Single-Use Plastics and Waste Management

Class 3
07/23/2023

Plan for Today's Class

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1. Finish Carbon Footprint Calculation

2. Single-Use Plastics

Part 1: Carbon Footprint of Supply Chains

Shipping Bananas

What do you think uses more fossil fuels?

1. Shipping 1 kg of bananas from Ecuador to Boston on a cargo ship and then trucking them to a Cambridge supermarket

2. Delivering 1 kg of bananas from a (magical) greenhouse in Pittsfield in Western Massachusetts to Boston farmers market

How far is it?

Use Google Maps to find the distance in MA and https://sea-distances.org/advanced to map the route between Boston and Guayaquil, Ecuador

How far is it?

Use Google Maps to find the distance in MA and https://sea-distances.org/advanced to map the route between Boston and Guayaquil, Ecuador

Boston-Guayaquil: 4850 km | 3000 miles

Boston-Pittsfield, MA: 220 km | 140 miles

Magic of Cargo Containers

(almost) standardized across the world!

TEU - twenty-foot equivalent unit

Shipping Bananas

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1 box = 18 kg

w:l:h = 16”:20”:10”

1 pallet: 48”:40”

1 container: 8’:20’:8’

How many pallets in one container?

How many kg of bananas per pallet?

How many tons of bananas per container?

Shipping Bananas

How many pallets in one container?
240”/48” x 2 = 5 /col x 2 /row

= **10 pallets**

How many boxes of bananas per pallet?
2 /row x 3 /col x 8 /height

= **48 boxes**

How many kg of bananas per pallet? 18 kg * 48 boxes = **864 kg**

How many tons of bananas per container? 0.864 tonnes x 10 pallets = **8.64 tonnes ~ 70,000 bananas**

We need Reefers - ships that carry refrigerated containers

Capacity of average reefer is about 450 TEU containers

102 g of CO2 emissions per 1 TEU-km

How many grams of CO2 would be emitted for one reefer trip from Guayaquil to Boston?

How much is it per 1 kg of bananas?

We need Reefers - ships that carry refrigerated containers

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450 TEU x 102 g CO2/1 TEU-km x 4850 km = 222,615 kg CO2 per trip

How much is it per 1 kg of bananas?

222,615 kg CO2 / (8,640*450) kg bananas = **0.057 kg CO2 per 1 kg bananas**

What if we sourced local bananas?

Estimate the carbon per kg of bananas emitted for trucking bananas from Western Mass?

Assume a large truck that is equivalent in size to a TEU and that it emits 162 g CO2 per 1 ton-mile

https://storage.googleapis.com/scsc/Green%20Freight/EDF-Green-Freight-Handbook.pdf

Truck	All	grams per mile	Distance	1,700.0	CO2	C
	Dray	grams per mile	Distance	1,750.0	CO2	C
	Expedited	grams per mile	Distance	1,200.0	CO2	C
	Flatbed	grams per mile	Distance	1,800.0	CO2	C
	Heavy Bulk	grams per mile	Distance	2,000.0	CO2	C
	LTL Dry Vans	grams per mile	Distance	1,625.0	CO2	C
	Mixed	grams per mile	Distance	1,700.0	CO2	C
	Refrigerated	grams per mile	Distance	1,750.0	CO2	C
	Tanker	grams per mile	Distance	1,750.0	CO2	C
	Truck-load Dry Vans	grams per mile	Distance	1,700.0	CO2	C
	All	grams per TEU-mile	Volume	597.4	CO2	A
	All	grams per short ton-mile	Weight	161.8	CO2	A

https://storage.googleapis.com/scsc/Green%20Freight/EDF-Green-Freight-Handbook.pdf

What if we sourced local bananas?

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140 miles x 0.6 kg CO2/ short ton-mile = 84 kg CO2 per *short tonne* of bananas

84 kg CO2/902 kg

→ **0.093 kg CO2 per kg bananas**

Local food is defined as 250 miles: **0.17 kg CO2/kg bananas**

https://storage.googleapis.com/scsc/Green%20Freight/EDF-Green-Freight-Handbook.pdf

Let's Compare

Boston-Guayaquil: 3000 miles | 450 containers

- 222.6 tonnes CO2 per trip
- **0.057 kg CO2 per 1 kg bananas**

Boston-Pittsfield, MA: 140 miles | 1 container

- 0.8 tonnes CO2 per trip
- **0.093 kg CO2 per kg bananas**

Are we accurate?

> What were the main simplifications that might've affected the final result?

> Which extra factors could significantly affect the result?

Eat Local?

> what do you think could be improved in this supply chains?

Trains vs Trucks

Rail	All	grams per rail-car mile	Distance	1,072.0	CO2	A
	All	grams per TEU-mile	Volume	292.8	CO2	A
	All	grams per short ton-mile	Weight	22.9	CO2	A
Truck	All	grams per mile	Distance	1,700.0	CO2	C

22.9 g CO2/ton-mile for a train vs **161.8** g CO2/ton-mile for a truck!

https://storage.googleapis.com/scsc/Green%20Freight/EDF-Green-Freight-Handbook.pdf

Part 2: Single-Use Plastics

Why So Much Plastic Packaging?

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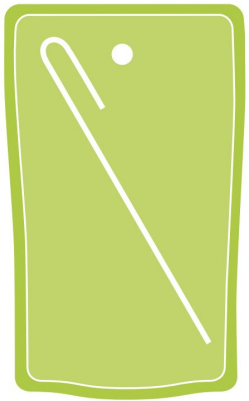
1. Light Weight - lowers carbon footprint of transportation
2. Cheap
3. Robust
4. Customizable
5. Easy to Produce - low energy, material, and water consumption
6. Makes products more shelf-stable

Case Study: Beverage Containers

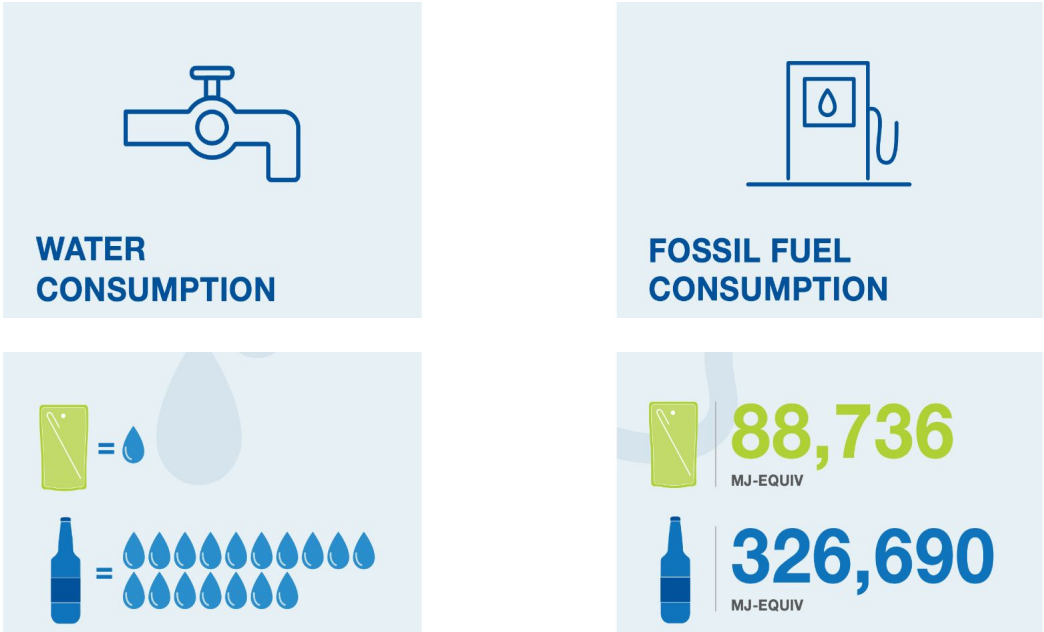


FLEXIBLE
DRINK POUCH

GLASS
BOTTLE

Flexible Packaging Association, flexpack.org

Case Study: Beverage Containers



Flexible Packaging Association, flexpack.org

Plastic Packaging Scavenger Hunt

> Go around the house and collect at least 10 things made of plastic

> log what the item is and its plastic #

1	2	3	4	5	6	7
PETE	**HDPE**	**PVC**	**LDPE**	**PP**	**PS**	**OTHER**
polyethylene terephthalate	high-density polyethylene	polyvinyl chloride	low-density polyethylene	polypropylene	polystyrene	other plastics, including acrylic, polycarbonate, polyactic fibers, nylon, fiberglass
soft drink bottles, mineral water, fruit juice containers and cooking oil	milk jugs, cleaning agents, laundry detergents, bleaching agents, shampoo bottles, washing and shower soaps	trays for sweets, fruit, plastic packing (bubble foil) and food foils to wrap the foodstuff	crushed bottles, shopping bags, highly-resistant sacks and most of the wrappings	furniture, consumers, luggage, toys as well as bumpers, lining and external borders of the cars	toys, hard packing, refrigerator trays, cosmetic bags, costume jewellery, audio cassettes, CD cases, vending cups	an example of one type is a polycarbonate used for CD production and baby feeding bottles
						

Discussion Questions

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1. What was the most common plastic item you found?

2. What was the most surprising plastic item you found?

3. Which items do you use?

4. How can these items be harmful to birds, other wildlife, and you?

5. How can you reduce your plastic use?

RECYCLE YOUR PLASTICS BY NUMBER

1 2 3 4 5 6 7

FRAMINGHAM DEPARTMENT OF PUBLIC WORKS

CAN I RECYCLE...?

PETE

YES RECYCLE IN YOUR CART.

HDPE

YES RECYCLE IN YOUR CART.

PVC

NO PUT NON-CONSTRUCTION DEBRIS IN THE TRASH.

The City does not collect construction debris!

LDPE

NO RECYCLE AT THE GROCERY STORE OR PUT THESE IN THE TRASH!

PP

YES RECYCLE IN YOUR CART.

PS

NO PUT THESE ITEMS IN THE TRASH!

OTHER

BRING #7 BULKY PLASTICS TO THE RECYCLING DROP-OFF (RDC) CENTER FOR PROPER DISPOSAL.

WHAT PRODUCTS HAVE THESE SYMBOLS?

PETE	Single-use food grade items, which include water and soda bottles. For one-time use ONLY.
HDPE	Food grade items, which include milk jugs, shampoo bottles, and detergent bottles.
PVC	Hard plastics such as pipes, mailboxes, medical supplies, and vinyl house siding.
LDPE	Film plastics. Such as plastic shopping bags, bread bags, and produce bags.
PP	Food safe plastics. Commonly used to make ketchup bottles and yogurt tubs.
PS	Styrofoam packing material has little to no value in the recycling market.
OTHER	Hard and durable plastics. Bulky items, such as furniture, large toys, and coolers.

Recycling is Complicated

Note how many different types of plastics there are.

Furthermore, each category has hundreds of subcategories with different properties: they can't be mixed together to make high-quality new products.

Additionally, post-consumer materials tend to be dirty, making them even less desirable for producers.

Recycling is *Even More* Complicated

- Collecting and sorting requires energy (usually comes from fossil fuels)

- Making new products out of post-consumer material might involve complicated processes that need a lot of energy and toxic chemicals

- Virgin materials tend to be very cheap, meaning that producers have no economic motivation to using recyclate

> this is not to say that we shouldn’t strive to pollute less and use less virgin material

> waste management and material footprint is just a **very** complex problem

Poll Time!

> How high is plastic packaging recycling rate:
>
> 1. In the US?
> 2. In Europe?
> 3. Globally?

Poll Time!

> How high is plastic packaging recycling rate:

1. In the US? ~5-10%
2. In Europe? ~30-40%
3. Globally? ~5-10%

What about other materials?

Recycling and composting as a percentage of generation

	1960	1970	1980	1990	2000	2005	2010	2015	2017	**2018**
Paper and Paperboard	17%	15%	21%	28%	43%	50%	63%	67%	66%	68%
Glass	2%	1%	5%	20%	23%	21%	27%	28%	25%	25%
Plastics	Neg.	Neg.	<1%	2%	6%	6%	8%	9%	9%	9%
Yard Trimmings	Neg.	Neg.	Neg.	12%	52%	62%	58%	61%	69%	63%
Lead-acid Batteries	Neg.	76%	70%	97%	93%	96%	99%	99%	99%	99%

> the best option is to not consume and reuse is better than recycle

Here’s What Happens to Curbside Recycling Items

Link for a virtual tour of a Casella Recycling Facility (serves numerous communities in Massachusetts)

Project Discussion: What's best for the boba shop?

Calculation

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1. Find an item online that can serve as an implementation of your suggested design. Plan on “purchasing” at least 1000 cups, so you’d want to find a wholesale supplier

2. See where the item is made or, at least, where does it get shipped from. Try repeating the same exercise as we did for bananas.

3. Start thinking about material footprint of your design. Is it heavy? Does it require a lot of water and energy to produce? We’ll give you more concrete guidelines in the future

Next Time: Energy Efficiency and Batteries