Higg Product Module (PM) Methodology

Last Edited: July 2024
Contact: product@cascale.org

Table of Contents

PREFACE

The Higg Product Module (PM) offers users the ability to complete full life cycle product impact assessments from cradle to grave; including materials production from the point of resource extraction, finished product manufacturing, packaging, distribution and sale, product care, and product end of life.

This document is focused on the Higg PM, which utilizes Higg MSI materials, trims, and packaging information to complete a product assessment. The Higg MSI has its own methodology document which can be accessed at:
https://howtohigg.org/higg-msi/higg-msi-methodology-document/

The release of the Higg PM is a significant milestone for the apparel, footwear, and home textiles industries in calculating their product impacts using a consistent reporting framework. *Purchased Goods and Services* is the largest category of Scope 3 greenhouse gas emissions for most brands and retailers, and it's very valuable to track this information to clearly understand how our core industries can reduce their environmental impacts.

The Higg Index tools are continuously evolving. We believe in releasing tools or features as soon as they are ready to enable the industry to progressively integrate these within their sustainability performance efforts. The Higg MSI and Higg PM will continue to receive data and methodology updates over time to align with best-available understanding of impacts.

CASCALE OVERVIEW

Cascale (formerly the Sustainable Apparel Coalition) is the apparel, footwear and home textile industry's foremost alliance for sustainable production. It was born from a dynamic and unconventional meeting of the minds when, in 2009, Walmart, America's biggest retailer and Patagonia, one of the world's most progressive brands, came together with a radical mission: Collect peers and competitors from across the apparel, footwear and textile sector and together, develop a universal approach to measuring sustainability performance.

Today Cascale has more than 300 members, including brands, retailers, manufacturers, academic institutions, and non-profit organizations across the global apparel, footwear, and home textile supply chain. Its focus remains the same: develop a standardized supply chain measurement tool for all industry participants to understand the environmental, social and labor impacts of making and selling their products and services. By measuring sustainability performance, the industry can address inefficiencies, resolve damaging practices, and achieve the transparency that consumers increasingly demand. By joining forces in a Coalition, members can address the urgent, systemic challenges that are impossible to change alone. For a comprehensive list of Cascale Members visit ttps://cascale.org/our-members/

WORLDLY OVERVIEW

Higg is an integrated platform for sustainability insights that helps consumer goods businesses take responsibility for their entire impact – from materials to products, from factories to stores, across energy, waste, water, and working conditions.

Worldly's software tools gather and organize primary data from each step of the value chain, so that business can understand – and improve – their impact.

Built on the leading framework for sustainability measurement, Higg is trusted by global brands, retailers, and manufacturers to provide the comprehensive intelligence they need to accelerate progress.

Spun out of Cascale in 2019 as a public-benefit technology company, Higg is the exclusive licensee of the Higg Index, a suite of tools for the standardized measurement of supply chain sustainability. To learn more about Worldly visit https://worldly.io/.

THE HIGG INDEX

The Higg Index is a suite of tools for the standardized measurement of supply chain sustainability. Developed collaboratively over the last decade by a coalition of brands, retailers, manufacturers, and other footwear, apparel and textile industry stakeholders through Cascale, the Higg Index enables accurate scoring and comparing of a company or product's overall sustainability performance and impact , across metrics such as greenhouse gas emissions, waste, water usage, and working conditions.

With the Higg Index, Cascale aims to accomplish the following goals:

- Understand and quantify the sustainability impacts of apparel, footwear, and home textile products
- Reduce redundancy in measuring sustainability in apparel, footwear, and home textile industries
- Drive business value through reducing risk and uncovering improvement opportunities
- Create a common means and language to communicate sustainability to stakeholders

The Higg Index suite of tools is identified below. More information on each of these tools is available at http://apparelcoalition.org/the-higg-index/

Figure 1. Higg Index Suite of Tools

Higg Brand & Retail Tools	Higg Facility Tools	Higg Product Tools
Higg Higg Brand & Retail Module (BRM)	*Higg Facility Environmental Module (Higg FEM)* *Higg Facility Social/Labor Module (Higg FSLM)*	*Higg Material Sustainability Index (Higg MSI)* *Higg Product Module (Higg PM)* *MSI Contributor*

PRODUCT ASSESSMENT IN THE HIGG INDEX

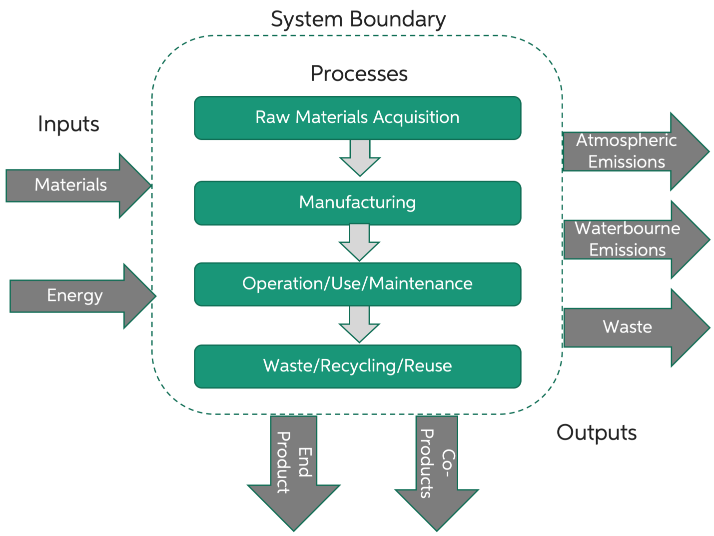
The Higg Product Tools are focused on the assessment of products, especially materials, apparel, footwear, and home textiles. This is done using a life cycle assessment (LCA) approach. LCA is a technique to assess environmental impacts associated with a product within structured system boundaries. Typically, the system boundaries are "cradle-to-grave" over the full product lifetime; from raw material extraction or production through material processing, product manufacture, distribution, use, and end of use. An assessment using "cradle-to-gate" system boundaries can also be used to assess impacts from raw material extraction or production through manufacture of a studied product.

Once the system boundaries are defined, LCAs consider the material and energy inputs to that system and the environmental outputs of that system to calculate its various potential environmental impacts (see Figure 2).

Designers and product development teams can use this process to help understand their products. LCAs help avoid a narrow outlook on environmental concerns by:

- Compiling an inventory of relevant energy and material inputs and environmental releases
- Evaluating the potential impacts associated with identified inputs and releases
- Interpreting the results to help make a more informed decision

Figure 2. Simplified LCA Model Diagram



HIGG INDEX PRODUCT TOOLS

The Higg Index Product Tools include three tools that are tied to assessing the environmental impacts of products using a life cycle assessment approach:

- **Higg Materials Sustainability Index (Higg MSI)**: a cradle-to-gate assessment tool for material, trim, and packaging manufacturing that uses life cycle impact assessment (LCIA) data and methodology to measure material impacts and engage product design teams and the global value chain in environmental sustainability.
- **Higg Product Module (Higg PM)**: a cradle-to-grave product assessment tool that uses the life cycle impact assessment (LCIA) data and methodology to measure product manufacturing footprints and the impacts-per-use of those same products. In addition to measuring impacts, the Higg PM provides credible

and consistent results for external communication to influence purchasing decisions and scale industry adoption of leading practices.

- **MSI Contributor**: a tool where anyone may submit primary material production data and/or life cycle analysis results to be reviewed and used to create new materials or processes in the Higg MSI and Higg PM.

HIGG PRODUCT MODULE PURPOSE

The focus of this document is the Higg Product Module. This section explains its purpose and Cascale's vision for its adoption.

The purpose of the Higg PM is to help companies produce more sustainable products. By providing an industry-applicable consistent methodology for calculating a product's footprint, the Higg PM allows companies to assess the environmental impacts of products and drive them to reduce that impact.

The three main reasons that the Higg PM was created are:

1. To allow companies to assess impact and develop more sustainable products consistently across the industry
2. To support industry in the Product Environmental Footprint (PEF)[1] process in Europe through submitting a meaningful (pre-aligned) approach
3. To create a basis for future consumer-facing communication of product environmental impacts

METHODOLOGICAL OBJECTIVES

The Higg PM is an industry-applicable and consistent methodology for calculating a product's environmental footprint. It provides unique differentiating methodological characteristics requested by Cascale members:

- It is expandable based on what users know, which improves the user experience.
- Consistent assumptions are applied where primary information isn't readily known, with the option to enter primary data to refine the results.
- Using a methodology on which the industry has aligned, the Higg PM improves the quality of LCA data and analysis for better decision making in product creation and innovation.
- Use of this tool incentivizes an industry-collaborative effort in data collection to improve data quality and the accuracy of Higg PM assessments.
- The Higg PM provides consistent and comparable environmental impact results.
- It provides a streamlined scoring approach based on robust data which can pave the way for end user/consumer communications.
- It aligns with and leverages relevant databases, such as GaBi, WALDB, and ecoinvent.
- The Higg Product Module covers the complete life cycle, including the use and end of use pathways for products.

[1] Harmonized methodology for the calculation of the environmental footprint of products (including carbon). It has been spearheaded by the European Commission and DG Environment.

UNITS OF ANALYSIS

The Higg PM has the ability to assess several apparel, footwear, and home textile product categories. An additional product category "Other" is also available in the tool to allow users with products other than apparel, footwear, and home textiles to consistently assess their product manufacturing footprint. This category is currently only available to measure the cradle-to-gate product manufacturing impacts and will not include use phase and end of life assessment. The "Other" product category shares the same manufacturing process options as Apparel and Home Textiles.

Table 1. Product Categories

Product Type	Product Category
Apparel	Apparel Accessory
	Dress
	Hosiery
	Underwear
	Leggings/Tights
	Baselayer
	Jacket
	Jersey (Uniform)
	Pants
	Shirt (Dress Shirt)
	Skirt
	Socks (pair)
	Sweater
	Swimsuit
	T-Shirt
Home Textiles	Blanket
	Comforter
	Cushion
	Duvet
	Duvet Cover
	Kitchen Towel
	Lighting Shade (roman shades, lamp shade)
	Mat
	Mattress Pad
	Napkin
	Pillow
	Place Mat
	Quilt
	Rug
	Sham
	Sheet Set
	Shower Curtain
	Slipcover

	Table Cloth
	Towel
	Upholstery
	Window Curtain
Footwear	Boots - steel toe
	Boots - non-steel toe
	Cleats
	Court (sport)
	Dress Shoes/Heel
	Other Athletic Shoe
	Sandals
	Sneakers
Other	Other

In life cycle assessment, a functional unit must be defined. A functional unit is a unit of production or output against which category indicator results are normalized. It's purpose is to provide a clear and fair comparison of options. It describes the function/service provided, the magnitude of the function or service, the expected level of function or service quality, and the duration of the function or service.

The Higg PM calculates impacts for the following functional unit:

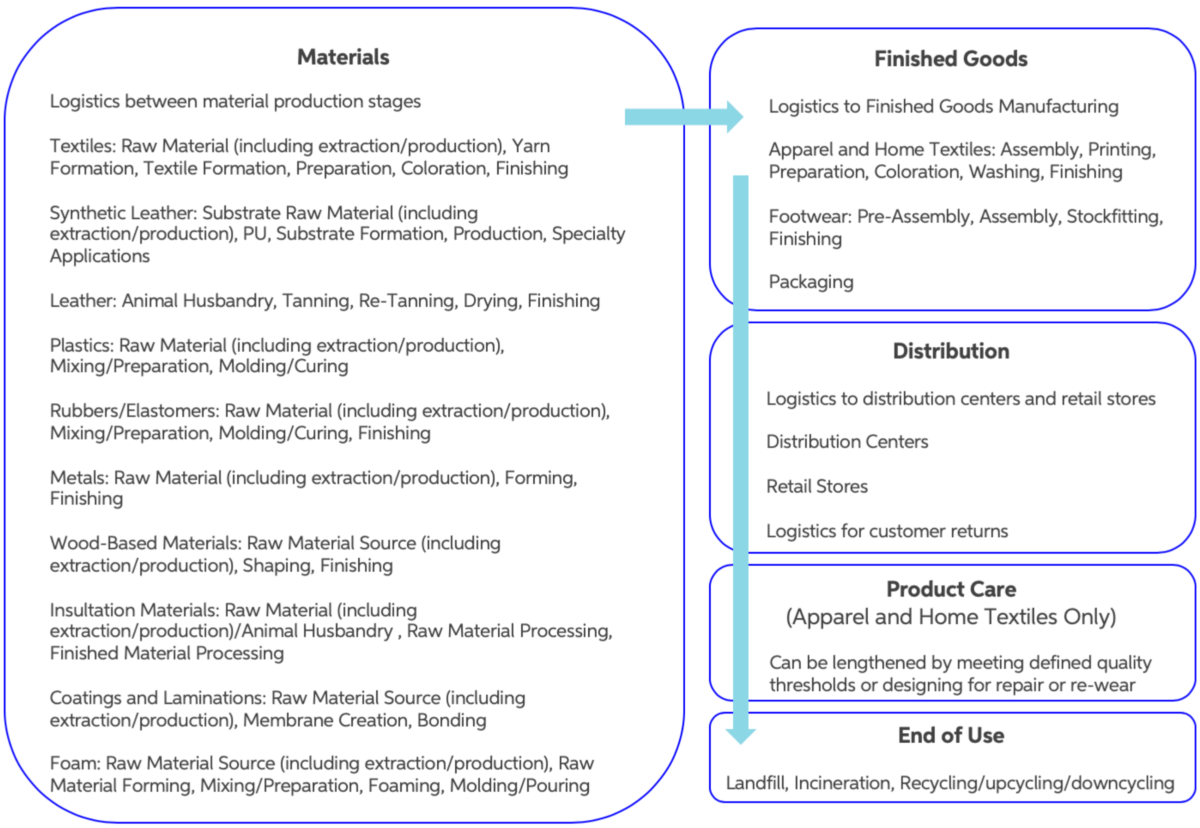
- **The function/service provided: "what":** Apparel, footwear, or home textile product. Analysis shall be done at the level of the style number (or equivalent system for designating key product design distinctions—such as product code or product number), with no differentiation based on the color. Typical sample size for each product assessed should be reflected and can consider products for infants, toddlers, youth, men's, women's, unisex, and other.
- **The magnitude of the function of service: "how much":** One apparel, home textile, or footwear product as sold with packaging. Footwear and socks must be considered as a pair.
- **The expected level of quality: "how well":** Wear in good condition with appropriate use for the given product.
- **The lifetime/duration/reference using time of the product: "how long"**: lifetime will be calculated based on the "per use" impacts of the product.

The reference flow has been defined as "one apparel product, one home textile product, or one pair of footwear or socks including packaging to be worn in good condition with appropriate use for its intended duration of service and for one wear". For footwear, since there are no product care impacts, a full use is defined as one year of service, or one full use per lifetime.

SYSTEM BOUNDARIES

The Higg PM calculations include inputs (electricity, water, heat, auxiliaries, etc.), emissions to air, water, soil, and production waste for all relevant life cycle stages. The Higg PM boundaries are shown in Figure 3 below.

Figure 3. Higg PM Boundaries



The first box on the left encompasses material production from raw material extraction or production up to the point when the material or part is ready to be assembled into a product. The raw materials, production stages, and processes included in the Materials section are consistent with the Higg MSI. The production stages (e.g. Raw Material (including extraction/production, Yarn Formation, Textile Formation, etc.) depend on the material category (e.g. Textiles, Synthetic Leather, Leather, etc.).

Finished Goods considers processes that take place to assemble, finish, and package a final product.

Distribution considers the impacts associated with the transportation and sale of a product. It considers energy and water inputs to distribution centers and retail stores. Impacts of logistics for consumer returns are also within scope.

Product Care and End of Use focus on the average impacts associated with consumer care and disposal. As Product Care and End of Use are past the point of sale, average impacts are used since precise impacts will depend on the individual consumer's decisions. However, both Product Care and End of Use can be influenced by product design decisions which can be quantified. This includes Duration of Service (Intrinsic Quality factors), Design for Repair, and facilitating product take back programs. These additional parameters can be used to modify the standardized care and end of use impact models.

Exclusions to the scope of the Higg PM include the following:

- Product care for Footwear
- Overhead impacts from Materials, Finished Goods, and brand offices.
- Consumer travel

Primary data is required to complete a Higg PM assessment. The primary data requirements are listed below:

Table 2. Primary Data Requirements

Section	Primary Data Required
Product and company Information	• Product Type • Product Category
Materials	• Bill of Materials (at least 95% by weight of materials and their amounts in yield or weight) • Material production processes (using Higg MSI) • Materials and their amounts used in trims/components if a suitable proxy is unavailable. • Packaging typically included for the assessed product in a retail store and when shipped to a consumer
Finished Goods Manufacturin g	• Tier 1 production processes (e.g cutting, sewing, assembly) and the magnitude at which each process is used.
Product Care	• Fabric Category (Material Type)

As mentioned above, the ability for companies to collect primary data for information within the boundaries can vary greatly. As brands' and manufacturers' data collection systems and procedures improve each year, primary data requirements may be expanded in future versions of the Higg PM. Until then, the use of some standardized assumptions based on industry data is necessary to allow for scaled calculation of thousands of products. Table 3 lists where assumptions occur where users have the option to override with primary data to calculate more accurate and representative results.

Table 3. Optional Primary Data Entries

Section	Optional Primary Data

Product and company Information	• What is the percent of products sold through assessing company's known distribution channels; including:
	  • The percent of products sold online
	  • Rate of product returns (online sales)
	  • Rate of product returns (in-store sales)
	  • Restock rate (online sales)
	  • Restock rate (in-store sales)

Materials	• Material/trim production process loss rates and defect rates • Material shipping modes and distances to Tier 1 facility • Ability to enter materials by yield (using material densities, widths, and thicknesses (if applicable)) • Material cutting efficiency (net use) • Packaging typically included for the assessed product in a retail store and when shipped to a consumer
Finished Goods Manufacturing	• What waste disposal methods are used in Finished Goods Manufacturing facilities? • What is the excess finished goods rate for your organization? • What waste disposal methods are used for excess finished goods? • What is the sample rate for your organization? • What waste disposal methods are used for production samples?
Packaging	• What additional packaging is used when shipping this product for online sales? • What additional packaging is used when shipping this product for in-store sales?
Logistics	• What inbound transportation is used from the manufacturing location to the distribution center(s)? • What outbound transportation is used from the distribution center(s) to retail locations? • What outbound transportation is used for direct to consumer sales (distribution center to customer)?
Retail	• What is the average electricity, natural gas, and water used per unit of product at your distribution center(s)? • What is the average electricity, natural gas, and water used per unit of product at your retail location(s)?

Product Care	• For Alternate Care Scenario only – not for reporting Higg Product Module results
	  • What is the average number of wears per wash for this product?
	  • How is the product laundered?
	  • How is the product dried?
	  • How is the product ironed?
	• What level of Duration of Service is achieved (see the "Duration of Service" section of this document for details)

End of Use	• What level of Design for Repair is achieved? (see the "Design for Repair" section of this document for details) • What percent of annual production is taken back for a re-wear program that has been used again in a new or refurbished product? • What percent of annual production is taken back and diverted to recycling (and not re-routed to landfill or incineration)?

IMPACT RESULTS

The impact results for the Higg PM can be reported as either the absolute or "per use" cradle-to-grave impacts of a product. The absolute impacts can be useful for Scope 3 greenhouse gas impact reporting and covers Category 1 (Purchased goods and services), Category 4 (Upstream transportation and distribution), Category 5 (Waste generated in operations), Category 9 (Downstream transportation and distribution), Category 11 (Use of sold products), and Category 12 (End-of-life treatment of sold products). However, a limitation of the absolute impacts for a product is that the longer it lasts, the higher its impacts. The "per use" impact takes the absolute impacts of the product and divides it by the expected number of uses of the product. This enables recognition of longer lasting products and is the expected reporting unit for the Apparel and Footwear Product Environmental Footprint Category Rules (PEFCR).

SELECTION OF IMPACT CATEGORIES

The impact categories for the Higg PM are the same as those in the Higg MSI. The selection of these impact categories is covered in the Higg MSI methodology document under the "Higg MSI Assessment Framework – LCIA Methodology" section on page 9. In addition to the impact categories, biogenic carbon and water consumption inventory metrics are provided in the Excel Export (similar in both Higg MSI and Higg PM).

Additional information on the LCIA method criteria used when deciding which impact categories to include in the Higg MSI and Higg PM is also covered in the Higg MSI methodology document under "Appendix C: LCIA Method Criteria". The Higg MSI methodology document is available for download through the howtohigg.org website.

DATA MODELLING PRINCIPLES

In the Materials and Finished Goods sections, users are required to select the specific processes that take place to manufacture the product and each of its materials. These processes come primarily from the GaBi database and the World Apparel Lifecycle Database (WALDB), with support from literature sources and stakeholders from the apparel, footwear, and home textile supply chains (e.g. manufacturers and trade organizations). For consistency, GaBi is used as the background database and for modeling of environmental impacts.

The initial process datasets used for the Higg Product Tools are based on best available data, and each dataset was modeled to be as representative of the process as possible. The electricity grid mix used for modeling global processes is shown in Table 4 and is based on a weighted average of major textile producing countries.[2]

Table 4. Electricity Mix

Country	Percent
China	42%
EU 28	28%
India	7%
Turkey	5%
Bangladesh	1%
Vietnam	2%
United States	5%
Republic of Korea	5%
Pakistan	4%
Indonesia	2%

The type of data associated with each raw material and process in the Higg Product Tools includes the following:

Inputs:

- Energy
- Water
- Materials and chemicals
- Agricultural Land

Outputs:

- Product (intermediate output) and amount

[2] https://www.wto.org/english/res_e/statis_e/its2014_e/its14_highlights2_e.pdf

- Solid Waste
- Emissions
- Wastewater

The modeling principles used for the construction of this database are based on leading international guidelines and standards, including:

- Ecoinvent data quality guidelines (Weidema et al. 2013)[3]
- ISO 14040[4]/14044[5]
- PEF Guide[6]

Detailed information on each process in the database, including process descriptions, modeling approaches, sources, and data quality ratings can be found in the Higg Product Tools by clicking on individual raw materials and production processes.

The Higg Product Tool database is managed in GaBi by qualified Data Managers. Data Managers must obtain the following qualifications:

- Knowledge of LCA and MSI methodology and taxonomy
- Be trained in the use of GaBi
- Knowledge of and experience with relevant standards (e.g. ISO 14040, 14044, 14025)
- Understanding of environmental impact category indicators
- Experience conducting LCAs and peer reviews of LCAs
- Demonstrates understanding of/alignment with Cascale and Materials Task Team vision, goals and existing structure/operating norms
- Strong communication skills, able to explain complex concepts in easy-to-understand terms, and must regularly update the applicant and Cascale on progress

As data is added or updated in the database, updates are published in the Higg Product Tools twice a year. This keeps the database updated and relevant while ensuring users have the ability to track changes to the system. Maintaining a separate LCA database allows for proprietary information to be protected, for consistent modeling and selection

---

[3] Weidema, B., C. Bauer, R. Hischier, C. Mutel, T. Nemecek, J. Reinhard, C. Vadenbo and G. Wernet (2013). Overview and methodology. Data quality guideline for the ecoinvent database version 3. St. Gallen, Swiss Centre for Life Cycle Inventories.

[4] ISO (2006a). Environmental management - Life cycle assessment - Principles and framework. Geneva, Switzerland, International Organization for Standardization. ISO 14040:2006.

[5] ISO (2006b). Environmental management - Life cycle assessment – Requirements and guidelines. Geneva, Switzerland, International Organization for Standardization (ISO). ISO 14044:2006.

[6] PEFCR Guidance Document, - Guidance for the Development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3 (Brussels, 2017)

of background data, and for flexibility as measurement, data, and impact methods evolve. All of the datasets for the Higg Product Tools are assigned a data quality rating as explained in the Higg MSI Methodology document ("Data quality criteria and scores" in Appendix B). Cascale and Worldly will continue to update the Higg Product Tools with new data submissions twice a year, including with processes listed in our ongoing Data Wishlist, which can be accessed at the following URL: https://msicontributor.higg.org/uploads/msicontributor.higg.org/sac_textpage_section_files/30/file/Data_Wish_List_6-8-20_Public.pdf

BILL OF MATERIALS

To assess a product in the Higg PM, users shall create a bill of materials (BOM) for a specific product. This should be completed by pulling in the custom materials, trims, and/or components present or created in the Higg MSI. Example materials from the Higg MSI can be used where more detailed information is unavailable. Once materials are entered into the BOM, users must enter the gross amount of each material. For materials, the cutting efficiency (net use) needs to be included. This is the net amount that is used in the product (out of the gross amount needed to construct the product). Default cutting efficiencies are provided and should be overridden with actual data when available. If the material arrives at assembly already formed into a part and does not need to be further cut, the net use is set to 100%. This is because the net use and defect rate are already factored in when creating the part as a Trim or Component in the Higg MSI. Finally, users are also asked about the mode and distance of transportation of the final material to the finished goods facility. A default of 500km by a large truck is provided but can be overridden if the information is available.

Table 5. Default Cutting Efficiencies

Product Type	Default Efficiency
Apparel	0.8
Footwear	0.7
Home Textiles	0.8
Other	0.8

FINISHED GOODS

The Finished Goods section of the Higg PM works similar to the Higg MSI in that it has a taxonomy and is supported by process data. It requires selecting the assembly and final product finishing processes used to create the product being assessed. The methodology allows the use of the industry average process data to feed the Higg PM values. In the future, Cascale plans on updating the methodology to include the use of primary data from the Higg FEM to modify process impacts.

FINISHED GOODS TAXONOMY

The Finished Goods section of the Higg PM holds representative production data that is third party provided, independently reviewed, and modeled to determine impacts. Unlike the Higg MSI, it does not have a scoring framework to produce a single score; rather, midpoints are used to understand the impacts that take place during finished goods processing. This database is organized according to a very specific taxonomy determined by Cascale members. This taxonomy defines the following:

- **Product Type**: Apparel, Home Textiles, Footwear, and Other
- **Production Stages**: Product production steps for which various processes could be used. A specific set of Production Stages is associated with each Product Type.
- **Processes**: Actual production processes used to assemble and finish the final product. Sets of processes are associated with each Production Stage.

The Finished Goods' Product Types and their respective Production Stages are:

Apparel, Home Textiles, and Other Product Types:

- Product Assembly
- Garment Preparation and Coloration
- Garment Printing
- Garment Washing and Finishing

Footwear Product Type:

- Pre-Assembly Footwear
- Stockfitting
- Assembly
- Finishing – Footwear

FINISHED GOODS PROCESS DATA

Finished Goods process data is modelled in accordance with the information in the previous *Data Modelling Principles* section. Guidance on selecting applicable processes and on completing the amount that the process takes place is covered in the Higg Product Module How to Higg Guide. Processes can have different unit types for the amount field, including:

- Per centimeter
- Per square centimeter
- Per cycle
- Per part
- Per stitched edge

There are also some instances in which processes may be listed in more than one production stage. For example, in the MSI, users can select “die cutting” for EVA foam. If it is selected there, users must be careful to not double count impacts from die cutting by also selecting it in Footwear Pre-Assembly (unless an additional dye cutting step is performed, in which case it is not double counting).

DISPOSAL MODES

The Higg PM also allows users to customize the disposal modes for different types of waste, including manufacturing wastes, excess finished goods inventory, and sample products. These can be customized by modifying the percentage of waste that goes to landfill or incineration versus waste that is recycled or downcycled. Default values are provided for all of these fields, including the amount of excess finished goods and samples.

PREVIOUSLY USED PRODUCT

Higg PM users can also calculate the impacts of second-hand products if a product has previously been owned by another end user (customer) and is re-sold rather than entering the waste stream. Examples include product sold through Patagonia’s Worn-Wear[7] program which enables consumers to trade in their used Patagonia gear for credit to purchase previously used products, or the Renewal Workshop[8], which takes discarded apparel and textiles and turns them into renewed apparel for purchase.

Assessing Previously Used Product functions similarly to assessing a new product, with key differences below:

- The incoming previously used product comes into the system “burden-free” at the point of its disposal (similar application of the cut-off principle as recycled materials)
- Transportation impacts associated with shipping the previously used product are still included in the impacts
- Users can specify any additional materials that are used during refurbishment using the Bill of Materials screen; however, you can proceed to Finished Goods Manufacturing without adding further materials.
- Finished Goods Manufacturing works in the same way for both Previously Used Product and new product assessment.

[7] https://wornwear.patagonia.com/
[8] https://renewalworkshop.com/

By including Previously Used Products into the Higg PM methodology, the tool enables users to also assess used products in a consistent manner to new products. Information on how to assess a Previously Used Product is covered in the Higg Product Module How to Higg guide.

PACKAGING

Packaging materials are available in the Higg MSI and can be entered into the Higg PM in a similar way to the Bill of Materials section. Users can select from pre-populated example packaging materials or customized packaging materials created using the Higg MSI. Depending on user preference and organization of their Bill of Materials, packaging materials can be entered in either the Bill of Materials section or the Packaging section. In the Packaging section, different packaging can be specified for online versus in-store sales.

LOGISTICS

Transportation is included in Higg PM calculations in the four ways shown below:

Table 6. Transportation

Where transportation is included	How transportation is included
Between material processing steps (up to when the material is final, not including transportation to assembly)	Included in the Higg MSI material models. Default value of 200km by large truck for each production stage. This is adjustable by the user in the Higg MSI if data is available.
Transportation to finished goods manufacturing (Tier 1) facility	Included in the Bill of Materials section. Default value of 500km by large truck for each material. This is adjustable by the user if data is available.
Transportation from Tier 1 to distribution center(s)	Default value of 14850km by ocean freight, 1000km by large truck, and 1750km by air freight. This assumption is from the draft Apparel and Footwear PEFCR. This is adjustable by the user if data is available.
Transportation from distribution center to the retail store(s)	Proxy of 1000km by large truck for each product. This is adjustable by the user if data is available.
Transportation direct from distribution center to customer	Proxy of 1000km by large truck for each product. This is adjustable by the user if data is available.

Transportation for customer returns is also within the scope of the Higg PM assessment. The percentage of product returned to store and by mail (entered under *Company Information*) is multiplied by the impacts associated with transportation to the customer.

RETAIL

The retail section of the Higg PM includes energy and water inputs of distribution centers and retail stores. The distribution and retail impacts are typically small and default values are provided. Users can update the default values with primary data if available. The default energy and water per unit of product for distribution centers are 0.065 kWh of electricity, 0.215kWh of natural gas, and 0.3 liters of water. For retail stores the default energy and water per unit of product are 0.75 kWh of electricity, 0 kWh of natural gas, and 2.65 liters of water. The values were created using Cascale member and expert data and represent the conservative end of the range. A global electricity mix based on domestic consumption[9] was used to represent the emission factors for retail locations. The global average AWARE water scarcity factor was applied to the water use.

PRODUCT CARE

Impacts associated with product care and end of use are difficult to measure because they are dependent on the end user of the product (the consumer) after the point of sale. Since the Higg PM is used by companies producing products, users will not be able to provide verifiable data on how a specific product will be cared for and disposed of. Therefore, standardized care scenarios based on product type and fiber category are required to be used.

The following tables contain the product care scenarios that are used to calculate use phase impacts of apparel and home textile products. Note that Higg PM users can separately adjust the product care methods and frequency for internal analysis ("Alternate Care"). The product care scenarios are based on consumer survey data that was collected for studies by Cotton Incorporated[10] and IWTO[11]. Fiber experts from Cotton Incorporated, IWTO, Toray, and INVISTA were further consulted to confirm differentiations between fibers. The final scenarios were reviewed and approved by the Use and End of Use task team of Cascale member experts. These scenarios are expected to be updated as further industry research is conducted.

The fiber differentiation is captured through a "Fabric Category" that users can select from. The table below explains when each should be applied.

Table 7. Fabric Categories

Fabric Category	Applicable to:
Cotton	Any product made from majority: cotton and other cellulosic fibers (linen, hemp, viscose, lyocell, etc.) OR Any product with no majority listed fiber ("typical average care"

[9] https://yearbook.enerdata.net/electricity/electricity-domestic-consumption-data.html
[10] *LCA Update of Cotton Fiber and Fabric Life Cycle Inventory*. 2016. https://cottontoday.cottoninc.com/lca-2016/
[11] Laitala, Klepp, and Henry. *Does Use Matter? Comparison of Environmental Impacts of Clothing Based on Fiber Type*. 2018. http://www.mdpi.com/2071-1050/10/7/2524

Synthetic	Any product made from majority: virgin, recycled, or biobased plastic polymer including polyester, nylon, polypropylene, acrylic, etc.
Wool	Any product made from majority: animal wool, including sheep, alpaca, mohair, etc.
Delicate	Any product requiring delicate care instructions

Table 8. Product Care Scenarios

Product Category	Fabric Category	Standard consumer care practice	Standard use frequency between washes	Lifetime Uses
Apparel Accessories	Cotton	Machine Wash Warm, Line/Air Dry	20	100
	Synthetic	Machine Wash Warm, Line/Air Dry	20	100
	Wool	Machine Wash Cool, Line/Air Dry	20	100
	Delicate	Machine Wash Cool, Line/Air Dry	20	100
Dress	Cotton	Machine Wash Warm, Line/Air Dry	4.2	69.5
	Synthetic	Machine Wash Warm, Line/Air Dry	4.2	69.5
	Wool	Machine Wash Cool, Line/Air Dry	4.2	69.5
	Delicate	Machine Wash Cool, Line/Air Dry	4.2	69.5
Hosiery	Synthetic	Machine Wash Warm, Line/Air Dry	1	52.3
	Delicate	Machine Wash Cool, Line/Air Dry	1	52.3
Underwear	Cotton	Machine Wash Warm, Line/Air Dry	1	59.8
	Synthetic	Machine Wash Warm, Line/Air Dry	1	59.8
	Wool	Machine Wash Cool, Line/Air Dry	1	59.8
	Delicate	Machine Wash Cool, Line/Air Dry	1	59.8
Leggings / Tights	Cotton	Machine Wash Warm Line/Air Dry	4.2	69.5
	Synthetic	Machine Wash Warm, Line/Air Dry	4.2	69.5

	Wool	Machine Wash Cool, Line/Air Dry	4.2	69.5
	Delicate	Machine Wash Cool, Line/Air Dry	4.2	69.5
Baselayer	Cotton	Machine Wash Warm, Line/Air Dry	1.5	29.8
	Synthetic	Machine Wash Warm, Line/Air Dry	1	29.8
	Wool	Machine Wash Cool, Line/Air Dry	3	29.8
	Delicate	Machine Wash Cool, Line/Air Dry	1	29.8
Jacket	Cotton	Machine Wash Warm Line/Air Dry	20	100
	Synthetic	Machine Wash Cool Line/Air Dry	20	100
	Wool	Dry Clean	20	100
	Delicate	Dry Clean	20	100
Jersey (Uniform)	Cotton	Machine Wash Warm, Line/Air Dry	1	26
	Synthetic	Machine Wash Warm, Line/Air Dry	1	12
	Delicate	Machine Wash Cool, Line/Air Dry	1	12
Pants	Cotton	Machine Wash Warm, Line/Air Dry	4.2	66
	Synthetic	Machine Wash Warm, Line/Air Dry	4.2	69.5
	Wool	Dry Clean	4.2	69.5
	Delicate	Dry Clean	4.2	69.5
Shirts (Dress Shirt)	Cotton	Machine Wash Warm, Line/Air Dry	2.3	41
	Synthetic	Machine Wash Warm, Line/Air Dry	2.3	38.5
	Wool	Machine Wash Cool, Line/Air Dry	2.3	38.5
	Delicate	Machine Wash Cool, Line/Air Dry	2.3	38.5

Skirt	Cotton	Machine Wash Warm, Line/Air Dry	4.2	69.5
	Synthetic	Machine Wash Warm, Line/Air Dry	4.2	69.5
	Wool	Machine Wash Cool, Line/Air Dry	4.2	69.5
	Delicate	Machine Wash Cool, Line/Air Dry	4.2	69.5
Socks	Cotton	Machine Wash Warm, Line/Air Dry	1.5	52.3
	Synthetic	Machine Wash Warm, Line/Air Dry	1.5	52.3
	Wool	Machine Wash Cool, Line/Air Dry	2.5	52.3
	Delicate	Machine Wash Cool, Line/Air Dry	1.5	52.3
Sweater	Cotton	Machine Wash Warm, Line/Air Dry	5	81.4
	Synthetic	Machine Wash Warm, Line/Air Dry	5	81.4
	Wool	Machine Wash Cool, Line/Air Dry	10	92.4
	Delicate	Machine Wash Cool, Line/Air Dry	4	81.4
Swimsuit	Cotton	Hand Wash Line/Air Dry	1	29.8
	Synthetic	Hand Wash Line/Air Dry	1	29.8
	Delicate	Hand Wash Line/Air Dry	1	29.8
T-Shirt	Cotton	Machine Wash Warm, Line/Air Dry	1.5	46
	Synthetic	Machine Wash Warm, Line/Air Dry	2	38.9
	Wool	Machine Wash Cool, Line/Air Dry	3	43.3
	Delicate	Machine Wash Cool, Line/Air Dry	2	38.9
Pillow	Cotton	No Wash	Infinite (0 washes)	2000

	Synthetic	No Wash	Infinite (0 washes)	
	Wool	No Wash	Infinite (0 washes)	
	Delicate	No Wash	Infinite (0 washes)	
Lighting shade (e.g. roman shades, lamp shade)	Cotton	No Wash	Infinite (0 washes)	2000
	Synthetic	No Wash	Infinite (0 washes)	
	Wool	No Wash	Infinite (0 washes)	
	Delicate	No Wash	Infinite (0 washes)	
Upholstery	Cotton	No Wash	Infinite (0 washes)	2000
	Synthetic	No Wash	Infinite (0 washes)	
	Wool	No Wash	Infinite (0 washes)	
	Delicate	No Wash	Infinite (0 washes)	
Duvet	Cotton	No Wash	Infinite (0 washes)	2000
	Synthetic	No Wash	Infinite (0 washes)	
	Wool	No Wash	Infinite (0 washes)	
	Delicate	No Wash	Infinite (0 washes)	
Rug	Cotton	No Wash	Infinite (0 washes)	2000
	Synthetic	No Wash	Infinite (0 washes)	
	Wool	No Wash	Infinite (0 washes)	
	Delicate	No Wash	Infinite (0 washes)	

Cushion	Cotton	No Wash	Infinite (0 washes)	2000
	Synthetic	No Wash	Infinite (0 washes)	
	Wool	No Wash	Infinite (0 washes)	
	Delicate	No Wash	Infinite (0 washes)	
Duvet Cover	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Wool	Machine Wash Warm Line/Air Dry	100	
	Delicate	Machine Wash Warm Line/Air Dry	100	
Comforter	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Wool	Dry Clean	100	
	Delicate	Dry Clean	100	
Quilt	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Wool	Machine Wash Warm Line/Air Dry	100	
	Delicate	Machine Wash Warm Line/Air Dry	100	
Sham	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Wool	Machine Wash Warm Line/Air Dry	100	
	Delicate	Machine Wash Warm Line/Air Dry	100	

Slip Cover	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Wool	Machine Wash Warm Line/Air Dry	100	
	Delicate	Machine Wash Warm Line/Air Dry	100	
Window Curtain	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Wool	Hand Wash Line/Air Dry	100	
	Delicate	Hand Wash Line/Air Dry	100	
Shower Curtain	Cotton	Machine Wash Warm Line/Air Dry	100	2000
	Synthetic	Machine Wash Cool Line/Air Dry	100	
	Delicate	Machine Wash Cool Line/Air Dry	100	
Mattress Pad	Cotton	Machine Wash Warm Line/Air Dry	60	1000
	Synthetic	Machine Wash Cool Line/Air Dry	60	
	Wool	Machine Wash Warm Line/Air Dry	60	
	Delicate	Machine Wash Warm Line/Air Dry	60	
Blanket	Cotton	Machine Wash Warm Line/Air Dry	60	1000
	Synthetic	Machine Wash Cool Line/Air Dry	60	
	Wool	Machine Wash Warm Line/Air Dry	60	
	Delicate	Machine Wash Warm Line/Air Dry	60	

Mat	Cotton	Machine Wash Warm Line/Air Dry	60	1000
	Synthetic	Machine Wash Cool Line/Air Dry	60	
	Wool	Machine Wash Warm Line/Air Dry	60	
	Delicate	Machine Wash Warm Line/Air Dry	60	
Table Cloth	Cotton	Machine Wash Warm Line/Air Dry	10	1000
	Synthetic	Machine Wash Cool Line/Air Dry	10	
	Wool	Machine Wash Warm Line/Air Dry	10	
	Delicate	Machine Wash Warm Line/Air Dry	10	
Towel	Cotton	Machine Wash Warm Line/Air Dry	4	1000
	Synthetic	Machine Wash Cool Line/Air Dry	4	
	Wool	Machine Wash Warm Line/Air Dry	4	
	Delicate	Machine Wash Warm Line/Air Dry	4	
Sheet	Cotton	Machine Wash Warm Line/Air Dry	10	1000
	Synthetic	Machine Wash Cool Line/Air Dry	10	
	Wool	Machine Wash Warm Line/Air Dry	10	
	Delicate	Machine Wash Warm Line/Air Dry	10	
Kitchen Towel	Cotton	Machine Wash Warm Line/Air Dry	5	1000
	Synthetic	Machine Wash Cool Line/Air Dry	5	
	Wool	Machine Wash Warm Line/Air Dry	5	

	Delicate	Machine Wash Warm Line/Air Dry	5	
Napkin	Cotton	Machine Wash Warm Line/Air Dry	3	1000
	Synthetic	Machine Wash Cool Line/Air Dry	5	
	Wool	Machine Wash Warm Line/Air Dry	5	
	Delicate	Machine Wash Warm Line/Air Dry	5	
Place Mat	Cotton	Machine Wash Warm Line/Air Dry	10	1000

Footwear does not have Product Care impacts in the Higg PM. According to brands' recommendations, specific cleaning or care is not widely recommended. Therefore, the base case for results calculations includes no shoe maintenance activities for the use phase. Also, use phase parameters tested (i.e., washing in household washer and application of durable water repellent spray) during the drafting of the non-leather footwear PEFCR had small effects on the results and are therefore out of scope for this assessment.

The specific washing, drying, and ironing impacts are calculated using the same global electricity and water scarcity factors as the Retail impacts (global average domestic consumption electricity mix and global AWARE factor). Data is based on the global consumer rather than a specific manufacturer or machine.

Table 9. Machine Washing

Washing Scenarios			
Washing temperature	Cold: 20C (68F)	Warm: 40C (104F)	Hot: 60C (140F)
Load	4 kg		
Energy consumption for a normal washing cycle (energy for washer only, not heating water)	0.79 kWh/load		
Energy for heating water	0 kWh 0 MJ NG	0.979 kWh 5.129 MJ NG	1.957 kWh 10.259 MJ NG
Water consumption	9 L/load		
Water Use	70 L/load		

Quantity of wastewater	61 L/load
Powder detergent quantity and type	0.020 kg detergent/kg clothes = 0.083 kg / avg load Powder detergent

Table 10. Drying

Drying Scenarios		
Drying Method	Air Dry	Machine Dry
Load	4 kg	
Energy consumption for a normal drying cycle	0	3.12 kWh/load

Table 11. Ironing – Average power for different iron settings

Maximum Ironing Temperature	Iron Setting	Average Power (W)	Electricity (kWh/minute)
110C	1 point	1100	0.0183
150C	2 points	1500	0.025
200C	3 points	2000	0.033
	Average		**0.0256**

Dry cleaning is a washing technique using a solvent to remove stains. The most-used solvent is perchloroethylene. Because of the toxicity of this substance, new technologies (e.g. those based on CO_2) are being developed. The process impacts in the Higg PM include electricity for the machines, softener, and perchloroethylene as a solvent.

Table 12. Dry Cleaning

Conditions	Electricity per event (kWh/kg product)	Powder detergent used per event (kg/kg product)	Softener used per event (g/kg product)	Solvent (perchloroethylene) used per event (g/kg product)	Water used per event (liters/kg product)	Wastewater produced per event (liters/kg product)
Dry Cleaning	0.3	0	22	15	--	--

The hand washing process describes washing a garment in the sink with water at low temperatures (20-30°C), generally done for delicate clothing made from fibers like wool or silk. The only inputs are soap and water, and the only output is wastewater.

Table 13. Hand Washing

Conditions	Electricity per event (kWh/kg product)	Powder detergent used per event (kg/kg product)	Water used per event (liters/kg product)	Water consumed per event (liters/kg product)	Wastewater produced per event (liters/kg product)
Hand Washing	0	0.0083	23	2.2	20.8

END OF USE

Similarly to product care, the specific end of use pathway for a product is dependent on the individual consumer and a standardized scenario is used based on global average consumer data. At the end of its life, a product is assumed to be either recycled (including upcycling and downcycling), landfilled, or incinerated. Composting was considered for inclusion but was rejected as it currently makes up a negligible portion of the apparel and footwear waste stream. Concerns were also raised around composting as a viable pathway for product end of life due to the amount of chemicals and polymers applied to apparel and footwear products during processing (i.e. regardless of fiber origin, apparel and footwear products are processed to the point where they are no longer part of the biological nutrient cycle but should be treated as part of the technical nutrient cycle). The breakdown of the standardized end of life pathway is detailed below:

Table 14. End of Life Pathway

Condition	Percent of Product End of Life	Emissions Model
Recycling	5%	Burden free from point of collection (Recycling Cutoff)
Landfill	63.7%	Municipal Waste, Landfill, from Sphera
Incineration	31.3%	Municipal Waste, Incineration, from Sphera

Higg PM users can modify the end of use scenarios by implementing circularity strategies. These include design for repair and product takeback programs. Standard intrinsic quality testing can also be used to demonstrate the likelihood of a longer product lifetime, which is covered in the "Duration of Service" section of this document. The questions and modifiers available in the End of Use section of the Higg PM are listed below:

Table 15. End of Use Modifiers

Mindful EoU Types	Answer Options	Requirements for each answer option	Methodology and Scoring
Longer Lifetime	Repair	• Level 1: design for repair • Level 2: Level 1 plus DIY repair guides and/or list of repair services • Level 3: In what % of countries where this product is sold do	These impact product longevity: • Level 1: 1.05 lifetime multiplier • Level 2: 1.10 lifetime multiplier • Level 3: 1.10 + (0.05*% entered) lifetime multiplier

		you promote and facilitate repair services?	
	Re-wear	• What % of your annual production volume is taken back for a re-wear program that is actually re-worn (and not re-routed to landfill/incineration by your company)?	These impact product longevity: • 1 + (0.15*% entered) lifetime multiplier
Diversion from Landfill	Recycling	• What % of your annual production volume is taken back that is actually recycled (and not re-routed to landfill/incineration by your company)?	The percent entered by user is added to the global Recycled/Downcycled assumptions listed in Table 13.

Examples of Designing for Repair include:

- Include spare parts (buttons, threads, buckles)
- Include repair supplies (patches or glue)
- Design products for easy and quick trim/fastener replacement
- Design products that can be repaired through a brand repair program (for example, Patagonia's Worn Wear program)

For re-wear, products collected through a take-back program do not need to be initially offered by the company taking it back, but it does need to be re-offered to consumers through a re-wear program.

Taking back product for recycling, upcycling, and downcycling improves the end of use pathway by diverting an additional percent of product away from landfill. The products collected through a take-back program do not need to be offered by the company taking it back, but it does need to be recycled/upcycled/downcycled. Products stored in a warehouse for potential recycling are not counted towards this number until the recycling has occurred.

DURATION OF SERVICE

Duration of Service is the lifetime of the product with appropriate use for its intended function. It is difficult to measure because it is dependent on specific consumer use and disposal. Products that are able to last longer have the potential to reduce industry impacts since fewer replacement products need to be purchased (and therefore, manufactured). The Higg PM leverages physical quality tests and thresholds to add a Duration of Service Factor (DoS Factor), or lifetime multiplier, if quality requirements have been achieved. The DoS Factor increases the lifetime uses of products, based on the standardized lifetimes shown in Table 8.

Cascale created a task team to investigate how to measure physical quality for duration of service in a consistent way. This work has shown that companies use many of the same quality tests that are described by international standards such as ISO, AATCC, and ATSM. The Higg PM builds upon these commonly accepted quality tests. If a product is to be used longer, it must have the ability to last longer. Emotional and style measurements of longevity (such as brand attachment, product colors, etc.) are out of scope for the Higg PM, but overall product trends are reflected in the default lifetime assumptions in the Higg PM functional units.

The Duration of Service section of the Higg PM considers material and full product tests for seven different types of products, focusing on the physical attributes that can make a product's service last longer. The number of tests for each product have been narrowed to those associated with the most common product failure modes identified by Cascale member experts. These have been further refined by the Technical Secretariat for the Global Apparel and Footwear Product Environmental Footprint Category Rules (PEFCR), which is developing a similar approach for including product quality into the product lifetime. The tests and thresholds in the Higg PM are not the final version of those being developed for the PEFCR, but were the most current versions at the time of the Higg PM being built. Once a final proposal is developed for the PEFCR, Cascale plans to update the Duration of Service section of the Higg PM.

There are seven product types included: waterproof breathable jackets, athletic shoes, athleisure (casual) shoes, knit products, denim products, bed linens, and woven products. These products were chosen because they cover a large range of products and because they were products where data was available. Achieving the tests and thresholds outlined in the tables below can improve Enabled Impact per Use results; however, if the product assessed is not covered in this section, or if thresholds are not met, results do not get worse[12].

Pre-Qualification tests, Performance Tests, and Garment Integrity Tests are considered. Pre-Qualification tests must be achieved before completing Performance Tests and Garment Integrity Tests. Pre-qualification tests are considered foundational quality assurance tests that must be met by materials and parts. Performance tests are additional material tests. Garment integrity tests are full garment tests after simulated aging has been conducted on the product through laundering. It is meant to represent how well a product lasts with consumer use.

There are three different levels for each test. The Basic level is the easiest to achieve and awards 5 points per test. The Moderate level awards 10 points per test. The Aspirational level is the most difficult level to achieve and awards 15 points per test. The percent of possible points achieved translate to a DoS Factor.

Product duration of service needs to consider all elements, but those elements can carry different levels of importance. Each test included has an associated weighting, based on how likely it is to contribute to full product failure. Pre-Qualification tests do not receive a weighting because they are a basic requirement. Performance tests have a combined weighting of 50%, while Garment Integrity Tests have a combined weighting of 50%.

In all cases where wash tests in the following tables are used, care instructions for washing and drying shall be followed. In case of tumble drying, one tumble dry cycle shall be performed each cycle of 10 washes.

Table 16. Duration of Service Requirements for Waterproof Breathable Jackets

Duration of Service Test and Rating		% Weighting per Test	Endurance Factors and Requirements		
Test Item	Test Standard		5 points (basic)	10 points (moderate)	15 points (aspirational)
Pre-Qualification (materials and parts)		N/A	Basic material performance specifications standards are available and tested Pass, at least including the following:		

---

12 The Cascale method ensures that users who are beginning to collect data and understand their product impacts at scale can do so without negative reinforcement. The PEFCR method proposes to include a negative modifier. Once the PEFCR approach is finalized, Cascale plans to adopt the outputs.

Fabric Dimensional Stability	ISO 6330 with frequency of tumbling and drying fixed at 10W + (10 wash, one dry)	N/A	Within ±3%		
Fabric Colorfastness	ISO 105 X12 OR AATCC 8 (to crocking)	N/A	Grade ≥4		
	ISO 105 C06 (at 40 degrees) OR AATCC 61, 2A (to laundering)	N/A	Grade ≥3 using grey scale for color change		
	ISO 105-B02, 20h OR AATCC 16, 20 AFU[13] (to light)	N/A	Grade ≥4		
Fabric Lamination bonding strength	DIN 53530	N/A	≥ 5 N		
Fabric Moisture Vapor Transmission Rate	* ISO 11092 ** JIS L1099	N/A	U-Urban wear, A-Active wear, M-Mountaineering wear Option1*, Ret: U: 13-20, A:6-13, M: ≤6 Option 2**, B1 & B2: U: ≥8000 & 5000, A: ≥12000 & 8000, M: ≥20000 & 10000.		
Initial Seam Waterproofness	Suter test (3psi 2 min.)	N/A	No leaks		
Zipper Quality	BS EN 16732 OR ASTM D2062	N/A	Selected zipper meets specification requirements. Operability, Repeat Cycles, etc.		
Performance Test (materials)	**Laundering: ISO 6330 4N tumble dry low**	**50%**	**Options: Cleaning cycles 10x**	**Options: Cleaning cycles 30x**	**Options: Cleaning cycles 60x**
Fabric Tearing strength	EN ISO 4674-1 B OR ASTM D1424	10%	ISO: < 100gsm ≥ 10N 100-120gsm ≥ 12N >120 gsm ≥ 15N Test as received ATSM: <0-70 gsm: ≥600g 71-120gsm: ≥800g 121-200gsm: ≥1100g >200gsm: ≥1500g Test as received	ISO: < 100gsm ≥ 11N 100-120gsm ≥ 13N >120 gsm ≥ 16.5N Test as received ATSM: <0-70 gsm: ≥660g 71-120gsm: ≥880g 121-200gsm: ≥1210g >200gsm: ≥1650g Test as received	ISO: < 100gsm ≥ 12N 100-120gsm ≥ 14N >120 gsm ≥ 18N Test as received ATSM: <0-70 gsm: ≥720g 71-120gsm: ≥960g 121-200gsm: ≥1320g >200gsm: ≥1800g Test as received
Fabric Water Proofness	ISO 811 OR AATCC 127	20%	≥2.6m & <20% change from initial value		
Fabric Water Repellency	ISO 4920 OR AATCC 22	20%	ISO: ≥4 AATCC: ≥80	ISO: ≥4 AATCC: ≥80	ISO: ≥3-4 AATCC: ≥70
Garment Integrity Test (whole garment after aging process)	**Laundering: ISO 16322/6330 (sprirality or angular variation) 4N tumble dry low**	**50%**	**Cleaning cycles 10x**	**Cleaning cycles 30x**	**Cleaning cycles 60x**
Seam sealing taping	Suter test (3psi 2 min.)	10%	No leaking @ multiple curve, X-points.		
Coating/Lamination degradation	Visual Exam (Comprehensive)	20%	No coating degradation no delamination		
Trim Failure	Visual Exam (Comprehensive)	20%	No component/trim failure (e.g. zipper, snaps)		

[13] AATC Fading Unit

Table 16. Duration of Service Requirements for Athletic Footwear

			5 points - basic	10 points - moderate	15 points - aspirational
Product Integrity			**50,000 forefoot flex cycles**	**60,000 forefoot flex cycles**	**70,000 forefoot flex cycles**
Cracking	Whole Shoe Flex test – Visual ISO 24266 30 degrees +/- 1 degrees 140 +/- 10 cycles per minute	• 25% if finished upper material not leather • 50% if finished upper material leather	• No cracking of the midsole or outsole		
Delamination			• No peeling or seam separation of the upper • No delamination between any component		
Bonding strength	EN ISO 17708 [daN/cm] or [N/mm]	25%	3.5	5.75	8
Material level test					
Outsole abrasion resistance	ISO 20871:2018	• 25% if finished upper material not leather • 0% if finished upper material leather	If density ≥ 0.9 g/cm3, then ≤ 400 mm3 If density < 0.9 g/cm3 , then ≤ 200 mg		
Determination of tear strength for upper materials	EN 13571 ISO 17696 (daN)	12.5%	5 daN	6.5 daN	8 daN
Martindale abrasion specific for fabrics	ISO 12947-2 [Cycles]	12.5%	3’000 cycles: coating totally abrased	3’000 cycles: coating partially abrased	3’000 cycles: coating not abrased

Table 17. Duration of Service Requirements for Casual Footwear (Athleisure)

Test Item	Test Standard	% Weighting of Failure Mode	Endurance Factors and Requirements		
			5 points - basic	10 points - moderate	15 points - aspirational
Product Integrity			30,000 forefoot flex cycles	40,000 forefoot flex cycles	50,000 forefoot flex cycles
Cracking	Whole Shoe Flex test – Visual ISO 24266 30 degrees +/- 1 degrees 140 +/- 10 cycles per minute	• 50% if finished upper material not leather • 100% if finished upper material leather	• No cracking of the midsole or outsole		
Delamination			• No peeling or seam separation of the upper • No delamination between any component		
Bonding strength	EN ISO 17708 [daN/cm] or [N/mm]	25%	3.5	5.75	8
Material level test					
Outsole abrasion resistance	ISO 20871:2018	50% if finished upper material not leather 0% if finished upper material leather	If density ≥ 0.9 g/cm3, then ≤ 400 mm3 If density < 0.9 g/cm3 , then ≤ 200 mg		
Determination of tear strength for upper materials	EN 13571 ISO 17696 (daN)	12.5%	5 daN	6.5 daN	8 daN
Martindale abrasion specific for fabrics	ISO 12947-2 [Cycles]	12.5%	3’000 cycles: coating totally abrased	3’000 cycles: coating partially abrased	3’000 cycles: coating not abrased

Table 18. Duration of Service Requirements for Knit Products

Duration of Service Test and Rating		% Weighting per test	Endurance Factors and Requirements		
Test Item	**Test Standard**		**5 points (basic)**	**10 points (moderate)**	**15 points (aspirational)**
Pre-Qualification (materials)		**N/A**	**Basic material performance specifications standards are available and tested Pass, at l the following:**		
Fabric Dimensional Stability	ISO 6330 4N with ISO 5077 wash/dry conditions based on care instructions, 1 wash. If tumble dry, use 10 wash / 1 dry OR • AATCC Monograph M6, according to care label AND ISO 5077 OR • AATCC Monograph M6, according to care label AND • AATCC 124	N/A	Skewness ±5% Shrinkage/Elongation ±5%		
Fabric Colorfastness	ISO 105 X12 OR AATCC 8 (to crocking) wet rub	N/A	Grade ≥3-4 using ISO / AATCC greyscale for color change		
	ISO 105 CO6 (at 40 degrees) OR AATCC 61, 1A (to laundering)	N/A	Grade >4 using ISO 105-A02 grey scale for color change / AATCC greyscale for color change		
	ISO 105 E04 OR AATCC 15 (to perspiration)	N/A	Grade >4 staining of multi-fiber using ISO 105-A02 grey scale for color change / AATCC greyscale for color change		
	ISO 105-B02, 20 hours of light exposure OR AATCC 16, Op3, 20 AFU (to light)	N/A	Grade ≥4 using ISO 105-A02 / AATCC blue scale for color change		
Performance Test (materials)		**50%**			
Pilling Resistance	ISO 12945-1, ISO 12945-1:2000Textiles — Determination of fabric propensity to surface fuzzing and to pilling — Part 1: Pilling box method	• 20%	Grade 3	Grade 3-4	Grade 4
Fabric Bursting	ISO 13938-2 OR ASTM D3786	• If there is a functional finish: 10% • If no functional finish: 30%	<150gsm: 133 N 150-250gsm: 178 N >200gsm: 222 N	<150gsm: 156 N 150-250gsm: 200 N >200gsm: 245 N	<150gsm: 178 N 150-250gsm: 222 N >200gsm: 267 N
Wicking or other function finishing (if applicable)	• ISO 6330 4N wash/dry conditions based on care instructions. If tumble dry, use 10 wash / 1 dry	• If there is a functional finish: 20%	For all types of substrates: <20% change from initial after wash 10x	For all types of substrates: <20% change after 30 wash.	For all types of substrates: < 30% change after 60 wash

	OR ● AATCC Monograph M6, according to care label AND ● AATCC 197 and 198	● If no functional finish: 0%			
Garment Integrity Test (whole garment after aging process)	**Options:** ● **ISO 16322/6330 (sprirality or angular variation) 4N with ISO 5077 wash/dry conditions based on care instructions. If tumble dry, use 10 wash / 1 dry** ● **AATCC Monograph M6, according to care label**	**50%**	**Cleaning cycles 10x**	**Cleaning cycles 30x**	**Cleaning cycles 60x**
Dimensional change	ISO 5077 OR AATCC 150 AND Visual Exam (Comprehensive)	20%	● Shrinkage ±5% ● Skewness ±5%		
Appearance	Visual Exam (Comprehensive)	30%	● Grade >3 pilling using ASTM/ISO pilling photos/replicas ● No component/trim failure (e.g. buttons, zipper) ● Color Change: Grade >4 using AATCC / ISO greyscale for color change ● No broken seams		

Table 19. Duration of Service Requirements for Woven Products

Duration of Service Test and Rating		% Weighting per Test	Endurance Factors and Requirements		
Test Item	Test Standard		5 points (basic)	10 points (moderate)	15 points (aspirational)
Pre-Qualification (materials and parts)			Basic material performance specifications standards are available and tested Pass, at least including the following:		
Fabric Dimensional Stability	• ISO 6330 4N with ISO 5077 wash/dry conditions based on care instructions, 1 wash. If tumble dry, use 10 wash / 1 dry OR • AATCC Monograph M6, according to care label OR (if dry clean only) • ISO 3175-2 and assessing via ISO 3175-1 AND • AATCC 124	N/A	Skewness ±4% Shrinkage/Elongation ±4%		
Fabric Colorfastness	ISO 105-C06 (at 40 degrees) OR AATCC 61, 2A (to laundering)	N/A	Grade >4 using AATCC / ISO grey scale for color change		
	ISO 105-X12 OR AATCC 8 (to crocking) wet rub	N/A	Grade ≥3 using AATCC / ISO grey scale for color change		
	ISO 105 E04 OR AATCC 15 (to perspiration)	N/A	Grade >4 staining of multi-fiber using AATCC greyscale for staining Grade >4 staining of multi-fiber using greyscale for staining		
	ISO 105-B02 OR AATCC 16, Op3, 20 AFU (to light)	N/A	Grade ≥4 using AATCC / ISO blue scale for color change		
Seam/Yarn slippage Resistance	ISO 13936-2 OR ASTM D1683	N/A	≤ 6 mm at 60 N for low weight fabrics (<220 gsm) ≤ 6 mm at 120 N for high weight fabrics (≥ 220 gsm)		
Stretch & Recovery (if garments have stretch claim)	EN 14704-1 OR ASTM 3107	N/A	For <5% spandex: 85% recovery @ 60 min For ≥5% spandex: 90% recovery @ 60 min		
Zipper Quality	BS EN 16732 OR ASTM D2062	N/A	Selected zipper meets specification requirements. Operability, Repeat Cycles, etc.		
Performance Test (materials)		50%			
Martindale Abrasion	ISO 12947-2 OR ASTM D4966 (Option 2 or 3)	• 20%	• Rupture of 2 yarns after 12'000 cycles	• Rupture of 2 yarns after 20'000 cycles	• Rupture of 2 yarns after 30'000 cycles

Fabric Tearing strength	ISO 13937-1 OR ASTM D1424	• If smoothness claimed: 10% • If smoothness not claimed: 15%	<70gsm: ≥ 8N 71-120gsm: ≥ 10 N 121-200gsm: ≥ 12N >200gsm: ≥ 16 N	<70gsm: ≥ 9N 71-120gsm: ≥ 11 N 121-200gsm: ≥ 13 N >200gsm: ≥ 17N	<70gsm: ≥ 10 N 71-120gsm: ≥ 12N 121-200gsm: ≥ 14 N >200gsm: ≥ 20 N
Fabric Tensile strength	ISO 13934-2 OR ASTM D5034	• If smoothness claimed: 10% • If smoothness not claimed: 15%	<150 gsm: Warp=220N, fill (weft)=110N 151-200 gsm Warp=290 N, fill=130 N 201-300 gsm Warp= 360 N, fill= 180 N 301-400 gsm Warp=400 N, fill=220 N >400 gsm: Warp=490 N, fill=290 N	<150 gsm: Warp=270 N, fill=160 N 151-200 gsm: Warp=330 N, fill=180 N 201-300 gsm : Warp=400 N, fill=220 N 301-400 gsm: Warp=440 N, fill=270 N >400 gsm: Warp=530 N, fill=330 N	<150 gsm: Warp=310 N, fill=200 N 151-200 gsm: Warp=380 N, fill=220N 201-300 gsm: Warp=440 N, fill=270 N 301-400 gsm: Warp=490 N, fill=310 N >400 gsm: Warp=580 N, fill=380 N
Smoothness (if claimed)	• ISO 6330 4N tumble dry low, 1 Wash OR • AATCC Monograph M6, according to care label AND • AATCC 124	• If smoothness claimed: 10% • If smoothness not claimed: 0%	Grade ≥4 after 10x wash	Grade ≥4 after 30x wash	Grade ≥3-4 after 60 wash
Garment Integrity Test (whole garment after aging process)	**Options:** • **ISO 16322/6330 (sprirality or angular variation) 4N with ISO 5077 wash/dry conditions based on care instructions. If tumble dry, use 10 wash / 1 dry** • **AATCC Monograph M6, according to care label** **OR ISO 3175-2 and assessing via ISO 3175-1 (if dry clean only)**	**50%**	**Cleaning cycles 10x**	**Cleaning cycles 30x**	**Cleaning cycles 60x**
Dimension	• AATCC 150 • Visual Exam (Comprehensive)	20%	• Dimensional change ±4% • Skewness ±4%		
Appearance	Visual Exam (Comprehensive)	30%	• Pilling Grade ≥3-4 using ISO / ASTM pilling photos/replicas • No component/trim failure (e.g. zipper, brad, buttons, studs) • Color Change: Grade >4 using AATCC / ISO greyscale for color change • No broken seams		

In the Higg PM, users indicate which tests and which levels have been achieved by the product and the materials that compose it. Internal test results are acceptable as long as the lab holds an internationally recognized accreditation for the tests being performed. Suitable proof for meeting requirements is development-based and not production-based, provided suitable production tolerances have been agreed upon with the manufacturers.

As the user completes this section, the percent of total possible points achieved translates to a DoS Factor, or multiplier to the product's lifetime (number of care cycles in the functional unit).

No tests performed or pre-requirement thresholds not achieved = DoS Factor of 1
Percent of possible points achieved below 50% but still passes pre-qualifications = DoS Factor of 1.1
Percent of possible points achieved between 50-80% = DoS Factor of 1.18
Percent of possible points achieved above 80% = DoS Factor of 1.25

The percent of possible points achieved is equal to the test score divided by the maximum number of points.

*Test score = Σ(test weight * test points achieved)*

The maximum number of points is 15.

APPENDIX A: HIGG PM EXTERNAL REVIEW REPORTS AND RESPONSES

Three external reviews were conducted for a previous version of this Higg PM Methodology document. As such, page numbers and section headers may not always match. The external reviewers were:

Dr. Subramanian Senthilkannan Muthu	Independent
Dr. Gregory Norris	NewEarth B
Dr. Sandra Roos	RISE IVF

Updates and clarifications requested in the reviews have already been incorporated into this current version of the document. Larger methodological recommendations will be discussed by Cascale members. Items that Cascale's Product Advisory Council (PAC) has requested to prioritize in these discussions include:

- Updating criteria for the selection of included environmental impact areas and LCIA methods;
- Furthering integration between the Higg FEM and Higg PM;
- Clarifying and perhaps updating the functional unit. At a minimum, clarification is needed for the nomenclature in the Higg MSI; and
- Updating Duration of Service assumptions.

Introduction (about yourself and your qualifications):

This is Dr Subramanian Senthilkannan Muthu, currently working for SgT & API as Head of Sustainability. I did all my studies from Diploma to Masters in Textiles & Apparel technology and did pursue my Doctoral Research in Eco-Functional Assessments for Textiles (precisely worked on life cycle assessment in textiles and development of scientific models for eco-functional assessment of textiles & clothing supply chain). Post PhD study from HK, have been working with many brands, retailers, manufacturers across the globe on various Environmental & Chemical Sustainability issues pertaining to Environmental Assessments, Chemical Assessments, Supply Chain Sustainability, and so on through training, capacity building, assessment, coaching & consulting. Also experienced with Life Cycle Assessment, Environmental Footprints, Green Claims, Verification of Recycled products for almost a decade in many countries. I have had hands on experience with life cycle assessment of many textile products. I have been a part of many critical and peer review panels for various LCA studies done by other LCA practitioners and also an editorial board member, reviewer for many academic research journals of Textiles & Clothing, Sustainability and Environmental Engineering disciplines. I began the very first research journal dedicated to Textiles & Clothing Sustainability for Springer as an Editor-in-Chief. I have also been working with Higg Index FEM since 2013 (V1, V2 and V3). Authored and edited around 80 scientific books to my credit on Environmental Sustainability related areas. Attached CV is evident for my skillsets.

Review approach:

-Critical review by reading through the whole document as a common man and the questions aroused are added;

- Second time reading as an expert and look at the document through scientific, practical and logical lenses;

-Third time review with industrial application context in terms of how this could be useful to a manufacturer/brand/retailer.

Reviewer Comments by section (possibly a table):

GLOSSARY AND TERMINOLOGY	A lot of terminologies can be explained further in a clear, understandable format and with further more details. For instance, allocation can be defined in an easy way and with further more details. Some important terms are missing as well, for ex, LCI- Life Cycle Inventory, End point (mid-point is

	explained, end point is missing), FEM, etc. Many such terms used in the document are missing. Terms used in initialisms are missing to be explained in this part such as BOM.
DOCUMENT INFORMATION **DOCUMENT REVIEW AND BACKGROUND** **SAC AND THE HIGG INDEX**	A few terms are missing in initialisms as well such as LCA. It would be beneficial to the audience to know the comments from the review of PAC and SAC's/task team's responses . P.14- Before this intro on Higg product module purpose and even before higg product tools, it would be beneficial to explain the concept of product and facility level assessments and their significances. Readers must be informed and oriented towards MSI, MSI contributor, DDM and PM beforehand. A brief explanation of cradle to gate and cradle to grave and the importance of these two variants in the context of product module need to be debriefed as well with the help of a LCA model diagram.
HIGG PRODUCT MODULE PURPOSE	P.15- How higg PM will help consumerism after empowering them? This has to be explained. P.15- Along with the three main reasons explained, is there anything Higg PM can do to inform consumers about the use and disposal phases of the life cycle of a typical textile product? P. 16- this quoted line is not clear-"The Higg PM is meant to be used during product development (for decision-making) as well as for the final product". What's the % of usage in product development (ideally or realistically if you have some sort of data)? What benefit will be served by Higg PM in the final product once the whole production is done? P. 16- this quoted line is not clear-" the scores could generate "live" as users explore options and then get "locked" once the product enters production".

HIGG PRODUCT MODULE METHODOLOGY DEVELOPMENT PROCESS	P.16- absolute and normalized impact results need to be explained a bit. P.17- Pls explain a bit more on the roadmap ahead for how impacts will be shown to customers? P.21- Better to append the pilot feedback.
UNITS OF ANALYSIS	P.23- I am sure not all important categories of products are covered in Table 3- for instance- Denim is missing which is certainly an important category. Some product categories are quite vague such as accessory, hosiery, dress, etc P24- How readers/users are assumed to know what's functional unit without explained beforehand and it's missing in the glossary as well? P.24- *with no differentiation based on the color-* Why? Certain colours come from specific dyes/pigment classes, impacts of them might be hypothetically different than other colours. - "*One apparel or home textile product, or one pair of footwear or sock"* – this is incomplete and very ambiguous. Is it one pair of socks or complete apparel set? With packaging and accessories? - "*Wear in good condition with appropriate use for the given product"*- very subjective- good condition cannot be felt in the same way between two users. What's appropriate use? P24- How readers/users are assumed to know what's reference flow without explained beforehand and it's missing in the glossary as well? -Reference flow is not clear- especially- *for its intended duration of service and for one wear".* P.24- There are many other variables decide the number of care cycles apart from what are listed here- product category, style, and fiber type. Pls complete this.

	P.25- Duration of Service -Table 4- Apparel Products -Uses per wash means what? -Who is assumed to be standard customer? What attributes he or she is supposed to have to be rated as an average customer? -How washes per lifetime were/are determined? - The parameters listed in the table are pertaining to functional considerations. How about non-functional considerations? - How the numbers listed or the values in Table 4 for each product category are determined? -What wash parameters were considered? - How these results were/are validated? The similar comments for other tables as well under duration of service.
SYSTEM BOUNDARIES **IMPACT RESULTS**	P.33- System boundaries- how about the packaging of products in Table 7? Packaging of packaging in Table 7 and Fig 2? There is a discrepancy of elements in Higg PM boundaries between Table 7 and Fig 2 Table 7- EOL- not complete- missing LF, Incineration. Mixed scenarios if any, etc. Fig 2- Raw materials extraction is included? Not clear. P.34- What's this rate- global average landfill, incineration, and recycling rates? Quoted line is not clear- "However, users may increase the recycling rate if certain requirements are met"- which requirements and till what rate is allowed? P.35- Table 8- Packaging of packaging? Consumables? P.36- "The typical LCA approach requires assumptions to be made regarding how a product is used and disposed of" – Not sure how this was concluded? Need not be and since many years we are trying to change in many sectors including textiles. Pls refer to Eco-functional Assessment methodologies.

	- For longer duration – how about personal preferences/attributes to lengthen the life which are subjective? - Better to debrief again in simple terms of absolute and normalized impacts. -Why only five impacts alone are chosen? Any rationale? If so, has to be explained. - In which way the results for these impacts are planned to be shown? P.37- I will be beneficial to explain with an example on how to select/calculate the absolute & normalized impacts.
SELECTION OF IMPACT CATEGORIES	P38- Why only midpoint assessments? For climate change, why only 100 years were chosen- why not 20 and 500 years? P 38 & 39- Doubting the coherence of results when 4 impacts are calculated quantitatively and one impact is qualitative? P.40- Criteria for choosing these 5 impact categories – missing some criteria such as industrial relevance and also some criteria such as data availability and data source- what these have to do with impact categories?
ASSUMPTIONS AND LIMITATIONS	P. 42- Why human toxicity was not considered at all which is very much relevant? P.43- Table 11- Materials- how about process loss? Not clear- Retail section part in Table 11- Water, energy per part in stores? P.43- Why GaBi alone? Gabi has many shortfalls in terms of availability, accuracy, user friendliness, etc especially for apparels and textiles- this is my personal opinion. Apart from this, why GaBi alone? P.44- Inputs: - Accessories? Auxillaries?Packaging? Outputs: Defective product?Sludge?

	- Ecoinvent data quality guidelines (Weidema et al. 2013) & PEF guide- they are not standards P.45- The Higg MSI database is managed in an LCA software platform by a "qualified Data Manager"- Who's this? How she/he was qualified? is it public? - Why 2 times a year? Integrating FEM- What happens to off-site verified data? How about off-site assessors? How it could work- "Process midpoints for the five Higg PM impacts are imported"- Not clear and why not end points? Chemistry is one of the impacts, which is qualitative- if so, which are these five impacts imported? P.46- Will discuss in detail on integration of FEM into PM P.48- Next steps- Any suggested timeline would be ideal. P.49- Secondary data: Rules followed by SAC to agree upon secondary data? Considerations? Independent review? What criteria was followed? Any guidelines for secondary data usage- it has to be used cautiously. Why four times a year for database update? Any specific reason? Collect more primary data: Any priorities identified already for datasets? Step 1: "Work with facilities to measure data for a few set processes"- which set processes? Not clear. -What's Higg product tool secondary data? Step 2: What sort of support SAC will do? Not clear. Any progress for steps 1 and 2 for collecting more primary data?
HIGG PM SECTIONS	

COMPANY INFORMATION	P. 52-How about the confidentiality part? How SAC is going to handle? This is the key.
MATERIALS	P.53- Materials data is not clear (cradle-to-gate Material production or life cycle impact assessment (LCIA) data). P.55- Table 13- Textile Formation- needs to be renamed P. 56- What % of loss rates are assumed? Why 1000 km by truck- any rationale? P.57-Higg MSI Scoring- Is single score required as it has a lot of subjective aspects and not generally accepted in scientific fraternity of LCA. P.57- Grammatically erred- Sources used to calculation the normalization factors are the following: P.57- Table 14- What's the difference between Cellulosic and Cotton fabrics? How about organic and conventional cottons? How about recycled materials? P.58, 59- 10% of loss, 3% excess material cut away- how these percentages were ascertained? Any ref? Global EOU assumptions- What's the ref and where is the reuse? P.61- Grammatically erred- If users are customizing or creating trims/components, they are be asked if the material.. P.62- Table 16- Default efficiency- any ref?
FINISHED GOODS	P.64- Any idea of timeline when FEM results will be added to PM?
PREVIOUSLY USED PRODUCT	How about clothing libraries? There is a great deal of research on assessing the LCIA of clothing libraries vis-à-vis normal use/virgin products. P.67- What if user is not aware of cleaning done by the seller or any materials added etc?

PACKAGING	P.68- some options are missing- for ex, HDPE shopping bag is common too.
LOGISTICS	P. 70- Basis for these assumptions?
RETAIL	P. 71- Any reference/basis for arriving at the proxies?
PRODUCT CARE	P.73- LCA community has moved farther ahead of using assumptions for use and EOL. This is no more accepted. Infact I did in my Phd about this aspect and eco-functional assessments are invented to get rid-off the assumptions in LCA., For textiles, these sorts of assumptions should not be used at all due to typical consumer behavior which can drive the results entirely different. I completely disagree to have assumptions. Table 19- What is MFG? and how standard consumer is defined? How the numbers mentioned in the table for each category are arrived at? How frequency of wears/uses were determined? -How about Denims? Washing frequency and cycles are entirely different. Denims are missing. P.86- What's DWR spray? P 87- Table 22- WALDB? Table 23- Not only PCE, there are many other solvents used now. Table 24- Is it soap powder or liquid soap as the unit is g/kg
END OF USE	Similar comments as above. Where is reuse? What's the reference for these assumptions? Very importantly, these assumptions are valid for which countries and are they country specific? For instance, no incineration for Asia. In this case, how to go about it? Table 26- has to be explained especially levels 1, 2 and 3 and life time multipliers.
INTENDED DURATION OF SERVICE	P.94- The quoted sentence is absolutely not right- "LCAs typically do not take this into consideration because there is no way to measure how long a

ANALYTICS	product actually lasts.", it's been proved by many researchers including me on how to measure the longevity and life of a many products including textile products and taken into LCA calculations. I have done the same for many textile products in industrial and academic fronts. Better to take one product and show screenshots.
Appendix A	Better to add relevance to apparels/textiles. How degree of acceptance is decided?

What you found most useful and logical:

- Coherence of the sections in the document and the flow

What needs to be improved and how it could be improved, including top priority areas that should be addressed first:

- All the points I listed above need to be improved
- Some sort of basic idea to orient all the readers to LCA, PM would be great as we cannot assume all readers will know LCA
- Relevance to textiles/apparels has to be considered

Review of HIGG PM Methodology Document

By: Gregory A. Norris
CEO, NewEarth B, PBC

Date: August 2019

Introduction

My main field of expertise is life cycle assessment (LCA), which I have practiced for more than 20 years: teaching LCA at Harvard, serving as a consultant to companies, agencies and non-profits, and addressing in research. I also have familiarity with the work of SAC over the years, serving as an advisor or collaborator on projects, and I provided input to the development of Nike's MSI which preceded the SAC.

Review Approach

I read the report in a linear fashion from start to finish, making notes as I went along in each of the three sections below; thus, noting key strong points and improvement opportunities along the way. I read from the perspective of myself as an LCA practitioner and sustainability analyst; I also attempted to imagine how the document might read to a more general audience of stakeholders in companies and other organizations who have an interest in product and corporate sustainability. My focus was less on wording and more on content, method, and the information being communicated. Where I felt there were opportunities to improve communication power of effectiveness, I noted this in the section below on "review comments."

Review Comments, by Section

General:

- Authors might consider adding chapter numbering, and section numbering within chapters.

Chapter: SAC and the Higg Index

- Page 15: should it be "producing products" ? (plural)
- Page 16: provide footnote to explain "PEF process"
- Page 16: Change "not only it is the" to "not only is it an"

- Page 16: Change “may be invited for” to “may be invited to”
- Page 17: make parallel: leverages and incorporates (currently reads leverages and incorporated)
- Section: Higg Product Module Purpose: I would suggest wording changes that make this section less of a “sales pitch” for the PM and more descriptive/objective in tone.
- Page 21: fix “methodology and not fit”
- Page 34: Table 8 is split across two pages, but doesn’t need to be.
- Page 36, and more generally throughout the report: The language of “normalized” and “absolute” impacts. See section below under Improvement Opportunities.
- Page 51: A summary figure could add significant value here.
- Pages 51-93: This section operates as a sort of users guide to the PM, but it does so without acknowledging this fact explicitly. Can it be re-cast a bit within the report to more explicitly recognize, and serve, this role?
- Page 112: move this table to the Impact Category section of the report (pages 38-41), and include the column headers on each page of the table.
- Page 150: The data “wish list” needs an explanation here at the top of this appendix. Text could be pulled from page 45 and expanded into a short paragraph.
- Page 154 – 182: consider including the column header titles on each page.
- Pages 197 and 202: include spelling out MSI and DMM; should probably do this for PM on page 203 for consistency, although that is not needed by page 203!!

Strong points, including aspects found to be most useful and logical

Tables 4 and 5 are highly useful and important data, presented clearly.

The writing is generally excellent, at the right level of professionalism and accessibility.

Table 7 and Figure 2 do a great job of clearly summarizing the system boundaries.

The entire Data Submission Process (described in Appendix C), including the structure and guidance and process flow, are a major contribution, as part of the PM. These should be spelled out as part of the PM and highlighted earlier in the report as well.

Page 45-48, regarding integration of FEM and PM. This is a vital topic, and the proposed approach appears to be well-considered. I would suggest moving this topic to its own section, rather than burying it within “Assumptions and Limitations”, and expanding a bit further on the proposed approach. This use case could be another one to include in a section on use cases.

Page 57: Approach to Normalization
I find the approach taken here to establishing the “reference system” for normalization – namely based on current materials production for the industry – to be valuable and sound.

I would support or suggest complimenting it with use of the conventional approach to Normalization within LCA, namely to select a geographic region such as global. A graph of how the normalization results vary between the two reference systems, and a brief discussion of the findings, would be instructive and useful.

Improvement Opportunities, including top priorities

Page 24: The section on the functional unit is not clearly expressed. The phrase "calculates impacts for the following functional units" makes it seem that multiple functional units are possible, or used. But there is no definition(s) or example(s) of an operational functional unit provided. Then at the base of the section, the reference flow is defined. This section needs to spell out: Are multiple choices available for the functional unit, or are there multiple aspects to the functional unit? The section should also begin with one or a few simple sentences which explain the purpose of a functional unit – namely to provide an equivalent basis for clear/fair comparison of options.

Tables 4 and 5 are highly useful and important data, presented clearly. This is a strong point. However, we lack a statement of the source(s) for this important data.
Concepts of "absolute" and "normalized" impacts.
Normalization has a specific and different meaning in LCA than is used here.
And the role of the functional unit is being missed in this language.
I would suggest that "normalized" results are in fact ***results per functional unit***, while "absolute" results are ***results per unit of product***. This adjustment could be made throughout the report, and connected to improved clarity about the functional unit (see earlier discussion).

Selection of Impact Categories
Pages 38-41: The table from Appendix A should be moved into this important section, since it is basically a discussion of the contents of this table. The text and table from page 42 should then be moved into this same new section. Right now, material addressing this single issue is spread across 3 different sections.

On page 40, what is meant by the reference to "general toxicity criteria 10"?
More generally, the decision to not include USEtox is, in my personal opinion, a mistake and a missed opportunity. While it is true that results have uncertainties that can reach 3 orders of magnitude, it is also the case that product life cycles can vary by 5-10 orders of magnitude in relation to the toxicity results using USEtox; in such a case, the results are highly definitive and conclusive. That is, the important issue is not strictly the scale of the uncertainty in the absolute results, but the ability of the method to provide definitive guidance on whether one product system is better or worse than another in relation to the impact categories.

Missing a clear "What it is" section

By the time I got to the section on System Boundaries (page 33), I found myself with mounting frustration, looking for a clear and concise yet punchy overview of what the Higg PM ***is*** and what it will be used to do, in practice. Namely, what specifically will I have in my hands when I sit down to use it, and what are some simple, illustrative use cases. It is said to be a "tool" but if so it needs some illustrated use cases. The bottom row of Table 1 says that the PM "allows for a full impact assessment for a given product based on LCA methodology." But so would a batch of PCRs in combination with background data; is this effectively what the PM amounts to? If so, that is still a very valuable resource, but this "essence" of the PM needs to be stated explicitly. The Purpose section hints in general terms how different stakeholders might apply it, but these are 1-sentence descriptions that fall short of illustrative use cases. Reference is made throughout the report to the existence of an API for PLM integration; this is apparently the basis for one of the most important use cases, which should be illustrated somewhere in the report. Also, the Data Submission Process could be the focus of another of the important use cases.

One idea, which would partly (but not fully) address this need is to move the chapter titled "Higg PM Sections" to much earlier in the report. But also we will also need usage flow charts and descriptions for each major use case: user steps and outcomes and uses/applications of the resulting information. The material in Appendix F, page 183 (!) comes closest to illustrating what the PM actually is and how a user would interact with it, but we need a shorter summary, and much sooner than in the next to last appendix.

Sandra Roos July 29, 2019

Review report on Higg Product Module (PM) Methodology

Reviewer introduction

Sandra Roos holds a Ph.D.in Environmental Systems Analysis and has focused her research on the environmental impacts of textile products. The area of expertise covers life cycle assessment (LCA) of and chemicals in textile products and production processes. She has performed several LCA studies of textile products both in research projects and commissioned by industry and authorities. Further, she has developed several (ISO 14025 standardized) Environmental Product Declarations (EPD) for fabrics and garments. Sandra was also moderator of the PCR committee for development of Product Category Rules (PCR) for garments within the International EPD System.

Sandra works as performer, supervisor and reviewer of textile LCA studies, supervises M.Sc. and B.Sc. students, reviews for scientific journals and is regularly interviewed in TV, radio as well as newspapers on the topic of sustainable textiles. During 2012-2019, Sandra participated in one of the largest research programs globally on sustainable fashion, the Swedish Mistra Future Fashion program, from 2015 as Theme Leader of the Supply Chain Theme.

Selected references:

Roos, S. (2016) Advancing life cycle assessment of textile products to include textile chemicals. Inventory data and toxicity impact assessment. Doctoral thesis, serie 4202, ISSN: 0346-718X, ISBN 978-91-7597-521-4, Chalmers University of Technology, Gothenburg, Sweden. http://publications.lib.chalmers.se/records/fulltext/246361/246361.pdf

Roos, S., Sandin, G., Zamani, B., & Peters, G. M. (2015). “Environmental assessment of Swedish fashion consumption. Five garments - sustainable futures.” Stockholm, Sweden: Mistra Future Fashion. Retrieved from http://mistrafuturefashion.com/wp-content/uploads/2015/06/Environmental-assessment-of-Swedish-fashion-consumption-LCA.pdf

Roos, S., Larsson, M. (2018) Klimatdata för textilier. Uppdragsrapport för Naturvårdsverket. *[Climate data on textiles. Report on commission from the Swedish EPA.]* https://www.naturvardsverket.se/upload/miljoarbete-i-samhallet/miljoarbete-i-sverige/uppdelat-efter-omrade/hallbar-konsumtion/rapport-klimatdata-for-textilier-swerea-2018.pdf

Sandin, G., Roos, S. and Johansson M. (2019) Environmental impact of textile fibres – what we know and what we don’t know, Mistra Future Fashion report number 2019:03 part 2, ISBN:978-91-88695-91-8. Retrieved from http://mistrafuturefashion.com/shifting-the-focus-from-fiber-to-process/

Review approach

The following sections were only read-through for correctness and readability:

- Glossary and Terminology
- Document Information
- Document Review and Background
- Appendix G: Frequently Asked Questions

The other sections were thoroughly reviewed based on:

- Coherence with the stated purpose in the document:
  - Higg Index general (p13):
    - Understand and quantify the sustainability impacts of apparel, footwear, and home textile products
    - Reduce redundancy in measuring sustainability in apparel, footwear, and home textile industries
    - Drive business value through reducing risk and uncovering improvement opportunities
    - Create a common means and language to communicate sustainability to stakeholders
  - Target audience: Consumers & Communities (p14)
  - Higg Product Module (PM): a tool to calculate the environmental impacts of apparel, footwear, and home textile products using a standard methodology. It is meant to be used by sustainability and communication experts to assess the full impacts of a finished product, scale industry adoption of leading practices, and provide credible external communication to influence purchasing decisions of consumers. (p14)
  - The Higg PM allows for a full impact assessment for a given product based on LCA methodology. (p15)
  - Higg Product Module Purpose as stated on page 15-16.
- Coherence with standards and best-practice documents in the field of LCA methodology applicable to textiles [1]

[1] ISO, *ISO 14044 - Environmental Management - Life Cycle Assessment - Requirements and Guidelines.* (Geneva, Switzerland: International Organization for Standardization – ISO, 2006); European Commission, "PEFCR Guidance Document, - Guidance for the Development of Product Environmental Footprint Category Rules (PEFCRs), Version 6.3" (Brussels, Belgium, 2017); European Commission, "Product Environmental Footprint (PEF) Category Rules (PEFCR) Pilot - T-Shirts. Draft v.7 – 31 January 2017" (Brussels, Belgium, 2017); EPD International, "General Programme Instructions for the International EPD® System Version 3.0" (Stockholm, Sweden, 2017), www.environdec.com.; R Schenk, "Sustainable Apparel Coalition Product Category Rule

- Interpretation of possible implications when applied for textile products, based on experience, see qualifications above
- Transparent and consistent information in the report

Guidance 2013," 2013, http://iere.org/wp-content/uploads/2013/08/SAC-PCR-Guidance-Final-2013.pdf; European Commission, *International Reference Life Cycle Data System (ILCD) Handbook—general Guide for Life Cycle Assessment—detailed Guidance*, 1st ed. (Luxembourg: Publications Office of the European Union, 2010), https://doi.org/10.2788/38479.

Sandra Roos July 29, 2019

Most useful and logical elements

1.
I appreciate the logic to put focus on and be transparent about activities that can be directly measured and affected by the members of the Coalition and the users of the Higg PM. The statement on page 13 "develop a standardized supply chain measurement tool for all industry participants to understand the environmental, social and labor impacts of making and selling their products and services" is therefore essential.

Consumer behavior and activities in other industry sectors needs many assumptions and are only indirectly affected. Though dialogue, collaboration and education are important, it is good to keep the speculative parts in the background.

2.
The secondary data is set to a conservative level and encourages collection of primary data in order to improve the scores. This is a good and useful approach.

(However, some assumptions are not very conservative according to my opinion, and could be checked iteratively with the members, to make new/updated assumptions after a while when more primary data is available. E.g. default defect rate of 1% and loss rate at yarn spinning of 10% (which is of course very connected to fibre type and quality requirements on the yarns). Perhaps this concerns Higg MSI and not the Higg PM.)

3.
Good that the tool collects all important activities included in the life cycle of the product, loss rates, samples, returns etc. Thus, to the burden of producing one garment is added the overhead burden of everything needed in reality to get this product sold. This means taking the system perspective instead of narrow focus on one garment as many previous studies have done, and will give a more accurate picture of the product's impact.

What needs to be improved and how it could be improved, including top priority areas that should be addressed first

1. Normative influence
This is a tool that will be broadly used throughout the industry and as such I would wish it to be more normative regarding what environmental aspects should be collected data for.

I think it would be wise to not ask at all for less relevant primary data in a first simplified approach, which is searched for on page 48. This reduces the workload both for the user and the reviewer (MSI Gatekeeper). The task of "Confirming data accurately down the supply chain to a practical and possible extent" (page 129) should not be loaded with insignificant data.

As an example, packaging and transports are often too much discussed in relation to the rather insignificant impacts that stems from these aspects (with the exception of air transport of course). But to even open up for thorough documentation of whether the paper in the hang tag is virgin or recycled (see page 68) might give the user the erroneous perception that this is important. The tool should ideally influence the textile industry to make the drastic improvements that are needed to live up to the Paris agreement and other environmental targets, and then time and effort cannot be wasted on insignificant aspects.

The time spent on 1) making improvement actions in reality and 2) collecting data will already be a challenge for many companies, and parameters of less importance could be down-prioritized. In order to reassure focus on actions and primary data collection for essential parts (e.g. Materials production and leftover rate), and possibly keeping primary data voluntary regarding insignificant aspects. An iterative approach in LCA, where detailed information is only collected for significant aspects is recommended by many sources, e.g. the ILCD handbook[2].

Thus, I'd like to see more reasoning about big and small aspects, such as on page 71 e.g. "Proxies are used by default because this is distribution and retail impacts are typically small". That could help users to put focus on the right things.

2. Accuracy and diversification between manufacturers and geography
A lot of the text in the document treats the future integration of the Higg Facility Environmental Module. This is an essential part, solving many of the issues discussed in the document, e.g.:

- The comment on page 21 "The methodology allows the use of the industry average, secondary data to feed the Higg PM values, erasing the sourcing

[2] European Commission, *International Reference Life Cycle Data System (ILCD) Handbook—general Guide for Life Cycle Assessment—detailed Guidance*.

choices from the users. Thus, the actual impact (which differs based on geography and manufacturer) will not be reflected".

- Also expressed on page 48: "It is understood that impacts from manufacturing processes vary greatly".

In order for the tool to achieve the goal: to empower consumers and companies producing product to reduce environmental impact, accuracy is essential.

How to handle the industry average scores, better scores and worse scores is a question for the Higg MSI as I see it. However, there is an important connection with the PM in that the PM results must not be overinterpret as if they are providing specific data.

As a first step there needs to be communication that the use of averages does currently not differentiate between a best in class-supplier and a worst in class-supplier. Many times, the difference between materials is insignificant compared to the difference between supplier performance for the environmental impact[3]. The tool must be transparent about that the Higg MSI data are generic and perhaps not representative for the specific material.

The plan for integrating the Higg Facility Environmental Module sounds like one good step ahead, and a lot of the document seems to rely on that it will be executed.

Possibly the FEM can be developed in the future to ask questions about specific processes and machinery, thereby using both the top-down and bottom-up approach. It would be great if the Higg FEM score could be benchmarked separately on efficiency, water, chemicals, energy sources etc., that is midpoints instead of a single score on facility efficiency.

[3] Gustav Sandin, Sandra Roos, and Malin Johansson, "Environmental Impact of Textile Fibres – What We Know and What We Don't Know. The Fiber Bible Part 2." (Stockholm, Sweden, 2019).

Reviewer Comments

General comments

The document contains a rather large part that describes the Higg MSI methodology and database structure. Since the tools are all foreseen to be constantly evolving, referencing will be better to avoid confusing between versions and unnecessary work with updating.

Also, a large space is given to future plans. This is ok but could be separated from the actual methodology to increase clarity.

No spelling or grammar comments are given, though some errors were noticed. A review by a native English speaker is recommended.

Please see the Table below for comments by page.

Page	Comment
16	Any comments about alignment with other databases, e.g. Ecoinvent, WALDB etc.?
25	Apparel for sports activities are not separated in Duration of service. Many sports products are give-aways with e.g. "NY Marathon" prints, which renders such t-shirts a very short life on average.
34	Here I need clarification: Percent of products sold, does that mean of all manufactured and distributed products? Or only the share between channels? Two answers are possible here: • Percent of products sold online = x% • Percent of products sold in store =100-x% Or • Percent of products sold online = x% • Percent of products sold in store =y% • Percent of products not sold at all (leftover rate) =100-x-y%
37	Could the equation be simplified by instead using the parameter 'Washes per Lifetime'?
38	There is redundant information about non-inclusion of impact categories in section Selection of Impact Categories and section Assumptions and Limitations. I suggest the first section discusses what is used and only refers to next section about limitations.
38	Cumulative Energy Demand (CED) is preferable over abiotic fossil fuel depletion according to me. The energy use is in itself an issue, as we have limited resources. CED also catch nuclear-based energy used.
40	Water consumption, is that net or gross? Would be good with a reference here to page 137. Also, it could be added and considered that water recycling consumes energy, and usually increases chemicals' dosage, so using machinery which

	is water saving is preferable over 'only' having recycling. Thus the gross value is also of interest.
42	Assumptions and Limitations. The content of this section does not entirely reflect the heading. A lot of the text is about 'next steps' and 'future work' and is advised to be put in a section with that heading to simplify for the reader.
42	About microfibers as an own category… here it is important to differ between particle effects of microplastic particles and chemistry effects. There is no evidence so far of particle effects, i.e. micro-sized particles do not have impacts the same way that nano-sized particles. However, microplastic particles can act as a vector to enter different organisms for chemical pollutants, but this means that it is rather suitable to add a distribution route for the fate model than an entirely new impact category. More investigation is needed before stating that microplastics per se have any detrimental effects.
43	I think it would be optimal to exclude less relevant data, e.g. Material shipping modes and distances to Tier 1 facility, packaging etc. The time spent on collecting data will be a challenge for many companies, and parameters of less importance could be down-prioritized.
44	Solid waste including sludge? Please clarify.
44	Better add/update footnote 7 with European Commission, "PEFCR Guidance Document, - Guidance for the Development of Product Environmental Footprint Category Rules (PEFCRs), Version 6.3" (Brussels, Belgium, 2017)?
52	Here I wondered if not leftover rate also should be reported here, it would be good to writer here that this is included in Finished Goods figures.
53	Here I'd appreciate also a graphical overview of databases to get the overview in a simple way.
57-58	Normalization based on volume of materials? This section was a bit difficult to understand, is product assembly not included in the total score but just percentage of materials times their score in the Higg MSI?
66	What is the data source behind the end of use assumptions?
67	"Examples include product sold through a Worn-Wear program of the Renewal Workshop." – the workshop is not known to me, later on it is referenced to Patagonia wich explains the example better… or remove this sentence.
67	It would be great to know in this section how (re)packaging, ironing etc. is handled. I assumed that packaging (including logistics) is applicable for all products regardless of type?
69	Any questions about anti-mold agents or drying agents? In the packaging and in the logistics (also container treatments) it could both fit in as they can be added at both stages.
70	Good that consumer returns are included!
73	Table 19 is unclear both in terms of heading and units. Column 6 for example is (I assume) the number of uses between washes, but it should be clear… Also, Machine Wash Warm/Cool does not have the same meaning across countries. It should be specified already in Table 19 what is meant.

87	Sentences like: "Because of the toxicity of this substance, new technologies (e.g. those based on CO2) are being developed" raise question marks, will this be added in the future?
87	Wrong headings in the table. And, soap for washing???
89	In Europe, some countries have Extended Producer Responsibility (EPR) which could be mentioned. Also, the EU Circular Economy Package was adopted in 2018, stating that all EU member states must collect textiles separately by 2025, though this may or may not be implemented as EPR.
89	Upcycling and downcycling needs to be defined.
90	For Designing for Repair, also a take-back program to refurbish, such as the one e.g. Nudie Jeans has implemented, is beneficial. For Designing for Rewear, the price of the product when sold second hand is an interesting parameter, where "limited editions" instead of overproduction has in some cases led to a higher second hand price than the original.
94	Can the tests be performed in-house or is a third party institute test required?
110	Please explain abbreviation MSRP
117	The chemistry framework includes Materials and thus excludes e.g. anti-mold agents such as dimethylfumarate. Even though it may be difficult to include, there can still be questions asked in the tool, as a reminder.
118	Please reconsider "Human toxicity LCIA results were not included because those results are very small compared to ecotoxicity (at least six orders of magnitude smaller), and they do not provide additional differentiation." The units are different for ecotoxicity and human toxicity, which means that the order of magnitude cannot be compared.
120	Please define Best Environmental Practice (BEP) and Best Available Technology (BAT). Is it according to e.g. the EU Industrial Emissions Directive (IED) or UNIDO? EU IED gives rather specific descriptions.
121	"Demonstrated low risk from chemical exposure", what does this mean? Here I come back to my thoughts about how to be time-efficient in the reporting, follow-up and reviewing of the scores. Connected to this, the more qualitative parts will probably need some scheme with examples of what is a demonstrated low risk and what is not.
128	Should this document name Tom G?
132	This is rather a comment for the Higg MSI, but accepting LCIA data inputs means that such data will age and become obsolete when LCIA methods are updated, which is done rather regularly.
139	The cut-off criteria are not suitable for chemicals when they later on hopefully will be added, and these criteria needs then to be rewritten.
146	I find the sentence "If input and output data are not available" a bit odd, how can accuracy of calculation to an LCIA result be checked if input and output data are not available?

APPENDIX B: HIGG PRODUCT MODULE METHODOLOGY DEVELOPMENT PROCESS

For several years Cascale has been working on product assessment tools which have contributed extensively to knowledge and learning about life cycle impacts of apparel and footwear products. Cascale's past work on Product Category Rules can also prove useful in a PEFCR development process. In 2013 Cascale wrote Style and Performance PCRs for Coats/Jackets, T-Shirts, and Slacks/Trousers/Shorts. In addition, Cascale led the Technical Secretariat in writing the Draft Non-Leather Footwear Product Environmental Footprint Category Rules (PEFCR). Cascale also leads the Technical Secretariat in drafting the Global Apparel and Footwear Product Environmental Footprint Category Rules (PEFCR). Through this work, Cascale understands the important impacts, complexities, and realities involved with product assessment in the apparel and footwear industries.

Documents Written by Cascale

- Sustainable Apparel Coalition Product Category Rule Guidance, 2013
- Product Category Rule for Style Slacks and Trousers and Shorts: Earthsure PCR # Style-53101500-2013
- Product Category Rule for Performance Slacks and Trousers and Shorts: Earthsure PCR # Performance-53101500-2013
- Product Category Rule for Style T-Shirts: Earthsure PCR # Style-53103000-2013
- Product Category Rule for Performance T-Shirts: Earthsure PCR # Performance-53103000-2013
- Product Category Rule for Style Coats and Jackets: Earthsure PCR # Style-53101800-2013
- Product Category Rule for Performance Coats and Jackets: Earthsure PCR # Performance-53101800-2013
- Footwear Product Environmental Footprint Category Rule (PEFCR): Second Draft with Stakeholder Comments Incorporated (Dec. 21, 2016)
- Technical Key Learnings and Recommendations Report: EU Product Environmental Footprint (PEF) Footwear Pilot

Additional Resources Consulted

- Cascale Members
- JRC Report on PEF method: https://eplca.jrc.ec.europa.eu/permalink/PEF_method.pdf
- Product Environmental Footprint Category Rules (PEFCR) Leather. Final version April 2018: https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_leather.pdf
- Product Environmental Footprint Category Rules (PEFCR) T-Shirts. Version 1.0 February 2019: https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_tshirt.pdf

- General Principles for an Environmental Communication on Mass-Market Products. Part 23: Methodology to assess apparel environmental impacts ADEME. March 2016.
- Wool LCA Guidelines:
  - https://www.iwto.org/sites/default/files/files/iwto_resource/file/IWTO%20Guidelines%20for%20Wool%20LCA.pdf
- Published wool LCA related papers:
  - https://link.springer.com/article/10.1007/s11367-015-0849-z
  - https://www.sciencedirect.com/science/article/pii/S0959652616001700
  - https://www.mdpi.com/2071-1050/10/7/2524
  - https://link.springer.com/article/10.1007/s11367-018-1538-5

Participants

Many Cascale Members participated in the Footprint Task Team which was responsible for Higg PM methodology development. Since different parts of the methodology require different expertise, members were split into five different teams.

Project Management and Facilitation	
Julie Brown	Cascale (2017 – 2020)
Joël Mertens	Cascale (2020 – 2021)

Materials & Manufacturing (2017-2018)	
Adam Brundage	Nike (sub-team chair)
Allan Williams	Cotton Research and Development Corporation (CRDC)
Brad Boren	Nørrona
Catherine Newman	Nike
Dave Kemp	Brooks Sports
Elena Egorova	Patagonia
Francis Mason	INVISTA
Joël Mertens	Mountain Equipment Co-Op (MEC)
Kevin McMullan	Toray
Karine Kicak	ALDO Group
Krishna Manda	Lenzing
Matt Thurston	REI
Matthias Bodin	H&M
Megan Meiklejohn	Eileen Fisher
Xiaofei Li	Eileen Fisher

Use & End of Use (2017-2018)	
Allan Williams	Cotton Research and Development Corporation (CRDC)
Brad Boren	Nørrona
Greg Scott	Mountain Equipment Co-Op (MEC)
Guru Larson	Columbia
Inka Apter	Eileen Fisher

James Rogers	The North Face
Karine Kicak	ALDO Group
Kevin McMullan	Toray
Les Jacques,	Invista
Michele Wallace	Cotton Incorporated
Paul Swan	International Wool Trade Organization (IWTO)
Rick McDonald	Nike
Sergio Blecua	INDITEX
Stewart Sheppard	W.L. Gore (sub-team chair)
Todd Krieger	DuPont

Chemistry (2017-2018)	
Bob Buck	The Chemours Company
Joël Mertens	Mountain Equipment Co-Op (MEC) (sub-team chair)
Michele Wallace	Cotton Incorporated
Kilian Hochrein	W.L. Gore
Krishna Manda	Lenzing
Xiaofei Li	Eileen Fisher

Higg PM Tool Outputs (2017)	
Adam Brundage	Nike
Allan William	Cotton Research and Development Corporation (CRDC)
Barruch Ben-Zekry	VF Corporation
Beverley Henry	International Wool Trade Organization (IWTO)
Elissa Foster	Patagonia
Gregory Gausewitz	REI
Greg Scott	Mountain Equipment Co-Op (MEC)
Guru Larson	Columbia
Julie Brown	Cascale (sub-team chair)
Les Jacques	INVISTA
Michele Wallace	Cotton Incorporated
Valerie Presolly	Mountain Equipment Co-Op (MEC)
Jigna Wright	Nike

Duration of Service (2017)	
Akihiro Omatsuzawa	JCFA
Alex Karahalis	W.L. Gore
Annika Washburn	Patagonia
Brian McAdams	W.L. Gore
Diana Wyman	AATCC
Greg Scott, MEC	Mountain Equipment Co-Op (MEC)
Jayakumar Gopalkrishnan	Pratibha Syntex
Jennifer Rodgers	ATSM

Jennifer List	Nike
John Shen	Mountain Equipment Co-Op (MEC)
Katina Boutis	Loomstate
Katy Stevens	European Outdoor Group (EOG)
Kazuyuki Masuda	Boken
Lalit Toshniwal	Target
Matthew Guenther	Williams-Sonoma, Inc.
Matthew McDonald	Mountain Equipment Co-Op (MEC)
Merle Heesch	Globetrotter
Michele Wallace	Cotton Incorporated
Minako Hayashi	Toray
John Moraes	Nike
Rick Horwitch	Bureau Veritas
Roy Kettlewell	International Wool Trade Organization (IWTO)
Sravanth Kanukuntla	SGS
Srini Venkataraman	Bureau Veritas
Stewart Sheppard	W.L. Gore (sub-team chair)
Ugamoorthi Ramakrishnan	Eastman Exports
Val Sin	Williams-Sonoma, Inc.
Yasuyuki Cho	Japan Textile Federation
You-Kyum Kim	FITI

Methodology development began in January 2017. By June 2017 a draft methodology was developed and ready to pilot. By December 2017 a Higg PM prototype was developed in Excel that was supported with data from the Higg MSI and Quantis. This prototype was used to pilot the methodology and data for three months by the following organizations:

Adidas Group
ALDO Group
ASICS
Brooks
Cotton Incorporated
Cotton Research and Development Corporation (CRDC)
Duke University
DuPont
Eileen Fisher
Fast Retailing
Globetrotter
H&M
INDITEX
I:Collect
International Wool Trade Organization (IWTO)

Mountain Equipment Co-op
New Balance
Nike
Patagonia
Sympatex
Target
The Swedish School of Textiles

The pilot ended in February 2018. Almost 400 pieces of feedback were submitted to Cascale. Between February and September 2018 the Footprint Task Team reviewed pilot feedback and updated the Higg PM methodology to address the feedback as much as possible.

In September and October 2018, the final Higg PM methodology was reviewed by the full Cascale membership over 30 days as part of a Full Member vote. Members were asked to vote on whether or not to continue Higg PM development for a 2019 tool release. An “approve” vote meant support for releasing the tool based on current methodology. An “Object” to the Higg PM release meant support for delaying the release of the Higg PM indefinitely in order to continue working on the methodology. One hundred and five Cascale member organizations voted, and the vote passed with a 90% approval rate.

APPENDIX C: Change Log

Changes since the June 15, 2021 version

Page	Changes	Date
n/a	Updated document with organization’s new name and branding elements.	July, 2024