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Comparison of GHG Emissions for US and India/China-based Poly Mailer Production for US Businesses across all Scopes

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1. Introduction

To determine the most sustainable option, we examined the potential impact of GHG emissions on the production of poly-mailers in the United States versus India/China and shipping them to the United States for American businesses. This paper outlines our methodology and computations, including certain assumptions. Our calculations are based on comparable medium-sized businesses and consider scope 1, 2, and 3 emissions.

A comprehensive analysis of the sustainability of poly-mailer production in the US versus India requires a detailed examination of each step of the production and transportation process. By carefully considering these factors, we can identify the most sustainable option for American businesses looking to source poly-mailers.

2. Background

The examined US company, IMPAK, operates its production facility in Richardson, Texas, where a significant portion of their business is attributed to the Re-Think PolyMailer (Figure 1). This product, comprising 50% post-industrial recycled (PIR) materials, constitutes approximately 16% of IMPAK's total production at this specific plant, amounting to 6,505,800 units. Specializing in the transformation of plastic film into PolyMailers used for commercial packaging solutions, IMPAK's core operation involves printing and cutting the PolyMailers as desired by their customers. (Figure 2)

The manufacturing journey commences in Houston, where natural gas is processed to create virgin plastic in the form of small pallets called resin. These pellets are then transported by train to the extruder, where they undergo a meticulous transformation process called blow extrusion. The extruder incorporates 50% post-industrial plastic waste into their mixture, contributing to the sustainable production of the plastic film.

Witnessing the blow extrusion at the extruder reveals a captivating process. As the plastic melts, it is subjected to hot air, resulting in the formation of a balloon-like structure (Figure 3). Subsequently, the material is flattened out to create the final film product. The entire sequence of operations, involving both the extruder and IMPAK, is visually represented in Figure 4, providing a comprehensive overview of the collaborative production process. This collaborative effort not only showcases the technical expertise of both entities but also highlights their commitment to sustainable practices in plastic production.

In our comparative analysis, we anticipate that the counterpart facility located in India or China of the same revenue as IMPAK, mirrors the scale and operational intricacies of the IMPAK facility in Richardson, Texas. Drawing parallels, we envision a facility of comparable size, emphasizing similar manufacturing processes and efficiencies. This assumption serves as a foundational basis for juxtaposing the production dynamics, sustainability practices, and overall operational frameworks between the two locations.

3. Approach

Our research journey commenced with an in-depth exploration of IMPAK's operations, seeking a comprehensive understanding of their production processes. Collaborating with esteemed professors, we conducted thorough analyses, eventually narrowing down our methodology to incorporate the use of Normative.io, a carbon accounting software trusted by many leading companies by the US. We also compared our results to the Scope3 Analyzer Software (https://scope3analyzer.pulse.cloud) and found similar results. It is worth highlighting that while Normative offers paid software tailored for larger enterprises, our selection of the free version was a strategic choice driven by IMPAK's relatively modest workforce of 54 employees. Despite being a no-cost option, the free version of Normative proved to be highly effective for our purposes.

A key advantage of opting for Normative was its capability to facilitate benchmarking, enabling us to compare IMPAK against the industry average for companies of similar revenue and size within the Plastic and Rubber Products manufacturing sector, both in the United States and globally. This benchmarking feature added valuable context to our analysis, allowing us to gauge IMPAK's sustainability performance relative to industry norms. The decision to leverage Normative's software was thus grounded in its accessibility for smaller firms and its ability to provide meaningful benchmarking insights for a more comprehensive assessment of IMPAK's sustainability practices.

The Normative calculation methodology is informed by leading climate experts and aligned with international standards like the Greenhouse Gas Protocol. The calculations are bolstered with tens of thousands of emissions factors, millions of industry data points, and a robust and flexible technology infrastructure. (1)

4. Introduction to corporate carbon footprints

The corporate carbon footprint encompasses the cumulative greenhouse gas emissions generated by all economic activities within the value chain. Direct measurement of GHGs is often impractical or unfeasible, particularly in the context of procuring goods and services, a substantial component of a company's operations. Indirect methods, grounded in economic or consumption data, serve as a practical means to estimate GHG emissions in such scenarios.

The procedure for indirect GHG emissions estimation relies on two primary sets of data:

- Business Data: This encompasses information describing the activities of the company. It can take the form of either spend or transaction data, indicating the monetary value paid to a specific entity (e.g., company X) for a particular good or service. Alternatively, it may involve activity data, quantifying metrics such as the volume of fuel purchased, or the weight of materials procured.

- Emission Factors: Emission factors play a pivotal role in this estimation process by specifying the mass of GHG emissions associated with a given unit of business data. These factors provide a standardized measure, allowing for the conversion of economic or activity data into equivalent GHG emissions.

Together, these two sets of data enable a comprehensive and effective estimation of indirect GHG emissions, facilitating companies in understanding and managing their carbon footprint throughout the value chain.

The GHG Protocol requires that companies set appropriate organizational and operational boundaries. Organizational boundaries relate to a clear attribution of business activities and the associated GHGs to separate legal entities and organizational structures – just as is required in financial accounting. Operational boundaries, on the other hand, assign all operational activities of your company to one of three scopes of emissions. These scopes help to distinguish between the activities and emissions that are under the direct control of the company and those on which the company only have indirect influence – but for which is still accountable. (2)

- Scope 1 covers the direct emissions that your company generates while performing its business activities. This includes electricity, heat, or steam that your organization itself generates; manufacture or processing of chemicals and materials, etc. (2)
- Scope 2 covers emissions from purchased and consumed energy. This includes purchased electricity; purchased heating; purchased steam; purchased cooling. (2)
- Scope 3 emissions are all other indirect emissions that occur in your company's value chain and are not already included within scope 2. These emissions are a consequence of your company's business activities but occur from sources your company does not own nor control. They account for approximately 88% of a company's total emissions. Scope 3 emissions include the following contributions: emissions generated in your company's supply chain, such as extraction, production, and transportation of purchased materials and fuels. (2)

Emission factors, which represent emissions per unit of activity, are essential to turn business data into emissions data.
In general, the calculation of the carbon emissions for a generic activity follows the equation below:

$$E\ [\text{kg } CO_2e] = BDP\ [\text{unit}] * EF\ [\text{kg } CO_2e/\text{unit}] \quad (3)$$

E: Emissions; CO_2e: Carbon Dioxide equivalent, i.e., GHGs translated into an amount of Carbon Dioxide (CO_2), which would result in the same contribution to global warming as the original GHGs; BDP: Business Data Point representing the activity; EF: Emission Factor

Thus, calculating emissions using business data and emission factors is equivalent to multiplying the quantity of an activity by an emission factor that represents the emissions per unit of activity.

For these approaches, Normative automatically sources emission factors from their deep database of about 26,500 such factors. There are also over 10,000 material and activity categorizations in the database, including regional-specific emission factors for all major countries. The database is populated with peer-reviewed, scientifically vetted sources. The emission factors are updated on an ongoing basis, always reflecting the most recent versions available. (2)

In addition to these updates, their R&D department tracks the most prominent research institutions and journals for the latest developments in the field to see if new or improved databases could be added.

5. Calculations

Figure 5 presents the comprehensive inputs gathered from the Normative, specifically pertaining to data attributed to the IMPAK facility in Richardson. The breakdown of total emissions (Scope 1-3) is detailed as 3,200 t of CO_2 emissions, with Scope 1 accounting for 49.9 t, Scope 2 at 316 t, and Scope 3 totaling 2,840 t. Additionally, the emissions directly associated with the Re-think 50% PolyMailer production amount to 512 t CO_2, calculated as 16% of the total emissions.

Assuming an equivalent revenue size facility in India, the data presented in Figure 6 reflects the average emissions obtained from Normative purely based on geographic conditions. The total emissions (Scope 1-3) for the Indian facility are recorded as 9,970 t of CO_2, with Scope 1, Scope 2, and Scope 3 contributing 279 t, 2,826 t, and 6,858 t, respectively. Correspondingly, the emissions specific to the production of PolyMailer in the Indian context amount to 1,595 t CO_2, calculated using the same 16% proportion.

Now, assuming an equivalent revenue size facility in China, the data presented in Figure 7 reflects the average emissions obtained from Normative purely based on geographic conditions. The total emissions (Scope 1-3) for the Chinese facility are recorded as 13,300 t of CO_2, with Scope 1, Scope 2, and Scope 3 contributing 1,200 t, 6,577 t, and 5,511 t, respectively. Correspondingly, the emissions specific to the production of PolyMailer in the Chinese context amount to 2,128 t CO_2, calculated using the same 16% proportion.

Figure 8 shows the comparative differences between Scope 1, Scope 2 and Scope 3 emissions in the Plastics and Rubber Products Manufacturing Industry between IMPAK, India and China. For context, IMPAK’s emissions are in line with US average emissions for the same industry. Figure 9 denotes the differences between IMPAK and US Average.

Total emissions to transport 6,505,800 units of RETHINK PolyMailers to the US, assuming a weight of 20gms per mailer and that it was sent by sea as calculated in Figure 9, from India is 116.04 t CO_2 and from China is 139.36 t CO_2.

Yearly total GHG emissions for all RETHINK PolyMailers comes out to be 512 t CO_2 for IMPAK, 1,711 t CO_2 for an Indian company and a whopping 2,321 t CO_2 for an average Chinese company.

6. Conclusion

India and China exhibit significantly higher emissions, approximately 234% and 353% more respectively, in comparison to the emissions associated with producing and shipping RETHINK PolyMailers from IMPAK. The emissions solely based on geographical location of the plant, with similar size and revenue, and not considering the transportation emissions is still 212% and 316% higher for India and China, demonstrating the substantial variation in emission factors largely determined by the country's electricity production. This large disparity illustrates the crucial role of manufacturing locations in determining emission outcomes, distinct from the emissions involved in transporting these PolyMailers to the USA

The United States, on the other hand, benefits from a cleaner energy infrastructure and improved worker conditions, contributing to a more environmentally sustainable and socially responsible production environment.

To provide a tangible illustration, let's consider a scenario where a company orders 100,000 units of PolyMailers from IMPAK, resulting in approximately 7.87 t CO_2 emissions. In contrast, sourcing the same quantity from India would result in 26.29 t CO_2 emissions, and from China, it would escalate to 35.67 t CO_2. By choosing IMPAK over China, the company stands to potentially save up to 27.08 t CO_2, equivalent to the emissions produced by 13.9 gasoline cars in a year or the electricity consumption of 18 households over one year per 100,000 units. This emphasizes the substantial environmental impact and potential carbon footprint reduction achievable through thoughtful sourcing decisions. (4)

APPENDIX

Figure 1: Rethink PolyMailer by IMPAK

Figure 2: Operations at IMPAK

Figure 3: Plastic Balloon in the plastic film production process

Figure 4: Flowchart of the PolyMailer Production Process

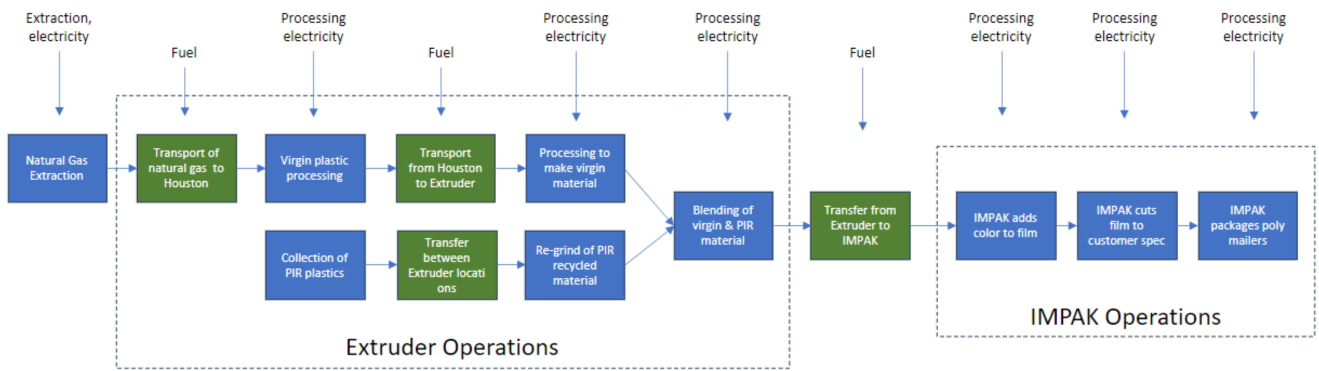
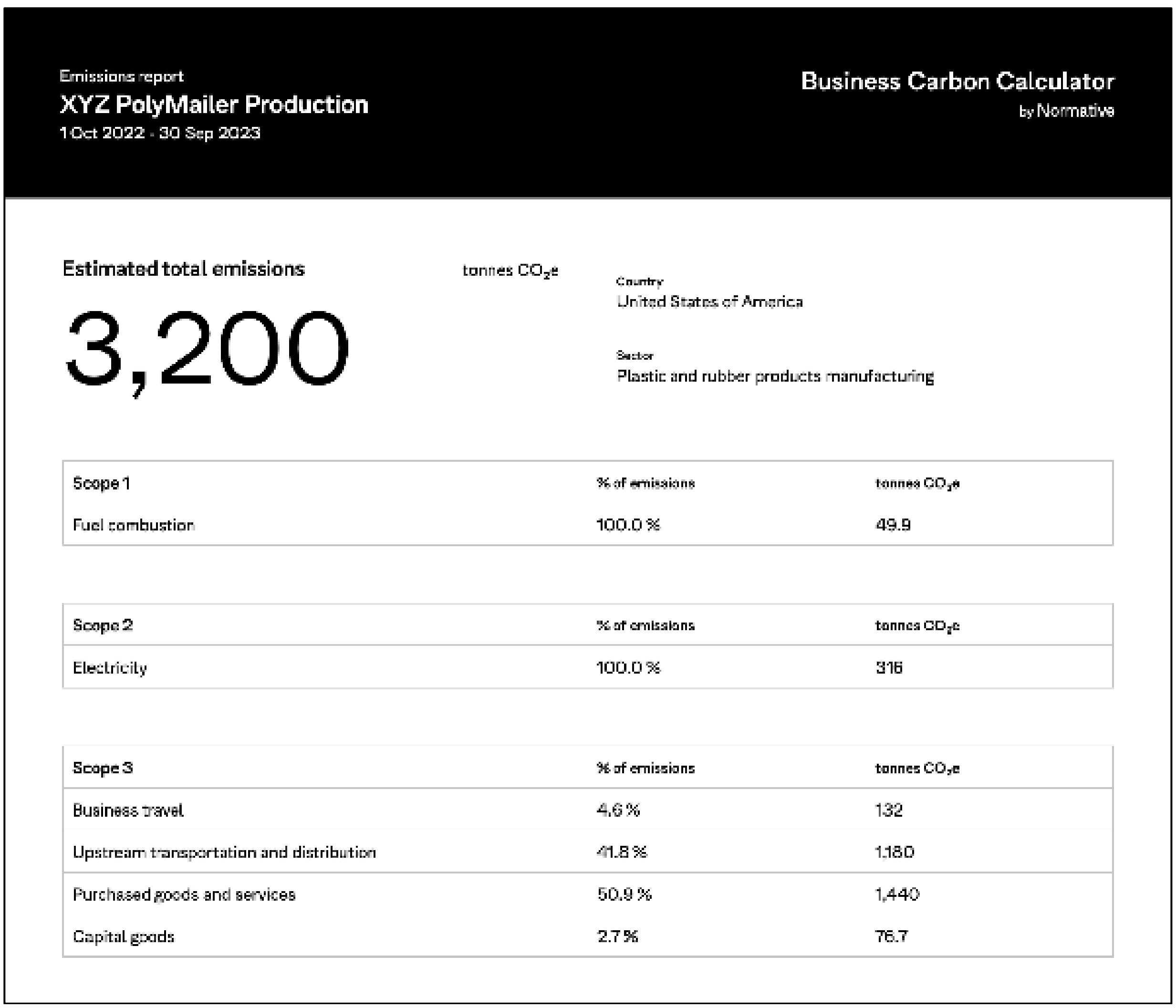


Figure 5 – Results for the IMPAK Operations using Normative.



Emissions report
XYZ PolyMailer Production
1 Oct 2022 - 30 Sep 2023

Business Carbon Calculator
by Normative

Estimated total emissions

3,200

tonnes CO_2e

Country
United States of America

Sector
Plastic and rubber products manufacturing

Scope 1	% of emissions	tonnes CO_2e
Fuel combustion	100.0 %	49.9

Scope 2	% of emissions	tonnes CO_2e
Electricity	100.0 %	316

Scope 3	% of emissions	tonnes CO_2e
Business travel	4.6 %	132
Upstream transportation and distribution	41.8 %	1,180
Purchased goods and services	50.9 %	1,440
Capital goods	2.7 %	76.7

Figure 6 - Results for similar sized Indian company's operations using Normative.

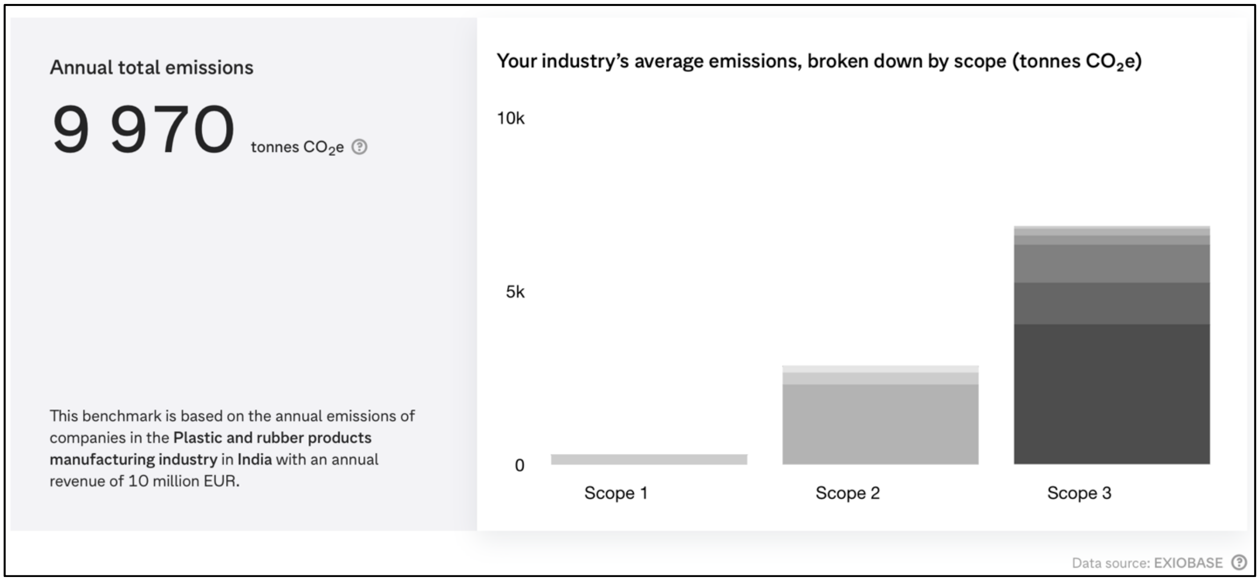


Figure 7 - Results for similar sized Chinese company's operations using Normative.

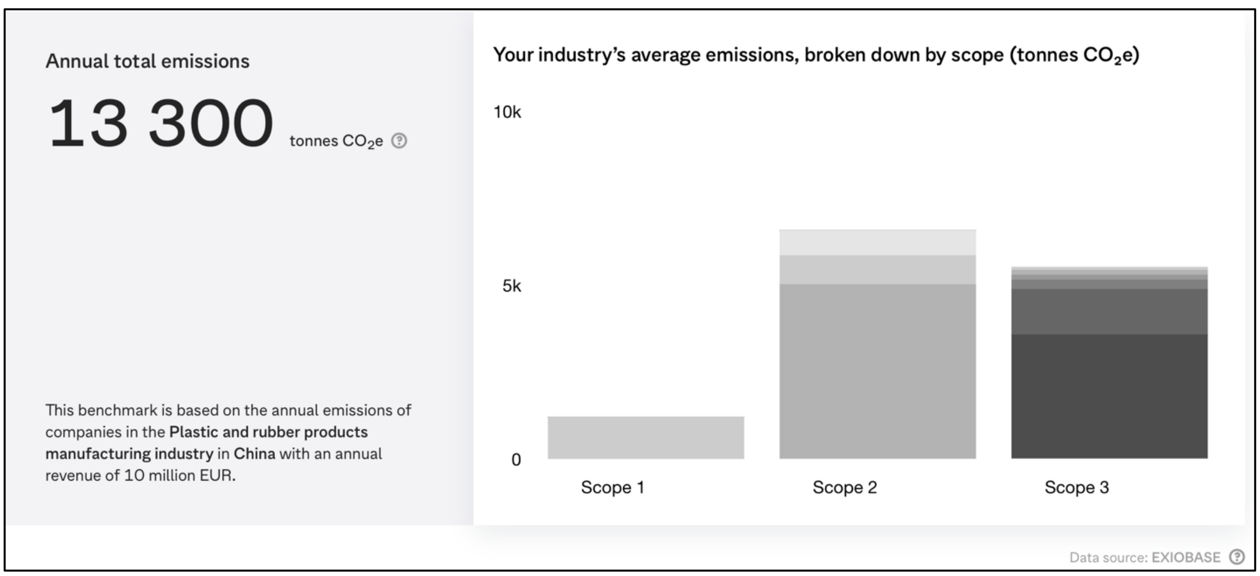


Figure 8 - Comparative differences between Scope 1, Scope 2 and Scope 3 emissions in the Plastics and Rubber Products Manufacturing Industry between IMPAK, India and China.

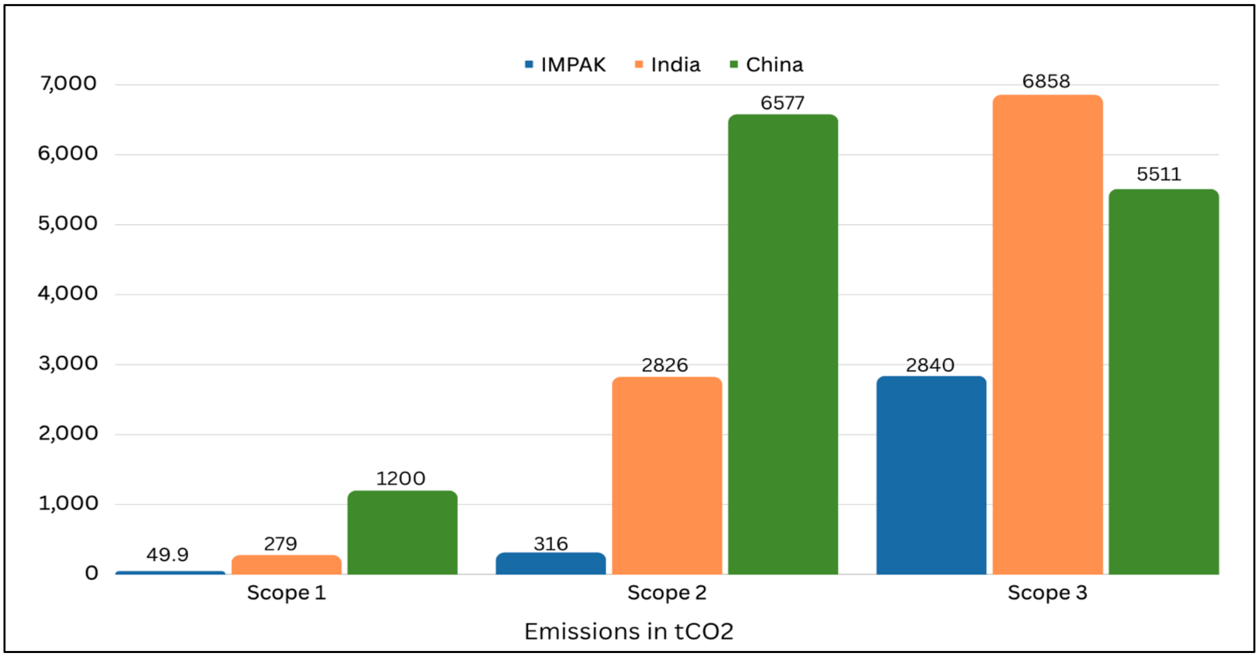
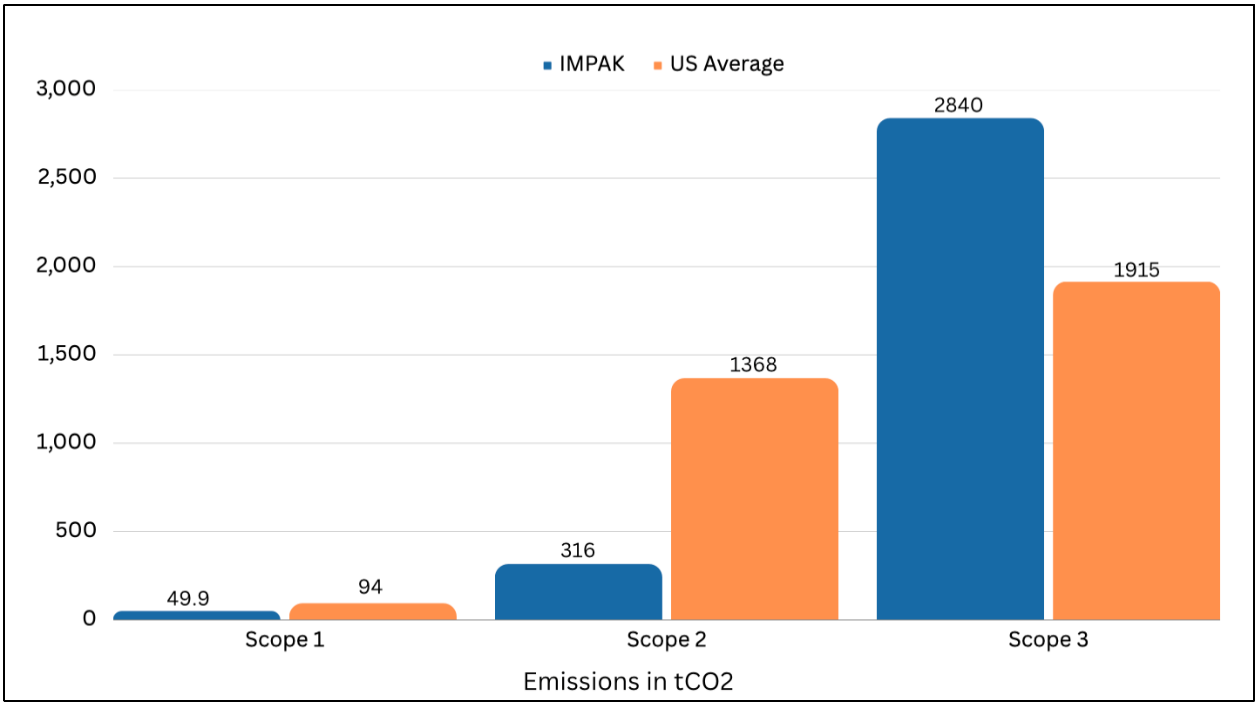


Figure 9 – Difference between IMPAK Operations and average US operations in the Plastics and Rubber Products Manufacturing with similar revenue.



Total US Average = 3380 t CO_2, Total IMPAK = 3200 t CO_2

Figure 9 – Emissions to Transport PolyMailers into the US

Emissions Factor from sea transport	0.05	kg CO_2e	
km from Mumbai to Houston	17,837	km	
km from Beijing to Houston	21,421	km	
poly mailers produced 2022	6,505,800	units	
weight of 1 poly mailer	20	grams	
weight of total poly mailers	130,116,000	grams	
weight of total poly mailers	130.116	tons	
total emissions from India	116,043	kg CO_2e	= weight of good tons x distance traveled km x emissions factor
	116.04	t CO_2e	
total emissions from China	139,361	kg CO_2e	
	139.36	t CO_2e	

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