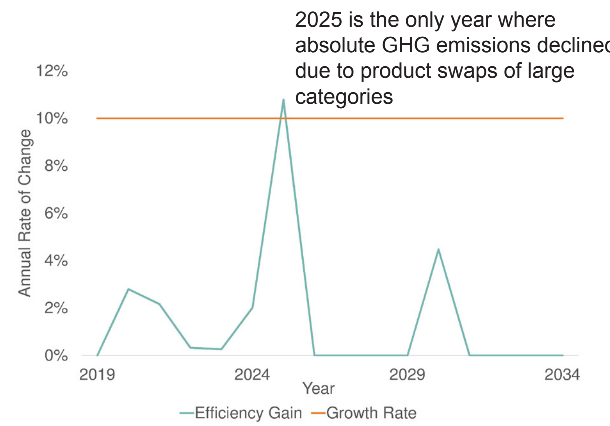
KEY FINDINGS

Patagonia and other apparel companies can proactively address environmental impacts during the design phase of products by using alternative material and dye technologies.

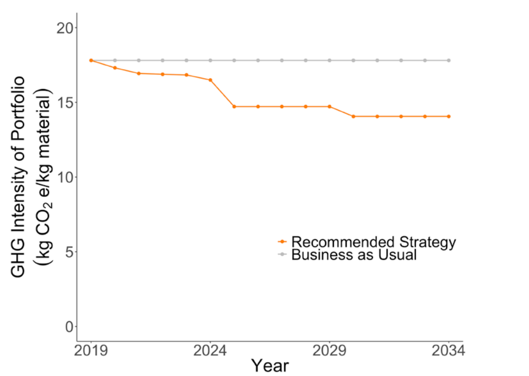
There is a tension between assumed company growth (orange) and the GHG savings rate (teal), which poses a challenge to reducing net GHG emissions.

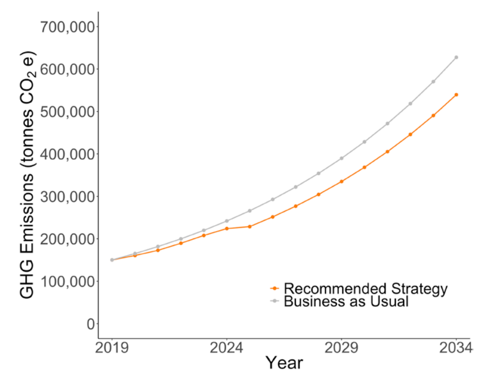
Limiting company growth was analyzed as a way to address this tension. To supplement the GHG savings from adopting the product swaps from the recomended strategy, Patagonia would need to restrict annual growth to **1.58%** to keep emissions at 2019 levels by the end of 2034.

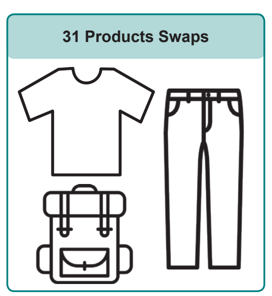


RECOMMENDATIONS

The recommended strategy for emissions reduction includes 31 product swaps. This results in approximately a 15% reduction in overall GHG emissions aggregated over the 15-year timeframe, compared to business as usual.







15% reduction in GHG emissions between 2019-2034

Implementing the recommended strategy decreases the GHG intensity of Patagonia's entire product portfolio as the 31 product swaps occur over the 15-year timeframe (left). When the GHG intensities are applied to the mass of products (right), GHG emissions are lower but continue to rise with annual growth.

To understand the full scope of apparel production's environmental impacts, other categories, such as water scarcity and eutrophication, should be analyzed. Considering these other impacts may yield different product change recommendations.

ACKNOWLEDGEMENTS AND REFERENCES

We would like to thank our advisors Dr. Roland Geyer, Jason Maier, Dr. Sangwon Suh, and Dr. Lisa Leombruni, as well as our clients Elissa Foster, Elena Egorova, and Steph Karba.

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More information about the project can be found at https://sustainapparel.wixsite.com/groupproject or by contacting gp-sustainapparel@bren.ucsb.edu.

REDUCING GREENHOUSE GAS EMISSIONS THROUGH MATERIALS INNOVATION IN THE APPAREL INDUSTRY

Giovanna Davila | Camille Herrera | Derek Hunter | Caitlin Martin | Bri Winkler

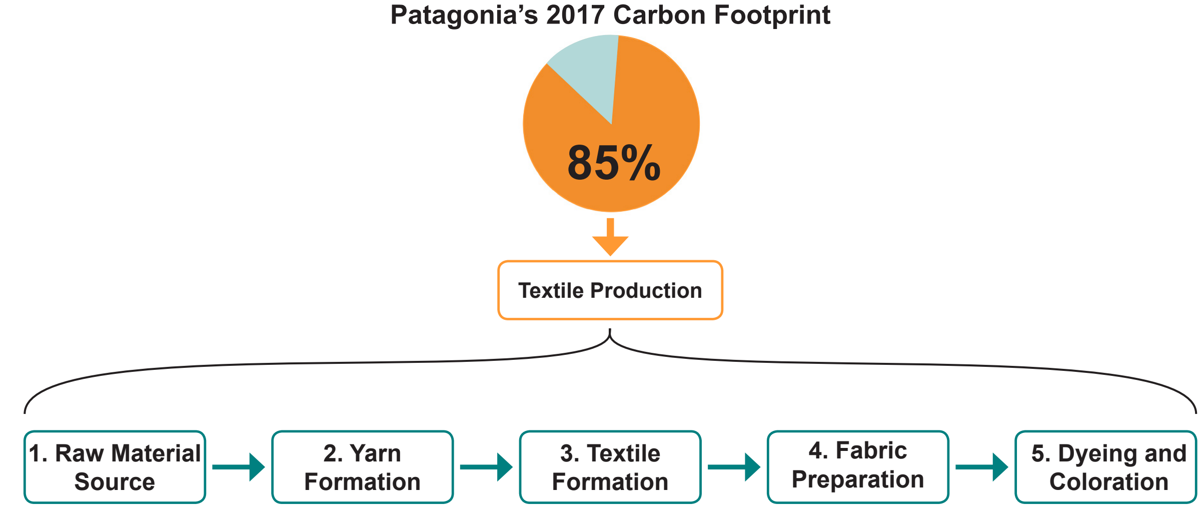
Advisor: Dr. Roland Geyer | PhD Mentor: Jason Maier

PROJECT MOTIVATION

The apparel industry accounts for 6.7% of global greenhouse gas (GHG) emissions.[1] In response, apparel companies are focusing on reducing their carbon footprints by setting aggressive GHG reduction goals, such as carbon neutrality and science-based targets.

Through a company-wide carbon footprint assessment for fiscal year 2017, Patagonia found that textile production accounts for 85% of total company GHG emissions.[2]

Patagonia's 2017 Carbon Footprint



Two stages of textile production were analyzed: raw material source and dyeing and coloration. Innovations in the apparel industry typically fall under material and dye technologies, and Patagonia has the ability to implement changes in these two stages.

RESEARCH QUESTIONS

To investigate how Patagonia can feasibly set and attain GHG reduction targets, the project was structured around the following research questions:

1. What are the GHG intensities of alternative materials and dyes?
2. How much can Patagonia reduce its GHG emissions by implementing less impactful materials and dyes?
3. How can a growing company like Patagonia feasibly reduce absolute GHG emissions?

APPROACH

61 changes in raw material source, dye technology, or a combination of the two were identified for various products in Patagonia's portfolio. The graphic below illustrates how these product swaps work.

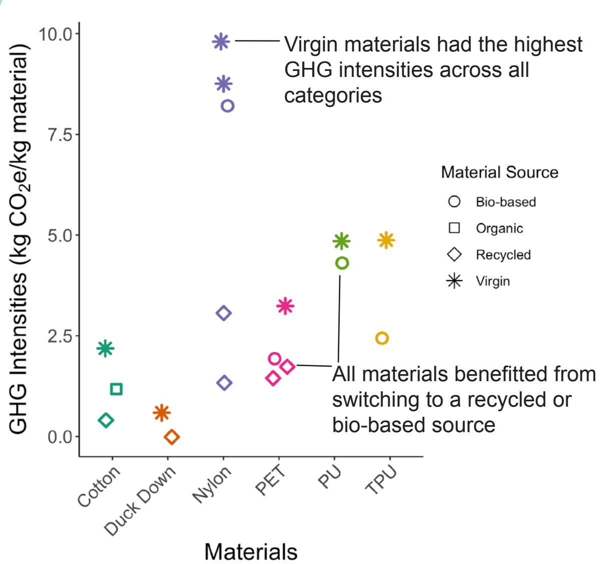
	Existing	Alternative
Raw Material Source	Conventional	Bio-based Recycled Organic
Dyeing and Coloration	Conventional	Energy-reducing Water-reducing Chemical-reducing

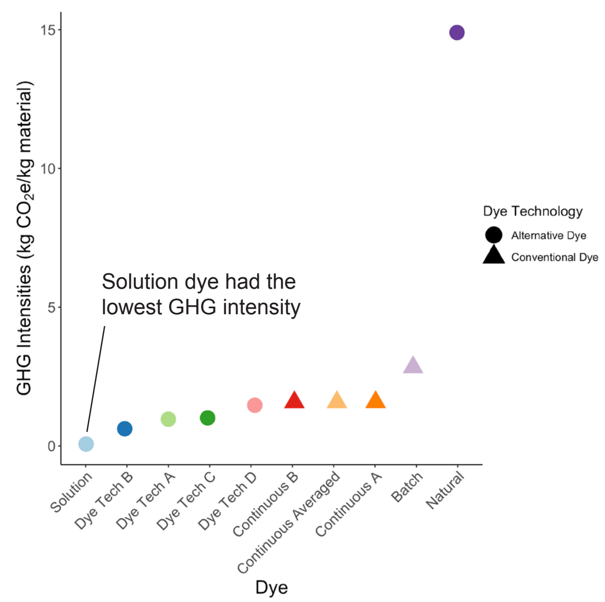
For each product swap, the GHG intensity of an existing material or dye technology was swapped for the alternative GHG intensity, and the resulting change in GHG emissions was calculated. The GHG intensity is the rate of GHG emissions per unit of material. By multiplying the GHG intensity by the mass of the products, the result is GHG emissions.

GHG Intensity (kg CO_2e/ kg material) x **Product Mass** (kg material) = **GHG Emissions** (kg CO_2e)

RESULTS

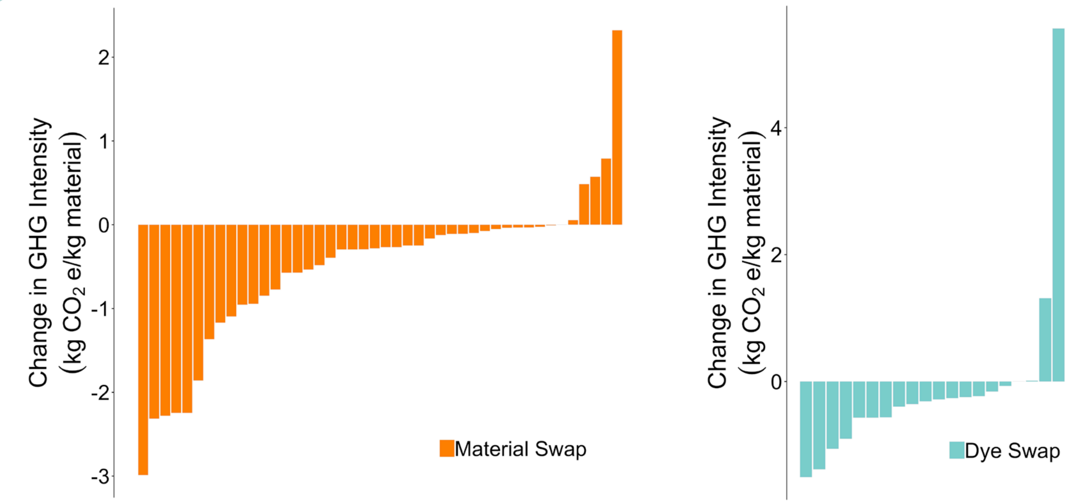
Different raw material and dye technologies have varying GHG intensities.





The GHG intensities (kg CO_2e/kg material) of conventional and alternative technologies: raw materials (left) and dyes (right).

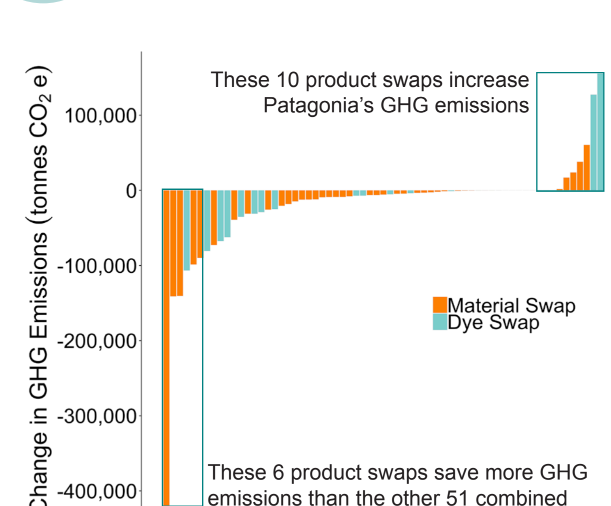
While 51 of the product swaps decreased GHG intensity, 10 product swaps made the impacted products more GHG intensive.

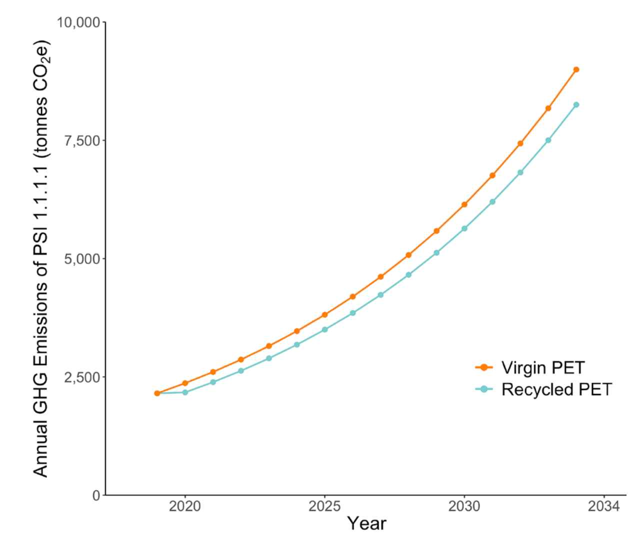


The graphs above show changes in GHG intensity (kg CO_2e/kg material) for material (left*) and dye (right) technologies. Decreases in GHG intensity are below the x-axis and increases are above. Changes in raw materials led to the reduction of GHG intensities in 39 product swaps. Changes in dye technologies led to the reduction of GHG intensities in 16 product swaps.

**Due to scale, PSI 1.2.1.2; 3.2.4; 4.3.5 with GHG intensity changes -48.19; -46.67; +30.99 kg CO_2e/kg material, respectively, were excluded.*

Changes in GHG intensity, multiplied by the mass of products impacted in each product swap, determine changes in GHG emissions. All product masses increase exponentially with company growth.





Changes in total GHG emissions (tonnes CO_2e) over the 15-year timeframe for all 61 product swaps. Each bar represents a product swap and those below the x-axis represent a decrease in GHG emissions compared to its baseline.

This is an example of GHG emissions savings (tonnes CO_2e) from one product swap. Once the change occurred in 2020, there was an immediate decrease in GHG emissions. As more products are sold over time, GHG emissions continue to increase exponentially.