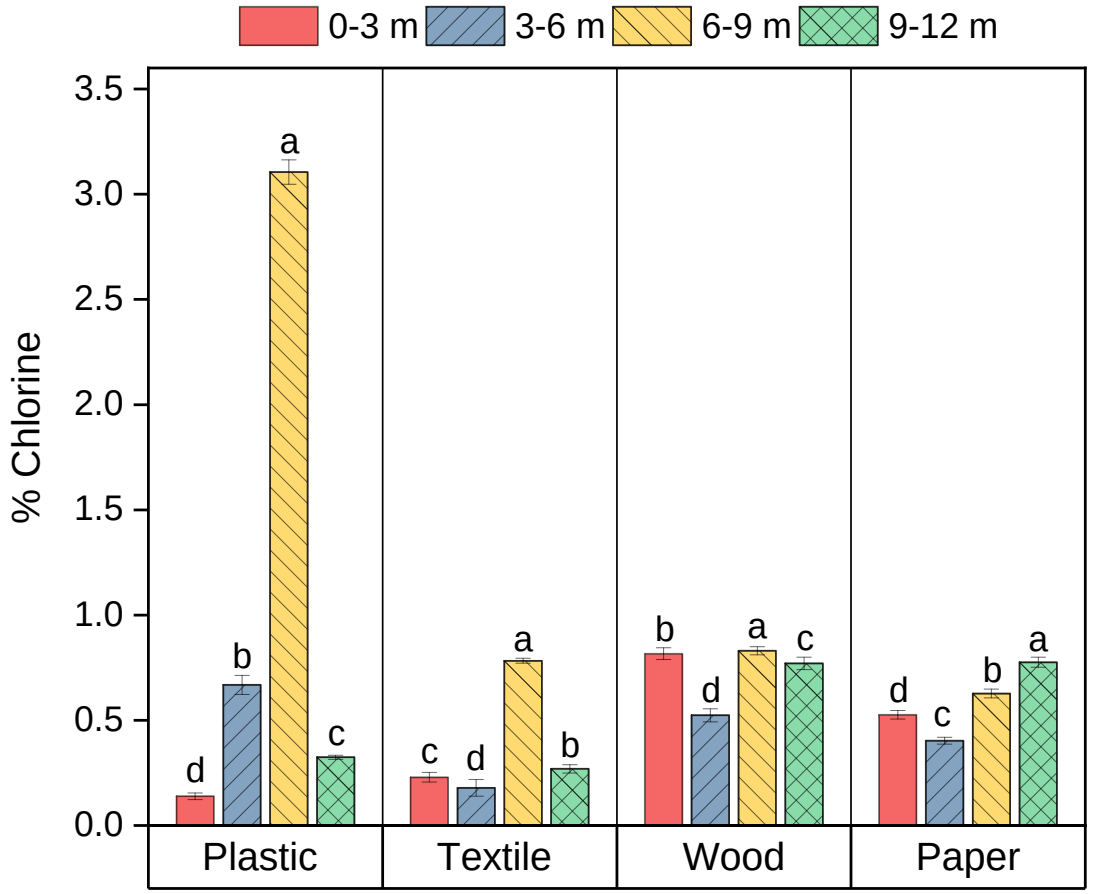
Average calorific value = 19.2 MJ/kg
= 15.3 MJ/kg*

*Assuming residual moisture content of 20% after sun-drying

Application	Requirement	Reference
RDF Grade I	>18.8 MJ/kg	1
RDF Grade II	>15.7 MJ/kg	1
RDF Grade III	>12.5 MJ/kg	1
Incineration	>6.3 MJ/kg	2

1. Guidelines on usage of refuse derived fuel in various industries. Central Public Health and Environmental Engineering Organisation, Ministry of Housing and Urban Affairs, Government of India, New Delhi.
2. Selection criteria for waste processing technologies. Central Pollution Control Board, Ministry of Environment, Forests and Climate Change New Delhi, India.

Chlorine Content



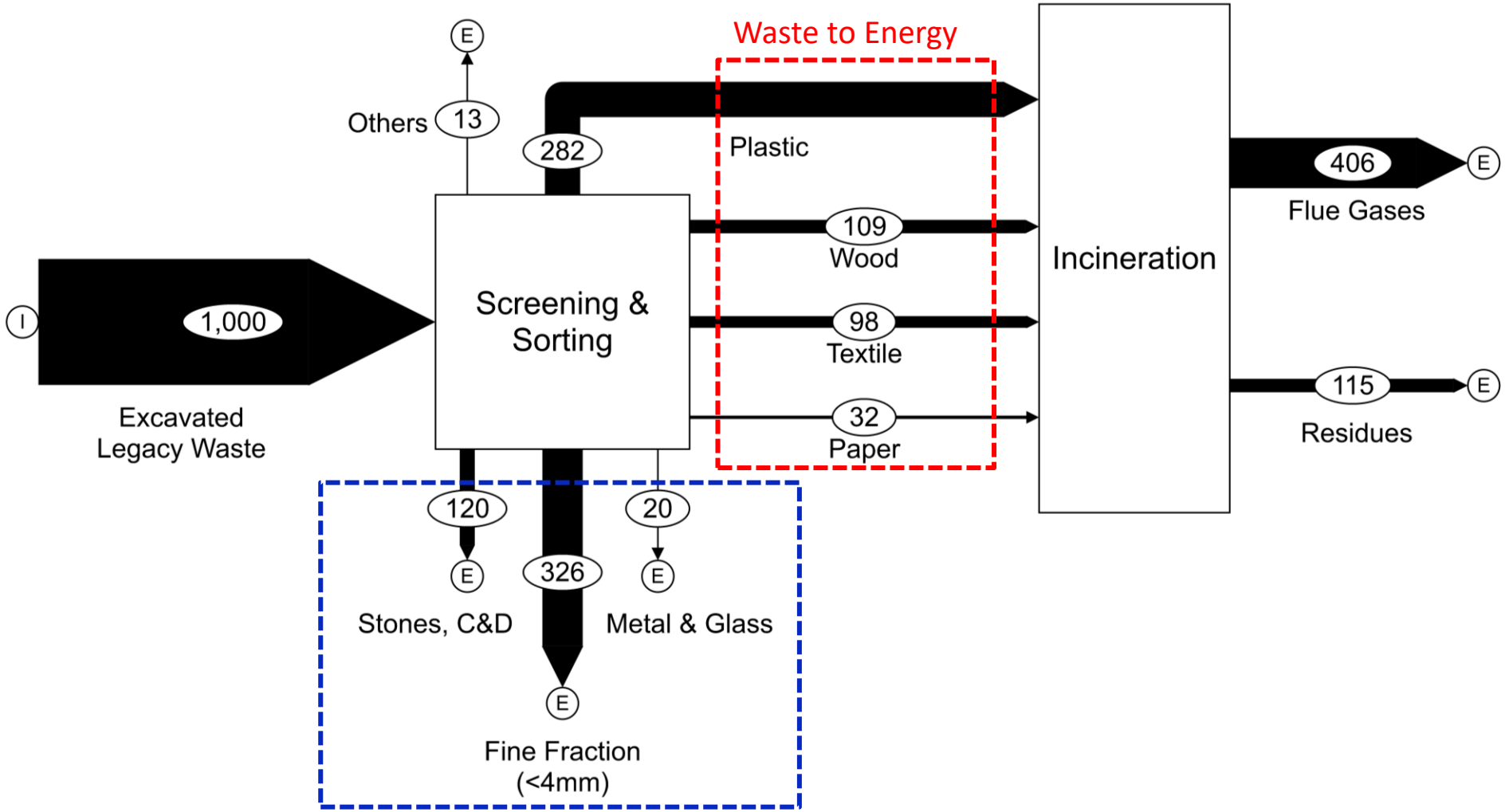
Average chlorine content = 0.9 %
= 0.7%*

Application	Requirement	Reference
RDF Grade I	<0.5%	1
RDF Grade II	<0.7%	1
RDF Grade III	<0.1%	1

1. Guidelines on usage of refuse derived fuel in various industries. Central Public Health and Environmental Engineering Organisation, Ministry of Housing and Urban Affairs, Government of India, New Delhi.

*Assuming residual moisture content of 20% after sun-drying

Material Flow Analysis



Energy Recovery Potential

$$\text{Energy recovery potential (kWh/tonne)} = \frac{CV \times 1000 \times Ei}{3.6}$$

CV is calorific value as GCV (19 MJ/kg)

E_i is the conversion efficiency (20%)

Energy recovery from legacy waste = 440 kWh/tonne of excavated waste*

*Dry basis

Summary

- Fine fraction was dominating with a share of **~33%**
- The analyzed combustible fraction meets all the required characteristics to use as feedstock for incineration
- required for the use of combustible waste as RDF, the analyzed waste satisfies the criteria to be used as **RDF grade III** for co-processing with other waste materials in cement kilns
- MFA for 1 tonne of excavated waste revealed that
  - 521 kg waste had the potential of energy recovery
  - 466 kg waste had the potential to be used as secondary raw material
- Energy recovery (electricity) through incineration of combustible fraction of legacy waste **440 kWh/tonne**
- Quality issues associated with the secondary raw material necessitates **additional research for identifying appropriate valorization options**

Thank You!