Waste Management

A Project Report

Submitted in partial fulfillment of the requirements for the award of degree of

B.TECH

(Computer Science And Engineering)

Submitted to

LOVELY PROFESSIONAL UNIVERSITY

PHAGWARA, PUNJAB

From 05/25/2020 to 07/03/2020

Submitted By

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LOVELY PROFESSIONAL UNIVERSITY

Annexure-II:

Student Declaration

To whom so ever it may concern

I, **MOHSIN MANZOOR BHAT, 11905269,** hereby declare that the work done by me on "**Waste Management"** from **May, 2020** to **July,2020 ,** is a record of original work for the partial fulfillment of the requirements for the award of the degree, **B.Tech (CSE) .**

Mohsin Manzoor Bhat (11905269)

Student's Sign

Dated: - 7-11-2020

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CHAPTER 1

INTRODUCTION OF THE WASTE MANAGEMENT PROJECT

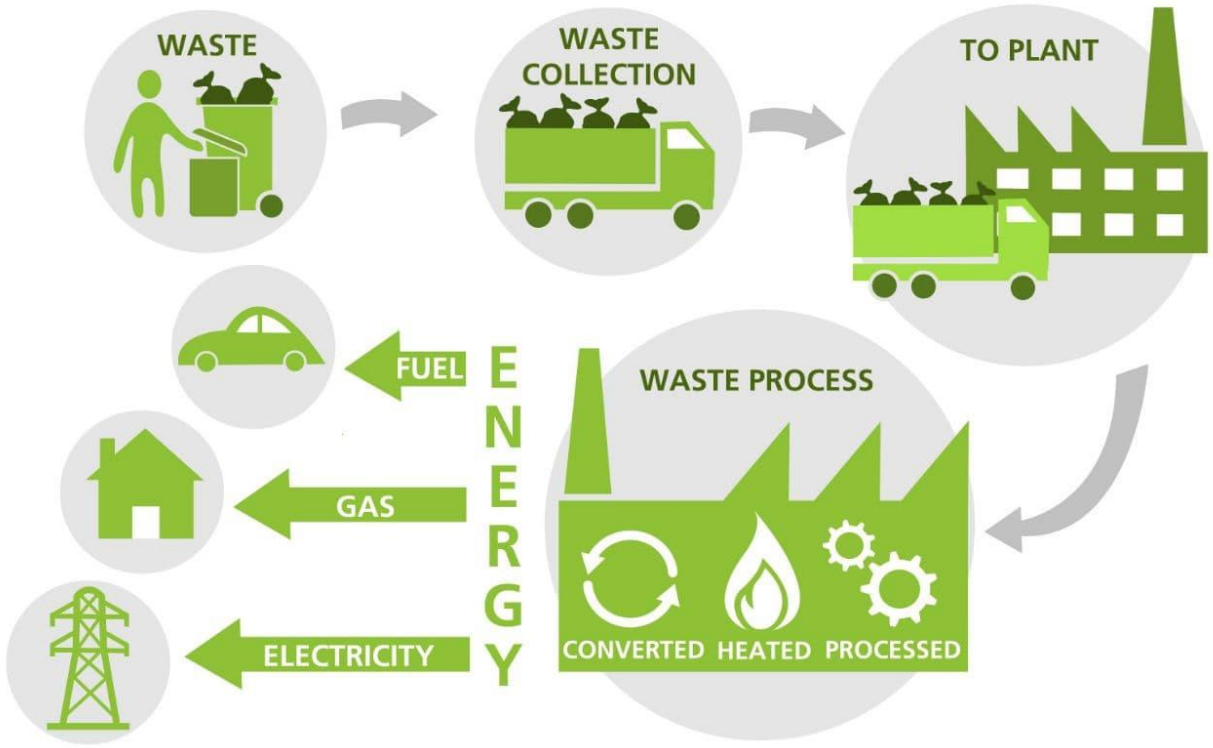


Figure 1.1

OBJECTIVE OF THE WASTE MANAGEMENT

1. To minimize the waste produced. Individuals can reduce the amount of waste they create by buying fewer products and by buying products which last longer.

2. To assess the activities involved for the proposed and determine the type, nature and estimated volumes of waste to be generated.

3. To identify any potential environmental impacts from the generation of waste at the site;

4. To recommend appropriate waste handling and disposal measures / routings in accordance with the current legislative and administrative requirements.

5. Transport, sort and manage waste from residential communities and businesses.

6. Reuse waste and materials wherever possible — preventing further waste, minimizing pollution and promoting recycling.

7. Remove and safely manage toxic or environmentally harmful materials like solvents, wastewater and industrial waste.

8. Convert waste to energy when it's not recyclable.

9. When necessary, dispose of unusable waste in the most environmentally responsible ways, ensuring disposal does not have a harmful impact.

10. To categories waste material where practicable (inert material / waste fractions) for disposal considerations i.e. public filling areas / landfill.

Importance of Waste Management

Planning the waste management and recycling for all of the rubbish produced in this country is an enormous task which involves both logistical planning and scientific knowledge and understanding in order to balance the impact on the environment and the cost effectiveness of the process.

The most important reason for waste collection is the protection of the environment and the health of the population. Rubbish and waste can cause air and water pollution. Rotting garbage is also known to produce harmful gases that mix with the air and can cause breathing problems in people. By inspecting the vegetation around landfill sites carefully you can determine the damage that can be caused by garbage and waste if left untreated in the open. To address this problem modern waste management professionals place garbage in lined holes and use bacteria to help facilitate its rapid decomposition. Rotting garbage and waste emanates a foul smell that can cause nausea among people who come into contact with it. It can also be a source for waterborne diseases such as cholera and abdominal conditions and discomfort. Since water sources need to be protected the role of waste disposal companies is very important. These organizations should make it a priority to secure their landfill sites so that water bodies are not affected by the garbage and waste collected from homes and commercial establishments. There are many challenges facing the waste management and recycling industry but there is also a lot of excellent work going on to ensure that this is an industry to be proud of and one that will continue to secure effective, sustainable and ecologically sound waste management and recycling for many years to come.

The World Health Organization states that:

"Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on health both in

households and across communities. The word ‘sanitation’ also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal.”

REASONS WHY WASTE MANAGEMENT IS IMPORTANT:-

1. Recycling Materials.
2. Health.
3. Make money.
4. Protect the aesthetics of nature.
5. Pave the way for sustainable development.

Applicability

- This project deals with the types and implications of various types of wastes that are piling up in our environment. It also deals with the various threats posed by the wastes to the hygiene and health of our ecosystem.

- We are trying to focus on the variety of methods in which we can reduce, Reuse and recycle the varied amounts of materials which in one way or another may be useful to us .

- Also we are trying to show the implications of hazardous materials on the health and hygiene of the ecosystem and the ways in which we can reduce the harmful impacts of the radioactive materials by disposing them off without any danger posed during and after.

WHAT IS THE REAL SCOPE OF WASTE MANAGEMENT?

The 3R concept (reduce–reuse–recycle) is becoming recognized around the world as an important guiding principle for realizing sound waste management solutions. But this approach will only enable improvements up to a certain point, even if programmes are perfectly implemented. Once this point is reached, we will get stuck and will not be able to further improve the situation by installing practical additional and sustainable material flow loops that help to reduce resource consumption and emissions along the value chain of extraction and processing of primary resources. The installation of functioning material loops is one of the main goals of the circular economy package currently under discussion in the European Union. When pursuing steps to attain that goal we must be well aware that:

- It is not only about finding technical solutions to recycle but that;

- We also have to make sure to put in place the right regulatory framework to allow for the utilization of secondary resources, while still making sure;
- To prevent harmful substances to remain and potentially accumulate in these material loops.

A crucial aspect of recycling is the quality of recyclables. Material loops can only effectively be implemented when the quality of secondary material becomes comparable with primary material, and secondary material therefore can fully replace primary material without impairing the quality of the primary products. Production of lower-than-optimal quality recyclables might help reduce waste disposal in the short term, but ambitious local and national recycling targets can only be met when recycling systems consistently produce high-quality secondary materials, thereby conserving the value of the original material and enabling the substitution of primary material.

To deal with recycling we need to keep these things in mind:-

1. We need to make sure that products that are brought to the market are recyclable. Materials and material combinations that pose problems down the recycling chain must be banned or must face significant economical disadvantages (for example higher participation fee in EPR-schemes).

1. We need to set up collection systems in a way to get hold of as much of the plastics waste as possible on one hand, and on the other hand still prevent unwanted impurities detrimental to recycling from entering the recycling chain at any point.
2. We need robust processing plants that are able to deal with impurities in the feed and still provide high-quality secondary material that the market demands.

In order for the whole system to work, close interactions between the producing and the waste management sectors are needed. Robust information loops must be implemented and used to gain all the relevant information down the value chain and feed it back to become part of the design decisions during the production stage. Only this will allow for a pro-active and future-oriented waste collection and recycling system capable of implementing a sustainable material loop for plastics.

RELEVANCE

1. As global human populations continue to grow uncontrollably, there is a foreseeable medium to long-term need for the utilization of deep ocean environments for disposal of waste materials to maintain sustainability of global environmental resources.

2. The assimilative capacity of deep ocean ecosystems is likely to be high relative to the quantities of waste that cannot be dealt with through alternative options such as waste minimization, recycling and incineration.

3. Deep ocean disposal may not be an acceptable option for the disposal of industrial organic compounds, which are persistent in the environment but for which alternative destructive procedures are available.

4. The choice of either a dispersive or accumulative regime for a disposal will need be based on the characteristics of the waste. Waste that is biologically or chemically degradable may best be dispersed.

5. Present knowledge of deep ocean ecosystems would suggest that disposal of inert, metal-rich, or even organic-rich wastes into accumulative regimes on the floor of the abyssal ocean would not create major deleterious impacts on living resources or other uses by Mankind of the oceans. Thus, under the present definition adopted by the Law of the Sea Convention this would not constitute large-scale pollution.

6. These tentative conclusions need to be evaluated by appropriately scaled experiments. Results from small-scale experimental procedures, based on the disposal of a few tones of waste and affecting a few square metres of sea-bed, cannot be extrapolated to predict confidently the impact of industrial scale disposal. Experiments approaching a tenth the size and extent of a full industrial exercise will be needed, but conducting such an experiment will not, in itself, carry significant environmental risk.

7. There are also some basic biological questions, mostly concerning the diversity of benthic assemblages and the processes that maintain their diversity, that will need to be resolved before deep-ocean disposal could be adopted.
8. There are major socio-economic problems about the global management of the abyssal ocean as a non-living resource which will have to be addressed internationally.

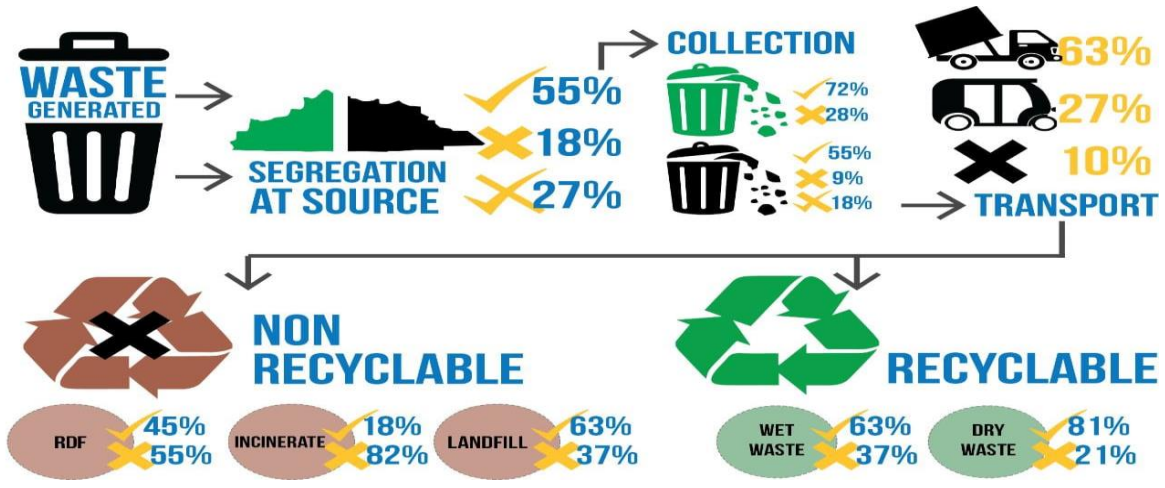


Fig. 1.2


Analysis
Recycling / Disposal
Collection
WASTE MANAGEMENT
Recovery
Transportation

Fig. 1.3

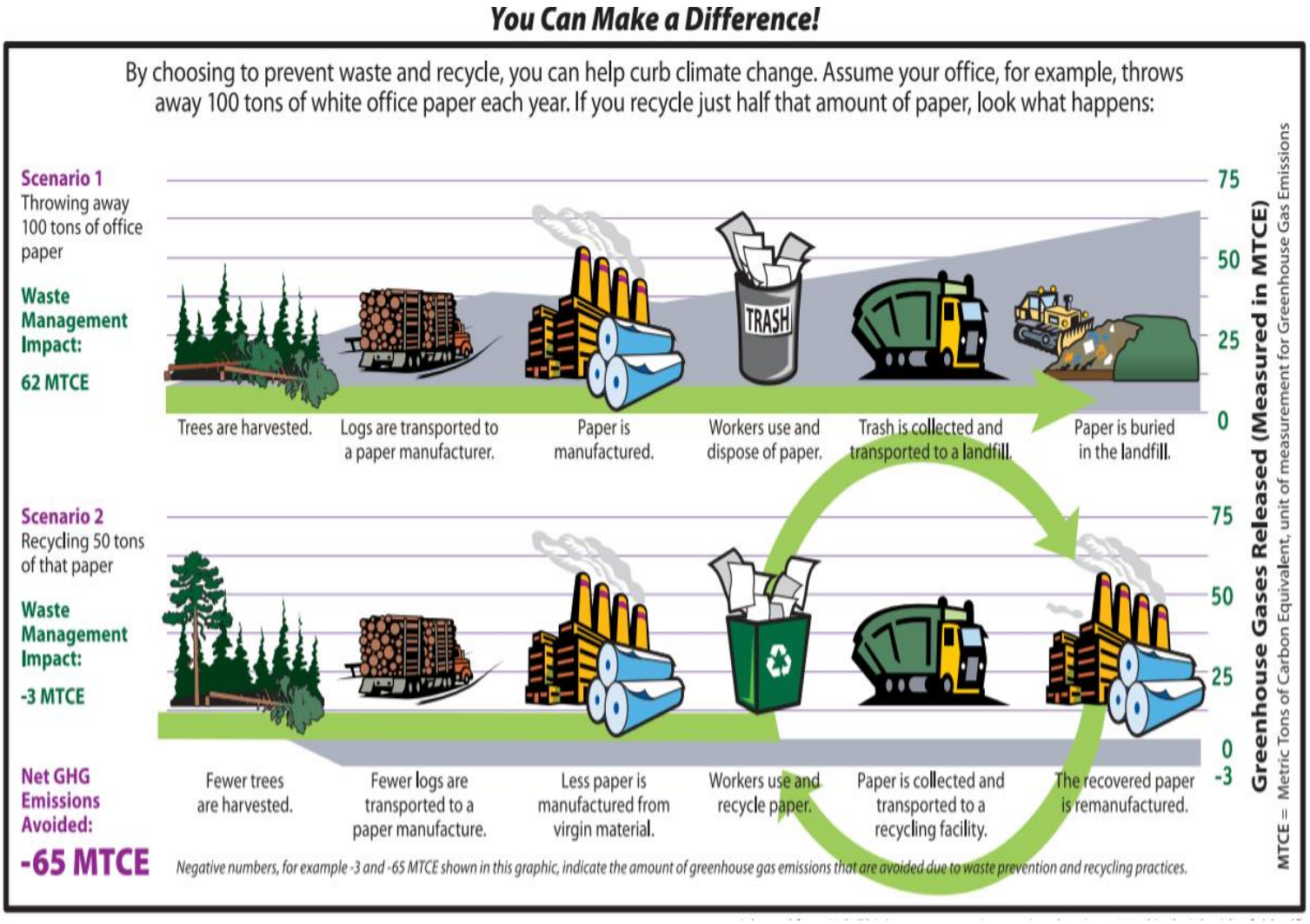

You Can Make a Difference!
By choosing to prevent waste and recycle, you can help curb climate change. Assume your office, for example, throws away 100 tons of white office paper each year. If you recycle just half that amount of paper, look what happens:
Scenario 1
Throwing away 100 tons of office paper
Waste Management Impact:
62 MTCE
Trees are harvested.
Logs are transported to a paper manufacturer.
Paper is manufactured.
Workers use and dispose of paper.
Trash is collected and transported to a landfill.
Paper is buried in the landfill.
TRASH
Scenario 2
Recycling 50 tons of that paper
Waste Management Impact:
-3 MTCE
Net GHG Emissions Avoided:
-65 MTCE
Fewer trees are harvested.
Fewer logs are transported to a paper manufacture.
Less paper is manufactured from virgin material.
Workers use and recycle paper.
Paper is collected and transported to a recycling facility.
The recovered paper is remanufactured.
75
50
25
0
-3
Greenhouse Gases Released (Measured in MTCE)
MTCE = Metric Tons of Carbon Equivalent, unit of measurement for Greenhouse Gas Emissions
Negative numbers, for example -3 and -65 MTCE shown in this graphic, indicate the amount of greenhouse gas emissions that are avoided due to waste prevention and recycling practices.

Fig . 1.4

CHAPTER 2

WHAT IS WASTE?

Wastes (or waste) are unwanted or unusable materials. A by-product by contrast is a joint product of relatively minor economic value. A waste product may become a by-product, joint product or resource through an invention that raises a waste product's value above zero.

The UNSD Glossary of Environment Statistics describes waste as "materials that are not prime products for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded."

The main types of wastes are:-

1. Solid wastes
2. Liquid Wastes
3. Organic Waste
4. Recyclable Wastes
5. Hazardous Waste
6. E-Waste

SOLID WASTES

INTRODUCTION:

Solid waste, commonly known as trash or garbage in the United States and rubbish in Britain is a waste type consisting of everyday items that are discarded by the public. "Garbage" can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately.

DEFINITION:

The composition of solid waste varies greatly from municipality to municipality, and it changes significantly with time. In municipalities which have a well developed waste recycling system, the waste stream mainly consists of intractable wastes such as plastic film and non-recyclable packaging materials. Most definitions of municipal solid waste do not include industrial wastes,

agricultural wastes, medical waste, radioactive waste or sewage sludge. Waste collection is performed by the municipality within a given area. The term residual waste relates to waste left from household sources containing materials that have not been separated out or sent for processing. Waste can be classified in several ways, but the following list represents a typical classification:-

- **Biodegradable waste**: Food and kitchen waste, green waste, paper ,although some difficult to compost plant material may be excluded.
- **Recyclable materials**: Paper, cardboard, glass, bottles, jars, tin cans, aluminum cans, aluminum foil, metals, certain plastics, textiles, clothing, tires, batteries, etc.
- **Inert waste**: Construction and demolition waste, dirt, rocks, debris
- **Electrical and electronic waste (WEEE)** - Electrical appliances, light bulbs, washing machines, TVs, computers, screens, mobile phones, alarm clocks, watches, etc.
- **Composite Wastes**: Waste clothing, Tetra Pack food and drink cartons, waste plastics such as toys and plastic garden furniture
- **Hazardous waste**: - Including most paints, chemicals, tires, batteries, light bulbs, electrical appliances, fluorescent lamps, aerosol spray cans, and fertilizers
- **Toxic waste: -** Including pesticides, herbicides, and fungicides
- **Biomedical waste**: - Expired pharmaceutical drugs, etc.

For example, typical municipal solid waste in China is composed of 55.9% food residue, 8.5% paper, 11.2% plastics, 3.2% textiles, 2.9% wood waste, 0.8% rubber, and 18.4% non-combustibles.

SOLID WASTE MANAGEMENT:

Solid-waste management, the collecting, treating and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease—that is, diseases spread by rodents and insects.

In ancient cities, wastes were thrown onto unpaved streets , where they were left to accumulate. It was not until 320 BCE in Athens that the first known law forbidding this practice was

established. In ancient Rome, property owners were responsible for cleaning the streets fronting their property. But organized waste collection was associated only with state-sponsored events such as parades. Disposal methods were very rudimentary, involving open pits located just outside the city walls. As populations soared, efforts were made to transport waste farther out from the cities.

A technological approach to solid-waste management began to develop in the latter part of the 19th century. Watertight garbage cans were first introduced in the United States, and sturdier vehicles were used to collect and transport wastes.

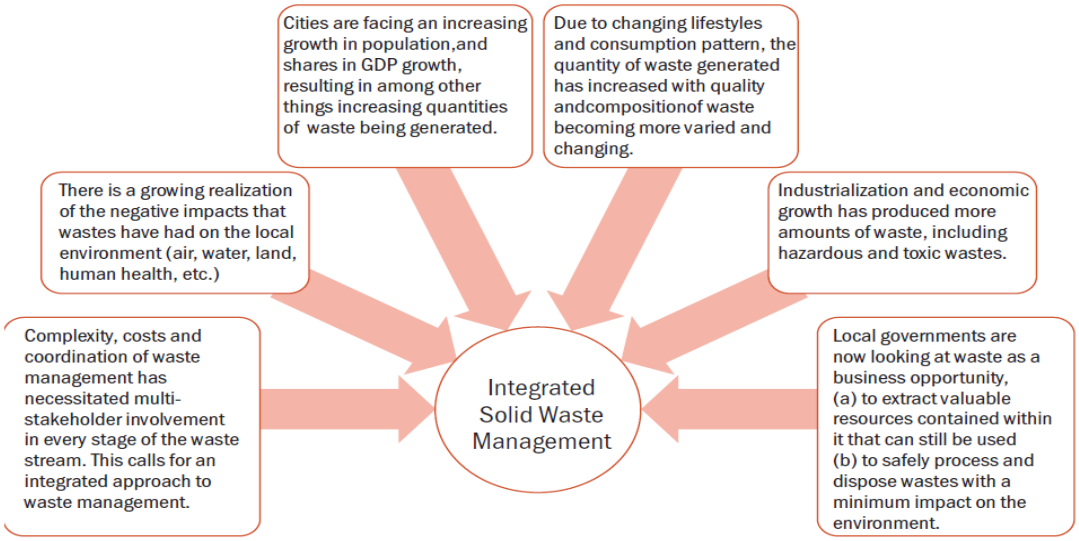


Fig. 2.1

PROJECTS IN THE DIRECTION OF SOLID WASTE MANAGEMENT:

Waste management involves the procedures and actions required to manage waste from its production to its disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process.

Waste can be solid, liquid, or gas and each type have different methods of disposal and management. In some cases, waste can prove drastic to human health. Waste is produced by human activity, for example, the extraction and processing of raw materials. Waste management is intended to reduce adverse effects of waste on human health, the environment or aesthetics.

A large portion of waste management practices deal with municipal solid waste (MSW) which is the bulk of the waste that is created by household, industrial, and commercial activity.

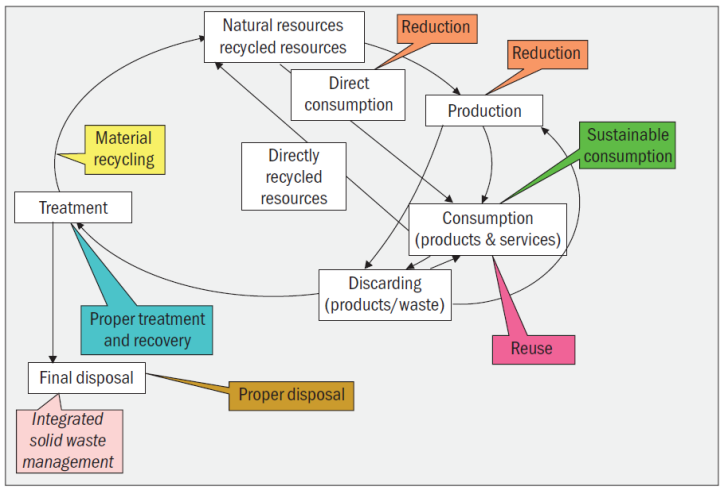


Fig. 2.2: Lifecycle - based integrated Solid Waste Management

Fig. 2.3

Type	Components of Waste	Process	
Biodegradable	Kitchen, Garden and Food Waste	Biological Treatment	Aerobic processes, Anaerobic processes
		Thermal treatment	Incinerations, Pyrolysis systems, Gasification systems
		Transformation	Mechanical Transformation, Thermal Transformation
Recyclable	Plastic	Plasma Pyrolysis Technology (PPT), Alternate Fuel as Refuse Derived Fuel RDF	
	Paper	Dissolution, Screening, De-inking, Sterilization and bleaching process	
	Glass	Vitrification Technology	
Inert	Sand	Landfilling: Jaw & Pulse Crusher	
	Pebbles & Gravels		

Table 2. 1

Municipal Solid Waste

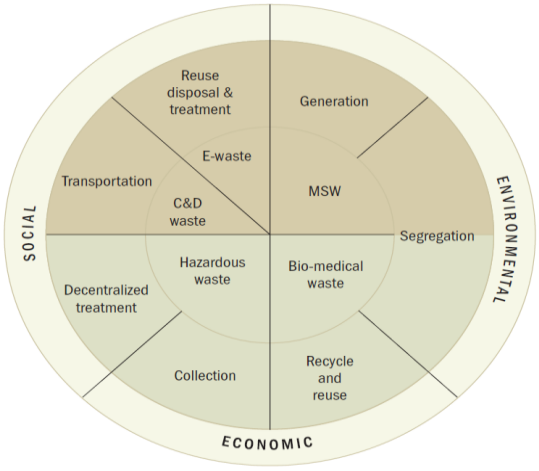
AWARENESS WITH REGARD TO MANAGE SOLID WASTES:

Waste can be considered as nothing but valuable material at wrong place. There is no substance in this world, which is not useful in one-way or other. It's man's ignorance that he considers certain things as waste and other thing as useful. With the development as types of waste are

changing, the attitude of people towards waste should change. People must realize that the waste which they throwing in the streets is not actually waste, it is the raw material for some other processes.

Raising awareness about municipal solid waste management is an essential component of effective waste management. It is important for key stakeholders to be aware of a city's waste management activities and have a strong understanding of the benefits of proper solid waste management. Although, many challenges arise when raising awareness about solid waste management, a variety of communication techniques can be used to address them. These strategies when chalked out results in:

- Use of city waste collection services by the public and private sectors.
- Funding for waste management from local elected officials.
- Adoption and enforcement of local waste management policies.
- Support for local-level activities from national or provincial governments.



Concept of Integrated Solid Waste Management Figure 2.4

LIQUID WASTES

INTRODUCTION:

Liquid waste is a major problem in the world, due to approximately 71% of the Earth's surface being covered in water. According to the Environmental Protection Agency (EPA), liquid waste is defined as any waste material that passes the definition of a "liquid." This means that the

material must, “pass through a 0.45 micron filter at a pressure differential of 75 psi,” according to the EPA’s provided definition of a liquid. The main producers of liquid waste are animals and human beings as natural excretion of waste is flushed into sewage and waste lines.

DEFINITION:

Liquid waste can be defined as such Liquids as wastewater, fats, oils or grease (FOG), used oil, liquids, solids, gases, or sludges and hazardous household liquids. They can also be discarded commercial products classified as “Liquid Industrial Waste” such as cleaning fluids or pesticides, or the by-products of manufacturing processes. There are general regulatory requirements relating to waste, additional regulations apply to generating, storing, transporting, treating and disposing of hazardous and liquid wastes.

WASTE WATER TREATMENT TECHNOLOGIES:

- Chemical oxidation and reduction
- Flocculation
- Filtration
- Carbon adsorption
- Biological treatment
- Oil/Water separation

LIQUID WASTE MANAGEMENT:

Domestic Waste is a serious threat to the public health in India. Absence to proper sanitation and unhygienic disposal of waste including domestic wastewater leads to pollution of natural resources and affects human health. Waste has an economic value once treated and re-used. In country like India, where there is crunch of natural resources, reuse of treated domestic waste water can lead to reduced depletion of fresh water sources and other natural resources. This training module has been formulated in order to enhance capacity of community groups for development of sanitation systems in villages and towns and create larger awareness on better sanitation practices and domestic wastewater management amongst local communities.

PROJECTS IN THE DIRECTION OF LIQUID WASTE MANAGEMENT:

Rapid development of the country has resulted into a sharp increase in water demand and the most accessible water resources, such as rivers and shallow aquifers are now almost entirely

committed. Alternative water resources are therefore imperative to meet with the ever increasing demand.

Fig. 2.5 Sewages dumped into river untreated

Fig. 2.6 Sewage Treatment Plant.

With the increase of water usage, the volume of sewage also increases and safe disposal of sewage has become a cause of concern. The appropriate reuse of treated sewage is the obvious and eminent solution. It is the most preferred approach as many parts in the country are not having suitable surface water sources. If wastewater reuse is exercised properly, the benefits that can be reaped are great and will far outweigh any associated costs.

AWARENESS REGARDING LIQUID WASTE MANAGEMENT:

Dealing with liquid wastes is one of the biggest challenges of urban sanitation. Liquid waste management requires capital investment, skilled personnel, coordination between different government departments and organizations, and awareness of the issues by the public. Failure to manage liquid wastes, especially human excreta, leads to health and environmental problems.

There are many houses and institutions with waterborne toilet systems that are not connected to the sewerage system. In these places, the sewage is sent to septic tanks. These different sanitation technologies require different techniques for managing and disposing of the wastes.

	Technology/ Processes	
Industrial Waste Water	Primary Treatment for Solid Removal	Screening, Grit Chamber
	Secondary Treatment for BOD Removal	Biological Digestion Process
	Tertiary Treatment for Meeting Specific Discharge Requirement	Coagulation, Oxidation, Sedimentation

Table 2. 2

ORGANIC WASTES

INTRODUCTION:

Organic wastes refer to the residue of plants, animals and microbes, or waste materials naturally generated from all living things.

DEFINITION:

Organic wastes contain materials which originated from living organisms. There are many types of organic wastes and they can be found in municipal solid waste, industrial solid waste, agricultural waste, and wastewaters. Organic wastes are often disposed of with other wastes in landfills or incinerators, but since they are biodegradable, some organic wastes are suitable for composting and land application.

MANAGEMENT OF ORGANIC WASTES:

Organic waste is probably what we're most familiar with in our day-to-day lives. The leaves we rake in our yard, the banana peel we throw out each morning, or what we clear off our dinner plates each evening. Organic waste encompasses any waste material that comes from plants or animals and is biodegradable.

Anaerobic digestion takes composting to the industrial level and has become very popular with food manufacturers as a way to handle food waste. Much like composting, the organic waste is decomposed to create a nutrient rich soil fertilizer. However, anaerobic digestion uses specialized sealed tanks that remove all oxygen while also speeding the process so that break-down takes as little as five days. In addition to producing fertilizer, anaerobic digestion creates a second valuable by-product. As the waste breaks down, it creates a biogas, which can be used to create power and heat energy.

PROJECTS IN THE DIRECTION OF ORGANIC WASTE MANAGEMENT:

1. Potato Power

One of the UK's biggest food manufacturing companies, 2 Sisters Foods, is using potato scraps from their mashed potatoes and pie product lines to create 3,500 megawatt hours of electricity

and 5,000 megawatt hours of steam, through anaerobic digestion, to power their manufacturing facility. Their sustainability goals are to reduce carbon emissions, cut food waste, reduce water use and achieve zero landfill across their facilities.

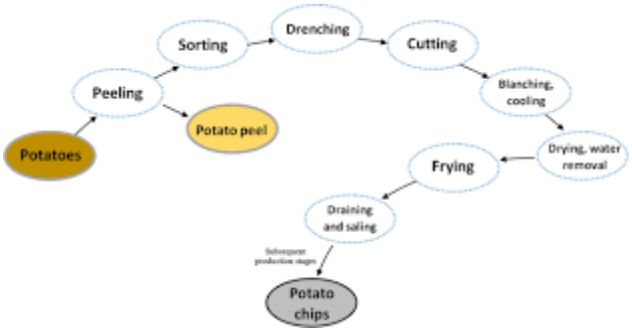


Fig 2.7

2. Pumpkin Power

Over one billion pounds of pumpkins are produced in the U.S. each year, many of them decorating your front porch throughout the fall season. In Oakland, CA, discarded pumpkins and other organic waste is collected and put through anaerobic digesters. It is estimated that digesting 100 tons of food waste for five days a week could generate the amount of electricity needed to power 1,000 homes.

Fig 2.8

AWARENESS REGARDING ORGANIC WASTE MANAGEMENT:

In Global South cities, food and organic waste is the main component of municipal waste, comprising as much as 80%. Around 30% of all the food grown for human consumption is lost

or wasted every year, 1/2 with most of it ending up in landfills. When disposed in a landfill it produces methane, an especially potent greenhouse gas, as well as water-polluting leachate. This organic waste can be instead being treated to produce compost, renewable fuel and other products, create jobs, and support local agriculture and forestry. As waste management is usually within the power of cities, cities can often implement food and organics waste schemes quickly.

RECYCLABLE WASTE

INTRODUCTION

The common waste materials which have the potential to be reused can be recycled as raw materials, can reduce energy consumption, reduce pollution, reduce further pollution of water and landfills; reducing the need for waste disposal. Recycling is processing used material into new, useful products.

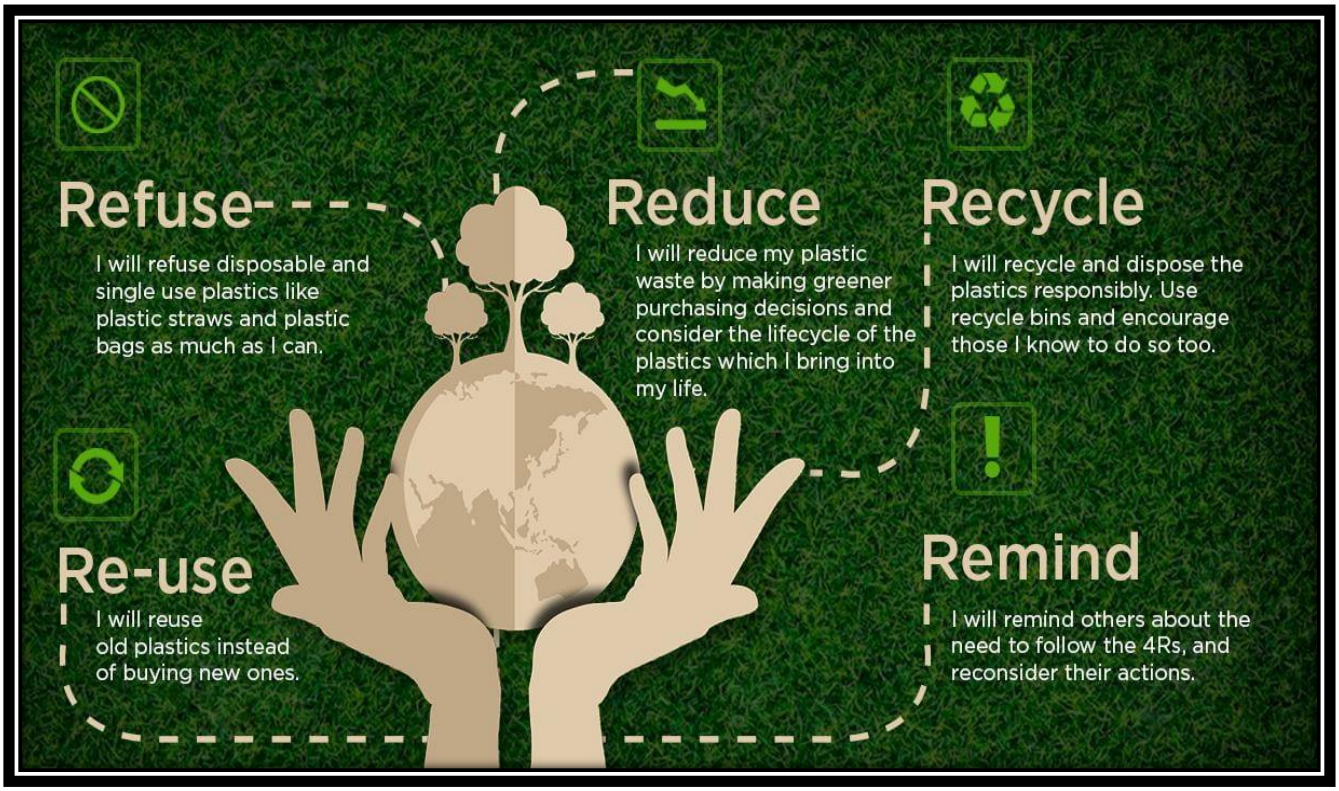


Fig 2.9

DEFINITION:- Although many government programs are concentrated on recycling at home, 64% of waste in the United Kingdom is generated by industry. The focus of many recycling programs done by industry is the cost–effectiveness of recycling. The ubiquitous nature of cardboard packaging makes cardboard a commonly recycled waste product by companies that deal heavily in packaged goods, like retail stores, warehouses, and distributors of goods. Other industries deal in niche or specialized products, depending on the nature of the waste materials that are present. The glass, lumber, wood pulp and paper manufacturers all deal directly in commonly recycled materials; however, old rubber tires may be collected and recycled by independent tire dealers for a profit.

MANAGEMENT OF RECYCLABLE WASTE:

E-waste recycling

E-waste is a growing problem, accounting for 20–50 million metric tons of global waste per year according to the EPA. It is also the fastest growing waste stream in the EU. Many recyclers do not recycle e-waste responsibly. After the cargo barge Khian Sea dumped 14,000 metric tons of toxic ash in Haiti, the Basel Convention was formed to stem the flow of hazardous substances into poorer countries. They created the e-Stewards certification to ensure that recyclers are held to the highest standards for environmental responsibility and to help consumers identify responsible recyclers.

Plastic recycling

Plastic recycling is the process of recovering scrap or waste plastic and reprocessing the material into useful products, sometimes completely different in form from their original state. For instance, this could mean melting down soft drink bottles and then casting them as plastic chairs and tables. For some types of plastic, the same piece of plastic can only be recycled about 2–3 times before its quality decreases to the point where it can no longer be used.

Physical recycling

Some plastics are remelted to form new plastic objects; for example, PET water bottles can be converted into polyester destined for clothing. A disadvantage of this type of recycling is that the

molecular weight of the polymer can change further and the levels of unwanted substances in the plastic can increase with each remelt.

Chemical recycling

For some polymers, it is possible to convert them back into monomers, for example, PET can be treated with an alcohol and a catalyst to form a dialkyl terephthalate. The terephthalate diester can be used with ethylene glycol to form a new polyester polymer, thus making it possible to use the pure polymer again.

Fig 2.10-2.13

AWARENESS REGARDING RECYCLABLE WASTE MANAGEMENT:

Recycling schemes can sometimes succeed with little attention but more often than not, staff and students have to be helped by being reminded of the importance of recycling. It is also important to ensure that people are provided with up-to-date information to help them contribute to the various schemes.

Arrange a programme of events that will help to raise awareness of your recycling schemes. Specifically this should include an induction for both new and existing students and staff and may tie in to broader environmental and sustainability issues. Use posters and publicise your initiatives in the student and staff press as well as over the institution's intranet. Posters can be obtained from recyclers such as ALUPRO or downloaded from the web. Additional information and free publicity material can be obtained from Recycle Now .

HAZARDOUS WASTE

INTRODUCTION:

Hazardous waste is waste that has substantial or potential threats to public health or the environment. Characteristic hazardous wastes are materials that are known or tested to exhibit one or more of the following hazardous traits: Ignitability, Reactivity, and Corrosivity.

DEFINITION:

Hazardous wastes are those that may contain toxic substances generated from industrial, hospital, some types of household wastes. These wastes could be corrosive, inflammable, explosive, or react when exposed to other materials. Some hazardous wastes are highly toxic to environment including humans, animals, and plants .

Radioactive waste was generated from use of radioactivity, in many but not all cases. Scientific society has approached the management of radioactive waste differently from the management of other waste types.

MANAGEMENT OF HAZARDOUS WASTES:

Radioactive wastes emit ionizing energy that can harm living organisms. Because some radioactive materials can persist in the environment for many thousands of years before fully decaying, there is much concern over the control of these wastes. However, the handling and disposal of radioactive material is not a responsibility of local municipal government

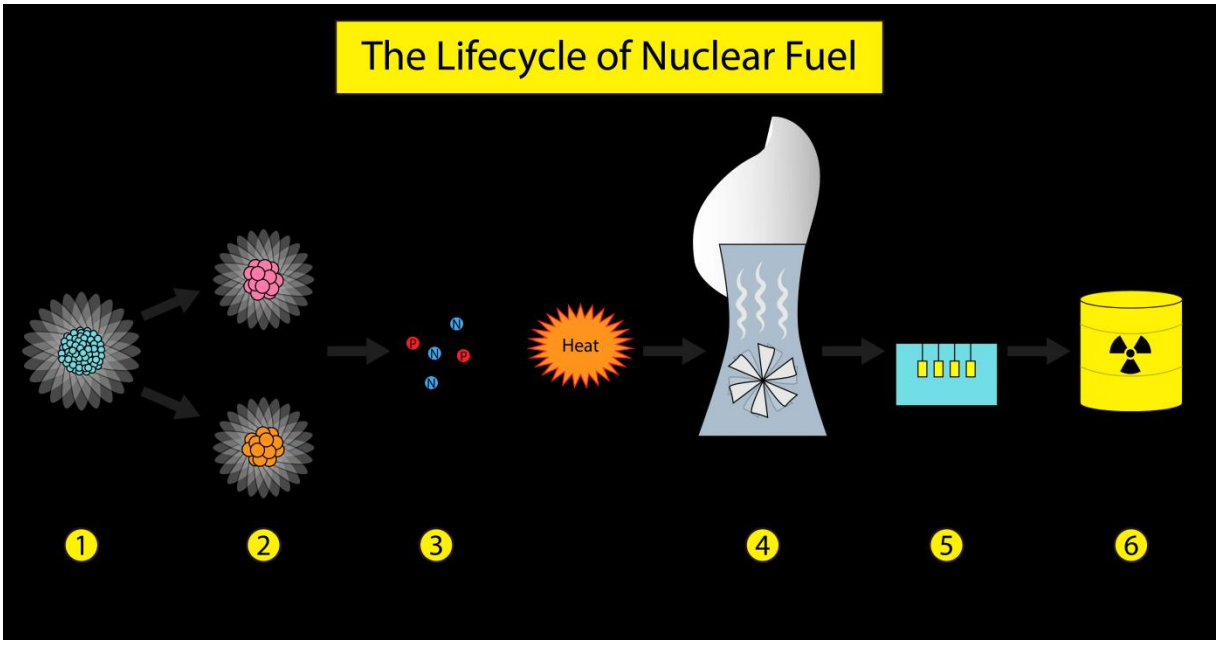


Fig 2.14

Hazardous waste is generally transported by truck over public highways. Only a very small amount is transported by rail, and almost none is moved by air or inland waterway. Highway shipment is the most common because road vehicles can gain access to most industrial sites and approved TSDFs. Railroad trains require expensive siding facilities and are suitable only for very large waste shipments.

Hazardous wastes can be shipped in tank trucks made of steel or aluminum alloy, with capacities up to about 34,000 litres (9,000 gallons). They also can be containerized and shipped in 200-litre (55-gallon) drums. Specifications and standards for cargo tank trucks and shipping containers are included in governmental regulations.

PROJECTS FOR HAZARDOUS WASTE MANAGEMENT:

The hazardous waste generated in the country per annum is estimated to be around 4.4 million tons while as per the estimates of Organization for Economic Cooperation and Development(OECD) derived from correlating hazardous waste generation and economic activities, nearly five million tons of hazardous waste are being produced in the country annually. This estimate of around 4.4 million MTA is based on the 18 categories of wastes which appeared in the HWM Rules first published in 1989. Out of this, 38.3% is recyclable, 4.3% is incinerable and the remaining 57.4% is disposable in secured landfills. Thirteen States of the country (Maharashtra, Gujarat, Tamil Nadu, Orissa, Madhya Pradesh, Assam, Uttar Pradesh, West Bengal, Kerala, Andhra Pradesh, Telangana, Karnataka and Rajasthan) account for 97% of total hazardous waste generation. The top five waste generating states are Maharashtra, Gujarat,

Andhra Pradesh, Telangana and Tamil Nadu. On the other hand, states such as Himachal Pradesh, Jammu &Kashmir, and all the North Eastern States excepting Assam generate less than 20,000 MT per annum. Given the wide variations in quantity and nature of waste generated across states and union territories (UTs) and also considering the wide variations in climatic as well as hydro-geological conditions in different regions of the country, the approach to waste management has to be essentially state specific.

AWARENESS REGARDING HAZARDOUS WASTE MANAGEMENT:

The environmentally sound management of hazardous wastes is becoming a major concern in developing countries due to the diversity of the waste stream and toxic material within it, as well as the negative environmental and public health impacts caused. Hence, several practical recommendations are suggested which include the following:-

1. Creation of public awareness of the potential of recycling hazardous wastes.
2. Source reduction.
3. Capacity building and human resources development for hazardous wastes recycling.
4. Monitoring and evaluation of hazardous wastes management systems as well a reporting programmes.
5. Development of appropriate infrastructure, technical knowledge, and expertise.
6. Strengthening and reforming existing regulatory frameworks.

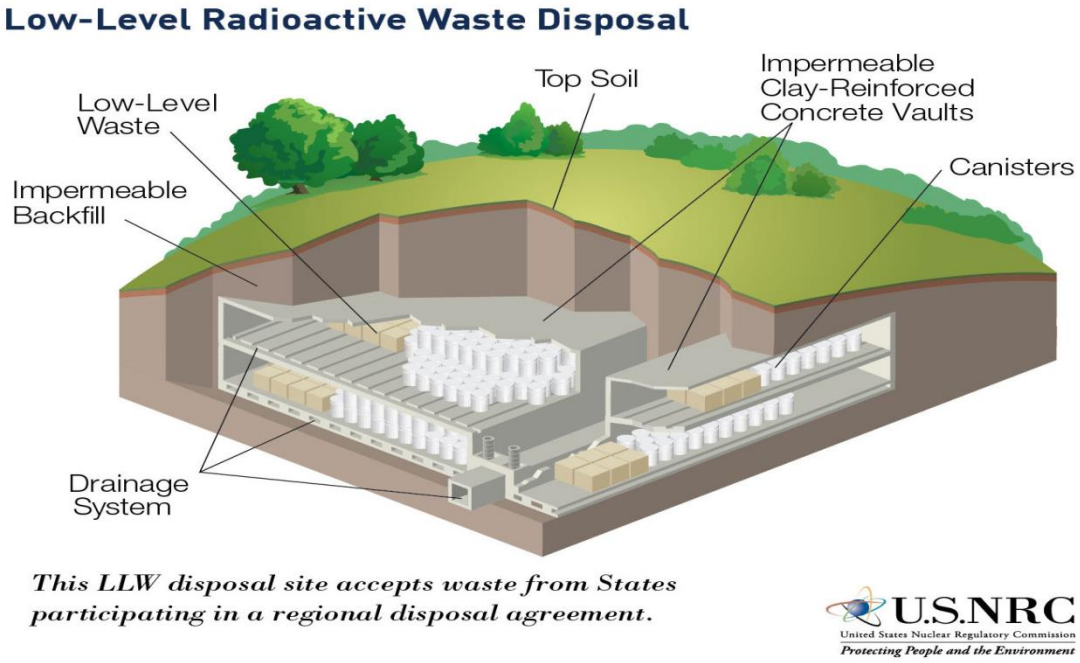


Fig 2.15

ELECTRONIC WASTES

INTRODUCTION:

Electronic waste or e-waste describes discarded electrical or electronic devices. Used electronics which are destined for refurbishment, reuse, resale, salvage recycling through material recovery, or disposal are also considered e-waste. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution.

DEFINITION:

E-waste or electronic waste is created when an electronic product is discarded after the end of its useful life. The rapid expansion of technology and the consumption driven society results in the creation of a very large amount of e-waste in every minute .

The Partnership on Measuring ICT for Development defines e-waste into six categories, namely:-

1. Temperature exchange equipment (e.g., air conditioners, freezers),
2. Screens, monitors (e.g., TV, laptop),
3. Lamps (e.g., LED lamps),
4. Large equipment (e.g., washing machines, electric stoves),
5. Small equipment (e.g., microwave, electric shaver), and
6. Small IT and telecommunication equipment (e.g., mobile phones, printers). Products in each category vary in longevity profile, impact, and collection methods, among other differences.

The high value of the computer recycling subset of electronic waste (working and reusable laptops, desktops, and components like RAM) can help pay the cost of transportation for a larger number of worthless pieces than what can be achieved with display devices, which have less (or negative) scrap value. In A 2011 report, "Ghana E-Waste Country Assessment", found that of 215,000 tons of electronics imported to Ghana, 30% were brand new and 70% were used. Of the used product, the study concluded that 15% was not reused and was scrapped or discarded. .

MANAGEMENT OF E-WASTES:

Waste management, especially when it comes to plastic, has been given much attention over the years in the country. Plastics took centre stage in the country's discourse on environmental conservation this World Environment Day. Still, somehow, the issue of e-waste, which is among the most dangerous kinds of waste — for it contains heavy metals and other toxic chemicals — remains insidious.

Even today, when India is among the world's largest consumer of mobile phones with 1.5 million tons of e-waste generated in 2015, most consumers are still unaware of how to dispose of their e-waste. Most Indians end up selling their e-waste to the informal sector, which poses severe threats to human (including children's) lives, with its improper and highly hazardous methods of extracting the trace amounts of precious metal from it and handling e-waste for profit.

The government passed the first law on e-waste management in 2011, based on Extended Producer Responsibility (EPR), which put the onus on the producer for the management of the final stages of the life of its product, in an eco-friendly way, by creating certain norms in tandem with state pollution control boards. However, it did not set collection targets; this was amended in the new law, passed two years ago.

The present rule has strengthened the Extended Producer Responsibility (EPR), which is the global best practice to ensure the take-back of the end-of-life products. A new arrangement entitled, 'Producer Responsibility Organization' (PRO) has been introduced to strengthen EPR further. PRO, a professional organization, would be authorized or financed collectively or individually by producers, to share the responsibility for collection and channelization of e-waste generated from the 'end-of-life' products to ensure environmentally sound management of such e-waste.

The present Rule ensures that every producer of electrical and electronic equipment (EEE) and their components or consumables or parts or spares shall ensure that new EEE and their components or consumables or parts or spares do not contain pollutants such as lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers beyond a maximum concentration value.

PROGRAMMES CONCERNING E WASTE MANAGEMENT:

E-waste management in India:

The Ministry of Environment and Forests, Government of India has notified the e-waste (Management and Handling) Rules, 2016 which became effective from 01 May 2016 ("Rules").

Guidance on the Disposal of End-of-Life Products:- Consumers could contribute to resource conservation and prevent potential environmental problems by a simple action — the proper disposal of their old consumer durable products and its accessories. Electronic waste is to be disposed off separately from the general waste stream via designated collection facilities identified by the Company. BSH Household Appliances Manufacturing Pvt. Ltd. ("BSH/Company") is a manufacturer and importer of household electronic appliances ("Appliances/ Products") involved in marketing, distribution and selling of Appliances throughout India under the brand names of "Siemens Home Appliances". The Company strives to be in compliance with the applicable laws of land and in lines with recently enacted E-waste (Management and Handling) Rules, 2016, BSH recognizes it responsibility to protect the environment. E-waste is any electrical and/or electronic equipment, whole or in part which is not useable and it is intended to be discarded. The rejects from the manufacturing and/or repair process also comes under this category. The accumulation of E-waste in the environment and their unscientific disposal causes extremely adverse environmental impact and is hazardous to human health. Recycle- Recycling is an important way for individuals and business to reduce the waste they generate and de-risk the negative impact that irresponsible disposal may cause. Recycling also conserves natural sources. Reducing, reusing, recycling and buying recycled products benefit our natural world and our economy.

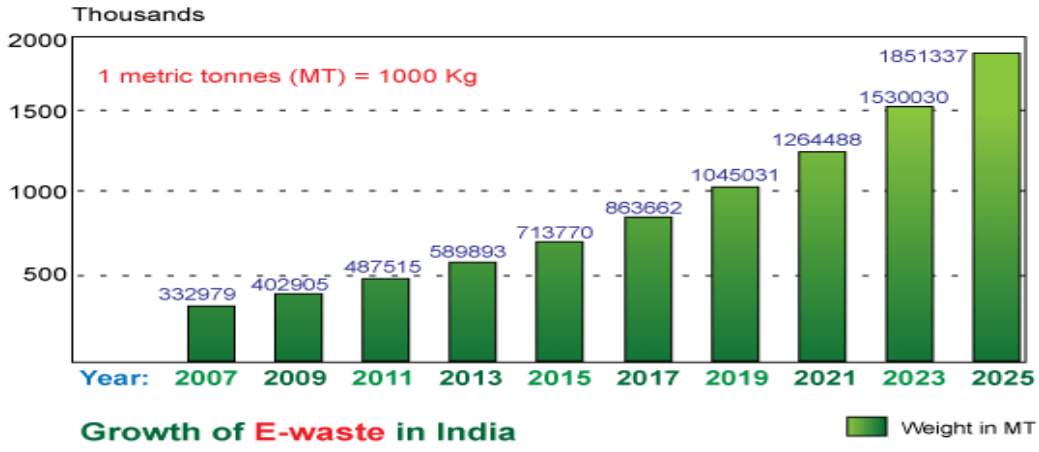


Table 2. 3

CREATIVE IDEAS IN REUSING E WASTES:

E-Waste is just scrap material and parts salvaged from electronics or commercial products. Some of these things can actually be reused or turned into awesome art. These projects with E-Waste to see what we can make from our old or broken-down stuff.

Fig. 2.16 - A collection of key chains and necklaces made from recycled e waste.

Fig. 2.17 In the picture above is a toilet paper roll constructed from e wastes

AWARENESS REGARDING E-WASTE MANAGEMENT:

As a consumer, one can bring enormous effort on the e-waste management. For this, start up with spreading the news about e-waste, the damages caused and all regarding e-waste to your friends, family and people at the workplace.

When we want to discard our computer or cell phone or any other electronic goods, take them to your nearest e-waste recycling center. Never push off this idea thinking that a small gadget doesn't matter. In truth, even the tiny cell phone contains thousands of carcinogens that can cause severe damage to the environment.

There are more than 1400 Staples stores in US. We need to pay $10 for the device to be recycled, and keyboard and mouse are recycled for no charges, and they stick to EPA standards. We can also join a Staples program and make them pay some amount to a school if the school gives them eligible ink toner or cartridge that they intend to discard.

E-Waste – Technology Fact Sheet

	Level 1	Output	Level 2	Sub-level 2	Output	Level 3	Output
E-waste	Decontamination, Dismantling, Segregation	Segregated hazardous wastes like CFC, Hg, Switches, bateries and capacitors	Hammering, Shredding, CRT, Electromagnetic separation, Eddy current separation Density separation	Density Media Sparation Cyclone Process	Sorted Plastic	Chemical/ Thermal Process Recycling, Incineration	Plastic Product, Energy Recovery
		Segregated non-hazardous E-waste like plastic, CRT, circuit board and cables		Splitting technology Thermal shcok, NiChrome hot wire cutting, Laser cutting, Magnetic & eddy current separation	Ferrous & nonferrous metal scrap, Sorted plastic, Glass fraction, Lead	Breaking, Recycling, Separation and Distillation	Copper/ Aluminium, Iron, Glass Cullet
				Dismantling Pulverization/ Hammering, Density separation using water	Ferrous & Nonferrous metal scrap, Lead, Mercury, Oil	Separation and Distillation	Oil recovery/ energy, Copper/ Aluminium, Iron

Table 2. 4

Chapter 3

Waste Management

What is waste management?

Waste management (or waste disposal) contains steps and efforts required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process.

Waste can be solid, liquid, or gas and each type have different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological and household. In some cases, waste can cause a threat to human health. Waste is produced by human activity every day, for example, the extraction and processing of raw materials. Waste management is intended to reduce adverse effects of waste on human health, the environment or aesthetics.

Proper , sequenced management of waste is important for building sustainable and livable cities, but it remains a challenge for many developing countries and cities. Effective waste management is quite expensive, usually comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported. In view of this, the World Bank finances and advises on solid waste management projects using a diverse suite of products and services, including traditional loans, results-based financing, development policy financing, and technical advisory. World Bank-financed waste management projects usually address the entire lifecycle of waste right from the point of generation to collection and transportation, and finally treatment and disposal.

Waste management practices are not same among countries (developed and developing nations); regions (urban and rural areas), and residential and industrial sectors can all take different approaches.

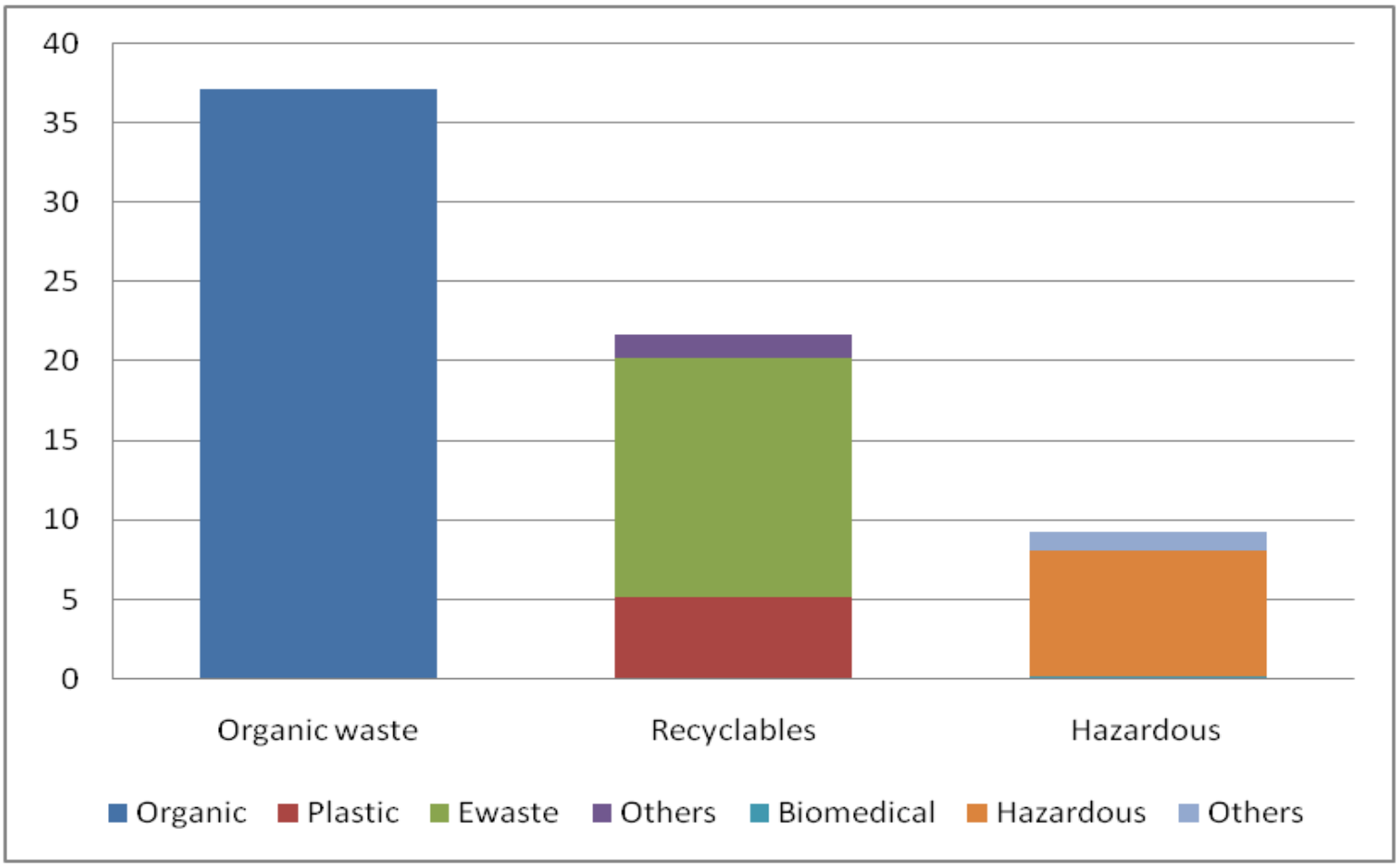


Table 3. 1

Types of waste management

1. Landfill

A landfill site, also known as a tip, garbage dump, or dumping ground, is a site for the disposal of waste materials. Landfill is the oldest and most common form of waste disposal, although the systematic burial of the waste with daily, intermediate and final covers only began in 1940s. In the past, refuse was simply left in piles or thrown into pits; in archeology this is known as a midden.

Some landfill sites are also used for waste management purposes, such as temporary storage, consolidation and transfer, or for various stages of processing waste material, such as sorting, treatment, or recycling. Unless they are stabilized, landfills may undergo severe shaking or soil liquefaction of the ground during an earthquake.

Fig 3. 1

2. Biogas And Fertilizer Generation

What is the process of biogas generation?

The process of biogas production is called anaerobic digestion (AD). It provides clean gaseous fuel for cooking and lighting. Chemical fertilizers can be done away with since the digested slurry obtained from the biogas plants can be used as enriched bio-manure.

Organic waste becomes a important resource, and compared to fossil fuel utilization, use of biogas yields a reduced carbon footprint. Biogas production through anaerobic digestion leaves organic residues, digestates, which are rich in nutrients. If these digestates are utilized in plant production, nutrients already within the nutrient cycle will be recycled and the sustainability of the biogas production process. In addition, use of organic fertilizers contributes to maintaining and/or improving soil quality.

Organic material in soil is not only important as a source of plant nutrients, it is also important for soil fertility ,porosity and structure, as well as the ability to store water and nutrients. Soils low in

organic matter are often compact, have poor structure and low nutrient binding capacity, as well as a low ability to store water.

The digestates from biogas production based on fundamentally different feedstock are promising as NPK fertilizers. The N fertilization can simply be based on the digestate NH4+ concentration and, at least for wheat production, considerable variation in the concentrations of K and P can be tolerated.

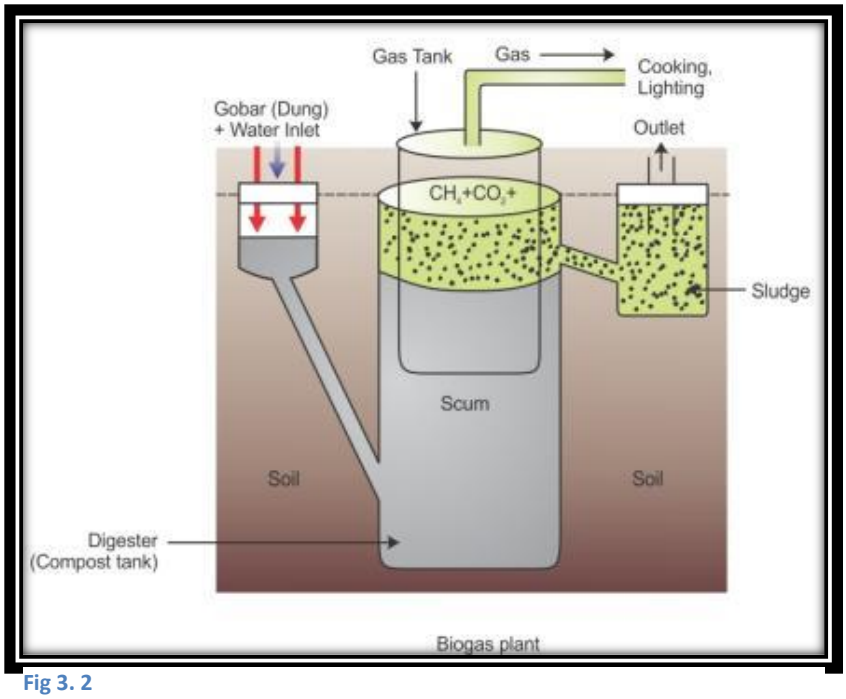


Fig 3. 2

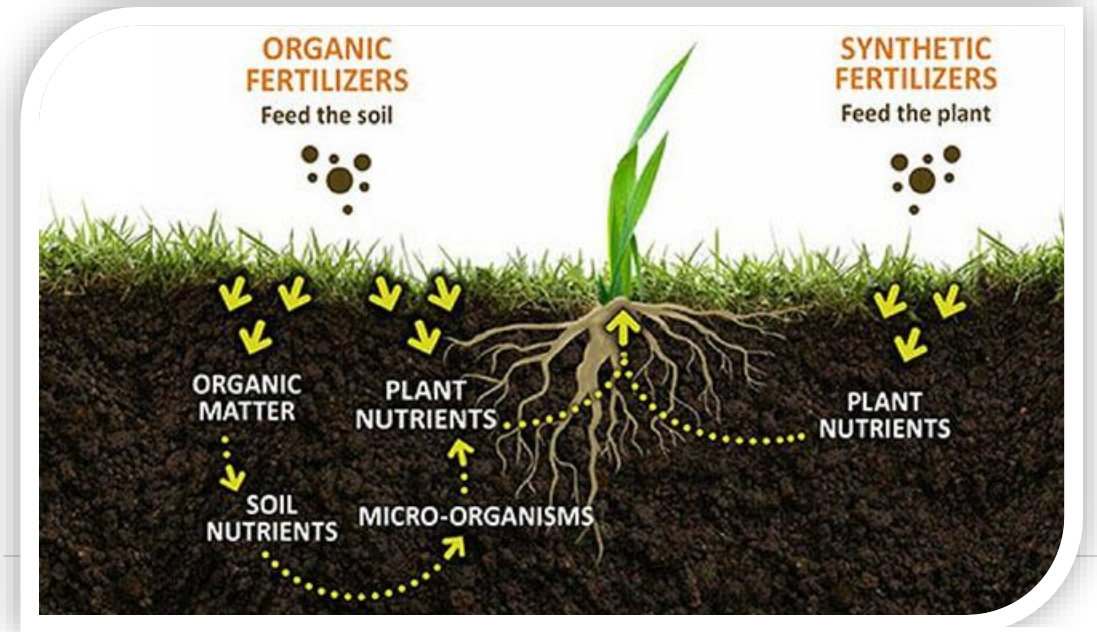


Fig 3. 3

3. Vermicomposting

Vermicomposting uses worms to decompose waste and make nutrient-rich "worm manure".

Vermicompost (vermi-compost) is the end- product of the decomposition process using various species of worms, usually red wigglers, white worms, and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials, and vermicast. This process is called Vermicomposting, while the rearing of worms for this purpose is called vermiculture. Vermicast (also called worm castings, worm humus, worm manure, or worm faeces) is the end-product of the breakdown of organic matter by earthworms. These castings have been shown to contain reduced levels of contaminants and a higher saturation of nutrients than the organic materials before vermicomposting. Vermicompost contains water-soluble nutrients and is an excellent, nutrient-rich organic fertilizer and soil conditioner. It is used in farming and small scale sustainable, organic farming. Vermicomposting can also be applied for treatment of sewage. A variation of the process is vermifiltration (or vermidigestion) which is used to remove organic matter, pathogens and oxygen demand from wastewater or directly from black water of flush toilets.

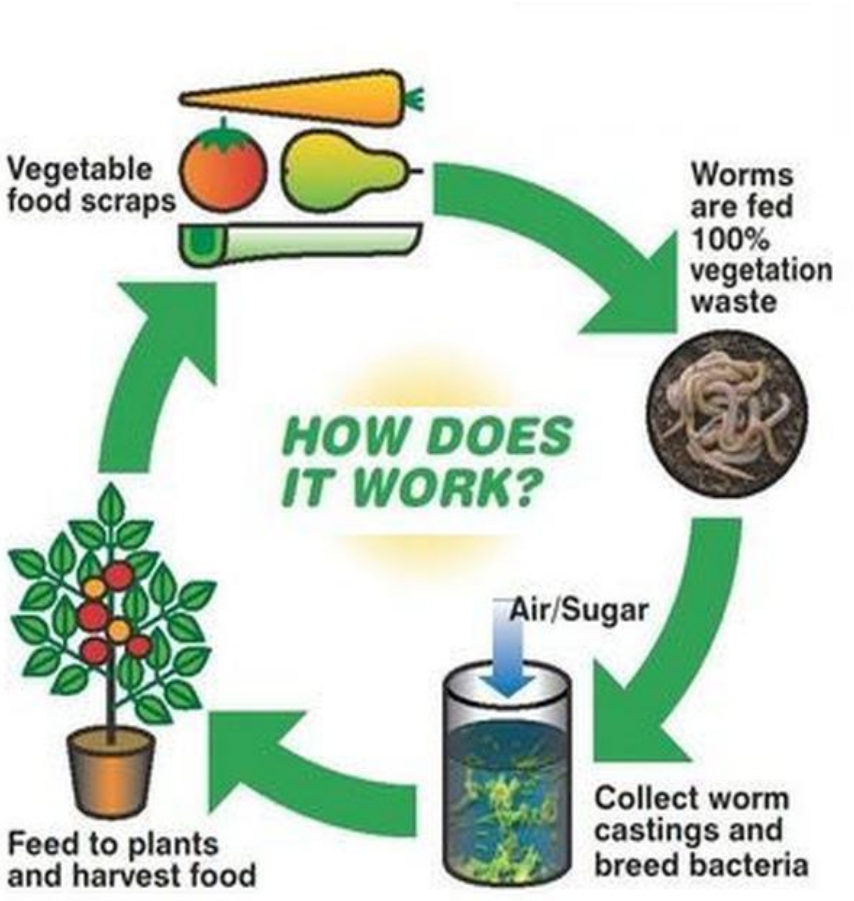


Fig 3. 4

Fig 3. 5

Fig 3. 6

4. Recycling and reuse

Recycling involves the collection of used and discarded materials processing these materials and making them into new products. It reduces the amount of waste that is thrown into the community dustbins thereby making the environment cleaner and the air fresher to breathe.

Surveys carried out by Government and non-government agencies in the country have all recognized the importance of recycling wastes. However, the methodology for safe recycling of waste has not been standardized. Studies have revealed that 7 %-15% of the waste is recycled. If recycling is done in a proper manner, it will solve the problems of waste or garbage. At the community level, a large number of NGOs (Non Governmental Organizations) and private sector enterprises have taken an initiative in segregation and recycling of waste (EXNORA International in Chennai recycles a large part of the waste that is collected). It is being used for composting, making pellets to be used in gasifiers, etc. Plastics are sold to the factories that reuse them. The steps involved in the process prior to recycling include

a) Collection of waste from doorsteps, commercial places, etc.
b) Collection of waste from community dumps.
c) Collection/picking up of waste from final disposal sites.

Most of the garbage generated in the household can be recycled and reused. Organic kitchen waste such as leftover foodstuff, vegetable peels, and spoilt or dried fruits and vegetables can be recycled by putting them in the compost pits that have been dug in the garden. Old newspapers, magazines and bottles can be sold to the *kabadiwala* the man who buys these items from homes.

In our own homes we can contribute to waste reduction and the recycling and reuse of certain items. To cover our books we can use old calendars; old greeting cards can also be reused. Paper can also be made at home through a very simple process and you can paint on them.

Waste recycling has some significant advantages:-

1 .It leads to less utilization of raw materials.
2 .Reduces environmental impacts arising from waste treatment and disposal.

3. Makes the surroundings cleaner and healthier.

4. Saves on landfill space.

5. Saves money.

6. Reduces the amount of energy required to manufacture new products.

7. In fact recycling can prevent the creation of waste at the source.

Fig 3. 7

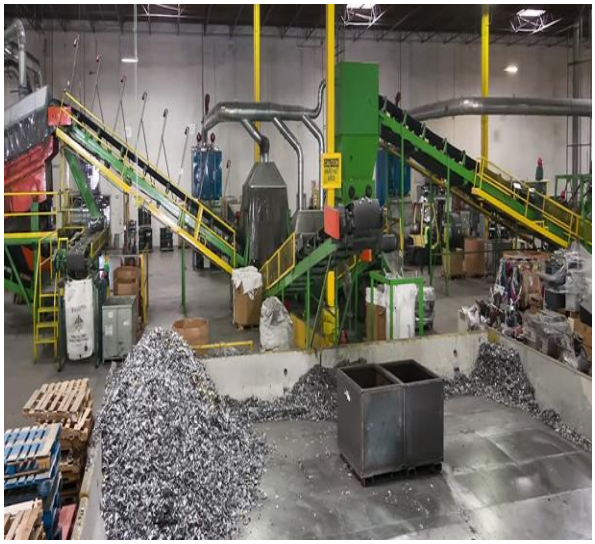


Fig 3. 8

5. Incineration

Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration and other high-temperature waste treatment systems are described as "thermal treatment". Incineration of waste materials converts the waste into ash, flue gas and heat. The ash is mostly formed by the inorganic constituents of the waste and may take the form of solid lumps or particulates carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, the heat that is generated by incineration can be used to generate electric power.

Incineration with energy recovery is one of several waste-to-energy technologies such as gasification, pyrolysis and anaerobic digestion. While incineration and gasification technologies are similar in principle, the energy produced from incineration is high-temperature heat whereas combustible gas is often the main energy product from gasification. Incineration and gasification may also be implemented without energy and materials recovery.

In several countries, there are still concerns from experts and local communities about the environmental effect of incinerators (see arguments against incineration).

In some countries, incinerators built just a few decades ago often did not include a materials separation to remove hazardous, bulky or recyclable materials before combustion. These facilities tended to risk the health of the plant workers and the local environment due to inadequate levels of gas cleaning and combustion process control. Most of these facilities did not generate electricity.

Incinerators reduce the solid mass of the original waste by 80%–85% and the volume (already compressed somewhat in garbage trucks) by 95%–96%, depending on composition and degree of recovery of materials such as metals from the ash for recycling. This means that while incineration does not completely replace landfilling, it significantly reduces the necessary volume for disposal. Garbage trucks often reduce the volume of waste in a built-in compressor before delivery to the incinerator. Alternatively, at landfills, the volume of the uncompressed garbage can be reduced by approximately 70% by using a stationary steel compressor, albeit with a significant energy cost. In many countries, simpler waste compaction is a common practice for compaction at landfills.

Incineration has particularly strong benefits for the treatment of certain waste types in niche areas such as clinical wastes and certain hazardous wastes where pathogens and toxins can be destroyed by high temperatures. Examples include chemical multi-product plants with diverse toxic or very toxic wastewater streams, which cannot be routed to a conventional wastewater treatment plant .

Fig. 3.9 Incineration plant in Malmö, Sweden, capable of handling 25 tones (28 short tons) per hour of household waste. To the left of the main stack, a new identical oven line is under construction (March 2007).

Fig. 3.10 Municipal solid waste in the furnace of a moving grate incinerator capable of handling 15 metric tons (17 short tons) of waste per hour. The holes in the grate supplying the primary combustion air are visible.

6. Disposal in water bodies

Inaccurate disposal of waste water and the problems of addressing challenges from wastewater discharge into water bodies have led to an increase in the rate of wastewater generation. Butchery wastes, industrial wastes from breweries, agricultural runoffs, and waste water from car wash located close to the River have adverse effects on the water quality. High levels of pollutants in river cause an increase in biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), and total suspended solids (TSS). Toxic metals such as Cd, Cr, Ni and Pb make such water unsuitable for drinking, irrigation, aquatic life and even pose a great risk to human health. It is observed that high economic activities taking place continuously on the River waterfront have contributed significantly to the high level of pollution experienced by the River. Industrial/commercial activities taking place within the metropolis include car wash, washing of rugs, livestock markets, abattoirs, and market waste disposal. However, public enlightenment, setting up proper waste water channels, establishment of wastewater treatment plants and wastewater management plans should be put in place. Therefore, it is important to emphasizes on the need for proper wastewater disposal in the River.

Fig 3.11 & Fig 3.12 Waste water from factories and drains being disposed in seas and oceans

CHAPTER 4

WASTE STORAGE

INTRODUCTION:

Storage of waste at source is the first essential step of Solid Waste Management. Every household, shop and establishment generates solid waste on day-to-day basis. The waste should normally be stored at the source of waste generation till collected for its disposal. In India, such a habit has not been formed and in the absence of system of storage of waste at source, the waste is thrown on the streets, treating streets as receptacle of waste. If citizens show such apathy and keep on throwing waste on streets and expect that municipal sweepers should/would clean the city, the cities will never remain clean. Even if local bodies make arrangements to remove all the waste disposed of by the citizens on the street on day-to-day basis, the city will remain clean only for two to three hours and not beyond till the habit of throwing waste on the streets is not changed.

DEFINITION:

Waste management (or waste disposal) includes the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process

THE STORAGE of hazardous materials must be in compliance with federal and state regulations. Your methods of handling waste are subject to unannounced inspections by state regulatory inspectors.

- All containers need to have a label at all time indicating contents. For waste materials, this could be a simple label such as "WASTE SOLVENT" or "USED ACETONE".
- All containers need a lid at all times when not actively adding or removing waste. Evaporation in a hood is not a legal disposal method. *Funnels do not count as lids.*
- Secondary containment is advised for liquid containers.
- Storage limits and locations are the same for waste as for new materials. For example, storage of flammable liquids in excess of 10 gallons requires a flammable liquid storage cabinet. Glass bottles may not be stored on the floor because they can easily be broken by accidental kicking.

Fig 4. 1

SEGERATION AND STORAGE OF WASTES

Segregation of waste wherever practiced, does not synchronize with Primary Collection System. System of storage of waste at source, wherever practiced, by and large, does not synchronize with the system of primary collection with the result the waste stored at homes, shops and establishments in domestic, trade or institutional bins also finds its way on the street resulting in unhygienic conditions on streets. Some types of receptacles presently used for storage are buckets, plastic bins, plastic bags, metal bins with or without lids. These are unsuitable for

Fig 4. 2

storage of food waste for 24 hours and more in the Indian conditions as waste starts stinking very fast due to putrefaction.

MEASURES TO IMPROVE THE SYSTEM

- The most effective way to reduce your organization's waste is to generate less in the first place. Waste prevention offers the greatest environmental benefits and cost savings.
- For keeping streets and public places clean throughout the day, it is necessary that waste producers co-operate and effectively participate in the waste management efforts of local bodies.
- People may be educated to form a habit of storing waste at source in their personal bin/bins and deposit such waste into the municipal system only, at specified times.
- Illegal dumping should be reduced which in turn will reduce health risks to the local population, improve hygiene conditions and the quality of the environment
- Food wastes of all kinds, cooked and uncooked, including eggshells, bones · Flower and fruit wastes including juice peels and house-plant wastes · House sweepings (not garden sweepings or yard waste: dispose on-site) · Household Inert (sweepings/ashes) should be kept in a separate bin.
- Discarded clothing, furniture and equipment Wastes such as used batteries, containers for chemicals and pesticides, discarded medicines and other toxic or hazardous household waste (as under), if and when produced, should be kept separately from the above two streams of waste.
-

PRIMARY COLLECTION OF WASTE

Primary collection is the collection of waste from the point where it is placed by the person or organization that has produced it. Primary collection is the collection of waste from the point where it is placed by the person or organization that has produced it. These collection points could be located outside each individual household and business, communal containers serving a number of households, or waste skips taking waste from households and businesses in the surrounding area. Primary collection can be done in many ways. Table 1.0 given below summarizes the lower-technology options that are suitable for collecting waste from households

and transporting it to a transfer station or local disposal site. These all have the benefit of being able to serve narrow streets in crowded areas.

SECONDARY COLLECTIONS OF WASTE

Secondary Collections are where the waste from a number of primary collections is taken from the transfer station to the final disposal site. Table 1.2 shows some options for secondary waste collection vehicles, but note that some of these are also used for primary collections in certain situations.

WASTE TRANSPORTATION: - The prevention of illegal hazardous waste transport is hitting a diverse snag. The means of control require extensive personal, technical, and logistic resources. These preconditions are not fulfilled in many countries, partly because the political intention is lacking. Unwanted or hazardous waste is often deposited on unsuspecting communities. Therefore, transportation of the waste stored at waste storage depots at regular intervals is essential to ensure that no garbage bins/containers overflow and waste is not seen littered on streets. Hygienic conditions can be maintained in cities/towns only if regular clearance of waste from temporary waste storage depots (bins) is ensured. Transportation system has to be so designed that it is efficient, yet cost effective. The potential for pollution releases during the transportation of waste varies; the more hazardous the waste and the larger the volume that is transported, the more devastating the environmental/human health impact if an accident occurs. The controversial aspects involving waste management and environmental health influenced by the political and economic situations in several parts of the world must be examined as closely interconnected issues.

ON-SITE TRANSPORT

Health-care waste should be transported within the hospital or other facility by means of wheeled trolleys, containers, or carts that are not used for any other purpose and meet the following specifications:

- Easy to load and unload.
- No sharp edges that could damage waste bags or containers during loading and unloading;
- Easy to clean.
- The vehicles should be cleaned and disinfected daily with an appropriate disinfectant
- All waste-bag seals should be in place and intact at the end of transportation.

OFF-SITE TRANSPORTATION OF WASTE:-

1. Regulation and control system
2. Special packaging requirements for off-site transport
3. Labelling
4. Labelling for radioactive waste
5. Preparation for transportation
6. Transportation vehicles or containers
7. Routing

1. Regulation and control system

The health-care waste producer is responsible for safe packaging and adequate labelling of waste to be transported off-site and for authorization of its destination. Packaging and labelling should comply with national regulations governing the transport of hazardous wastes, and with international agreements if wastes are shipped abroad for treatment.

2. Special packaging requirements for off-site transport

In general, the waste should be packaged in sealed bags or containers, to prevent spilling during handling and transportation. The bags or containers should be appropriately robust for their content (puncture-proof for sharps, for example, or resistant to aggressive chemicals) and for normal conditions of handling and transportation, such as vibration or changes in temperature, humidity, or atmospheric pressure.

In addition, radioactive material should be packed in containers whose surfaces can be easily decontaminated. The United Nations recommend further packing requirements for infectious substances. For infectious health-care wastes, it is recommended that packaging should be design type-tested and certified as approved for use.

3. Labelling

All waste bags or containers should be labelled with basic information on their content and on the waste producer. This information may be written directly on the bag or container or on preprinted labels, securely attached.
It is also recommended that the last two digits of the year of manufacture of the packaging specified by the competent authority are marked on the package, as well as a special code designating the type of packaging.

For health-care waste, the following additional information should be marked on the label:

- Waste category

- Date of collection
- Place in hospital where produced (e.g., ward)
- Waste destination.

4. Labelling for radioactive waste

Three labels have been designed by the UN/IAEA for radioactive material, providing information on the levels of activity of a given package. If the two types of conditions of Table 4.1 differ, the package shall be assigned to the higher category. This categorization is as recommended in *Regulations for the safe transport of radioactive material* (IAEA, 1996).

Fig. 4.3 Trucks Carrying Liquid Radio Active Waste

Fig 4.4 Geological Disposal Of Nuclear Waste

Conditions		Category
Maximum radiation level at a distance of 1m from the external surface of the package	**Maximum radiation level at any point on the external surface**	
Not more than 0.0005mSv/h	Not more than 0.005mSv/h	I-WHITE
More than 0.0005mSv/h but not more than 0.01mSv/h	More than 0.005mSv/h but not more than 0.5mSv/h	II-YELLOW
More than 0.01mSv/h but not more than 0.1mSv/h	More than 0.5mSv/h but not more than 2mSv/h	III-YELLOW

Table 4.1 *Categories of packages for radioactive waste*

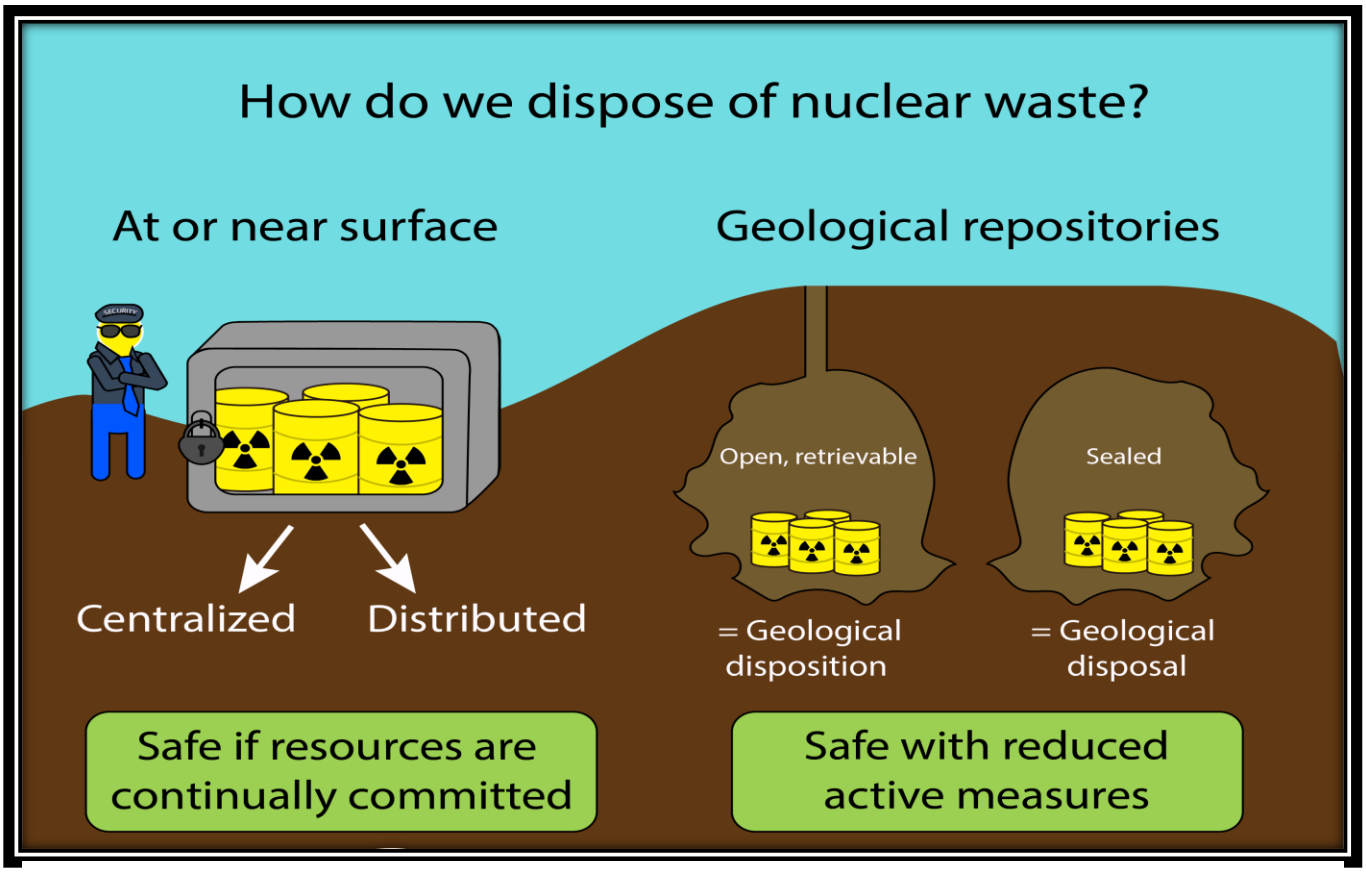


Fig 4. 5

5. Preparation for transportation

Before transportation of the waste, dispatch documents should be completed, all arrangements should be made between consignor, carrier, and consignee, and, in case of exportation, the consignee should have con-firmed with the relevant competent authorities that the waste can be legally imported and that no delays will be incurred in the delivery of the consignment to its destination.

6. Transportation vehicles or containers

Waste bags may be placed directly into the transportation vehicle, but it is safer to place them in further containers (e.g., cardboard boxes or wheeled, rigid, lidded plastic or galvanized bins). This has the advantage of reducing the handling of filled waste bags but results in higher disposal costs. These secondary containers should be placed close to the waste source.

Any vehicle used to transport health-care waste should fulfill the following design criteria:

- The body of the vehicle should be of a suitable size commensurate with the design of the vehicle, with an internal body height of 2.2 meters.
- There should be a bulkhead between the driver's cabin and the vehicle body, which is designed to retain the load if the vehicle is involved in a collision.
- There should be a suitable system for securing the load during transport.
- Empty plastic bags, suitable protective clothing, cleaning equipment, tools, and disinfectant, together with special kits for dealing with liquid spills, should be carried in a separate compartment in the vehicle.
- The vehicle should be marked with the name and address of the waste carrier.
- The international hazard sign should be displayed on the vehicle or container, as well as an emergency telephone number.

Vehicles or containers used for the transportation of health-care waste should not be used for the transportation of any other material. They should be kept locked at all times, except when loading and unloading. Articulated or demountable trailers (temperature-controlled if required) are particularly suitable, as they can easily be left at the site of waste production. Other systems may be used, such as specially designed large containers or skips; however, open-topped skips or containers should never be used for transporting health-care waste.

7. Routing

Health-care waste should be transported by the quickest possible route, which should be planned before the journey begins. After departure from the waste production point, every effort should be made to avoid further handling. If handling cannot be avoided, it should be pre-arranged and take place in adequately designed and authorized premises. Handling requirements can be specified in the contract established between the waste producer and the carrier.

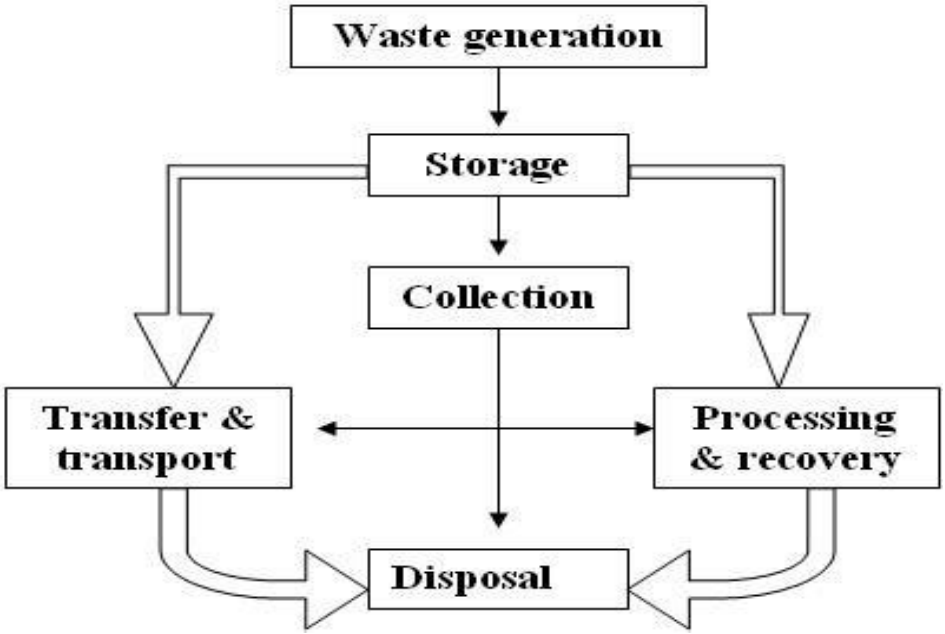


Fig. 4.6 Steps Involved In Routing

Fig. 4.7 Vehicle Carrying Bio Medical Waste

CHAPTER 5

WASTE AND ENVIRONMENT

Disposing of waste has huge environmental impacts and can cause serious problems. In the UK much is buried in landfill sites – holes in the ground, sometimes old quarries, sometimes specially dug. Some waste will eventually rot, but not all, and in the process it may smell, or generate methane gas, which is explosive and contributes to the greenhouse effect. Leachate produced as waste decomposes may cause pollution. Badly-managed landfill sites may attract vermin or cause litter.

Incinerating waste also causes problems, because plastics tend to produce toxic substances, such as dioxins, when they are burnt. Gases from incineration may cause air pollution and contribute to acid rain, while the ash from incinerators may contain heavy metals and other toxins. Because of these problems there are active campaigns against waste incineration. Greenpeace actively worked on these issues and some information, including a map of UK waste incinerators, can be found by searching the Greenpeace website for waste incineration. However, burning waste can generate energy and there are operational schemes. The Renewable Energy Association website provides more information including a map of biomass and energy from waste projects.

Throwing away things wastes resources. It wastes the raw materials and energy used in making the items and it wastes money. Reducing waste means less environmental impact, less resources and energy used and saves money.

Climate Change:- The way we dispose of waste is troubling. What is worse, in this decade alone, it would seem that waste disposal has become more careless . What we have failed to do is to put into action the ideas we believe will help us mitigate or adapt to climate change. Case in point: the trash that is dumped in landfills releases methane gas. Taken one step further open landfills were found to represent 91% of all landfill methane emissions. Researchers have calculated that approximately 40% of the world's trash is burned in this fashion, posing large-scale risks to both our atmosphere and the people that live near these burning sites.

Wildlife: - Ecosystems vary widely from location to location. However, one of the most outsize consequences of our global waste problem manifests itself in relation to our marine life and waterways. Simply put, it affects the people who depend on the ocean for their livelihoods. They cannot distinguish between what is or isn't food. They consume the trash, which results in death because the aquatic animal could not process it. There are some animals that do but plastic fragments have been known to be able to last 100 years. When it comes to biodiversity, our waste problem is severely plaguing the health of the world's species.

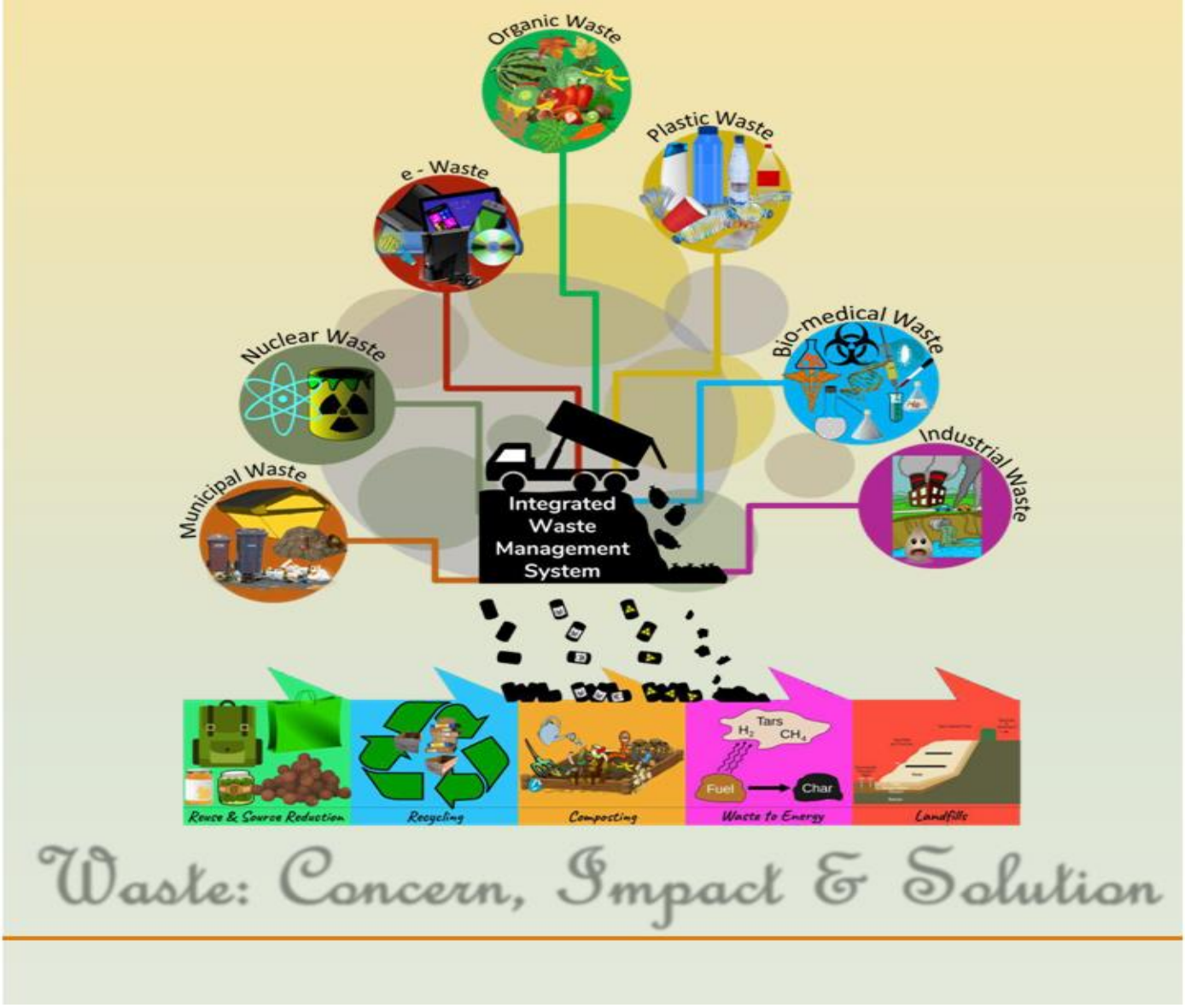
Public Health:-Human health is at risk through our inaction. We keep producing large amounts of trash, we do not dispose of it correctly, and in the end that will be our downfall as it is for the environment and wildlife in the ecosystems we all share. We cannot prevent or promote longevity with how we treat our Earth. The more emissions that we produce due to how much trash we generate, affects us long term. One can develop diseases such as asthma, birth defects, cancer, cardiovascular disease, childhood cancer, COPD, infectious diseases, low birth weight, and preterm delivery. Bacteria, vermin and insects can also be added to the problem that trash causes.

WATER BODIES: - The wastes that are dumped into the oceans tend to have toxic substances, which soak in all the oceanic oxygen. This leads to a marked depletion of oxygen available to mammals and other marine animals causing death of aquatic life .

Fig 5. 1 – Fig 5.3

WASTE MANAGEMENT IN INDIA

Waste: Concern, Impact & Solution



Geo diversity & Impact on Environment

Waste And Waste Management In India

Introduction:

Waste can be considered as a demon with multiple heads. When we try to address one of the issues, many more complex issues arises, and it becomes a vicious circle. At times it seems that the situation will go out of hand and we will not be able to address issue of waste. However determined action can address the issue of waste, steps should be taken in systematic and regular manner and those solutions should be adopted which are sustainable as well as environment friendly.

To understand and effectively address the issue of waste management we need to understand what is waste . According to The United Nations Statistics Division (UNSD): (UN Statistics Division, 2011) *"Wastes are materials that are not prime products (that is products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose"*.

The Basel convention outlined waste as: (UNEP, 2004) *"Substances or objects which are disposed or are intended to be disposed or are required to be disposed of by the provisions of national laws"*.

Waste management is a major problem for many of the urban aggromalations in our country. Effective SWM is a big challenge in cities which are already facing resource scarcity like less land space and very high population, resulting in high population density. This high population density generates thousands of tons of municipal solid waste daily.

There are many reasons which are directly and indirectly contributing to the enormous quantity of the solid waste worldwide and becoming one of the most important environmental problems for the global community. Some of the key contributors in this problem are exponential increase in population, indiscriminate natural resource exploitation, economic and industrial development, increased per capital income and consumerism. Indiscrimate and

unsustainable usage of resources has not only stressed out our natural resources but created menanse of huge waste generation. The amount of waste generated has direct corelatin with

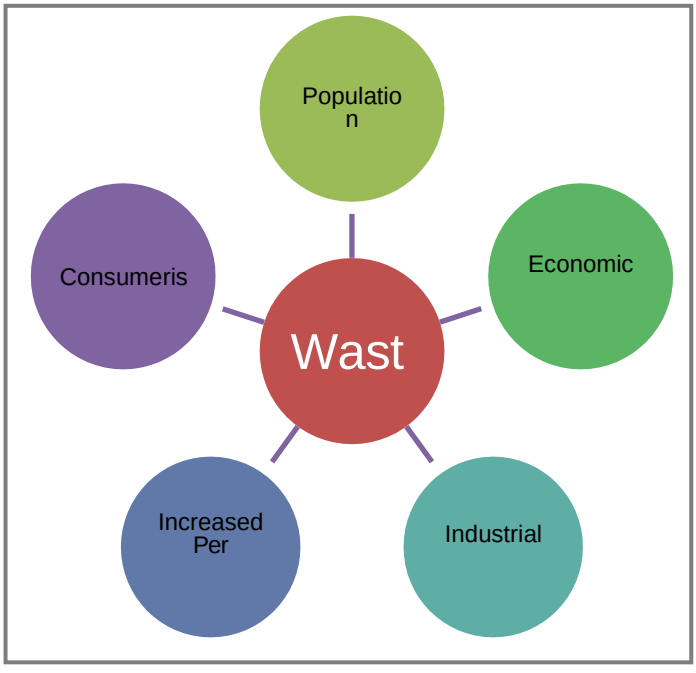
the amount of resource exploition.

In India our current waste disposal practices and attitude is to just get rid of the waste and throw it away. Improper disposal of waste not only causes pollution, it affects ground water, local flora and fauna, causes many diseases and has huge environmental and economic cost. We need to change our attitude and waste management techniques, both at individual and implementational level. We need to adopt scientific, sustainable, environment friendly as well as cost effective solutions.

Considering the present urban trends, it's not the least bit shocking to say that the MSW quantum in India will see a rise of double the present volumes by ten years down the line. Infact, it is projected to hover around 80-85 MTs by 2030, offering a business case of approximately USD 20 Billion.

Waste Generation in India

India is experiencing population explosion and direct effect of this population growth is rapid urbanization. The population of India is 1354 million in 2018 [4], compared with 1028 million in 2001. Population growth is directly correlated to increased solid waste generation



As the population increase demand for resources increases this generates wastes as their by-products.

Growth of Urban Agglomerations in India

Trends suggest that 50 per cent of India's population will live in the urban areas by 2050. Large urban agglomerations face challenges of effective waste management, with the quantities being beyond the assimilative capacity of the indigenous infrastructure and management capacities of environmental sinks . Tremendous growth of 75.8% in number of urban agglomerations from 1901 to 2011 as shown in figure 2. A staggering 81 per cent of the total Municipal Solid Waste (MSW) in India is generated in the Class-I cities of the country. (Swachh Bharat Mission: Solid Waste Management Manual, 2016) This is predicted to go up from the current per capita generation of 0.2-0.6kg (CPHEEO manual) in typical Indian cities, in the coming years.

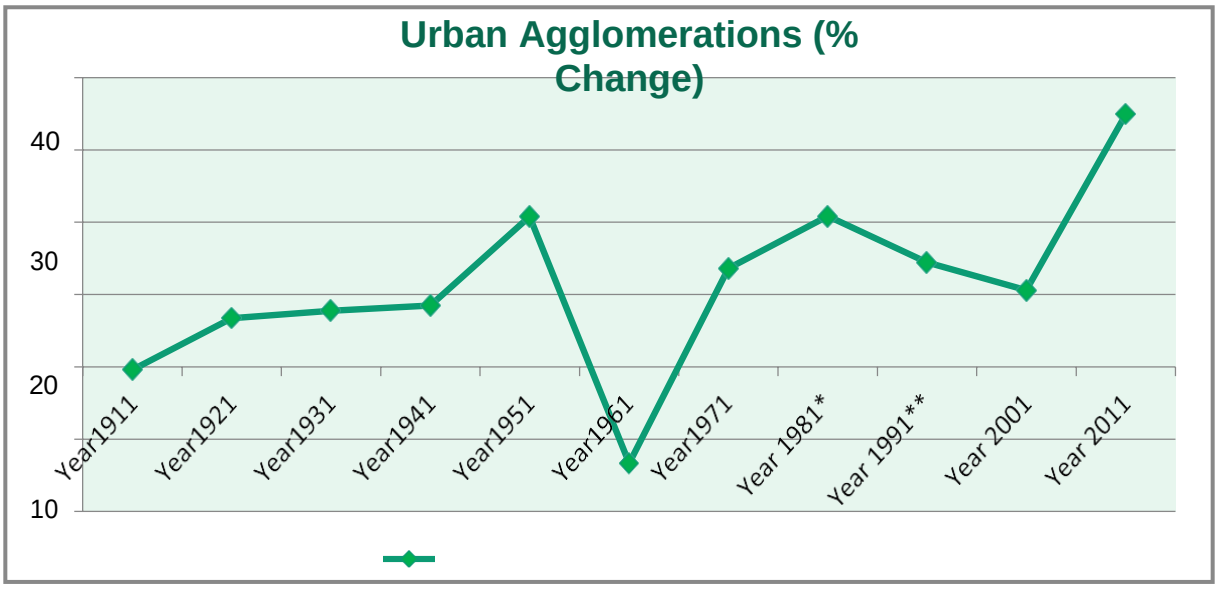


Table 5.1 : Percentage change in Urban Agglomeration in India (1911-2011)

Source: Ministry of Urban Employment & Poverty Alleviation, Office of the Registrar General and Census Commissioner, India & Ministry of Statistics and Programme Implementation, Govt. of India.

(*Note: *: Excludes figures for Assam where census of 1981 was not held.*

***: Excludes figures of Jammu & Kashmir where census of 1991 was not conducted*)

Waste generation and characteristics

Estimating the quantity and characteristics of MSW in India and forecasting waste generation is fundamental to successful waste management planning [6]. The quantity of MSW generated depends on various contributing factors like living standards, type of commercial activities and their scale, individual choices of the society like eating habit, reuse and recycling etc. [7].

Waste generation rate depends on many factors, such as population density, economic status, per capita income, economic development and industrial development, cultural and individual behaviour of the society. Figure 3 provides data on MSW generation in different states, indicating high waste generation in Maharastra (21867 tons per day), Tamil Nadu (14500 tons per day), Gujarat (10480 tons per day), Karnataka (8697 tons per day), Delhi (8370 tons per day). Lowest waste generation occurs in Arunachal Pradesh (13 tons per day), Lakshadweep (21 tons per day), Sikkim (49 tons per day), Daman & Diu (85 tons per day).

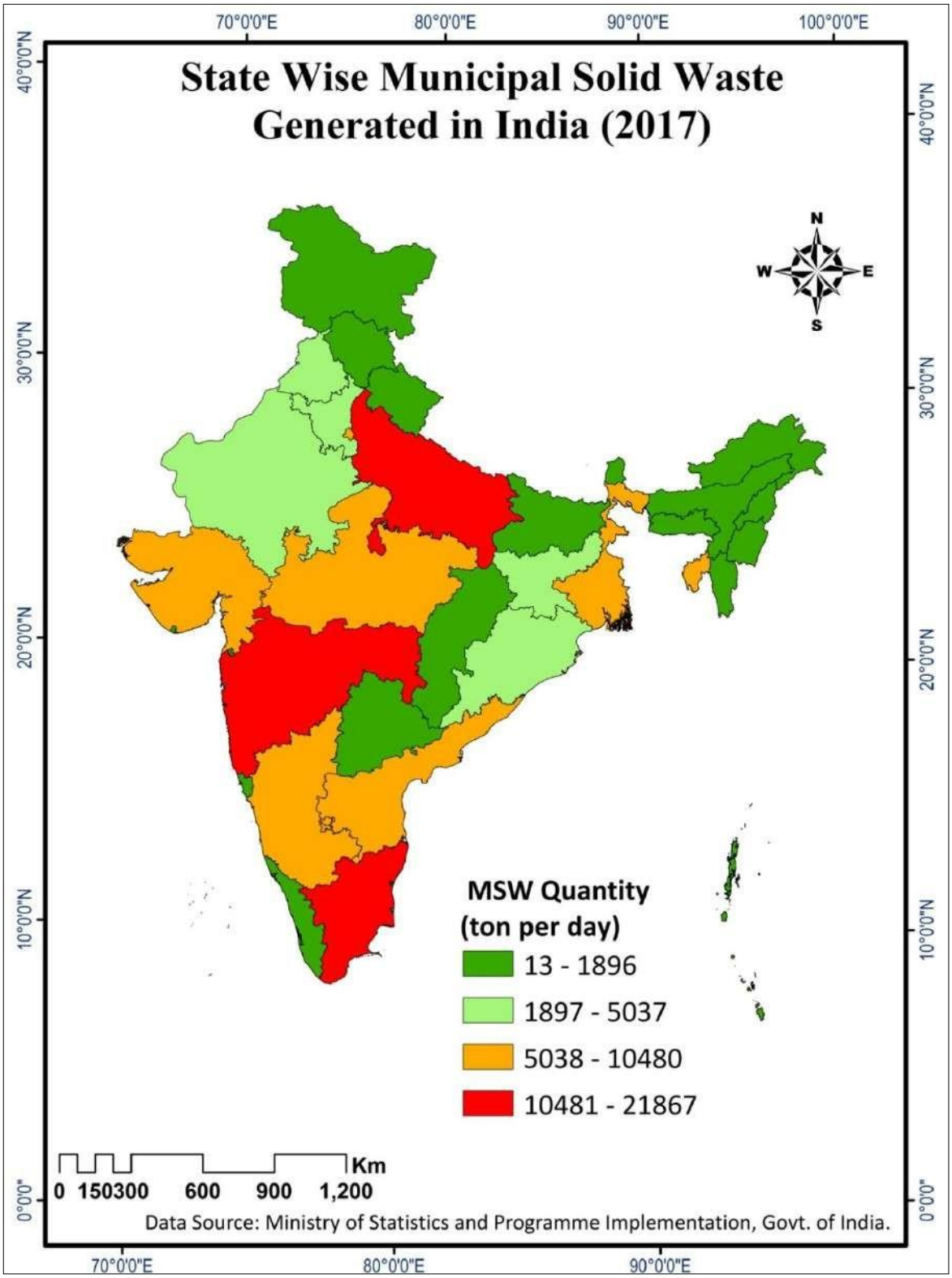


Fig.5.5: State-wise Municipal Solid Waste generation in India (2017)

(*Dataset Source: Ministry of Statistics and Programme Implementation, Govt. of India*)

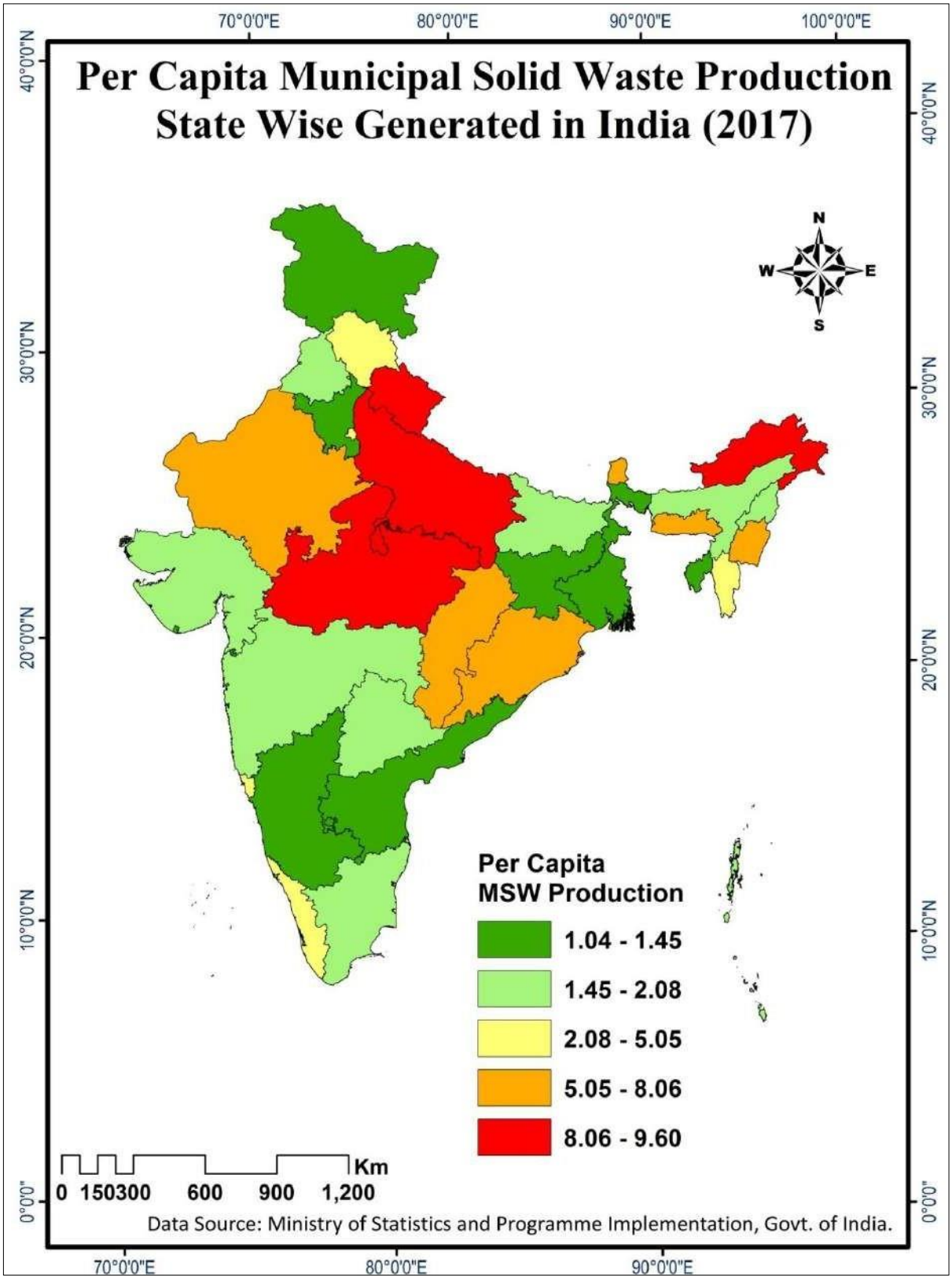


Fig.5.6: State-wise Per capita Municipal Solid Waste generation in India (2017)

(*Dataset Source: Ministry of Statistics and Programme Implementation, Govt. of India*)

Waste Characterization data

Economy and commercial activity impacts the composition of waste, as high income groups use more packaged products, resulting in higher volumes of plastics, paper, glass, metal and textiles. Changes in waste composition can have impact on waste management practices [8]. The average composition of MSW produced by Indian cities is approximately 44 weight percentage organic waste which is compostable, rest is non-compostable around 56 weight percentage, out of which 40 weight percentage is inert and 16 weight percentage potentially recyclable materials. Organic waste is mostly sourced from households where as inert waste is generated from construction, demolition and road sweeping [9]. Inert waste which is almost 40 weight percentage is generally land filled. In 2016 however, MoEF&CC notified the Construction and Demolition (C&D) Waste Management Rules. Construction and Demolition (C&D) waste should not be considered as waste but a resource. These should be recovered, recycled and reused. Construction and Demolition (C&D) waste should be segregated into various categories like concrete, soil, steel and wood, plastics, bricks and mortar. Bureau of Indian Standard (BIS) amended Indian Standard (IS):383 to include recycle concrete as part substitution for concrete in construction.

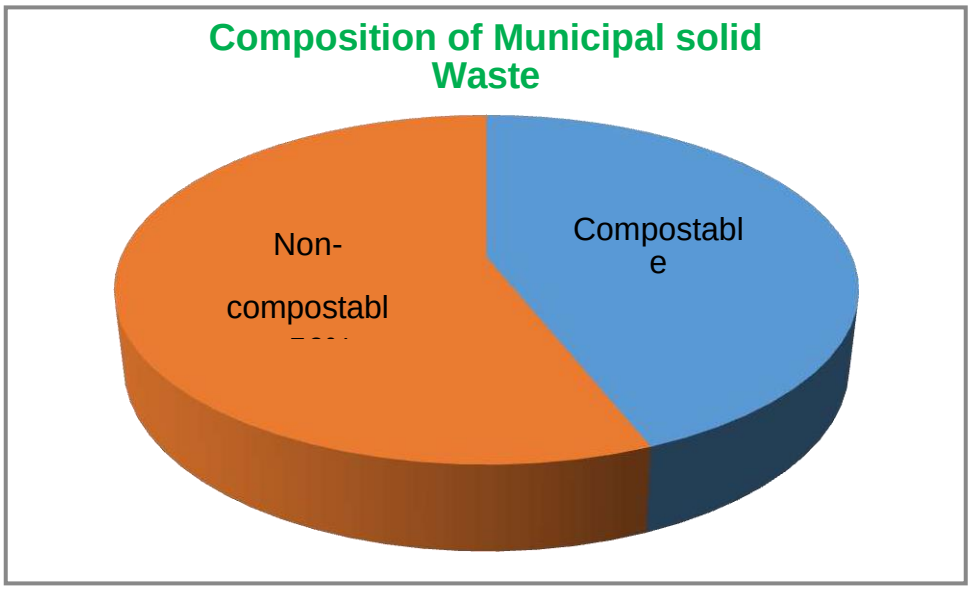


Fig. 5.7: Composition of Municipal Soild Waste in India

Sustainable Development Goals and Waste Management

Any environmental problem; like waste can be addressed holistically if sustainable development is linked to it. In the 2030 Agenda for Sustainable Development **"Transforming Our World"** we can clearly see the focus addressing the concern of waste. In Sustainable Development Goal (SDGs) Goal number 11, it was decided to make Cities and Human Settlements inclusive, safe and resilient and sustainable. Till 2030 member states decided to reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management (Target 11.6). Under sustainable development Goal 12, member states agreed to ensure sustainable consumption and production patterns. In target 12.3 it was agreed that 'by 2030, value per capita global food waste at the retail and consumer levels and reduce food losses along production and supply claims, including post – harvest losses.". Target 12.4 highlights that "by 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks and significantly reduce their to minimize their adverse impacts on human health and the environment. Target 12.5 decides "by 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse. Other targets aims to achieve access to adequate and equitable sanitation and hygiene for all, improve water quality by reducing pollution eliminating dumping and minimizing release of hazardous chemical and materials, having the proportion of untreated waste water and substantially increasing recycling and safe reuse globally and expand cooperation and capacity- building support to developing countries in recycling and reuse technologies.

Solution to waste management: Intergrated Soild Waste Managemnet System

New approach in the Integrated Solid Waste Management (ISWM) calls for various tier approaches from tier 1 to tier 5. First of all, focus should be on waste prevention and minimization, reuse and recycling. One of the main problems of waste is the indiscrimate consumerism that developed countries have followed now days the developing countries are also blinding following the path of consumerism. Consumerism creates unnecessary demand

and simultaneously waste is generated in the process. If we can address the issue of waste generation and minimize waste, half the battle would be won, because we will be able to solve the problem at the source. Secondly, we can minimize waste generation, if we inculcate the habit of reuse and recycling. Habit of reuse and recycling not only provides economical benefits but leads environmental benefits also. Next we should focus on technologies which are environmentally sound and sustainable to dispose waste and encourage mechanism like waste to energy. Full proof wastes to energy technology are win-win situation as problem of waste disposal is addressed along with highly priced energy.

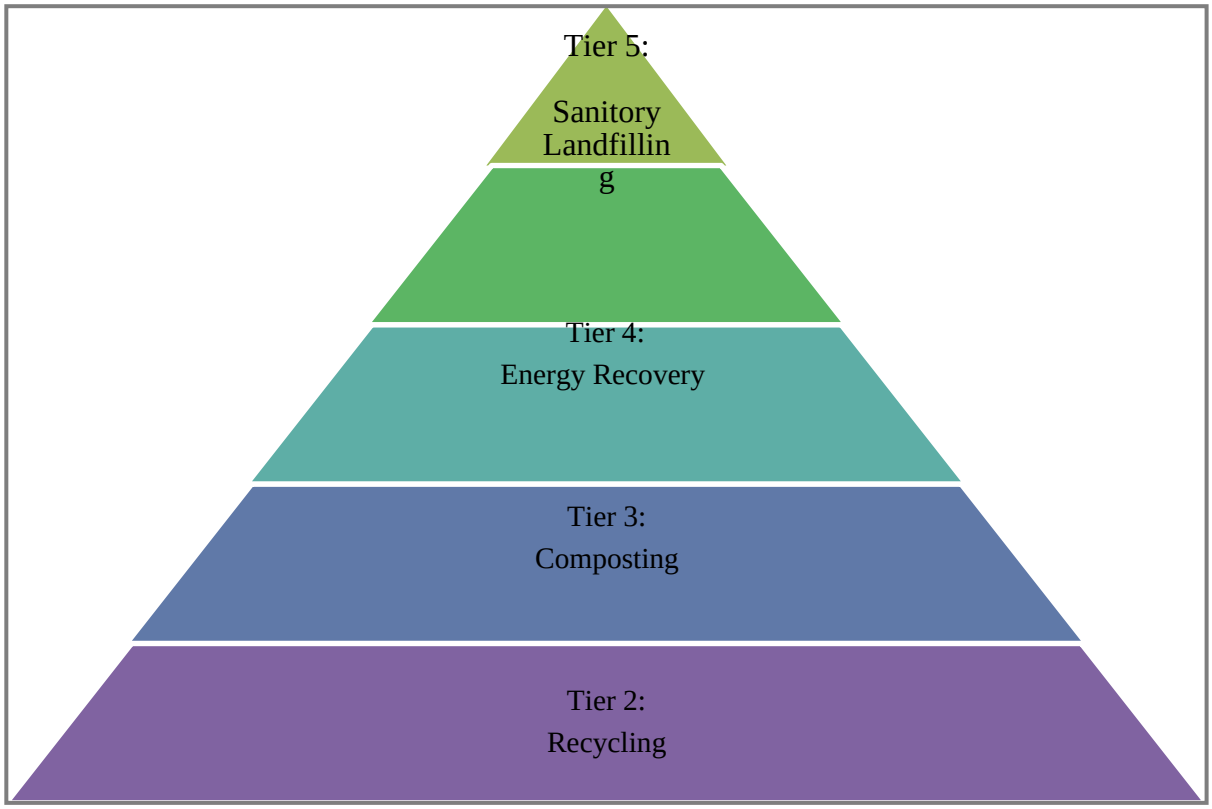


Fig. 5.8: Tier Approach in Integrated Solid Waste Management.

According to The U.S. Environmental Protection Agency (EPA) Intergrated Solid Waste Managemnet (ISWM) as a holistic waste reduction process, which includes collection, composting, recycling, and disposal system. ISWM is the strategic approach to sustainable

management of solid wastes covering all sources and all aspects, covering generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with maximum efficiency. Its leads to safe, clean and hygienic surrounding, higher efficiency, lower quantity of waste to handle for final disposal. It turns vicious circle to virtuous circle. ISWM is a holistic approach of waste management which includes all the steps right from waste generation to its graveyard that land filling. Not only the various stages are important but various stakeholders are also considered very important in this system where stakeholders right from policy makers, industries, institutions, individual households, waste management companies and workers are considered active participants. Functional Elements of Integrated Solid Waste Management has been depicted in Fig no. 5.9.

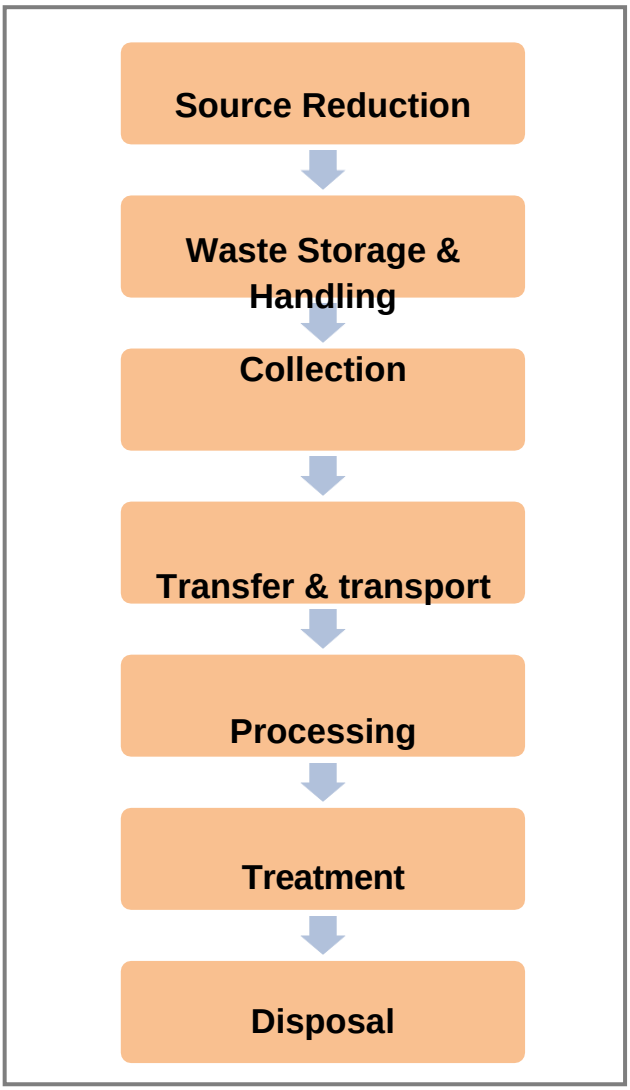


Fig. 5.9: Soild waste Managemnet System basic outline

Institutional Framework in India to manage solid waste

Municipal Authorities:

1. It is the responsibility of municipal authority to collect, store, segregate, transport, process and dispose municipal solid wastes.
2. The municipal authority or operators of a facility are responsible for setting up waste processing and disposal facility including landfills.
3. Prepare annual report on status of municipal solid waste.

State Government and the Union territory Administrations:

1. The Secretary-in charge of the Department of Urban Development of the concerned State or the Union territory are responsible for enforcement of the Municipal Solid Wastes (Management and Handling) Rules, 2000
2. The District Magistrate or the Deputy Commissioner of the concerned district has the overall responsibility for the enforcement of the rules within the territorial limits of their jurisdiction.

Central Pollution Control Board and the State Board or the Committees:

1. The State Board or the Committee shall monitor the compliance of the standards regarding ground water, ambient air, leachate quality and the compost quality including incineration standards.
2. The State Board or the Committee shall issue the authorization to the municipal authority or an operator of a facility.
3. The Central Pollution Control Board shall co-ordinate with the State Boards

and the Committees with particular reference to implementation and review of standards and guidelines and compilation of monitoring data. [12]

Indian laws concerning wastes and waste management in India:

1. The water (Prevention and Control of Pollution) Act., 1974
2. The water (Prevention and control of pollution) Rules, 1975
3. The water (Prevention and Control of Pollution) Cess Act, 1977
4. Water (Prevention and Control of Pollution) Cess Rules, 1978
5. The Air (Prevention and Control of Pollution) Act, 1981
6. The Environment (Protection) Act, 1986
7. The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989
8. The Public Liability Insurance Act, 1991
9. The National Environment Tribunal Act, 1995
10. The National Appellate Authority Act, 1997
11. The Municipal Solid Wastes (Management and Handling) Rules, 2000
12. Batteries (Management and Handling) Rules, 2001
13. National Green Tribunal Act, 2010
14. Solid Waste Management Rules 2016
15. Plastic Waste Management Rules 2016
16. e-Waste (management) Rules, 2016
17. Bio-Medical Waste Management Rules, 2016
18. Construction and Demolition Waste Management Rules, 2016
19. Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules 2016.

Conclusion

Waste management sector has lot of potential to become a resource. Waste management should be dealt in a holistic manner with sustainable development approach. Since waste has been a part of informal sector historically in India, we need to focus on informal sector and specific policies should be designed. Waste should be managed in a decentralized approach and in- situ at production site. This reduces quantity of waste and economic cost of handling.

Remediation practices should be focused on public awareness and encouraging public participation. Green remediation and management practices are the need of the hour. It will not only solve the issue of waste management but will be the sustainable long-term solution. User fee should be charged by government according to the quality and quantity of waste. Waste to energy and such new technologies should be adopted in waste management. At the policy level we have many rules and regulations currently in India; we just need stringent enforcement and punishment to offenders.

WASTE MANAGEMENT IN DEVELOPED COUNTRIES

Waste has become a challenge before society as it is being continuously neglected in the field of environment which is getting harmful for the health of living beings as well as the environment in a way that it ends up in surface water contamination, soil pollution because many chemicals like cyanides, mercury etc are highly toxic and exposure can lead to disease or death. Waste includes all forms but solid waste is becoming a major health and environment concern in most of the developing countries. Environmental effects like dirty sites and foul odor are becoming a common site in rural and urban areas of developing countries.Epidemiological effects such as transmission of diseases, clogging of sewers, and emission of harmful gases are also creating a major impact on the human health .Strategies like incineration, land filling, dumping of wastes are also affecting the air and soil by release of polluting chemicals and accumulation of various heavy metals in the soil. Effective waste management strategies are required that involves a synchronized system of controlling the production and disposal of wastes. Most of the developed countries are using advanced management techniques like

Germany (Enhanced Resolution, Mobile sorting) that are proving to be very helpful in eluding the waste as well as creating a better probability of recycling and reuse. Use of such techniques has allowed increasing the level of recycling to 62% by 2010, and land filling was almost reduced to zero by that time. Although, adequate laws are required to run a country waste free as Germany put a ban on land filling MSW by defining requirements to the organic content. Direct land filled (maximum 5% carbon content) or maximum 18% if the waste has been pre-treated. The first initiative was taken in 1993 that followed up in 2001 and 2002 and was fully implemented in 2005. This initiative has made a boon in the development of Mechanical biological treatment plants (MBTs) that redirects the biodegradable material to fermentation and composting plants for the production of biogas. Likewise, Netherlands works on the principle of 'Lansnik's ladder' (Proposed in 1994) that follows the avoidance as well as recovery of valuable components from the waste .Under this, more than 35 waste categories were banned by 1995 and landfill tax was introduced that increased the recycling rate from 45% to 50% in the period of 2001 to 2009, eleven years ahead of the deadline. Thermal waste incineration has been followed in Netherlands since 1919 due to its dependency in accommodating variations in composition and calorific value of MSW (7, 8). By 2012, Netherlands established 12 incineration plants that helped 50,000 households in Amsterdam to attain 25% heat requirements from waste incineration (9). However, developing countries like India have been using aerobic composting (organic compost as fertilizers), anaerobic composting (biogas as fuel or electricity) or refuse derived fuel (secondary fuel for solid fuel industry) to manage their municipal solid waste . The most common technique considered as composting had nearly 70 plants established in India by 2012, most of them located in Maharashtra. Out of 57 cities that generate municipal solid waste more than 200 TPD, 38 cities have composting plants managing around 4361 TPD of waste . 6 refuse derived fuel plants along with sanitary landfills in eight cities have helped a lot to manage the municipal solid waste efficiently. Waste-to-Energy combustion is also being used for breakdown of solid waste thermally and production of electricity or other form of energy. The waste produced in India contains nearly 60% organic content and 10% paper, making the waste 70% renewable as bio-fuel energy. The waste-to-energy combustion decreases the volume of waste by 90%, thus increasing the life of landfills from 20 to 200 years, approximately. India has been facing struggles in the field of data and awareness related to waste, lack of consultants and trained professionals along with improper finances. Inadequate knowledge of calorific values, composition and quantity of waste is creating an impact on waste management industries. However, progressive steps are being considered in the field of waste management and the government is realizing the impact of waste on human health and environment. Introduction of 'landfill project' in Shimla and mega awareness programs are being organized in cities like Aurangabad and Mumbai. European countries are managing the solid waste with the best approach and laws by reducing the solid waste and recovering energy from wastes. The waste

composition in India is different from European countries due to climatic and cultural variations leading to a completely different approach to manage the waste i.e. composting. Although, providing better finances, data, and trained consultants will help developing countries like India to create a waste free nation.

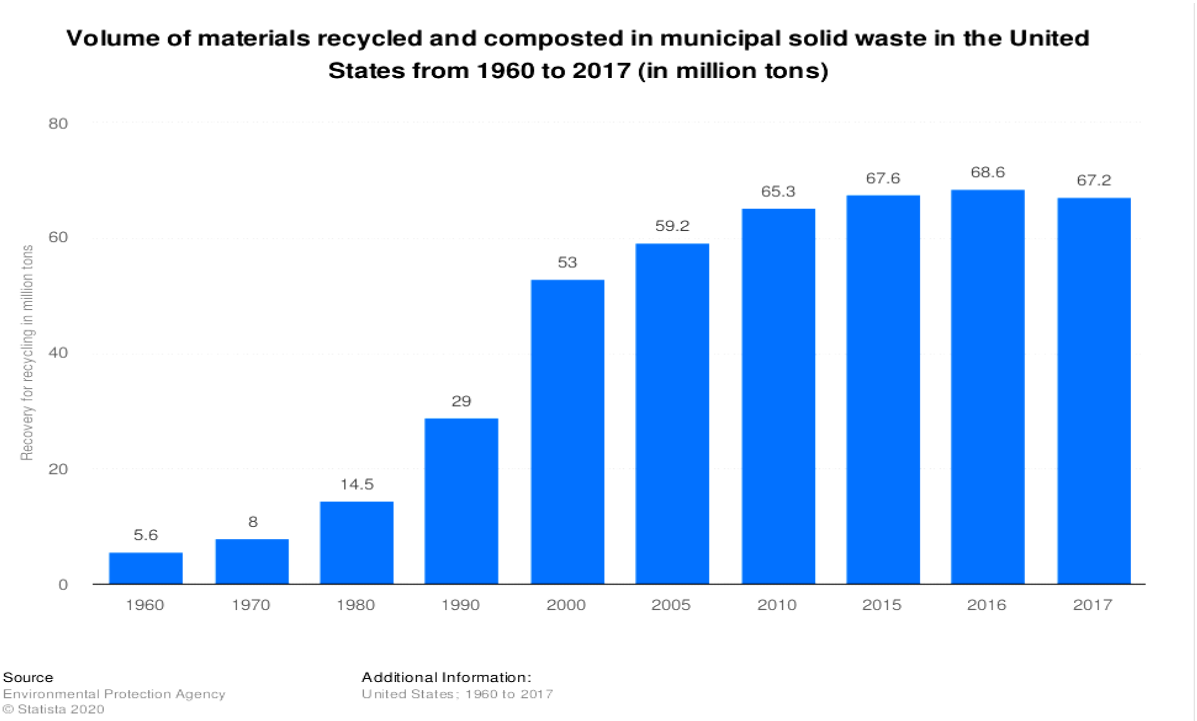


Fig. 5.10 Waste Management Plant In Florida

CONCLUSION

1. Present system of management should be upgraded.

2. Segregation of waste at source for recyclable material should be encouraged so that the quantity of waste to be disposed can be minimized and recycling should be adpted.

3. Frequency of collection and transportation to disposal site should be improved to avoid health hazards and to ensure asthetic environmental conditions.

4. Awareness among the public can help the proper management of municipal solid waste.

5. NGOs should also be able to participate in policy making.

6. E-marking ‘’NO LETTER ZONES’’ should be introduced.

7. Mechanisms by which smaller entrepreneurs, civil society etc.can participate in new waste management procedures and regimes should be developed.

8. Waste segregation should begin at home so that the disposal gets easier and manageable.

9. Public should be made aware about vermicomposting and recycling. By doing this they can also produce organic fertilizers at home and also make usable things from the waste that they usually throw away.

10. Organize knowledge camps to make every single individual aware about consequences of improper waste disposal on the environmental and personal hygiene.

11. Holding recycling events at school, college and community level to make each and every person socially and environmentally knowledgeable in context to reduce, reuse and recycling materials we refer to as waste but which actually can be a potent resource.

With increase in global population, the rising demand of food and other requirements has lead to tremendous increase in the amount of waste by each house hold. If this will not be managed properly ,it can become the cause of lethal diseases and will show its adverse effects on the rest of environment as well. A proactive approach will us to succeed in an era of increased population and pollution.

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Links

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