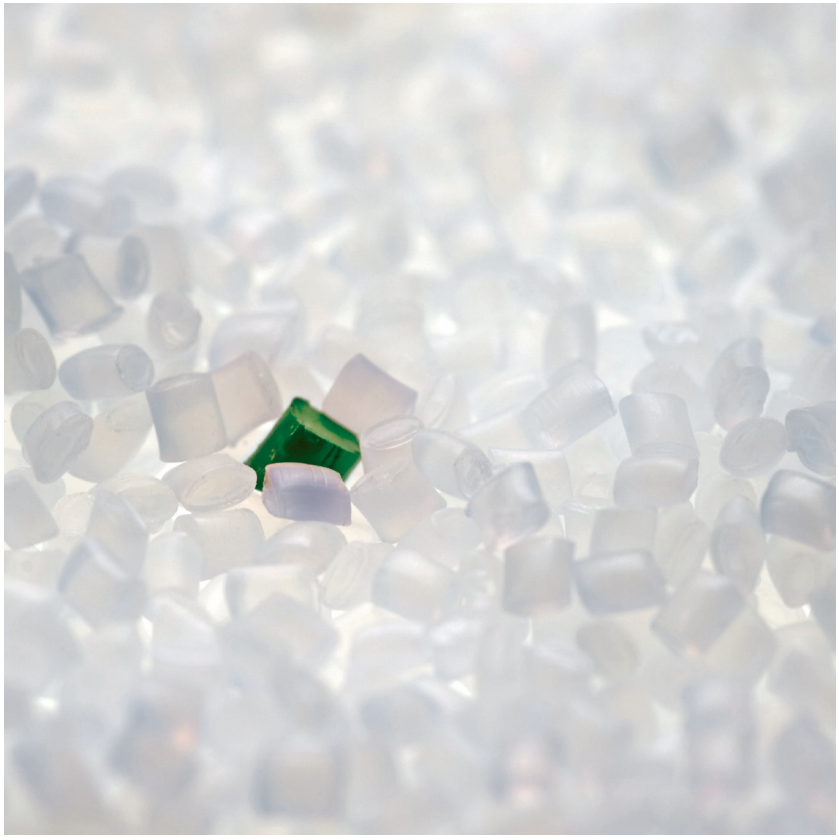
HIGH PERFORMANCE POLYMERS



EPD®

ENVIRONMENTAL PRODUCT DECLARATION

in accordance with ISO 14025:2006.

POLYAMIDE SCRAP RECOVERY SERVICE

Registration:	**No. S-P-00708**
Date of publication:	**2015 April 30**
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CPC Code	**8942**
PCR	**2013:08 vers. 2.13**

RADICI GROUP

POLYAMIDE SCRAP RECOVERY SERVICE

Programme

The International EPD® System

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Accountabilities for PCR, LCA and independent, third-party verification

Product Category Rules (PCR):
PCR 2013:08 Plastic waste and scrap recovery (recycling) services, version 2.13 UN CPC 8942.

PCR review conducted by:
The International EPD® System Technical Committee
Chair: Lars-Gunnar Lindfors
Contact at info@environdec.com

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:
☒ EPD verification by EPD Process Certification ☐ External

Internal auditor:
Paolo Simon-Ostan

Third-party verification:
CERTIQUALITY S.r.l. - Istituto di Certificazione della qualità - Milan, Italy

Third-party verifier is accredited by:
ACCREDIA - Accreditation No.: 0008PRD

Procedure for follow-up of data during EPD validity involves third-party verifier:
☒ Yes ☐ No

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EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

The Group

Radici Novacips SpA is the headquarters of the **RadiciGroup** High Performance Polymers Business Area – a multinational organization with the capacity **to manufacture and supply engineering polymers** (based on polyamide, polyester and other materials) around the globe, with the backing of a production and sales network across all continents, as well as research and development increasingly focused on high-performance polymers.

With eight production plants – strategically located in in Italy, Germany, Brazil, the USA, Mexico, China and India – and a worldwide sales network, RadiciGroup High Performance Polymers provides high-quality product standards on a global scale, besides offering state-of-the-art support in research & development and processing technologies. Through its Computer Aided Engineering services, RadiciGroup can provide customers with technological support in applications development and in the design of products with greater environmental sustainability.

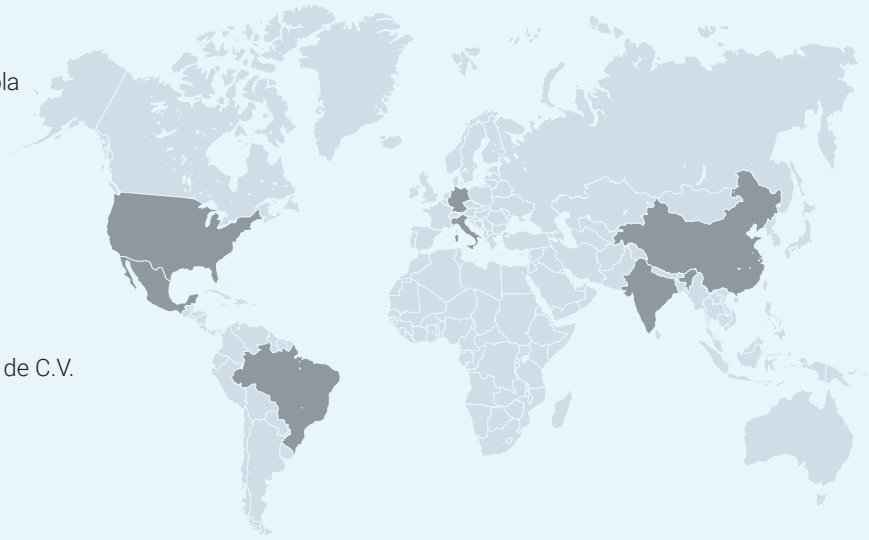
RadiciGroup High Performance Polymers is a vertically integrated compounder, whose strengths range from the independent management of its whole production chain, from primary polyamide production to the manufacture of primary and industrial-grade engineering plastics, i.e., plastics produced from secondary PA6/66, obtained through the plastic waste and scrap recovery service at the Radici Novacips plant in Chignolo d'Isola.
The Chignolo d'Isola plant was started in the 1980s with the objective of recovering plastic waste and scrap generated by the other Group companies. Over the years, the rising interest of target markets in recovered and reused materials has allowed the company to exploit its experience and process optimization technologies developed in the field of plastics recovery and recycling. Today Radici Novacips has the competence and technologies needed to run its plastics recovery and engineering plastics manufacturing operations simultaneously. RadiciGroup High Performance Polymers is vertically integrated and has control over its entire production chain, including the recovery of plastic waste and scrap generated by the Group plants upstream. Waste and scrap are sorted, mechanically ground by qualified suppliers and extruded at the Chignolo d'Isola plant, where all the material recovered is used to manufacture the products of the Renycle® range and other grades that use this feedstock.

The plant is certified to ISO 14001 and ISO 45001, in addition to ISO 9001; the entire recovery process is carried out under proper environmental, health and safety management control, using only hydropower energy.

Production sites

RadiciGroup High Performance Polymers has production sites in:

- **ITALY**
  RADICI NOVACIPS SpA Villa d'Ogna
  RADICI NOVACIPS SpA Chignolo d'Isola
- **GERMANY**
  RADICI PLASTICS GmbH
- **BRAZIL**
  RADICI PLASTICS Ltda.
- **The USA**
  RADICI PLASTICS USA Inc.
- **MEXICO**
  RADICI PLASTICS MEXICO S. de R.L. de C.V.
- **CHINA**
  RADICI PLASTICS (Suzhou) Co., Ltd.
- **INDIA**
  RADICI PLASTICS INDIA PVT. LTD.



The products covered in this Environmental Product Declaration (EPD) are manufactured at the Radici Novacips SpA - Via Bedeschi, 20 - 24040 Chignolo d'Isola (BG) - Italy plant.

Recovery technology

The treatment considered in this EPD is commonly applied to polyamide 6 and 66 scraps and consists of both pre- treatment – cutting and/or grinding – and a final extrusion process that outputs a product in granular form, also called "cips", suitable for use in compounding.

Grinding, outsourced to authorized companies, is often the only process performed on the material, which then ceases to be legally considered "waste" and becomes commercially available as secondary material, although still needing to undergo extrusion for its complete recovery and reuse as a final product. In this physical form (small irregular flakes of various sizes), the material may not be suitable for processing in all types of extrusion plants. Indeed, the technological characteristics of extruders do not always allow them to process materials having irregular or not perfectly homogeneous sizes and shapes.

Not only does the Radici Novacips plant at Chignolo d'Isola have the right extrusion technology, but it can also perform further processing. The plant can complete the recovery process and produce secondary raw material suitable for use as a replacement of primary polymer for the production of engineering plastics. Recovery extrusion and production compounding can also occur at the same time.

The Radici Novacips case, as described above, is typical and unique at the same time. Typical, because it uses mechanical treatment, which is the most widespread method in the field of plastics recovery, and, unique, because Radici Novacips' experience, expertise and production chain synergies allow for running its recovery operations and production process even simultaneously.

RadiciGroup High Performance Polymers' production activities are part of a vertically integrated production chain, in which polymer 66 from Radici Chimica and polymer 6 from RadiciFil and Radici Yarn are the inputs for the production of the Radilon® product range while waste and scrap from polymerization, spinning and compounding are used to manufacture the Renycle® and other compounds that use this secondary raw material.

The purpose of this EPD is to clarify some aspects of the process, by sharing the information and the knowledge that RadiciGroup High Performance Polymers has acquired in the course of over thirty years of experience in managing the entire plastics production chain. This information is intended for whoever wants to understand the environmental contribution from the recycling and re-use of post-industrial plastic waste and scrap for the production of secondary raw materials to be used in the manufacture of second-generation engineering plastics.

Sorting criteria

The recovery service covered in this EPD is concerned with polyamides (PA6 and PA66) of industrial origin. So-called post-industrial waste consists of material that has never been fully processed into a commercially available product. Post- industrial waste includes scrap from polymerization, extrusion, and processing.

On the other hand, post-consumer waste comprises goods sold commercially to consumers that have fulfilled the intended purpose for which they were manufactured and have been disposed of (automobiles, household appliances, furnishings, etc.). In the case of collected polyamide obtained from post-consumer sources, after the separation and sorting of the various components of the goods, the waste arrives for treatment in a condition comparable to that of post-industrial waste.

For over thirty years, waste material (scrap and by-products) generated by other Group companies and associated companies has been recovered and used for the production of engineering plastics at the Radici Novacips Chignolo d'Isola plant.

At Radici Novacips, the available extrusion technology, the acquired experience and know-how, and the availability of waste through the Group production chain create an opportunity for the best use of a "simple" and widely recognized technology to obtain secondary raw materials suitable for use in the manufacture of materials with consistent performance characteristics. These materials are usually targeted at industries, such as automotive, which require exacting performance characteristics.

The geographical scope of the Declaration is Europe.

Service technical specifications and recycled content

The recovery service produces a semi-finished product, which is solely used at the Chignolo d'Isola plant for the production of compounds in the Renycle® family and in other materials that use this feedstock. Technical characteristics are not evaluated at this stage, but only at the completion of the production cycle for the commercially available item. Likewise, the recycled content is disclosed in the specifications of the commercially available product, the last stage of the production cycle.

Recycling yield: 98%. The environmental performance of the recovery service will be expressed in declared units, as required by the PCR.

The feedstock energy, in in the case of material subject to end-of-life energy recovery, is 34,2 MJ per kg of PA6 and 31 MJ per kg of PA66 (source: Plastics Europe).

Environmental performance assessment

Product environmental performance was assessed using the Life Cycle Assessment (LCA) method, from the extraction of the raw materials to the distribution of the finished product. The study was conducted in accordance with the ISO 14040 standard and the product category rules set forth in PCR 2013:08 v.2.13 PLASTIC WASTE AND SCRAP RECOVERY (RECYCLING) SERVICES, approved by the International EPD® System technical committee.

The version used for the list of environmental performance indicators is the 2.0 and the calculation is in accordance with EF 3.1 and EN15804.

Declared unit

The declared unit is the recovery/recycling of 1000 kg of plastic waste and/or scrap in bulk form as collected, before any treatment.

General system boundaries

The system boundaries are illustrated in the Figure below and comprise the waste collection processes (upstream processes) and the pre-treatment and advanced treatment processes (core processes) of the material. Storage and packaging of the final product have been excluded from the post-production processes (down-stream processes), as the material obtained is used entirely for the production of engineering plastics at the plant.

The definition of the system boundaries follows the rules established in the relevant PCR document.

Upstream processes include:

- Maintenance materials production

The other upstream processes defined in the PCR (such as virgin raw material production and additive production) do not apply to the process under consideration, because they are not directly involved in the plastic scrap recovery service

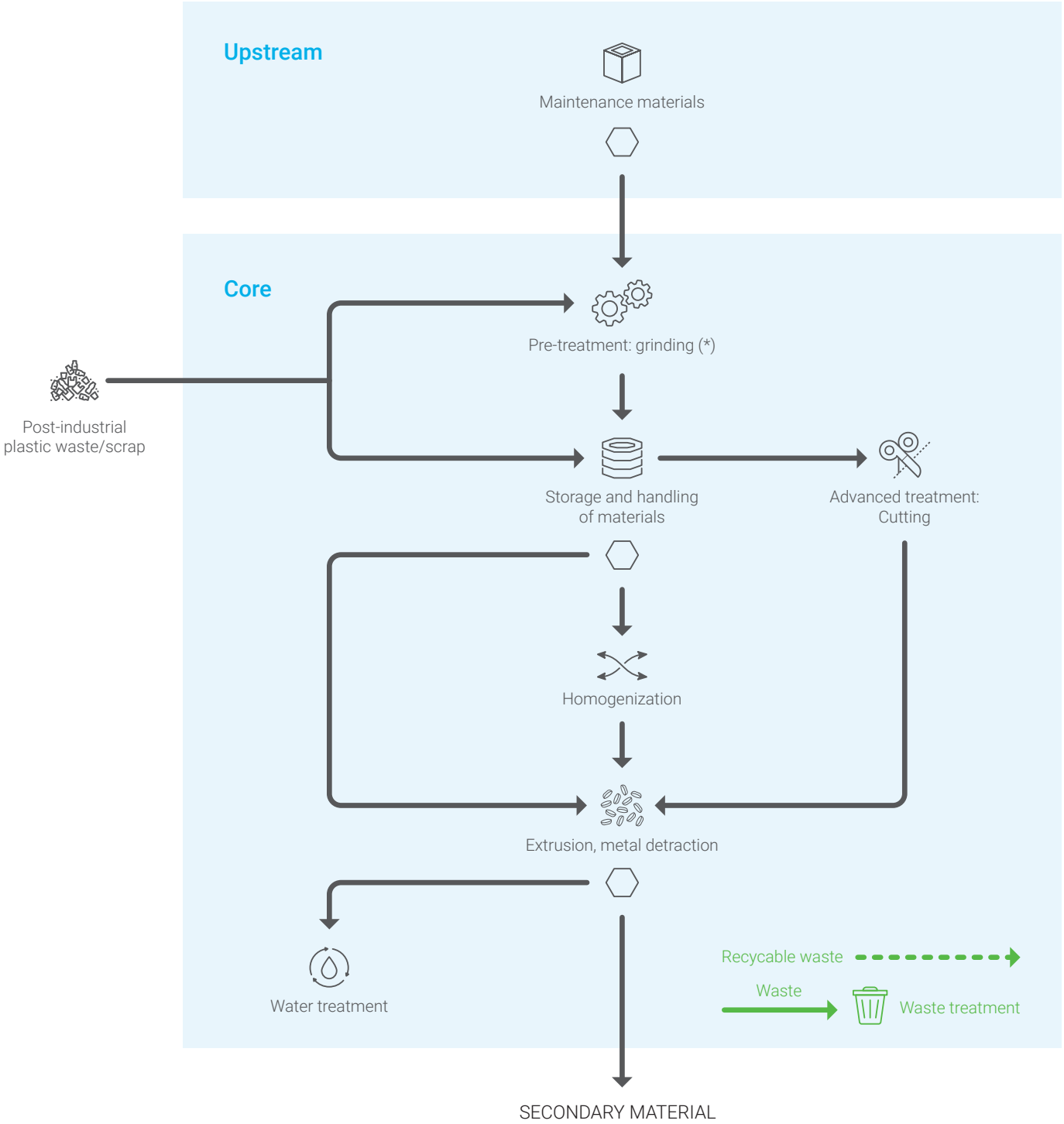
Production processes (core processes) include:

- Grinding (outsourced) or cutting
- Transportation of materials from the pre-treatment site (if needed) Internal storage and handling of materials
- Homogenization (if needed) Extrusion and pelletizing
- Auxiliary extrusion processes (e.g., water treatment)

Product packaging does not apply to the service under consideration, because the material is entirely and solely used at the Radici Novacips Chignolo d'Isola plant as secondary raw material for the manufacture of engineering plastics, and thus packaging is not required.

Likewise, the system boundaries do not include post-production processes (downstream processes), and in particular do not include the recycled material distribution phase, since the material is entirely used as secondary raw material for the production of the engineering plastics in the Renycle® family and in other grades that use this feedstock.

System boundaries



Cut-off rules

In compliance with the provisions of the relevant PCR, data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts are included.

Data quality

The data quality rules followed for this EPD are those defined in the relevant PCR. In accordance with such rules, use was made of both specific data gathered directly from the plastic treatment and recovery sites during the year 2022 and generic data extracted from the commercial database in Simapro v 9.5.0.1 (Ecoinvent 3.9.1).

Service environmental profile

Below is reported the product environmental profile of the scrap recovery service. The data reported relate to the process for the recovery of 1000 kg of waste and scrap as collected, prior to any treatment, broken down into the pre-treatment phase (upstream processes) and the treatment phase (core processes).

Environmental impacts

IMPACT CATEGORY		UNIT	TOTAL	UPSTREAM	CORE
Global warming (GWP100a)	Fossil	kg CO_2 eq	6.90E+01	6.03E+00	6.30E+01
	Biogenic	kg CO_2 eq	4.34E-01	6.00E-02	3.74E-01
	Land use and land use change	kg CO_2 eq	3.15E-02	6.33E-03	2.51E-02
	TOTAL	kg CO_2 eq	6.95E+01	6.10E+00	6.34E+01
Acidification potential (AP)		mol H^+ eq.	3.33E-01	3.19E-02	3.01E-01
Eutrophication potential (EP)	Freshwater	kg P eq.	1.97E-02	2.24E-03	1.74E-02
	Marine	kg N eq.	1.71E-01	6.13E-03	1.65E-01
	Terrestrial	mol N eq.	1.01E+00	6.21E-02	9.49E-01
Photochemical ozone creation potential (POCP)		kg NMVOC eq.	3.49E-01	2.17E-02	3.27E-01
Ozone depletion potential (ODP)		kg CFC 11 eq.	1.92E-06	8.03E-08	1.84E-06
Abiotic depletion potential (ADP)*	Minerals and metals	kg Sb eq.	2.79E-04	1.25E-04	1.54E-04
	Fossils resources	MJ	8.89E+02	7.20E+01	8.17E+02
Water depletion potential (ODP)*		m^3 world eq. deprived	9.78E+00	1.03E+00	8.75E+00

* Disclaimer: the results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.

Use of resources and other indicators

PARAMETER		UNIT	TOTAL	UPSTREAM	CORE
Primary Energy Resources - Renewable	Used as energy carrier	MJ	2.52E+03	1.47E+01	2.51E+03
	Used as raw material	MJ	8.11E+00	2.18E+00	5.93E+00
	TOTAL	MJ	2.53E+03	1.69E+01	2.51E+03
Primary Energy Resources - Non Renewable	Used as energy carrier	MJ	9.51E+02	7.66E+01	8.74E+02
	Used as raw material	MJ	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ	9.51E+02	7.66E+01	8.74E+02
Secondary Material		kg	1.00E+03	0.00E+00	1.00E+03
Renewable secondary fuels		MJ	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels		MJ	0.00E+00	0.00E+00	0.00E+00
Water consumption		m^3	3.02E-01	4.24E-02	2.60E-01

Waste production

WASTE	UNIT	TOTAL	UPSTREAM	CORE
Not-hazardous waste disposed	kg	5.82E+01	5.18E+00	5.31E+01
Hazardous waste disposed	kg	4.52E-03	2.01E-04	4.32E-03
Radioactive waste* disposed	kg	8.36E-04	1.44E-04	6.92E-04

* RadiciGroup DOESN'T use radioactive materials or additives, and DOESN'T manage processes that could, directly or undirectly, produce radioactivity or radioactive leftovers. The item reported is attributable EXCLUSIVELY to the share of waste allocated to the nuclear part of national electricity energy mix, used for absolutely independent processes from RadiciGroup production and its suppliers.

Output flows

PARAMETER	UNIT	TOTAL	UPSTREAM	CORE
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	5.02E+01	0.00E+00	5.02E+01
Materials for energy recovery	kg	2.43E+00	0.00E+00	2.43E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00

Differences versus to the previous version

All the primary data used refer to the year 2022 and the environmental impact indicator are in accordance with EF 3.1 and EN15804 (version 2.0 of the default list of indicators).There is a marginal increase in the overall impact assessment, mainly due to the transportation from outsourced pre-treatment phase.

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