Life Cycle Analysis of Plastic Products in the Plastic Value Chain

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National Policy Workshop Webinar Series18th May, 2020

Background of the presentation

- Today, opportunity to turn the tide through circular-economy solutions to expand the scope of recycling methods, across the plastics value chain.
- Leakage of plastic waste into the environment is the least desirable, and disposal in landfills is only marginally preferable.
- Hierarchy of plastic waste management requires high-level guidance on type of recycling that is preferable, with three dimensional need :

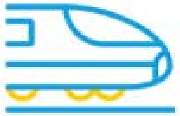
  Categorize products made of "single family" or "multi-family" on the basis of their extent of recyclablility.

  Quantify how much difficult it is to recycle based on mechanical and energy impact

  Establish best waste-to-energy solution depending on the calorific values of different plastics.

Life Cycle Analysis - to preserve the value of plastics and to efficiently design the products for best possible post consumers usage ………….

NEED OF PLASTIC RECYCLING: SUSTAINABLE DEVELOPMENT



By 2050

We will need ...

35% more food

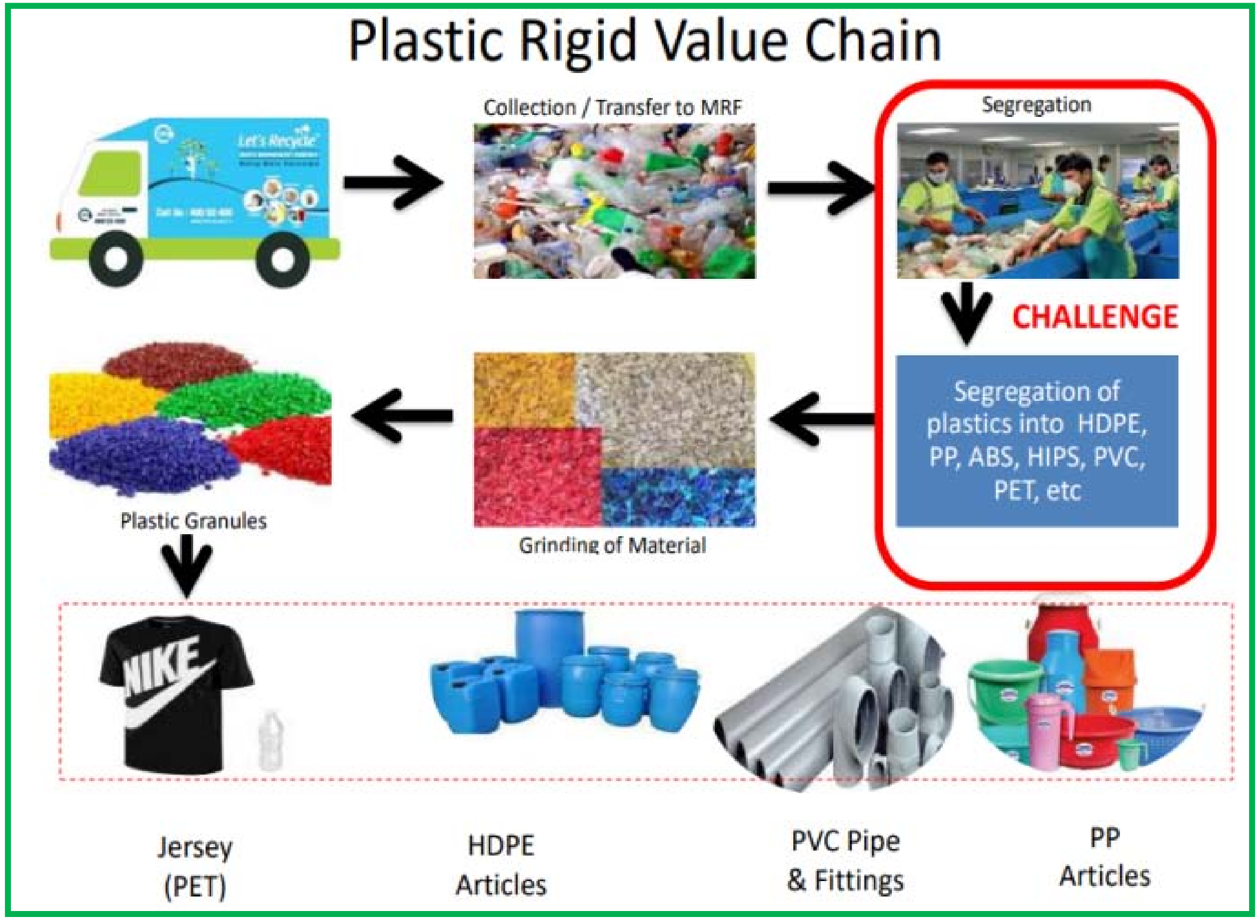
50% more energy

40% more water

Waste Management……. to………. Materials Management

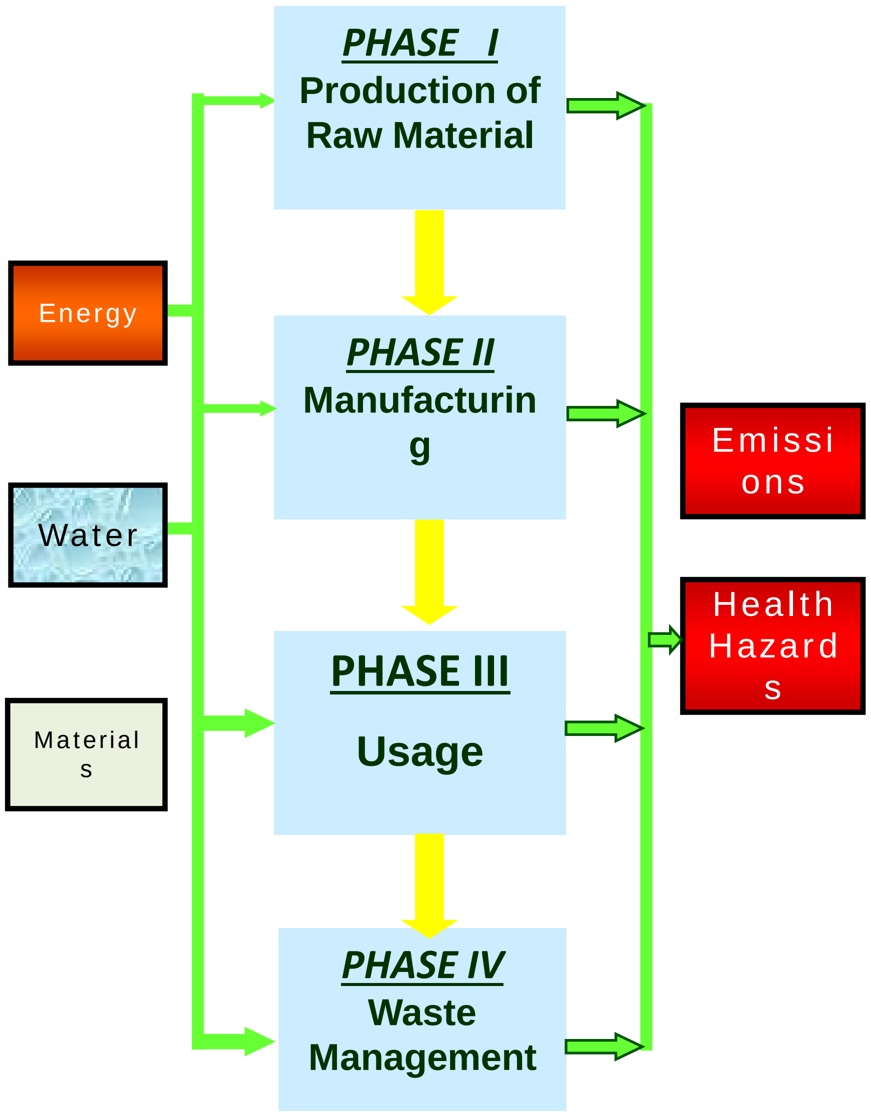
STAGES OF CIRCULAR ECONOMY MODEL

STAGE 1



STAGE 2

Life Cycle Analysis

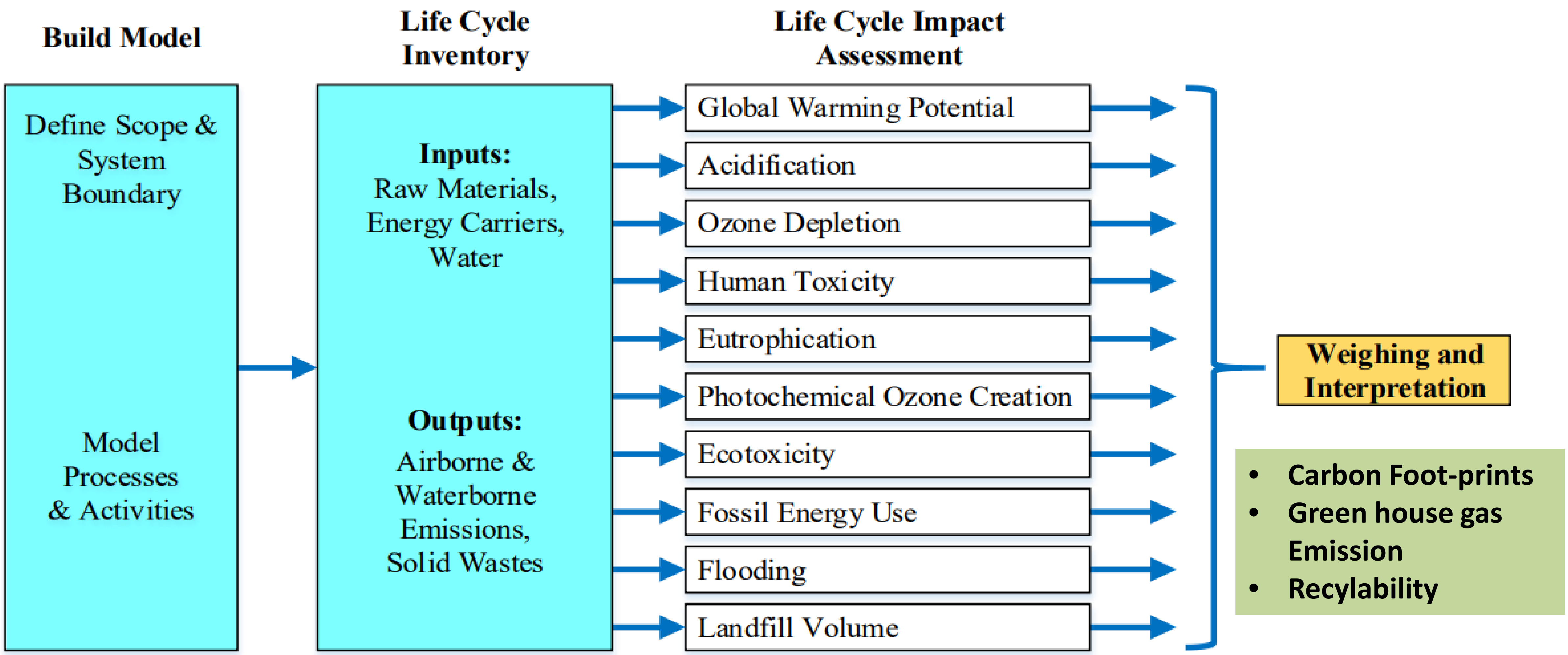


Benefits of LCA on Plastic Products

- **Comparison**
  - Between products (selection/evaluate)
  - Between processes/method/management
- **Product Development/Improvement**
  - Green design/Eco-design
  - Green products/more environmental friendly
  - Better eco-efficiency (economic & ecology)
- **Communication**
  - Reports
  - Environmental declaration
  - Labels
- **Policy**
  - Decision making
  - Management policy
  - Environmental tax/subsidization/investment

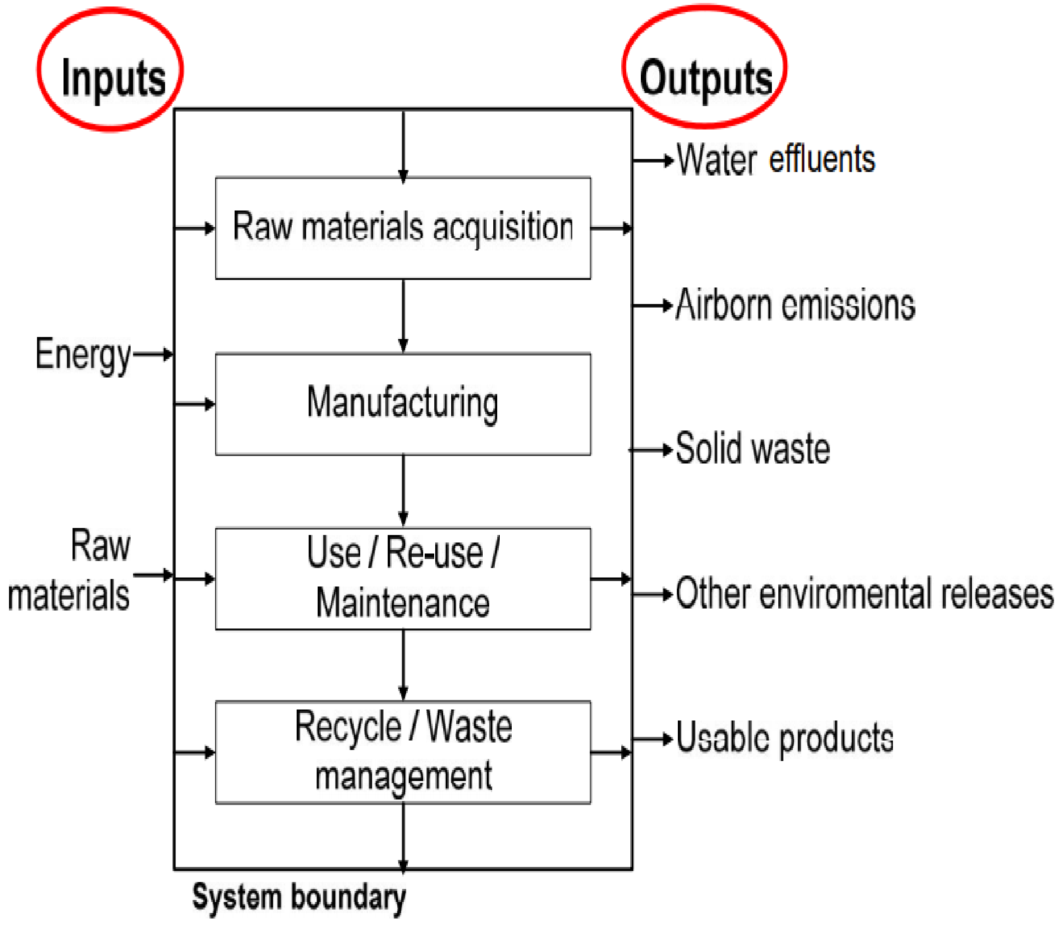
Life Cycle Impact Assessment

Life Cycle Assessment (LCA) standards: ISO 14040 and ISO 14044.

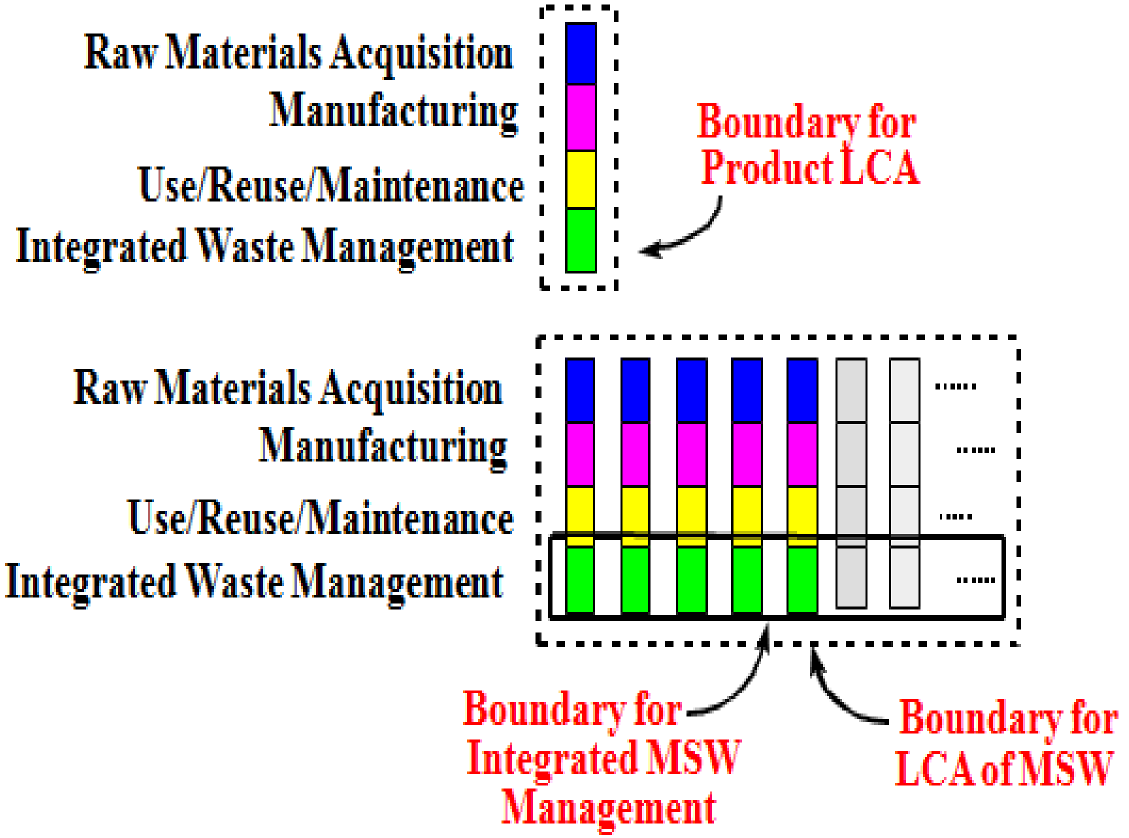


"Cradle to Grave" / "Cradle to Cradle" approach

Comparison of product and waste LCA



(Source: *EPA, 1993*)



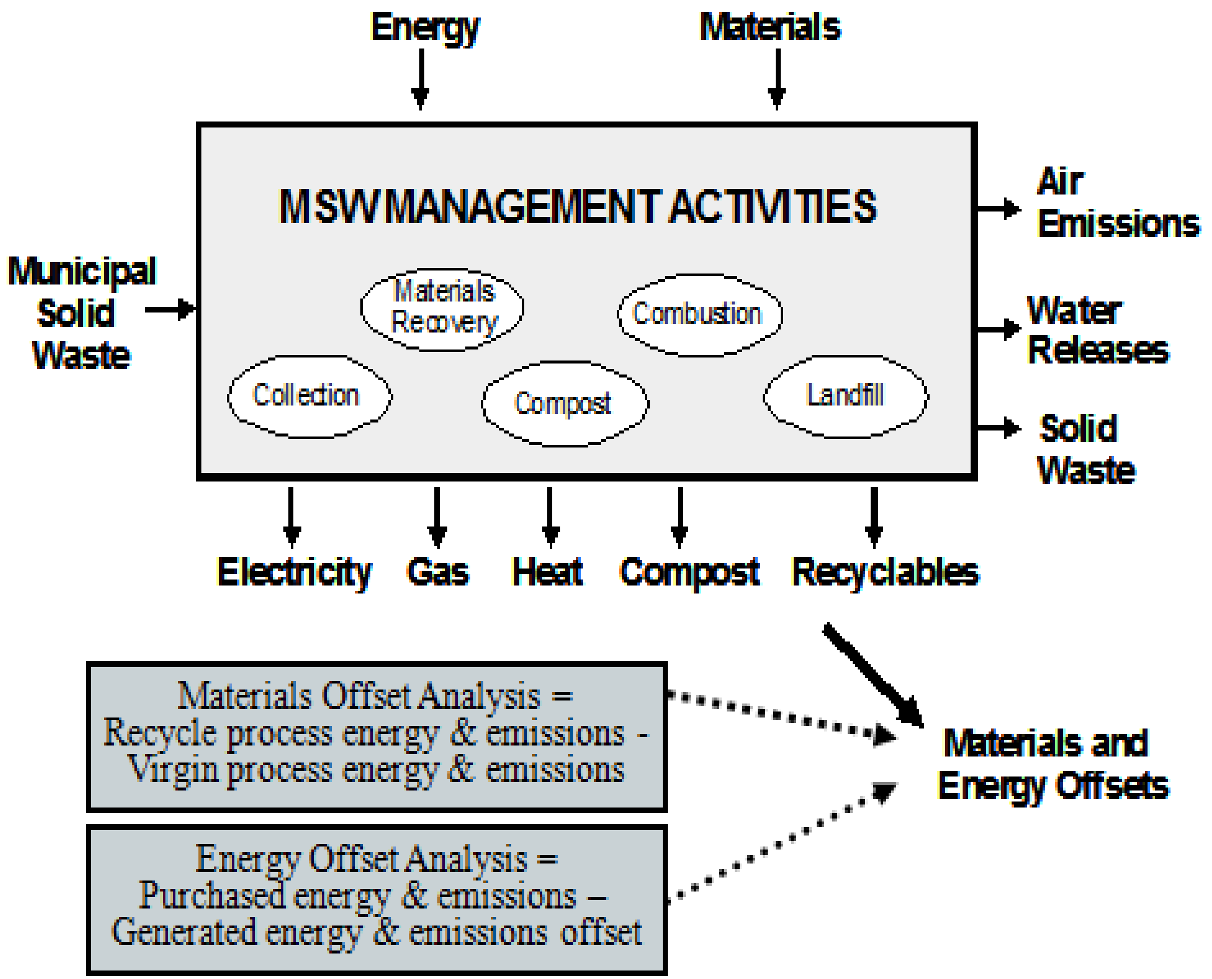
Source: Modified from White et al, 1995.

Life-cycle methodology accounts for energy and water consumption

- **Direct emissions such as collection, transport, and waste management facilities**
- **Indirect emissions from electricity consumption**
- **Indirect emissions from fuel (e.g., coal extraction and processing) and materials (e.g., landfill liner) production**

- **the total water consumption involves**
  - **Cooling water**
  - **Process water**
  - **Water involved in any other sub system like transport**

Materials and waste management



Milk

Today, 45 Million families daily receive fresh & unadulterated milk ….. thanks to Pouches

- Material consumption
  - PE Pouches : 0.8 million MT
  - Equivalent Glass : 14.7 million MT
- Power consumption
  - Manufacture usage : 27.6 Billion Units
  - equaling 4 X 1000 MW Thermal power stations

Edible Oil

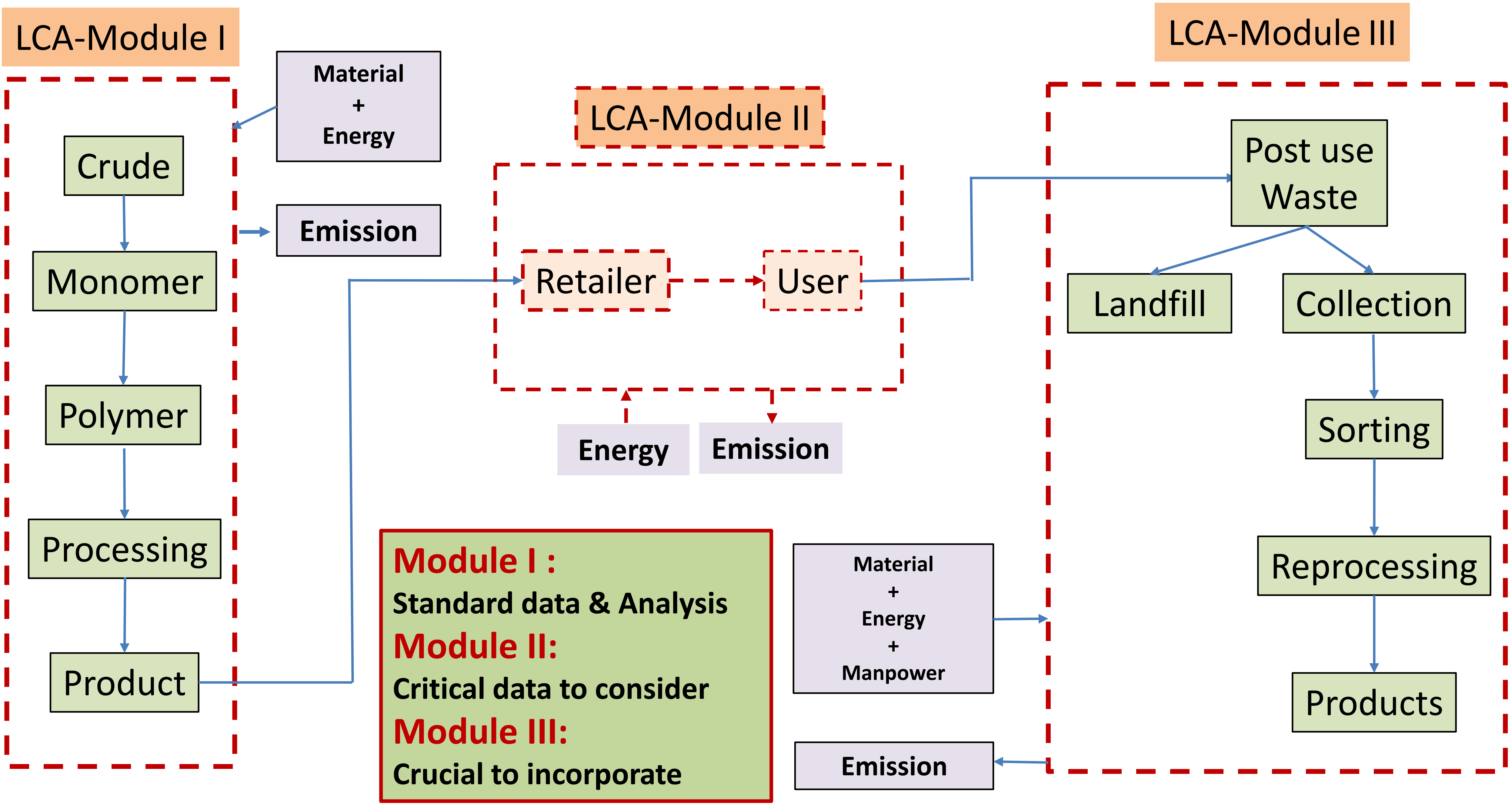
2.8 MMT reaching consumers safely in Plastic Packaging

- Material consumption
  - Plastics packaging : 167 KT
  - Equt. Tin plate container : 330 KT
- Power Consumption :

  Additional power load for

  -Tinplate V/s. Plastics : 325 MW

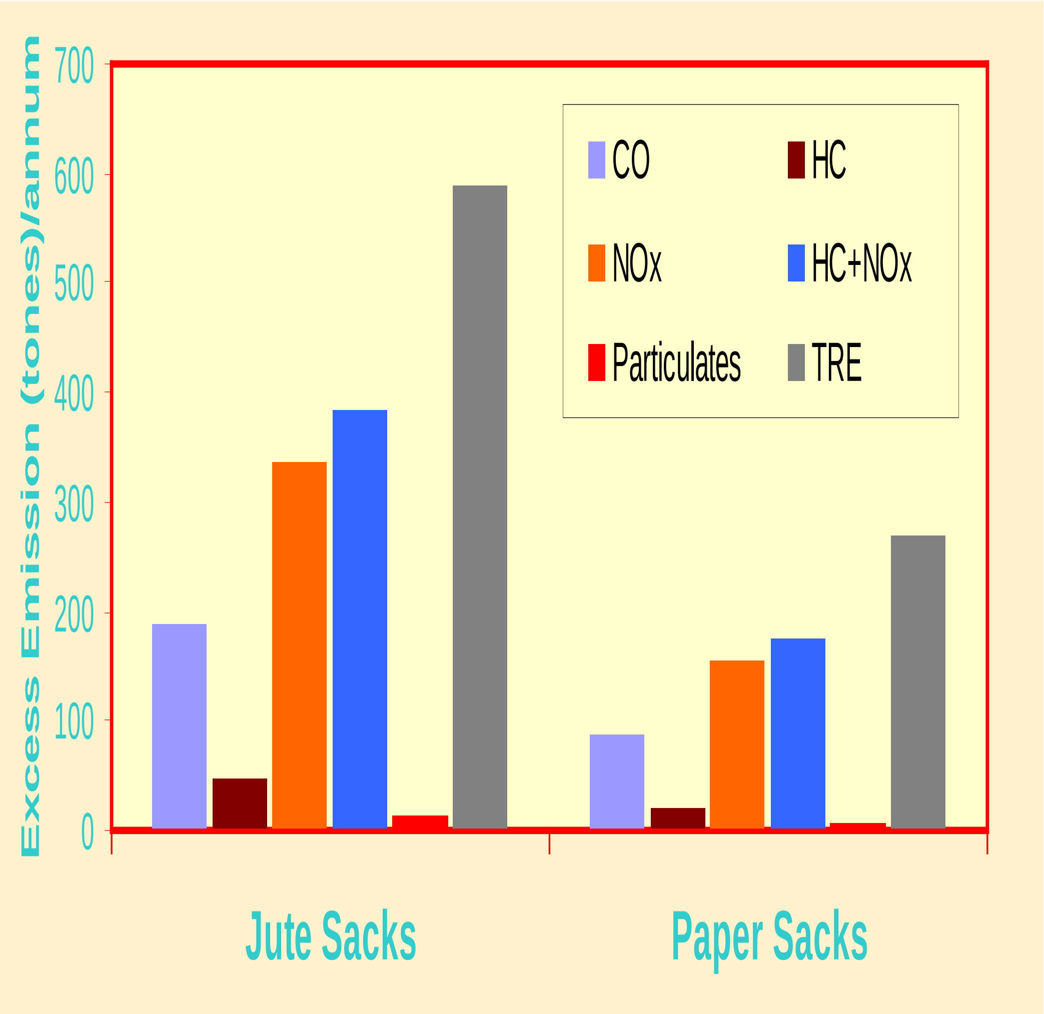
  ~ 50% of Delhi's power load



LCA-Module I
Material + Energy
Crude
Emission
Monomer
Polymer
Processing
Product
LCA-Module II
Retailer
User
Energy
Emission
LCA-Module III
Post use Waste
Landfill
Collection
Sorting
Reprocessing
Products
Material + Energy + Manpower
Emission
Module I :
Standard data & Analysis
Module II:
Critical data to consider
Module III:
Crucial to incorporate

Transportation Considerations

Excess emissions generated during transport 350MMT of commodities in Jute Bags and Paper Bags vs. PP-HDPE woven Sacks.



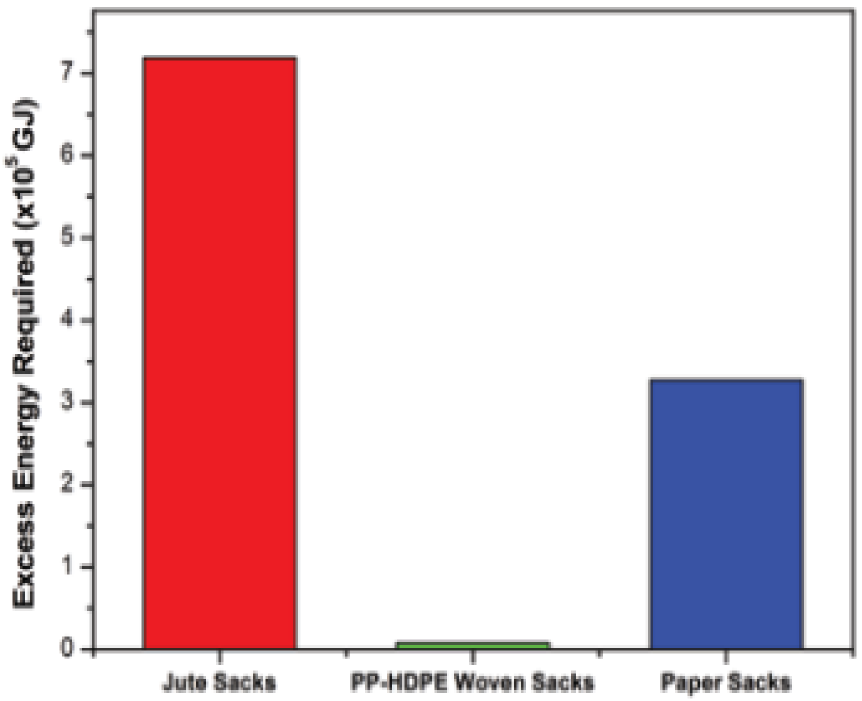
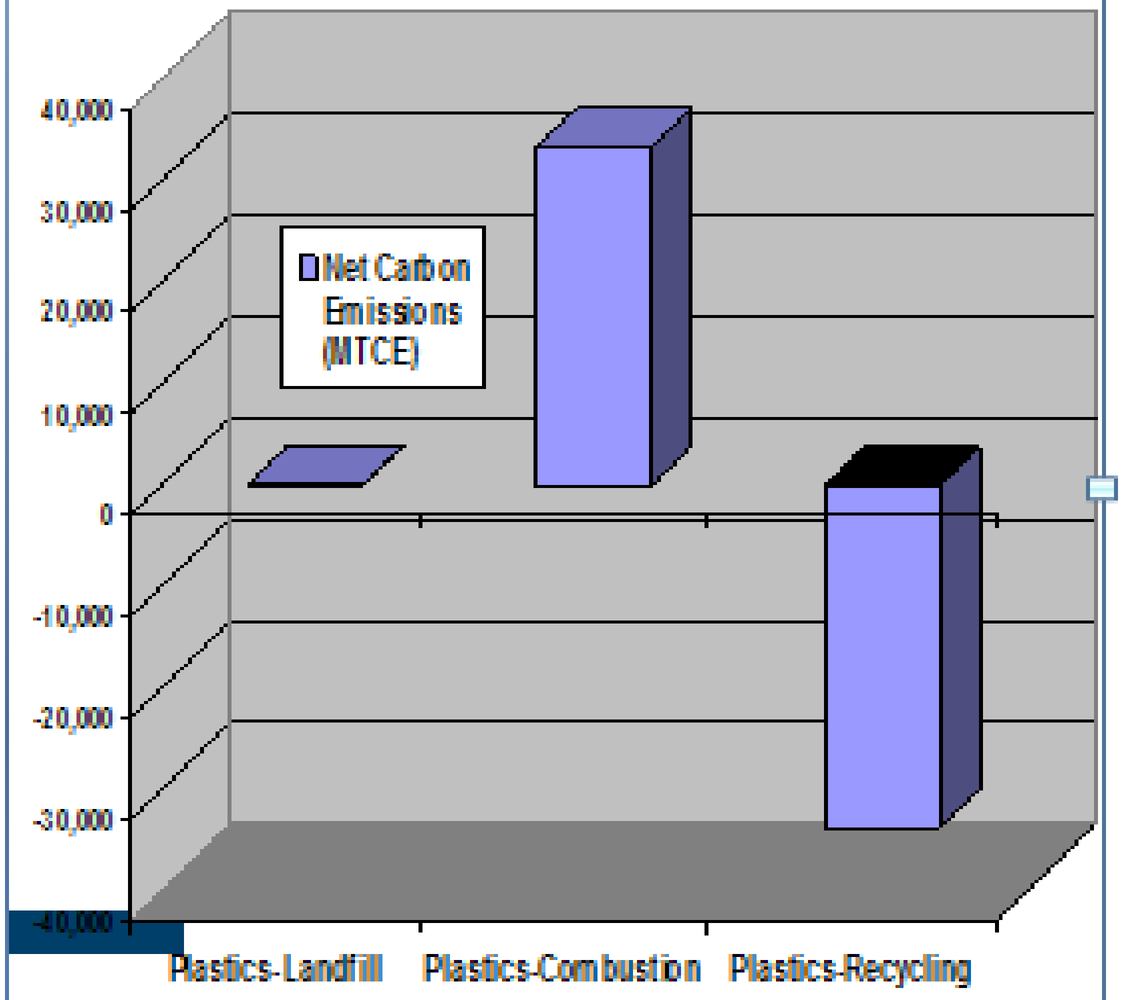
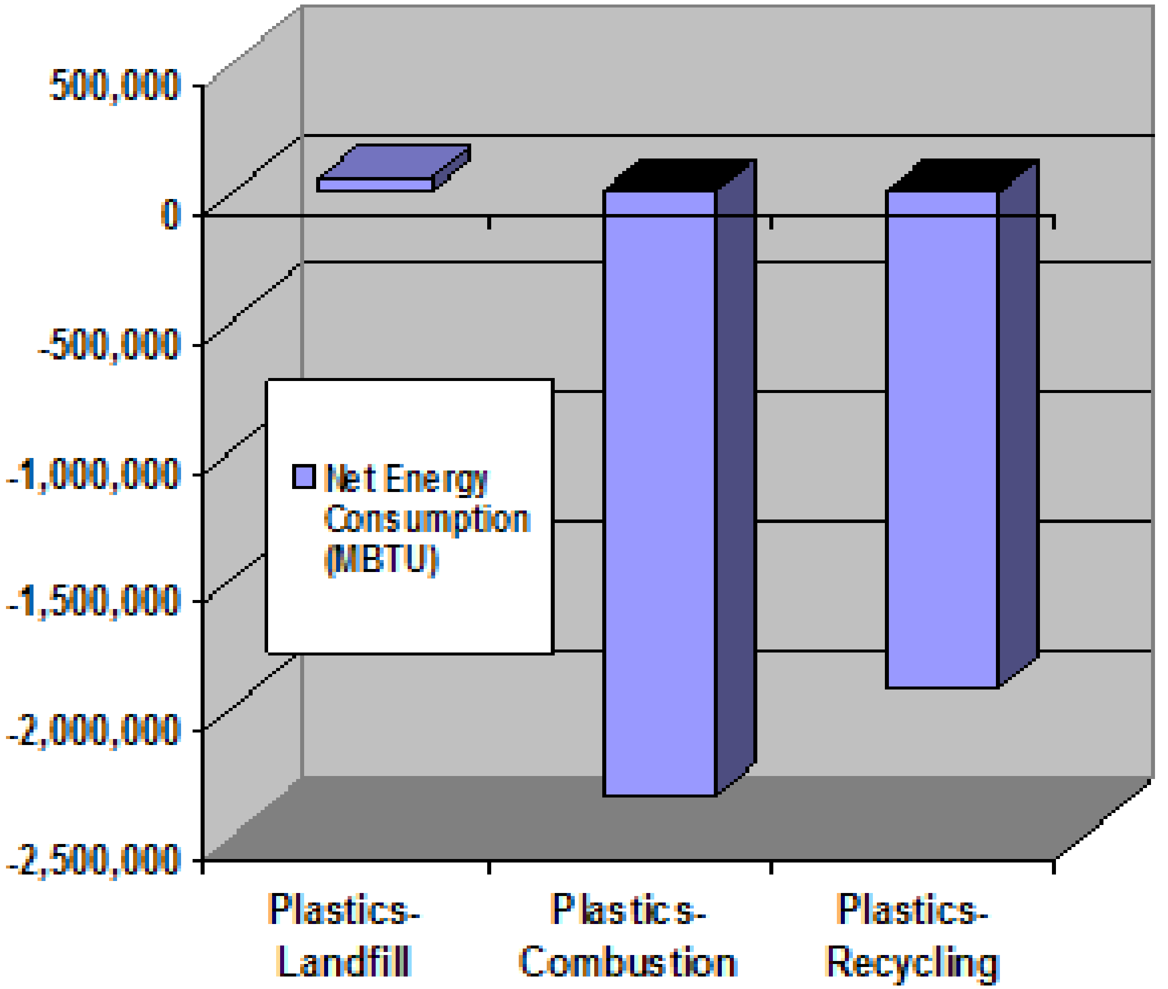


Figure 3: Excess energy required during transportation in jute and paper sacks as compared with PP-HDPE woven sacks for total (350 Mt) and 1Mt of bulk commodities.

Comparing Carbon Emissions and Energy Consumption for Plastics Management





US-EPA, 2013

"Product Life Cycle"

7. Optimization of end-of-life system

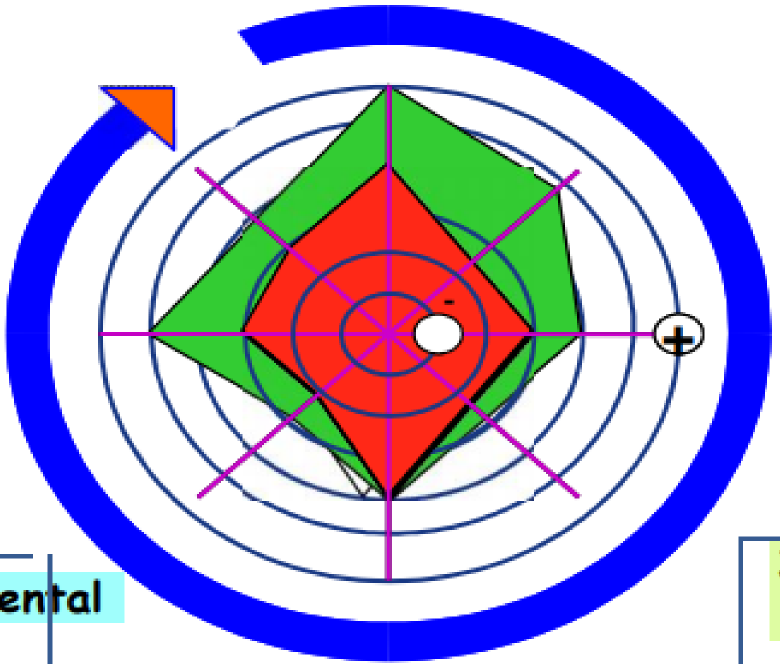
- Reuse of product
- Remanufacturing/refurbishing
- Recycling of materials
- Clean incineration

6. Optimization of initial life-time

- Reliability and durability
- Easy maintenance and repair
- Modular product structure
- Classic design
- User taking care of product

5. Reduction of the environmental impact in the user stage

- Low energy consumption
- Clean energy source
- Few consumables needed during use
- Clean consumables during use
- No energy/auxiliary material use



4. Efficient distribution system

- Less/clean packaging
- Efficient transport mode
- Efficient logistics

3. Optimization of production techniques

- Alternative production techniques
- Fewer production processes
- Low/clean energy consumption
- Low generation of waste
- Few/clean production consumables

1. Selection of low-impact materials

- Non-hazardous materials
- Non-exhaustable materials
- Low energy content materials
- Recycled materials
- Recyclable materials

2. Reduction of material

- Reduction in weight
- Reduction in (transport) volume

Priorities for the new product

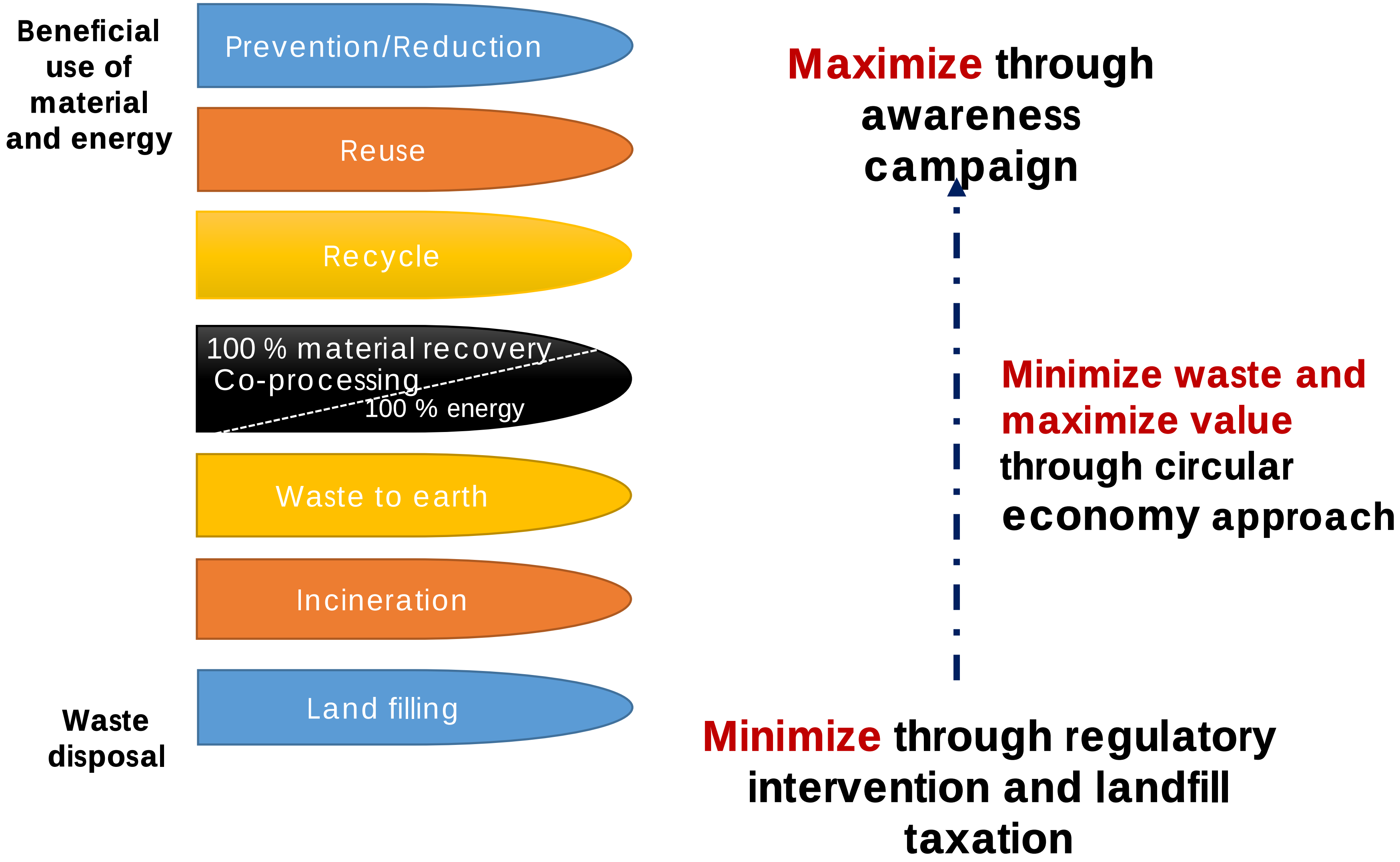
Existing product

Life Cycle Thinking ……………

There is need for clear definition/understanding of the recyclable for the plastics products based on the carbon foot prints, ease of recycling, economics and life cycle analysis for policy decision on:

- **Defining recyclability**
- **Establishing recyclable hierarchy**
- **Effect on recyclability due to presence of other similar or non-similar materials**
- **Materials reduction (in terms of thickness) vs. collection/recyclability from waste**
- **Synthetic vs. biodegradable nature of materials**
- **Single use plastics (very widely used in the present pandemic situation)**

INNOVATIVE AND COLLABORATIVE APPROACH TO ADDRESS THESE KEY CHALLENGES SYSTEMATICALLY



Thank you
for your kind attention!!