Organization Environmental Footprint (OEF)
and Product Environmental Footprint (PEF)
of Sensitive® Fabrics
synthetic warp-knitted fabrics

2021
Summary

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Reference data

Organisation:	EUROJERSEY SPA
Location:	Via S. Giovanni Bosco, 260 - 21042 Caronno Pertusella (Va) Italy
Economic activity code (NACE)	13.91
Contacts	+39 02 966541 www.sensitivefabrics.it
Technical support	ICA - Società di Ingegneria Chimica per l'Ambiente S.r.l. – Bergamo, Italy
Independent review	CERTIQUALITY S.r.l. – Istituto di Certificazione della Qualità – Milan, Italy. N. Attestato PEF010/22 N. Attestato OEF003/22

1 Goals of the study

The study aims to quantify the impact generated by Sensitive® Fabrics production throughout their lifecycle, from the extraction of raw materials and energy production to the manufacturer's gate. The study used the evaluation method described in EU Recommendation 2021/2279.

The system examined in this study is the supply chain leading to the production of Sensitive® Fabrics, which takes place at the EUROJERSEY S.p.A. plant in Caronno Pertusella (VA).

This study was conducted according to a *B2B* (*Business to Business*) perspective, nevertheless it is not intended to be used for comparisons or comparative assertions.

2 Scope of the study

2.1 Organisation

Organisation EUROJERSEY SPA

Location: Via S. Giovanni Bosco, 260 - 21042 Caronno Pertusella (Va) Italy

With the contribution of the following companies for the primary data of the raw materials analysed:

- RadiciYarn S.p.A.

Organisation: RADICI YARN SPA

Location: Via Provinciale, 1125IT - 24020 – Villa d'Ogna (BG)

- Nurel

Organisation: Nurel S.A.

Location: Ctra. Barcelona km 329 (N-IIa) 50016 Zaragoza (Spain)

- INVISTA UK Limited

Organisation: A&AT GmbH

Location: Maydown Works - United Kingdom

2.2 Products included in the Product Environmental Footprint (PEF) analysis and Functional Unit

The Product Environmental Footprint (PEF) analysis encompassed the following products (whose acronyms are given in brackets):

- Light Dyed Fabric [*CH*]
- Dark Dyed Fabric [*SC*]
- White Fabric to be Printed [*BS*]
- Fabric Printed with a Traditional Method [*T*]
- Fabric Printed with Ecoprint Method [*E*]
- Fabric Printed with Ink-Jet Method [*J*]
- Bonded Fabric [B]
- Perforated Fabric [*F*]
- Reco® Fabric [*R*]

Sensitive® Fabrics articles may be produced to different values of grammage (weight per square meter); in particular, four fabric classes have been identified, each of which represents a grammage range, as listed in the table below. Each class is homogeneous in terms of its manufacturing process; the variation in environmental footprint within each class is proportional to its grammage.

Product class	Grammage (g/m^2)	Average weight for the class (g/m^2) 2021 DYED FABRICS	Average weight for the class (g/m^2) 2021 PRINTED FABRICS
1	< 100	82,22	80,00
2	100 - 150	127,51	124,89
3	150 - 200	170,37	167,98
4	> 200	227,70	227,81

Table 2–1 Fabric classes

A **'Functional unit'** is the quantified performance of a product system to be used as a reference unit. The unit of analysis adopted in this environmental footprint study is **1 m^2 of Sensitive®Fabrics warp-knitted fabric**. It shall be defined taking into account the quality features of the fabric: the grammage of the fabric and the dyeing and/or printing process applied.
The results of PEF studies are specific for each class, as listed in Table 2–1, and type of fabric (dyed fabric or printed fabric).

What	Warp-knitted fabric
How much	1 m^2 of warp-knitted fabric in synthetic fibre characterised by a specific grammage.
How well	Description of fabric types: - grey - dyed with light colours - dyed with dark colours - white for printing - printed traditionally - ecoprint printed - inkjet printed - bonded - perforated - Reco®
How Long	The warp-knitted fabric is an intermediate product which in its turn serves as a raw material for further manufacturing processes. Fabric durability depends on its end use, but in view of the fact that a fabric's use stage extends beyond the boundaries of the system considered in this study, this parameter cannot be defined.
Reference Year	2021

Table 2–2 Definition of the system's boundaries

2.3 System's boundaries

According to Recommendation 2021/2279/UE, system boundaries include all processes linked to the product supply chain relative to the unit of analysis. The study is defined **cradle to gate** since has been considered a partial product supply chain, from the extraction of raw materials (cradle) up to the manufacturer's "gate". As can be seen from Figure 2-2, the system boundaries include up-stream processes (raw materials and energy acquisition) and producer's site-level processes. The use stage and end-of-life stages have been omitted because the fabrics are intermediate products which serve as raw materials in further production cycles

The cradle-to-gate system starts when resources are extracted from nature and ends when the product leaves the factory gate, thus the extraction of raw materials and the production process of intermediates and auxiliary materials have been considered. Transports of raw materials to the factory gate has been included. The processes included in the system boundaries can be divided into *foreground processes* (i.e. core processes in the product life cycle for which direct access to information is available) and *background processes* (i.e. those processes in the product life cycle for which no direct access to information is possible).

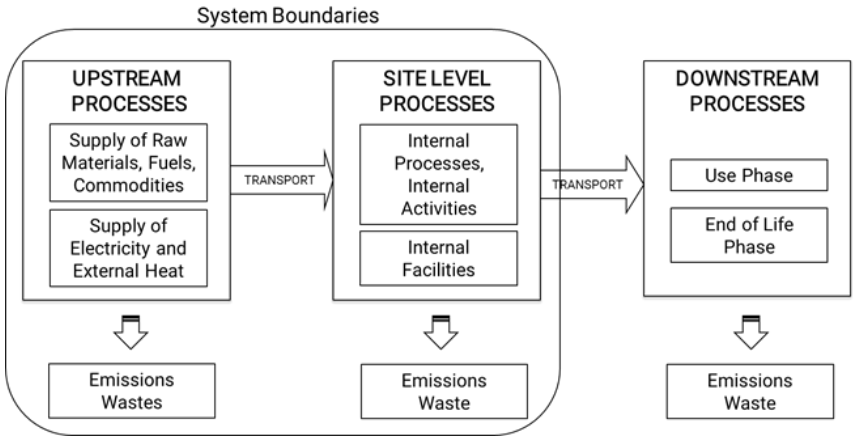

Figure 2-1: Schematic representation of system boundaries

Foreground processes	**Brief description**
Polyamide production	Polymer Production: - Extraction and transport of the main raw materials for the polymerisation process at the plant - Production and transport of additives/auxiliary materials for production/packaging at the plant - Energy consumption (electric and thermal power) - Water consumption - Emissions (to the air, water, ground) - End-of-life disposal of waste leaving the polymer production plants
Polyamide yarn production	Polyamide Yarn Production : - Polymer transport - Production and transport of additives/auxiliary materials for production/packaging at the plant - Energy consumption (electric and thermal power) for the spinning and possible the warping stage - Water consumption - Emissions (to the air, water, ground) - End-of-life disposal of waste leaving the yarn production plants
Elastane yarn production	Elastane yarn Production : - Extraction and transport of the main raw materials at the plant - Production and transport of additives/auxiliary materials for production/packaging at the plant - Energy consumption (electric and thermal power) - Water consumption - Emissions to the air, water, ground - End-of-life disposal of waste leaving the polymer production plants

Foreground processes	Brief description
Fabric production	Warp-knitted fabric Production: : - Energy consumption for scouring, thermofixing and weaving - Emissions in air, water, ground - End-of-life disposal of waste generated during the stages described above
Fabric dyeing	Dyed fabric Production: - Colorants and additives - Energy consumption - Emissions to the air, water, ground - End-of-life disposal of waste generated during the stages described above
Printing	Printed fabric Production : - Colorants and additives - Energy consumption - Emissions to the air, water, ground - End-of-life disposal of waste generated during the stages described above
Bonding[1]	- Energy consumption - Adhesive - End-of-life disposal of waste generated during the stages described above
Perforing	- Energy consumption - End-of-life disposal of waste generated during the stages described above - Transports

Table 2–3 Foreground processes for which primary data is available

[1] *Bonding is carried out internally 93% of the total production) during the reference year.*

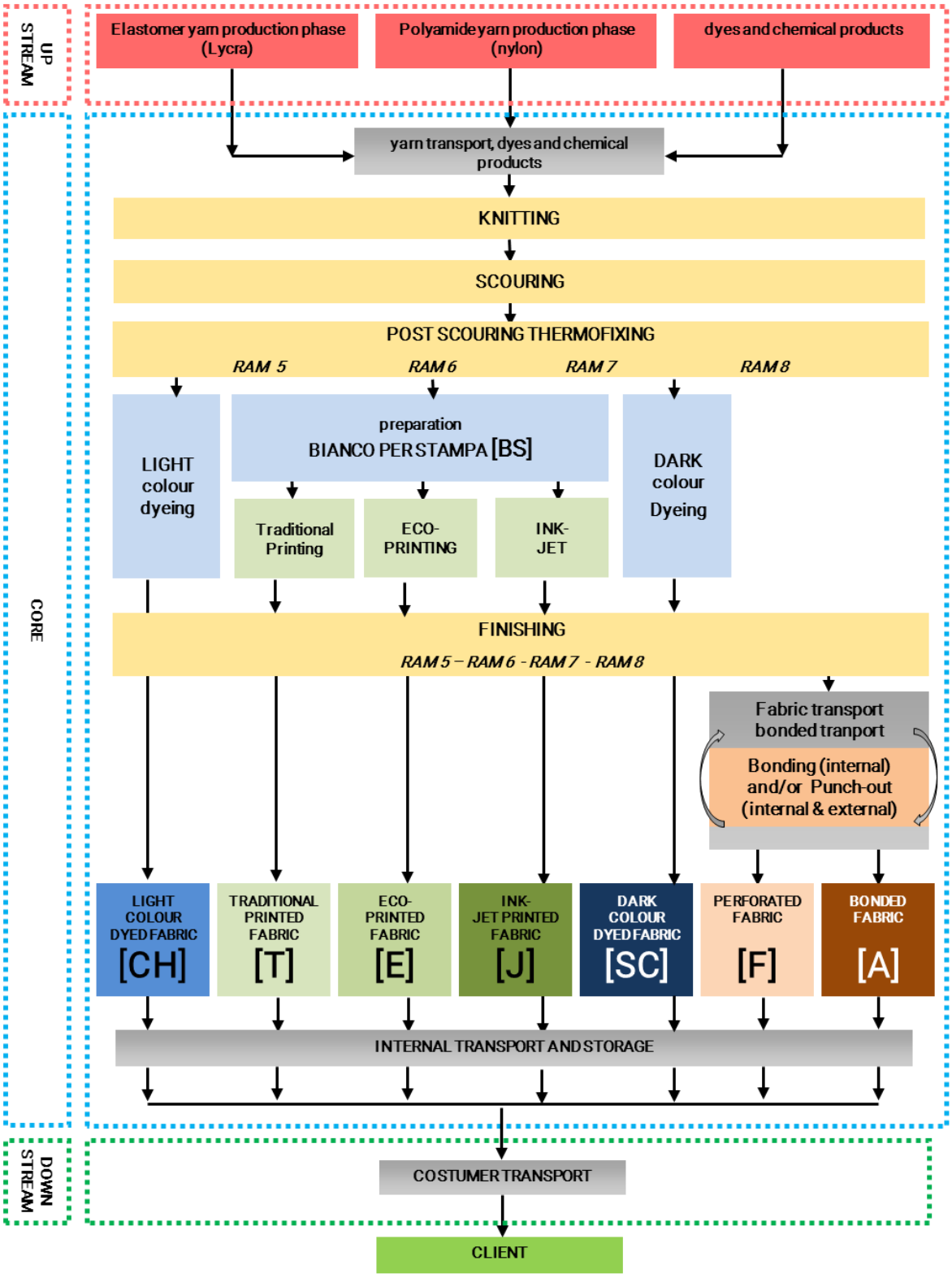

Figure 2-2 Schematic view of system boundaries considered in the PEF study

2.4 Impact category selection

The environmental footprint of the products was evaluated by applying all the impact categories and the relative methods provided for in Recommendation 2021/229/UE.

2.5 Assumptions and restrictions

All the data collected during the reference period of one year (2021) were taken into account in the analysis. The exclusion of particular consumption items for which was impossible to obtain reliable data from databases did not exceed 1% by mass of the total input. Infrastructures, capital goods and maintenance works were excluded for a cut-off of 1% the total mass of model inputs. Conservative assessments were developed to model the transports between the different supply chain stages, while kilometres covered are specific and relative to the reference year.

In order to model in a representative way the processes relating to the additives and colorants used in the dyeing and printing stages, specific inventories were elaborated on the basis of specific material safety data sheets. The chemical composition was then modelled using the databases available. The items excluded from the modelling as a percentage of the total mass of model inputs are listed in the following Table. The Table also lists the proxy data used, always expressed as percentages of the total mass of model inputs.

	Dyeing CH	Dyeing SC	Dyeing BS	Printing T	Printing E	Printing J
Proxy data	0,322%	1,137%	--	--	0,138%	--
Cut off	0,183%	0,201%	0,195%	0,524%	0,130%	0,317%

Table 2–4 Items excluded from the modelling and proxy data (% of the total mass of material inputs)

Reco fabric with recycled PA6 can be realized in different weights and compositions. The impact was conservatively calculated for Reco fabrics of weight class 4, dark dyed, however taking into account the specific composition in terms of % Nylon 6 (PA6) and % elastane (EA).

The allocations related to water emissions is based on the basis of the actual use of chemicals for the various processes.

The distribution phase takes into account the weighted average of the sales distances during the reference year and are not specific for the article.

2.6 Resource and emission utilization profile: inventory analysis

An inventory (profile) of all material/energy resource inputs/outputs and emissions into air, water and soil have been compiled as a basis for modelling the PEF. The model of the product supply chain have been constructed using facility and product-specific data, collecting facility-specific inventory during the reference period (2021).

Whenever possible, system specific inventory data were used. The study used specific data supplied by EUROJERSEY S.p.A. for all production stages directly controlled by the company.

Specific data collected by the main suppliers were also used to model the profiles of the polyamide 6 yarn (72%) and elastane yarn (28%). For background processes where the company does not have direct access to specific data, the information used were sourced from a third-party life-cycle-inventory database that complies with the data quality requirements of the PEF method. In particular all the background data used in the study were retrieved from the Ecoinvent v. 3.8 databank.

The allocation by mass of the environmental impacts for the different grammage values was developed on the basis of production volumes in the reference year.

3 Evaluation of data quality

All the data related to the processes under the direct control of EUROJERSEY S.p.A., as well as the data relating to the most significant raw materials, are primary data. The overall quality level of the data used is "*Very Good",* according with the requirements set out in the Recommendation 2021/2279/EU.

4 Environmental footprint assessment stage (Life Cycle Impact Assessment (LCIA) stage)

The software used in modelling the environmental impact result was **SimaPro 9.4**.

The method used for the calculation phase was:

- *EF Method 3.0 v.1.03*

4.1 PEF results

The overall results of the PEF study relating to warp-knitted Sensitive® Fabrics by Eurojersey have been calculated for all the impact categories required by Recommendation 2021/2279/EU.

The results were analysed to disclose the contribution associated to the different stages of the supply chain. In order to identify the most significant impact categories, the environmental impact results were normalised with respect to the reference data provided for in the latest reference guidelines for the implementation of PEF studies[2] and were subsequently weighted. The Table below reports the most significant impacts.

It was also possible to subdivide the value of each impact indicator between the various contributions, highlighting which may be related with production processes taking place during fabric manufacturing and which should be ascribed instead to other life cycle stages. In particular, the study details the impacts associated with the following stages:

- Spinning
- Knitting
- Scouring
- Thermofixing
- Dyeing/printing

Then, the dyeing and printing stages were analyzed in greater detail, so as to determine which *core processes* were correlated with the most significant impacts, with special regard to:

- Electric energy (EE) consumption
- Natural gas (ET) consumption
- Direct plant emissions (Direct emissions to the atmosphere and to water)
- Additives and colorants.

[2] *The normalisation factors were determined using statistical data relating to emissions to the air and the ground, and the consumption of extracted resources. Normalization factors for the Environmental Footprint Reference Package 3.0.*

Upstream+ Core Processes												
Impact category	**Unit**	**White for printing**				**Light colour dyed fabric**				**Dark colour dyed fabric**			
		Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Climate change – Total	kg CO_2 eq	0,763	1,204	1,662	2,241	0,901	1,425	1,956	2,633	0,962	1,550	2,12	2,858
Particulate matter	disease inc.	2,69E-08	4,64E-08	6,58E-08	9,39E-08	2,92E-08	5,01E-08	7,08E-08	1,01E-07	3,29E-08	5,69E-08	7,99E-08	1,13E-07
Ecotoxicity, freshwater	CTUe	11,481	20,629	29,561	43,238	10,827	19,685	28,301	41,546	16,103	28,942	40,665	58,078
Water use	m^3 depriv.	0,847	1,281	1,745	2,277	1,277	1,967	2,661	3,500	1,546	2,484	3,35	4,425
Resource use, fossils	MJ	13,992	21,945	30,230	40,585	16,204	25,486	34,962	46,897	17,040	27,266	37,34	50,085

Table 4–1: PEF study results – Dyed and white for printing fabrics – Upstream+Core Processes

Upstream+ Core Processes												
Impact category	**Unit**	**ECOPRINT PRINTING**			**INK-JET PRINTING**				**TRADITIONAL PRINTING**			
		Class 2	**Class 3**	**Class 4**	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Climate change – Total	kg CO_2 eq	1,510	2,07	2,796	1,922	3,000	4,08	5,516	1,639	2,759	3,75	5,077
Particulate matter	disease inc.	5,66E-08	7,95E-08	1,13E-07	4,37E-08	7,23E-08	1,01E-07	1,41E-07	3,69E-08	6,40E-08	8,95E-08	1,26E-07
Ecotoxicity, freshwater	CTUe	32,915	46,032	65,565	18,152	30,966	43,468	62,091	31,575	56,375	77,644	108,446
Water use	m^3 depriv.	1,923	2,61	3,445	2,906	4,475	6,04	8,103	2,979	5,076	6,85	9,200
Resource use, fossils	MJ	27,413	37,56	50,521	32,590	50,791	69,04	93,200	28,107	47,052	64,00	86,386

Table 4–2: PEF study results –Fabrics printed with traditional, ecoprint and ink-jet methods

Downstream Processes									
Impact category	**Unit**	**Dyeing**				**Printing**			
		Class 1	**Class 2**	**Class 3**	**Class-4**	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Climate change – Total	kg CO_2 eq	0,026	0,038	0,050	0,066	0,025	0,037	0,049	0,066
Particulate matter	disease inc.	1,71E-09	2,55E-09	3,33E-09	4,40E-09	1,67E-09	2,50E-09	3,30E-09	4,40E-09
Ecotoxicity, freshwater	CTUe	0,264	0,393	0,515	0,679	0,257	0,385	0,509	0,679
Water use	m^3 depriv.	0,001	0,001	0,002	0,003	0,001	0,001	0,002	0,003
Resource use, fossils	MJ	0,364	0,542	0,710	0,937	0,355	0,531	0,702	0,937

Table 4–3: PEF study results –Transport of printed and dyed fabrics

4.1.1 Bonded Fabric

Bonded fabrics may be produced by combining two types of Sensitive® Fabrics.

Impact category	Unit	Bonded fabric BFT5		Bonded fabric SDM5 and GGT5	
		Upstream + Core Processes	Downstream Processes	Upstream + Core Processes	Downstream Processes
Climate change – Total	kg CO_2 eq	4,14	0,097	3,036	0,074
Particulate matter	disease inc.	1,50E-07	6,49E-09	1,07E-07	4,91E-09
Ecotoxicity, freshwater	CTUe	60,115	1,003	42,255	0,758
Water use	m^3 depriv.	5,57	0,004	4,129	0,003
Resource use, fossils	MJ	74,73	1,383	55,085	1,045

Table 4–4: PEF study results –Bonded fabric: upstream+core processes + downstream processes

Bonded fabric results were determined with reference to bonded fabrics produced with two class 2 dark dyed fabrics (SDM5 and GGT5) and two class 3 dark dyed fabrics (BFT5), which were deemed representative of the bonded fabric produced in 2021. It should be noted, however, that bonded fabric may also be made with light dyed fabrics and fabrics belonging to different grammage classes; in this connection, the impact relating to the bonding process alone was quantified separately. The Table below lists the results for the bonding stage expressed per m^2 of fabric.

Impact category	Unit	Results
Climate change – Total	kg CO_2 eq	0,083
Particulate matter	disease inc.	3,01E-09
Ecotoxicity, freshwater	CTUe	1,447
Water use	m^3 depriv.	0,052
Resource use, fossils	MJ	2,253

Table 4–5: Results – bonding of 1 m^2 of fabric

4.1.2 Perforated Fabric

Bonded fabric results were determined with reference to perforated fabrics produced from class 2 dark dyed fabrics (GGR1), which is representative of the perforated fabric produced in 2021.

Impact category	Unit	Perforated Fabric GGR1	
		Up-stream + Core Processes	Downstream
Climate change – Totale	kg CO_2 eq	1,61	3,81E-02
Particulate matter	disease inc.	5,60E-08	2,55E-09
Ecotoxicity, freshwater	CTUe	21,754	3,93E-01
Water use	m^3 depriv.	2,14	1,48E-03
Resource use, fossils	MJ	28,40	5,42E-01

Table 4–6:Results – Perforated Fabric GGR1: up-stream+core processes + downstream processes

It should be noted, however, that perforated fabric may also be produced from light dyed fabrics and fabrics belonging to different grammage classes; for this reason, the impact related to the process was quantified separately. The Table below lists the results for the process expressed per m^2 of fabric.

Impact category	Unit	Results
Climate change – Totale	kg CO_2 eq	0,068
Particulate matter	disease inc.	1,95E-09
Ecotoxicity, freshwater	CTUe	0,494
Water use	m^3 depriv.	0,015
Resource use, fossils	MJ	0,873

Table 4–7:Results – impacts of the process to realize 1 m^2 of perforated fabric

4.1.3 Sensitive Reco

Sensitive Reco results were determined with reference to class 4 facrics, taking into account the different composition in terms of PA6 and Elastane. Should be noted, however, that Reco® fabric may also be made with light dyed fabrics and fabrics belonging to different grammage classes.

Impact category	Unit	Tessuto Sensitive®Reco Up-stream + Core Processes				Downstream
		26% EA 74% PA6	27% EA 73% PA6	32% EA 68% PA6	41% EA 59% PA6	
		- SENSITIVE® UNITO RECO UFD - CLASSIC RECO	- SENSITIVE® PLUS RECO - LIFE RECO	SENSITIVE® FIT NUREL RECO	- SENSITIVE® SCULPT RECO	
		--	- SENSITIVE® SAND RECO	--	- SENSITIVE® SCULPT LIGHT RECO	
Climate change – Totale	kg CO_2 eq	1,95	1,97	2,06	2,23	0,07
Ecotoxicity, freshwater	CTUe	51,538	52,590	57,849	67,309	0,679
Water use	m^3 depriv.	2,65	2,66	2,72	2,82	0,003
Resource use, fossils	MJ	30,49	30,82	32,48	35,47	0,94
Resource use, minerals and metals	kg Sb eq	1,79E-05	1,78E-05	1,73E-05	1,65E-05	1,65E-07

Table 4–8: Results Reco Fabric: up-stream+core processes + downstream processes

4.2 Uncertainty of the results

Table 4-9 shows the results of the uncertainty analysis performed for each of the impact indicators determined with the EF Method (adapted) for class 4 fabrics (i.e., the fabric associated with the most relevant impacts). The uncertainty associated with the results was evaluated by Montecarlo Analysis with a 95% confidence interval. The impact indicator with the lowest standard deviation is GWP_{100}. The impact indicator associated with the highest uncertainty is the "*Water Footprint*" indicator.

Lavorazione	dyed fabric light Color	dyed fabric dark Color	Printed Fabric Ecoprint	Printed Fabric Inkjet	Printed Fabric Traditional
Water use					
Resource use, fossils					
Particulate matter					
Ecotoxicity, freshwater					
Climate change					

>50%	*Very high uncertainty. Unreliable result.*
10%<x<50%	*High uncertainty. Fairly reliable result.*
5%<x<10%	*Acceptable uncertainty. Reliability of the result.*
≤5%	*Low uncertainty. Reliability of the result.*

Table 4-9: Uncertainty analysis - 95% confidence interval – Class 4 traditionally printed fabric

5 OEF results

The following Table shows the most significant results of the OEF study.

Impact category	Unit	Upstream+Core Processes results
Climate change – Total	kg CO_2 eq	37.537.193
Particulate matter	disease inc.	1,32
Ecotoxicity, freshwater	CTUe	589.157.076
Water use	m^3 depriv.	53.552.762
Resource use, fossils	MJ	662.727.212

Table 5–1: OEF study results – Upstream + Site-level Processes