Activity/Case-study 1

Identify an existing fossil fuel plastic that can be replaced by an eco-designed plastic, e.g. PET with PLA, based on food and functional properties

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Scenario 1

- Polyethylene terephthalate (PET) is a widely used plastic in the food packaging industry due to its excellent barrier properties, durability, and clarity. However, its reliance on fossil fuels and the challenges of recycling have raised environmental concerns. Polylactic acid (PLA), a bioplastic derived from renewable resources like cornstarch, offers a sustainable alternative but comes with challenges related to functional properties and cost.
- Your company, **EcoPack Solutions**, has tasked you to evaluate as alternative to PET packaging for a client, a mid-sized company looking to adopt eco-friendly practices. The company currently uses PET **bottles/films/trays** for their products, which include **carbonated soft drinks, sugar and pasta**.

Task Overview

Working in different teams:

1. **Analyze the suitability of PET and PLA for food packaging,** considering functional properties (e.g., barrier to oxygen and moisture, durability, clarity), food safety, and compatibility with beverages.
2. **Evaluate the environmental impact** of both materials across their lifecycle (e.g., carbon footprint, biodegradability, recyclability).
3. **Propose an eco-designed solution** tailored to the client's needs, identifying challenges and trade-offs.
4. **Develop a transition plan** for the client, considering economic feasibility, regulatory compliance, and consumer acceptance.

Resources to be provided to the students

- Technical datasheets for PET and PLA.
- Summary of LCA data for PET and PLA.
- Case examples of companies that transitioned to bioplastics.
- Access to online tools for calculating material carbon footprints.

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For the tutor

Discussion Points Post-Case Study

- What are the limitations of PLA as a replacement for PET in food packaging?
- How can advancements in bioplastic technology improve the adoption of eco-design practices?
- What role do consumer perceptions play in the success of sustainable packaging transitions?
- This case study is designed to equip industry professionals with the skills to evaluate and implement eco-design solutions in the food packaging sector, fostering innovation and sustainability.

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Task Overview

Working in different teams:

1. **Analyze the suitability of as food packaging replacing PET,** considering functional properties (e.g., barrier to oxygen and moisture, durability, clarity), food safety, and compatibility with the food commodities under consideration (= **carbonated soft drinks, sugar and pasta**).
2. **Evaluate the environmental impact** of both materials across their lifecycle (e.g., carbon footprint, biodegradability, recyclability).
3. **Propose an eco-designed solution** tailored to the client's needs, identifying challenges and trade-offs.

NOTE: please consider the fact that the company did not require the use of monomaterials!!! Therefore, the proposed solution can be based on multilayer FCM.

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Resources you need to work on this challenge

- Technical datasheets for PET and PLA.
- Summary of LCA data for PET and PLA.
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Activity/Case-study 2

Propose/describe an innovative solution from holistic perspective (applications, environmental impact, raw materials, cost etc.)

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Scenario 2

"Developing Eco-Friendly Edible Coatings to Extend Food Shelf Life: A Holistic Perspective"

- Fictional Scenario: *“You are a team of innovators tasked by a multinational food company (EcoPack solutions) to develop a sustainable and eco-designed coating to reduce food waste in freshly produced vegetables without increasing plastic usage.”*

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Information provided to the students

Working in different teams:

1. **Problem:** Fresh fruits and vegetables often spoil before reaching consumers, contributing to 30% of food waste globally. Existing plastic-based packaging solutions exacerbate environmental pollution.
2. **Proposed eco-designed solution** e.g. development of a biodegradable, edible coating made from food-grade polysaccharides (e.g., pectin) and essential oils.
3. **Identify key functionalities:** barrier properties to moisture and oxygen. Enhances shelf life while maintaining food safety. Can be safely consumed by end-users or washed off.
4. **Assessment from holistic perspective** (see next slide)

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Holistic perspective

A. Applications:

1. Coating fruits, vegetables, and bakery products.
2. Market suitability for high-waste categories like avocados, bananas, and berries.

B. Environmental perspective:

1. Eliminates single-use plastics.
2. Made from renewable, biodegradable resources.

C. Raw Materials:

1. Derived from food industry by-products (e.g., citrus peels for pectin).
2. Derived from non food industry by-products (from fresh fruits).

D. Regulatory requirements

1. Compliance
2. PPWR (Upcoming Regulation on wastes)

E. Cost Considerations:

1. Compared production cost vs. traditional plastic coatings (indicative).
2. Assess scalable manufacturing potential for small and large producers.

F. Consumer perspective

1. Acceptance to pay additional cost.
2. Safety of raw materials (waste, new materials)
3. Scalability (raw materials, sustainability).

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Interactive discussion/Stakeholder perspectives

- Groups represent stakeholders (1) Food manufacturers, (2) Environmentalists, (3) Regulators, and (4) Consumers.

- Evaluate the proposed solution from your stakeholder's perspective (1-4; see above). What are the benefits and potential challenges?”

- **Guiding Questions:**
  1. Is the innovation practical and scalable?
  2. What regulatory or logistical barriers might arise?
  3. How does this align with consumer trends and expectations?

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For the tutor

Discussion Points Post-Case Study

- Encourage critical thinking and inter-group dialogue to explore conflicting priorities (e.g., cost vs. sustainability)

Recap:

- Restate the importance of taking a holistic perspective when proposing innovations.
- Summarize the key points discussed (applications, environmental impact, raw materials, cost).

Take-Home Message:

- "Sustainable solutions in the food industry require balancing technical feasibility, economic viability, and environmental responsibility."

Closing Engagement:

- Ask participants: *“What other sustainable innovations could address similar challenges in the food industry?”*

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Information provided to the students

Working in different teams:

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3. **Identify key functionalities:** barrier properties to moisture and oxygen. Enhances shelf life while maintaining food safety. Can be safely consumed by end-users or washed off.
4. **Assessment from holistic perspective** (see next slide)

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Holistic perspective

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E. Cost Considerations:

1. Compared production cost vs. traditional plastic coatings (indicative).
2. Assess scalable manufacturing potential for small and large producers.

F. Consumer perspective

1. Acceptance to pay additional cost.
2. Safety of raw materials (waste, new materials)
3. Scalability (raw materials, sustainability).

Interactive discussion/Stakeholder perspectives

- **Each group represents the innovators team.**

- **Evaluate the proposed solution from 4 different perspectives**:
  1. Manufacturing.
  2. Environmental.
  3. Regulatory.
  4. Consumers perspective.

- **Consider the following guiding questions (in relation to previous point):**
  1. Is the innovation practical and scalable?
  2. What regulatory or logistical barriers might arise?
  3. How does this align with consumer trends and expectations?

- **Highlight and list the potential benefits and potential challenges.**

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Case examples – Companies transition to bioplastics

1. Case 1: Biocup (eCup, El Surtidor; Mexico) – Expansion into the U.S. Market

A. Company Overview:

Biocup, originally known as El Surtidor, is a Mexican company specializing in biodegradable, recyclable, and compostable disposable containers. The company rebranded to eCup for its U.S. operations. Biocup expanded into the U.S. market, launching in Laredo, Texas. The company aimed to offer sustainable packaging solutions in a market with higher disposable container consumption.

B. Challenges Faced:

- **Higher Production Costs:** Bioplastics often have higher production and material costs compared to traditional plastics, affecting pricing and competitiveness.
- **Limited Composting Facilities:** The scarcity of industrial composting infrastructure can hinder the effective processing of compostable materials.
- **Regulatory and Certification Hurdles:** Navigating different regulations and obtaining necessary certifications for bioplastic products can be complex and time-consuming.
- **Consumer Behavior:** Ensuring that consumers properly dispose of bioplastic products is crucial for realizing their environmental benefits, and recycling based on applied closed-loop approaches..

2. Case 2 - TotalEnergies Corbion (The Netherlands)

A. Company Overview:

A joint venture between TotalEnergies and Corbion, this company produces Luminy® PLA, a range of polylactic acid polymers used in various applications, including food packaging. Their bioplastics are designed to be compostable and have a lower carbon footprint compared to traditional plastics and eventually to be used as FCM.

B. Challenges in Transitioning to Bioplastics

While the move towards bioplastics offers environmental benefits, industries face several challenges:

- **Cost Implications**: Bioplastics often have higher production costs compared to conventional plastics, affecting pricing and competitiveness.
- **Performance Limitations**: Some bioplastics, and especially PLA, may not match the barrier properties or durability of traditional fossil fuel plastics, potentially impacting shelf life and product protection.
- **Infrastructure Gaps**: The lack of widespread composting and recycling facilities for bioplastics can hinder their end-of-life processing, leading to environmental concerns.
- **Regulatory Hurdles**: Navigating varying regulations and obtaining certifications for bioplastic use in food contact materials (FCM) can be complex and time-consuming., also considerting proper risk assessment (no rules at the moment) by the European Food Safety Authority (EFSA).
- **Consumer Perception**: Educating consumers on the proper disposal and benefits of bioplastics is essential to ensure their effective use and environmental impact and recycling based on applied closed-loop approaches.

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♻ Life-Cycle Assessment (LCA) Summary: PET vs PLA

Aspect	PET (Polyethylene Terephthalate)	PLA (Polylactic Acid)
Raw Material Origin	Petroleum-based (non-renewable resource)	Bio-based (typically corn, sugarcane – renewable resources)
Greenhouse Gas Emissions	Higher CO_2 emissions during production	Lower CO_2 emissions (approximately 30–70% less)
CO_2 emissions	2.2 kg CO_2 /kg PET	1.0-1.8 kg CO_2/kg PLA
Energy Consumption	High energy demand (extraction and refining of oil)	Lower energy demand during resin production
End-of-Life Options	Widely recyclable (mechanical recycling)	Compostable (industrial composting required); limited recycling (mainly to monomers and reuse as starting monomer materials).
Biodegradability	Non-biodegradable (persists in the environment)	Biodegradable under industrial conditions (high heat, humidity)
Water Consumption	Lower than PLA in production	Higher water usage (especially in crop cultivation phase)
Land Use	Minimal land impact (oil drilling)	Requires significant agricultural land for crops
Toxicity/Environmental Impact	Potential microplastics and chemical leaching in degradation	Potential for eutrophication from agricultural runoff
Waste Management Infrastructure	Mature (global PET recycling systems exist)	Emerging (composting infrastructure still limited)
Overall Environmental Impact	Higher across most impact categories	Lower in climate change impacts but higher in water/land usage

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