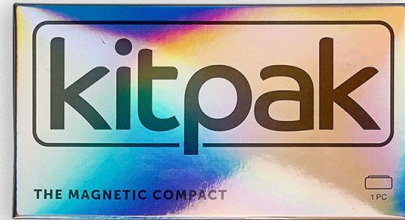


March 29, 2022

Packaging Redesign

Life Cycle Assessment Retro

by Nia Starr



Intro

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Intro

- The Company
- Redesign Overview

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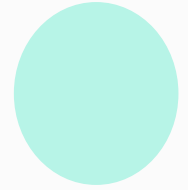
Measurement

- The Goal
- The Scope
- Inventory Analysis

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- Impact Improvement
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- Life Cycle Stage Impact
- Recommendations
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Original: Plastic Mylar Bag

Product: Compact

- Two Pieces
- Branded



Paper Box: Holographic Paper

Product: Compact

- One Piece
- Branded
- Less Expensive per piece

Measurement

The Scope

Functional Unit

- The functions of the packaging is to protect the product within for a given amount of time: the transit time from the manufacturer to the consumer.
- FU = 1 week of encasing a Kitpak product for delivery

System Boundary

- The production of packaging from the raw materials up to the EOL of the finished packaging
- This assessment includes the weight of the product inside the packaging during transport, but not the environmental system of the internal product itself.

Assumptions

- I am assuming the raw materials are processed in Dongguan China, the typical factory town that feeds into Shenzhen factories.
- Data was collected by Sustainable Minds' collection
- Total kilometers accounts for final delivery to NYC

Inventory Analysis

Mylar Bag

Outer packaging aside, the plastic bag has the most mass.

Component	Plastic Bag	Paper Tag	Ink	Corrugated Cardboard Mailer Box	Shipping Label	Weight of Compact
Amount/Unit	7.69 grams	0.84 grams	0.1 grams	97.32 grams	1.27 grams	88.5 grams
Core Material	PET	Paper	Pigment	Paper	Paper	
Raw Material	Crude Oil	Wood	Minerals	Wood	Wood	
Material Processing	Oil Refining, Polymerization, Pellet Production	Wood Pulping	Varnishing, Pigment Dispersal	Pulped	Pulped, Bleached, Mixed with Rosins	
Manufacturing	Film Extrusion, Lamination	Print	Print	Corrugation, Dieline cut	Print	
Use	N/A	N/A	N/A		N/A	
Distribution	8,103.21 km Shenzhen, China --> Anchorage, Alaska USA by Air Freight					
	7018.349184 km Alaska to NYC by Truck					
	8.04672 km NYC distribution center to Brooklyn by Truck					158.3594 km Allentown, Pennsylvania --> NYC
Total	15287.96 km					
End of Life (EOL)	Incinerated					

Holographic Paper Box

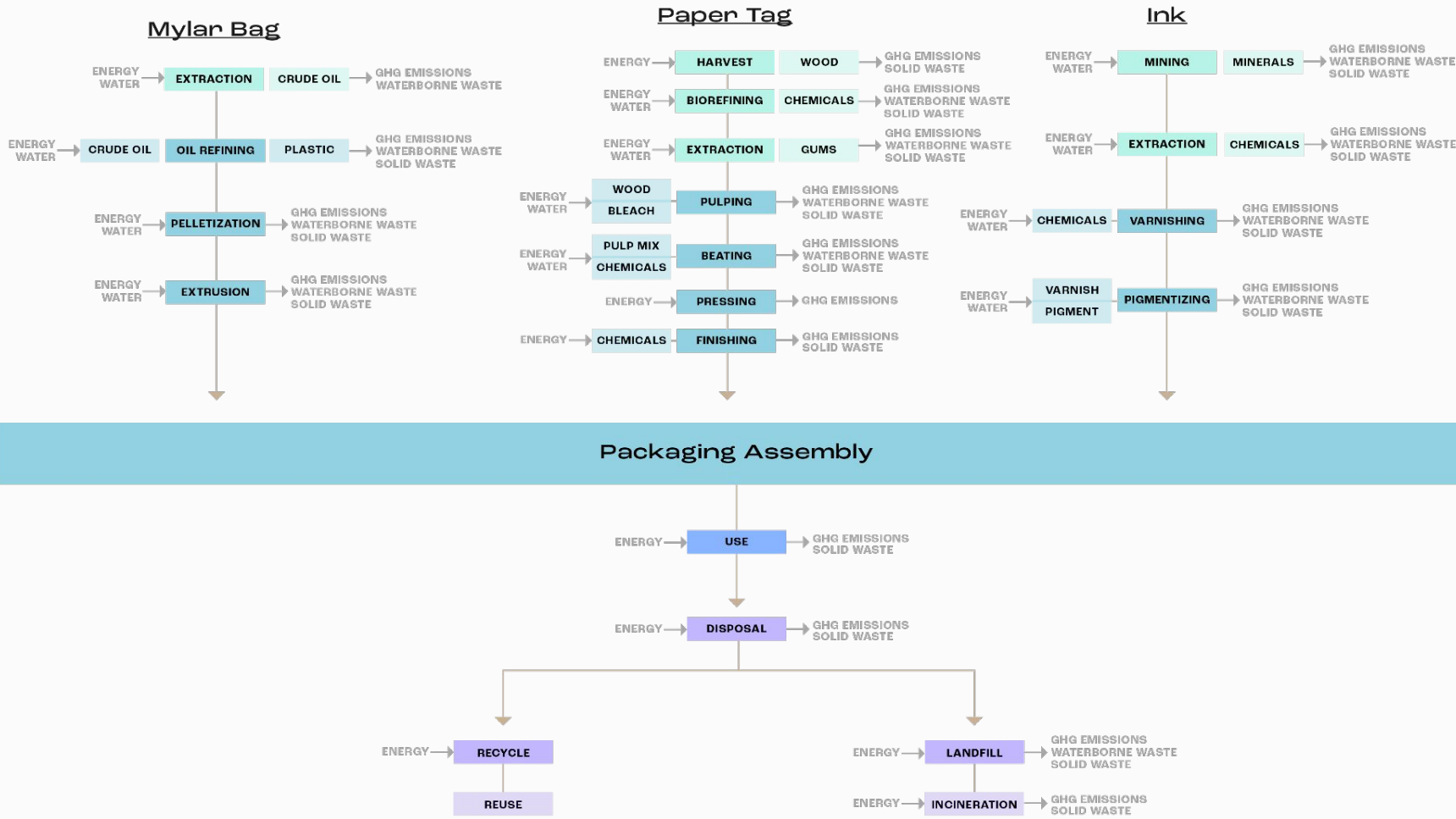
Outer packaging aside, the paper box has the most mass.

Component	Paper Box	Aluminum Coating	Plastic Coating	Glue	Ink	Corrugated Cardboard Mailer Box	Shipping Label
Amount/Unit	7.47 grams	1.28 grams	3.98 grams	0.16 grams	0.1 grams	97.32 grams	1.27 grams
Core Material	Paper	Aluminum	Polyethylene	Polyvinyl Acetate	Pigment	Paper	Paper
Raw Material	Wood	Minerals (Bauxites)	Crude Oil	Crude Oil	Minerals	Wood	Wood
Material Processing	Pulped	Refining, Smelting	Oil refining, polymerization	Emulsifying, Mixing	Varnishing, Pigment Dispersal	Pulped	Pulped, Bleached, Mixed with Rosins
Manufacturing	Dieline cut	Metallized (Vaporized), Embossed	Extrusion	Application	Print	Corrugation, Dieline cut	Print
Use	N/A	N/A	N/A	N/A	N/A		N/A
Distribution	8103.21 km Shenzhen, China --> Anchorage, Alaska USA by Air Freight					158.3594 km Allentown, Pennsylvania --> NYC	
	7018.349184 km Alaska to NYC by Truck						
	8.04672 km NYC distribution center to Brooklyn by Truck						
Total	15287.96 km						
End of Life (EOL)	Incinerated						

MYLAR BAG PACKAGING

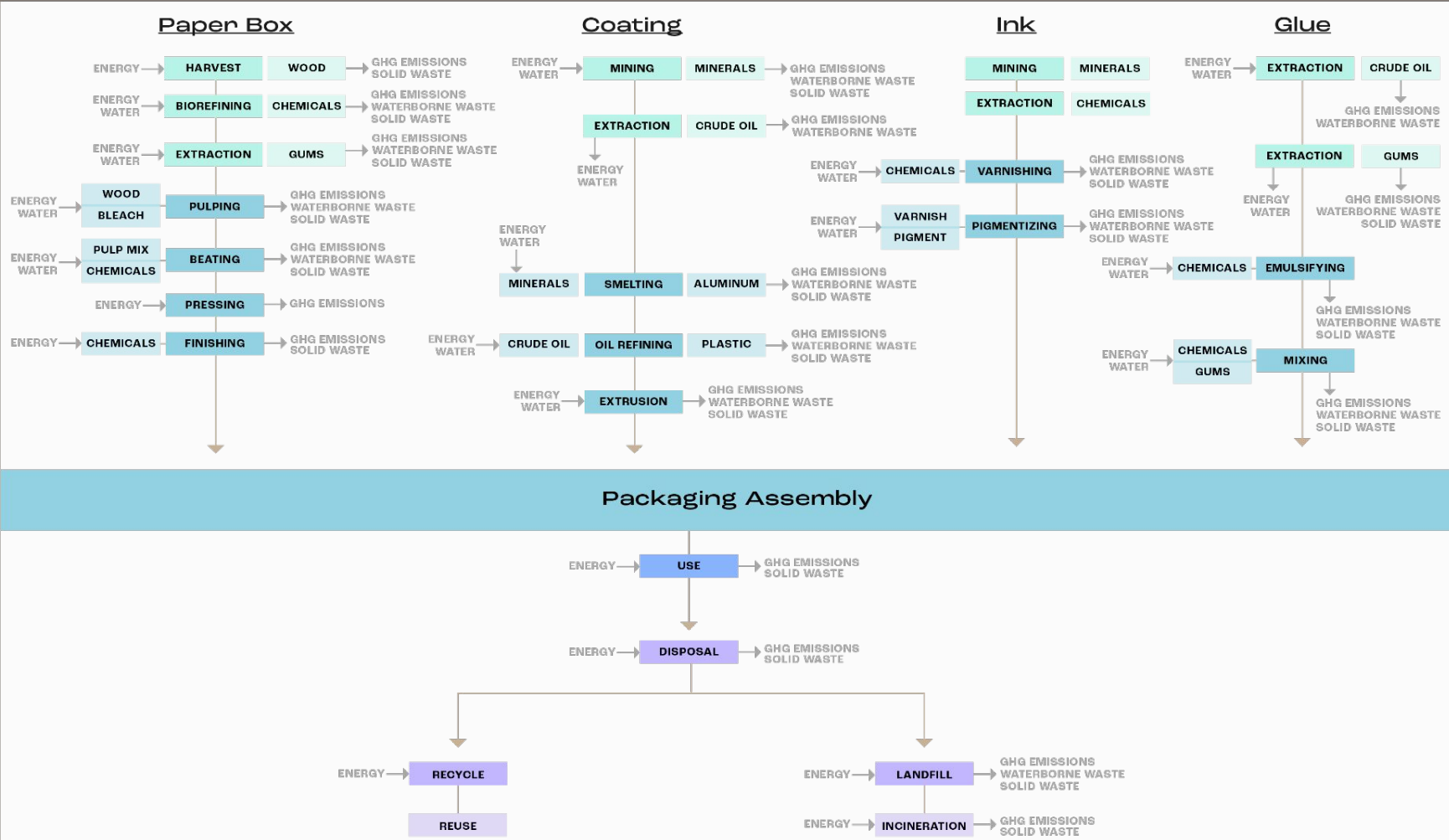
- Raw Material
- Manufacture
- Use
- End of Life

All instances of arrows indicate transportation, with inputs of fossil fuels and outputs of GHG emissions.



HOLOGRAPHIC PAPER PACKAGING

- Raw Material
- Manufacture
- Use
- End of Life



All instances of arrows indicate transportation, with inputs of fossil fuels and outputs of GHG emissions.

OUTER PACKAGING



Raw Material



Manufacture

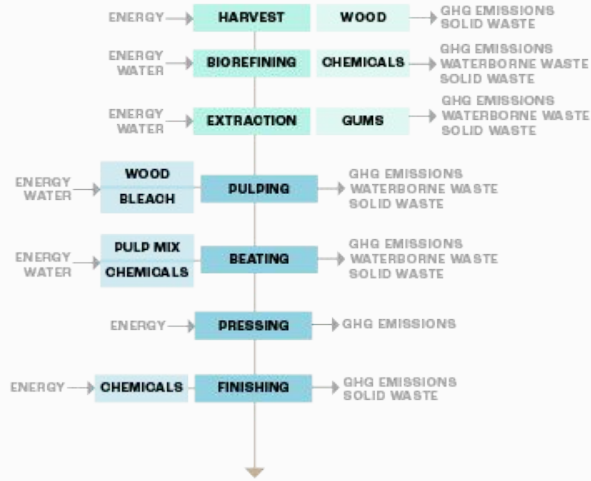


Use

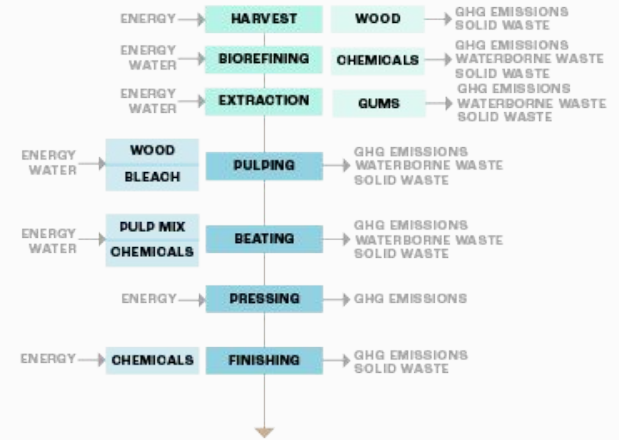


End of Life

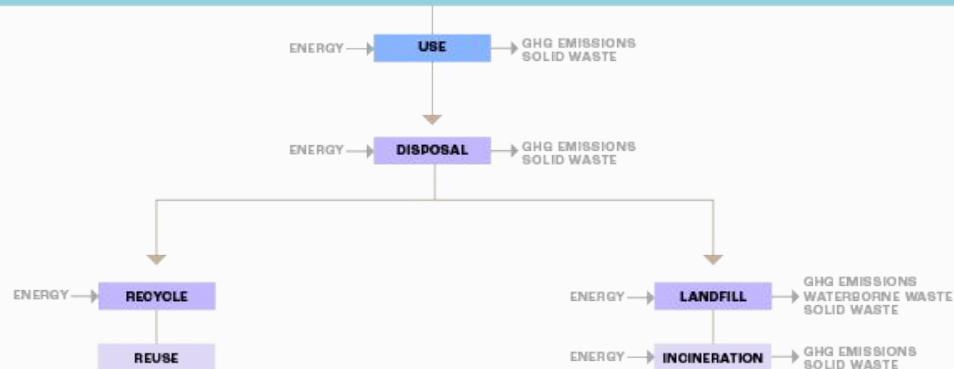
Cardboard Box



Shipping Label

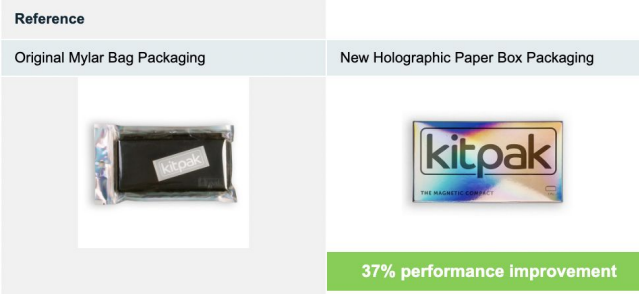


Packaging Assembly



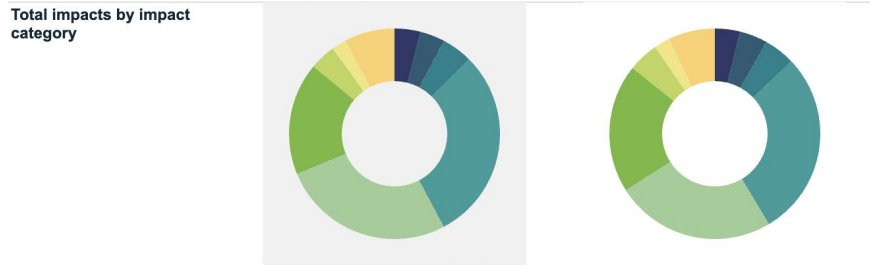
All instances of arrows indicate transportation, with inputs of fossil fuels and outputs of GHG emissions.

Assessment



Impacts per functional unit	0.10 mPts per 1 week of use	0.066 mPts per 1 week of use
Total amount of service delivered	1 x 1 week of use	1 x 1 week of use
Impacts of total service delivered	0.10 mPts	0.066 mPts
Assessment level	Estimate	Estimate

Greatest impacts	SBOM input Impact category Life cycle stage	Aircraft, freight, intercontinental Global warming Transportation	Aircraft, freight, intercontinental Global warming Transportation
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Impact category	%	Impact category	%
Ecological damage		Ecological damage	
Acidification	3.98	Acidification	3.86
Ecotoxicity	3.8	Ecotoxicity	4.27
Eutrophication	4.73	Eutrophication	4.8
Global warming	29.75	Global warming	28.49
Ozone depletion	0.05	Ozone depletion	0.04
Resource depletion		Resource depletion	
Fossil fuel depletion	26.45	Fossil fuel depletion	24.51
Human health damage		Human health damage	
Carcinogenics	17.29	Carcinogenics	19.75
Non carcinogenics	3.98	Non carcinogenics	4.67
Respiratory effects	2.28	Respiratory effects	2.42
Smog	7.69	Smog	7.19

How'd we do?

According to Sustainable Minds' calculation, there is a 37% impact performance improvement with the new paper box design.

What are the greatest environmental impacts?

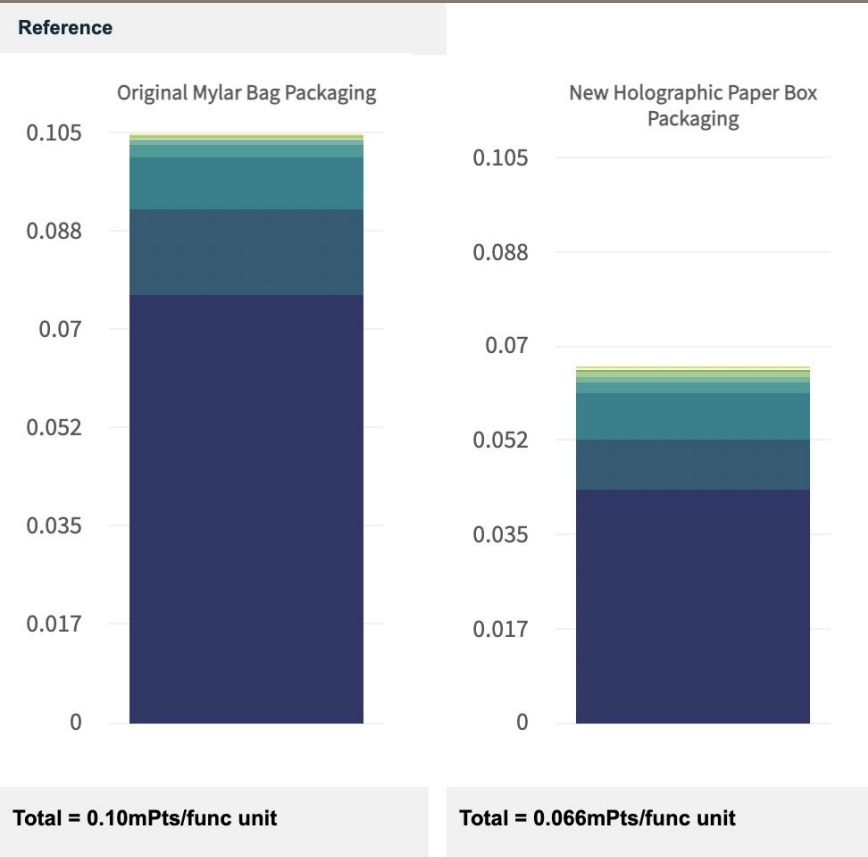
For both package types the following impact categories carry the most weight:

- Ecological Damage
 - Global Warming
- Resource Depletion
 - Fossil Fuel Depletion
- Human Health Damage
 - Carcinogenics

Impacts by System Bill of Materials (SBOM)

For both packages, the inputs causing the most impact is transportation, followed by the outer corrugated cardboard box. The new packaging design has proportionally less.

The actual branded product packaging has the least impact proportionally for each respective concept.



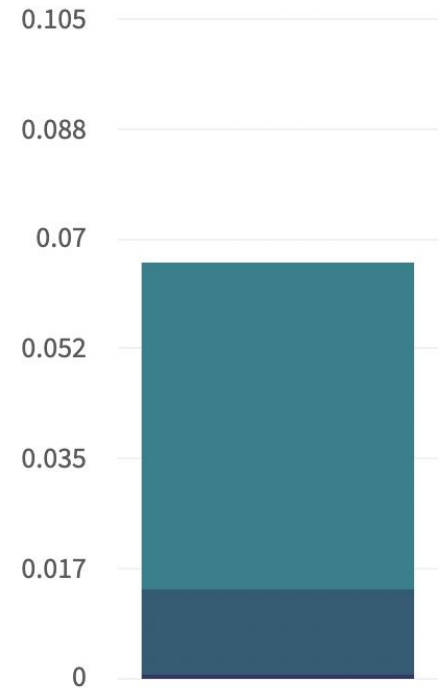
Input	mPts/func unit	Input	mPts/func unit
Transportation - Aircraft, freight, intercontinental	0.0762	Transportation - Aircraft, freight, intercontinental	0.0434
Transportation - Truck, >16t	0.0153	Material - Corrugated board, fresh fibre, single wall	0.00932
Material - Corrugated board, fresh fibre, single wall	0.00932	Transportation - Truck, >16t	0.00872
Material - Polyethylene terephthalate, granulate, amorphous, PET	0.00211	Material - Aluminium, production mix	0.00189
EOL - Polyethylene terephthalate, granulate, amorphous, PET: Incineration, polyethylene terephthalate	9.16x10 ⁻⁴	Material - Polyethylene terephthalate, granulate, amorphous, PET	0.00109
Process - Polyethylene terephthalate, granulate, amorphous, PET: Extrusion, film, plastics	2.63x10 ⁻⁴	Material - Solid bleached board	0.00102
EOL - Empty material input: Landfill, polyethylene	2.45x10 ⁻⁴	EOL - Polyethylene terephthalate, granulate, amorphous, PET: Incineration, polyethylene terephthalate	4.74x10 ⁻⁴
Process - Kraft paper, laminates, FSC certified recycled: Manufacturing, thin decorative laminates	1.53x10 ⁻⁴	Process - Kraft paper, laminates, FSC certified recycled: Manufacturing, thin decorative laminates	1.53x10 ⁻⁴
Material - Kraft paper, bleached	1.34x10 ⁻⁴	Process - Polyethylene terephthalate, granulate, amorphous, PET: Extrusion, film, plastics	1.36x10 ⁻⁴
Material - Kraft paper, laminates, FSC certified recycled	1.10x10 ⁻⁴	Material - Kraft paper, laminates, FSC certified recycled	1.10x10 ⁻⁴

Reference

Original Mylar Bag Packaging



New Holographic Paper Box Packaging



Total = 0.10mPts/func unit

Total = 0.066mPts/func unit

Lifecycle stage	mPts/func unit
End of life	0.00118
Manufacturing	0.0121
Transportation	0.0915

Lifecycle stage	mPts/func unit
End of life	4.95x10 ⁻⁴
Manufacturing	0.0138
Transportation	0.0522

Impacts by Life Cycle Stage

Transportation for both the original and new paper-based design has the greatest impact in both of the packaging's life cycle, with the mylar bag having greater impact in that category.

Raw materials processing and manufacturing is almost the same for both packaging types.

Recommendations

Impact Improvement by Component

What if we used only recycled materials as the inputs for our manufacturing processes?

Impact Improvement by Life Cycle Stage

What if we ordered our boxes from a domestic factory rather than from China?



Improving Impact by Material Components

Reference

New Holographic Paper Box Packaging

Recycled Holographic Paper Box Packaging



5.4% performance improvement

0.066 mPts per 1 week of use

0.063 mPts per 1 week of use

Impacts per functional unit
Total amount of service delivered
Impacts of total service delivered
Assessment level

1 x 1 week of use
0.066 mPts
Estimate

1 x 1 week of use
0.063 mPts
Estimate

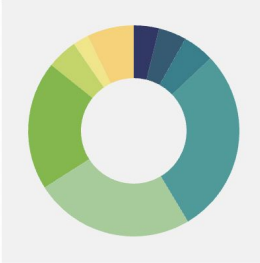
Greatest impacts

SBOM input
Impact category
Life cycle stage

Aircraft, freight, intercontinental
Global warming
Transportation

Aircraft, freight, intercontinental
Global warming
Transportation

Total impacts by impact category



Impact category	%	Impact category	%
Ecological damage		Ecological damage	
Acidification	3.86	Acidification	3.77
Ecotoxicity	4.27	Ecotoxicity	4.77
Eutrophication	4.8	Eutrophication	4.47
Global warming	28.49	Global warming	29.13
Ozone depletion	0.04	Ozone depletion	0.05
Resource depletion		Resource depletion	
Fossil fuel depletion	24.51	Fossil fuel depletion	25.82
Human health damage		Human health damage	
Carcinogenics	19.75	Carcinogenics	17.17
Non carcinogenics	4.67	Non carcinogenics	5.33
Respiratory effects	2.42	Respiratory effects	2.1
Smog	7.19	Smog	7.39

How'd we do?

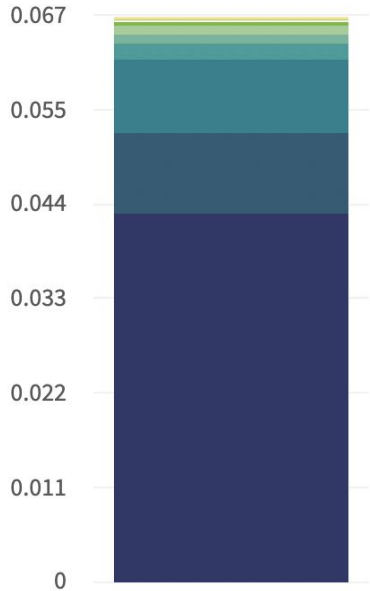
According to Sustainable Minds' calculation, there is only a **5.4% impact performance improvement** with recycled inputs in the manufacturing process.

Impacts by System Bill of Materials (SBOM)

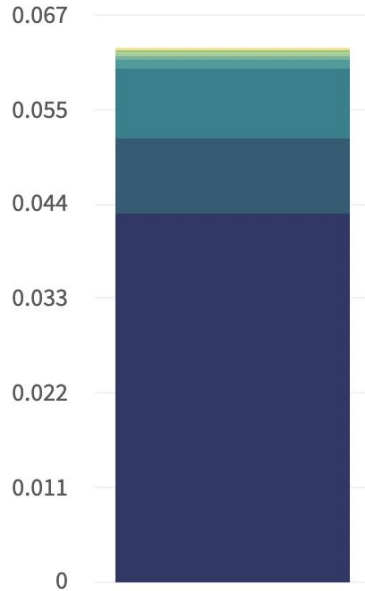
There is only a 0.003 mPT reduction from the Sustainable Minds scorecard for SBOM Impact.

Reference

New Holographic Paper Box Packaging



Recycled Holographic Paper Box Packaging



Total = 0.066mPts/func unit

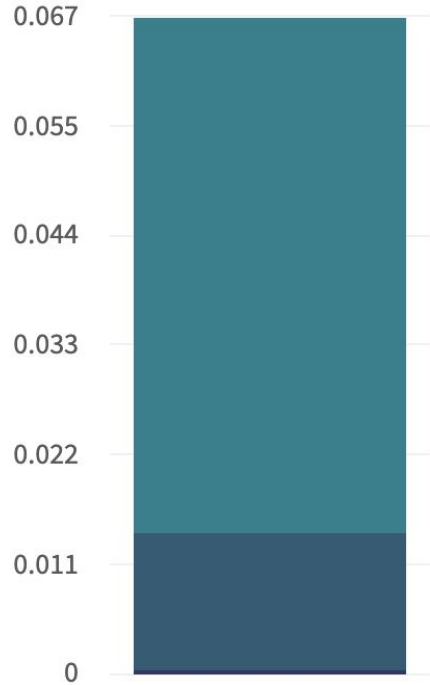
Total = 0.063mPts/func unit

Input	mPts/func unit
Transportation - Aircraft, freight, intercontinental	0.0434
Material - Corrugated board, fresh fibre, single wall	0.00932
Transportation - Truck, >16t	0.00872
Material - Aluminium, production mix	0.00189
Material - Polyethylene terephthalate, granulate, amorphous, PET	0.00109
Material - Solid bleached board	0.00102
EOL - Polyethylene terephthalate, granulate, amorphous, PET: Incineration, polyethylene terephthalate	4.74x10 ⁻⁴
Process - Kraft paper, laminates, FSC certified recycled: Manufacturing, thin decorative laminates	1.53x10 ⁻⁴
Process - Polyethylene terephthalate, granulate, amorphous, PET: Extrusion, film, plastics	1.36x10 ⁻⁴
Material - Kraft paper, laminates, FSC certified recycled	1.10x10 ⁻⁴

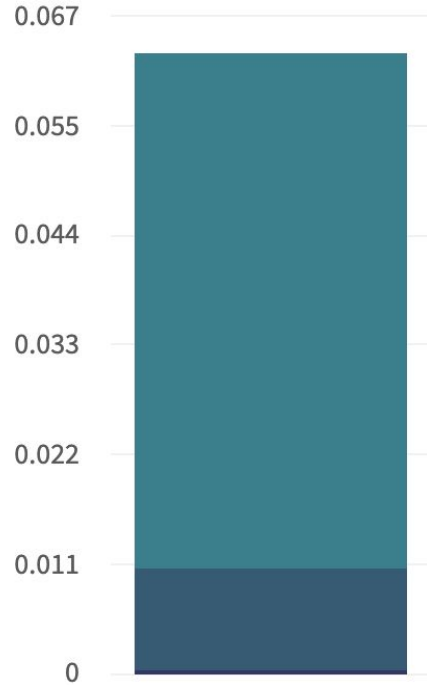
Input	mPts/func unit
Transportation - Aircraft, freight, intercontinental	0.0434
Transportation - Truck, >16t	0.00872
Material - Corrugated board, recycling fibre, single wall	0.00829
Material - Solid bleached board	0.00102
EOL - PET, recycled granulate: Incineration, polyethylene terephthalate	4.74x10 ⁻⁴
Material - Aluminium, secondary, from old scrap	3.29x10 ⁻⁴
Process - Kraft paper, laminates, FSC certified recycled: Manufacturing, thin decorative laminates	1.53x10 ⁻⁴
Process - PET, recycled granulate: Extrusion, film, plastics	1.36x10 ⁻⁴
Material - PET, recycled granulate	1.29x10 ⁻⁴
Material - Kraft paper, laminates, FSC certified recycled	1.10x10 ⁻⁴

Reference

New Holographic Paper Box Packaging



Recycled Holographic Paper Box Packaging



Impacts by Life Cycle Stage

There is only a 0.003 mPT reduction from the Sustainable Minds scorecard for SBOM Impact.

It's a reduction, but I would synthesize this as not as significant a route to pursue when identifying where to reduce carbon intensive processes.

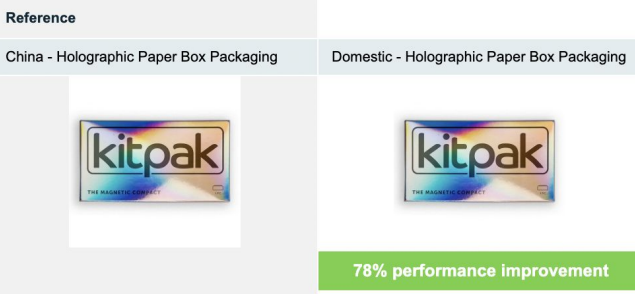
Total = 0.066mPts/func unit

Lifecycle stage	mPts/func unit
End of life	4.95x10 ⁻⁴
Manufacturing	0.0138
Transportation	0.0522

Total = 0.063mPts/func unit

Lifecycle stage	mPts/func unit
End of life	4.95x10 ⁻⁴
Manufacturing	0.0102
Transportation	0.0522

Improving Impact by Transportation



Impacts per functional unit	0.066 mPts per 1 week of use	0.015 mPts per 1 week of use
Total amount of service delivered	1 x 1 week of use	1 x 1 week of use
Impacts of total service delivered	0.066 mPts	0.015 mPts
Assessment level	Estimate	Estimate

Greatest impacts

SBOM input	Aircraft, freight, intercontinental	Corrugated board, fresh fibre, single wall
Impact category	Global warming	Carcinogenics
Life cycle stage	Transportation	Manufacturing



Impact category	%	Impact category	%
Ecological damage		Ecological damage	
Acidification	3.86	Acidification	2.91
Ecotoxicity	4.27	Ecotoxicity	11.02
Eutrophication	4.8	Eutrophication	6.05
Global warming	28.49	Global warming	18.89
Ozone depletion	0.04	Ozone depletion	0.01
Resource depletion		Resource depletion	
Fossil fuel depletion	24.51	Fossil fuel depletion	9.43
Human health damage		Human health damage	
Carcinogenics	19.75	Carcinogenics	34.67
Non carcinogenics	4.67	Non carcinogenics	10.5
Respiratory effects	2.42	Respiratory effects	3.48
Smog	7.19	Smog	3.03

How'd we do?

According to Sustainable Minds' calculation, there is a **78% impact performance improvement** with the adjusted transportation distance and mode.

Cutting out air freight and 14,861 kilometers.

Distribution	418.429 km Virginia to NYC
	8.04672 km NYC distribution center to Brooklyn by Truck

What are the greatest environmental impacts?

For the domestic packaging, transportation and fossil fuel no longer becomes the standout impact, but the human health damage impact.

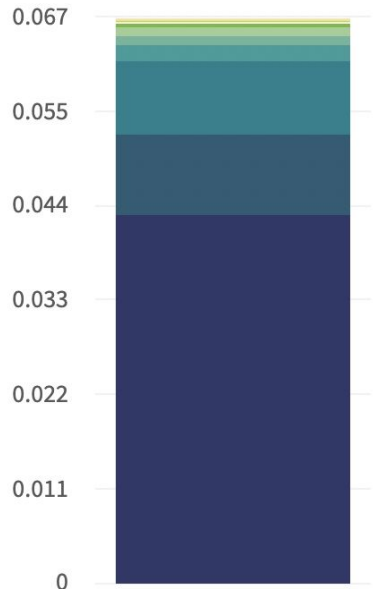
Impacts by System Bill of Materials (SBOM)

Transportation no longer is the impact issue with the packaging if we switch to a domestic producer.

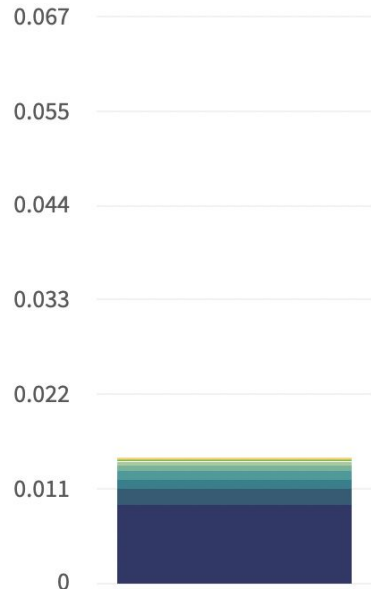
Corrugated cardboard for the outer packaging would be our next hurdle to jump over.

Reference

China - Holographic Paper Box Packaging



Domestic - Holographic Paper Box Packaging



Total = 0.066mPts/func unit

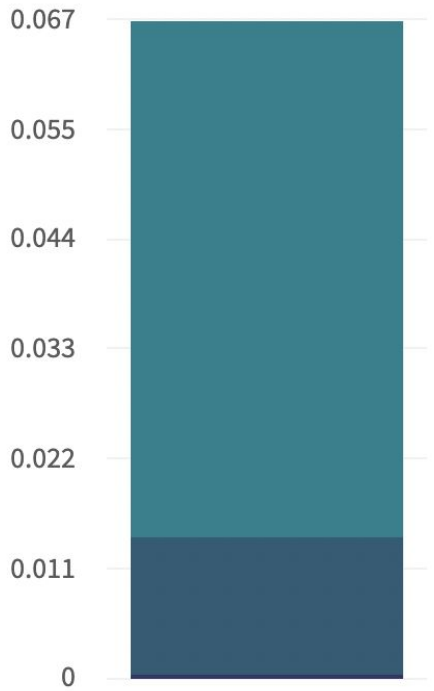
Total = 0.015mPts/func unit

Input	mPts/func unit
Transportation - Aircraft, freight, intercontinental	0.0434
Material - Corrugated board, fresh fibre, single wall	0.00932
Transportation - Truck, >16t	0.00872
Material - Aluminium, production mix	0.00189
Material - Polyethylene terephthalate, granulate, amorphous, PET	0.00109
Material - Solid bleached board	0.00102
EOL - Polyethylene terephthalate, granulate, amorphous, PET: Incineration, polyethylene terephthalate	4.74x10 ⁻⁴
Process - Kraft paper, laminates, FSC certified recycled: Manufacturing, thin decorative laminates	1.53x10 ⁻⁴
Process - Polyethylene terephthalate, granulate, amorphous, PET: Extrusion, film, plastics	1.36x10 ⁻⁴
Material - Kraft paper, laminates, FSC certified recycled	1.10x10 ⁻⁴
Material - Toner, colour, powder	4.22x10 ⁻⁵

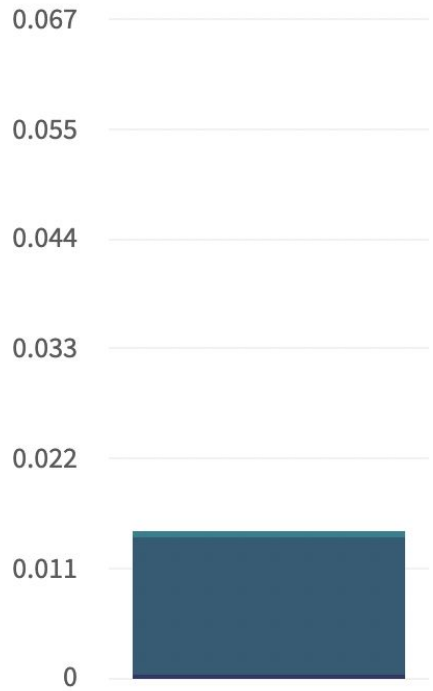
Input	mPts/func unit
Material - Corrugated board, fresh fibre, single wall	0.00932
Material - Aluminium, production mix	0.00189
Material - Polyethylene terephthalate, granulate, amorphous, PET	0.00109
Material - Solid bleached board	0.00102
Transportation - Truck, >16t	5.20x10 ⁻⁴
EOL - Polyethylene terephthalate, granulate, amorphous, PET: Incineration, polyethylene terephthalate	4.74x10 ⁻⁴
Process - Kraft paper, laminates, FSC certified recycled: Manufacturing, thin decorative laminates	1.53x10 ⁻⁴
Process - Polyethylene terephthalate, granulate, amorphous, PET: Extrusion, film, plastics	1.36x10 ⁻⁴
Material - Kraft paper, laminates, FSC certified recycled	1.10x10 ⁻⁴
Material - Toner, colour, powder	4.22x10 ⁻⁵

Reference

China - Holographic Paper Box Packaging



Domestic - Holographic Paper Box Packaging



Total = 0.066mPts/func unit

Lifecycle stage	mPts/func unit
End of life	4.95x10 ⁻⁴
Manufacturing	0.0138
Transportation	0.0522

Total = 0.015mPts/func unit

Lifecycle stage	mPts/func unit
End of life	4.95x10 ⁻⁴
Manufacturing	0.0138
Transportation	5.62x10 ⁻⁴

Impacts by Life Cycle Stage

There is a vast improvement in the impact assessment when working with a domestic producer vs. from overseas.

Once impact from air freight is cut out, the manufacturing process becomes the next step for accounting what process to reduce impact in.

Social Impacts

Dongguan, China

The World's Factory

Dongguan is sometimes called “the world’s factory” due to its prosperous manufacturing industry, and 75% of its 8.34m population are migrant workers. Since the mid-1980s, Dongguan has been China’s leading export and manufacturing base, a hothouse for churning out low cost products bearing the ubiquitous “Made in China” label. Today, it’s fulfilling the tech industry’s orders.

Environmental Impact

With almost 1m registered factories in Dongguan, air pollution can be a serious problem. In 2017, levels of PM2.5, the most harmful fine carcinogenic particulate, increased by 5.3% across the Guangdong region, which incorporates Dongguan. Reports of widespread smog and foul odours in the air are commonplace in the city.





Labor Conditions

Even if purchasing reams of products from China is significantly cheaper than domestic sources, that cost is carried elsewhere: the factory workers.

Factory workers are often crammed into factory spaces, work extremely long hours, and are exposed to incredibly harmful industrial-grade level chemicals.

Outside of the factory, the workers – principally female – are usually housed in dormitories, several to a room.

- Recommended Reading:
 - Disney's Ariel Mermaid Doll
 - The Foxconn Technology Group Suicides Scandal
 - High Tech Misery in China, *National Labor Committee (NLC)*
 - Dirty Toys, *Institute for Global Labour and Human Rights*

Thank you.