# LCA Report: Peloton de Paris Cycling Jerseys

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**Delivered to Peloton de Paris**

# Table of Contents

## Executive Summary

This report details the cradle-to-distribution life-cycle assessment (LCA), undertaken by CleanMetrics, for two of Peloton de Paris's cycling jerseys, the Anibal/Matrix jersey and the Fez/Green Fly recycled jersey. The impact categories of interest are embodied carbon, embodied energy and embodied water[1]. The LCA is based on standards, and uses the best-available secondary life-cycle inventory (LCI) data for materials, energy and waste disposal. Peloton de Paris provided the activity data which quantifies the manufacturing process and supply chain.

The table summarizes the results of the life-cycle impact assessment (LCIA) for the two jerseys. The three life-cycle impact categories considered in this study are embodied carbon (Kg CO2e), embodied energy (MJ) and embodied water (L).

| Anibal/Matrix EU sourced Jersey | Carbon | Energy | Water |
|---|---|---|---|
| Energy use (fuel, electricity) | 3.26 | 48.41 | 0.00 |
| Inflows (materials, goods, services) | 3.60 | 63.96 | 36.06 |
| Transport | 1.35 | 17.93 | 0.00 |
| Waste disposal | 0.02 | (0.03) | 0.00 |
| Total | **8.23** | **130.27** | **36.06** |

| Fez/GreenFly (EU + Recycled) | Carbon | Energy | Water |
|---|---|---|---|
| Energy use (fuel, electricity) | 2.52 | 37.48 | - |
| Inflows (materials, goods, services) | 2.13 | 48.63 | 2.19 |
| Transport | 1.03 | 13.65 | - |
| Waste disposal | 0.01 | (0.02) | - |
| Total | **5.69** | **99.74** | **2.19** |

| % Impact of Recycled Jersey to Ori | Carbon | Energy | Water |
|---|---|---|---|
| Energy use (fuel, electricity) | 77% | 77% | - |
| Inflows (materials, goods, services) | 59% | 76% | 6% |
| Transport | 76% | 76% | - |
| Waste disposal | 84% | 84% | - |
| Total | **69%** | **77%** | **6%** |

The key takeaways and recommendations from the LCIA results and sensitivity analysis follow:

- The Fez/GreenFly recycled jersey has a much lower impact than the original Anibal/Matrix jersey across all three life-cycle-impact categories analyzed. It has

[1] The terms "embodied carbon" and "carbon footprint" are synonymous and refer to the climate change impact. Similarly, the terms "embodied water" and "water footprint" are synonymous.

only 69% and 77% of the embedded carbon and energy impact, and but 6% of the embedded water impact.

- This improvement comes from the reduced weight of the recycled jersey and from the use of recycled rather than virgin materials. The value of using recycled materials is especially apparent from the embodied water.
- Most of the carbon and energy impact comes from the energy embedded in fabric production and the fiber production for both types of jerseys. Sourcing fibers and fabrics from Europe rather than China results in 10% less embedded carbon. Sensitivity results shows that fiber and fabric production have the highest embedded carbon even if the estimates are off by +/- 50%.
- Neither the zipper nor the bag make a significant contribution across any of the life-cycle-impact categories analysed.
- Despite the large distances associated with the supply chain, the transportation link with the greatest impact is the relatively short distance between the factory and warehouse traversed by air. If it is logistically feasible, switching to ground transportation for delivering the jerseys to the warehouse in Belgium would further reduce the overall carbon and energy impacts by 20% and 14% respectively.

# 1. Introduction

This report details the cradle-to-distribution life-cycle assessment (LCA), undertaken by CleanMetrics, of Peloton de Paris's two cycling jerseys. The impact categories of interest are embodied carbon (climate change), embodied energy and embodied water. The LCA is based on standards, and uses the best-available secondary life-cycle inventory (LCI) data for materials, energy and waste disposal. Peloton de Paris provided the activity data which quantifies the manufacturing process and supply chain for both cycling jerseys.

# 2. Standards

The LCA complies with and is guided by the following international standards for LCAs and product carbon footprinting: ISO 14040/14044; PAS 2050; and the ILCD Handbook: General guide for Life Cycle Assessment.

# 3. Goal and Scope Definition

The product system consists of the manufacture of one packaged cycling jersey and the supply chains used to source the necessary components and other materials that are consumed in the manufacture, including transportation to the warehouse.

The functional unit for the LCA is one packaged cycling jersey. We consider two types of jerseys, the original comprised of a blend of Anibal/Matrix fabric (Figure 1a) and one made from mostly recycled content, a blend of Fez/GreenFly Fabric (Figure 1b).

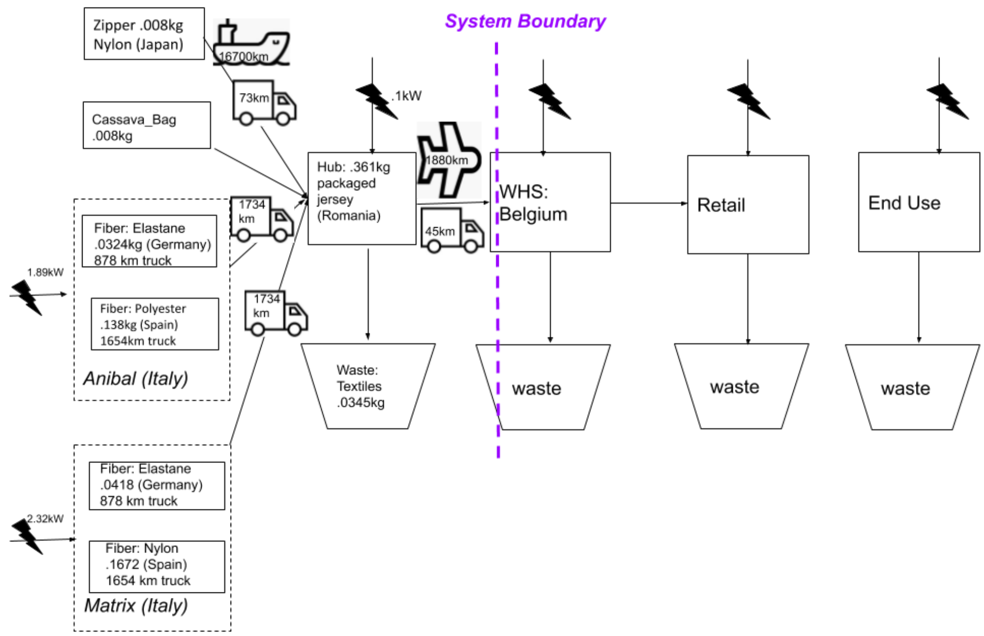
As seen in Figure 1a and 1b, the system boundary is cradle to distribution, starting from the extraction of raw materials and ending at the warehouse. This boundary is a slight extension on the traditional cradle to gate boundary, which ends with the factory's output gate. The system includes all raw material and component production, energy production, water production, solid waste disposal, wastewater treatment, production and assembly of finished products, incoming transportation, and packaging of the final products. This analysis ends at the warehouse and does not include warehouse activities, transport to distribution and retail locations, use phase, and end-of-life disposal.

The three life-cycle impact categories or footprints of interest in this LCA study are:

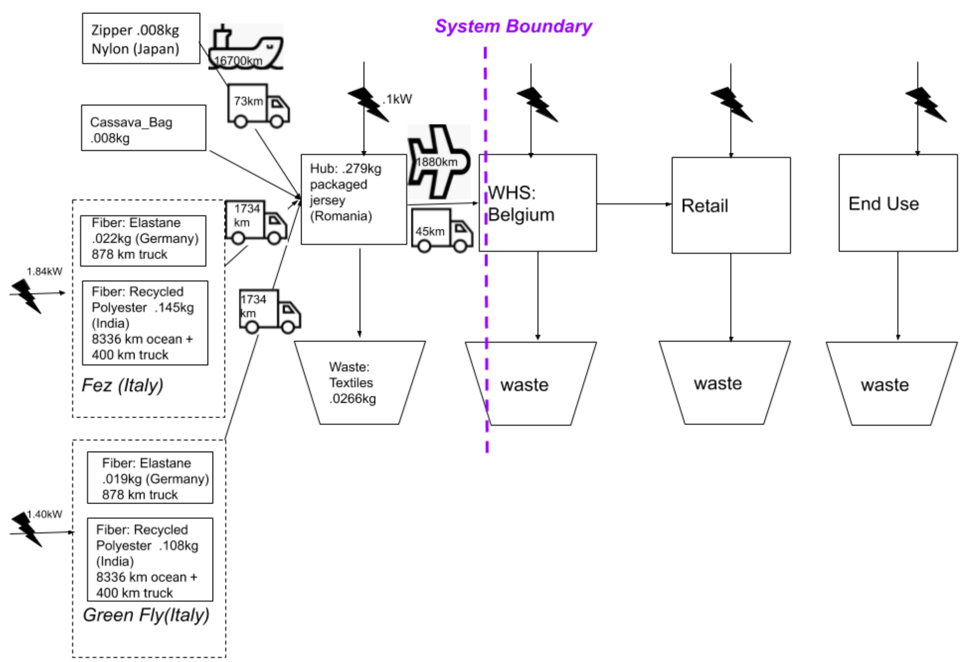
- **Embodied carbon** = carbon dioxide equivalent ($CO_2e$) emissions reflecting the major greenhouse gas emissions (generally carbon dioxide, methane and nitrous oxide) and quantifying the climate change impact, in units of Kg of $CO_2e$
- **Embodied energy** = primary energy combusted + feedstock energy, in units of MJ
- **Embodied water** = water consumption, in units of Liters

CarbonScope is used to conduct this LCA study for the purpose of quantifying and comparing the carbon, energy and water footprints for the two different types of packaged cycling jerseys.

### Figure 1a Life Cycle Inventory and System Boundaries for Anibal/Matrix Jersey




### Figure 1b Life Cycle Inventory and System Boundaries for Fez/GreenFly Jersey



## Table 1: Activity data for one packaged cycling jersey

| Purchased materials (all inputs needed for production of one functional unit, including agricultural commodities and water) | Description, if needed | Manufacturing location (zipcode or country) | Delivery or use location (zipcode or country) | Transport modes (truck, rail, ocean, air - could be more than one mode) | Transport distance for each mode (km or miles) | Material quantity and units (kg, tonne, lb, etc.) | Assumptions/ Substitutions/ Additional Notes |
|---|---|---|---|---|---|---|---|
| **Materials unique to the Anibal/Matrix Jersey** | | | | | | | |
| **Elastane** | For Anibal fabric | *Germany* | **Italy (Urgnano)** | Truck | *878km* | **.0324kg** | *10% additional weight added for loss during cutting, sub:elastane similar to virgin polyester fabric,* |
| | | **Italy (Urgnano)** | **Romania** | Truck | *1734km* | | |
| **Polyester (Virgin)** | For Anibal fabric | *Spain* | **Italy** | Truck | *1654km* | **0.138kg** | *10% additional weight added for loss during cutting Spain assumed as location start* |
| | | **Italy** | **Romania** | Truck | *1734km* | | |
| **Elastane** | For Matrix fabric | *Germany* | **Italy** | Truck | *878km* | **.0418kg** | *10% additional weight added for loss during cutting, sub:elastane similar to virgin polyester fabric,* |
| | | **Italy** | **Romania** | Truck | *1734km* | | |
| **Nylon** | For Matrix fabric | *Spain* | **Italy** | Truck | *1654km* | **.1672kg** | *10% additional weight added for loss during cutting Spain assumed as location start* |
| | | **Italy** | **Romania** | Truck | *1734km* | | |
| **Materials unique to the Fez/GreenFly Recycled Jersey** | | | | | | | |
| **Elastane** | For GreenFly fabr | ***Germany*** | **Italy (Urgnano)** | Truck | *878km* | **.019kg** | *10% additional weight added for loss during cutting, sub:elastane similar to virgin polyester fabric,* |
| | | **Italy (Urgnano)** | **Romania** | Truck | *1734km* | | |
| **Recycled Polyester** | For GreenFly fabr | **India** | **Italy** | Ocean + Truck | *8336km ocean + 398km truck* | **.108kg** | *10% additional weight added for loss during cutting* |
| | | **Italy** | **Romania** | Truck | *1734km* | | |
| **Elastane** | For Fez fabric | ***Germany*** | **Italy** | Truck | *878km* | **.022kg** | *10% additional weight added for loss during cutting, sub:elastane similar to virgin polyester fabric,* |
| | | **Italy** | **Romania** | Truck | *1734km* | | |
| **Recycled Polyester** | For Fez fabric | **India** | **Italy** | Ocean + Truck | *8336km ocean + 398km truck* | **.145kg** | *10% additional weight added for loss during cutting* |
| | | **Italy** | **Romania** | Truck | *1734km* | | |
| **Materials common to both Jerseys** | | | | | | | |
| **Zipper** | Nylon | *Japan* | **Romania** | Ocean + Truck | *16700km ocean + 75km truck* | **.008kg** | *presumed source for zipper ykk (Japan)* |
| **Cassava Bag** | Cassava Root | | | | | **.008kg** | *no orgin available, recycled paper subbed for casava* |

# 4. System Description and Activity Data

Table 1 details the activity data provided by Peloton de Paris for the fabrication of both cycling jerseys **in bold** and subsequent analysis by CleanMetrics *in italics* for missing data. While the CleanMetrics database is large, it is not exhaustive, so when substitutions were occasionally used they have been explicitly listed; this and other assumptions are explained further in Section 5.2 (Methodology Considerations). The activity data includes:

- Components and materials used in the production, including materials consumed.
- Transport of components and materials to the final assembly location.
- Energy and water used in the final assembly and packaging.
- Solid waste and wastewater generated in the final assembly.
- Recyclable waste generated in the manufacturing process.

# 5. Life-cycle Data and Methodology

### *5.1 Life-cycle Inventory Data*

The analysis leverages the CleanMetrics CarbonScopeData life-cycle inventory (LCI) database. CarbonScopeData is one of the largest and most comprehensive LCI databases in North America. Additional materials that contribute non-trivially to the final impacts and not currently in the database have been researched and added as needed.

Table 2a and 2b list the per-unit embodied carbon, embodied energy and embodied water used in the analysis for all materials, energy and waste for the Anibal/Matrix Jersey and Fez/GreenFly recycled jersey, respectively. All of the significant materials and all of the energy sources have been mapped to the best available secondary data from the LCI database as listed in the table. It is necessary to use secondary data since suppliers do not usually provide any specific data regarding their internal manufacturing processes. Secondary data for a specific material or manufacturing process generally represents a typical process, a similar process or an average of similar processes. Sometimes multiple data points for specific materials exist, and we have used our best judgment in conjunction with input from Peloton de Paris to choose the most suitable data points.

## Table 2a- Annibal/Matrix embodied carbon/energy/water from LCI database

| Model Name | Process Type | Process | Quantit | Units | Carbon | Energy | Water |
|---|---|---|---|---|---|---|---|
| Fabric-Anibal-EU:Hub | Energy | Electricity (grid mix) - grid: Italy | 1.89 | KWh | 1.435 | 21.314 | 0 |
| Fabric-Matrix-EU:Hub | Energy | Electricity (grid mix) - grid: Italy | 2.32 | KWh | 1.762 | 26.163 | 0 |
| zipper:MaterialIn | Material/Process (cradl | Polyamide 6 (Nylon 6), Europe | 0.008 | kg | 0.073 | 0.964 | 1.48 |
| Fabric-Matrix-EU:Nylon-Spain | Material/Process (cradl | Polyamide 6 (Nylon 6), Europe | 0.1672 | kg | 1.522 | 20.143 | 30.93 |
| Fabric-Anibal-EU:Elastane-Germany | Material/Process (cradl | Polyester fiber, Virgin, USA | 0.0324 | kg | 0.305 | 6.523 | 0.56 |
| Fabric-Anibal-EU:Spanish-Polyester | Material/Process (cradl | Polyester fiber, Virgin, USA | 0.138 | kg | 1.300 | 27.784 | 2.37 |
| Fabric-Matrix-EU:Elastane-Germany | Material/Process (cradl | Polyester fiber, Virgin, USA | 0.0418 | kg | 0.394 | 8.416 | 0.72 |
| zipper:MaterialIn | Transport | Ocean, large tanker | 16700 | km | 0.000 | 0.006 | 0 |
| zipper:MaterialIn | Transport | Semi-trailer truck | 73 | km | 0.000 | 0.001 | 0 |
| Fabric-Anibal-EU:ManufacturingToWarehou | Transport | Semi-trailer truck | 1734 | km | 0.022 | 0.292 | 0 |
| Fabric-Anibal-EU:Elastane-Germany | Transport | Semi-trailer truck | 878 | km | 0.002 | 0.028 | 0 |
| Fabric-Anibal-EU:Spanish-Polyester | Transport | Semi-trailer truck | 1645 | km | 0.017 | 0.224 | 0 |
| Fabric-Matrix-EU:ManufacturingToWareho | Transport | Semi-trailer truck | 1734 | km | 0.027 | 0.358 | 0 |
| Fabric-Matrix-EU:Elastane-Germany | Transport | Semi-trailer truck | 878 | km | 0.003 | 0.036 | 0 |
| Fabric-Matrix-EU:Nylon-Spain | Transport | Semi-trailer truck | 1654 | km | 0.021 | 0.273 | 0 |
| Hub | Energy | Electricity (grid mix) - grid: Central/Ea | 0.1 | KWh | 0.060 | 0.939 | 0 |
| bag | Material/Process (cradl | Paper, Kraft, unbleached, 100% recyc | 0.008 | kg | 0.009 | 0.128 | 0 |
| ManufacturingWaste | Solid Waste | Textiles (Landfill, Anerobic) | 0.0345 | kg | 0.016 | (0.027) | 0 |
| Romania-to-Belgium | Transport | Air, short haul | 1880 | km | 1.258 | 16.691 | 0 |
| Romania-to-Belgium | Transport | Semi-trailer truck | 45 | km | 0.001 | 0.016 | 0 |
| | | **Total** | | | **8.228** | **130.270** | **36.06** |

## Table 2b Fez/GreenFly embodied carbon/energy/water from LCI database

| Model Name | Process Type | Process | Quantity | Units | Carbon | Energy | Water |
|---|---|---|---|---|---|---|---|
| Fabric-Fez-EU:Hub | Energy | Electricity (grid mix) - grid: Italy | 1.84 | KWh | 1.40 | 20.75 | - |
| Fabric-Greenfly-EU:Hub | Energy | Electricity (grid mix) - grid: Italy | 1.4 | KWh | 1.06 | 15.79 | - |
| zipper:MaterialIn | Material/Process (cradl | Polyamide 6 (Nylon 6), Europe | 0.008 | kg | 0.07 | 0.96 | 1.48 |
| Fabric-Fez-EU:RecycledPoly | Material/Process (cradl | Polyester fiber, Recycled, China | 0.145 | kg | 0.95 | 22.52 | - |
| Fabric-Greenfly-EU:RecycledPoly | Material/Process (cradl | Polyester fiber, Recycled, China | 0.108 | kg | 0.71 | 16.77 | - |
| Fabric-Fez-EU:Elastane-Germany | Material/Process (cradl | Polyester fiber, Virgin, USA | 0.022 | kg | 0.21 | 4.43 | 0.38 |
| Fabric-Greenfly-EU:Elastane-Germa | Material/Process (cradl | Polyester fiber, Virgin, USA | 0.019 | kg | 0.18 | 3.83 | 0.33 |
| zipper:MaterialIn | Transport | Ocean, large tanker | 16700 | km | 0.00 | 0.01 | - |
| Fabric-Fez-EU:RecycledPoly | Transport | Ocean, large tanker | 8336 | km | 0.00 | 0.05 | - |
| Fabric-Greenfly-EU:RecycledPoly | Transport | Ocean, large tanker | 8336 | km | 0.00 | 0.04 | - |
| zipper:MaterialIn | Transport | Semi-trailer truck | 73 | km | 0.00 | 0.00 | - |
| Fabric-Fez-EU:ManufacturingToWa | Transport | Semi-trailer truck | 1734 | km | 0.02 | 0.29 | - |
| Fabric-Fez-EU:Elastane-Germany | Transport | Semi-trailer truck | 878 | km | 0.00 | 0.02 | - |
| Fabric-Fez-EU:RecycledPoly | Transport | Semi-trailer truck | 400 | km | 0.00 | 0.06 | - |
| Fabric-Greenfly-EU:Manufacturing | Transport | Semi-trailer truck | 1734 | km | 0.02 | 0.22 | - |
| Fabric-Greenfly-EU:Elastane-Germa | Transport | Semi-trailer truck | 878 | km | 0.00 | 0.02 | - |
| Fabric-Greenfly-EU:RecycledPoly | Transport | Semi-trailer truck | 400 | km | 0.00 | 0.04 | - |
| Hub | Energy | Electricity (grid mix) - grid: Cent | 0.1 | KWh | 0.06 | 0.94 | - |
| MaterialIn | Material/Process (cradl | Paper, Kraft, unbleached, 100% | 0.008 | kg | 0.01 | 0.13 | - |
| ManufacturingWaste | Solid Waste | Textiles (Landfill, Anerobic) | 0.029 | kg | 0.01 | (0.02) | - |
| Romania-to-Belgium | Transport | Air, short haul | 1880 | km | 0.97 | 12.90 | - |
| Romania-to-Belgium | Transport | Semi-trailer truck | 45 | km | 0.00 | 0.01 | - |
| | Total | | | | **5.69** | **99.74** | **2.19** |

As this study uses existing secondary LCI data collected from a wide variety of sources over time, the global warming potentials (GWPs) used in this study for material inputs are based on the IPCC Fourth Assessment Report[2]. GWPs from the IPCC Fifth Assessment Report are used for fuel combustion in electricity generation and/or directly in the manufacturing process.

[2] Although it would have been desirable to use the more recent GWPs from the Fifth Assessment, it is not practical to change this in the existing LCI data and any difference in the final results would have been quite marginal in any case since the emissions are dominated by carbon dioxide (the other two important greenhouse gases, methane and nitrous oxide, are generally minor contributors in LCAs like this and the GWPs for these vary only by +/- 10% between the Fourth and Fifth Assessments).

### *5.2 Methodology Considerations*

We list here several important methodology considerations that we apply to LCA studies in general:

1. Use of placeholders/substitutions for missing data, and the use of sensitivity analysis to verify that the placeholders do not materially change the final results.
2. Use of hybrid modeling (process LCI combined with selective use of EEIO LCI) when data is missing or is of low quality in the process LCI database.
3. Avoidance of cutoffs (i.e., completely omitting some inputs due to lack of data - this is a last resort for many LCAs) by using placeholders and hybrid modeling.
4. Recycling of waste as an output as well as use of recycled materials as inputs are both handled using the "recycled content" method.
5. Allocation of environmental burdens to co-products will be based on the economic values of the co-products. Mass-based allocation is generally avoided.
6. Production of capital goods is excluded from the product life-cycle impacts.
7. Time-based modeling of carbon storage and carbon releases follows the PAS 2050 standard and applies to carbon in soils, landfilled waste, concrete, wood/trees, etc.

The following placeholders and modeling decisions apply specifically to the cycling jersey systems in this study:

1. Based on LCA literature,the fiber manufacture for Elastane is similar to PET (polyester). Virgin polyester is thus used as a substitute for Elastane.
2. Data for the final jersey assembly from the inputs was not provided to us. Sewing is a process consuming relatively low energy (.08 - .2kW/hour, per sewing machine). A placeholder of .1kW shows that even assuming a high energy .2kW and low productivity (2 jerseys/hour) yields little impact.
3. Fiber production by country is a level of granularity that is not currently available in the LCI database and is divided into regions with cleaner energy inputs (US) and more carbon intensive ones (China). Thus, fiber production within the EU and India are assumed to be similar to the US and China, respectively.
4. We substitute recycled paper bags for cassava bags, as both are plant-based and did not include transport. The low weight and recycled nature of the bag makes any impact of this bag negligible.
5. Based on Peloton de Paris's estimates, cutting waste is captured by inflating inputs by 10%, and the disposal of scraps is assumed to be localized, so no transport was modeled.

## 6. Inventory Analysis and Impact Assessment

The inventory analysis step constructs a model of the entire cradle to distribution product system, combining processes such as the production of the components and materials used for production, transportation, energy use, and waste disposal. This generally combines the LCI data for all the individual processes and generates an aggregated table of emissions and resource uses (collectively known as environmental flows) for the full product system. The impact assessment step converts these environmental flows into contributions to the relevant impact categories. This conversion, known as characterization, generates the final life-cycle impact figures for the categories of interest.

### *6.1 Life-cycle Impact Assessment Results*

The LCI database and other data sources used in this study merge these two steps and provide data for the impact categories directly. For the purposes of this study, these impact categories are embodied carbon, embodied energy and embodied water as defined in Section 2. Table 3 summarizes the results of the life-cycle impact assessment (LCIA) for the baseline system and shows the contributions of each process category to each of the three impact categories.  Additional details are available in the spreadsheet delivered along with this report.

**Table 3 Life-cycle Impact Assessment (LCIA) Results for Both Jerseys**

| Anibal/Matrix EU sourced Jersey | Carbon | Energy | Water |
|---|---|---|---|
| Energy use (fuel, electricity) | 3.26 | 48.41 | 0.00 |
| Inflows (materials, goods, services) | 3.60 | 63.96 | 36.06 |
| Transport | 1.35 | 17.93 | 0.00 |
| Waste disposal | 0.02 | (0.03) | 0.00 |
| Total | **8.23** | **130.27** | **36.06** |

| Fez/GreenFly (EU + Recycled) | Carbon | Energy | Water |
|---|---|---|---|
| Energy use (fuel, electricity) | 2.52 | 37.48 | - |
| Inflows (materials, goods, services) | 2.13 | 48.63 | 2.19 |
| Transport | 1.03 | 13.65 | - |
| Waste disposal | 0.01 | (0.02) | - |
| Total | **5.69** | **99.74** | **2.19** |

| % Impact of Recycled Jersey to Ori | Carbon | Energy | Water |
|---|---|---|---|
| Energy use (fuel, electricity) | 77% | 77% | - |
| Inflows (materials, goods, services) | 59% | 76% | 6% |
| Transport | 76% | 76% | - |
| Waste disposal | 84% | 84% | - |
| Total | **69%** | **77%** | **6%** |

Figures 2, 3 and 4 illustrate the results using charts to show the relative magnitudes of the various contributors to the three impact categories in comparison for the Fez/Greenfly Recycled Jersey (in blue) to the Anibal/Matrix Jersey (in red).

**Figure 1 Embodied carbon breakdown**

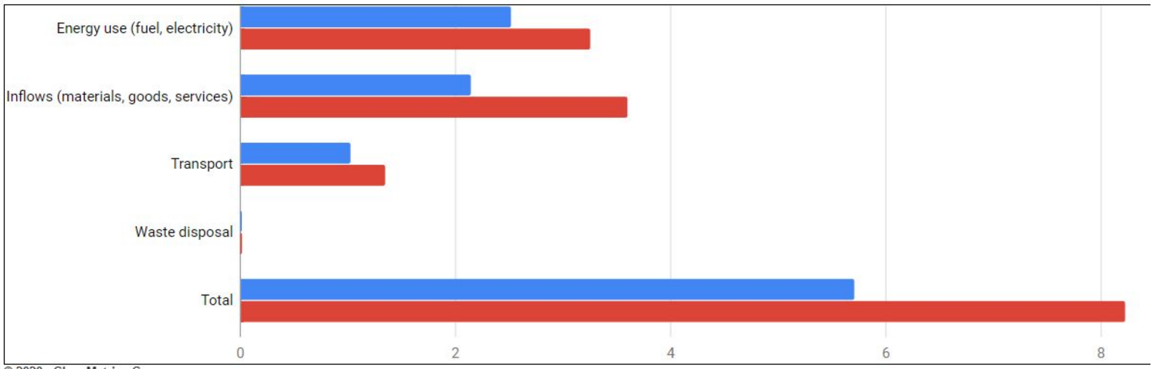



**Figure 2 Embodied energy breakdown**

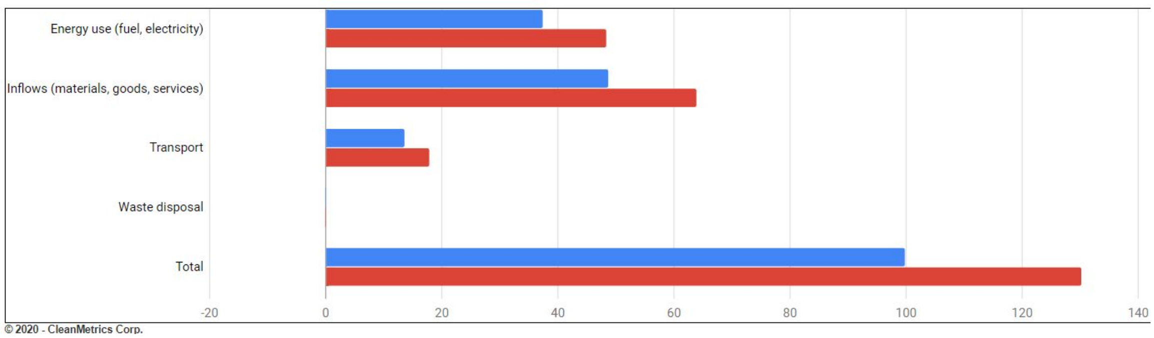



**Figure 3 Embodied water breakdown**

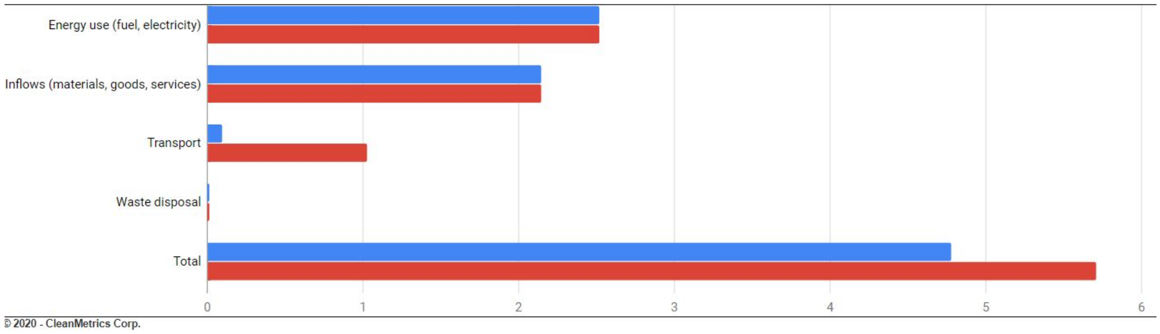

### *6.2 Alternate Scenarios*

Table 4 summarizes the impacts of the alternate scenario, using ground transport (Trucking from Romania to Belgium) instead of airfreight for the recycled jersey, reducing the embodied carbon by 20% and energy by 14%. While the impact is not as pronounced as the switch to recycled materials is, this alternative may be worth investigating should a reliable LTL trucking service or parcel carrier be available.

**Table 4 LCIA Results for Base and Alternate Transport Scenario for Fez/GreenFly Jersey**

| Category | Carbon | Carbon-Airhaul avoided | Energy - % Change | Energy | Energy-Airhaul avoided | Energy - % Change |
|---|---|---|---|---|---|---|
| Energy use (fuel, elect | 2.52 | 2.52 | - | 37.48 | 37.48 | - |
| Inflows (materials, go | 2.13 | 2.13 | - | 48.63 | 48.63 | - |
| Transport | 1.03 | 0.10 | 945% | 13.65 | 1.29 | 958% |
| Waste disposal | 0.01 | 0.01 | - | (0.02) | (0.02) | - |
| **Total** | **5.69** | **4.76** | **20%** | **99.74** | **87.38** | **14%** |

Figure 4 Comparing Trucking to Airfreight for Fez/GreenFly Recycled Jersey




# 7. Interpretation and Conclusion

The interpretation step primarily deals with the meaning and robustness of the impact assessment results presented in the previous section. We will first address the robustness question and then move on to the takeaways from the results and next steps.

### *7.1 Sensitivity Analysis*

The key issues around the robustness, uncertainties and limitations of the underlying LCI data were discussed in Section 5. A standard way of examining the robustness of a modeling exercise is through a sensitivity analysis of the model parameters. Table 5a and 5b summarize the results of a sensitivity analysis on the LCIA results. It shows the percentage contribution of each process to the total embodied carbon, energy and water. In addition, these tables show the percentage by which the total embodied carbon for the product system would vary if the embodied carbon for an individual process varied by -50% and +50% due to extreme errors and uncertainties in either the activity data or the emission factors. As the fiber and fabric production processes are the ones with the largest carbon impacts, they are also the ones which exhibit the greatest sensitivity. Fortunately, the bill-of-materials for both jersey's fabrics has been well documented by Peloton de Paris, and the underlying data for these processes is supported by papers referenced in the CarbonScopeData database. The processes that we had less data for, such as those associated with the production and transport of the zipper and bag, the sewing and disposal of the cuttings, and the non-air transport links have little potential impact.

Due to our misunderstanding of where the fabrics were sourced from, we erroneously had all fiber and fabric production sourced in China for our first pass. When we revisited these assumptions and instead used European sources for all fabrics save the recycled polyester (which comes from India), the overall carbon and energy footprint for both jerseys improved by 10% and 2% respectively, as shown in Table 5 for Fez/Green Fly Jersey. The Anibal/Matrix jersey exhibits a similar improvement. Fiber and fabric production are high energy processes, and Europe's electricity is less carbon-intensive.

## Table 5a Sensitivity Analysis Results for Anibal/Matrix Recycled Jersey

| Model Name | Process Type | Process | Quant | Uni | Carbon | Energy | Water | Carbon % | Carbon - 50% | Carbon +50% | Energy % | Water % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fabric-Anibal-EU:Hub | Energy | Electricity (grid mix) - grid: Italy | 1.89 | KWh | 1.44 | 21.31 | - | 17% | -9% | 9% | 16% | 0% |
| Fabric-Matrix-EU:Hub | Energy | Electricity (grid mix) - grid: Italy | 2.32 | KWh | 1.76 | 26.16 | - | 21% | -11% | 11% | 20% | 0% |
| zipper:MaterialIn | Material/Process (crac | Polyamide 6 (Nylon 6), Europe | 0.008 | kg | 0.07 | 0.96 | 1.48 | 1% | 0% | 0% | 1% | 4% |
| Fabric-Matrix-EU:Nylon-Spain | Material/Process (crac | Polyamide 6 (Nylon 6), Europe | 0.1672 | kg | 1.52 | 20.14 | 30.93 | 18% | -9% | 9% | 15% | 86% |
| Fabric-Anibal-EU:Elastane-Germa | Material/Process (crac | Polyester fiber, Virgin, USA | 0.0324 | kg | 0.31 | 6.52 | 0.56 | 4% | -2% | 2% | 5% | 2% |
| Fabric-Anibal-EU:Spanish-Polyest | Material/Process (crac | Polyester fiber, Virgin, USA | 0.138 | kg | 1.30 | 27.78 | 2.37 | 16% | -8% | 8% | 21% | 7% |
| Fabric-Matrix-EU:Elastane-Germ | Material/Process (crac | Polyester fiber, Virgin, USA | 0.0418 | kg | 0.39 | 8.42 | 0.72 | 5% | -2% | 2% | 6% | 2% |
| zipper:MaterialIn | Transport | Ocean, large tanker | 16700 | km | 0.00 | 0.01 | - | 0% | 0% | 0% | 0% | 0% |
| zipper:MaterialIn | Transport | Semi-trailer truck | 73 | km | 0.00 | 0.00 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Anibal-EU:ManufacturingT | Transport | Semi-trailer truck | 1734 | km | 0.02 | 0.29 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Anibal-EU:Elastane-Germa | Transport | Semi-trailer truck | 878 | km | 0.00 | 0.03 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Anibal-EU:Spanish-Polyest | Transport | Semi-trailer truck | 1645 | km | 0.02 | 0.22 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Matrix-EU:Manufacturing | Transport | Semi-trailer truck | 1734 | km | 0.03 | 0.36 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Matrix-EU:Elastane-Germ | Transport | Semi-trailer truck | 878 | km | 0.00 | 0.04 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Matrix-EU:Nylon-Spain | Transport | Semi-trailer truck | 1654 | km | 0.02 | 0.27 | - | 0% | 0% | 0% | 0% | 0% |
| Hub | Energy | Electricity (grid mix) - grid: Cent | 0.1 | KWh | 0.06 | 0.94 | - | 1% | 0% | 0% | 1% | 0% |
| bag | Material/Process (crac | Paper, Kraft, unbleached, 100% | 0.008 | kg | 0.01 | 0.13 | - | 0% | 0% | 0% | 0% | 0% |
| ManufacturingWaste | Solid Waste | Textiles (Landfill, Anerobic) | 0.0345 | kg | 0.02 | (0.03) | - | 0% | 0% | 0% | 0% | 0% |
| Romania-to-Belgium | Transport | Air, short haul | 1880 | km | 1.26 | 16.69 | - | 15% | -8% | 8% | 13% | 0% |
| Romania-to-Belgium | Transport | Semi-trailer truck | 45 | km | 0.00 | 0.02 | - | 0% | 0% | 0% | 0% | 0% |
| | **Total** | | | | **8.23** | **130.27** | **36.06** | | | | | |

## Table 5b Sensitivity Analysis Results for Fez/GreenFly Recycled Jersey

| Model Name | Process Type | Process | Quanti | Units | Carbo | Energy | Water | Carbon % | Carbon -50 | Carbon +50% | Energy % | Water % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fabric-Fez-EU:Hub | Energy | Electricity (grid mix) - grid: It | 1.84 | KWh | 1.40 | 20.75 | - | 25% | -12% | 12% | 21% | 0% |
| Fabric-Greenfly-EU:Hub | Energy | Electricity (grid mix) - grid: It | 1.4 | KWh | 1.06 | 15.79 | - | 19% | -9% | 9% | 16% | 0% |
| zipper:MaterialIn | Material/Process (cradle-to | Polyamide 6 (Nylon 6), Euro | 0.008 | kg | 0.07 | 0.96 | 1.48 | 1% | -1% | 1% | 1% | 68% |
| Fabric-Fez-EU:RecycledPoly | Material/Process (cradle-to | Polyester fiber, Recycled, Ch | 0.145 | kg | 0.95 | 22.52 | - | 17% | -8% | 8% | 23% | 0% |
| Fabric-Greenfly-EU:RecycledPoly | Material/Process (cradle-to | Polyester fiber, Recycled, Ch | 0.108 | kg | 0.71 | 16.77 | - | 12% | -6% | 6% | 17% | 0% |
| Fabric-Fez-EU:Elastane-Germany | Material/Process (cradle-to | Polyester fiber, Virgin, USA | 0.022 | kg | 0.21 | 4.43 | 0.38 | 4% | -2% | 2% | 4% | 17% |
| Fabric-Greenfly-EU:Elastane-Germany | Material/Process (cradle-to | Polyester fiber, Virgin, USA | 0.019 | kg | 0.18 | 3.83 | 0.33 | 3% | -2% | 2% | 4% | 15% |
| zipper:MaterialIn | Transport | Ocean, large tanker | 16700 | km | 0.00 | 0.01 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Fez-EU:RecycledPoly | Transport | Ocean, large tanker | 8336 | km | 0.00 | 0.05 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Greenfly-EU:RecycledPoly | Transport | Ocean, large tanker | 8336 | km | 0.00 | 0.04 | - | 0% | 0% | 0% | 0% | 0% |
| zipper:MaterialIn | Transport | Semi-trailer truck | 73 | km | 0.00 | 0.00 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Fez-EU:ManufacturingToWarehous | Transport | Semi-trailer truck | 1734 | km | 0.02 | 0.29 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Fez-EU:Elastane-Germany | Transport | Semi-trailer truck | 878 | km | 0.00 | 0.02 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Fez-EU:RecycledPoly | Transport | Semi-trailer truck | 400 | km | 0.00 | 0.06 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Greenfly-EU:ManufacturingToWare | Transport | Semi-trailer truck | 1734 | km | 0.02 | 0.22 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Greenfly-EU:Elastane-Germany | Transport | Semi-trailer truck | 878 | km | 0.00 | 0.02 | - | 0% | 0% | 0% | 0% | 0% |
| Fabric-Greenfly-EU:RecycledPoly | Transport | Semi-trailer truck | 400 | km | 0.00 | 0.04 | - | 0% | 0% | 0% | 0% | 0% |
| Hub | Energy | Electricity (grid mix) - grid: C | 0.1 | KWh | 0.06 | 0.94 | - | 1% | -1% | 1% | 1% | 0% |
| MaterialIn | Material/Process (cradle-to | Paper, Kraft, unbleached, 10 | 0.008 | kg | 0.01 | 0.13 | - | 0% | 0% | 0% | 0% | 0% |
| ManufacturingWaste | Solid Waste | Textiles (Landfill, Anerobic) | 0.029 | kg | 0.01 | (0.02) | - | 0% | 0% | 0% | 0% | 0% |
| Romania-to-Belgium | Transport | Air, short haul | 1880 | km | 0.97 | 12.90 | - | 17% | -9% | 9% | 13% | 0% |
| Romania-to-Belgium | Transport | Semi-trailer truck | 45 | km | 0.00 | 0.01 | - | 0% | 0% | 0% | 0% | 0% |
| | **Total** | | | | **5.69** | **99.74** | **2.19** | | | | | |

## Table 6 Sourcing Fiber/Fabric in China as Compared to Predominantly EU Sourcing

| Category | Carbon | Carbon-Chinese fiber production | Carbon - % Change | Energy | Energy-Chinese fiber production | Energy - % Change |
|---|---|---|---|---|---|---|
| Energy use (fuel, electricity) | 2.52 | 3.14 | -20% | 37.48 | 40.46 | -7% |
| Inflows (materials, goods, service | 2.13 | 2.15 | -1% | 48.63 | 48.64 | 0% |
| Transport | 1.03 | 0.99 | 3% | 13.65 | 13.19 | 3% |
| Waste disposal | 0.01 | 0.01 | 0% | (0.02) | (0.02) | 0% |
| **Total** | **5.69** | **6.30** | **-10%** | **99.74** | **102.27** | **-2%** |

### *7.2 Key Takeaways*

We summarize below the key takeaways from the LCIA results and sensitivity analysis:

- The Fez/GreenFly recycled jersey has a much lower impact than the original Anibal/Matrix jersey across all three life-cycle-impact categories analyzed. It has only 69% and 77% of the embedded carbon and energy impact, and but 6% of the embedded water impact.
- This improvement comes from the reduced weight of the recycled jersey and from the use of recycled rather than virgin materials. The value of using recycled materials is especially apparent from the embodied water.
- Most of the carbon and energy impact comes from the energy embedded in fabric production and the fiber production for both types of jerseys. Sourcing fibers and fabrics from Europe rather than China results in 10% less embedded carbon. Sensitivity results shows that fiber and fabric production have the highest embedded carbon even if the estimates are off by +/- 50%.
- Neither the zipper nor the bag make a significant contribution across any of the life-cycle-impact categories analysed.
- Despite the large distances associated with the supply chain, the transportation link with the greatest impact is the relatively short distance between the factory and warehouse traversed by air. This link also comprises 17% and 13% of the overall carbon and energy impacts associated with the recycled jersey, and a similar amount for the original jersey.

### *7.3 Mitigation of Environmental Impacts*

Based on the above takeaways, here are some mitigation strategies that Peloton de Paris could consider for reducing or neutralizing the carbon and water footprints of their cycling jerseys. We wholeheartedly recommend they substitute the production and sale of the recycled jersey in place of the original jersey, given its reduced environmental impact. They should also continue to rely on Europe sourcing for as much of the fiber and fabric production as possible. If it is logistically feasible, switching to ground transportation for delivering the jerseys to the warehouse in Belgium would further reduce the overall carbon and energy impacts by 20% and 14% respectively.