October 25, 2016

Plastic Waste Management

Dr. Mohamed El-Newehy
Associate Professor

King Saud University
Petrochemical Research Chair, Department of Chemistry, College of Science,
Riyadh 11451, Saudi Arabia
http://fac.ksu.edu.sa/melnewehy

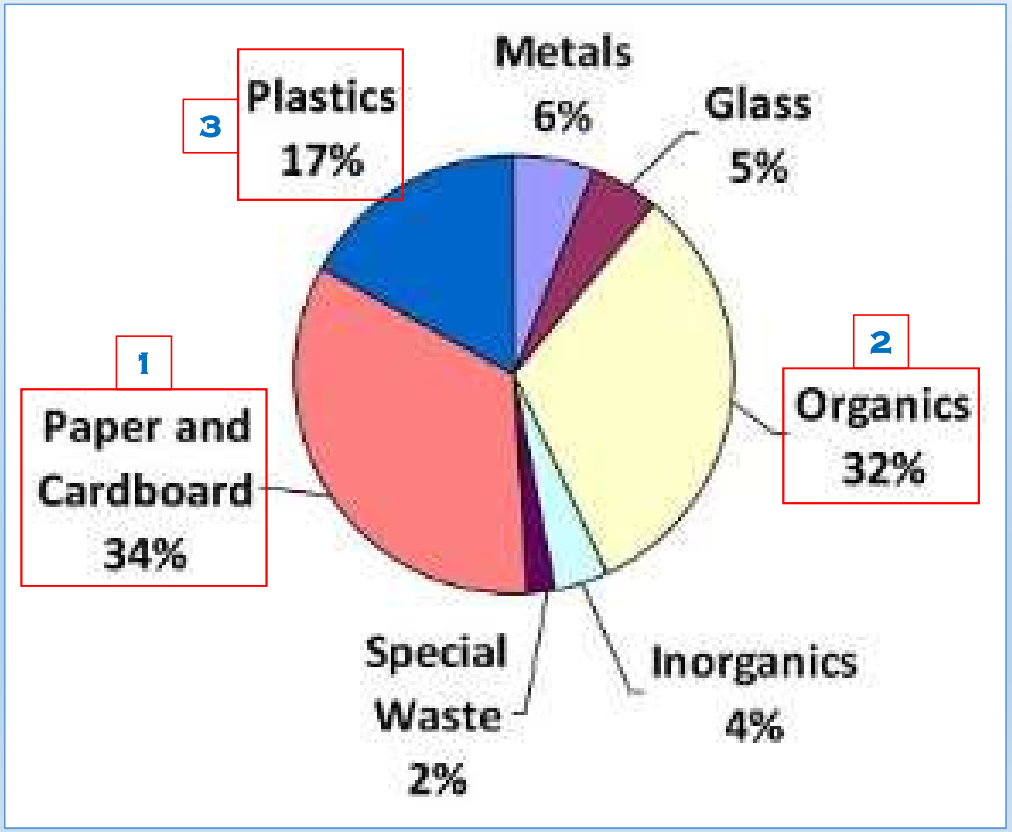
Presentation Outlines

- INTRODUCTION
- PLASTIC WASTE MANAGEMENT
  - DEFINITION AND TYPES OF PLASTIC MATERIALS
  - SOURCES OF PLASTIC WASTE AND STATICS
  - ENVIRONMENTAL ISSUES ON DISPOSAL PLASTIC WASTES
  - WHAT ARE THE COMMON RECYCLED PLASTICS?
  - PROCESS OF PLASTIC RECYCLING
  - PLASTIC WASTE MANAGEMENT IN SAUDI ARABIA

Introduction

Sources of Wastes

- After food waste and paper waste, plastic waste is the major constitute of municipal and industrial waste in cities.



- Economic growth and changing consumption and production patterns are resulting into rapid increase in generation of waste plastics in the world.
- Even the cities with low economic growth have started producing more plastic waste due to:
  - plastic packaging,
  - plastic shopping bags,
  - PET bottles
  - and other goods/appliances using plastic as the major component.

- 20 times more plastic is produced today than 50 years ago.

  The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes.

- This implies that on:

  More resources are being used to meet the increased demand of plastic, and more plastic waste is being generated.

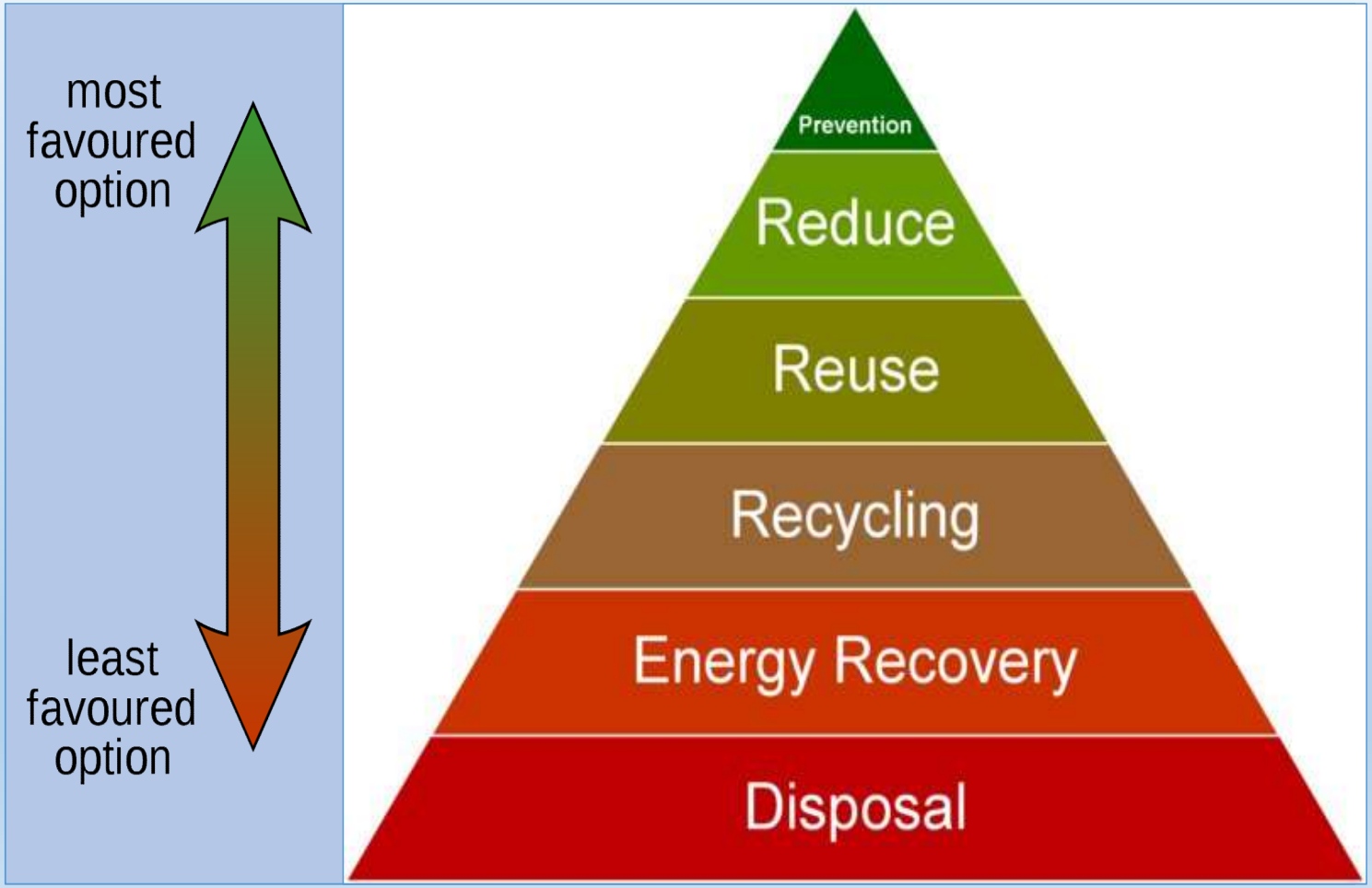
- Due to lack of integrated solid waste management (ISWM), most of the plastic waste is neither collected properly nor disposed of in appropriate manner to avoid its negative impacts on environment and public health.

- On the other hand, plastic waste recycling can provide
  - the most environmental friendly way.
  - economically viable, as it generates resources, which are in high demand.
- Some of the developed countries have already established commercial level resource recovery from waste plastics.

Integrated Solid Waste Management (ISWM)

3R (reduce, reuse and recycle) principle.

Waste Managements Strategies



Plastic Waste Management

DEFINITION AND TYPES OF PLASTIC MATERIALS

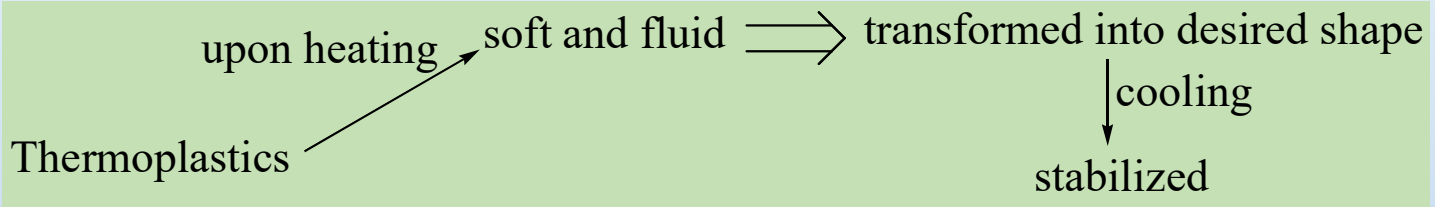
- The term "Plastics" includes materials composed of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine and sulfur.

- Plastics are macromolecules, formed by polymerization and having the ability to be shaped by application of reasonable amount of heat and pressure or another form of forces.

- Plastics, depending on their physical properties, may be classified as thermoplastic or thermosetting plastic materials.

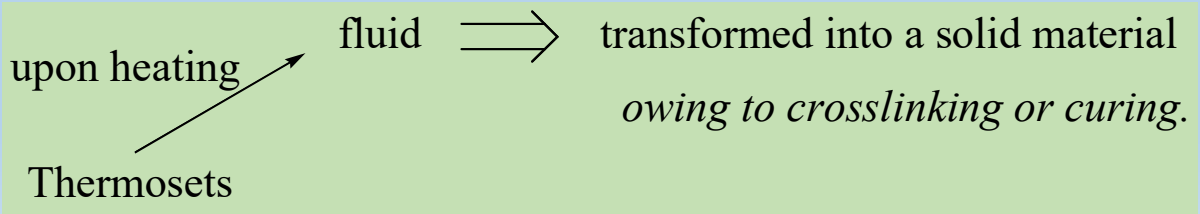
- **Thermoplastic materials** can be formed into desired shapes under heat and pressure and become solids on cooling.

  Examples are polyethylene, polystyrene and polyvinyl chloride, among others.



- **Thermosts or Thermosetting materials** which once shaped cannot be softened/remoulded by the application of heat.

  Examples are phenol formaldehyde and urea formaldehyde.



❖ **Out of total uses of plastic, 80% are Thermoplastic and 20% are thermosetting.**

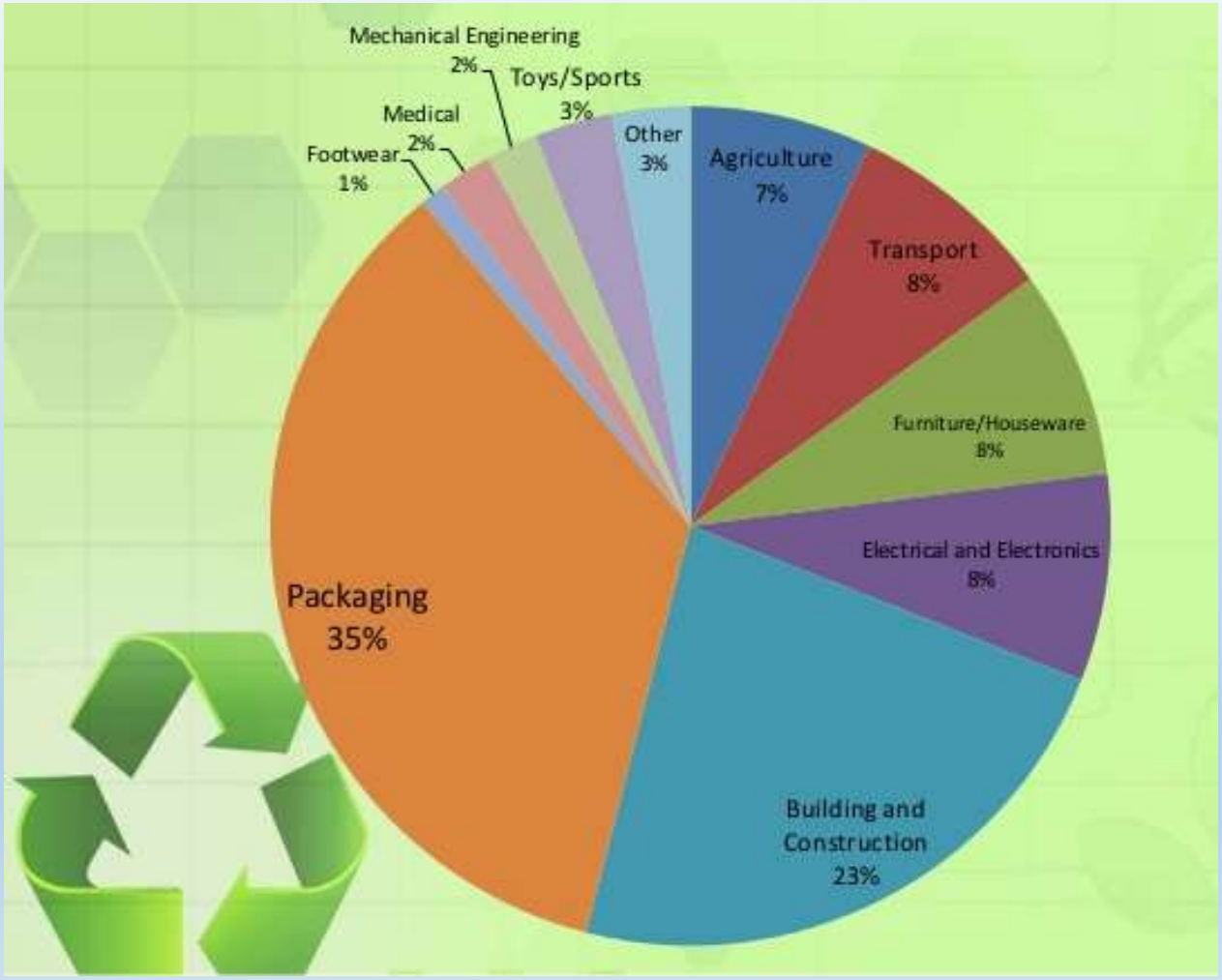
- Rapid population growth, urbanization and industrial growth have led to severe problem of waste generation in urban centers.

- The waste quantities increased from 46 million tones in 2001 to 65 million tones in 2010.

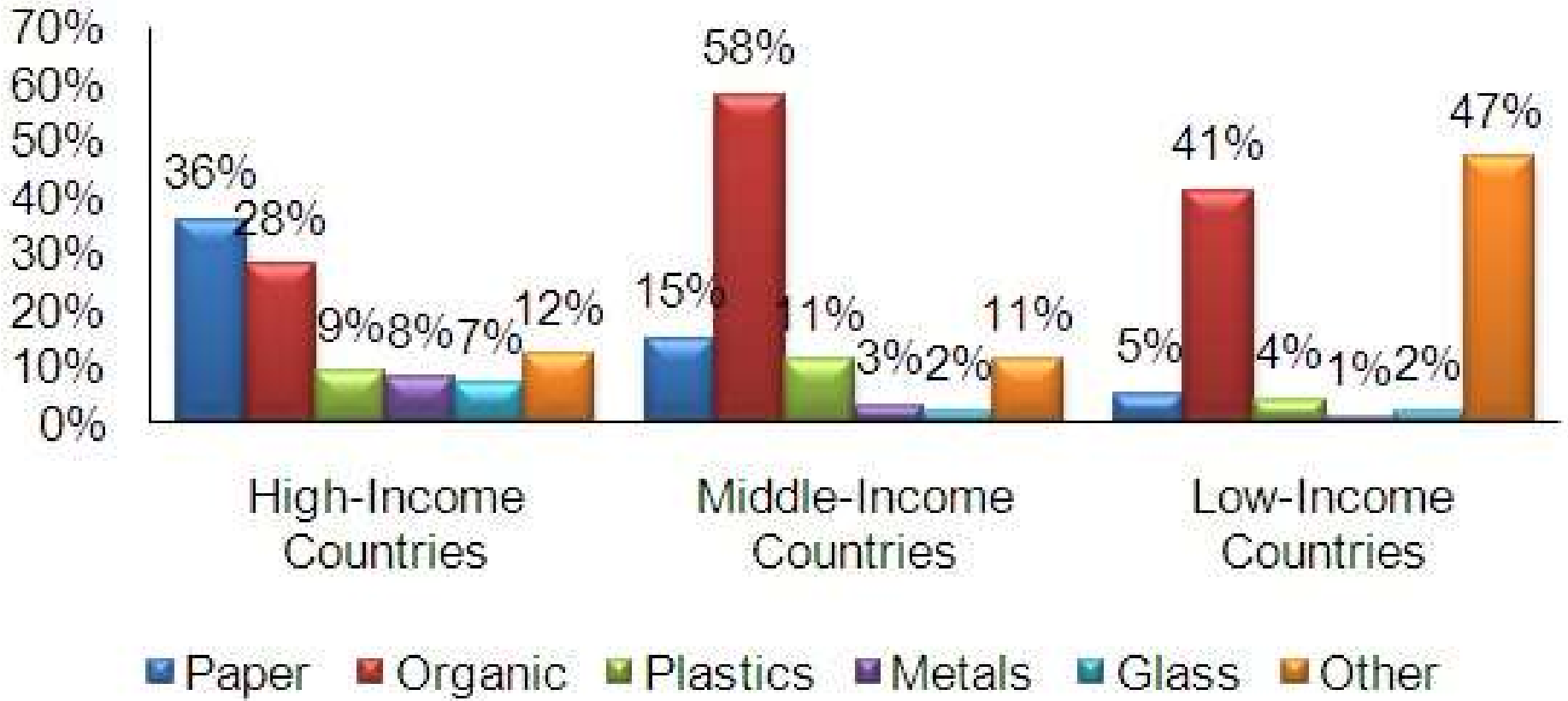
- Report says that per capita per day production will increase to 0.7 kg in 2050.

- The characteristics of waste depends on various factors such as food habits, traditions, lifestyle, climate …. Etc.

PERCENTAGE OF PLASTIC USED IN DIFFERENT FIELDS



CHARACTERISTICS OF MSW STREAMS DEPENDING ON INCOME (UNDESA, 2010)



Environmental Issues on Disposal Plastic Wastes

1. PLASTIC POLLUTE BEACHES AND OCEANS

2. PLASTIC LITTER THE LANDSCAPE

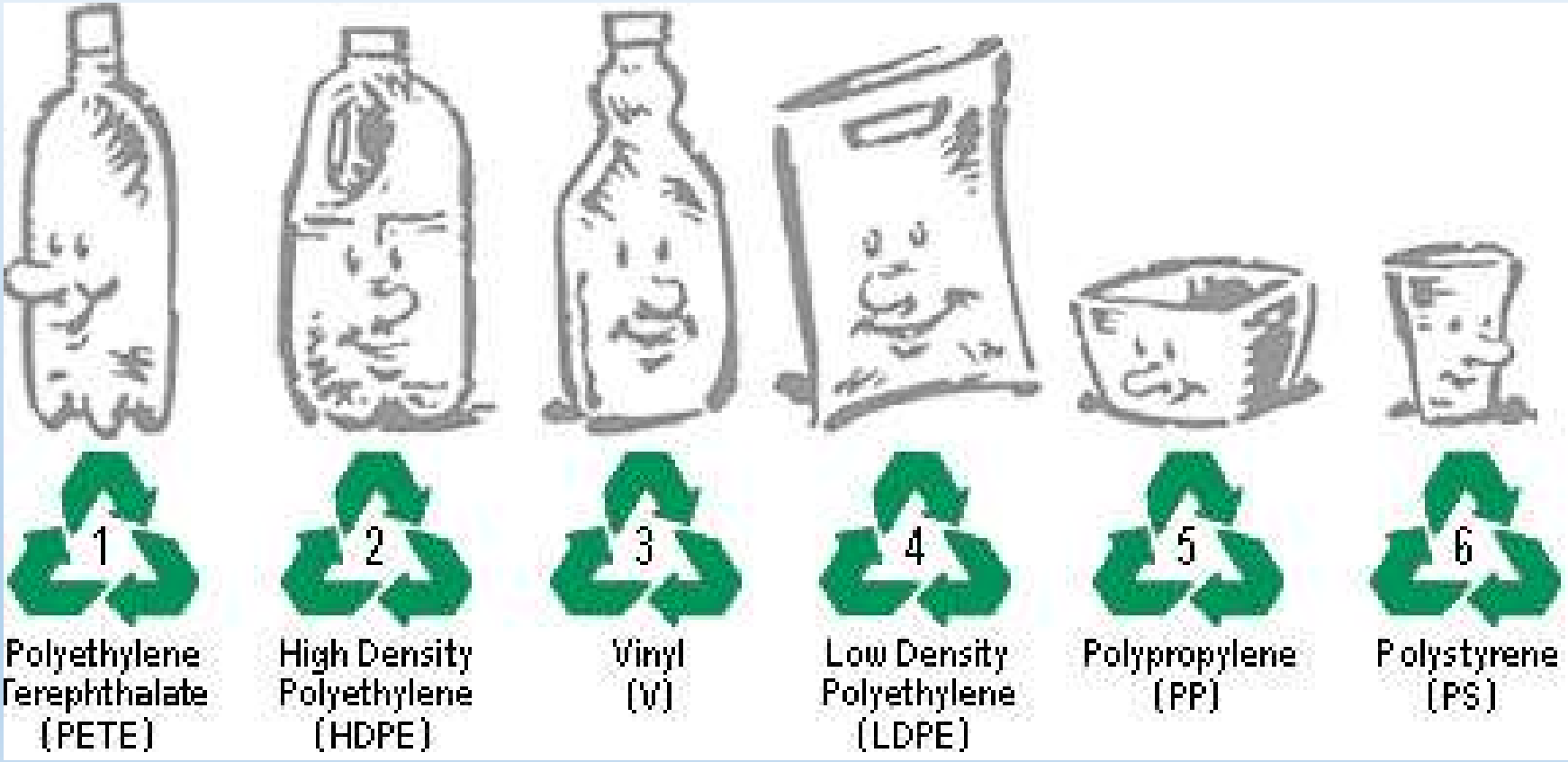
3. PLASTIC BAGS KILL ANIMALS

4. BURNING OF PLASTIC GENERATE TOXIC FUMES

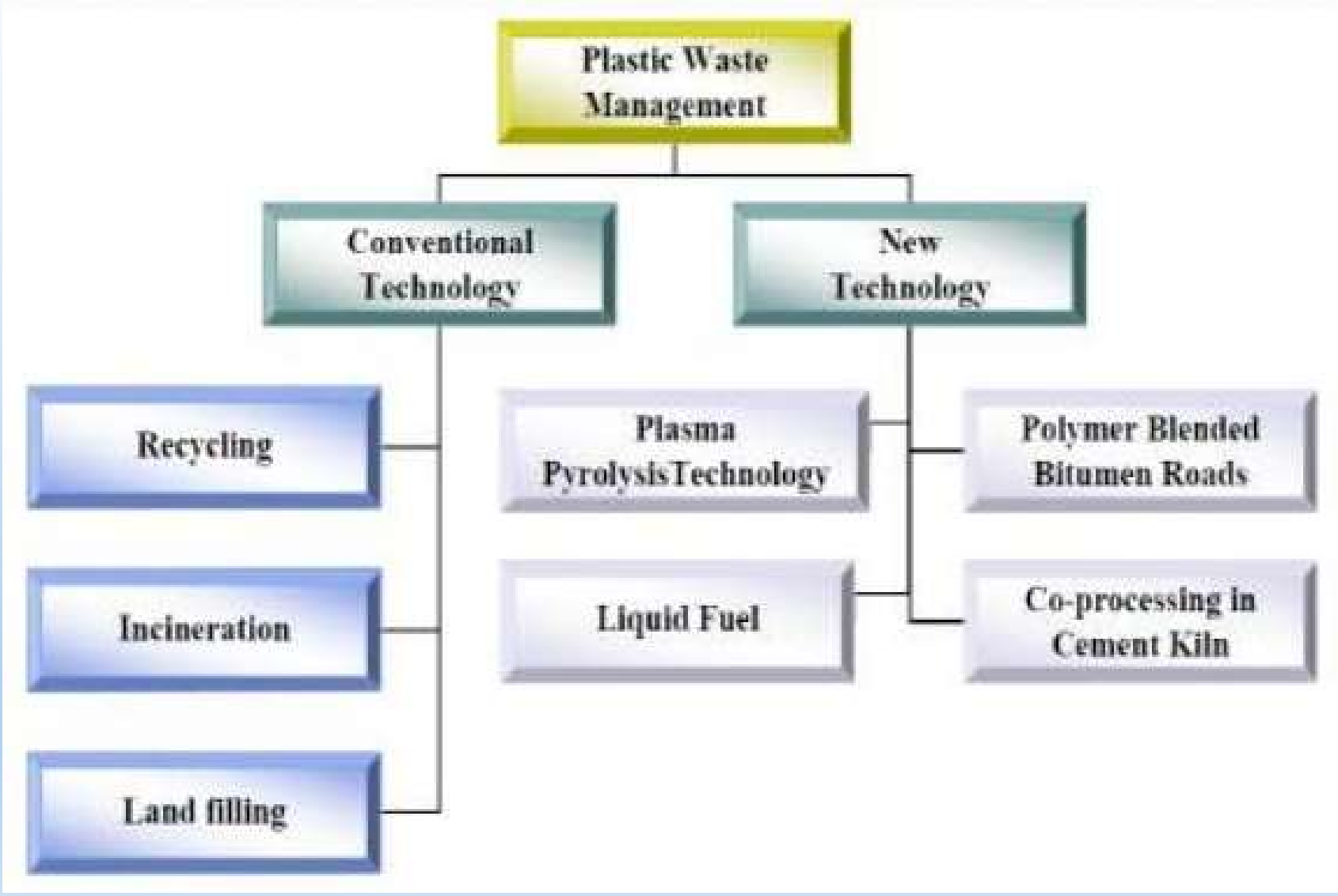
Carbon monoxide, chlorine, hydrochloric acid, dioxin, furans, amines, nitrides, styrene, benzene, 1,3-butadiene, CCl_4 and acetaldehyde

- Sub-standard plastic bags, films etc. pose problem in collection and recycling.
- Garbage mixed with plastics interferes in waste processing facilities and also cause problems in landfill operations.
- Lead and cadmium pigments, commonly used in LDPE, HDPE and PP as additives are toxic and are known to leach out.
- Littered plastics give unaesthentic look and choke the drain.
- Non-recyclable plastic wastes poses disposal problem.

What are the Common Recycled Plastics?



Process of Plastic Recycling


Plastic Waste Management
Conventional Technology
New Technology
Recycling
Incineration
Land filling
Plasma PyrolysisTechnology
Liquid Fuel
Polymer Blended Bitumen Roads
Co-processing in Cement Kiln

Conventional technology

Plastic Recycling

Plastic recycling refers to the process of recovering waste or scrap plastic and reprocessing it into useful product.

1. COLLECTION

- Plastics forms; for example plastic containers, bottles, plastic bags, packaging plastic, ...etc.
- Waste from our homes is generally collected by;
  - our local authorities through regular waste collection,
  - or by special collections for recycling (*plastic collecting business as a source of income*).
- Unfortunately, not all countries have the capacity to recycle plastic. Very few developing countries can actually recycle plastic.

2. SORTING

- The actual plastic recycling process starts with sorting of the different plastic items by their resin content.
- Companies that buy recycled resins want those recycled resins to have the same characteristics as virgin resins. *Otherwise, it is not efficient to use recycled materials.*
- Example: Recycling is the case of PET and PVC

  These two resins are contaminants to each other. combinations of PVC and PET resins can result in the release of hydrochloric gases.

  The PET resin will be ruined even with only a few parts per million of PVC resin.

2. SORTING

❖ Manual sorting;

Most of the current plastic sorting is done by hand.

- simple process
- needs very little technology,

But

- it leaves much room for improvement.
- costly,
- and inefficient method for sorting
- it is difficult to differentiate between the resin types used in packages through the visual means employed by-manual sorting

2. SORTING

❖ Macrosorting

- Microsorting deals with plastic after it has been chopped up into pieces.
- This type of sorting is the only one currently available commercially.
- It has the advantage of
  - needing very little or no preparation before sorting.
  - lower shipping costs
  - larger volume processing.

2. SORTING

❖ Macrosorting

- ❑ Prospects for automated sorting of post-consumer plastics:
  - ○ SPECTROSCOPY
    - *Near-Infrared waves* (600 to 2500 nm in wavelength).

      This technique involves irradiating the unsorted, unidentified plastic.
    - *X-RAYS*

      This separation method exposes the unknown plastic to waves (the transmission and reflection from waves in the x-ray region of the spectrum are studied).

2. SORTING

○ SINK FLOAT SYSTEMS

Sink float separation systems are very common and simple methods of separating materials of different densities.

	Density range (g/cm³)
Polyolefins	
Polypropylene	0.916-0.925
Low-density polyethylene	0.936-0.955
High-density polyethylene	0.956-0.980
Non-olefins	
Bulk polystyrene	1.050-1.220
Polyvinyl chloride	1.304- 1336
Polyethylene terephthalate	1.330—1.400

Example: **Some plastics, like PVC and PET, have very similar densities and cannot be separated by normal sink float system.**

2. SORTING

- There are specially designed machines that help in sorting of the plastics according to their resin content.
- Then the recycling mill sorts the scrap plastic by symbols at the bottom of the plastics.

3. SHREDDING

- After sorting the plastics, the next step is to cut the plastics into tiny chunks or pieces.
- The heavier and lighter plastic flakes are separated using a specially designed machine.
- The separation process helps in ensuring that the different plastics are not put together or mixed up in the final product.

4. CLEANING

- After a complete separation, the flakes or chunks are then washed with detergents to remove the remaining contamination.
- Once the cleaning process is complete, the clean flakes are passed through specialized equipment that further separates the plastic resin types.
- The plastic flakes are then subjected to moderate heat to dry.

5. MELTING

- The dry flakes are melted down.
- They can be melted down and molded into a new shape or they are melted down and processed into granules.
- The melting process is done under regulated temperatures. There is specialized equipment designed to melt down plastic without destroying them.

6. MAKING OF PELLETS

❖ After the melting process, the plastic pieces are then compressed into tiny pellets and become ready for reuse or be redesigned into new useful plastic products.

Advantages of Recycling Plastics

Plastics should be recycled because of a number of reasons as can be seen below:

1. PROVISION OF A SUSTAINABLE SOURCE OF RAW MATERIALS

Recycling plastics provides a sustainable source of raw materials to the manufacturing industry.

2. REDUCES ENVIRONMENTAL PROBLEMS

Since plastics are non-biodegradable, they pose a high risk to the people and the environment as a whole.

3. REDUCES LANDFILL PROBLEMS

Recycling plastics minimizes the amount of plastic being taken to

- diminishing landfill sites.
- little plastic garbage (can be used for agriculture or for human settlement).

4. CONSUMES LESS ENERGY

- Recycling of materials including plastics requires less energy as compared to making the plastic from scratch.
  - energy can be diverted to other important things in the economy.
  - it will save the economy billions of money.
- The process of manufacturing plastic using natural raw materials is expensive and time consuming compared to the recycling process.

5. ENCOURAGES A SUSTAINABLE LIFESTYLE AMONG PEOPLE

- Individuals who have ventured into plastic collection and recycling business will experience improved lifestyles as they will get their daily income from the business.
- This will in the long run improve the economy and boost the living standards of the people.

Conventional technology

Landfilling

- Landfill is the conventional approach to waste management, but space for landfills is becoming scarce in some countries.
- In a landfill, (with portions of MSW), as waste breaks down methane is generated. This gas can be recovered and used to generate electricity.
- Plastic waste creates an eternal problem as plastic products synthesized from petroleum are not biodegradable.
- For this reason, plastic waste remains in landfills, without breaking down or changing composition.

Conventional technology

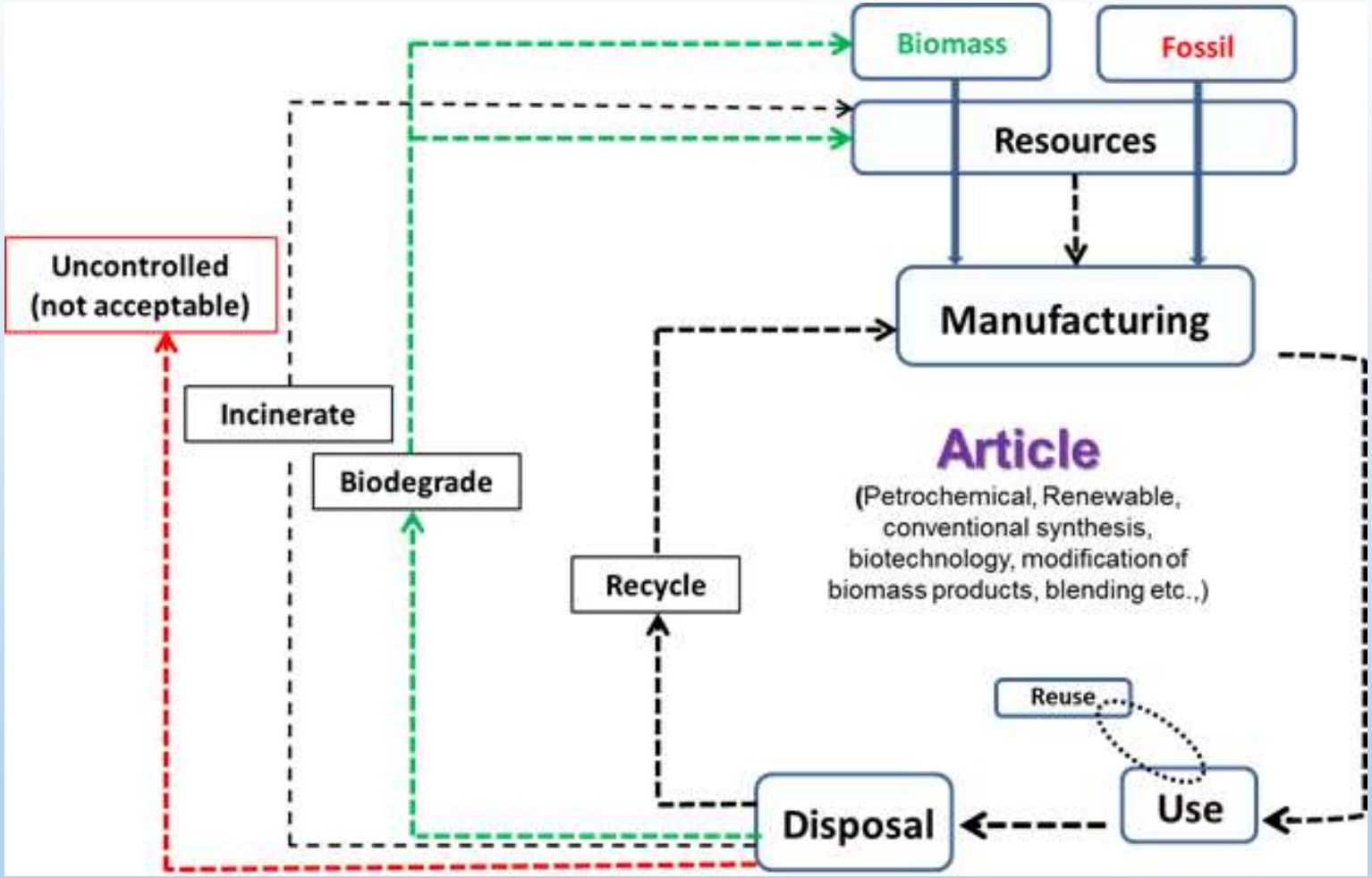
Incineration

- Incineration reduces the need for landfill of plastics waste, however, there are concerns that hazardous substances may be released into the atmosphere in the process.
- Incineration can be used with recovery of some of the energy content in the plastic.

- When the plastics disposed to landfill/sewage/marine water, they do not degrade and biodegrade, and generally it takes more than 100 years to degrade under natural conditions.
- Incineration and pyrolysis techniques are not successful for plastic wastes now a days.
- Eco-friendly as an alternative is required, the plastics have to be regarded as;
  - resources to be re-used
  - or biodegraded at the end of their service life.

  in order to mitigate their negative environmental impact.

- There is an increasing interest in polymeric materials that can be converted to the so-called compostable plastics.
- Biological recycling is considered as an alternative to the more traditional recycling procedures;
  - biodegradable
  - and compostable plastics can be returned to the biological cycle after use, wherever possible to convert at least part of the carbon of the plastic waste into cell biomass.



Concept of renewability within the general life cycle thinking of biobased polymeric materials

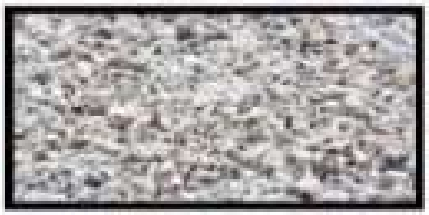
NEW TECHNOLOGY

Construction of polymer (plastics) coated bitumen road

Plastic waste collection, segregation & storage.

Cleaning & drying of Plastic waste .

Shredding plastic waste into required size (2 to 4 mm).



Stone aggregate (granite, ceramic) heated to around 160°C-170°C.

Shredded polymer waste (5-10% w/w) is added to heated stone aggregate for 30-40 sec and mixed for uniform coating at surface of aggregate

The coated aggregate is mixed with hot bitumen at temperature ranges from 155°C-163°C.

The mix (composite) known as waste plastic- aggregate-bitumen mix (130°C-140°C). This composite used for road laying at temperature between 110°C-130°C.

NEW TECHNOLOGY

Co-processing in cement kilns

- **Co-processing of plastic waste as an alternative Fuel and Raw Material (AFR).**
  - **Co-processing indicate substitution of primary fuel and raw material by waste.**
  - **Waste material such as plastic waste used for co-processing are referred to as alternative fuels and raw material (AFR).**
  - **One of the advantage of recovery method used in existing facility is eliminating the need to invest on other plastic waste practices and to secure land filling**

NEW TECHNOLOGY

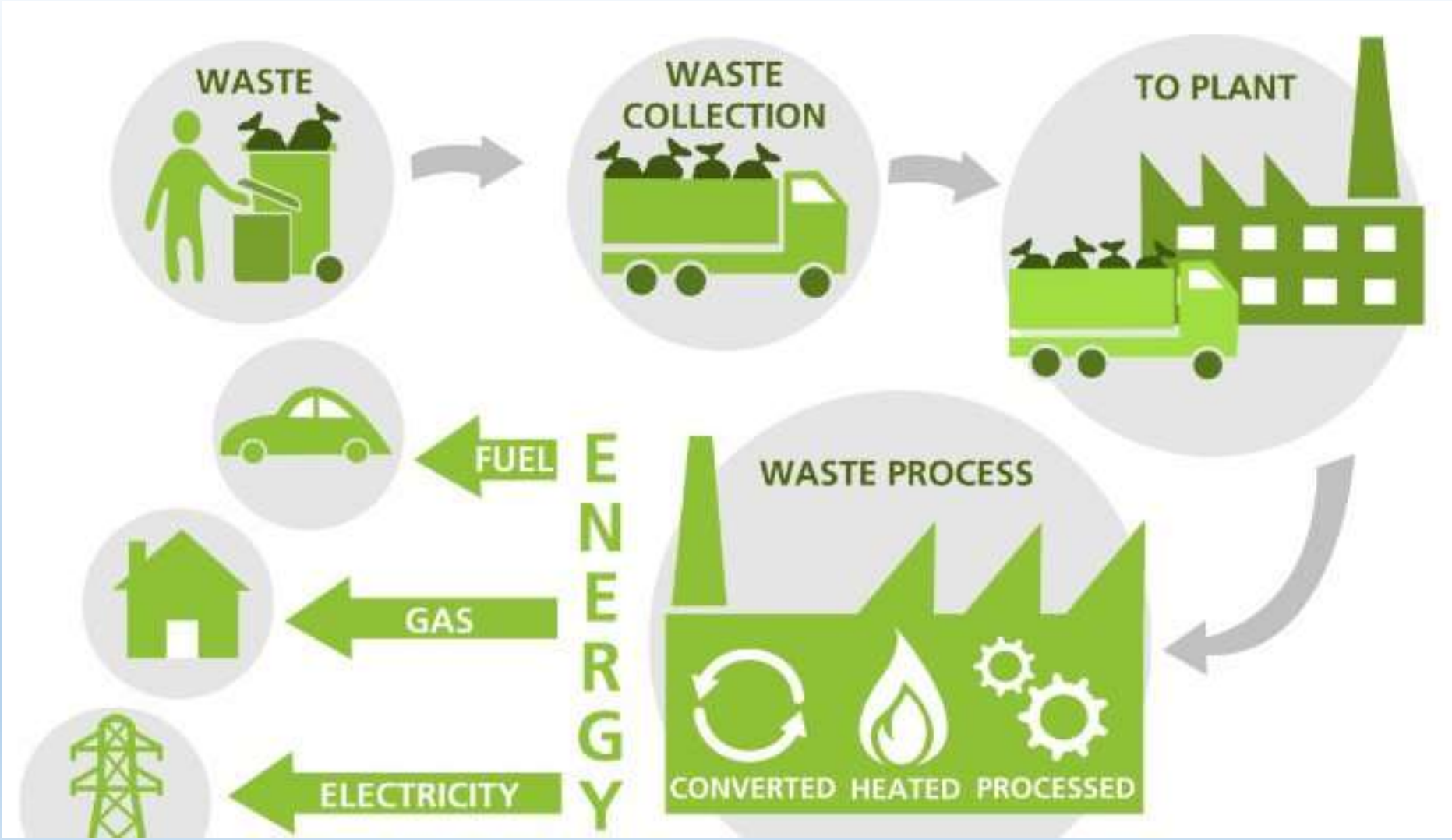
Plasma pyrolysis technology

- Pyrolysis is the thermal disintegration of carbonaceous material in oxygen-starved atmosphere.
- The intense and versatile heat generation capabilities of Plasma Pyrolysis technology enable to dispose of all type of plastic waste including polymeric, biomedical and hazardous waste in a safe and reliable manner.
- When optimized, the most likely compounds formed are methane, carbon monoxide, hydrogen, carbon dioxide and water molecules.

NEW TECHNOLOGY

Liquid fuel

- **Conversion of Plastics Waste into liquid fuel.**
  - **The entire process is undertaken in closed reactor vessel followed by condensation, if required.**
  - **Waste plastics while heating up to 2700 to 3000°C convert into liquid-vapour state, which is collected in condensation chamber in the form of liquid fuel.**
  - **The tarry liquid waste is topped-down from the heating reactor vessel.**
  - **The organic gas is generated which can be used in dual fuel diesel generator set for generation of electricity.**


WASTE
WASTE COLLECTION
TO PLANT
WASTE PROCESS
FUEL
GAS
ELECTRICITY
ENERGY
CONVERTED
HEATED
PROCESSED

PLASTIC WASTE MANAGEMENT IN SAUDI ARABIA

- In Saudi Arabia, last few decades
  - rapid industrialization,
  - high population growth rate
  - and fast urbanization
  - levels of pollution and waste have been increased.
  - Solid waste management is becoming a big challenge for the government and local bodies with each passing day.
- With population of around 15 million, Saudi Arabia generates more than 15 million tons of solid waste per year (*largest cities – Riyadh, Jeddah and Dammam – exceeds 6 million tons per annum*).
- The per capita waste generation is estimated at 1.5 to 1.8 kg per person per day.

- In Saudi Arabia, garbage is collected from individual or community bins and disposed of in landfills or dumpsites.
- Recycling, reuse and energy recovery is still at an early stage, although they are getting increased attention.
- Waste sorting and recycling are driven by an active informal sector.
- Recycling rate ranges from 10-15%, mainly due to the presence of the informal sector which extracts paper, metals and plastics from municipal waste.
- Recycling activities are mostly manual and labor intensive.
- Composting is also gaining increased interest in Saudi Arabia due to the high organic content of MSW (around 40%).

- Efforts are also underway to deploy waste-to-energy technologies in the Kingdom.
- All activities related to waste management are coordinated and financed by the government.
- The 2011 national budget allocated SR 29 billion for the municipal services sector, which includes water drainage and waste disposal.

PLASTIC RECYCLING COMPANIES IN SAUDI ARABIA

https://www.environmental-expert.com/companies/keyword-plastic-recycling-30821/location-saudi-arabia


GO GREEN
AND
REDUCE,
REUSE,
RECYCLE!
THANK YOU...