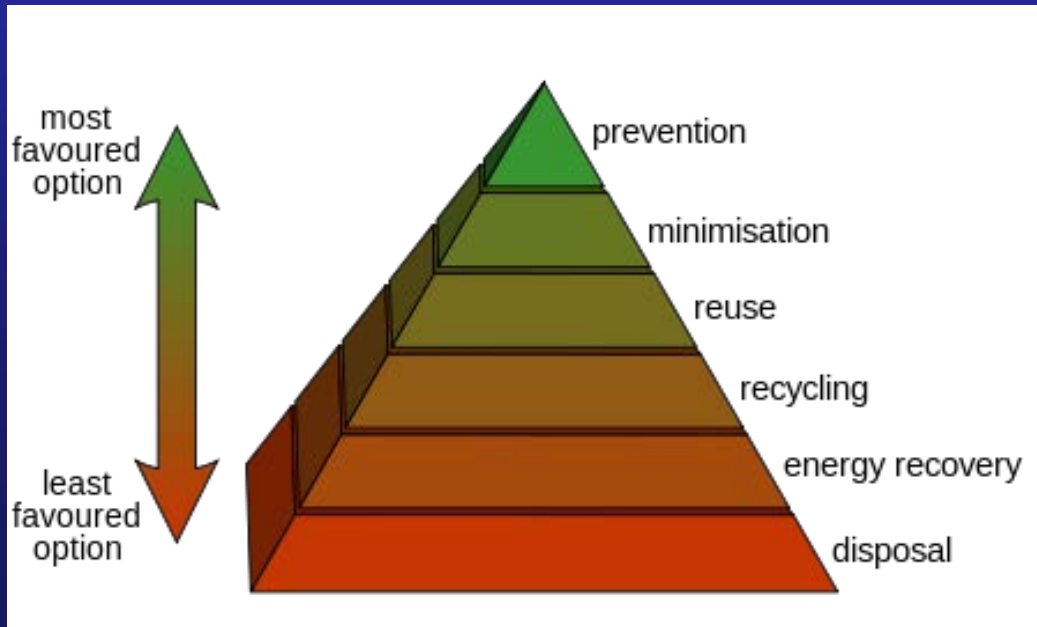
Solid and Hazardous Waste

Major types	Agricultural wastewater · Biodegradable waste · Brown waste · Chemical waste · Construction waste · Demolition waste · Electronic waste (by country) · Food waste · Green waste · Hazardous waste · Heat waste · Industrial waste · Litter · Marine debris · **Biomedical waste** · Mining waste · Municipal solid waste · Open defecation · Photodegradation · Post-consumer waste · Radioactive waste · Sewage · Toxic waste · Wastewater
Processes	Anaerobic digestion · Biodegradation · Composting · Illegal dumping · Incineration · Landfill · Landfill mining · Mechanical biological treatment · Mechanical sorting · Open dump · Recycling · Resource recovery · Sewage treatment · Waste collection · Waste picking · Waste sorting · Waste treatment · Waste-to-energy
Countries	Armenia · Bangladesh · Brazil · Hong Kong · India · New Zealand · Russia · Switzerland · UK · USA
Agreements	Bamako Convention · Basel Convention · EU directives (batteries · landfills · RoHS · framework · incineration · waste water · WEEE) · London Convention · Oslo Convention · OSPAR Convention
Other topics	Cleaner production · Downcycling · Eco-industrial park · Extended producer responsibility · High-level radioactive waste management · History of waste management · Sewage regulation and administration · Upcycling · Waste hierarchy · Waste legislation · Waste minimisation · Zero waste

Key Concepts

- Types and Amounts of Wastes
- Preventing Waste
- Methods of dealing with Wastes

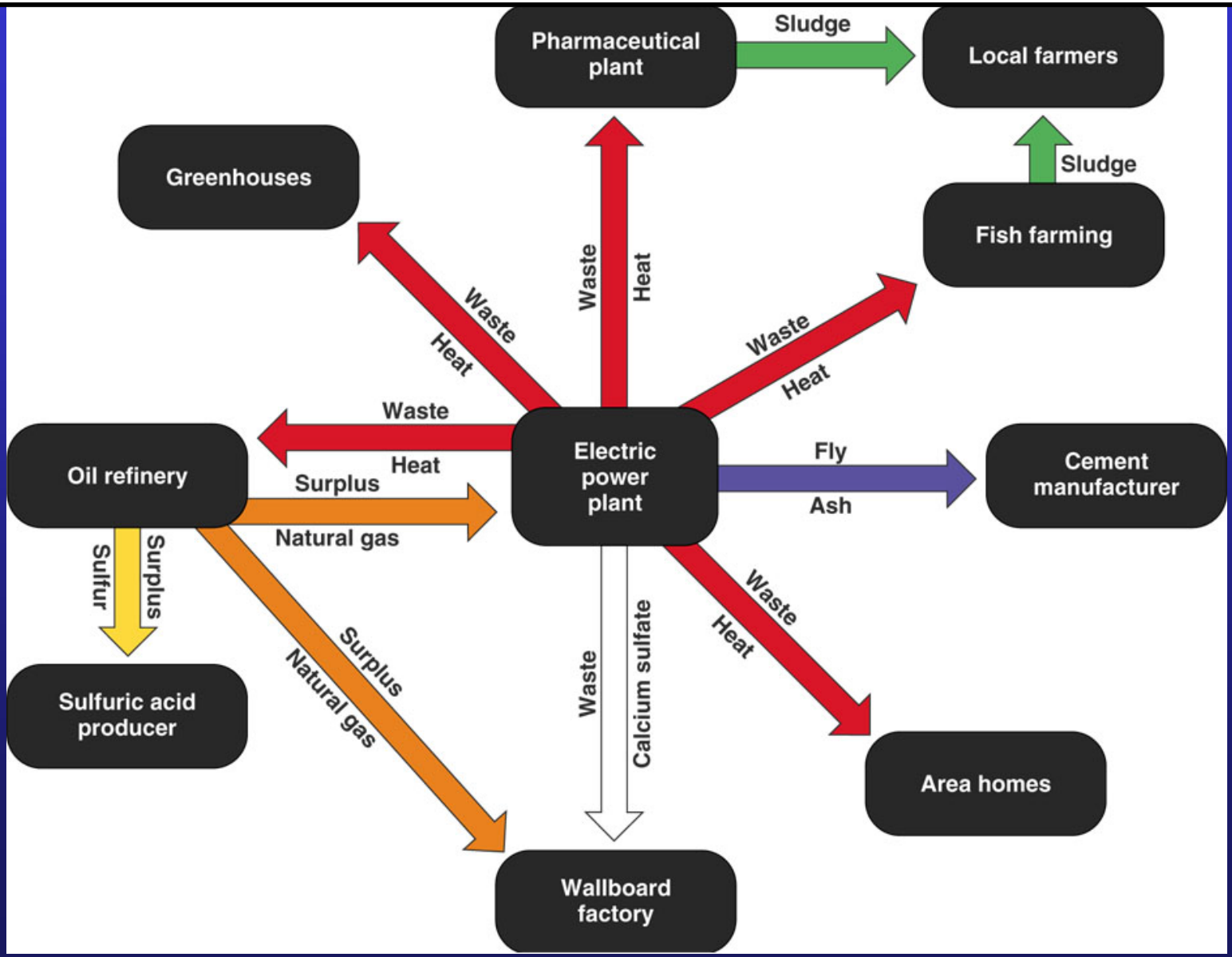


Solutions: Cleaner Production

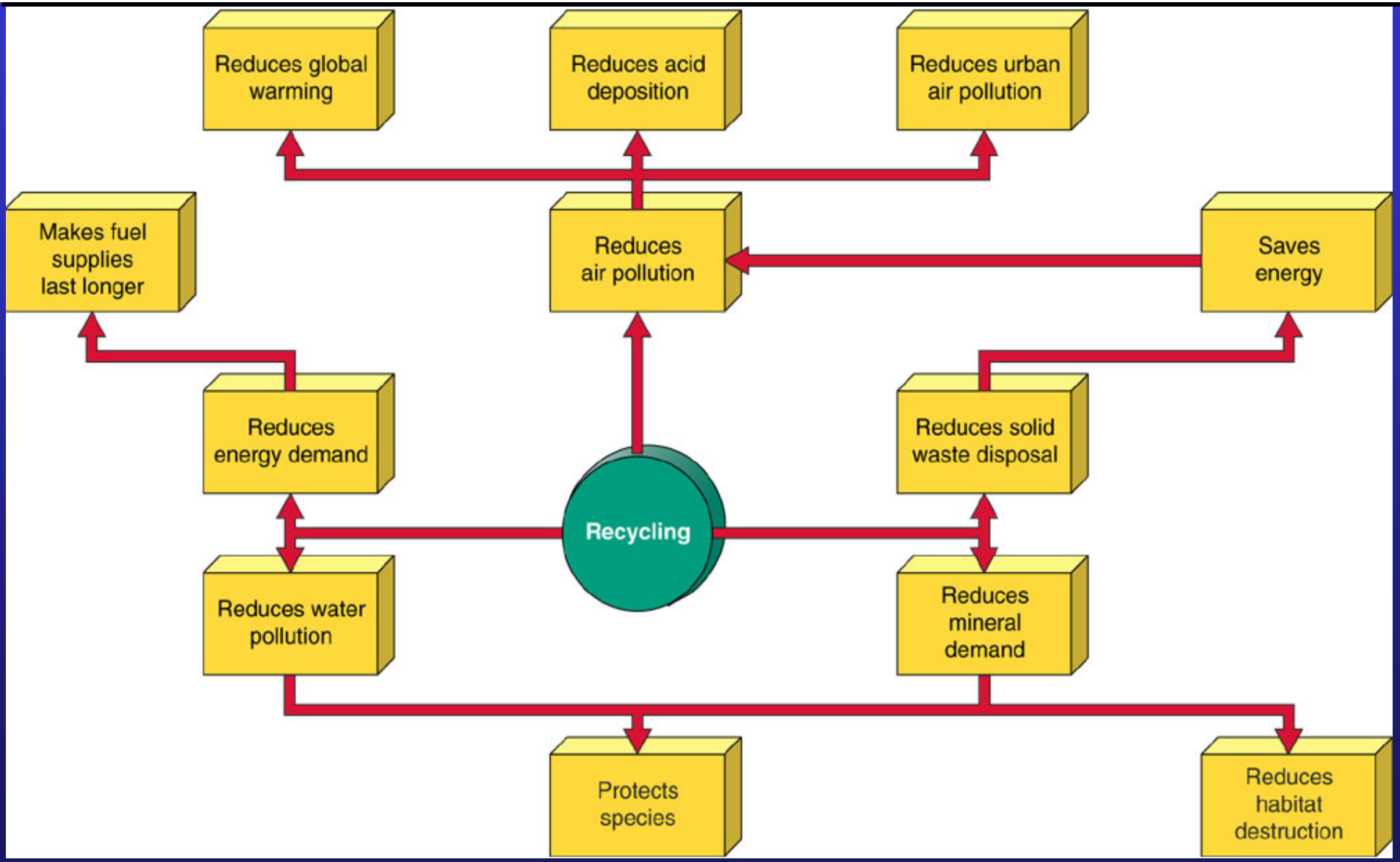
- Eco-industrial revolution
- Resource exchange webs
  - waste from one industry is raw material for another

- Bio-mimicry (mimic nature)
  - no waste in nature
  - **Biological reprocessing Mulch or Compost**

Industrial Ecosystem in Denmark



Benefits of Recycling



Burning Wastes

- Mass burn incineration
- Air pollution
- Waste to energy

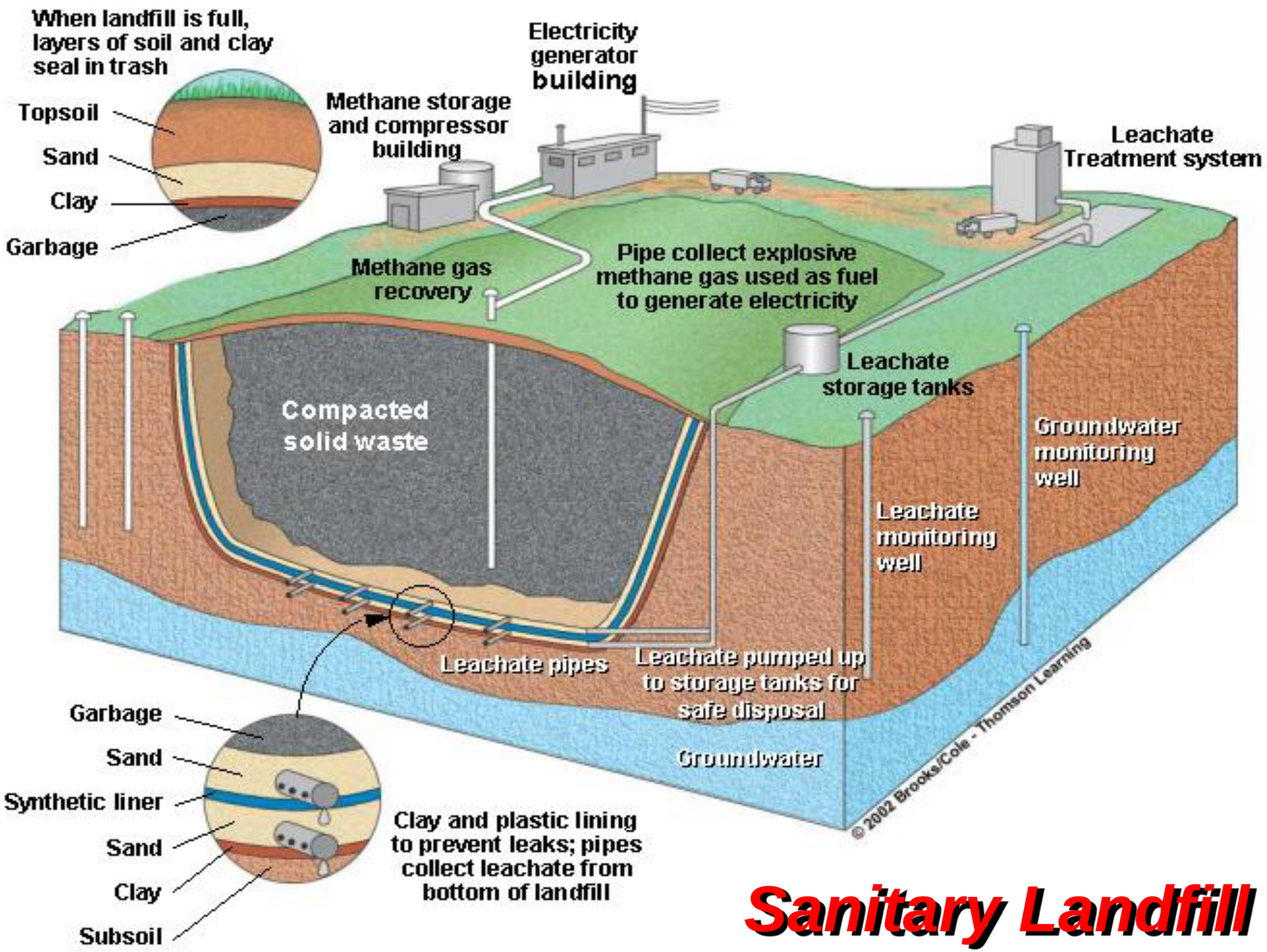
Trade-Offs

Incineration

Advantages	Disadvantages
Reduced trash volume	High cost
Less need for landfills	Air pollution (especially toxic dioxins)
Low water pollution	Produces a highly toxic ash
Quick and easy	Encourages waste production
	Discourages recycling and waste reduction

Burying Wastes

- Landfills most common method of waste disposal - cheap and convenient.
- Open pits no longer acceptable.
- Complex impermeable bottom layers to trap contaminants
- Daily deposits are covered by layer of dirt.
- Methane gas and leachate monitoring wells



Sanitary Landfill

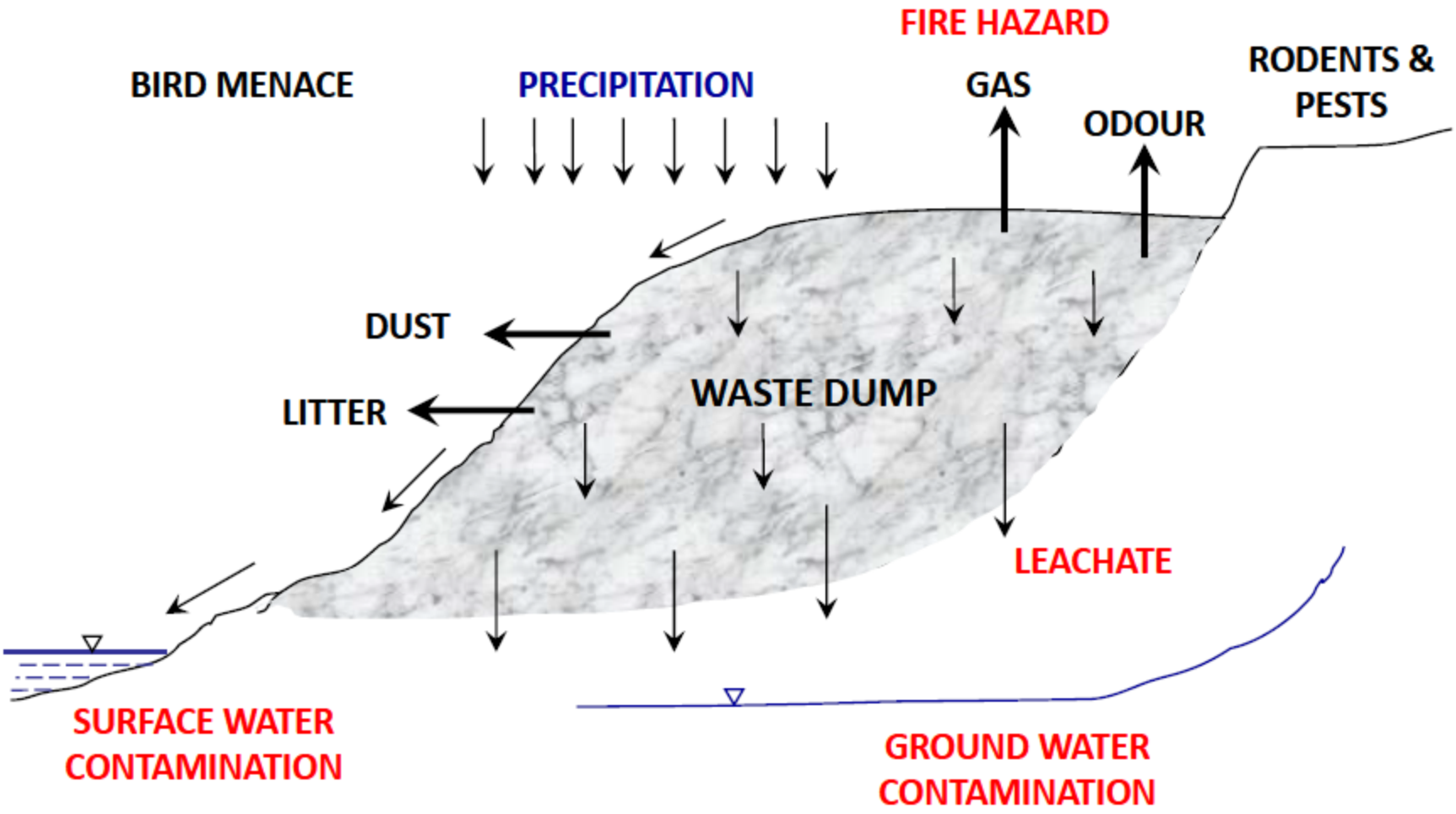
Sanitary Landfills: Trade-offs

Trade-Offs

Sanitary Landfills

Advantages	Disadvantages
No open burning	Noise and traffic
Little odor	Dust
Low groundwater pollution if sited properly	Air pollution from toxic gases and volatile organic compounds
Can be built quickly	Releases greenhouse gases (methane and CO_2) unless they are collected
Low operating costs	Groundwater contamination
Can handle large amounts of waste	Slow decomposition of wastes
Filled land can be used for other purposes	Discourages recycling and waste reduction
No shortage of landfill space in many areas	Eventually leaks and can contaminate groundwater

NON-ENGINEERED WASTE DUMPS



LANDFILL ENGINEERING SYSTEMS

- An engineered landfill is a controlled method of waste disposal.
- The objective of a landfill facility is to contain the waste in a manner that is protective to human health and the environment.
- Landfills perform by controlling and managing the movements of fluids.
- Landfills are engineered facilities for the disposal of
  - Municipal Solid Waste
  - Hazardous Waste

ENGINEERED LANDFILLS - TYPES

Based on Site Topography and Capacity Requirements:

- **Above Ground Landfill (Area Landfill)**
- **Below Ground Landfill (Trench Landfill)**
- **Above and Below Ground Landfill**
- **Slope Landfill**
- **Valley Landfill (Canyon Landfill)**

CRITERIA FOR LANDFILLS

1. Site Selection

- Location criteria
- List of potential sites
- Selection of few best ranked sites
- Environmental impact assessment
- Final site selection

2. Site Investigation

- Subsoil investigation
- Ground water/ Hydrogeological investigation
- Topographical investigation
- Geological and Seismic investigation
- Environmental investigation

CRITERIA FOR LANDFILLS

3. Landfill Planning & Design

- Essential components
- Design life
- Waste volume, waste compatibility and landfill
- Landfill layout and section
- Phased operation
- Estimation of leachate quantity
- Liner system
- Leachate drainage, collection and removal

Contd…

CRITERIA FOR LANDFILLS

3. Landfill Planning & Design

- Leachate management
- Landfill gas management(Flare System)
- Final cover system
- Surface water drainage system
- Base stability, slope stability and seismic aspects
- Site infrastructure
- Environmental monitoring system
- Closure and post-closure maintenance system

CRITERIA FOR LANDFILLS

4. Construction of landfill and operation criteria

- Landfill site construction and development
- Site procedures : Record keeping and waste inspection
- Phase development
- Phase operation
- Pollution prevention and safety during operation
- Phase closure
- Landfill Closure
- Post-closure vegetative stabilization

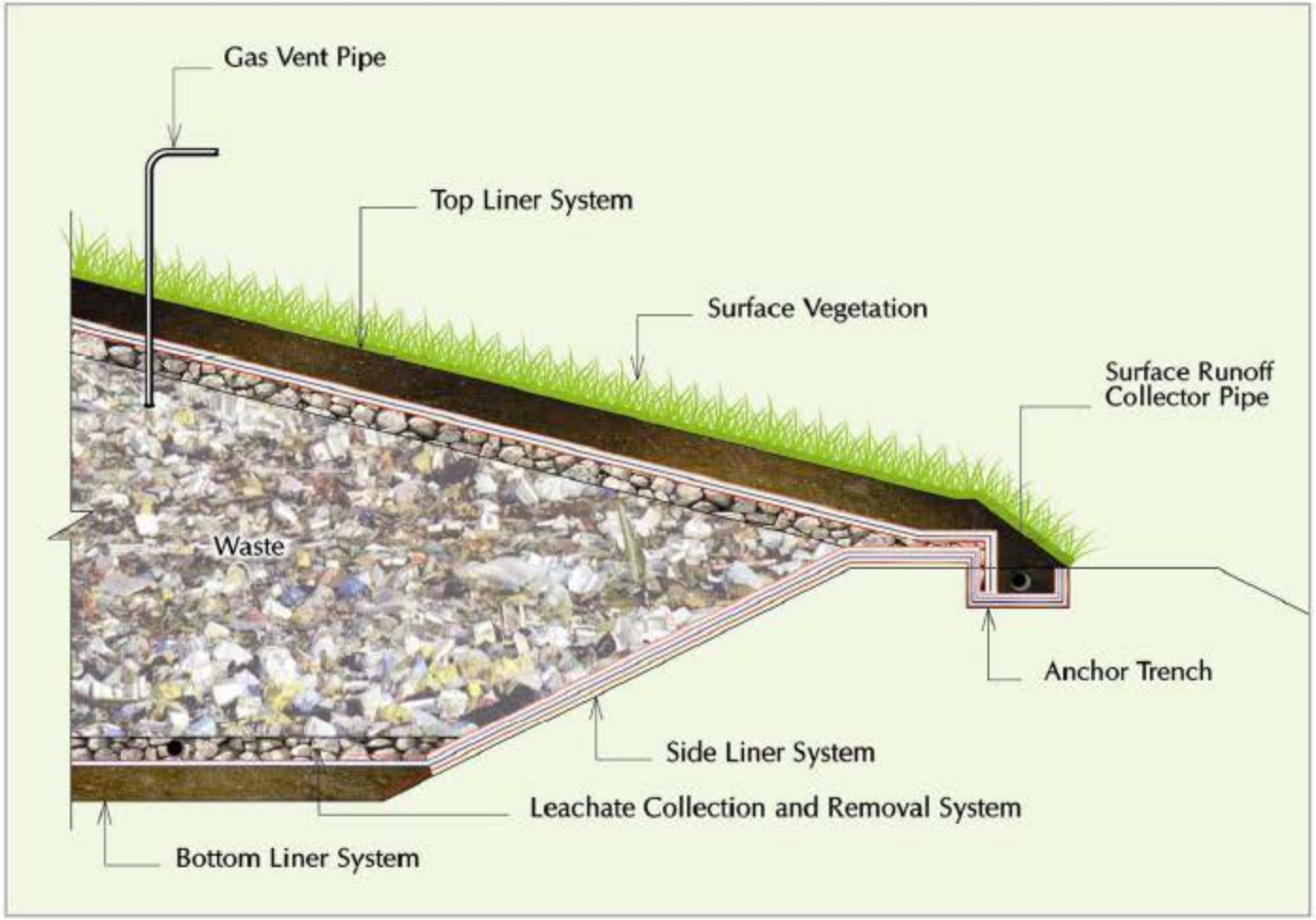
CRITERIA FOR LANDFILLS

5. Inspection, monitoring and record keeping criteria

- During construction of liners and covers
- During operation
- During closure and post-closure period
- Environmental monitoring systems

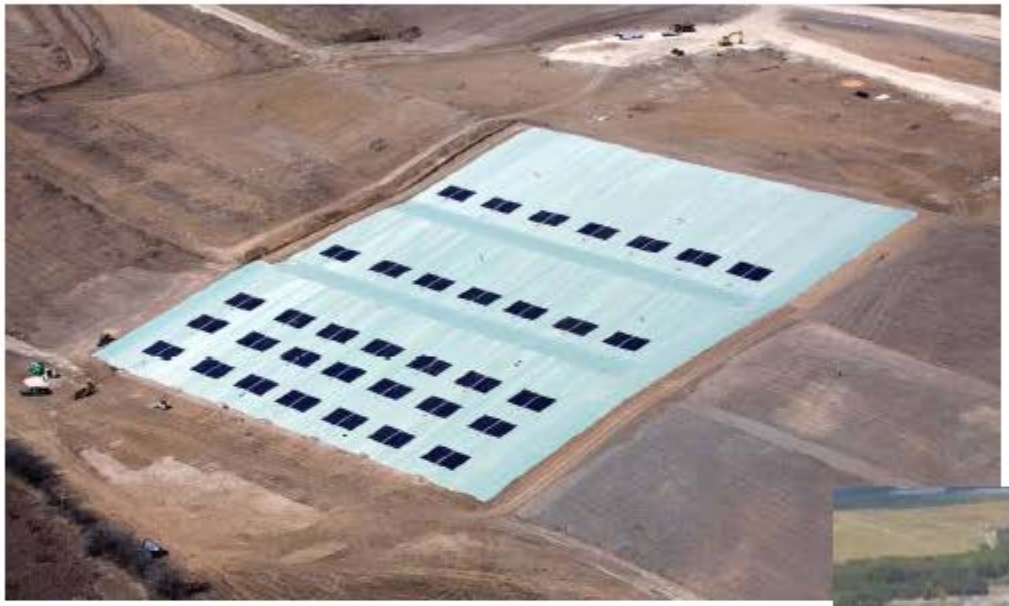
6. Post-closure Criteria

LANDFILL COMPONENTS



Typical Cross-Section of Landfill

GENERATION OF SOLAR ENERGY !!!



Hazardous Wastes: Types

- Contains at least one toxic compound
- Catches fire easily
- Reactive or explosive
- Corrodes metal containers

Some common hazardous chemicals

- Lead
  - paint, gasoline, pipes, accumulates in soil and water
  - neurological damage, slows brain development, kidney disorders; children especially vulnerable
- Mercury
  - paint, batteries, old thermometers, industrial processes, combustion of coal, dental fillings, contaminated historical mining sites
  - damages brain, kidneys, developing fetus, learning disabilities, death with high doses

Some common hazardous chemicals

- Arsenic
  - treated wood, industrial processes, contaminated soil and water
  - impairs organ, heart, and blood functions; damages nervous system
- PCBs (Ploycholorinated biphenyls)
  - industrial chemical (used in fire retartands, lubricants, insulation for electrical transformers, some printing inks)
  - carcinogenic, birth defects, lower IQ, learning disabilities, impairs neurological development

Detoxifying and Removing Wastes

- Physical methods
- Chemical methods
- Bioremediation
- Phytoremediation
- Plasma incineration

Factors influencing biological treatment

Suitability of the waste:

- composition
- physical form
- pH

- Biological treatment is only suitable for organic wastes with relatively low toxicity

- It is not 100% efficient in destroying organic material

Advantages of biological waste treatment

In the right conditions - *ie* temperature, humidity and pH - biological treatment is:

- Effective
- Tolerant to changes in waste composition - these may result in a short period of inactivity, but do not halt the process

Emerging applications for biological treatment

- For many waste types, biological treatment is still in early stage of development
- New applications are being tested and developed eg
  - for treating additional hazardous waste streams
  - for integrating biological processes with physical-chemical treatment

SUMMARY

Biological treatment of hazardous waste

- optimises a natural process
- is suitable for low concentration organic wastes *eg* sludges
- requires good control of process conditions
- is relatively low cost, effective and tolerant to changes in waste
- is most widely used for wastewater treatment
- may be on-site or off-site
- new applications being developed