LCA – CUP CASE

Comparing Different types of Cups (Jolliet, Ch 2.4)

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Objectives of this LCA is to compare the environmental impact of:

1. **Paper Cup**
2. **Polyethylene cup (PET)**
3. **Polypropylene (PC)**
4. **Polypropylene (PC), accounting for wash, transport, and 5% loss @ every event**

Goal & Functional Unit

State the goal – why are you conducting the analysis?

The goal is to compare the environmental impacts of different types of cups used in stadiums during sporting or cultural events.

State the functional unit:

The functional unit used as a basis for comparison must be common to all scenarios and represent the considered function, in the case of this example the functional unit would be one use of a 300mL cup.

System Boundary – Paper Cup, single use

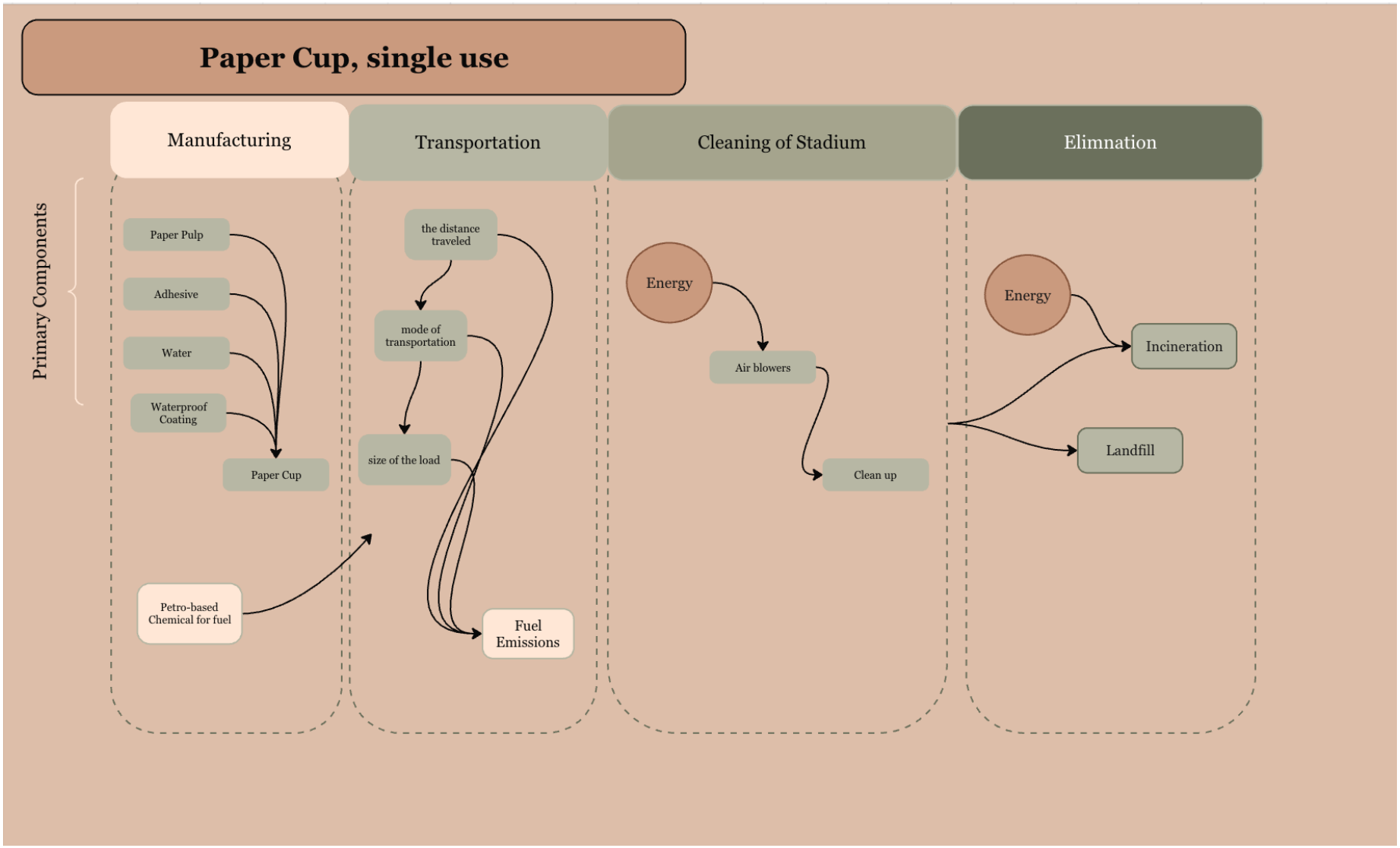
State the processes that are included within the system boundary.

Within the system boundary, the processes for single use cup is manufacturing, transportation, cleaning of stadium, and elimination.

State the processes that are excluded.

Raw materials collection

Life-cycle Diagram



System Boundary – Polyethene (PET) cup, Single use

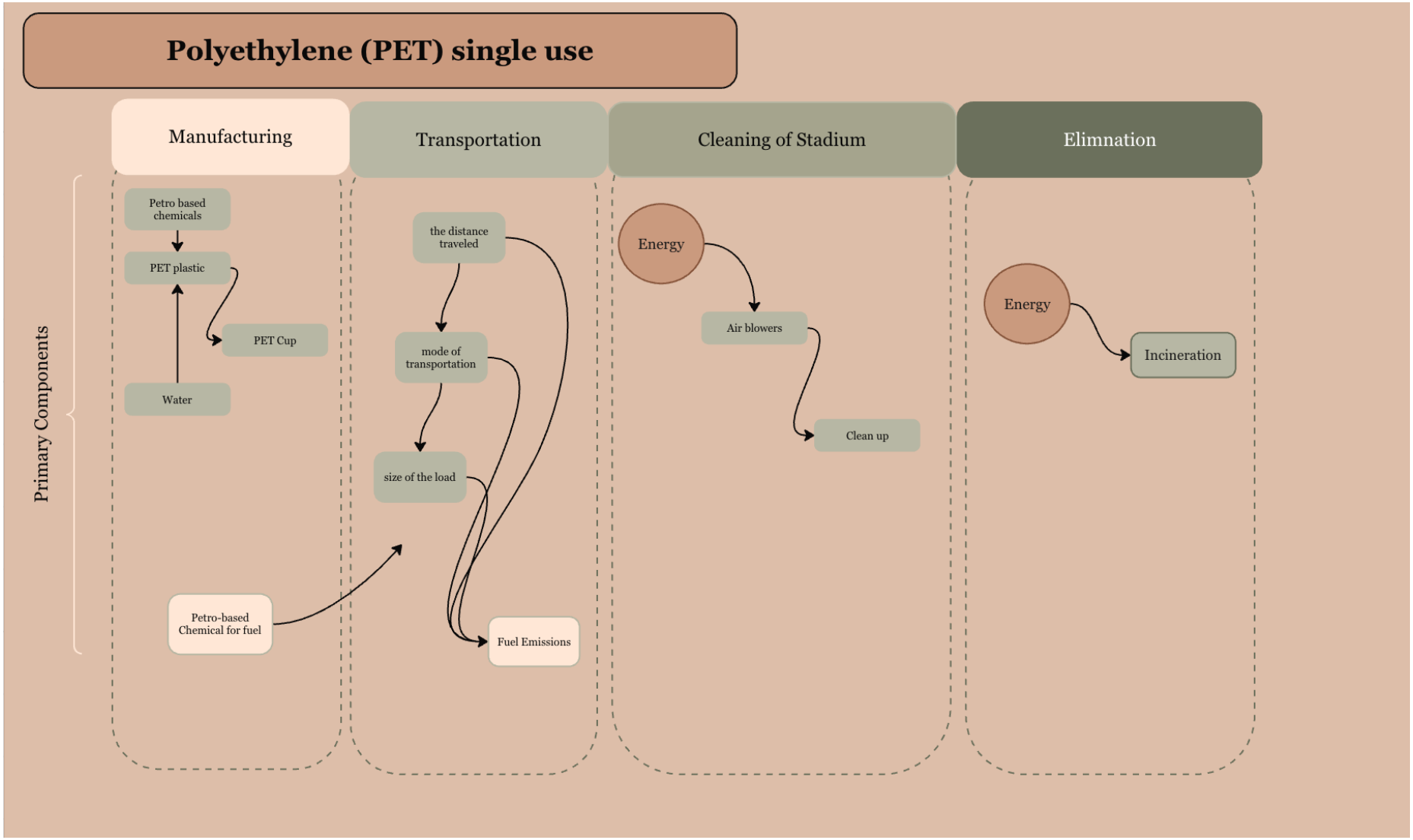
State the processes that are included within the system boundary.

The processes for single use PET cup is manufacturing, transportation, cleaning of stadium, and elimination.

State the processes that are excluded.

Raw material collection is excluded

Life-cycle Diagram



System Boundary – Polypropylene (PC), 150 uses

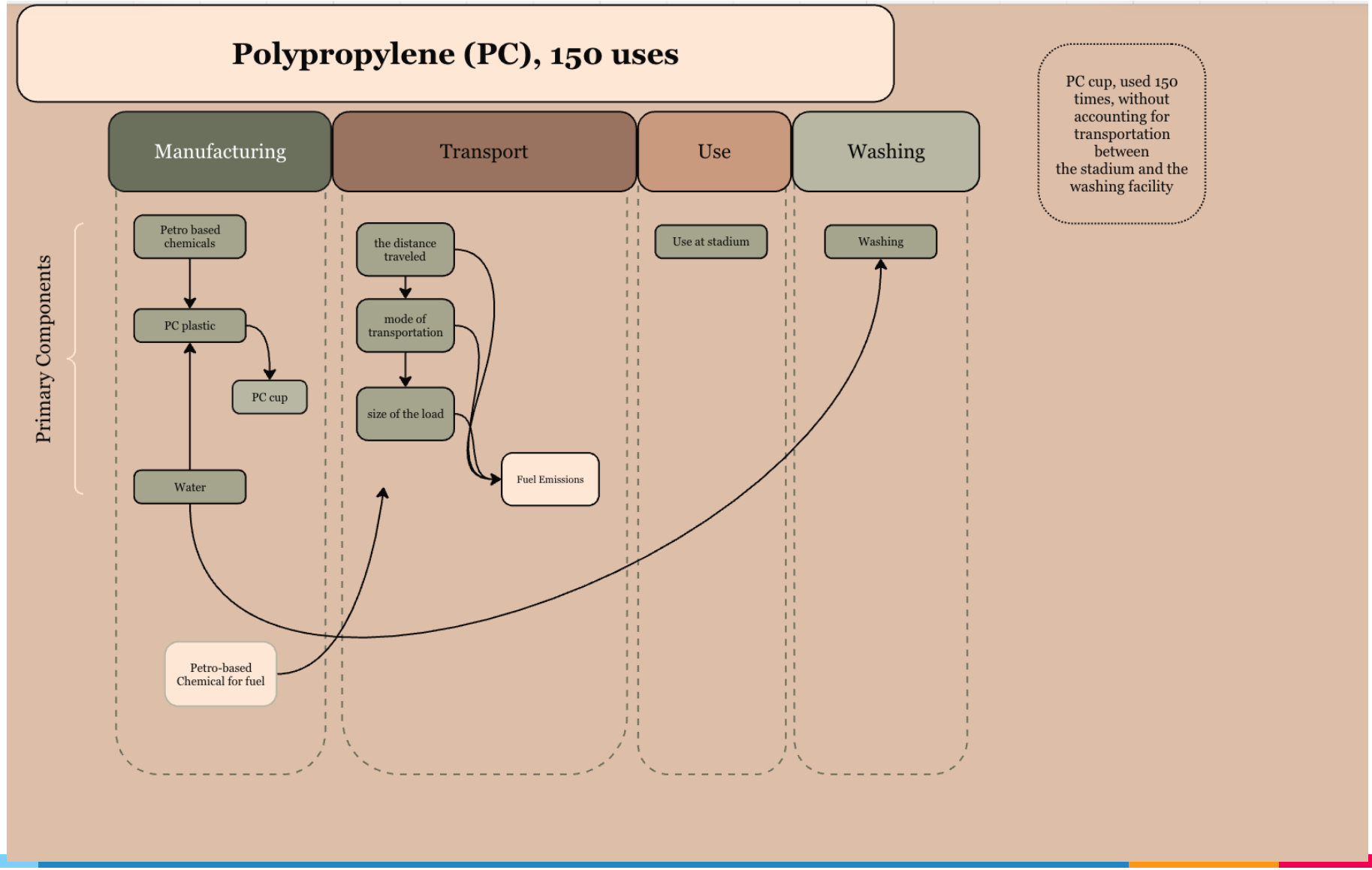
State the processes that are included within the system boundary.

For a multiuse cup the processes are manufacturing, transportation to/from washing, and elimination.

State the processes that are excluded.

Raw materials collection

Life-cycle Diagram



System Boundary – Polypropylene (PC), accounting for wash, transport, and 5% loss @ every event

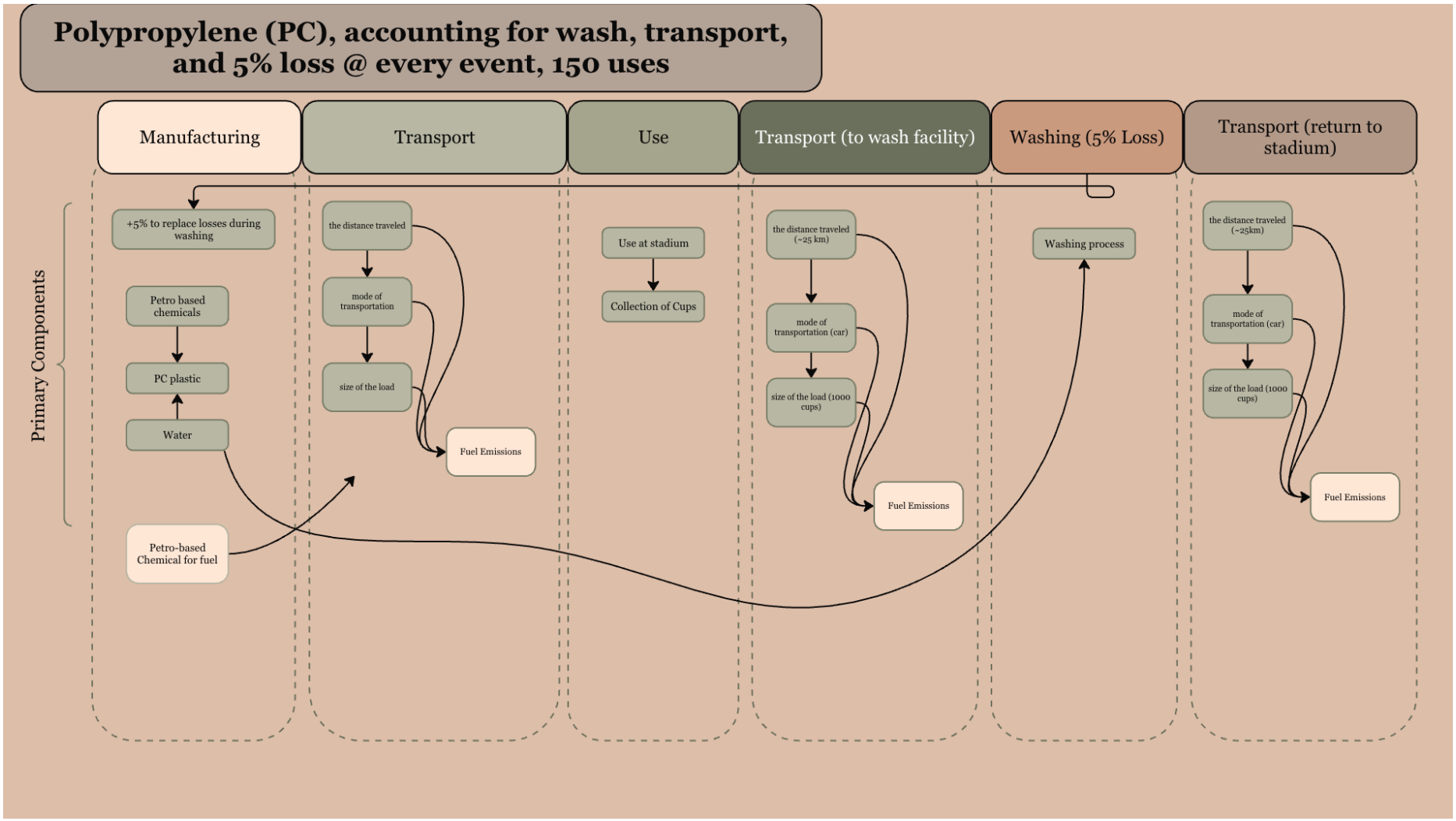
State the processes that are included within the system boundary.

For a multiuse cup the processes are manufacturing, transportation to/from washing, and elimination.

State the processes that are excluded.

Raw materials collection and elimination for the 150 uses

Life-cycle Diagram



Impact Assessment Indicators

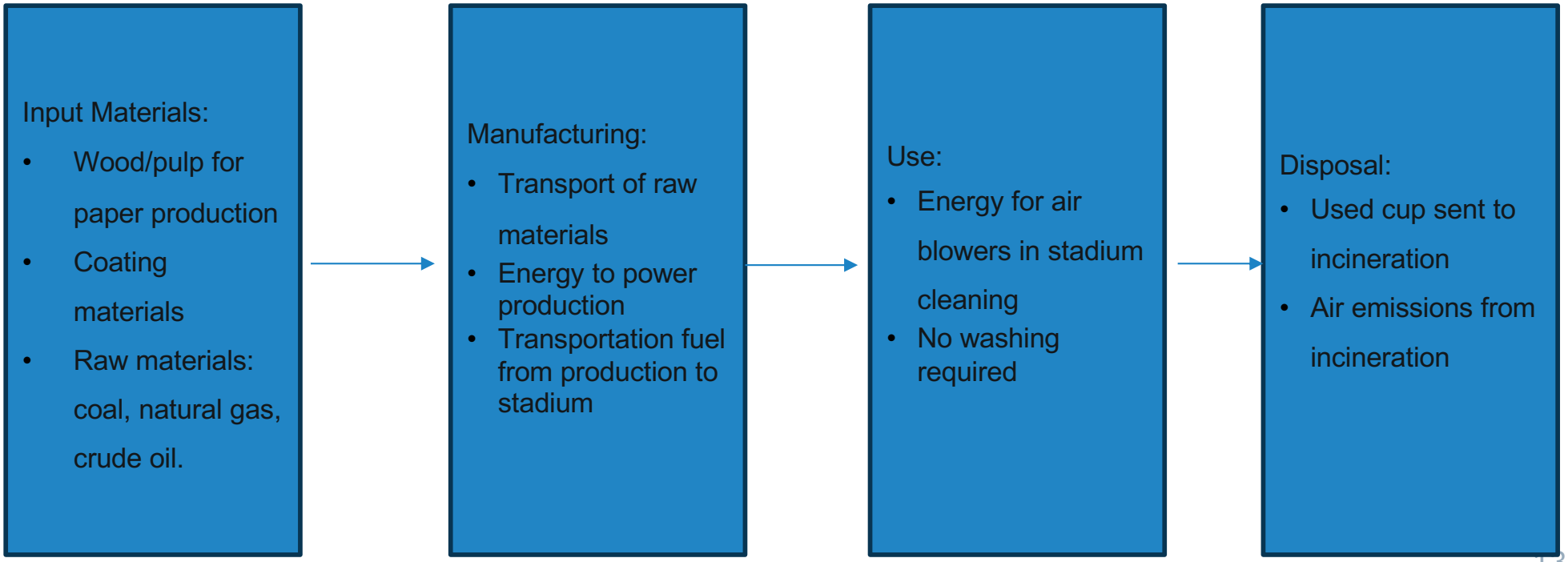
State the indicators that will be used for assessment.

The Eco-Indicator 99 was used to estimate the impacts of the inventory's emissions on various areas such as human health, ecosystem quality, and natural resources.

Life Cycle Inventory

State the material flows that are part of the system – for each stage or alternative of the life cycle (Use additional slides if required)

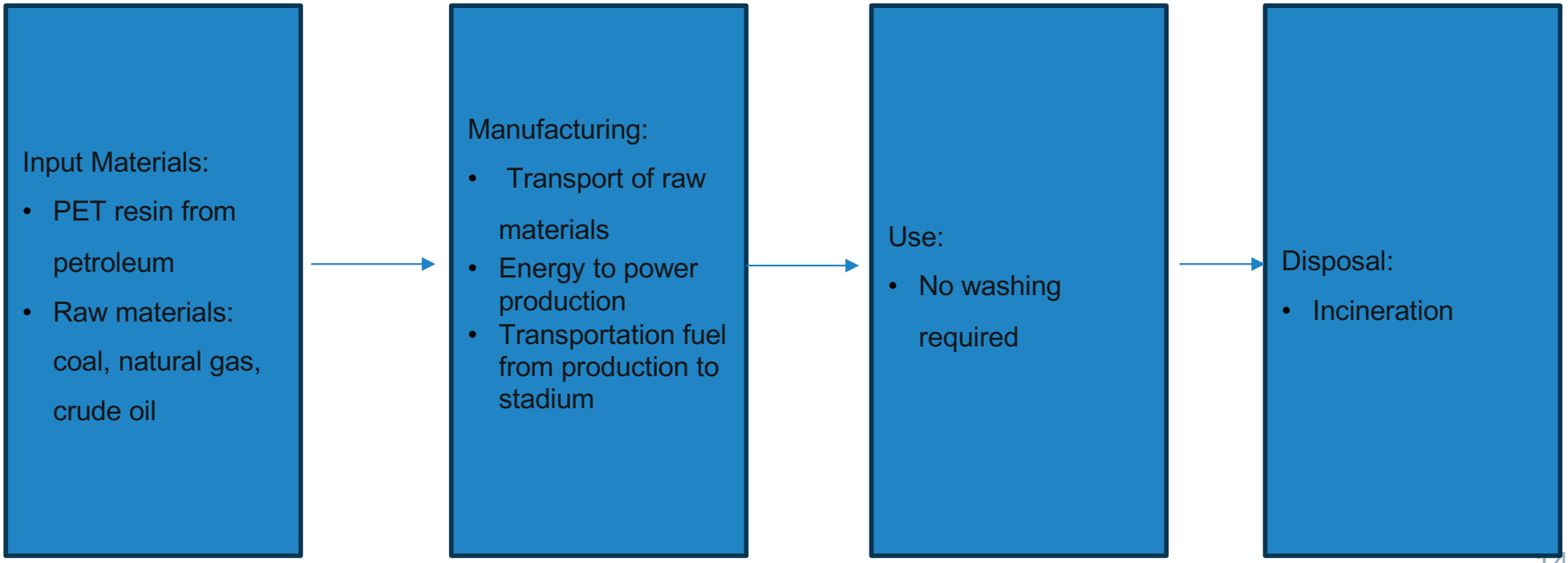
Paper single use cup



Life Cycle Inventory

State the material flows that are part of the system – for each stage or alternative of the life cycle (Use additional slides if required)

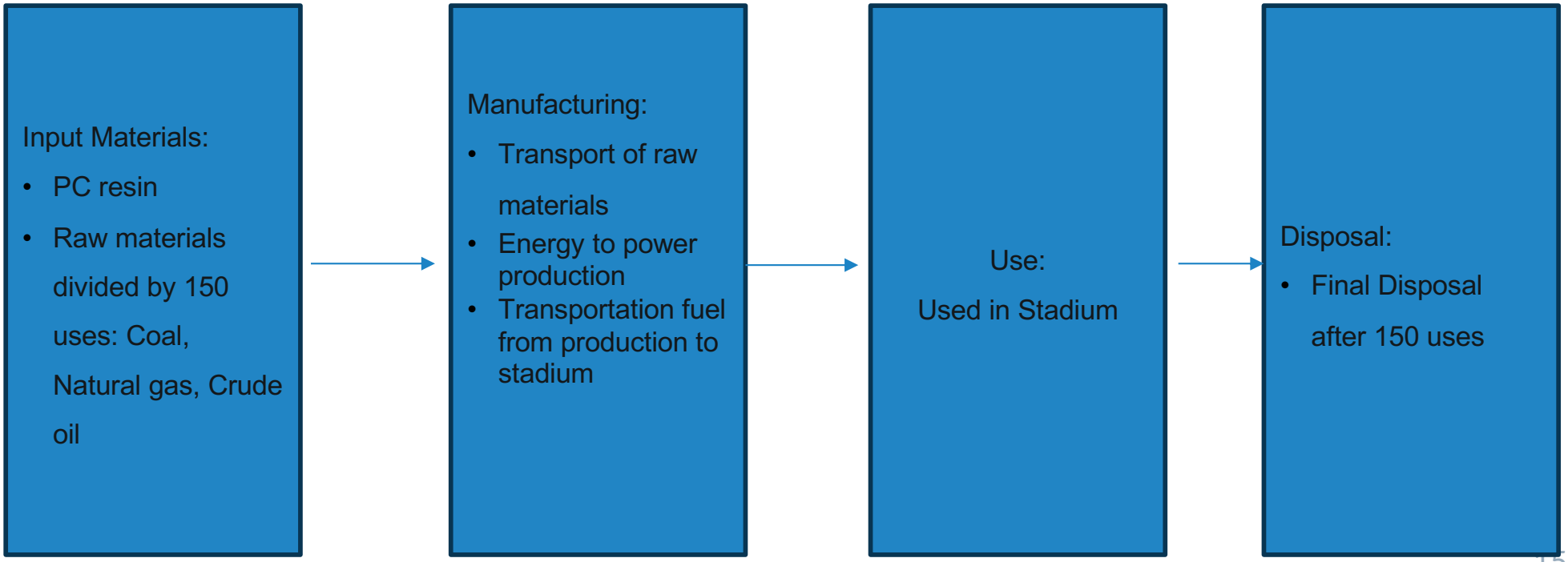
PET single use cup:



Life Cycle Inventory

State the material flows that are part of the system – for each stage or alternative of the life cycle (Use additional slides if required)

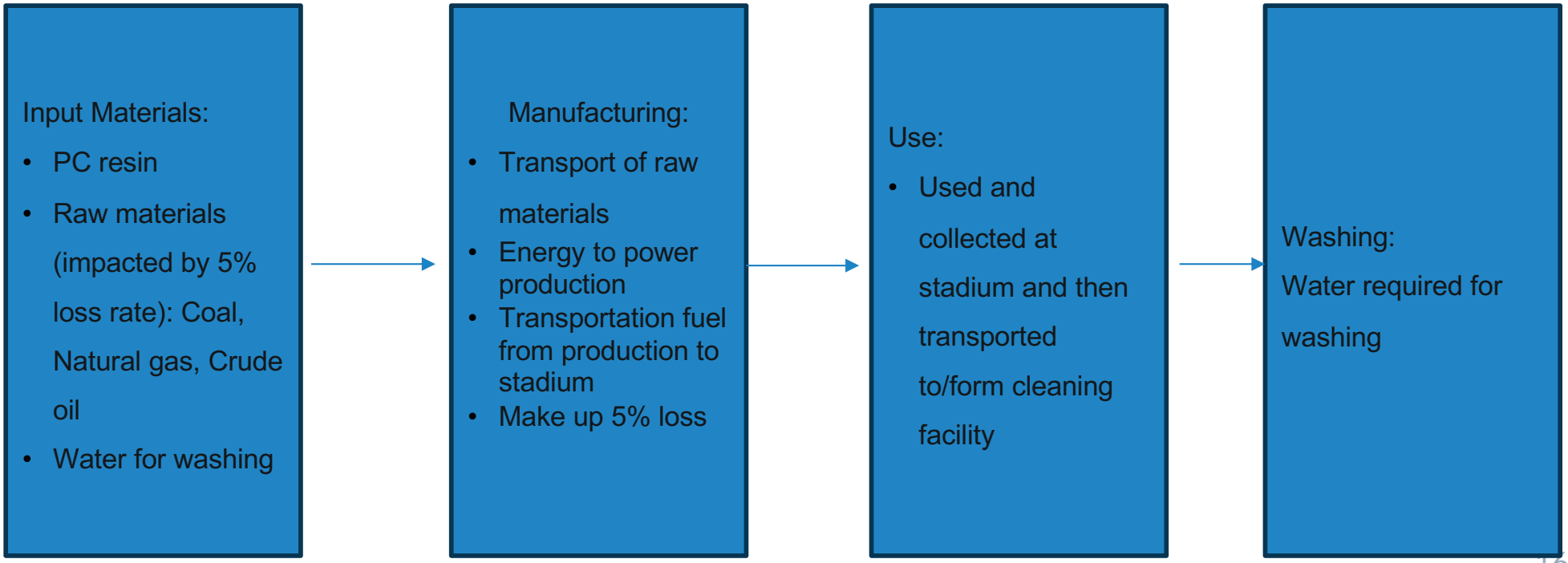
PC cup, 150 uses:



Life Cycle Inventory

State the material flows that are part of the system – for each stage or alternative of the life cycle (Use additional slides if required)

PC cup, 150 uses, accounting for wash, transport, and 5% loss @ every event:



Impact Assessment

State the Impact Assessment Method Used.

The impact assessment method used in the cup case study was the Eco-indicator 99 method. The method aggregates the impacts into these damage categories and allows for a weighted sum to calculate a total impact score

Results:

Human Health, Ecosystem Quality, and Resources all showed the same relative ranking:

- Highest impact: Single-use PET cup
- Medium impact: PC cup with losses/transport and Paper cup
- Lowest impact: PC cup without losses

Impact Scores (table 2.5):

PET cup: ~4.5E-03 points PC cup with transport/losses: ~2.2E-03 points Paper cup: ~1.5E-03 points PC cup without losses: ~2.5E-04 points

Results from Eco-Indicator99

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Human Health, Ecosystem Quality, and Resources all showed the same relative ranking:

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Impact Scores (Table 2.5):

- PET cup: ~4.5E-03 points
- PC cup with transport/losses: ~2.2E-03 points
- Paper cup: ~1.5E-03 points
- PC cup without losses: ~2.5E-04 points

Discuss the aggregated results in terms of life-stages.

Manufacturing Stage

•Highest contributor across all scenarios

•PET cup: ~3.8E-03 points

•Paper cup: ~1.0E-03 points

•PC cup with losses: ~1.2E-03 points

•PC cup without losses: ~2.0E-04 points

Transportation to Stadium

•Minor impact across scenarios

•Slightly higher for PET cups

•Minimal for all other options

Stadium Cleaning

•Only applicable to single-use cups

•Very small contribution

•Negligible compared to manufacturing impacts

Transport to Washing

•Only applies to PC cup with losses

•Significant impact (~1.0E-03 points)

•Nearly doubles total environmental impact

Cup Washing

•Only for PC cup with losses

•Small contribution

•Note: Washing agent impacts not included

Disposal

•Smallest contributor across all scenarios

•Minimal impact on total environmental score

Interpretation of Results

State which category of environmental externalities impact the most for each scenario.

Ecosystem quality tends to be the most significant impact category across scenarios, particularly for paper and PC cups with losses. However, PET cups show consistently high impacts across all categories.

State which processes are the 'eco-hotspots' for each alternative.

Paper Cup (manufacturing), PET Cup (Manufacturing and crude oil consumption), PC Cup without losses, (manufacturing), PC Cup (with losses & transport) Two major hotspots: Manufacturing and Transport to washing facility.

State which alternative seem to be ‘greener’ with some recommendations on which process needs to managed. (Use additional slides if required)

PC Cup (Without Losses)

Total Impact: 0.2E-03 points

Key Benefits:

- Lowest environmental impact across all categories
- Effective distribution of manufacturing impacts
- No washing transport needed

Recommendations:

- Implement robust tracking system to maintain reuse rate
- Ensure proper collection system
- Monitor cup quality for durability

Paper Cup

Total Impact: 1.5E-03 points

Key Benefits:

- Lower crude oil consumption
- Moderate CO2 emissions
- No washing needed

Recommendations:

- Source from sustainable forestry
- Optimize manufacturing efficiency
- Consider biodegradable alternatives