Environmental Engineering-1

Lecture 5- Solid Waste Management

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Introduction

Waste (also known as rubbish, garbage, refuse, trash, junk) is any unwanted or useless materials.

Or

"Any *material that no longer has any value to the person who is responsible for it, and is not intended to be discharged through pipe*".

Solid Waste can be defined as :

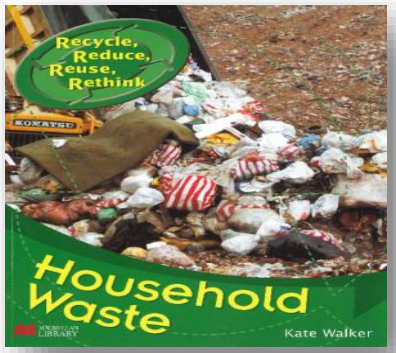
"Any material that we discard, that is not liquid or gas, is solid waste"

Municipal Solid Waste

- Municipal Solid Waste includes commercial and residential wastes generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.

- Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets.

Municipal Solid waste comes from variety of sources including;



Household

Commercial

Street sweepings

Hotels and restaurants

Clinics & dispensaries

Construction & demolition

Horticulture

Sludge

Source	Typical facilities, activities or locations	Types of solid wastes
Residential	Homes, flats, apartment blocks etc.	Food wastes, paper, cardboard, plastics, textiles, yard waste, wood, glass, metals, special wastes(eg bulky items such as white goods ,batteries, oil tyres), household hazadarous wastes
Commercial	Shops, restaurants, markets, office buildings, hotels, motels, print shops, service stations, auto repair shops etc.	Paper, cardboard, plastics, glass, wood, metals, food wastes, special wastes, hazadarous wastes
Institutional	Schools, hospitals, universities, prisons, government centers etc.	As above in commercial
Construction and demolition	New construction sites, road repairs, building demolition.	wood., steel, concrete, dirt etc.
Municipal services (excluding treatment works)	Street cleaning, landscaping, park and beaches, creek bed cleaning, litter bins.	Special wastes, rubbish, litter, sweepings debris general wastes.
Treatment plant	Water, wastewater, industrial treatment processes	Effluent plus residual sewage
Municipal solid waste(MSW)	All of the above	All of above
Industrial	Construction, fabrication, light and heavy manufacturing refineries, chemical plants, power stations, demolition etc	Industrial process wastes, scrap materials etc.Non –industrial wastes including food wastes, rubbish, ashes demolition , and construction

Terminology

Garbage:

- Garbage is the animal ,fruit and vegetable wastes resulting from handling, preparing , and cooking food.
- It does not include food processing wastes from canneries, slaughterhouses etc.
- Garbage originates mostly from domestic kitchens, stores, markets, restaurants etc.
- These are putrescible and decompose rapidly leading to development of offensive odour.

Rubbish:

- Rubbish consists of combustible and non-combustible solid wastes from homes , stores, and institutions but does not include garbage.

Combustible:

- The combustible consists of paper, rags, wood, tree branches etc.

Non-Combustible:

- Non- combustible includes material which can't be burned at 700-1100°C-the organic portion such as tin cans, glass, ashes soil etc.

Organic Wastes:

- Typically the organic wastes include food waste (also known as garbage), paper, cardboard, plastics, textiles, wood, yard wastes etc.

Inorganic Wastes:

- The inorganic fraction includes glass, metals, ferrous and non ferrous (eg aluminum), and dirt.

Waste Composition

The term *"Composition"* is used to describe the individual components that make up a solid waste stream and their relatives distribution, usually based on percentage by weight.

Waste Characterization

Waste Category	USA	Sydney
Food waste	9	27.5
Paper	34	15.2
Cardboard	6	5.6
Plastics	7	7.6
Textiles	2	2.3
Rubber	0.5	0.6
Yard waste	18.5	20.5
Wood	2	0.6
Other organics	0.5	0.6
Glass	8	9.3
Metal cans	6	5.3
Aluminium cans	0.5	0.3
Dirt, ash etc	3	3.6

Waste Characterization

Component	Lahore	Multan	Peshawar	Faisalabad
Vegetable+ fruit residue	30.32	32.35	13.80	17.2
Paper	2.70	2.4	2.10	2.1
Plastics and rubber	5.63	4.39	3.70	4.8
Leaves , grass, straws	20.32	20.22	13.60	15.6
Rags	7.50	6.98	4.30	5.2
Wood	1.24	1.30	0.60	0.7
Bones	1.03	1.03	1.70	2.9
Animal waste	2.37	2.65	7.50	0.8
Glass	0.7	0.8	1.30	1.3
Metals	0.32	0.3	0.30	0.2
Dust ,ash, stones, bricks	27.83	27.51	7.30	4.6
unclassified	0.04	0.07	-	-

Solid Waste Generation Rate

Solid waste generation rate refers to "*the amount of solid waste produced by one person in one day on the* average".

- Solid waste generation rate in Pakistan urban centers is between 0.4-0.8kg/c/d

✓ Lahore →0.6 kg/c/d,

✓ Peshawar → 0.489 kg/c/d,

✓ Multan → 0.45 kg/c/d,

✓ Karachi → 0.613 kg/c/d.

Impacts of Solid Waste Generation

Following problems arises due to solid waste generation:

- Breeding of rats, flies, fleas etc , carrying the germs of disease and outbreak of diseases e.g. Plague in 14^{th} century killed half of Europeans.
- Improper management of solid waste give rise to 22 human diseases.
- Improper management of solid waste give rise to water and air pollution

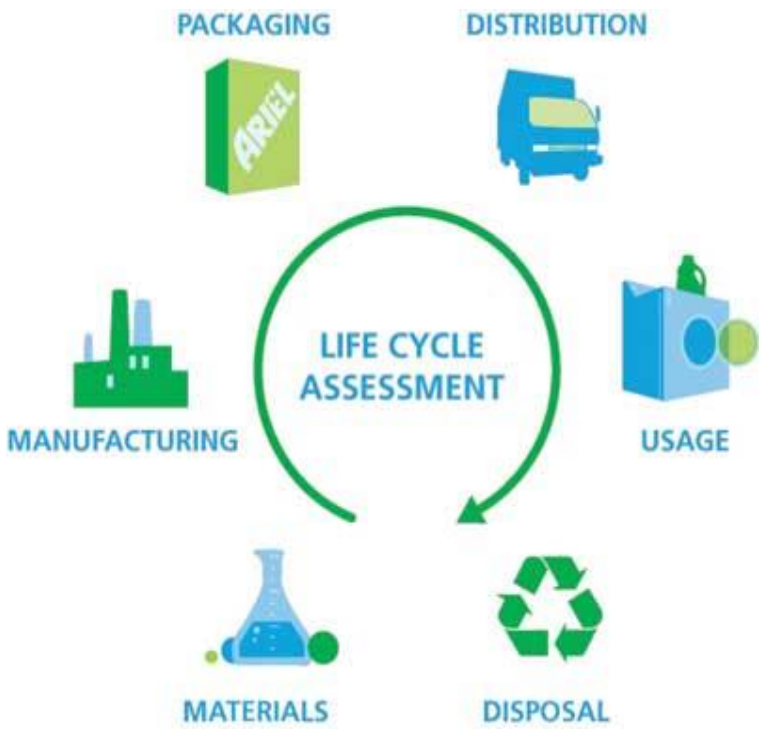
Municipal Solid Waste Management (MSWM)

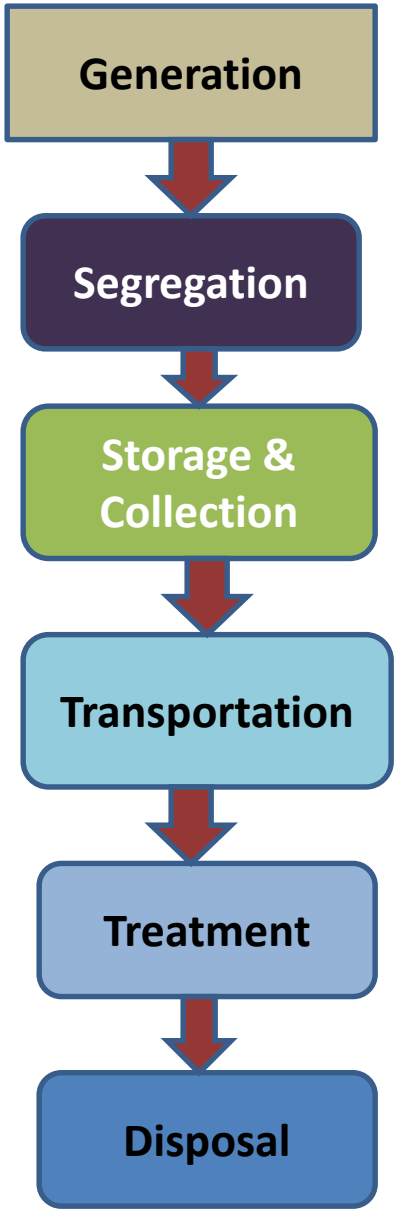
- *Municipal Solid Waste Management (MSWM)* refers to the collection, transfer, treatment, recycling, resource recovery and disposal of solid waste in urban areas.

Goals & Principles of MSWM

- The first goal of MSWM is to protect the health of the urban population, particularly that of low-income groups who suffer most from poor waste management.
- Secondly, MSWM aims to promote environmental conditions by controlling pollution (including water, air, soil and cross media pollution) and ensuring the sustainability of ecosystems in the urban region.
- Thirdly, MSWM supports urban economic development by providing demanded waste management services and ensuring the efficient use and conservation of valuable materials and resources.
- Forthly, MSWM aims to generate employment and incomes in the sector itself.

Life Cycle of Municipal Solid Waste





Components of MSWM

a) **Generation**

Waste generation encompasses those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal.

b) Storage

- Two types of containers are used:

1. Separate containers: used by households and manually handled .
2. Communal Containers: used by community collectively and mechanically handled

- Good storage offers four advantages

✓ Containment,

✓ Convenience in collection,

✓ Cover,

✓ Environmental protection

Components of MSWM

Encourage ***two bin system*** at individual premises for ease in processing and disposal of SW.

1. Wet waste- kitchen waste
2. Dry waste- paper, plastics, glass, metal etc

3 bin System

c) Collection :

Collection includes both the gathering of solid waste (recyclable and non- recyclable)and the transport of these materials, after collection, to the location where the collection vehicle is emptied, such as a material- processing facility, a transfer station or a landfill.

Waste Collection methods include:

- Primary or pre collection method i.e. the waste collected by street sweepers and sanitary workers and then transported to collection points via handcarts, donkey carts and wheelbarrows.

Waste Collection methods include:

- Secondary Collection method

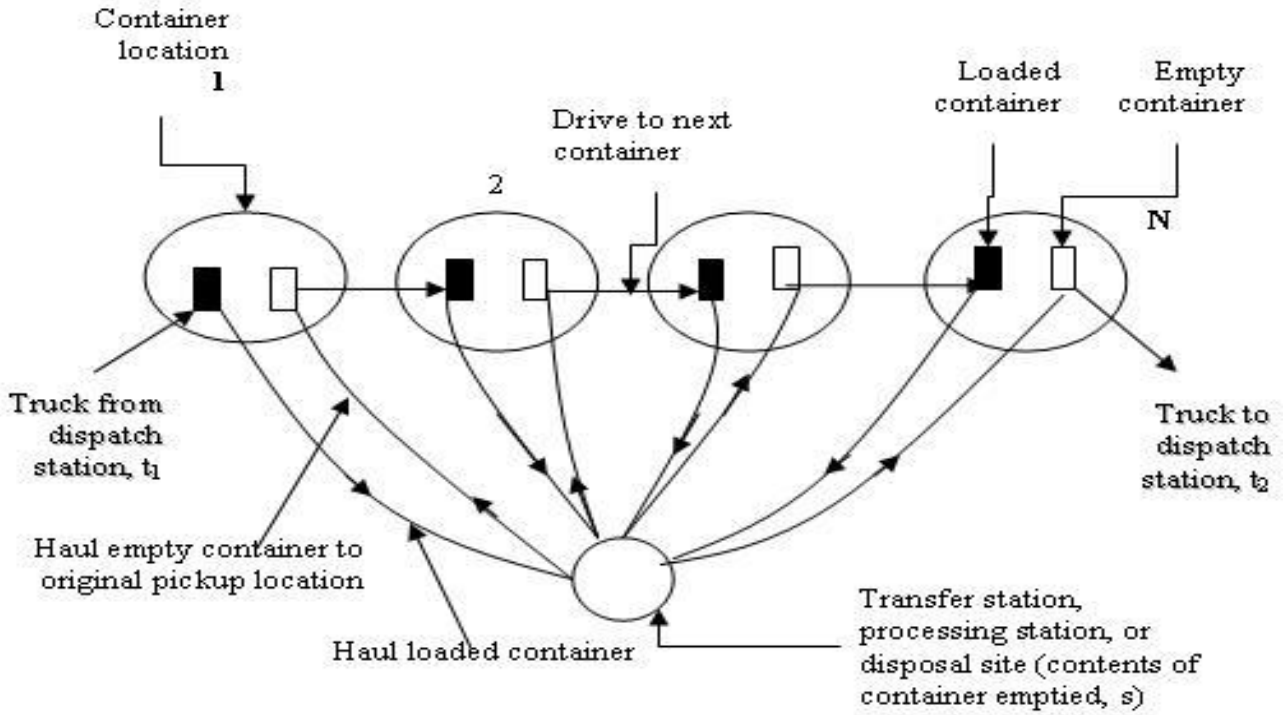
Two systems are used:

1. Hauled Container System
2. Stationary Container System

- Other collection methods employ:

1. Tractor trolleys
2. Open body trucks
3. Animal carts

Hauled Container System



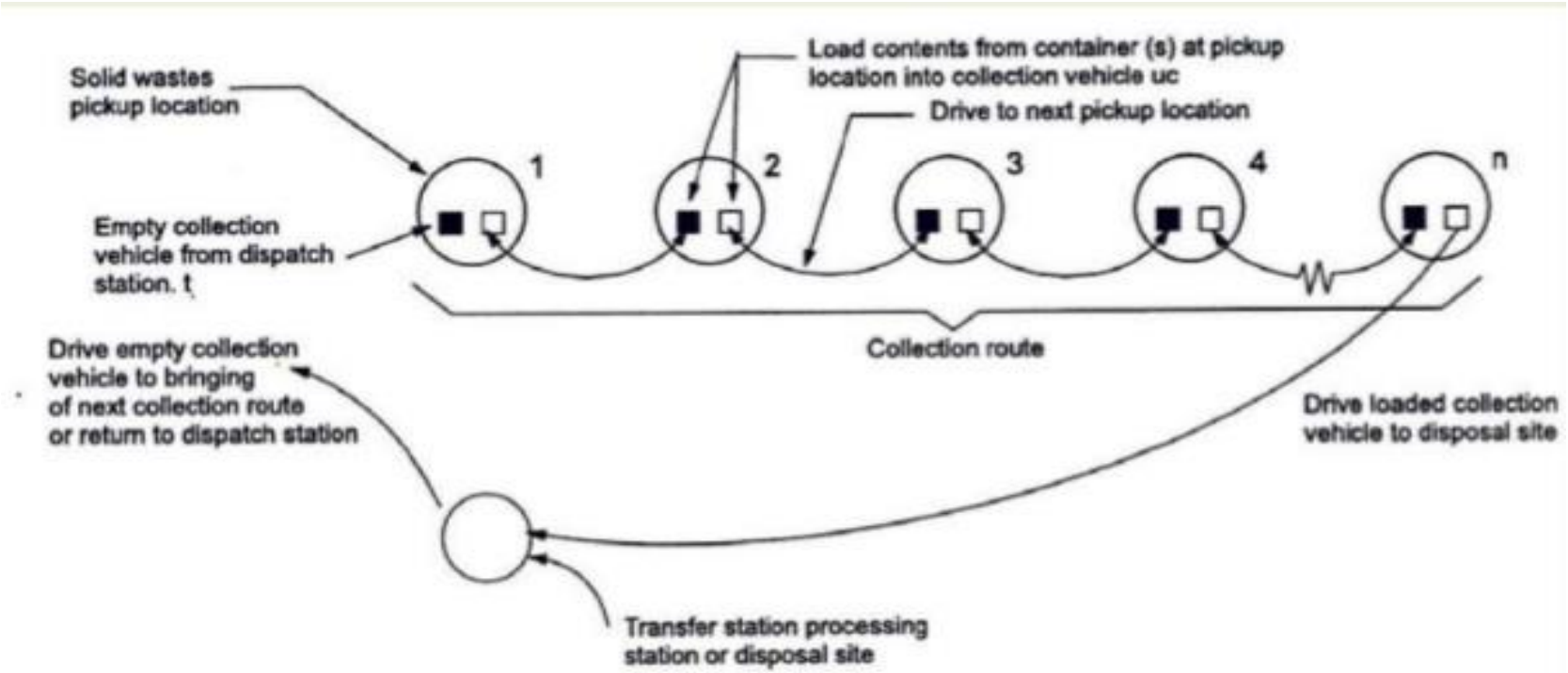
(a) Hauled container.

Container is hauled to disposal sites, emptied, and returned to original location or some other location

Hauled Container System

- Suitable for sources of high generation rate
- Lower container handling time
- Reduced unsanitary conditions
- Flexibility in container size /shape
- Low container Utilization

Stationary Container System



Stationery container system

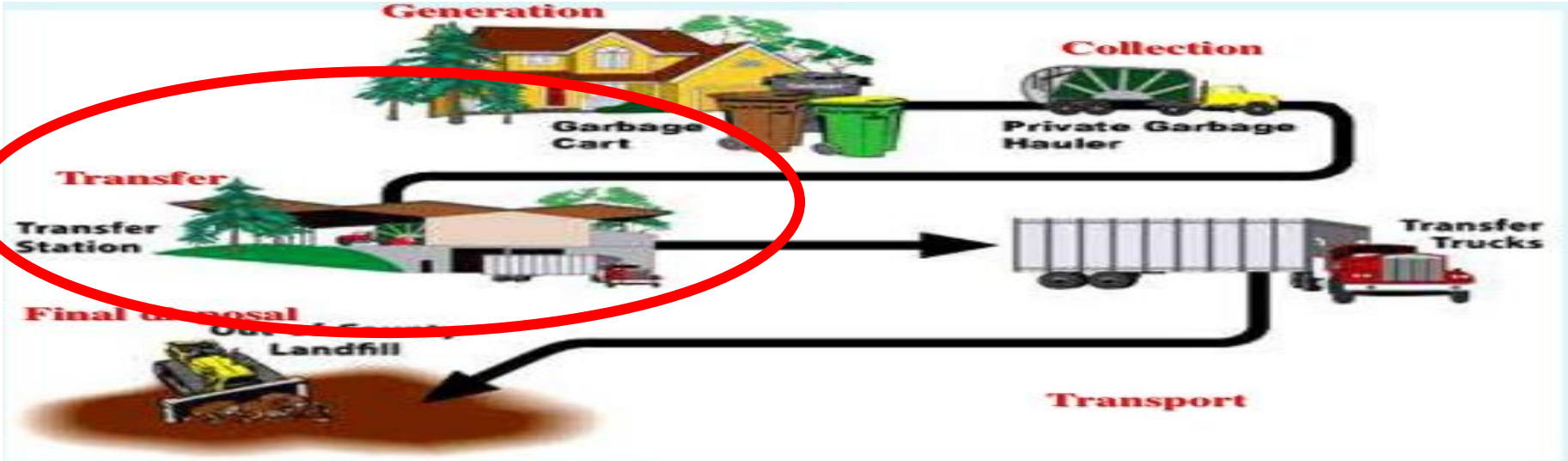
Storage containers remain at point of generation

Stationary Container System

- Manual/Mechanical loading/compaction into collection vehicle.
- Increased container utilisation
- Not suitable for heavy industrial waste/rubbish
- Labour intensive

d) Transfer and Transport

- SW is collected in small vehicles and transfer by large vehicles to transfer station or processing centers or disposal sites.
- Transfer stations are needed when disposal sites are located at long distances and collection vehicles are small in size.
- Transfer stations should be located as to avoid public inconvenience and environmental degradation.



e) Solid waste Disposal & Treatment

- **Processing and Recovery**

Processing includes techniques used to improve the efficiency of SWM operations. It includes:

- *Compaction*: used to reduce the volume of solid waste.
- *Shredding :* used to reduce the size of solid waste.

Recovery refers to separation of paper, plastics, glass for reuse.

Waste Treatment & Disposal

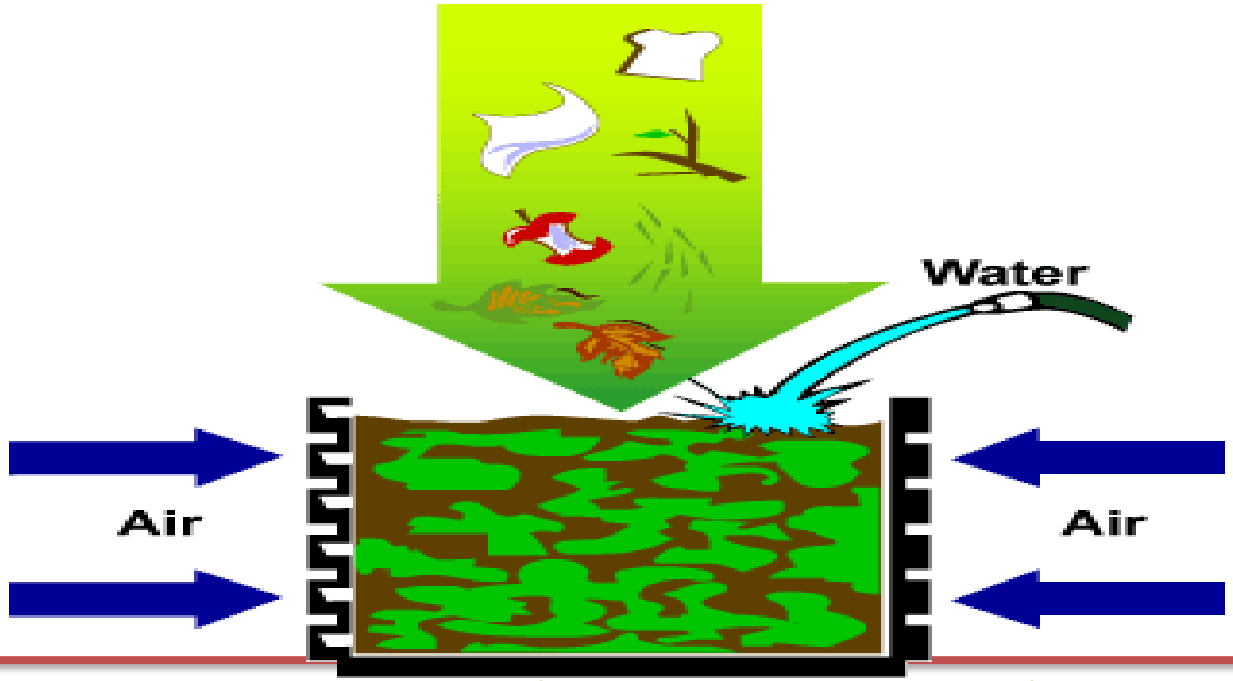
- Waste treatment and disposal refers to the activities required to ensure that waste has the least practicable impact on the environment.

TECHNOLOGIES

- Established waste treatment and disposal technologies are:

COMPOSTING

- Water, nitrogen, carbon, and oxygen all together is a perfect mixture to combine with organic matter to materialize the process of decomposition. This procedure will result to productions of compost which will eventually help the soil become healthy for planting.



Lahore Compost facility

Composting process takes steps of:

- Screening,
- Second screening,
- Mixing making windrow,
- Packaging.

Lahore compost plant

First screening

Second screening

Compost packaging

Windrows

Sorting unit

- Sorting line

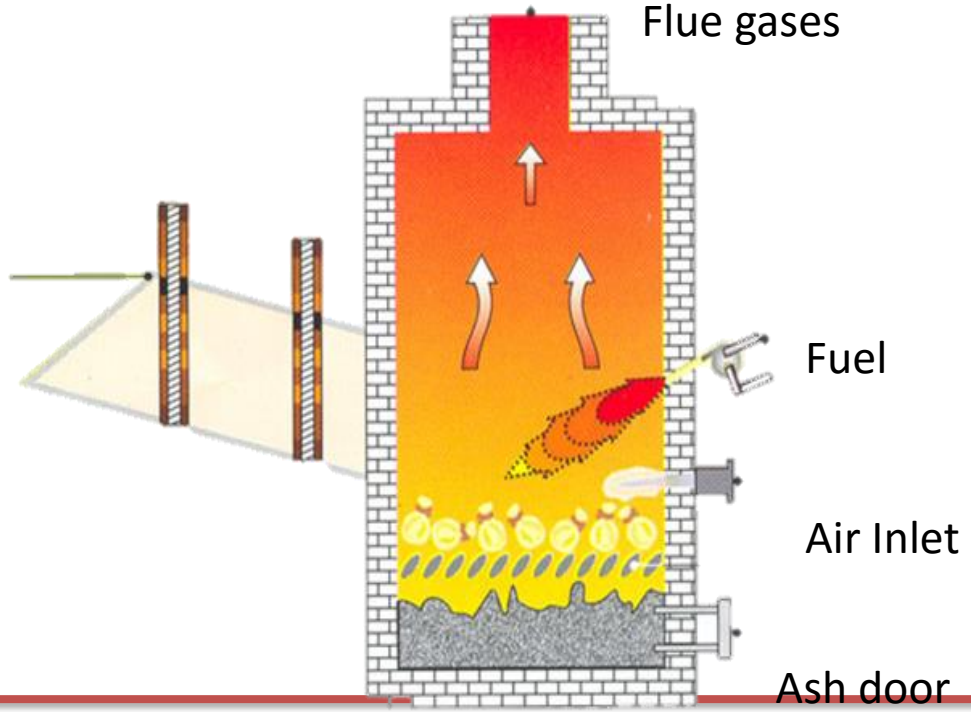
Shedder

Windrow Management

Final Product – compost

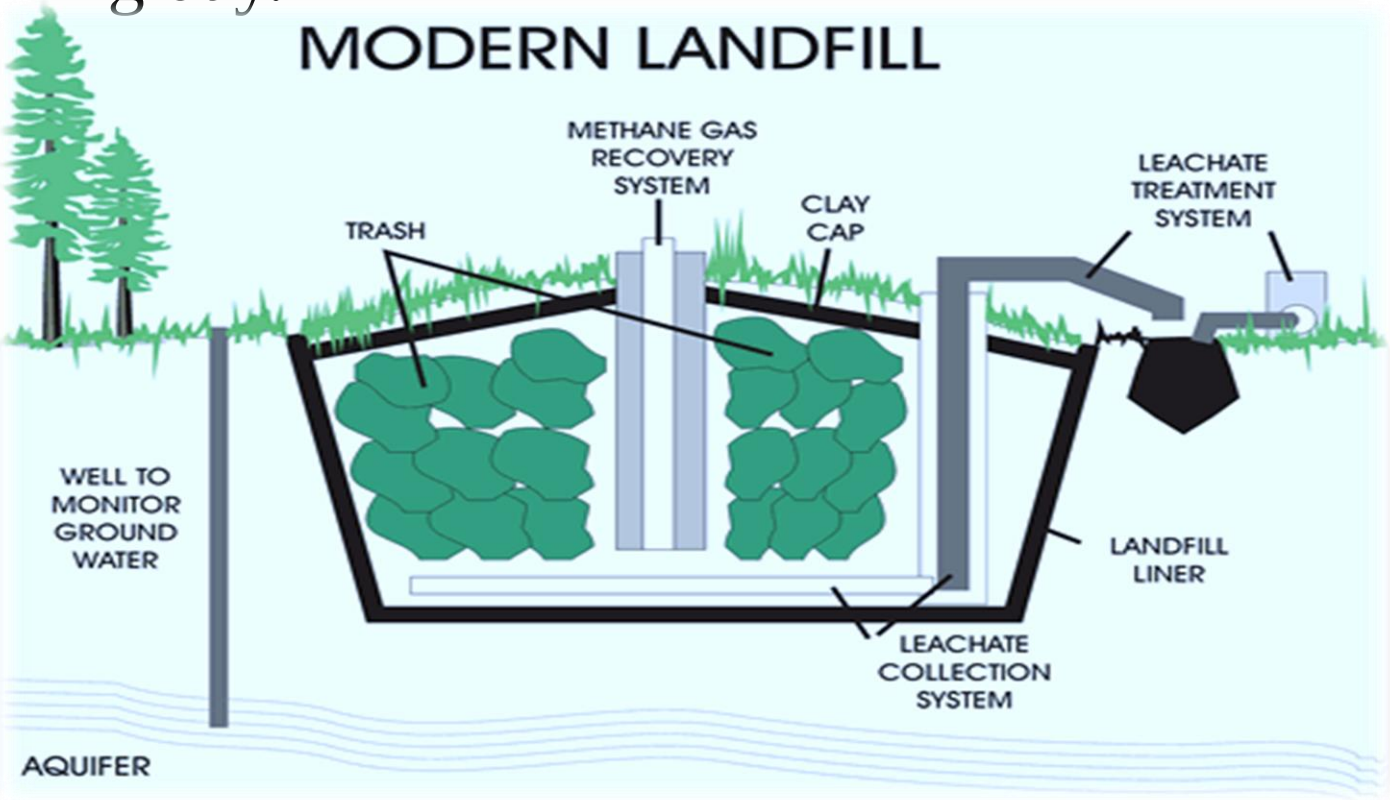
INCINERATION

Waste destruction in a furnace by controlled burning at high temperatures. Incineration removes water from hazardous sludge, reduces its mass and/or volume, and converts it to a non-burnable ash that can be safely disposed of on land, in some waters, or in underground pits



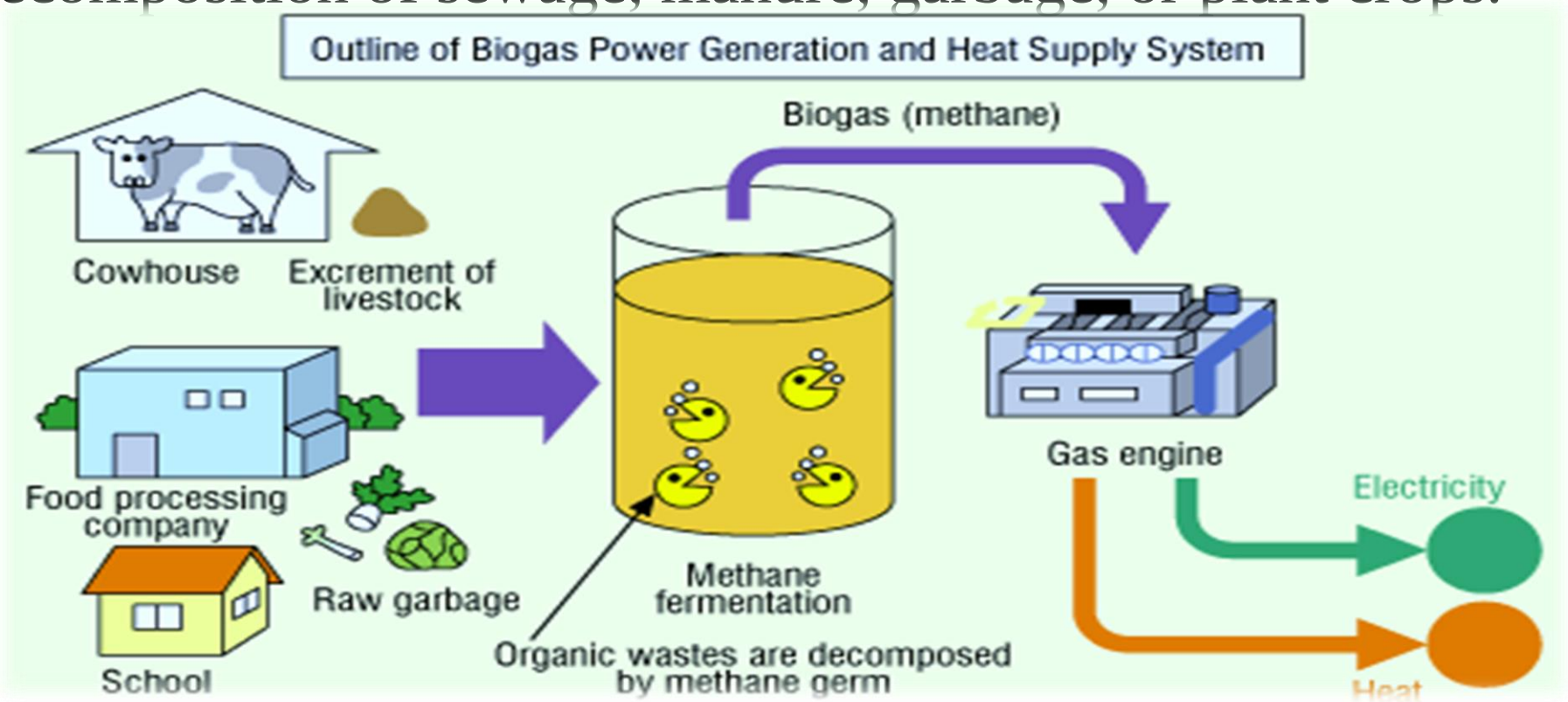
LANDFILLING

Environmentally acceptable disposal of waste on ground. Sanitary landfills are where non-hazardous waste is spreading layers, compacted, and covered with earth at the end of each working day.

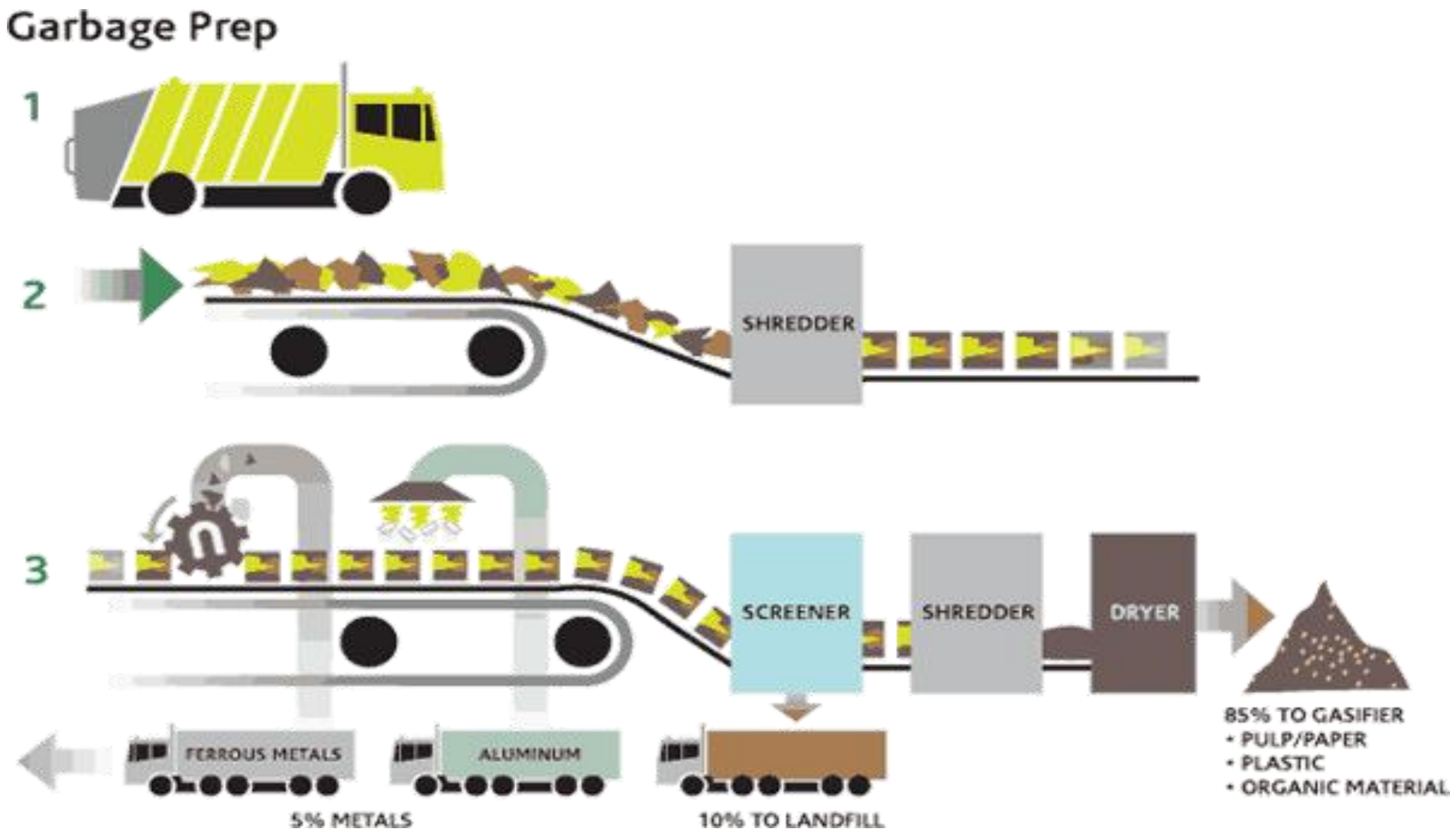


BIOGAS GENERATION

Any gas fuel derived from the decay of organic matter, as the mixture of methane and carbon dioxide produced by the bacterial decomposition of sewage, manure, garbage, or plant crops.



Refuse Derived Fuel

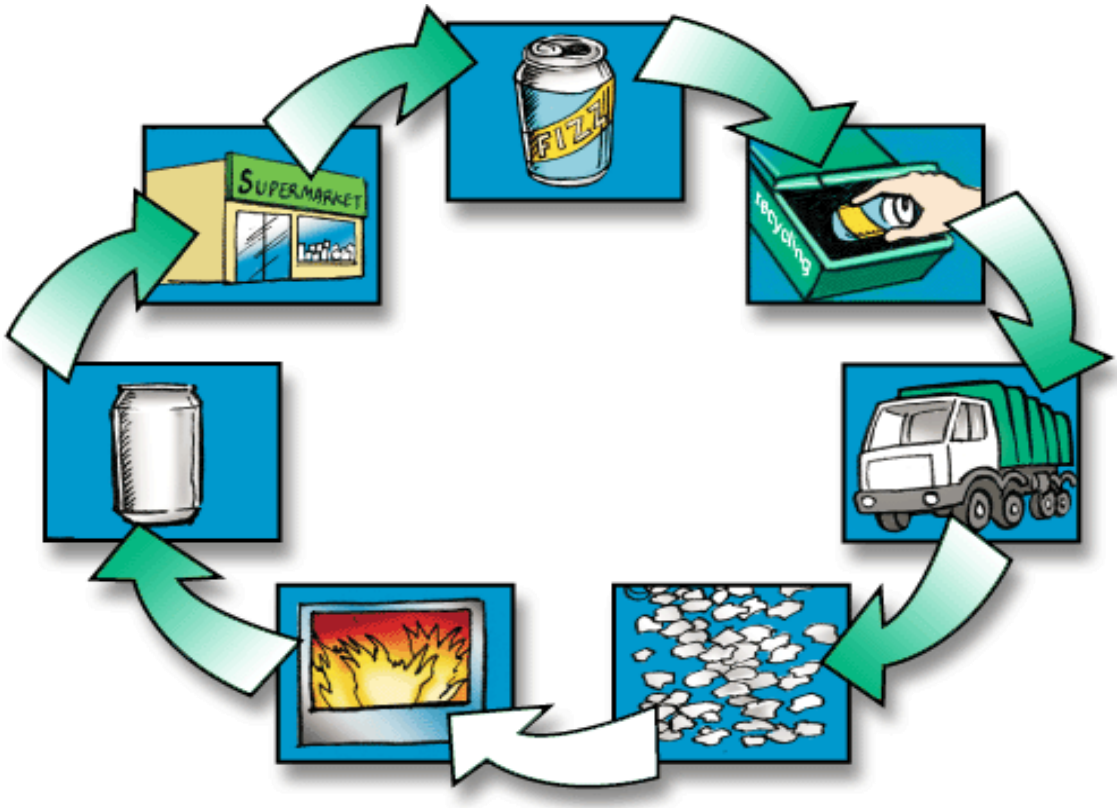


Refuse Derived Fuel

A fuel produced by shredding municipal solid waste (MSW). Noncombustible materials such as glass and metals are generally removed prior to making RDF. The residual material is sold as-is or compressed into pellets, bricks, or logs. RDF processing facilities are typically located near a source of MSW, while the RDF combustion facility can be located elsewhere.

RECYCLING

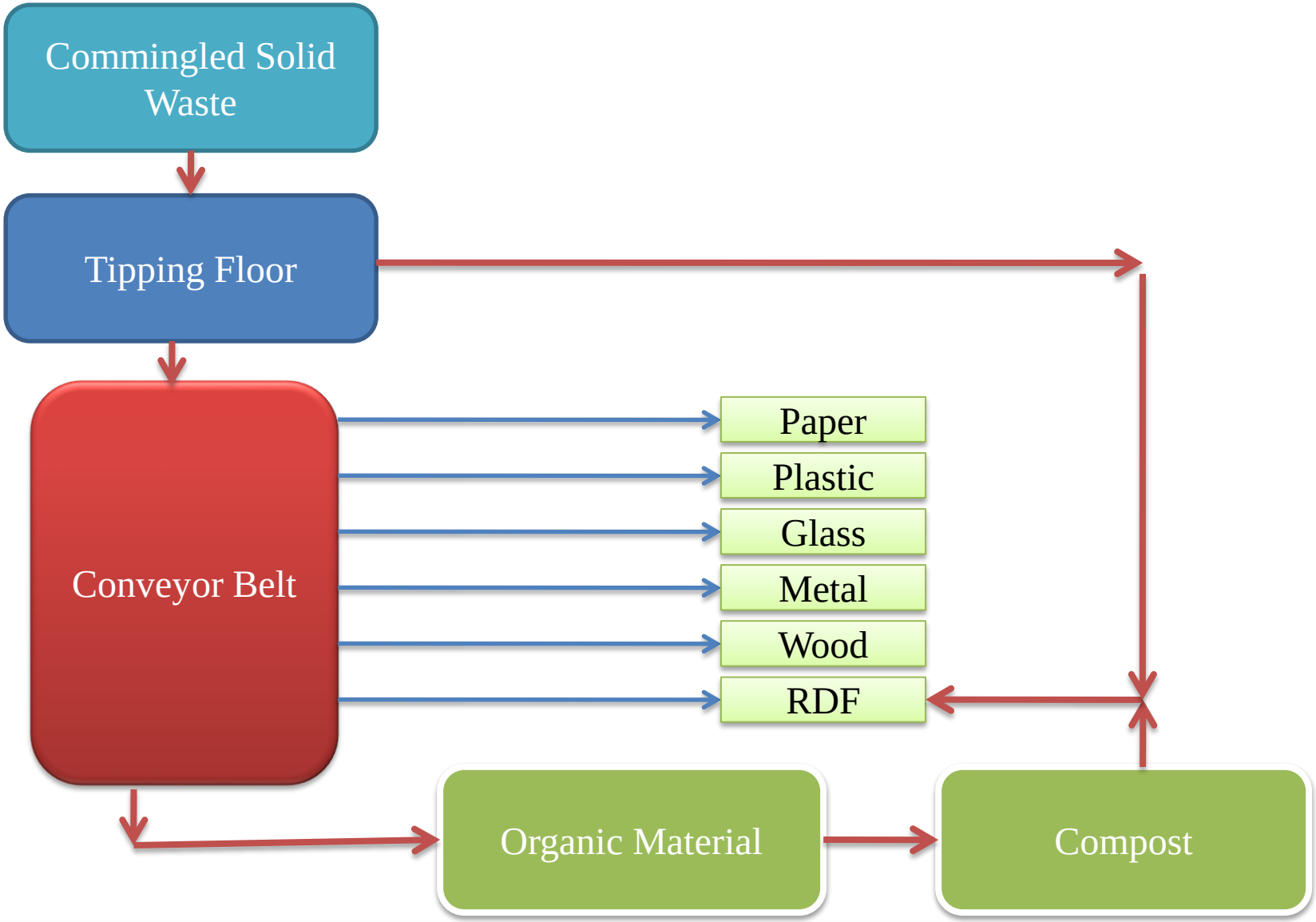
To treat or process (used or waste materials) so as to make suitable for reuse: *recycling paper to save trees.*



Material Resource Recovery

It is the process in which manual and mechanical processes are used to recover useful materials from the waste like metals , paper, organic material etc.

Material Resource Recovery(BASIC CONCEPT)



Scenario in Pakistan

- Treatment and disposal technologies are comparatively new concepts in Pakistan.
- Open dumping is the most common practice throughout Pakistan and dumpsites are commonly set on fire to reduce the volume of accumulating waste, hence adding to the air pollution caused by the uncovered dumped waste itself.