

**RETRO FITTING
REPURPOSING CAPITAL TO ENVIRONMENTAL SUITABILITY**

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MAIN AREAS TO BE COVERED

- Waste Handling
 - Packaging
- Plastic Products

WASTE HANDLING I

- Liquid Waste, Sewage
- Drainage
- Industrial Solid Waste
- Domestic Solid Waste

Not dealing with specialist areas, such as medical and hazardous waste, toxic waste, tyres, etc.

WASTE HANDLING II

- Pollution Control and Prevention
- Sustainability and Resource Recovery
- Cost
- Who Pays?

COMPONENTS OF SOLID WASTE HANDLING– MUNICIPAL SOLID WASTE

- Collection Systems, e.g. kerbside, drop-off and buy-back centres
- Source Separation
- Storage
- Disposal

DISPOSAL

- Materials Recovery Facilities (MRFs)
- Landfilling
- Incineration, including waste to energy
- Recycling
- Chemical Recovery
- Composting
- Anaerobic Digestion
- Volume Reduction

MATERIALS RECOVERY FACILITIES

- Separation of materials
- Disposal for further treatment

LANDFILL

- Not just a dump
- Modern sanitary landfill have specific requirements to prevent leachate
- Covered daily
- Can be used to generate methane gas for energy generation
- Many countries (for example Germany) are eliminating landfill as an option because it is wasteful of a valuable resource

INCINERATION INCLUDING WASTE TO ENERGY

Technologies Available:

- Landfill gas capture
- Combustion
- Pyrolysis
- Gasification
- Plasma arc gasification

RECYCLING

- For many materials, for example plastics, glass, metals and paper, recycling is usually the best option
- It enables sustainability and helps recover the value of materials
- Mechanical recycling involves reprocessing of the material without changing its structure
- Chemical recycling involves the breaking down of the composition into a useful compound or compounds

COMPOSTING

- Composting is the aerobic (in the presence of air) microbiological digestion of organic waste, such as food residues, agricultural by-products, etc. It is typically carried out industrially under thermophilic conditions ($>60^{\circ}\text{C}$ to ensure killing of pathogens).
- Home composting is also carried out, but the temperatures tend to be be more variable and lower
- Packaging can be designed to be compostable, but there are many negatives with this – cost, use of resources, etc.

ANAEROBIC DIGESTION

- Anaerobic digestion is the treatment of organic waste with microorganisms to anaerobically (without air or oxygen) convert the organic content of waste to mainly methane gas
- The methane gas is used as a fuel for heating or power generation

VOLUME REDUCTION

- Modern techniques to reduce waste volume by up to 90%
- Use of high temperature ($> 70^{\circ}\text{C}$) extremophiles
- Advetec Technology
- Handling of medical and hazardous waste

PACKAGING

Options for packaging materials:

- Paper and paper board (often plastic coated)
- Plastics
- Glass
- Metal
- Fibreboard

Because of its low cost, flexibility, lightweight and functionality, plastics has increasingly become the material of choice

PLASTICS

The fate of plastics after their primary use is the source of considerable debate and concern.

The share of plastics ending up in the oceans (which is ultimately where most littered plastics ultimately end up) is small, about 5%, but the increasing amount and accumulation over time create huge problems:

- Visible pollution
- Animal entrapment and ingestion
- Fouling of the environment

With no change to current practices it is estimated that there will be one billion tons of plastic in the oceans by 2050

FATE OF PLASTICS, 2015

Annual Plastic Production 407 Mt		
Plastic waste 302 Mt		Plastics in use e.g. building materials 105 Mt
Mismanaged plastic waste 42 Mt	Properly disposed plastic waste 260 Mt	
Fugitive 13 Mt		

RESPONSIBLE DISPOSAL OF PLASTICS

In Europe in 2016 the proportion of types of responsible disposal was:

Energy Recovery	41.6%
Recycling	31.1%
Landfill	27.3%

COSTS

The investment needed in different countries to implement the technologies outlined above are approximately as shown on the next slide.

This is obviously a very large burden on a low income country.

COSTS

	Low income country	Lower middle income country	Upper middle income country	High income country
Investment per GNI, %	1.46	0.41	0.097	

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WHO PAYS?

This is a question for the politicians and industry.

The Industry – plastics manufacturers and users – have initiated an Alliance to End Plastic Waste and has committed \$1 billion to work on the problem during the next 5 years. This is not enough to solve the problem!

In addition to the capital requirement they are also operating expenses and a need for education of the consumers.

ALTERNATIVES I

There are alternatives to the scenario outlined above which require no investment.

One way to alleviate the problem of plastic litter is to incorporate an additive to programme the lifetime of the plastic article, principally those made from polyolefins, such as polyethylene (PE) and polypropylene (PP). If the product is discarded in the environment it will break down harmlessly and not become a persistent nuisance. Such an additive is supplied by Green Club of Canada.

Another way is to use a biodegradable plastic, such as polylactic acid (PLA), but this is more expensive and not as flexible.

ALTERNATIVES II

Requirements for successful implementation of programmed life plastics based on additives for polyolefines (PE and PP):

- Professionally designed and manufactured “drop-in” additive
- Standards for ensuring appropriate degradation and full biodegradation
- Enforcement of standards
- Must also be recyclable
- No toxic residues
- Minimum incremental cost (<10%)

ALTERNATIVES III

- The introduction of simple laws on a non-scientific basis are not a solution. Properly conducted life cycle analysis (LCA) of alternatives needs to be conducted
- Banning plastic bags is not the answer to the pollution problem
- Plastic is used for a reason – food protection, etc.
- Alternatives to plastic, such as paper, can have a worse environmental impact
- Degradable agricultural mulch film is a better alternative than other proposed solutions to the disposal of the film after harvesting the crop