Environmental Product Declaration

Pictured above: New Malorka

Residential Wool Broadloom

Certified Environmental Product Declaration
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EPD Information			
Program Operator		NSF-I www.nsf.org	
Declaration Holder		The Dixie Group	
Product: Broadloom Carpet	Date of Issue: 03/16/2026 Date of Update:	Valid Until: 03/16/2031	Declaration Number: EPD11225
This EPD was independently verified by NSF International per ISO 14025 (2006) and ISO 21930 (2017): Internal ☒ External			
This life cycle assessment was independently verified by Ecoform per ISO 14044 and the reference PCR: NSF Program Operator Rules/Instructions, 31 Aug. 2023.			

LCA Information	
Basis LCA	Lifecycle Analysis of The Dixie Group Residential Broadloom Carpets with Synthetic Face Fibers
LCA Preparer	Evan Griffing & Michael Overcash Environmental Clarity, Inc. www.environmentalclarity.com
This life cycle assessment was critically reviewed per ISO 14044 by:	

PCR Information	
Program Operator	NSF
Reference PCR	Flooring: Carpet, Resilient, Laminate, Ceramic, Wood Version 2, ISO 14025 (2006), and ISO 21930 (2017)
PCR review was conducted by:	Evan Griffing & Michael Overcash Environmental Clarity www.environmentalclarity.com mrovercash@earthlink.net

PRODUCT DEFINITIONS AND INFORMATION

Company Name and Location

This Environmental Product Declaration was prepared for:

The Dixie Group, LLC
475 Reed Road
Dalton, GA 30720
USA

Company Description

The Dixie Group began in 1920 as the Dixie Mercerizing Company headquartered in Chattanooga, Tennessee. Mercerized cotton was not then widely used in the United States.

The company's business philosophy of manufacturing specialized products for select market segments drove The Dixie Group's business strategy. Specialized apparel and industrial yarns soon made room for Dixie's entry into the high-volume tufting yarn market, and a new name change for the company in 1965 to Dixie Yarns Inc.

In the late eighties, the textile industry was facing its toughest times due to stiff foreign competition, changing markets and the requirements for heavy investment in modernization of facilities. Dixie began a restructuring plan that included selling, closing, or consolidating those facilities that did not fit its strategic plan. In conjunction with the restructuring plan, Dixie began diversifying into the carpet industry and made its first major carpet acquisition, Carriage Carpets, in 1993. In 1999, Dixie sold its remaining traditional textile operations and began operating solely as a floorcovering company. Over the next 10 years The Dixie Group acquired the brands Masland, Fabrica and launched Dixie Home. These three brands focus on the higher-end segments of the soft floor covering market.

Product Description

The Dixie Group's products that are covered by this Environmental Product Declaration (EPD) are tufted broadloom carpets with wool face fiber. The face constructions included are loop pile, cut pile, and cut/loop pile. Each product has a backing of SBR latex and a primary layer and secondary layer of polypropylene fabric. These backings are the same for each product reviewed.

The carpet face is dyed to achieve the colorations appropriate for the intended markets. Dixie carpets use a mix of piece dyeing (beck), skein dyeing, and space dyeing.

Products included in the study include Dixie Group brands *DH Floors, Fabrica, and Masland Carpets*. **A representative product based on a market average weight was chosen from the combined products as the basis for the report. All products in this report are manufactured in the United States.**

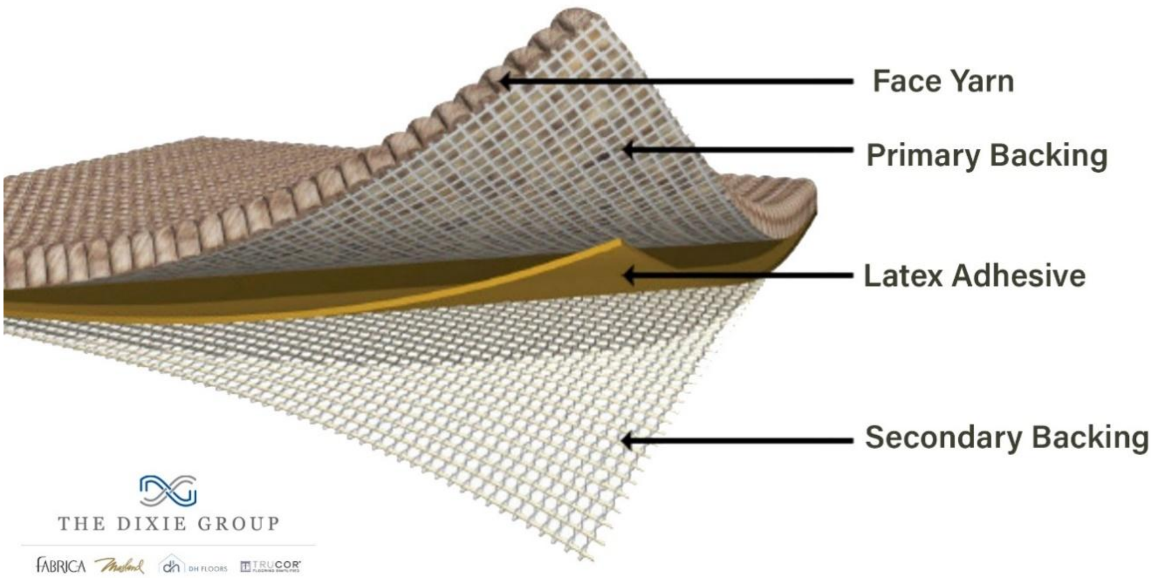


Figure 1: Product Construction for a Typical Wool Carpet

The Dixie Group Broadloom Carpets are intended to be used for residential housing flooring applications. **The market focus of all these products is the United States. There are no regulated materials contained in these products.** Additional information about the products and their uses may be found at thedixiegroup.com by clicking one of the brands at the top of the website.

Product Properties and Test Results

This EPD for Dixie Group Wool Products covers all wool products manufactured by Dixie with face weights of 0.917 – 2.72 kg/m^2. The production representativeness is 100%.

Table 1: Product Properties (architecture)

Aspect	Value
Roll Width	12 feet
Yarn Type	Wool
Primary Backing Type	Polypropylene
Secondary Backing Type	Polypropylene
Surface Pile Weight	1.49 Kg/m^2 (Weighted Average)
Primary Backing Weight	0.14 Kg/m^2
S/$CaCO_3$ Weight	1.11 Kg/m^2
Secondary Backing Weight	0,13 Kg/m^2
Surface Pile Thickness	0.3175 cm – 1.905 cm
Total Thickness	1.27 cm – 2.54 cm
Total Product Weight	2.86 Kg/m^2

Table 2: Performance Testing

	Standard	Value
Surface Flammability	ASTM D 2859	Pass
Delamination Strength	ASTM D3936	3.4 lbs./in.
Tuft Bind	ASTM D1335	12.2 lbs.
Vetterman Drum	ASTM D5417	4.0 Rating
Accelerated Soiling	ASTM D6540	3.0 Rating
Resistance to Staining	Proprietary	4.5 Rating
Green Label Plus	CRI	Pass
CRI Rating	CRI	N/A*

***CRI rating is not performed on residential products.**

Material Flow and System Boundary

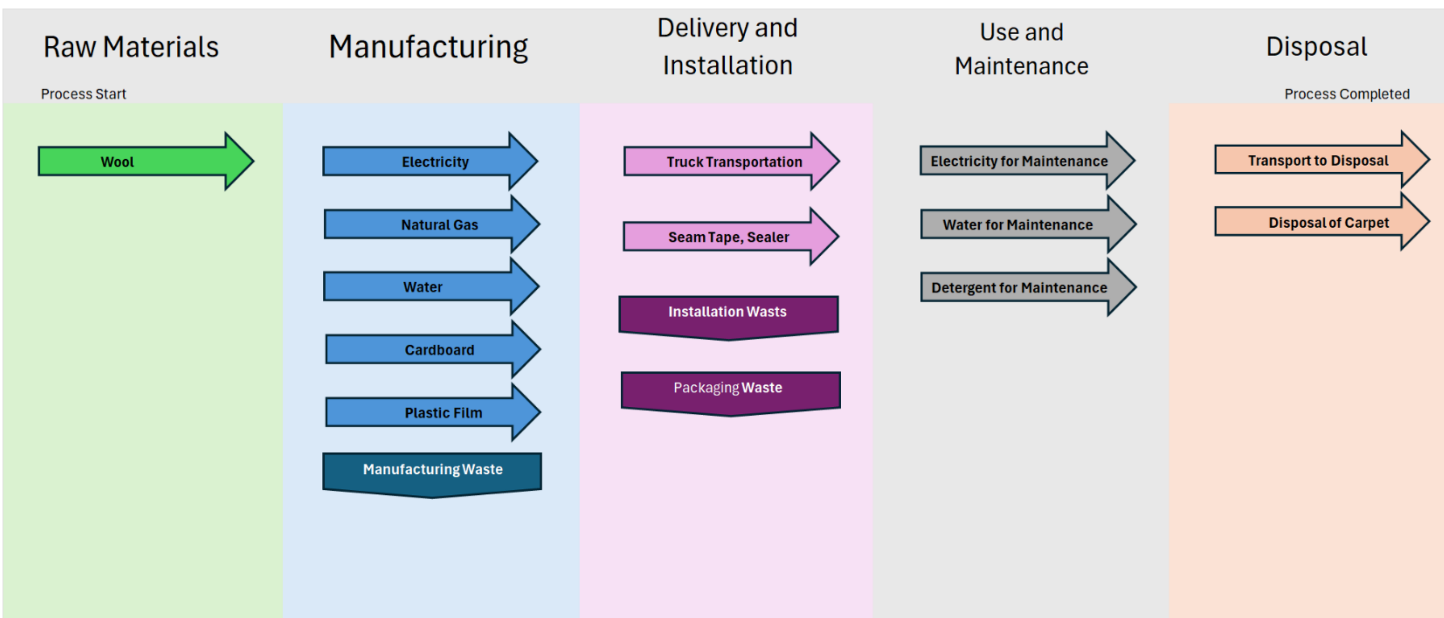


Figure 2: Material Flow and System Boundary.

Manufacturing and Packaging

The Dixie Group manufactures products in the United States. All the raw materials for the products in this report are sourced from suppliers in the United States.

Manufacturing begins with purchased yarn. This yarn is transported to the Dixie facilities for processing. Next, the yarn is tufted into a primary backing consisting of polypropylene. After this step a coating of SBR latex with calcium carbonate is applied to the tufted substrate and the secondary backing of polypropylene is attached.

Dyeing of the carpet utilizes several methods. Skein and space dyeing are dyeing processes utilized for dyeing yarn before it is tufted into carpet. Beck dyeing is used to dye tufted carpet. All carpet in this report is dyed.

The final processes in the manufacture and packaging of carpet are inspection, cutting, and packaging of the finished product for shipment to the customer.

Figure 3: Product Flow

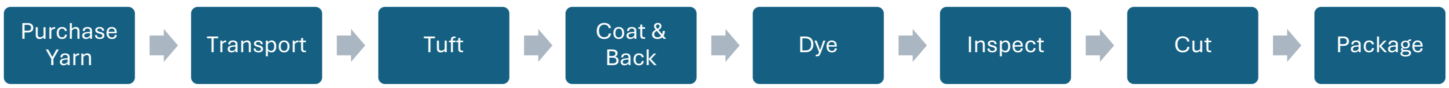


Table 3: Product Components

Material	% Finished Product
Wool	52
Polypropylene	9
SBR	7
Calcium Carbonate	32

Table 4: Packaging

Material	Weight per M^2
Cardboard	0.107Kg
Plastic Wrap	0.013Kg

Transportation

The assumption is that all products are distributed by semi-trailer trucks. Transportation of raw materials from their source to the manufacturing facility and between facilities within The Dixie Group was calculated for each material using primary data. The average distance of transportation from The Dixie Group warehouse to the installation site was estimated to be 500 miles.

Product Installation

Product installation instructions are available at https://www.fabrica.com/pages/warranty-installation; https://www.maslandcarpets.com/pages/warranty-installation; https://www.dixie-home.com/pages/warranty-and-installation. Installation tools are required but not included in the study as the impacts per unit declared are considered negligible. Carpet may be installed over a pad or directly glued to the floor depending on the intended usage and customer preference. Installation typically utilizes tack strips to hold the carpet to the floor. Tack strips were included in the LCA. Carpet installed over a pad normally has better appearance retention over time. Waste in this phase is assumed to be 5%.

Use and Maintenance

Detailed maintenance instructions are provided on the brand websites: https://www.fabrica.com/pages/warranty-installation; https://www.maslandcarpets.com/pages/warranty-installation; https://www.dixie-home.com/pages/warranty-and-installation. The total frequency for vacuuming and cleaning is provided in Table 5.

Table 5: Maintenance and Use

Process	Occurrences
Vacuum	52/year
Clean	1/year

Reference Service Life

The reference service life of the residential broadloom products is assumed to be 15 years with recommended installation and maintenance. With an estimated building life of 75 years there will be 4 replacement cycles over the life of the building.

Product End of Life

The Dixie Group encourages consumers to reuse or recycle carpet when it is replaced. There are no products of concern contained within the carpets produced by The Dixie Group family of brands. Therefore, all these products qualify for all carpet recycling programs. The products may be landfilled or sent to waste-to-energy facilities where recycling is not available.

For purposes of this study, the product is 100% recycled as specified in the Life Cycle Assessment Calculation Rules and Report Requirements from UL Environment, Sections 2.8.5 and 2.8.6 of Part A.

LIFE CYCLE ASSESSMENT BACKGROUND INFORMATION

OVERVIEW

This document summarizes the LCA report on the wool carpet EPD for The Dixie Group (Dixie, 2025), which comprises carpets by DH Floors, Masland, Fabrica, and TruCOR. The LCA results are based on manufacturing data from 2024, and the EPDs are to be published in 2025. Details about the LCA, reference standards, and carpet categories (EPDs) are given in

Table 6.

Table 6: Report on information standards

LCA authors	Evan Griffing and Michael Overcash, Environmental Clarity, Inc.
Report Date	November 21, 2025
Client	The Dixie Group
Carpet categories	Wool face fiber
EPD Program Operator	NSF International
Standards	ISO 14025 (2006) and ISO 21930 (2017)
Core PCR	UL (2018) Product Category Rules for Building-Related Products and Services Part A v4: Life Cycle Assessment Calculation Rules and Report Requirements, NSF Program Operator Rules/Instructions, 31 Aug. 2023.
Sub-category PCR	UL (2018a) Product Category Rule (PCR) Guidance for Building-Related Products and Services, Part B: Flooring EPD Requirements

Environmental declarations from different programs may not be comparable. Full conformance with the PCR for Products allows EPD comparability only when variations and deviations are possible. Different LCA software and background LCI datasets may lead to differences in data for upstream or downstream of the life cycle stages declared.

Comparison of the environmental performance of Flooring Products using EPD information shall be based on the products' use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building.

PRODUCT DESCRIPTIONS

This report covers wool carpet category. All the carpets use the same backing architecture in terms of materials and mass. The face fiber is tufted onto a primary backing that is woven polypropylene (PP). The backing system uses an adhesive layer including styrene butadiene rubber (SBR) with calcium carbonate filler. The SBR is applied to the primary backing, and then a second woven PP backing (secondary backing) is applied with additional SBR compound. The materials and weighted average masses of each layer per m^2 are given in **Error! Reference source not found.**. The backing systems are all nominally similar in mass and composition with up to 2% variation.

There are no hazardous materials involved in the manufacture of these carpets.

Table 7: Carpet architectures, using weighted average face fiber weights.

	Wool
Face fiber, kg / m2	1.49
Total PP backings[1], kg / m2	0.27
Primary backing, kg / m2	0.14
Secondary backing, kg / m2	0.13
SBL/CaCO3, kg / m2	1.11
SBL, kg / m2	0.23
CaCO3, kg / m2	0.88
Total carpet, kg / m2	2.86
Total carpet, oz / SY	84.3

Backings are woven polypropylene.

SCOPE

PRODUCT SYSTEMS

This report covers all wool carpet product types and face weights.

The architecture of these carpets is shown in

Table and Table . **The face fiber and total carpet weights are given as the market weighted average and as a range from the lowest face weight carpet to the highest face weight carpet.** The backings are all substantially similar. The primary backing varies by as much as 10%, but it is a small mass relative to the overall carpet mass (about 4%). Thus, the variability in overall carpet mass due to this variation is < 0.5%. The SBR/CaCO3 layer can vary by as much as 1.3%. Thus, the overall variability in backing materials is <2%.

Table 8. Carpet architecture in oz / SY.

	Wool
Face fiber, oz / SY	43.8 (27-80)
Primary backing, oz / SY	4.0
SBL/CaCO3, oz / SY	32.7
Secondary backing, oz / SY	3.8
Total carpet, oz / SY	84.3 (67.5-121)

Table 9. Carpet architecture in kg / m2.

	Wool
Face fiber, kg / m2	1.49 (0.917-2.72)
Primary backing, kg / m2	0.14
SBL/CaCO3, kg / m2	1.11
Secondary backing, kg / m2	0.13
Total carpet, kg / m2	2.86 (2.29-4.09)

FUNCTIONS

Carpets provide a variety of functions in residential properties including aesthetics, thermal insulation, comfort, safety, and noise reduction. For the purposes of this LCA, the function will be to provide floor covering.

FUNCTIONAL UNIT, REFERENCE SERVICE LIFE, AND BUILDING SERVICE LIFE

The functional unit is 1 square meter for a period of 75 years, which is the estimated service life of a building as specified in PCR Part B. Each carpet is assumed to last for 15 years (reference service life of product). This service life was chosen, based on a general agreement between carpet manufacturers.

The Dixie Group wool carpets do not have a defined warranty but are thought to also last for 15 years. Thus, over 75 years, each carpet will be installed once and then replaced 4 times for a total of 5 carpet installations.

SYSTEM BOUNDARIES

This LCA is cradle to grave**.** Capital goods and infrastructure used in the manufacture of carpets do not significantly impact the results and conclusions of the LCA. These are excluded from the calculations, as per the PCR part B. We used data from Dixie facilities including overhead energy used for lighting, heating, ventilation, and air conditioning. **No known flows are deliberately excluded from this EPD**.

Results are presented according to the life cycle stages listed in ISO 21930 (2017). These stages are:

A1: extraction and upstream processing (or processing of secondary materials)

A2: transport to factory (includes internal transport)

A3: manufacturing

Modules A1-A3 may be presented in aggregate. Each module includes the full supply chain and emissions associated with energy use throughout. For example, manufacturing includes raw material use and emissions associated with energy use in the manufacturing stage. Wastes from processes in A1-A3 that are recovered for secondary use shall be treated as a waste and no burdens shall be allocated to these flows.

A4: Transport to site (transport to warehouse if applicable and subsequently to the installation site)

A5: installation (Includes product waste and transport to site) Based on our understanding of ISO 21930, the CTG manufacturer of all the carpets that end up as waste in the installation phase is included in this phase. In this report, landfill of packaging and scrap carpet is included in A5,

Modules A4 and A5 shall include all materials and energy used as well as disposal of residues from these stages.

B1: Use of installed products. Generally, other EPDs do not include emissions in this category. There may be emissions of volatile organic compounds (VOCs) from new carpets or adhesives. These are not included in this study, and B1 is excluded from results and reported as not applicable (NA).

B2: Maintenance, vacuum and / or wash, cleaning agents, transport of cleaning materials, eol of waste materials (i.e. wwtp of cleaning wastewater). This includes water use. This is for use for one expected service life (15 yrs in this study).

B3: Repair (not applicable, and excluded from results)

B4: Replacement (new carpet replacement(s) after reference service life). The impact of each replacement includes A1-A5 plus B2 plus C2+C4. In this EPD the values in B4 are for 4 replacement cycles that are required to achieve 75 years.

B5: Refurbishment (NA)

B6: Operation energy (NA). All maintenance energy use is included in B2.

B7: Operational water use (NA). All maintenance water use is included in B2.

C1: deconstruction/demolition (NA).

C2: transport to waste processing/disposal (i.e. to landfill) This includes the mass of the installed product (excluding scrap and packaging).

C3: waste processing (for recovery, NA)

C4: disposal (management of disposal site, i.e. landfill). C1-C4 includes the end of life from each installation of the installed carpet (1 m^2 times the total number of installations). This includes the mass of the installed product and tack strips used in the installation process (excluding carpet scrap and packaging, the disposal of which is included in A5). In this GTG, we assume that all of the installed carpet is sent to landfill, and the values in C2 and C4 are for disposal of 1 m2 of carpet and associated tack strips.

The LCA for one carpet use is the total of all columns except for B4. The impact over 75 years while assuming that each carpet will be in place for 15 years is calculated by summing all columns.

There are no impacts for Categories B3, B5, B6, B7, C1, C3, and D.

Table 10. Reference service life

Name	Value	Unit
RSL	15	Years
Declared product properties	All Dixie carpets, see descriptions	
Design application parameters	Installed as recommended	
Assumed quality of work	Industry standard installation	
Outdoor environment	Not applicable	
Indoor environment	Normal residential conditions	
Use conditions	Residential use, normal conditions	

Maintenance	18 months maximum	Between hot water extractions

Table 11: Life Cycle Stages Included in Study

Production			Construction		Use							End of Life				Benefits & Loads Beyond System Boundaries
Raw Material Supply	Transport	Manufacturing	Transport to Site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste Processing	Disposal	Reuse, Recovery, Recycling Potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	NA	X	NA	X	NA	NA	NA	NA	X	NA	X	NA

X = Module Included, ND= Module Not Applicable

IMPACT ASSESSMENT METHODOLOGY AND METRICS

PCR part A (Section 4) prescribes a list of life cycle impact assessment metrics and some additional metrics for natural resource use, waste flows, biogenic carbon flows, and land use change impacts.

RESOURCE CONSUMPTION

The resource consumption parameters and definitions are copied directly from PCR part A, except for the freshwater description, which is summarized. Renewable energy sources enter the life cycle through purchased electricity. The cardboard used for packaging is assumed to be from renewable sources. Wool decomposed in the landfill will result in landfill gas, which results in some recovered energy, but that is recovered energy exported from the system. The exported energy is an optional item reported elsewhere. To be consistent with ISO 21930, recovered energy was considered waste and no allocation was used. `

Table 12: Impact assessment metrics that must be included in the assessment, reproduced from PCR part A.

Parameter	Description	Units
Parameter Description Unit RPRE: Renewable primary resources used as energy carrier (fuel)	(First use) bio-based materials used as an energy source. Hydropower, solar and wind power used in the technosphere are also included in this indicator	[MJ]
RPRM: Renewable primary resources with energy content used as material	(First use) biobased materials used as materials (e.g., wood, hemp, etc.).	[MJ]
NRPRE: Non-renewable primary resources used as an energy carrier (fuel)	(First use) materials such as peat, oil, gas, coal, and uranium used as an energy source.	[MJ]
NRPRM: Non-renewable primary resources with energy content used as material	(First use) primary resources such as oil, gas and coal, used for products (e.g., plastic-based products).	[MJ]
SM: Secondary materials	Materials recycled from previous use or waste (e.g., scrap metal, broken concrete, broken glass, plastic, and wood) that are used as a material input from another product system. These include both renewable and non-renewable resources, with or without energy content, depending on the status of the material when it was originally extracted from the environment	[kg]
RSF: Renewable secondary fuels	Renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g., biomass residue pellets, chipped waste wood)	[MJ]

NRSF: Non-renewable secondary fuels	Non-renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g., processed solvents, shredded tyres).	[MJ]
RE: Recovered energy	Energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources.	[MJ]
FW: Use of net freshwater resources See Section	Calculated according to ISO 14046. Evaporation (e.g., cooling towers), evapotranspiration (evaporation of irrigated water), embedded freshwater (concrete), drainage of freshwater into the ocean. See also ISO 21930 section 7.2.13.	m^3

In addition to these metrics, waste metrics that must be included are included in

Table . Additional notes provide examples of some of these wastes. For example, high level radioactive waste refers to spent fuel from nuclear reactors.

Table 13: Waste flows that must be included in the results, reproduced from PCR part A.

Parameter	Description	Unit
HWD	hazardous waste disposed	kg
NHWD	Non-hazardous waste disposed	kg
HLRW	High-level radioactive waste, conditioned, to final repository	kg or m3
ILLRW	Intermediate- and low-level radioactive waste, conditioned, to final repository	kg or m3
CRU	Components for reuse	kg
MR	Materials for recycling	kg
MER	materials for energy recovery	kg
EE	Recovered energy exported from the product system	MJ LHV

BIOGENIC CARBON UPTAKE AND EMISSIONS

Rules are taken from ISO 21930 Section 7.2.7. Biogenic carbon in packaging materials (e.g. cardboard) was included in scenario information in module A5. In the CTG of cardboard, there is a small amount of carbon that is absorbed. The amount absorbed does not reflect the amount of carbon in the cardboard, because most of the cardboard is assumed to be recycled. We assume that at the end of life, 75% of the core board is recycled, 20% is landfilled, and 5% is incinerated. When materials are recycled, we assume that the biogenic carbon that was absorbed is emitted. When it is incinerated, the biogenic carbon is again emitted. During landfill, some of the biogenic carbon is sequestered, and this produces a very small net sequestration of biogenic carbon. However, we do not include this sequestration in the biogenic carbon accounting.

Calcium carbonate is used as a backing material. The C in this is already fully oxidized and does not lead to any CO2 exchanged during the life cycle of the product.

Other than packaging and energy, the other biogenic material within the scope of this LCA report is wool for the wool face fiber carpets and wood for tack strips.

The use of wool does result in a temporary removal of CO2 from the atmosphere, resulting in a delayed emission when the wool decomposes in the landfill. This benefit was not included in the LCA or discussed in supplemental calculations. The removal of carbon going into the wool was included and all this carbon is emitted at the end of life, resulting in a net zero flow of carbon.

The use of wood in tack strips also results in a temporary sequestration. In addition, a significant portion of wood remains in the landfill after 100 years. However, this wood is generally not considered to be from sustainably managed forests, and thus this carbon flow is excluded from the report.

The carbon flows associated with biological processes, calcination, carbonation, and waste handling are discussed in **Error! Reference source not found.**.

Table 14: Biogenic carbon flows accounting. Parameter and description are from PCR part A. Comments include activities that might directly contribute to the results in this project. We do not include all of the potential flows in the supply chain.

Parameter	Description	Comments
BCRP	Biogenic carbon removal from product	wool during growth, food,
BCEP	Biogenic carbon emission from product	CO^2 from sheep, including CO^2 emitted at end of life in the landfill. Excludes biogenic CH^4
BCRK	Biogenic carbon removal from packaging	growth of wood for cardboard
BCEK	Biogenic carbon emission from packaging	decomposition of cardboard?
BCEW	Biogenic carbon emission from combustion of waste from renewable sources used in production processes	There is no direct combustion of waste. The combustion of methane generated when wool decomposes in the landfill (biogas) was excluded from this indicator, as recommended by the ACLCA guidance document (2019). However, it was included as CO2 in the LCA results.
CCE	Calcination carbon emissions	

CCR	Carbonation carbon removals	
CWNR	Carbon emissions from combustion of waste from non-renewable sources used in production processes.	

In the Ecoinvent 15804 inventory dataset, several resource inputs are identified associated with carbon tracking for biogenic carbon flows. These are detailed in Table 15. The flows for carbon in soil as a natural resource are not included in biogenic carbon flows. There are two flows of CO^2 from soil to air or in the reverse direction as shown in Table 15.

Table 15: Resource flows for biogenic CO2 in the Ecoinvent 15804 database

Resource name	Description	Impact factor for biogenic carbon accounting
Carbon dioxide, in air	CO2 that is absorbed from the air, such as that absorbed by a plant during growth.	-1
Carbon dioxide, non-fossil, resource correction	This is also CO2 that is absorbed during plant growth, but this is a correction for CO2 that was allocated to another product. This is used to make sure that the carbon absorbed is equal to the carbon that is within the biological product.	-1
Carbon, in organic matter, in soil	This is carbon from CO2 absorbed by the plant and converted to plant matter (e.g. leaves), and then later incorporated into the soil on decomposition. This carbon has to be expected to stay in the soil for > 100 years.	0[a]
Carbon, organic, increase in soil or biomass stock	Reflects changes in biomass stock in the forests used to make product. Also has >100-year qualification.	0[a]

a. While these flows are non-zero, these are not included in this life cycle.

Table 16: Emission flows relating to biogenic CO2 in Ecoinvent 15804 database that are included in the TRACI GWP method.

Emission	Impact in TRACI	Comments
Carbon dioxide, from soil or biomass stock	1.0	To air, CO2 from soil converted to CO2 in air
Carbon dioxide, to soil or biomass stock	-1.0	CO2 that is stored in soil as C

LAND USE CHANGE ACCOUNTING

When significant, land use change emissions must be reported separately. Wool production typically is done from sheep raised on established pastureland. However, the LCI data used was based on a mix of extrinsic and intrinsic farming. Thus, there were some emissions associated with land use change.

LIFE CYCLE IMPACT ASSESSMENT METRICS

For US markets, the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI v 2.1) is the basis for LCIA metrics. The PCR Part A prescribes a subset of this impact methodology as a minimum for reporting, as described in **Error! Unknown switch argument.**. In the most recent version of TRACI (2.1).

"LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks."

"These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes."

Table 17. LCIA metrics that must be included in the EPD.

Acronym	Metric	Units
GWP 100	Global warming potential	kg CO2 eq
ODP	Ozone Depletion Potential	kg CFC 11 eq
AP	Acidification Potential	kg SO2 eq
EP	Eutrophication Potential	kg N eq
SFP	Smog Formation Potential	kg O3 eq
ADPfossil	Abiotic Resource Depletion Potential of Non-renewable (fossil) Energy	MJ surplus, LHV

In this report, we do not include the other TRACI LCIA impact categories, which should not be used for any comparative purposes. The Abiotic depletion potential included in TRACI has units of MJ, but this is not a heat value

The PCR prescribes use of CML-IA version 4.2 with conformance to EN 15804 for European markets. Additional metrics are prescribed for use outside of the US and Europe. This LCA and the associated EPDS are for use in the US market, and we do not include any of these metrics in the results.

No substances required to be reported as hazardous are associated with the production of this product.

PRODUCT USE PHASE

During the use phase, carpets are typically vacuumed on a regular basis, and a deeper cleaning such as a hot water extraction is used on a less frequent basis. This LCA is for a consumer carpet used in a typical USA household.

General carpet cleaning data for commercial buildings were collected during the CRI project (CRI, 2008). In that study, the carpets were divided into low, medium, and high use areas, and an average amount of vacuum and deeper cleaning events were estimated. Commercial buildings are cleaned much more frequently than a typical consumer carpet in a typical US household. Thus, in this project we used estimates for residential carpets.

Most experts suggest that households steam clean carpets every 6-12 months for high traffic areas and 12 to 18 months of use for lower traffic areas. This is most often done with hot water extraction (USA Today, 2015; Daltonflooringcenter.com). The Carpet and Rug Institute suggests cleaning the carpet as needed, but at a minimum of every 24 months. **We assume that the carpet is steam cleaned once every 12 months.**

In residential areas, carpets are vacuumed at varying frequencies. CRI recommends vacuuming once or twice a week in high use areas and once a week in general areas (CRI, 2025). People with pets, children, or allergies may vacuum more frequently, and some may vacuum much less frequently. **We used a frequency of 1 vacuum event per week.**

Table 6. Maintenance (B2)

Name	Value	Unit
Vacuum cycles	52	Cycles / yr
Vacuum cycles	780	Cycles / RSL
Hot water extraction	1	Cycles / yr
Hot water extraction	15	Cycles / RSL
Net freshwater consumption	0.35	Kg / m2 / yr (Left on carpet to evaporate)
Detergent active ingredient	0.002 (excluded based on cut-off)	Kg / m2 / yr
Other ancillary inputs	0	Kg
Extraction energy	4.3E-2	MJ/m2 / event

Vacuum energy	1.1E-2	MJ/m2 / event
Blue water consumption	0.35	Kg/m2/extraction
Direct emissions to air	0	kg

Residential spaces typically contain more furniture and irregular layouts compared to commercial spaces, resulting in longer cleaning times and higher energy per event, therefore we use 1 MJ / 1000 SF / event for vacuum. The energy is calculated in **Error! Not a valid bookmark self-reference.**.

Table 19: Electricity use in use phase.

	MJ / 1000 SF	MJ / m2	# times
Hot water extraction per event	4	0.043	
Vacuum per event	1	0.011	
Hot water extraction per year		0.043	1
Vacuum per year		0.560	52
Total electricity / yr		**0.603**	

Repair (B3) and refurbishment (B5) are not included in this LCA. These activities are typically not done for residential carpets. There is no operational energy use (B6) or operational water use (B7), and these are excluded. Tables for stages B3 through B7 follow.

Table20. Repair (B3)

Name	Value	Unit
Repair process information	Product not typically repaired during use	
Inspection process information	Product not typically inspected during use	
Repair cycle	0	Cycles / RSL
Repair cycle	0	Cycles / ESL
Net freshwater	0	m3
Ancillary materials	0	kg
Energy input	0	MJ
Waste materials	0	Kg
Direct emissions to air	0	Kg
Further assumptions	NA	

Table21. Replacement schedule (B4)

Name	Value	Unit
Reference service life, RSL	15	Years
Replacement cycle	4	(ESL/RSL)-1
Energy input	0	MJ
Net freshwater	0	m^3
Ancillary materials	9.8e-2	kg tack strips
Replacement of worn parts	NA	
Direct emissions to ambient air, soil, and water	0	Kg
Further assumptions	NA	

Table 22. Refurbishment (B5)

Name	Value	Unit
Refurbishment process description	Product typically not refurbished during use	
Replacement cycle	0	# / RSL
Replacement cycle	0	# / ESL
Energy input	0	MJ
Net freshwater consumption specified by water source and fate	0	m^3
Material inputs for refurbishment, including ancillary materials	0	kg
Waste materials generated	0	kg
Direct emissions to ambient air, soil, and water	0	kg
Further assumptions	NA	

Table 22A. Operational energy use (B6) and water use (B7

Name	Value	Unit
Net freshwater consumption	0	m^3
Ancillary materials	0	Kg
Energy input, specified by activity, type, and amount	0	MJ
Equipment power output	0	kW
Characteristic performance	NA	
Direct emissions	0	
Further assumptions for scenario development	NA	

UNITS

SI units and their derivatives (e.g., kg, m^2, and MJ) are used to report all results. Commonly used units such as lbs./sy are included separately for certain parameters to facilitate review by carpet industry personnel.

ESTIMATES AND ASSUMPTIONS

The biggest sources of variation in the product are in the face fiber weights, which vary from product to product. The impact of this on the GWP is shown in an additional set of results for each carpet type. The biggest potential sources of error in the LCIA values for any given carpet type and face fiber weight are from (1) the background LCI data and (2) the LCIA impact assessment factors.

The background data were mostly from Ecoinvent as specified in the PCR, and this will be specified in detail in the relevant section of this report.

For LCIA assessment factors, some categories, such as global warming, have established impact factors. In the GWP category, certain assumptions—such as the selected time frame—are inherent; for instance, using a 100-year time horizon influences the comparative impacts of methane and CO2. In other categories, methods may include incomplete or less clearly defined impact factors.

TRANSPORTATION ASSUMPTIONS

The PCR states that the transportation distance of the carpet from the point of purchase to the installation point is 800 km (500 miles) by diesel-powered truck/trailer. We assume that this means the point of manufacture to the point of installation. This is roughly consistent with logistics for Dixie, where carpets are typically shipped from Dalton GA to the eastern half of the US and from the Los Angeles area in CA to points on the west half of the country. Shipment from the installation site to waste disposal is specified by the PCR to be 161 km.

Table 23. Transport to building site

Name	*Value*	*Unit*
Distance, from production to installation	*800*	*Km*
Truck type	*Diesel-powered truck/trailer*	
Material transported	*3.33*	*Kg / m2*
Total transport	*2.66*	*tkm*

Table 7. Transport to end of life (sorting facility, incineration, and landfill)

Name	Value	Unit
Distance transported	161	Km

INSTALLATION ASSUMPTIONS

During installation, tack strips are used to secure the carpet to the flooring. On a m2 basis, 0.098 kg tack strips are used. These are comprised of 0.08 kg wood and 0.018 kg of steel. There is, 0.05 m2 of carpet scrap produced per m2 installed. This is 5% of the installed carpet lost in the installation phase.

Table 8. Installation into the building

Name	Value	Unit
Ancillary materials: tack strips	9.8E-2	kg
Freshwater	0	
Other resources	0	
Electricity	0	
Other energy	0	
Product loss per functional unit	5	%
Packaging: cardboard cores	5.4E-2	Kg / m2
Packaging: LDPE wrap	3.3E-3	Kg / m2
Biogenic carbon in packaging	1.78E-2	Kg CO2eq / m2
Direct emissions to air	0	
VOC emissions	0	

END OF LIFE ASSUMPTIONS

The end-of-life assumptions for carpet and packaging are specified in the PCR part A. All carpet is assumed to be sent to the landfill. Polymeric packaging (LDPE wrap) is assumed to use a mix of recycling (15%), landfill (68%), and incineration (17%). Pulp packaging (core board) is assumed to be a mix of recycling (75%), landfill (20%), and incineration (5%). The end of life of tack strips (ancillary installation material) is landfilled. Transport to the recycling center is accounted for and is assumed to be equal in distance to the transport to the landfill. Details on mass flows are given in the Supply chain and installation data section.

Capital equipment is used in manufacture of material inputs to the carpet plant, the carpet making facilities, transport, and at the installation site (tools). Production of the capital equipment used in the carpet manufacturing facilities was excluded as specified in the PCR (part B).

Table 9. End of life (C1-C4) for wool carpet, 1 m2 = 2.86 kg

Name		Value	Units
Assumptions for scenario development		Product is manually removed	
Collection process	Collected separately	0	m^2
	Collected with mixed waste	1	m^2
Recovery	Reuse	0	m^2
	Recycling	0	m^2
	Incineration	0	m^2
	Incineration with energy recovery	0	m^2
	Energy recovery efficiency	NA	
Disposal	Product or material for disposal	1	m^2
Removals of biogenic carbon (excluding packaging)		2.81	kg CO2/m^2 emitted to the environment at end of life

CUT-OFF RULES

All the primary inputs (face fiber, primary and secondary backings, and SBR/CaCO3 layer) were included in the calculations. A sample dye was also included, although the impact was small in all categories. Additional chemicals used in insignificant amounts for stain resistance / soil release, and these are not known to have a significant impact. No PFAs are used in the stain resist / soil release products. **No hazardous materials are present in the products.**

All known material and energy flows to the carpet manufacturing stage are included.

DATA SOURCES

Data sources include Ecoinvent, proprietary databases from Environmental Clarity and others along with proprietary data from Dixie personnel.

Foreground data related to carpet manufacturing was systematically collected by Dixie personnel. The various stages of production occur at several sites, with some facilities located in California and others situated near Dalton, GA. At each facility, comprehensive utility usage—including energy, water, and waste disposal—was tracked throughout an entire year (2024) and attributed to specific unit operations such as yarn production, twisting and heat setting, tufting, dyeing, and finishing. For each unit operation, a weighted average of energy consumption per kilogram of material processed was determined. Energy consumed for heating, ventilation, air conditioning, and lighting was included in the total metered energy; these overhead requirements were proportionally allocated to each unit operation rather than itemized separately. As a result, the reported energy figures encompass both direct and overhead energy demands.

A gate-to-gate (GTG) model was developed for carpets with a wool face fiber. These GTGs cover production of carpet based on the energy values for each step in the process, and the materials processed. In addition to different masses of material processed, the wool face fibers had different ratios of dyeing methods. However, the weighted average energy was the same as the metered energy per square meter. Transportation between facilities was included within the carpet production gtg.

Packaging is used to take the carpet from Dixie manufacturing sites to a distribution center and on to customers. Additionally, packaging is used within Dixie to move material from plant to plant. The carpet is wrapped around cardboard cores, and then an LDPE plastic wrap is used to protect the carpet and keep it together. The total packaging used was based on purchases in 2024, and this included packaging for internal use as well as shipment of final product.

The primary and secondary backings are woven polypropylene fibers, and these are purchased from vendors. The extrusion into fiber and weaving energy for these backing materials are based on the Environmental Clarity model for these operations.

The energy for each carpet was then calculated based on the mass per square meter of carpet. In this way, the total energy was equal to that metered at the facilities.

Secondary data from Ecoinvent 3.11 was then used for the mass and energy inputs to the carpet.

LCIA calculations were performed by OpenLCA version 2.4.1, using the EN15804 extension produced by the OpenLCA team. The EN15804 extension was developed to make sure that the datasets were consistent with EN15804 and ISO 21930. The impact assessment method used was TRACI 2.1 version 03.11.00 from the EPD methods category.

Ecoinvent does not have data for wool yarn. There is data for greasy wool from sheep, and these data are originally from the US LCI database from NREL and apply to the years 2001-2006. The unallocated dataset is based on 20% intensive and 80% extensive pastureland. LCI data for wool yarn was calculated by combining the ctg for sheep fleece in the grease (lanolin) from the wool and producing a yarn.

Ecoinvent does not have data for wool yarn. There is data for wool from sheep, and these data are from the US LCI database from NREL and apply to the years 2001-2006. The unallocated dataset is based on 20% intensive and 80% extensive pastureland. LCI data for wool yarn can be calculated by mixing yarn production gtgs with the ctg for sheep fleece in the grease. However, this would not include separation of the grease from the wool fleece.

The basis of the gtg is 1 sheep for 1 year, and the gtg produces 4.2 kg of sheep fleece with grease and 7.85 kg of sheep for slaughtering. The allocated gtg for sheep fleece with grease produces 1 kg of sheep fleece. Inputs include 4.45 kg maize grain, 2.92 kg soybean meal, 0.42 kg ammonium nitrate, 0.049 kg P2O5 fertilizer, 0.368 m3 (368 kg) irrigation water, 2.7 kg limestone, 0.42 kg NaCl, and 0.12 kg KCl.

DATA QUALITY

Manufacturing data collected by Dixie were from 12 months during calendar year 2024 except for one plant opened in 2024, so data were based on March 2024 through February 2025 for this location. This data is consistent with the technology currently in use. Wool production data do not accurately reflect the wool production that is typical in the region (New Zealand) where Dixie sources wool for carpets. There is also a wide range of enteric emissions in the literature on wool production, and this leads to a high uncertainty in the global warming impact of wool carpets. Geographic representativeness was achieved as well as the reference database allowed by selecting appropriate regions and energy sources. The data completeness was good, as specific data were available for all components with significant contributions to the total impacts.

ALLOCATION

Attributional allocation was used when allocation was needed in this report and performed by some carpet facilities to each of the primary steps of carpet production.   The micro-allocation was done based on expert judgement of Dixie personnel based on technical knowledge of the processes, motor sizes, and energy use during various campaigns. ISO 14044 states that micro-allocation (dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes) should be done wherever possible. Most plants only cover a partial subset of carpet manufacturing. In the case of Dixie plant logistics, micro-allocation provides a much more accurate result than simply allocating all plants by area or mass, because some carpets do not utilize all unit processes of each facility. For example, some carpets utilize the dyeing process, and some do not. Simply allocating the full plant energy by area or mass would produce misleading results.

In the supply chain datasets, the EN15804 version was used. This dataset uses the allocation cut-off by classification. This is the version of datasets within Ecoinvent that was developed to make the allocation as consistent as possible with EPDs whether EN15804 or 21930. Within the polymer datasets used by carpets there may be embedded allocations that were not handled consistently by Ecoinvent. Figuring out all of these allocation issues is beyond the scope of this report, and these datasets, with any embedded allocation issues, are explicitly endorsed for use within the relevant PCRs. The polymeric primary backing (PP) comes from Plastics Europe. According to Plastics Europe documentation (Plastics Europe, 2019), allocation is first by system expansion when a dominant identifiable displaced product is produced. After that, the allocation methods are by mass or energy (depending on causal relationships), followed by stoichiometric allocation (NaCl is allocated to NaOH and Cl by the amount of Na and Cl in the products instead of the total mass of products), and then economic allocation.   While system expansion is considered avoiding allocation it is typically used in the consequential framework. Thus, while we used attributional allocation when we were given a choice, we recognize that the supply chain data have embedded allocation methods that are more consistent with the consequential approach.

CARPET MANUFACTURING FOR DIXIE RESIDENTIAL CARPETS

Dixie produces carpets at two sites: the Susan Street facility in Santa Ana, operates tufting, dyeing, and finishing, while the Eton facility in Dalton, GA performs tufting, with nearby partners completing finishing and various dyeing methods.

Table 27. Dixie and 3rd party facilities performing each step in carpet production.

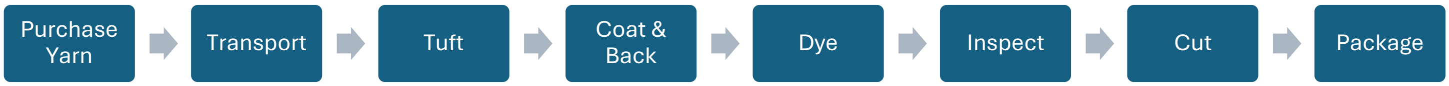
Processing step	Dixie facilities	3rd party facilities	Comments
Extrusion	Calhoun, GA	Several vendors	Data based on Calhoun, GA plant
Twisting and heat setting	Porterville, CA and Roanoke, AL		Not applied to all carpets. Average of 2 plants used.
Tufting	Santa Ana, CA Eton, GA		Average of two plants is used for all carpets. Santa Ana is also referred to as Susan St.
Finishing	Santa Ana, CA	Vendor in GA	CA facility was used to collect data, and these values were used for all carpets.
Dyeing, Beck	Santa Ana, CA		Santa Ana is sometimes referred to as Susan St. These data were used
Dyeing, Continuous		JV, US, East coast	Primary data from JV were used.
Dyeing, Skein		JV, US, East coast	Primary data from JV were used.
Dyeing, Space		JV, US, East coast	Primary data from JV were used.
Dyeing, Solution		3rd parties providing fiber and compounded pellets	See data in supply chain section.

MANUFACTURING STEPS AND PROCESS LOGISTICS

The carpet manufacturing process begins with wool fiber and includes tufting, finishing, and dyeing in Dixie facilities or those of strategic partners. The tufting and finishing operations use primary and secondary backing, latex solution, packaging materials, dyes, and topicals.

This document outlines these operations and provides representative energy data for each group of processes. When Dixie owns and operates the plants, energy inputs are supplied by Dixie as required by the PCR. Some of these processes were conducted by a joint venture, and primary energy values were sourced from those facilities accordingly. Electricity consumption at Dixie facilities was reported in kWh and converted to MJ for uniform comparison. Natural gas usage was reported in therms (considered as higher heating value) and converted to MJ HHV for consistency in reporting.

Figure 4: Product Flow



TWISTING AND HEAT SETTING

All of the wool fiber used is purchased in yarn form and is twisted and heatset by the supplier. This is tufted without internal twisting and heat setting. There is zero energy for this operation in the wool carpets.

TUFTING

Dixie has tufting operations at Santa Ana (CA) and Eton (GA). The Eton plant primarily does tufting with little other activities. This gives us a measure of the energy consumed by the equipment in that plant. The Santa Ana plant (Susan St.) also does finishing and dyeing operations, and the metered energy in the Santa Ana plant was allocated by Dixie personnel using technical information and expert judgement. The electricity use was consistent between the two facilities, and it was with the range of data seen on other carpet projects. The natural gas use in the Eton facility was for heating, and there did not appear to be significant cooling overhead energy use.

Tufting comprises preparing the yarns for the tufting machine and operation of the tufting machines themselves. The total energy includes warping, tufting, material handling, and setup/inventory. The tufting process alone was estimated to use 80% of the energy. The natural gas use is for heating.

Table 10. Tufting energy in Dixie facilities.

	Electricity	natural gas (HV of gas)	Steam	Blue water	Water
Eton, MJ / kg face fiber tufted	1,557	394	0	0	0
Susan St, MJ / kg face fiber tufted	1,650		0	0	29.1
Weighted average, MJ / kg extruded	1,577	309	0	0.0	6

FINISHING

Dixie finishes carpets in their own facility in Santa Ana, California. The east coast operations utilize a 3rd party facility in Georgia. The California facility utilities were allocated to the different carpet production stages. Energy data from California finishing processes was used to calculate energy for all Dixie finishing.

Dixie currently uses water-based topicals. Application of topicals is done as part of the finishing process, and the small amount of additional energy required to evaporate the water is thus included in the finishing energy measurements. Several products are used across the product range. We used a proxy (acrylic copolymer) to estimate the small impact from manufacture of topicals. We estimate the active ingredient to be less than 0.1% of total carpet weight.

DYEING

Dixie used a combination of dyeing techniques listed in

Table . The Beck dyeing data came from the Susan St. plant. Continuous dyeing was done in a joint venture facility on the east coast, and this plant provided data. Skein dyeing and space dyeing were done in another facility on the east coast, and these utilities were allocated by Dixie personnel to each dyeing method. Beck dyeing blue water consumption was estimated by the amount of water removed from the dryer. The other blue water values were based on metered water and sewage usage.

Table 29: Dyeing types by carpet fiber

	Wool, % of total m2
Piece dyed (Beck)	20
Continuous dyed	0
Solution dyed	0
Yarn dyed - Skein	28
Yarn dyed Space	52
Total	100

Table 30. Dyeing utility and blue water measurements at Dixie facilities

Dyeing method	Electricity, MJ/1000kg FF	Natural gas, MJ HHV/1000kg FF	Total water use, kg / 1000 kg FF	Blue water, kg / 1000 kg FF
Beck dyeing	3,276	45,604	30,521	1,000
Continuous dyeing	2,866	21,349	178	7
Skein (yarn)	7,355	24,144	998	40
Space (yarn)	6,005	19,714	815	33

Table 31: Dyeing energy per 1000 kg of face fiber for each face fiber type, based on dyeing methods

	Wool
Electricity, MJ/1000 kg FF	5,837
Natural gas, MJ/1000 kg FF	26,133
Blue water, kg / 1000 kg FF	228
Metered water, kg / 1000 kg FF	6,807

Table 32: Dyeing energy per m2 of face fiber (based on market average face fiber weight).

	Wool
Electricity, MJ / m2	8.70

Natural gas, MJ / m2	38.94
Blue water, kg / m2	0.34
Metered water, kg / m2	10.1

Due to the difference in the dyeing methods used and to a lesser degree to the face fiber weight, the dyeing energy is quite different.

TOPICALS

Dixie currently uses water-based topicals. Application of topicals is done as part of the finishing process, and the small amount of additional energy required to evaporate the topical solution water is thus included in the finishing energy measurements. Several products are used across the product range. Chemical formulations of topicals are proprietary, but polyacrylics and polyurethanes are commonly used. We used a copolymer of methacrylate and ethyl acrylate as a proxy for these polyacrylate chemicals and use 2 kg / 1000 kg of face fiber as the input.

YIELD AND WASTE

Dixie measured several categories of waste flows. These measurements were used to calculate the amount of yarn inputs to the manufacture of carpets.

The waste is categorized as soft waste (yarn) and hard waste (finished carpet). The soft waste was about 25% obsolete yarn, and the remainder was waste mostly from the tufting operations. The hard waste includes carpets found to be damaged by a variety of issues.

WATER USE

Process blue water (net water consumption) is dominated by water evaporation in the fiber drying processes and is linked to the dyeing method. Little additional blue water is used in the carpet manufacturing process. Additional evaporative water is from the finishing process released by the latex compound and that is assumed to be in the latex CTG. The primary source of metered water is from dyeing processes, and we assume that this is treated and sent back to the same source where it originated. Ergo, there is no blue water for these other components.

INTERNAL TRANSPORT

Dixie provided the transport energy (gallons of diesel consumption) for each of their plants, allowing us to calculate the total transport energy for 2024. The emissions and LCIA for this transport were modeled by a generic module for transport using a combination truck of over 32,000kg. Diesel consumption was distributed evenly per unit area of carpet.

PACKAGING

Packaging is used to protect the carpet while being transported from Dixie manufacturing sites to a distribution center and on to customers. Additionally, packaging is used within Dixie to move material from plant to plant. The carpet is wrapped around cardboard cores and then covered with an LDPE plastic wrap to protect the carpet. The total packaging used was based on purchases in 2024, and this included packaging for internal use as well as shipment of final product.

The LDPE consumption was 0.20% of the face fiber mass in finished carpet and the total consumption of cardboard cores was 3.3% of the face fiber mass in finished carpet.

We assumed that the packaging is the same per unit area regardless of the fiber weight of the carpet. Any variation in packaging for different face-weight fibers will be insignificant compared to the overall impact of the carpets.

CALCULATION OF LCIA FOR VARYING FACE WEIGHTS

The energy for each carpet step is either a function of face fiber weight or carpet area. Yarn mass input and hard waste is a function of face fiber weight. The backing material inputs are constant per m^2 of carpet. OpenLCA was used to calculate impacts for each of the carpet inputs and energy consumptions. These were used to calculate the environmental impacts for each carpet as a function of face weight.

SUPPLY CHAIN AND INSTALLATION DATA

Secondary data for the supply chain from Ecoinvent 3.11 was used when available. When these data were incomplete or not available, data from Environmental Clarity were used to supplement.

In general, datasets were often available for Europe (RER) and for the rest of world (RoW). In addition, datasets are available as a market. The market version may contain multiple production technologies or a single technology, and it typically contains transport of the products to a regional distribution center. In general, the allocation methods available in Ecoinvent are (1) allocation cut-ff by classification (2) allocation at the point of substitution (3) substitution, consequential, long-term. The EN15804 version incorporates cut-off by classification, and that is what is used in this study. The cut-off method makes the recyclable products 'burden-free' at the point of production (source). Transport is assigned to the recycling system and subsequent products.

Table 33: Data modules used for the inputs to the carpet manufacturing gate

Material	Data module	Source	Comments
Wool yarn	CTG of sheep fleece in the grease and additional processing energy	See next lines for individual components used in CTG.	CTG is the CTG of sheep fleece in the grease + conversion of sheep fleece in the grease to grease and sheep wool, and conversion of sheep wool to yarn. See text for details.
Sheep fleece in the grease[3]	Market for sheep fleece in the grease | sheep fleece in the grease | EN15804GD, U – GLO	Ecoinvent 3.11	Data based on US and RoW locations. Market weighted average amount of transport
GTGs for conversion of sheep fleece in the grease to grease and sheep wool, then to yarn	Environmental Clarity datasets.	Environmental Clarity	Developed for this project **from literature and models.** Used NZ as location for electricity grid.
Polypropylene, woven, for primary and secondary backings	1) Market for polypropylene, granulate | polypropylene, granulate | EN15804GD, U – GLO 2) <Fiber production> 3) Weaving of synthetic fiber, for industrial use, | weaving, synthetic fibre | EN15804GD, U - GLO	(1) Ecoinvent 3.11 (2)Environmental Clarity (3) Ecoinvent 3.11	We did not find a module from Ecoinvent for extrusion of synthetic polymers to create fibers. Thus, data from Environmental Clarity were used.
Styrene butadiene latex	market for latex | latex | EN15804GD, U – RoW	Ecoinvent 3.11	There was also an RER version, so this is global excluding Europe.
Calcium carbonate	limestone production, milled, loose | limestone, milled, loose | EN15804GD, U - ROW	Ecoinvent 3.11	There was also an RER version, so this is global excluding Europe.

1. Data was available for Europe (RER) and rest of world (ROW). ROW was selected.
2. Originally from Plastics Europe
3. Biogenic carbon flow was modified to close carbon balance. See separate section on biogenic carbon flow.

FACE FIBERS

Finished wool is not available in Ecoinvent. The dataset is based on US data, some from USLCI database, and some from 'statistics, literature, farm survey reports, documents from extension services, and expert knowledge.' There is a dataset for production of sheep fleece in the grease from sheep farmed for wool, and another dataset for sheep fleece in the grease as a byproduct of sheep meat consumption. In this report, we used the Ecoinvent model for sheep fleece in the grease, because the PCR prescribes the available databases. We added additional processing for (1) cleaning and separation of the fleece from crude lanolin (grease) and (2) conversion of the fleece to yarn.

The second gtg for wool processing includes the worsted process for fine wool yarn and the woolen process for coarse wool yarn. These processes are not independent as a portion of the wool from the worsted process is fed to the woolen process. The allocation for each of these gtgs was done by mass, and gtgs were used within openLCA, so that ecoinvent data were used for all the inputs. The ecoinvent datasets used to model these inputs are listed in Table .

Table 34. Additional inputs for the wool cleaning and processing gtgs, propylene extrusion gtgs, and packaging

Material	Data module	Source	Comments
Electricity	electricity voltage transformation from medium to low voltage | electricity, low voltage | EN15804GD, U - NZ	Ecoinvent 3.11	Low voltage is below 1 kV.
Heat, from natural gas	heat production, natural gas, at industrial furnace >100kW | heat, district or industrial, natural gas | EN15804GD, U - ROW	Ecoinvent 3.11	Small amount of heat needed for yarn processing gtg.
Sulfuric acid	market for sulfuric acid | sulfuric acid | EN15804GD, U - RoW	Ecoinvent 3.11	Small amount used to treat wool in yarn production
Weaving, synthetic fiber	weaving of synthetic fibre, for industrial use | weaving, synthetic fibre | EN15804GD, U - GLO	Ecoinvent 3.11	Used for weaving polypropylene backing
LDPE pallet wrap	market for packaging film, low density polyethylene | packaging film, low density polyethylene | EN15804GD, U - GLO	Ecoinvent 3.11	This is for the extruded wrap

BACKING MATERIALS

The primary and secondary backings are purchased as a woven polypropylene textile. We used Ecoinvent data for polypropylene granulate. This is converted to a yarn using the primary data that was collected from Dixie for fiber production.

Ecoinvent also has a database for styrene butadiene latex.

Calcium carbonate is a product acquired locally and typically has a low environmental impact.

Table 35: Additional inputs for the wool cleaning and processing gtgs, propylene extrusion gtgs, and packaging

Material	Data module	Source	Comments
Electricity	electricity voltage transformation from medium to low voltage | electricity, low voltage | EN15804GD, U - NZ	Ecoinvent 3.11	Low voltage is below 1 kV.
Heat, from natural gas	heat production, natural gas, at industrial furnace >100kW | heat, district or industrial, natural gas | EN15804GD, U - ROW	Ecoinvent 3.11	Small amount of heat needed for yarn processing gtg.
Sulfuric acid	market for sulfuric acid | sulfuric acid | EN15804GD, U - RoW	Ecoinvent 3.11	Small amount used to treat wool in yarn production
Weaving, synthetic fiber	weaving of synthetic fibre, for industrial use | weaving, synthetic fibre | EN15804GD, U - GLO	Ecoinvent 3.11	Used for weaving polypropylene backing
LDPE pallet wrap	market for packaging film, low density polyethylene | packaging film, low density polyethylene | EN15804GD, U - GLO	Ecoinvent 3.11	This is for the extruded wrap

ENERGY MODULES

Electricity modules for electricity in the US were based on fuel consumption mixes in eGrid. The PCR (part A) states that preference should be given to subnational consumption mixes that account for power trade between regions. However, eGrid is a production-based resource, and consumption mixes are not included. In this work, we use the production-based generation fuel mix from eGrid 2023 rev 2. Electricity modules were then created in openLCA combining electricity by fuel mix with eGrid data on the electricity fuel mix. The east coast plants are in the South subregion inside of the SERC grid (SRSO). The west coast plants are in the CAMX region of the WECC grid. The electricity mix by fuel for these as well as the US average grid are given in Table . We used this data to build a grids by fuel type. Other fossil and other unknown ones were entered as natural gas.

Regarding consumption mixes compared to production mixes, a recent study (Sharma et al., 2023) provided results for the production-based grid and a calculated consumption-based grid. The difference in these grids was typically small (<5%) for CO2, SOx, Nox, and methane. There are a few exceptions for emissions from several grids.

For carpet manufacturing, electricity was from a mix of the SRSO grid and the CAMX grid, which apply for Georgia and California locations. For other operations, such as the use phase and end of life, electricity was from the US average grid. Within Ecoinvent, heat from natural gas has an assumed 90% efficiency factor based on lower heating value. Natural gas is sold in the US based on higher heating value, which is about 10% higher (in MJ) than the lower heating value. Thus, when metered heat was given, 1 MJ of metered heat was multiplied by 0.8 to calculate the amount of heat by natural gas used in the process.

For electricity modules by fuel type, we used USLCI when available for electricity and natural gas and Ecoinvent when USLCI data were not available as shown in

Table 11. These modules were for power at the power plants. Thus, each module was converted to power delivered using a 6% transmission and conversion loss. Other energy modules are given in Table 12. It is important to use US data when available for some fuels such as coal and hydro power, because the coal mixes and hydro dams are significantly different in the US and Europe.

The USLCI database uses FEDEFL naming convention, which is incompatible with the naming convention used by Ecoinvent. The implementations of TRACI 2.1 that are distributed with OpenLCA that are meant to be used with the Ecoinvent naming conventions. Thus, we used a version (TRACI_2.1_json_v1.1.3) from the Federal LCA commons that uses these conventions. We utilized this methodology for the electricity modules from the USLCI database.

Table 36 Electricity generation by fuel mix in relevant grids

	CAMX	SRSO	US mix
Coal	2.1%	14.5%	16.1%
Oil	0.0%	0.1%	0.5%
Gas	42.9%	55.4%	43.2%
Nuclear	8.0%	20.4%	18.5%
Hydro	14.1%	2.4%	5.7%
Biomass	2.2%	3.6%	1.1%
Wind	6.6%	0.0%	10.0%
Solar	20.1%	3.6%	3.9%
Geothermal	3.6%	0.0%	0.4%
Other fossil	0.7%	0.0%	0.5%
Other unknown	-0.3%	0.0%	0.1%
Total	100.0%	100.0%	100.0%

Table 11. Modules used for electricity

	Type	Database	Module
Coal	Bituminous (92% coal mix)	USLCI	Electricity, bituminous coal, at power plant
	Lignite (8% coal mix)	USLCI	Electricity, lignite coal, at power plant
Oil	Only one type listed	USLCI	electricity production, oil | electricity, high voltage | EN15804GD, U, US-WECC
Gas	No differentiation in database between combined cycle and single	USLCI	Electricity, natural gas, at power plant
Nuclear	USLCI has only one type of nuclear plant for US (not subdivided by type)	USLCI	electricity production, nuclear, boiling water reactor | electricity, high voltage | EN15804GD, U, US-WECC
Hydro	Used reservoir model, because vast majority of production in US is from a reservoir. USLCI has hydro data by plant, but does not have a general hydro across whole grid	Ecoinvent	electricity production, hydro, reservoir, alpine region | electricity, high voltage | EN15804GD, U
Biomass		USLCI	USLCI: Electricity, biomass, at power plant
Wind	Most is onshore, and about ½ of current installed base is >3MW. All new is >3MW	Ecoinvent	electricity production, wind, >3MW turbine, onshore | electricity, high voltage | EN15804GD, U
Solar	This size represents industrial installations	USLCI	electricity production, photovoltaic, 570kWp open ground installation, multi-Si | electricity, low voltage | EN15804GD, U - US-WECC
Geothermal		Ecoinvent	electricity production, deep geothermal | electricity, high voltage | EN15804GD, U

Table 12. Other Energy modules used

Type of energy	Modules (from Ecoinvent 3.11)	Comments
Electricity for wool processing to yarn	electricity voltage transformation from medium to low voltage | electricity, low voltage | EN15804GD, U – NZ	Based on New Zealand grid, low voltage (230 V).
Heat by natural gas	heat production, natural gas, at industrial furnace >100kW | heat, district or industrial, natural gas | EN15804GD, U - RoW	This includes a 90% efficiency of generation of heat. Thus, 1 MJ of metered gas is equal to 0.9 MJ of heat production, natural gas....

TRANSPORT

Transport occurs in 3 areas. First, trucks are used to transport materials between facilities. Dixie reported the gallons of diesel fuel consumed for this transport. This is transport within the carpet manufacturing gtg. Second, transport of product to the installation site, which is specified in metric tons transported per 1 km. Based upon the PCR standard, this is assumed to be 800 km. Third, transport is used at the end of the useful life of the carpet for disposal in the landfill. The PCR states this to be 161 km.

Table 39. Transport to building site

Name	Value	Unit
Fuel type	Diesel	
Liters of fuel	Not specified in documentation	l/100km
Vehicle type	Articulated trailer > 32 tons	
Transport distance	800	km
Capacity utilization	53	%
Gross density	Not applicable[1]	Kg/m3
Weight of products	Not applicable	Kg
Volume of products	Not applicable	M3
Capacity utilization volume factor (factor: =1 or <1 or _ 1 for compressed or nested packaging products)	Not applicable	-

1- These are not applicable to Ecoinvent Transport Models which is based on mass and distance as an input, and is based on generic values for gross utilization factors.

INSTALLATION (A5)

During the installation phase (A5) tack strips are consumables used to hold the carpet in place. Tools used to install the carpet are excluded from the LCA. There are several small nails for attaching the strip to the floor and over 100 thin angled nails pointing up that hold the carpet in place. An estimate was made of the amount of wood and metal used per m^2 of carpet.

In addition, the impact of carpet scrap from the installation process is recorded in this section. It is assumed that 5% loss of material occurs during the installation. The end-of-life product waste and all packaging is included in this phase. After installation, the cardboard is transported to the transfer station and is assumed to be recycled. The polymeric wrap (LDPE) is assumed to be landfilled.

After installation, the cardboard, polymeric wrap (LDPE), and tack strips are treated with the end-of-life methods specified in the end-of-life section. Impacts from these activities are included in A5. Parameters for installation are given in Table .

Table 40. Installation into the building

Name	Value	Unit
Ancillary materials, tack strips wood	0.08	Kg
Ancillary materials, tack strips nails (steel)	0.015	kg
Net freshwater consumption specified by water source and fate (e.g., X m3 river water evaporated, X m3 city water disposed to sewer)	0	M3
Other resources	Not applicable	
Electricity consumption	Not applicable	kWhr
Other energy carriers	Not applicable	
Product loss per functional unit[2]	0.05	M2
Waste materials at the construction site before waste processing	0.095+0.057=0.15	Kg
Output materials from onsite processing	Not applicable	
Mass of packaging waste Cardboard cores LDPE wrap	 0.054 0.0033	 Kg kg
Biogenic carbon in the packaging[1] = 0.45 kg C / kg core board	0.09	Kg CO2
Direct emissions to ambient air, soil and water	Not applicable	
VOC emissions	Not applicable for tack strip installation	

1. This is based on the total carbon content of core board.
2. Product loss is 5% of installed area. The mass depends on the mass of the carpet.

END OF LIFE

The end of life activities are given by mass for each synthetic carpet in **Error! Reference source not found.**, and for wool carpet in Table . As discussed, 100% of the carpet goes to the landfill. The core board packaging is split between recycling (75%), landfill (20%), and incineration (5%). The LDPE packaging is split between recycling 15%, landfill, 68%, and incineration (17%). The tack strips are an ancillary installation material, and these are assumed to be landfilled 100% of the time. For the tack strips, wood is 50% carbon by weight, and 10% degrades over 100 years.

Table 41. End-of-life scenario details for wool carpet

Name	EOL activity	Wool	Unit
Carpet waste (C2/C4)	Landfill	2.86	kg / m2
Carpet scrap (A5)	Landfill	0.143	kg / m2
Packaging waste, LDPE wrap	Total	3.30E-03	kg / m2
	Recycling	8.10E-03	kg / m2
	Landfill	3.67E-02	kg / m2
	Incineration	9.18E-03	kg / m2
Packaging waste, cardboard core wrap	Total	5.40E-02	kg / m2
	Recycling	4.05E-02	kg / m2
	Landfill	1.08E-02	kg / m2
	Incineration	2.70E-03	kg / m2
Biogenic content in packaging (cardboard core)	0.45 kg C / kg core-board	8.91E-02	kg CO2eq / m2

WASTE PROCESSING IN LANDFILL

The PCR specifies that all of the carpet is disposed of in the landfill. Ecoinvent has several modules for landfill treatment. These were supplemented with the Environmental Clarity module for carbon decomposition, because there was no similar module in Ecoinvent that transparently showed the fate of decomposed carbon in the landfill.

Inert material in landfill has no emissions from the material in the landfill but does account for emissions from construction and operation of the landfill. Landfill of polymeric material included 1% degradation of carbon. Landfill of tack strips was included in the C4 stage, though it is not part of the product.

Table 13. Waste treatment modules used to model disposal of carpets in the landfill.

Item	Data module	Source	Comments
Transport of carpet to landfill	Transport, freight, lorry, 7.5-16 metric ton, diesel, Euro 6, ROW And Transport, freight, lorry, 16-32 metric ton, diesel, Euro 6, ROW	Ecoinvent 3.11	Smaller lorry 10 km to transfer station and larger for 151 km to landfill.
Landfill of inert materials (non-polymer)	Treatment of inert waste, inert material landfill | inert waste, for final disposal | EN15804GD, U-RoW	Ecoinvent 3.11	Used for $CaCO_3$ portion of carpet and for the operations energy for wool face fiber.
Landfill of polymeric materials	Treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | EN15804GD, U-RoW	Ecoinvent 3.11	Used for polymeric face fiber, backing layers, and SBL polymer. Includes 1% degradation in landfill
Landfill of tack strips, emissions associated with decomposition	LF disp, C decomp	Environmental Clarity	Assumed that 10% of the carbon decomposes (IPCC)
Landfill of core board, emissions associated with decomposition	LF disp, C decomp	Environmental Clarity	Assumed that 100% of carbon decomposes to be consistent with the PCR, although the IPCC states that 50% is typically decomposed.
Landfill of wool, emissions associated with decomposition	LF disp, C decomp	Environmental Clarity	Assumed that 100% of carbon in wool decomposes, resulting in 3.05 kg CO_2 and 0.224 kg CH_4 emitted per kg C decomposed. 50% of wool is carbon, thus, 0.4 kg of C decomposition per kg wool.

Generally, over a life cycle of a biological product, carbon is absorbed from the atmosphere during the growth (production) phase and emitted during the end of life (decomposition) phase. However, complications occur due to allocation and sequestration. For allocation, Ecoinvent uses adjustment factors to balance the C after allocation distortions. Most LCIA methods use a 100-year time frame to calculate the relative impact of carbon emissions, and most LCIA studies refer to decomposition fractions after 100 years. However, this sequestration is not permanent, and some PCRs and standards require that biogenic emissions of CO^2 match absorption amounts in the growth phase unless sequestration is proven. Thus, all the carbon that is removed in the growth phase is counted as an emission at the end of life, regardless of what fraction is emitted during the time frame used in the LCIA method. We follow this accounting approach, here to comply with the PCR.

Cardboard cores used as packaging to roll the carpet for shipping. At the end of life these are recycled (75%), landfilled (20%, and incinerated (5%). When the cardboard cores are produced, carbon is removed from the atmosphere as trees grow. At the end of life, all this carbon is assumed to be emitted. Thus, there is an emission that balances the removal, and the net biogenic carbon emission is 0 kg CO2eq/m2.

During wool production, carbon dioxide is removed from the atmosphere, and the carbon is converted into proteins in the wool. The CO2 equivalent of the carbon in the wool is counted as a removal during wool growth. At the end of life, 100% of the wool is assumed to decompose in the landfill. Thus, the carbon emission balances the removal, and the net emission is 0 kg CO2eq/m2.

A portion of the carbon is emitted as methane, which has a larger GWP impact than CO2. The additional impact from conversion to methane is included in the GWP calculation.

Table 43: Biogenic carbon balance for wool, as reported in EPD results. Net biogenic flow in CTG dataset is balanced by carbon in wool and carbon correction used to make the carbon balance.

Flow	Mass flow, kg	C content, kg C	Impact, kg CO2eq	Classification
CH4, non-fossil	0.77	0.58	19.26	
CO2, air, resource	9.79	-2.67	-9.79	BCRP
CO2, non-fossil, resource correction	-0.17	0.05	0.17	BCRP
CO2, non-fossil emissions	0.32	0.24	0.32	BCEP
Net biogenic flow in CTG dataset		-1.81		
CO2, non-fossil correction for carbon balance	4.80	1.31	4.80	BCEP
CO2, in wool	1.83	0.50	1.83	
CH4, emitted from landfill	0.09	0.07	2.27	
CO2, emitted from landfill	1.22	0.33	1.22	BCEP
CO2, remaining in landfill	0.37	0.10	0.37	
Net flow		0.00	35.66	
Fraction decomposed in landfill	0.8			

DATA QUALITY ASSESSMENT

All the input data modules were assessed according to factors of source, time, geography, and technology. Most of the polymer datasets were originally developed in the 1990s by Ian Boustead. Since that time, these have been updated and modified by Ecoinvent or Plastics Europe. Thus, the time ranges reflect this development time. Most of the polymeric data originates from several plants located in Europe. The production routes are largely the same as those used in other locations like the United States. Technology differences between European and United States production along the route for various chemicals are typically small and often originate from differences in starting materials (e.g. crude oil) and differences in fuel prices (e.g. gas versus oil). Within Ecoinvent, location specific updates are typically made through the addition of location specific energy modules and potentially transportation data. However, the underlying datasets typically use the same technology regardless of the stated geography. For polymer datasets, the difference in results between different geographies is typically very small as discussed in the section on face fiber data.

The biggest impacts on the carpet production are from the face fibers.

The wool yarn impacts are largely from the Ecoinvent dataset for 'sheep fleece in the grease' that was derived from a mix of data from the USLCI database and literature. The technology did not match contemporary production in NZ. The details of this mismatch are discussed in the Face fibers section. Additionally, there is a wide range of enteric emissions in the literature, and the Ecoinvent model impact is on the high side of this range. Thus, the uncertainty of the wool GWP impact is very large relative to the other face fibers. Proprietary data were used to scour the wool (separate sheep fleece from grease). As discussed in the section on face fibers, the allocation for this multi-output process was done by mass.

Datasets used in the supply chain of wool and for ancillary inputs to the carpet plant are given in Table , and inputs for end of life are specified in Table . Data sets for the CTG production of electricity by fuel type are given in Table 15. The cleaned wool processing to yarn was based on a proprietary dataset developed by Environmental Clarity for this project. The energy use for these steps was obtained from several literature sources (Bianco et al. 2023; EUPMS, 2022; Textile school, 2011). The impacts from the proprietary data portion of the wool carpets were less than the 33% requirement in the PCR part A.

Table 14. Dataset quality assessment by material input

Material	Scope	Source	Original source	Time	Geography	Technology	Comments
Wool	CTG	Ecoinvent	USLCI and literature	2001-2024 (yield data from 2001-2006)	GLO	From mix of sheep grown for wool and sheep grown for meat	Geography and production systems are not specific to contemporary practices in NZ, where Dixie sources wool.
Wool processing to yarn	GTGs	Environmental Clarity	Literature	2025	NZ	Technology is current	Technology representative of world, energy from NZ.
Polypropylene	CTG	Ecoinvent 3.11	Plastics Europe	2011-2014	GLO		
Weaving PP backing	GTG	Ecoinvent 3.11		2018-2024	GLO	Technology is unspecified, but likely current based on time.	Generic weaving.
SBR (Latex)	CTG	Ecoinvent 3.11	Plastics Europe and Ecoinvent refinery	1995-2024	RoW	17 European plants. Emulsion polymerization of styrene and butadiene	Tech is current, and # of plants is large. Styrene from ethyl benzene from Plastics Europe. Butadiene is a purification gtg on the C4 refinery stream.
Limestone ($CaCO_3$)	CTG	Ecoinvent 3.11		2020-2024	RoW	One company in Switzerland	Limestone mining is simple low energy surface mining.
Solution dyeing	GTG	Environmental Clarity		2006-2018	US	Electric compounding of pellets	Electricity for compounding from US in CA and GA (near Dixie facilities).

Table 45: LCI datasets used as inputs to gtgs used to convert materials to inputs to the carpet process

Material	Scope	Source	Original source	Time	Geography	Technology	Comments
Electricity in NZ	CTG	Ecoinvent 3.11	IEA/Ecoinvent	2020-2024	NZ	Mixed supply	Used for processing wool in NZ
Heat, from natural gas	CTG	Ecoinvent 3.11		2020-2024	RoW	Mix of industrial heating	Used in wool processing
Sulfuric acid	CTG	Ecoinvent 3.11		2011-2024	RoW	Mix (50% direct, and 50% as byproduct)	Used in wool processing
LDPE pallet wrap	CTG	Ecoinvent 3.11		1993-2024	GLO	High pressure polymerization of ethylene	Technology still relevant.
Electricity, GA	Based on electricity modules by fuel type						
Electricity, CA	Based on electricity modules by fuel type						

Table 46: LCI datasets used for end-of-life processing

Material	Scope	Source	Original source	Time	Geography	Technology	Comments
Electricity in NZ	CTG	Ecoinvent 3.11	IEA/Ecoinvent	2020-2024	NZ	Mixed supply	Used for processing wool in NZ
Recycling all materials		Cut-off					
Landfill carbon decomposition	GTG	Environmental clarity	Literature/ model	2008-2022	US	Mixed technologies	Used for decomposition of C in core board and wool
Landfill operations	GTG	Environmental clarity	Literature	2008-2022	US		Used for landfill of all materials
Incineration core board	GTG	Ecoinvent 3.11		2006-2024	GLO		
Incineration polyethylene	GTG	Ecoinvent 3.11		2006-2024	GLO		

Table 15. Electricity modules by fuel type used to create electricity grid data

Fuel use for generation	Source	Time	Geography	Technology	Module
Coal, bituminous	USLCI	2001-2002	US	Not stated	Electricity, bituminous coal, at power plant
Coal, lignite	USLCI	2001-2002	US	Not stated	Electricity, lignite coal, at power plant
Oil	USLCI	1998	US	Not stated	electricity production, oil | electricity, high voltage | EN15804GD, U, US-WECC
Gas	USLCI	2001-2002	US	Not stated	Electricity, natural gas, at power plant
Nuclear	USLCI	1996-2002	US	Light water reactors	electricity production, nuclear, boiling water reactor | electricity, high voltage | EN15804GD, U, US-WECC
Hydro	Ecoinvent	1945-2024	RoW	52 plants in Switzerland, 150 yr dam 80 yr materials cycle	electricity production, hydro, reservoir, alpine region | electricity, high voltage | EN15804GD, U
Biomass	USLCI	1996	US	Poplar tree 7 yr growth cycle	USLCI: Electricity, biomass, at power plant
Wind	Ecoinvent	2012-2024	US	>3 MW, average of 3 subregions	electricity production, wind, >3MW turbine, onshore | electricity, high voltage | EN15804GD, U
Solar	Ecoinvent	2008-2024	US	Multiple Si panel modules > 570 kWp	electricity production, photovoltaic, 570kWp open ground installation, multi-Si | electricity, low voltage | EN15804GD, U - US-WECC
Geothermal	Ecoinvent	2015-2024	US	Rankine cycle with benzene as working fluid	electricity production, deep geothermal | electricity, high voltage | EN15804GD, U

RESULTS FOR MARKET AVERAGE FACE WEIGHT CARPETS

LCA results for the metrics and life cycle stages specified by the PCR are given per m^2 of installed carpet. Except for B4, other stages are for 1 carpet. The carpet reference lifespan is 15 years. For a building with a reference life of 75 years, the carpet will need to be replaced 4 times (75/15-1). Stage B4 is the impact of the wool carpets' replacements (full CTG impact). These LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Results for wool face fiber carpets are given in .

Table 48. LCIA and resource flow results, wool carpet, (1.49 kg face fiber/m²)

	A1-A3	A4	A5	B2	B4	C2	C4
TRACI 2.1 indicators (GWP with and without biogenic credit)							
GWP 100 with biogenic, kg CO2eq	6.34E+01	2.69E-01	3.51E+00	1.41E+01	3.37E+02	9.17E-02	2.86E+00
GWP 100 without biogenic, kg CO2eq	6.62E+01	2.69E-01	3.49E+00	1.41E+01	3.37E+02	9.17E-02	5.50E-02
ODP, kg CFC-11eq	2.35E-07	3.88E-09	1.33E-08	1.09E-08	1.06E-06	1.32E-09	5.81E-10
AP, kg SO2eq	1.00E+00	8.55E-04	5.11E-02	5.50E-02	4.45E+00	1.96E-04	1.32E-04
EP, kg Neq	4.27E-01	3.96E-04	2.49E-02	2.44E-03	1.91E+00	1.30E-04	2.21E-02
SFP, kg O3 eq	1.59E+00	2.10E-02	9.97E-02	7.77E-01	9.97E+00	3.66E-03	3.69E-03
ADP fossil, MJ surplus	2.05E+01	5.27E-01	1.20E+00	1.37E-01	9.03E+01	1.73E-01	0.00E+00
Resources							
RPRE, MJ	2.61E+02	5.41E-02	1.74E+01	2.36E+01	1.21E+03	1.82E-02	5.07E-03
RPRM, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRPRE, MJ	2.07E+02	3.90E+00	1.23E+01	1.75E+00	9.09E+02	1.29E+00	4.84E-01
NRPRM, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM, kg	3.14E+00	2.90E-03	1.65E-01	1.16E-02	1.33E+01	9.36E-04	2.46E-04
RSF, MJ	4.58E-01	3.78E-04	2.34E-02	1.97E-03	1.94E+00	1.11E-04	4.36E-05
NRSF, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW, m3	8.36E-01	5.77E-04	4.48E-02	5.30E-02	3.73E+00	1.77E-04	-1.46E-03

Table16: Waste parameters and unique carbon emissions/uptake, wool carpet (1.49 kg face fiber/m^2)

	A1-A3	A4	A5	B2	B4	C2	C4
Waste parameters and output flows							
HWD, kg	1.84E+00	6.37E-03	1.00E-01	1.81E-02	7.87E+00	2.17E-03	4.43E-04
NHWD, kg	7.29E+00	3.48E-02	4.91E-01	1.60E-01	3.72E+01	1.26E-02	1.31E+00
HLRW, kg	1.87E-05	2.39E-07	1.49E-06	6.66E-07	8.48E-05	7.53E-08	1.52E-08
ILLRW, kg	4.86E-05	5.86E-07	3.67E-06	1.64E-06	2.19E-04	1.81E-07	3.77E-08
CRU, kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MR, kg	8.33E-01	2.42E-03	4.34E-02	1.47E-02	3.58E+00	8.26E-04	1.93E-04
MER, kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE, kg	1.04E-01	7.53E-04	6.22E-03	1.77E-03	4.51E-01	2.90E-04	5.96E-05
Carbon emissions and uptake							
BCRP, kg CO2	2.80E+00	0.00E+00	1.40E-01	0.00E+00	1.18E+01	0.00E+00	0.00E+00
BCEP, kg CO2	0.00E+00	0.00E+00	1.40E-01	0.00E+00	1.18E+01	0.00E+00	2.80E+00
BCRK, kg CO2	1.78E-02	0.00E+00	0.00E+00	0.00E+00	7.13E-02	0.00E+00	0.00E+00
BCEK, kg CO2	0.00E+00	0.00E+00	1.78E-02	0.00E+00	7.13E-02	0.00E+00	0.00E+00
BCEW, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCE, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCR, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNR, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

and **Error! Reference source not found.**. The CTG is responsible for between 85% and 95% of the emissions in all of the TRACI categories.

For the CTG, the GWP impacts are 58.6 kg CO^2eq/m^2 for wool carpets. There is a large uncertainty in this number, as discussed on the section on data for wool.

The net biogenic carbon absorption is -6.9 kg CO^2eq/m^2. This excludes the impact of methane emissions, which are relatively large (30 kg CO^2eq / m^2 carpet). The carbon balance for wool is somewhat complicated, but it does close as shown in the section on biogenic carbon tracking.

Table 48. LCIA and resource flow results, wool carpet, (1.49 kg face fiber/m²)

	A1-A3	A4	A5	B2	B4	C2	C4
TRACI 2.1 indicators (GWP with and without biogenic credit)							
GWP 100 with biogenic, kg CO2eq	6.34E+01	2.69E-01	3.51E+00	1.41E+01	3.37E+02	9.17E-02	2.86E+00
GWP 100 without biogenic, kg CO2eq	6.62E+01	2.69E-01	3.49E+00	1.41E+01	3.37E+02	9.17E-02	5.50E-02
ODP, kg CFC-11eq	2.35E-07	3.88E-09	1.33E-08	1.09E-08	1.06E-06	1.32E-09	5.81E-10
AP, kg SO2eq	1.00E+00	8.55E-04	5.11E-02	5.50E-02	4.45E+00	1.96E-04	1.32E-04
EP, kg Neq	4.27E-01	3.96E-04	2.49E-02	2.44E-03	1.91E+00	1.30E-04	2.21E-02
SFP, kg O3 eq	1.59E+00	2.10E-02	9.97E-02	7.77E-01	9.97E+00	3.66E-03	3.69E-03
ADP fossil, MJ surplus	2.05E+01	5.27E-01	1.20E+00	1.37E-01	9.03E+01	1.73E-01	0.00E+00
Resources							
RPRE, MJ	2.61E+02	5.41E-02	1.74E+01	2.36E+01	1.21E+03	1.82E-02	5.07E-03
RPRM, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRPRE, MJ	2.07E+02	3.90E+00	1.23E+01	1.75E+00	9.09E+02	1.29E+00	4.84E-01
NRPRM, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM, kg	3.14E+00	2.90E-03	1.65E-01	1.16E-02	1.33E+01	9.36E-04	2.46E-04
RSF, MJ	4.58E-01	3.78E-04	2.34E-02	1.97E-03	1.94E+00	1.11E-04	4.36E-05
NRSF, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW, m3	8.36E-01	5.77E-04	4.48E-02	5.30E-02	3.73E+00	1.77E-04	-1.46E-03

Table16: Waste parameters and unique carbon emissions/uptake, wool carpet (1.49 kg face fiber/m²)

	A1-A3	A4	A5	B2	B4	C2	C4
Waste parameters and output flows							
HWD, kg	1.84E+00	6.37E-03	1.00E-01	1.81E-02	7.87E+00	2.17E-03	4.43E-04
NHWD, kg	7.29E+00	3.48E-02	4.91E-01	1.60E-01	3.72E+01	1.26E-02	1.31E+00
HLRW, kg	1.87E-05	2.39E-07	1.49E-06	6.66E-07	8.48E-05	7.53E-08	1.52E-08
ILLRW, kg	4.86E-05	5.86E-07	3.67E-06	1.64E-06	2.19E-04	1.81E-07	3.77E-08
CRU, kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MR, kg	8.33E-01	2.42E-03	4.34E-02	1.47E-02	3.58E+00	8.26E-04	1.93E-04
MER, kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE, kg	1.04E-01	7.53E-04	6.22E-03	1.77E-03	4.51E-01	2.90E-04	5.96E-05
Carbon emissions and uptake							
BCRP, kg CO2	2.80E+00	0.00E+00	1.40E-01	0.00E+00	1.18E+01	0.00E+00	0.00E+00
BCEP, kg CO2	0.00E+00	0.00E+00	1.40E-01	0.00E+00	1.18E+01	0.00E+00	2.80E+00
BCRK, kg CO2	1.78E-02	0.00E+00	0.00E+00	0.00E+00	7.13E-02	0.00E+00	0.00E+00
BCEK, kg CO2	0.00E+00	0.00E+00	1.78E-02	0.00E+00	7.13E-02	0.00E+00	0.00E+00
BCEW, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCE, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCR, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNR, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

RESULTS FOR OTHER FACE WEIGHTS

The PCR (part A) requires that all the carpets covered by each EPD have results that do not differ by more than 10% of the total impact. Face fiber weights in the carpet market typically vary by much more than this amount, and face fibers tend to make up more than 50% of the cradle to gate impacts of carpets. The face fiber weights and ranges for Dixie carpets are 1.49 (0.917-2.72) kg / m2 for wool. The face fiber weights vary by a factor of 2 to 3 for wool. Therefore, the impacts for the heavier face fiber carpets are much greater than those with lower piles (face fiber weights).

To be transparent about the impact of face weight on the overall result, we provide the cradle to gate of one carpet install (the sum of all categories except B4) as a function of face weight for each face fiber. This provides accurate cradle to grave results for any carpet that is in use for 15 years covered under each of the EPDs.

Table 50. LCIA and resource impacts for one carpet cradle to grave (all stages except B4) as a function of face fiber (FF) for Wool

Face Fiber, kg / m2	0.9	1.1	1.4	1.49	1.8	2.2	2.7
TRACI 2.1 indicators (GWP with and without biogenic credit)							
GWP 100 with biogenic, kg CO2eq	4.53E+01	5.42E+01	6.75E+01	7.15E+01	8.53E+01	1.03E+02	1.25E+02
GWP 100 without biogenic, kg CO2eq	4.53E+01	5.42E+01	6.75E+01	7.15E+01	8.53E+01	1.03E+02	1.25E+02
ODP, kg CFC-11eq	1.72E-07	2.00E-07	2.42E-07	2.55E-07	2.99E-07	3.55E-07	4.26E-07
AP, kg SO2eq	6.50E-01	7.90E-01	9.99E-01	1.06E+00	1.28E+00	1.56E+00	1.91E+00
EP, kg Neq	3.03E-01	3.61E-01	4.49E-01	4.75E-01	5.66E-01	6.83E-01	8.29E-01
SFP, kg O3 eq	1.23E+00	1.42E+00	1.71E+00	1.79E+00	2.09E+00	2.47E+00	2.94E+00
ADPfossil	1.80E+01	1.95E+01	2.18E+01	2.24E+01	2.48E+01	2.78E+01	3.16E+01
Resources							
RPRE, MJ	1.73E+02	2.10E+02	2.64E+02	2.81E+02	3.38E+02	4.11E+02	5.02E+02
RPRM, MJ							
NRPRE, MJ	1.70E+02	1.89E+02	2.17E+02	2.26E+02	2.55E+02	2.93E+02	3.40E+02
NRPRM, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM, kg	2.03E+00	2.46E+00	3.11E+00	3.31E+00	3.98E+00	4.84E+00	5.92E+00
RSF, MJ	2.95E-01	3.59E-01	4.54E-01	4.82E-01	5.80E-01	7.07E-01	8.65E-01
NRSF, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE, MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW, m3	5.57E-01	6.69E-01	8.38E-01	8.89E-01	1.06E+00	1.29E+00	1.57E+00

Table 51: Waste and carbon impacts for one carpet cradle to grave (all stages except B4) as a function of face fiber (FF) for Wool

Face Fiber, kg / m2	0.9	1.1	1.4	1.49	1.8	2.2	2.7
Waste parameters and output flows							
HWD, kg	1.22E+00	1.46E+00	1.84E+00	1.95E+00	2.34E+00	2.84E+00	3.46E+00
NHWD, kg	7.27E+00	7.91E+00	8.87E+00	9.16E+00	1.02E+01	1.14E+01	1.30E+01
HLRW, kg	1.48E-05	1.67E-05	1.97E-05	2.06E-05	2.37E-05	2.76E-05	3.26E-05
ILLRW, kg	3.84E-05	4.35E-05	5.10E-05	5.33E-05	6.10E-05	7.11E-05	8.36E-05
CRU, kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MR, kg	5.44E-01	6.58E-01	8.30E-01	8.81E-01	1.06E+00	1.29E+00	1.57E+00
MER, kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE, kg	7.18E-02	8.51E-02	1.05E-01	1.11E-01	1.32E-01	1.58E-01	1.92E-01
Carbon emissions and uptake							
BCRP, kg CO2	1.78E+00	2.17E+00	2.77E+00	2.95E+00	3.56E+00	4.35E+00	5.34E+00
BCEP, kg CO2	1.78E+00	2.17E+00	2.77E+00	2.95E+00	3.56E+00	4.35E+00	5.34E+00
BCRK, kg CO2	1.78E-02	1.78E-02	1.78E-02	1.78E-02	1.78E-02	1.78E-02	1.78E-02
BCEK, kg CO2	1.78E-02	1.78E-02	1.78E-02	1.78E-02	1.78E-02	1.78E-02	1.78E-02
BCEW, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCE, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CCR, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CWNR, kg CO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Wool uses a mix of Beck, Skein, and Space dyeing. Due to the larger overall GWP impact for wool carpets, the dyeing method makes an even smaller impact on a percent change basis.

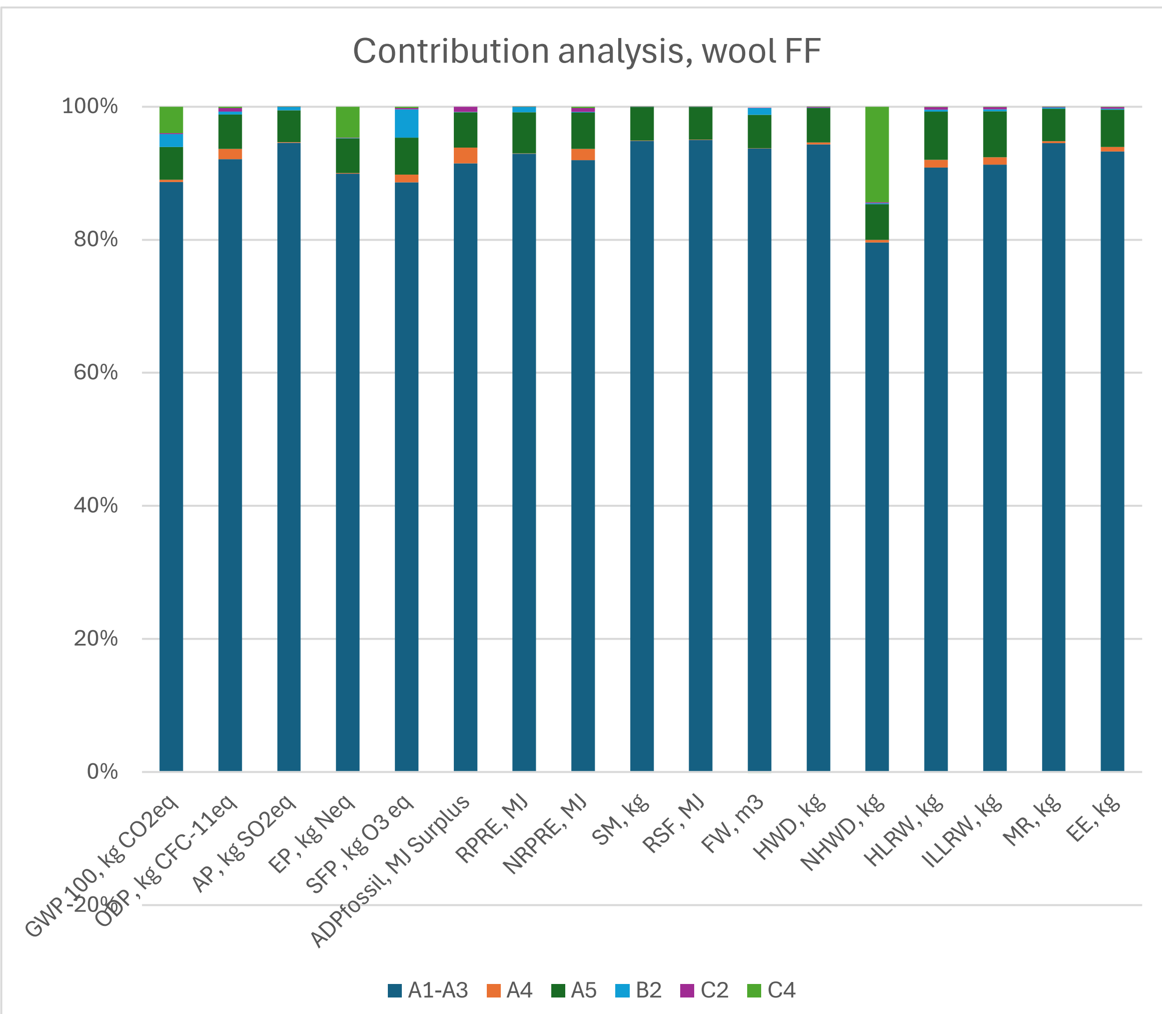
INTERPRETATION

WOOL FIBER CARPETS INTERPRETATION

For the wool fiber carpet, the CTG (A1-A3), extraction and processing, transport, and manufacturing represents most (70-90%) of the impacts in most categories. Some exceptions are eutrophication potential and biogenic carbon flows. Additionally, the CTG impact is strongly correlated with face fiber weight. Thus, we provided a set of results for different face fiber weights. These were shown for the cradle to grave life cycle of one carpet that has been installed for 15 years.

The data represents production methods and logistics in place in Dixie and 3rd party facilities in 2024. Data for supply chain materials were judged to be good, which the exception of wool production. The background database likely overestimates impact of this. Graphs showing how each life cycle stage contributes to the cradle to grave impacts of one carpet installed for 15 years is shown Figure .

Figure 5: Contribution analysis for wool carpets.



LIMITATIONS

A variety of implicit and explicit assumptions were made to conduct this LCA. The implicit assumptions are those embedded in the LCI data of the materials used as inputs into the carpet making process. There is a large variety of methods used to make wool, and there is a large range of estimates for GWP emissions from sheep meat and wool production. The face fiber comprises most (77-95%) of the impacts for wool carpets. Thus, there is a very large uncertainty in the wool carpet life cycle. However, the data comes from a source that is common to most carpet EPDs.

There is a wide range of face weights used in the residential market. If one user uses a particularly light or heavy carpet, this will have a large impact on the results per m^2 for their situation.

The use phase impacts were not large (4% of the total), but these were based on weekly vacuum and yearly extractions. If the vacuuming were daily and extractions were every two months, for example, this would increase the impacts by about 25-30% (4% x 7).

The user's location will impact on the type of electricity generation used in the use phase. For example, a user in CA will have lower impacts from electricity use than one in a more fossil fuel intensive region. The results shown in this report are based on the US average grid.

The carpet replacement schedule is very important, because the results mostly result from the non-use phase (production, transport, installation, and disposal), which are the phases that are required for each carpet change. For example, if the carpets were replaced every 5 years, instead of every 15 years, the life cycle impacts would increase by nearly 200%.

Thus, the results here reflect those from a representative user in the US who keeps the carpet for 15 years, vacuums once per week, does a hot water extraction once per year, and uses a carpet with a typical face weight. Any variation in these conditions could result in significantly different impacts.

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