Life Cycle Assessment Study of FITT Force

Summary Report

Revision no. 0 on 15/03/2021

Standard-compliant Life Cycle Assessment Study

ISO 14040:2006/Amd 1:2020 e ISO 14044:2006/Amd 2:202

Sommario

1. General aspects and goal of the study

Company information

FITT, a leading international group founded in Italy in 1969, is a pioneer in the production and development of highly innovative solutions for the passage of fluids for domestic, professional and industrial use. FITT exists to improve the business of its customers by supplying pipes and complete systems in thermoplastic material for the transport of liquid, gaseous and solid substances, with products at the forefront of technology, design and use. From the headquarter in Sandrigo (Vicenza), FITT exports to 87 countries, having a total staff of 910 employees, 9 production sites (6 in Italy and 3 in other countries), 11 logistics sites worldwide and 5 subsidiaries. In 2019, FITT had a turnover of 233 million euros.
In 2019, FITT embarked on a journey to assess the environmental performance of its products through life cycle analysis (LCA), obtaining in early 2020 the EPD for FITT Bluforce and FITT Bluforce RJ products (https://www.environdec.com/Detail/?Epd=17991).

Product information

FITT Force is a lightweight, compact and durable garden hose suitable for both intensive use, perfect for large gardens and irrigation activities; and for everyday, domestic use. The hose is made of vulcanised thermoplastic elastomer material (TPV) and No Torsion System (NTS) polypropylene mesh. The TPV, finished with HD-TECH technology, ensures easy handling, flexibility, high abrasion and puncture resistance, while the NTS mesh prevents knots and kinks. The two materials, TPV and PP, are compatible and, as such, make the product recyclable.
The hose is flat at rest and takes on its classic round shape when in use. When the flow is stopped, it returns to its original size: the water drains away and the product is immediately manageable, compact and easy to store. This feature also has a very positive impact on logistics, as it takes up less space in the warehouse, on the shelves and on the means of transport.
The fittings, made of high quality thermoplastic material with a soft rubber cover for maximum grip even with wet hands, are easily detachable from the hose, facilitating their replacement in case of breakage, thus increasing the useful life of the product and facilitating the correct disposal of the two materials at the end of their life. The multi-jet gun, developed in collaboration with MOMODESIGN Style Centre, stands out for its elegant and modern look. Thanks to its ergonomics, it is extremely precise for professional use. The thumb-operated adjustment lever allows you to modulate the water flow rate, ensuring maximum effectiveness and ease of use.

Study information and goal

This summary report, based on the contents of the technical report “Life Cycle Assessment Study of FITT Force, FITT IKON and FITT NTS” Rev.3 of 26/01/2021, has as its main purpose the external communication of the results obtained from the assessment and quantification of the environmental performance of the following products:

- FITT Force Grey/Lime 15mm 20m Spray 1/4p (hereafter FITT Force 20m (Spray Gun));
- FITT Force Grey/Lime 15mm 40m Spray 1/4p (hereafter FITT Force 40m (Spray Gun));
- FITT Force 5/8" Grey/Lime 15m+NOZZ 1/4PLT (hereafter FITT Force 15m (Mini Nozzle)).

The baseline study was conducted by the Centre for Environmental Quality Studies (CESQA) of the Department of Industrial Engineering at the University of Padua between November 2020 and January 2021 and was subjected to a critical review by SGS Italia S.p.a.

The following standards have been referred to for the conduction of the study and this document:

- ISO 14040:2006/Amd 1:2020 Environmental management - Life cycle assessment - Principles and framework Amendment 1 (ISO 2020)
- ISO 14044:2006/Amd 2:2020 Environmental management - Life cycle assessment - Requirements and guidelines Amendment 2 (ISO 2020)

The results presented in this report refer uniquely to the practices and assumptions of the company and as such have not been calculated to be compared to those of other companies, as differences in methodological choices, assumptions about data quality and choice of databases may produce non-comparable results. The analysis conducted has no comparative purpose.

2. Scope of the study

Functional unit

The functional unit is one metre of hose (and its accessories) used for one year to conduct water for the manual irrigation of vegetable gardens, gardens, terraces or other hobby purposes.

Table 1 Key aspects of the functional unit

Question	Answer
What?	A hose (and relative accessories if expected in the configuration) used to conduct water for the manual irrigation of vegetable gardens, gardens, terraces or other hobby purposes
What quantity?	One metre (measured under operating conditions)
How?	Under operating conditions in line with the product instruction manual
How long?	One year

Table 2 Characteristics of the FITT Force family products analysed and definition of the reference flow

Question	FITT Force 20m (Spray Gun)	FITT Force 40m (Spray Gun)	FITT Force 15m (Mini Nozzle)
What quantity?	20,00 m	40,00 m	15,00 m
How long?	30 years (warranty)	30 years (warranty)	30 years (warranty)
Reference flow	1,667E-03 pcs	8,333E-4 pcs	2,222E-03 pcs

System boundary

The boundaries of the system include the whole life cycle of the analysed product, according to a "from cradle to grave" application, with the exception of the use phase. It should be noted that the construction, maintenance and decommissioning of infrastructures, understood as buildings and machinery, as well as the occupation of industrial land have not been considered, as their contribution to the environmental impact relative to the functional unit is considered to be negligible.

The production process for FITT Force hose starts with raw materials in granule form, which is dehumidified and degassed by drying them at 86°C for three hours before being subjected to the substrate extrusion stage. The extruded substrate is then wound onto a reel and transferred to the knitting and winding processes. This is followed by the second stage of extruding the tube cover, which requires, as with the first extrusion, the drying of the granules. Next, the extruded hose goes through the flattening process and is then wound onto a reel. The final steps are semi-automatic and manual packaging.

The following flows/processes were considered in conducting the study:

- Upstream: production process and transport of raw materials used (including accessories), production process and disposal of the packaging used for their transport, production process of the electricity purchased from the grid, natural gas supply process;
- Core: production of electricity and cooling energy through the trigeneration plant, air emissions from the production process, management of the waste generated during production, production and disposal of auxiliary materials used in production, withdrawal and discharge of water resources, consumption associated with internal handling and other auxiliary activities;
- Downstream: distribution of the finished product, disposal of the product and its packaging.

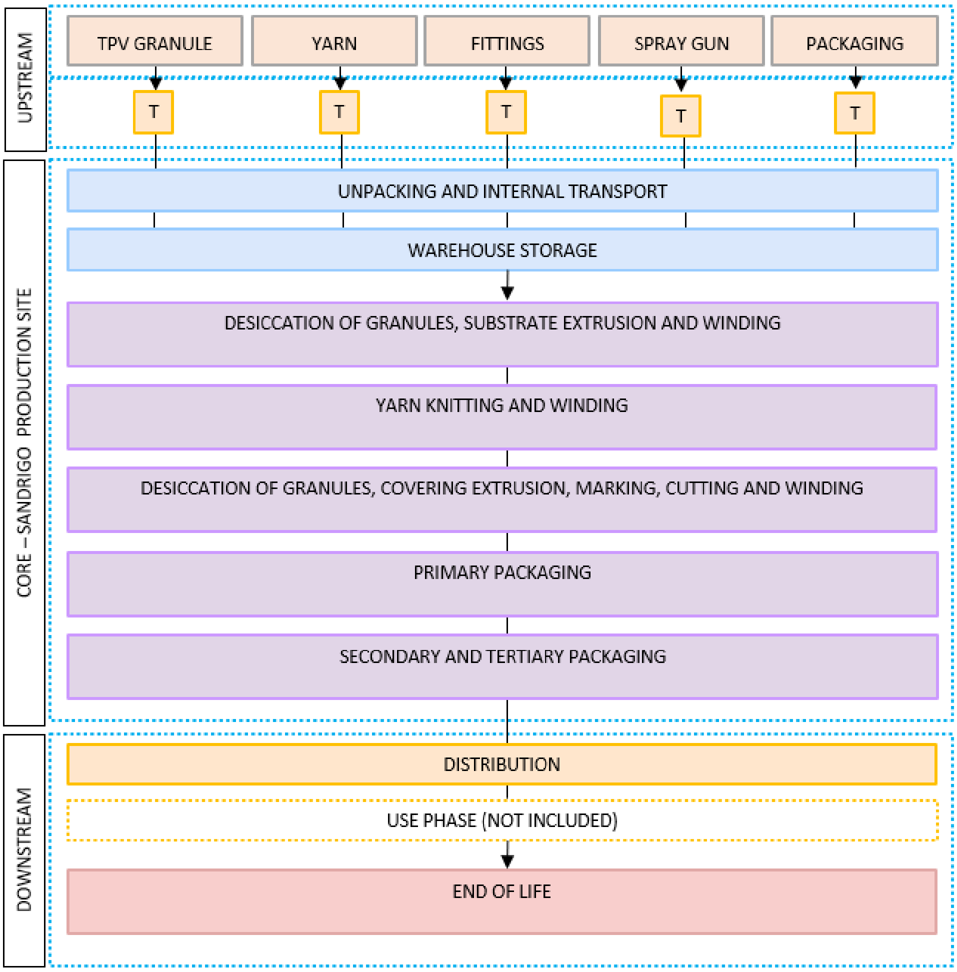

Figure 1 Diagram of the production process for FITT Force family products

Cut off criteria

The criterion chosen for the initial inclusion of inputs and outputs is based on the definition of a 1% cut-off level, both in terms of mass, energy and environmental significance. This means that a process has been neglected if it is responsible for less than 1% of the total mass, primary energy and impact. However, all processes for which data are available have been taken into account, even if they contribute less than 1%. Consequently, this threshold value has been used to avoid collecting unknown data, but not to disregard data that are already available. This choice is confirmed by similar LCA studies reported in the literature (Humbert et al., 2009).

Assumptions and limitations

For the conduction of this study, reference was made to primary data, where available. Where access to this type of data was not possible, datasets from the Ecoinvent v3.5 database (Frischknecht, 2005) were used as reference.
The following were excluded from this study: the construction, maintenance and decommissioning of infrastructure, i.e. machinery and buildings, and the occupation of industrial land (if this information was not already present in the dataset used).

FITT Force was produced on a pilot basis only in 2019, entering full production (in PET yarn configuration) in 2020. The subject of this study refers to the product with PP yarn, which was produced at pilot level in 2020 and will enter full production in 2021. In order to guarantee the robustness of the study, general plant data (plant energy profile, general consumption, waste generated, water consumption) for the whole 2019 were taken as reference, while for specific energy and material consumption of the production line, data collected in the period January – August 2020 were used. Information such as composition and origin of materials, accessories, packaging and distribution scenario is specific to FITT Force. For the definition of the characteristics of the products, reference was made to the BOMs for the year 2020.

The packaging of incoming raw materials has been modelled precisely for granules and accessories, while the packaging in which the materials for packaging the finished product arrive at the plant has been omitted. A proxy dataset was considered for modelling the dyes used in the granule production process. This assumption proved to be irrelevant in the light of the results of the contribution analysis.
At the Sandrigo plant there is no accurate monitoring of the consumption of the refrigeration system supporting the trigeneration plant. An efficiency equivalent to the system in use at the Fara Vicentino plant was therefore considered, for which energy consumption profiles are available. This assumption is based on the technical characteristics of the two plants, which use the trigeneration plant as the main source and the refrigeration machine as support. The consumption profiles of the two machines were considered to be similar as the operating temperatures are comparable. A sensitivity analysis was carried out on the consumption of refrigeration energy, which showed no significant variations (a 20% increase in consumed refrigeration energy is associated with a maximum variation of 2%).

General consumption has been modelled on the basis of data for the year 2019. This assumption is considered valid, as the contribution of this item is always less than 4% and in 2020 there are no changes in the activities taking place at the plant that would lead to significant changes.

3. Life Cycle Inventory Analysis

Data collection procedures

The information- gathering phase was carried out by preparing a sheet collecting input and output data, in terms of mass and energy consumption and emissions in the various environmental compartments for the product analysed.
The data collection sheet was verified and checked by means of mass balance and by reporting any inconsistencies, which were clarified and resolved.
In the choice of data to be used for the LCA study, priority was given to primary data. In particular, the following primary data were used:

- The transport of input materials for the production of the analysed products, as well as auxiliary materials such as accessories and packaging;
- Waste produced during the manufacture of the products analysed (quantity and type) and raw materials used (quantity and type). In particular, process efficiencies (and the related waste generated) are inferred from the ratio between finished product and quantity of discarded hose, data collected on a monthly basis by the company;
- The production process of the starting granules and yarn conducted by the suppliers (material composition, energy consumption);
- The hose extrusion and knitting process at the Sandrigo plant (mass balance, energy consumption and emissions).

The following information has been extracted from specific documents (shown below in brackets) and relates to the products analysed:

- Chemical composition of the raw materials used (bill of materials, technical and safety data sheets, data from suppliers);
- Weights and composition of accessories and packaging materials (accessories design documents and bill of materials).

Where no primary data or models were available for the calculation of such data, secondary data obtained through consultation of internationally recognised databases were used, favouring the use of the most up-to-date ones where possible. In particular, secondary data concern:

- Vehicle combustion processes: emissions, maintenance, road use, fuel consumption (Ecoinvent version 3.5 data sets)
- Electricity: production processes, distribution network (Ecoinvent 3.5 data sets)
- The productions of the materials used (Ecoinvent 3.5 data sets with the exception of Polyoxymetylene used for an accessory, which has been characterised using the specific Industry Data 2.0 database).

Product bill of materials

[information is omitted for confidentiality reasons]

Description of the unit processes

[information is omitted for confidentiality reasons]

Allocation principles and procedures

The need to allocate flows in and out of a product system between the system itself and other external systems maya rise in two cases (Nicholson, et al. 2009) (Toniolo, et al. 2017):

- In the case of simultaneous products, i.e. in the case of production of products and co-products (co-product allocation);
- In the case of subsequent products, i.e. in the case of materials entering a recycling process (end of life allocation/allocation procedure of reuse, recycling, recovery).

In general, almost all industrial processes produce more than one product or recycle waste (Frischknecht 2005). In order to ensure homogeneity in the application of the allocation procedures within the study, the mass of the processed material was chosen as the physical criterion. This choice was considered appropriate as it is considered that the material/energy flows to be allocated (e.g. quantity of waste, packaging materials, energy consumption for handling) are more influenced by mass than by other physical quantities (volume, length).
In this study, the allocation interpreted as "end of life allocation" was applied for the following flows:

- For the waste streams generated at FITT's plants and destined for recycling operations, the impacts associated only with the transport of the waste itself were considered, in line with the end of life allocation methodology called "cut-off" or "recycled content" (Toniolo et al., 2017). Similarly, the same principle was adopted for the characterisation of the finished product stream sent to recycling operations.

Within this study, the procedure of "co-product allocation" (based on mass compared to the total plant production) was adopted to allocate the following impacts:

- Sandrigo plant. The following plant consumptions have been broken down: electricity consumption for general services (such as compressors, pumps and offices), water withdrawals and discharges, diesel consumption, consumption of lubricants, solvents and steel, as well as waste transport and disposal (such as lubricating oils, absorbent materials, steel).

The allocation procedure was also used for the allocation between thermal and electrical energy of the impacts resulting from the cogeneration process.

Data quality assessment

The quality level of the study data was calculated using the formula provided by the PEFCR Guidance (European Commission 2018) which takes into account the weighted average of 4 quality parameters:

- Ter – Technological representativeness: the degree to which the data refer to the technology that is actually used in the process under consideration.
- Gr – Geographic representativeness: the degree to which the data relate to the actual geographical location in which the processes take place.
- Tir – Temporal representativeness: the degree to which data relate to a time frame as current as possible.
- P – Accuracy/Uncertainty: the degree to which data are statistically representative of the processes to which they relate. This principle is ensured by conducting an uncertainty analysis, which assesses the influence of statistical variability in the data on the results of the study.

The calculation was applied to all the contributions that make up the life cycle of the three products, which are: granule, yarn, spray gun, other accessories, primary packaging, other packaging, transport of raw materials, electrical energy, cooling energy, production waste management, other production's consumption, distribution, waste transport and end of life. In accordance with the requirements of PEFCR Guidance v. 6.3, once the most relevant processes had been identified, a score was assigned to each of them for the four parameters (on a scale from 1 to 5, where 1 corresponds to maximum representativeness). For the products analysed, the overall score is 2, which is "good".

4. Life Cycle Impact Assessment

The impact assessment phase involves the use of the results obtained in the previous inventory analysis phase to define the potential impacts that the system under investigation may have on the environment. In accordance with ISO 14040 and ISO 14044 Standards, the assessment phase in this study is limited to the mandatory elements, i.e. the definition of the impact categories, classification and characterisation. It should be noted that, as required by the Reference Standards for conducting LCA studies, the results of the impact assessment are relative expressions and do not include considerations of exceedances of thresholds, safety margins or risks.

The results are presented according to the following life cycle phases:

- **Raw materials (Granules and Yarn):** includes all processes for the production of granules and yarn, as well as the packaging used for their input transport;
- **Raw materials (Accessories):** includes all impacts associated with the production of fittings and guns, as well as the packaging used for their input transport;
- **Raw materials (Packaging):** includes all impacts associated with the production of the final product packaging;
- **Transport:** includes the transport activities of raw materials that take place throughout the life cycle and the distribution of the finished product;

- **Production processes:** this category includes all impacts due to the transformations that take place within the plant, such as energy consumption, waste management, emissions and plant consumption;
- **End of life:** this category covers the end of life of the product and its accessories and packaging, including transport operations.

The analysis of the relationships between the inventory analysis and the impact assessment results is addressed in the analysis of the contributions reported in the interpretation of results section.

Impact Categories

The methodology chosen to assess the potential environmental impacts of the product under study was created in such a way as to include the impact categories classified as *"Core environmental impact indicators"* by the Standard EN 15804 (CEN, 2019). This choice was made in order to ensure consistency between the different studies that the company has carried out and will carry out in the current year for its other products, some of which are aimed at obtaining EPDs. The impact categories analysed are those foreseen by the EN15804+A2 Standard and are listed below:

- Depletion of abiotic resources-elements (kg Sb equiv.) and Depletion of abiotic resources-fossil fuels (MJ). These impact categories concern the protection of human wellbeing, human health and ecosystem health, and the extraction of minerals and fossil fuels.
- Acidification (mol H^+ equiv.). This impact category covers acidifying substances that cause a wide range of impacts on soil, groundwater, surface water, organisms, ecosystems and materials.
- Ozone depletion (kg CFC 11 equiv.). This category covers stratospheric ozone depletion, which can have harmful effects on human health, animal health, terrestrial and aquatic ecosystems, biochemical cycles and materials.
- Climate change (kg CO_2 equiv.). Climate change can cause adverse effects on ecosystem health, human health and material wellbeing. Climate change is linked to greenhouse gas emissions into the air.
- Eutrophication aquatic freshwater (kg PO_4^{3-} equiv), Eutrophication aquatic marine (kg N equiv) and Eutrophication terrestrial (mol N equiv). Eutrophication includes all impacts due to excessive levels of macronutrients in the environment caused by nutrient emissions to air, water and soil.
- Photochemical ozone formation (kg NMVOC eq.). Photochemical ozone formation is the formation of reactive substances (mainly ozone) that are harmful to human health and ecosystems and can also damage crops. This problem is also referred to as 'summer smog'. Winter smog does not fall under this category.
- Water use (m^3 world eq. deprived.) This indicator assesses the potential for deprivation of the water resource, both for humans and ecosystems, based on the assumption that the less water remains available, the more likely it is that an additional user, be it human or an ecosystem, will be deprived of it (Boulay et al., 2016).

Results for FITT Force 20 m (Spray Gun)

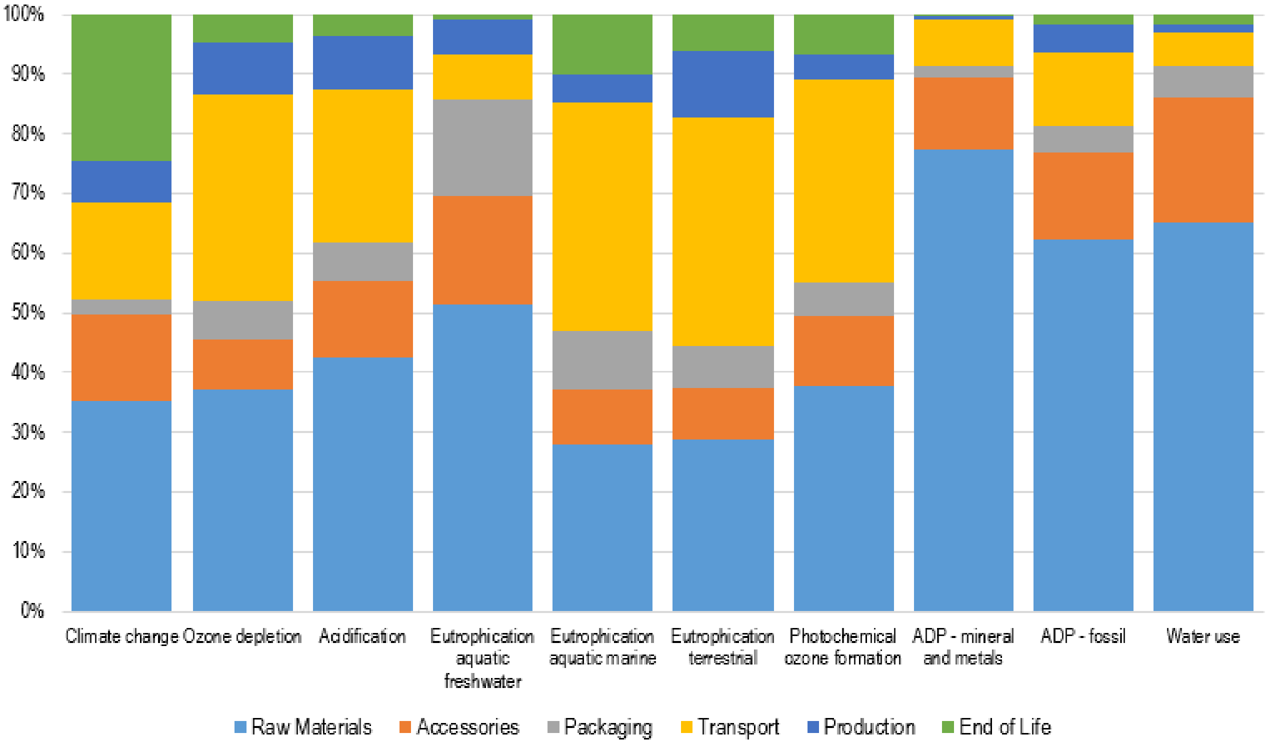

Figure 3 Graphical Impact Assessment Results for FITT Force 20m (Spray Gun)

Table 12 Assessment of impacts (related to the functional unit) by life cycle phases for FITT FORCE 20 m (Spray Gun)

Impact Category	Unit of Measurement	Total	Raw Materials	Accessories	Packaging	Transport	Production	End of Life
Climate change	kg CO2 eq	1,54E-2	5,43E-3	2,23E-3	4,13E-4	2,48E-3	1,08E-3	3,80E-3
Ozone depletion	kg CFC11 eq	1,66E-9	6,18E-10	1,39E-10	1,06E-10	5,72E-10	1,42E-10	7,89E-11
Acidification	mol H+ eq	7,29E-5	3,09E-5	9,44E-6	4,63E-6	1,88E-5	6,46E-6	2,70E-6
Eutrophication aquatic freshwater	kg P eq	2,68E-6	1,38E-6	4,89E-7	4,37E-7	2,05E-7	1,58E-7	1,76E-8
Eutrophication aquatic marine	kg N eq	1,78E-5	4,94E-6	1,67E-6	1,75E-6	6,78E-6	8,31E-7	1,78E-6
Eutrophication terrestrial	mol N eq	1,96E-4	5,63E-5	1,68E-5	1,40E-5	7,46E-5	2,21E-5	1,19E-5
Photochemical ozone formation	kg NMVOC eq	5,93E-5	2,24E-5	6,86E-6	3,34E-6	2,03E-5	2,33E-6	4,02E-6
ADP - mineral and metals	kg Sb eq	9,31E-8	7,20E-8	1,14E-8	1,81E-9	7,12E-9	4,78E-10	3,31E-10
ADP - fossil	MJ	3,05E-1	1,90E-1	4,40E-2	1,35E-2	3,81E-2	1,40E-2	5,12E-3
Water use	m3 depriv.	4,77E-3	3,10E-3	1,01E-3	2,52E-4	2,58E-4	7,75E-5	7,32E-5

Results for FITT Force 40 m (Spray Gun)

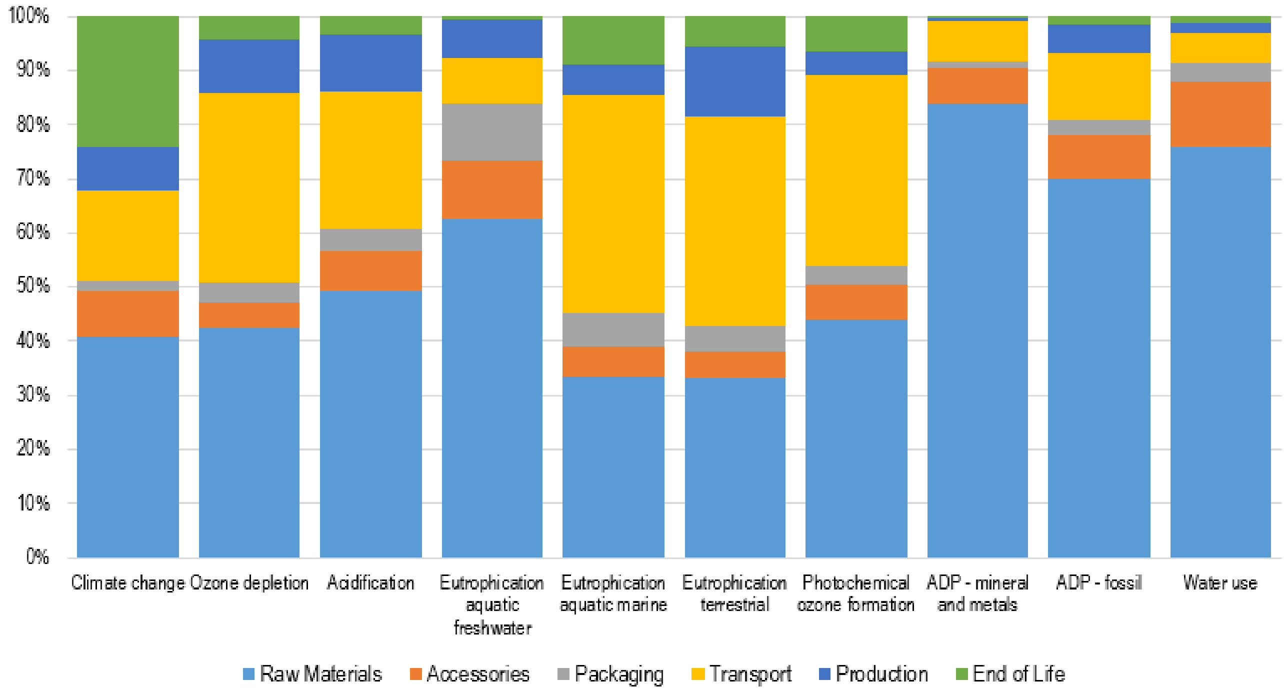

Figure 4 Graphical Impact Assessment Results for FITT Force 40m (Spray Gun)

Table 3 Assessment of impacts (related to the functional unit) by life cycle phases for FITT FORCE 40 m (Spray Gun)

Impact Category	Unit of Measurement	Total	Raw Materials	Accessories	Packaging	Trasport	Production	End of Life
Climate change	kg CO2 eq	1,42E-2	5,80E-3	1,19E-3	2,46E-4	2,36E-3	1,15E-3	3,42E-3
Ozone depletion	kg CFC11 eq	1,56E-9	6,59E-10	7,39E-11	6,00E-11	5,45E-10	1,52E-10	6,75E-11
Acidification	mol H+ eq	6,69E-5	3,30E-5	5,04E-6	2,60E-6	1,71E-5	6,89E-6	2,31E-6
Eutrophication aquatic freshwater	kg P eq	2,35E-6	1,47E-6	2,61E-7	2,46E-7	1,93E-7	1,68E-7	1,50E-8
Eutrophication aquatic marine	kg N eq	1,58E-5	5,27E-6	8,89E-7	9,89E-7	6,35E-6	8,86E-7	1,43E-6
Eutrophication terrestrial	mol N eq	1,80E-4	6,01E-5	8,98E-6	7,85E-6	6,98E-5	2,36E-5	1,02E-5
Photochemical ozone formation	kg NMVOC eq	5,44E-5	2,39E-5	3,66E-6	1,87E-6	1,91E-5	2,49E-6	3,44E-6
ADP - mineral and metals	kg Sb eq	9,15E-8	7,68E-8	6,07E-9	1,02E-9	6,88E-9	5,10E-10	2,89E-10
ADP - fossil	MJ	2,90E-1	2,03E-1	2,35E-2	7,58E-3	3,62E-2	1,49E-2	4,39E-3
Water use	m3 depriv.	4,37E-3	3,31E-3	5,38E-4	1,41E-4	2,46E-4	8,26E-5	5,21E-5

Results for FITT Force 15 m (Mini Nozzle)

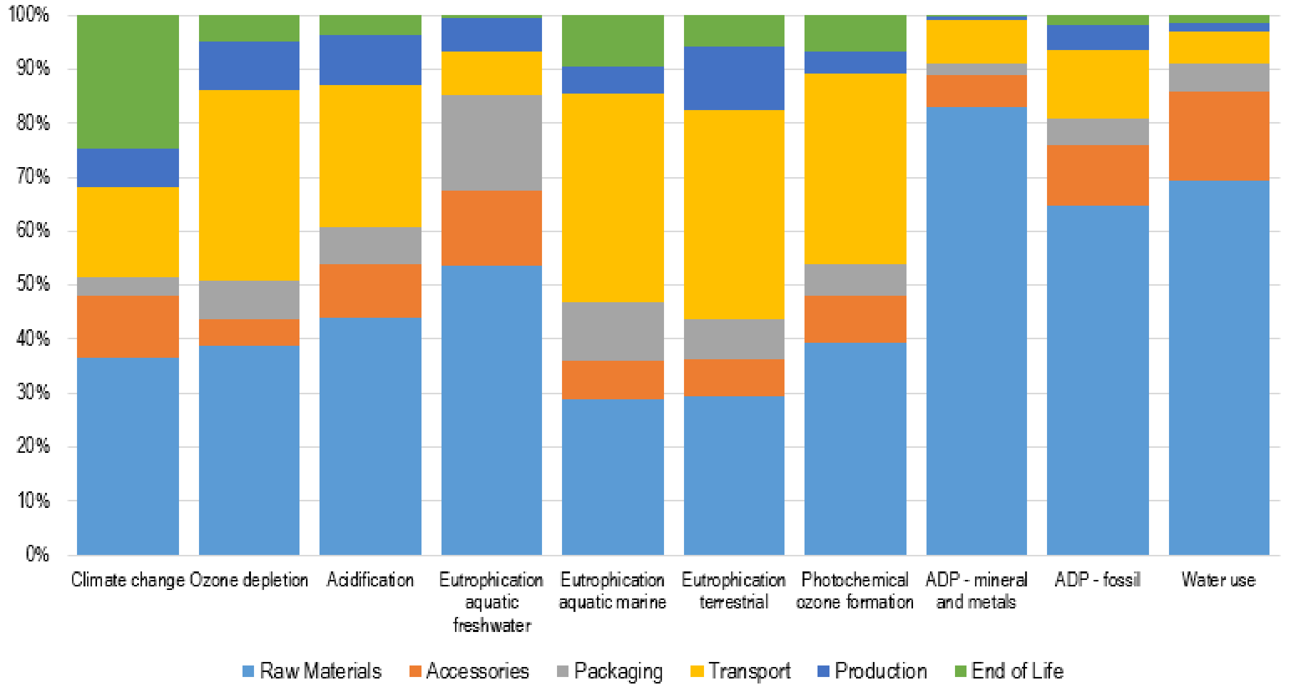

Figure 5 Graphical Impact Assessment Results for FITT Force 15m (Mini Nozzle)

Table 14 Assessment of impacts (related to the functional unit) by life cycle phases for FITT FORCE 15m (Mini Nozzle)

Impact Category	Unit of Measurement	Total	Raw Materials	Accessories	Packaging	Trasport	Production	End of Life
Climate change	kg CO2 eq	1,48E-2	5,43E-3	1,69E-3	5,20E-4	2,45E-3	1,08E-3	3,65E-3
Ozone depletion	kg CFC11 eq	1,59E-9	6,18E-10	7,85E-11	1,11E-10	5,65E-10	1,42E-10	7,64E-11
Acidification	mol H+ eq	7,01E-5	3,09E-5	6,95E-6	4,77E-6	1,84E-5	6,46E-6	2,59E-6
Eutrophication aquatic freshwater	kg P eq	2,56E-6	1,38E-6	3,56E-7	4,56E-7	2,02E-7	1,58E-7	1,68E-8
Eutrophication aquatic marine	kg N eq	1,72E-5	4,94E-6	1,27E-6	1,84E-6	6,67E-6	8,31E-7	1,66E-6
Eutrophication terrestrial	mol N eq	1,90E-4	5,63E-5	1,26E-5	1,45E-5	7,34E-5	2,21E-5	1,14E-5
Photochemical ozone formation	kg NMVOC eq	5,71E-5	2,24E-5	5,07E-6	3,39E-6	2,00E-5	2,33E-6	3,88E-6
ADP - mineral and metals	kg Sb eq	8,66E-8	7,20E-8	4,98E-9	1,85E-9	7,05E-9	4,78E-10	3,20E-10
ADP - fossil	MJ	2,94E-1	1,90E-1	3,31E-2	1,42E-2	3,76E-2	1,40E-2	4,96E-3
Water use	m3 depriv.	4,47E-3	3,10E-3	7,30E-4	2,38E-4	2,55E-4	7,75E-5	6,42E-5

5. Life Cycle Interpretation

In relation to what is defined in the reference standards (ISO 2006a, b) the life cycle interpretation phase consists of analysing the results of the inventory analysis (LCI) and impact assessment (LCIA), including several elements:

- identification of the significant factors;
- evaluation;
- conclusions, limitations, recommendations.

It is important to note that the LCIA results are based on a relative approach and refer to potential environmental impacts.
The study was carried out in order to identify the operations and specific activities with the greatest environmental impact for the product system studied.
As required by the reference standards (ISO, 2006a,b), it should be pointed out that in relation to the objective of the study, the unit chosen proved to be appropriate for the system studied, since it made it possible to identify the operations and specific activities with the greatest environmental impact for the product system studied. The criteria defined for the evaluation of data quality were consistently met. In the light of these considerations, the different elements of the interpretation phase are analysed below.

Contribution analysis

In order to facilitate the interpretation of the results obtained, a detailed analysis of the potential environmental impacts is given below, in order to identify the most relevant processes/materials.

Table 15 Analysis of relevant contributions for FITT FORCE 20 m (Spray Gun)

Contribution	Climate change	Ozone depletion	Acidification	Eutrophication aquatic freshwater	Eutrophication aquatic marine	Eutrophication terrestrial	Photochemical ozone formation	ADP - mineral and metals	ADP - fossil	Water use
Granule	29,8%	36,2%	37,2%	47,9%	23,9%	25,2%	32,8%	76,9%	54,6%	51,1%
Yarn	5,4%	1,1%	5,2%	3,4%	4,0%	3,6%	5,0%	0,4%	7,8%	13,9%
Dyes	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Spray Gun	10,2%	5,9%	9,0%	11,9%	6,4%	5,8%	7,9%	8,7%	9,7%	15,4%
Other Accessories	4,3%	2,5%	4,0%	6,3%	2,9%	2,8%	3,7%	3,5%	4,7%	5,8%
Primary Packaging	0,2%	0,2%	0,4%	0,7%	0,3%	0,3%	0,3%	0,1%	0,4%	0,7%
Other Packaging	2,4%	6,2%	6,0%	15,6%	9,6%	6,8%	5,3%	1,9%	4,0%	4,6%
Raw Material Transport	10,3%	22,0%	17,3%	4,9%	24,8%	24,8%	22,3%	4,8%	8,0%	3,4%
Electricity	5,1%	6,6%	8,1%	5,4%	3,6%	10,2%	2,9%	0,2%	3,8%	1,6%
Refrigeration Energy	1,8%	1,9%	0,7%	0,4%	1,0%	1,0%	1,0%	0,3%	0,8%	0,0%
Waste Management Production	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%

Contribution	Climate change	Ozone depletion	Acidification	Eutrophication aquatic freshwater	Eutrophication aquatic marine	Eutrophication terrestrial	Photochemical ozone formation	ADP - mineral and metals	ADP - fossil	Water use
Other Consumption Production	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,0%	0,1%	0,0%
Distribution	5,8%	12,6%	8,4%	2,7%	13,4%	13,3%	12,0%	2,9%	4,5%	2,0%
Waste Transport	0,0%	0,1%	0,0%	0,0%	0,1%	0,1%	0,1%	0,0%	0,0%	0,0%
End of Life	24,6%	4,7%	3,7%	0,6%	10,0%	6,0%	6,7%	0,3%	1,7%	1,5%

Table 16 Analysis of relevant contributions for FITT FORCE 40 m (Spray Gun)

Contribution	Climate change	Ozone depletion	Acidification	Eutrophication aquatic freshwater	Eutrophication aquatic marine	Eutrophication terrestrial	Photochemical ozone formation	ADP - mineral and metals	ADP - fossil	Water use
Granule	34,6%	41,1%	43,3%	58,3%	28,6%	29,2%	38,1%	83,5%	61,4%	59,6%
Yarn	6,3%	1,2%	6,0%	4,2%	4,8%	4,1%	5,8%	0,4%	8,7%	16,2%
Dyes	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Spray Gun	5,9%	3,3%	5,2%	7,3%	3,9%	3,4%	4,6%	4,7%	5,5%	9,0%
Other Accessories	2,5%	1,4%	2,3%	3,8%	1,8%	1,6%	2,1%	1,9%	2,6%	3,4%
Primary Packaging	0,1%	0,1%	0,2%	0,4%	0,2%	0,2%	0,2%	0,0%	0,2%	0,4%
Other Packaging	1,6%	3,7%	3,7%	10,1%	6,1%	4,2%	3,2%	1,1%	2,4%	2,8%
Raw Material Transport	11,3%	23,7%	17,8%	5,6%	27,5%	26,5%	24,0%	5,0%	8,5%	3,8%
Electricity	5,9%	7,4%	9,5%	6,6%	4,3%	11,8%	3,3%	0,2%	4,2%	1,9%
Refrigeration Energy	2,1%	2,2%	0,8%	0,5%	1,2%	1,2%	1,2%	0,4%	0,9%	0,0%
Waste Management Production	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Other Consumption Production	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,0%	0,1%	0,0%
Distribution	5,4%	11,3%	7,8%	2,6%	12,7%	12,2%	11,1%	2,5%	4,0%	1,8%
Waste Transport	0,0%	0,1%	0,0%	0,0%	0,1%	0,1%	0,1%	0,0%	0,0%	0,0%
End of Life	24,1%	4,3%	3,4%	0,6%	9,0%	5,6%	6,3%	0,3%	1,5%	1,2%

Table 17 Analysis of relevant contributions for FITT FORCE 15 m (Mini Nozzle)

Contribution	Climate change	Ozone depletion	Acidification	Eutrophication aquatic freshwater	Eutrophication aquatic marine	Eutrophication terrestrial	Photochemical ozone formation	ADP - mineral and metals	ADP - fossil	Water use
Granule	31,0%	37,7%	38,8%	50,1%	24,6%	25,9%	34,0%	82,7%	56,6%	54,6%
Yarn	5,7%	1,1%	5,4%	3,6%	4,1%	3,7%	5,2%	0,4%	8,1%	14,8%
Dyes	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Spray Gun	5,5%	1,5%	4,4%	5,1%	3,3%	2,8%	3,8%	0,7%	4,7%	8,1%
Other Accessories	5,9%	3,5%	5,5%	8,8%	4,0%	3,8%	5,1%	5,0%	6,5%	8,2%
Primary Packaging	0,3%	0,1%	0,2%	0,4%	0,2%	0,2%	0,2%	0,0%	0,4%	0,3%
Other Packaging	3,2%	6,9%	6,6%	17,4%	10,5%	7,4%	5,7%	2,1%	4,4%	5,0%
Raw Material Transport	10,7%	22,8%	17,7%	5,1%	25,4%	25,3%	23,0%	5,1%	8,2%	3,7%
Electricity	5,3%	6,8%	8,5%	5,6%	3,7%	10,5%	3,0%	0,2%	3,9%	1,7%
Refrigeration Energy	1,9%	2,0%	0,7%	0,4%	1,1%	1,0%	1,0%	0,4%	0,8%	0,0%
Waste Management Production	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Other Consumption Production	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,0%	0,1%	0,0%
Distribution	5,9%	12,7%	8,5%	2,7%	13,4%	13,3%	12,1%	3,0%	4,6%	2,0%
Waste Transport	0,0%	0,1%	0,0%	0,0%	0,1%	0,1%	0,1%	0,0%	0,0%	0,0%
End of Life	24,6%	4,7%	3,7%	0,6%	9,6%	5,9%	6,7%	0,4%	1,7%	1,4%

Sensitivity Analysis

In order to consolidate the results and conclusions of the LCA study, four sensitivity analyses were carried out:

1. Alternative scenario for the destination of FITT Force waste. In the base case production waste is destined for recycling operations, while in the alternative case waste is destined for disposal (landfill/incineration);
2. Evaluation of the effect on the final results of a 20% increase in cooling energy consumption;
3. In the base case it is assumed that all withdrawn water is discharged, while in the alternative case 20% evaporation is assumed;
4. In the base case EURO 3 vehicles are used for the distribution of the finished product, in this sensitivity analysis they are replaced by EURO 4 vehicles.

The results obtained show that the assumptions made do not affect the goodness of the results obtained, with variations always lower (in absolute terms) than 5%.

Uncertainty Analysis

This analysis was conducted in order to identify the level of uncertainty related to the data used on the final results of the study. This analysis was conducted using the Monte Carlo method. The results obtained demonstrate a good reliability of the data used, with Coefficients of Variation (CVs) below 23% in all impact categories, with the exception of the categories Eutrophication aquatic freshwater (42%), Ozone depletion (32%) and Water Scarcity (due to the high uncertainty of the applied method).

6. Conclusions

FITT has decided to use the LCA (Life Cycle Assessment) methodology according to the international standards ISO 14040 and ISO 14044 to assess the potential environmental impacts associated with 3 product codes, belonging to the FITT Force family of garden hoses.
The objective of the study is to provide results that can support the company in identifying the main sources of impact, as well as support the external communication of the results themselves, once the critical review has been carried out by an independent third party.
For the inventory analysis, company-specific data referring to the Sandrigo plant were collected. Where primary data were not available, the Ecoinvent v.3.5 database was used.
In order to guarantee the robustness of the study, the data (energy consumption and process yield) of the production lines involved in similar products and considered as representative were taken as reference. It should be noted, however, that the characteristics of the hoses such as: types of granule and yarn, characteristics of the accessories and packaging are specific to the products under study. The specific data such as energy consumption and yield of the processes of the specific lines refer to the period January - August 2020. For general plant data (e.g. energy mix, efficiency of the cogeneration system, auxiliary energy consumption) reference was made to the last calendar year for which overall data is available (2019). Product characteristics were defined on the basis of the 2020 BOMs.
The results of the study show that, for the products studied, the impacts derive mainly from the production processes of the raw materials, and to a lesser extent from the energy consumption of the production processes and the transport processes of the raw materials and the finished product.
The sensitivity analyses carried out allowed us to verify that the assumptions adopted in the modelling phase do not have significant repercussions on the final results.
The uncertainty analysis carried out using the Monte Carlo method made it possible to identify the categories for which the results are most uncertain and which require greater caution in their use and interpretation. These data, although characterised by their uncertainty, can be considered valid for the achievement of the objectives set by the company.
It should be noted that the results of the study assume a relative value, are valid in relation to the assumptions made and the choice of the system and are not intended for comparative purposes.

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