GlobalEPD
A VERIFIED ENVIRONMENTAL DECLARATION

AENOR

Environmental Product Declaration

UNE-EN ISO 14025:2010
UNE-EN15804:2012+A2:2020/AC:2021

Crumb rubber modified bitumens

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The holder of this declaration is responsible for its contents and for preserving the supporting documentation that substantiates the data and statements included therein during the validity period.

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AENOR is a founding member of ECO Platform, the European Association of Verification Programmes for Environmental Product Declarations

European Standard EN 15804:2012+A2:2020/AC:2021 serves as the basis for the EPD
Independent verification of the Declaration and data, according to Standard EN ISO 14025:2010 ☐ Internal ☒External
Verification body AENOR Product certification body accredited by ENAC under accreditation Nº 1/C-PR468

1. GENERAL INFORMATION.

1.1. The organisation.

The holder of this Environmental Product Declaration (EPD) is **RLESA.**

Repsol is a global company that seeks people's well-being and takes a proactive role in building a better future through the development of smart energy solutions. It is an integrated and broadly diversified company, spanning from traditional businesses such as exploration, refining, and the sale and distribution of fuels, to others like LPG (a global leader) and new energies (e.g., wind power).

Repsol Lubricantes, Aviación, Asfaltos y Especialidades, S.A. (RLESA) is one of the companies in the Repsol group, responsible for developing, producing, and marketing lubricants and specialties, as well as asphalt bitumen and related derivatives.

1.2. Scope of the Declaration.

This Environmental Product Declaration describes the environmental information related to the life cycle of bitumens with crumb rubber from end-of-life tyres produced by RLESA in 2022 at its production plant in Puertollano (Ciudad Real, Spain).

The primary function of these products is to act as a binder and provide cohesion to bituminous asphalt mixes, being the main determinant of their properties.

The results presented reflect the environmental performance of the average bitumen with crumb rubber from end-of-life tyres. The scope of this Environmental Product Declaration (hereinafter, "EPD") is cradle-to-gate with options, including end-of-life (modules C1–C4) and benefits and loads beyond the system boundary (module D), i.e., A1–A3, C, and D.

1.3. Lyfe-cycle and compliance.

This EPD has been developed and verified in accordance with UNE-EN ISO 14025:2010 and UNE-EN 15804:2012+A2:2020/AC:2021, "Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products."

Table 1. PRODUCT CATEGORY RULES	
Descriptive title	Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products
Reference code & version	UNE-EN 15804:2012+A2:2020/AC:2021
Publication date	2021
Program operator	AENOR

This Environmental Product Declaration includes the following life cycle stages:

Table 2. System boundaries — Information modules considered

Products stage	A1	Raw material supply	X
	A2	Transport to factory	X
	A3	Manufacturing	X
Construction	A4	Transport to site	MNE
	A5	Installation/construction	MNE
Use stage	B1	Use	MNE
	B2	Maintenance	MNE
	B3	Repair	MNE
	B4	Replacement	MNE
	B5	Refurbishment	MNE
	B6	Operational energy use	MNE
	B7	Operational water use	MNE
End of life	C1	Deconstruction/demolition	MNE
	C2	Transport	MNE
	C3	Waste processing	MNE
	C4	Disposal	MNE
	D	Potential for reuse, recovery and/or recycling	MNE

X =Module included in the LCA; NR = Module not relevant;MNE = Module not evaluated

This EPD may not be comparable with those developed under other Programs or in accordance with different reference documents.

Likewise, EPDs may not be comparable if the data sources differ (e.g., databases), if all relevant information modules are not included, or if they are not based on the same scenarios.

Comparison of construction products shall be made for the same function, using the same functional unit and at the building—or at the level of architectural, engineering, or civil works—, that is, including the product's performance over its entire life cycle—as well as the specifications in Clause 6.7.2 of Standard UNE-EN ISO 14025:2010.

2. THE PRODUCT.

2.1. Identification of the product.

Repsol, in its ongoing drive for innovation and focus on environmental improvement, has developed a proprietary technology to use rubber from end-of-life tyres (ELT) that enhances certain properties of conventional penetration-grade bitumens and yields properties similar to polymer-modified bitumens.

These bitumens (CPC 33500) offer not only technical advantages but also significant environmental benefits by helping to avoid landfilling of ELT.

Bitumens produced with this technology can be regarded as intermediate between conventional bitumens and polymer-modified bitumens.

In compliance with the specifications set out in OC 21/2007 (on the use and specifications for binders and asphalt mixes incorporating rubber from ELT) and OC 21bis/2009 (on rubber-enhanced bitumens and high-viscosity rubber-modified bitumens from ELT, including criteria for in-situ manufacture and on-site storage), RLESA employs an industrial wet-process manufacturing route that ensures traceability, quality, and the required digestion times.

The stability and homogeneity of the final product have been achieved through this specific process and the use of pre-selected bitumens, resulting in the following product range: Rubber-Enhanced Bitumens, Rubber-Modified Bitumens, and High-Viscosity Rubber-Modified Bitumen.

2.2. Intended use of the product.

The main applications of bitumens with crumb rubber from end-of-life tyres are in the manufacture of asphalt mixtures, in accordance with the provisions of the road standard PG-3 (General Technical Specifications for Road and Bridge Works).

2.3. Product composition.

The following table shows the main components of the product.

Table 3. Product composition

Substance/Component	Content	Units
Bitumen	90-95	%
ELT crumb rubber	5-10	%

None of the raw materials used to produce this product are included on the Candidate List of Substances of Very High Concern (SVHC) for authorisation or are otherwise regulated.

2.4. Product performance.

Those described in OC 21/2007 and OC 21bis/2009 for products manufactured at RLESA’s facilities.

3. LCA INFORMATION

3.1. Life cycle assessmet.

The study "LCA Report for conventional bitumen, polymer-modified bitumen, bitumen with crumb rubber from end-of-life tyres, and bituminous emulsions — REPSOL. V2," which underpins this EPD, was prepared by ReMa-INGENIERÍA, S.L. using data provided directly by RLESA for its bitumens with crumb rubber from end-of-life tyres, produced in 2022 at its production plant in Puertollano (Ciudad Real, Spain).

The life cycle assessment (LCA) on which this declaration is based was carried out in accordance with UNE-EN ISO 14040:2006 (and UNE-EN ISO 14040:2006/A1:2021), UNE-EN ISO 14044:2006 (and UNE-EN ISO 14044:2006/A1:2018 and UNE-EN ISO 14044:2006/A2:2021), and UNE-EN 15804:2012+A2:2020 (and UNE-EN 15804:2012+A2:2020/AC:2021).

The LCA was performed with the support of SimaPro software version 9.6.0.1 and the Ecoinvent 3.10 (2023) database.

For the asphalt plants in Spain, the electricity supplier is Repsol Comercializadora de Electricidad y Gas, S.L.U., and the 2022 remaining energy mix published by the CNMC has been used (0.00 kgCO_2/kWh).

3.2. Declared unit.

The declared unit was defined as: **"1 tonne of life crumb rubber bitumen".**

3.3. Reference service life (RSL)

Not applicable.

3.4. Allocation and cut-off criteria.

For the crude oil extraction, transport, and refining stages, the allocation rules described in "THE EUROBITUME LIFE-CYCLE ASSESSMENT 4.0 FOR BITUMEN. March 2025" have been applied.

General framework: When a process yields multiple products, environmental impacts are allocated among them in accordance with ISO 14044:2006, 4.3.4.2.

Refinery: In atmospheric and vacuum distillation, with multiple co-products, the base criterion is energy allocation (net calorific value) for all inputs and non-product flows. Energy allocation is also used in the background LCI data for the joint production of crude oil and gas. In the refinery model used for the background LCI datasets (e.g., HFO, heavy fuel oil), energy allocation is applied to feedstock inputs and mass allocation to energy consumption.

Cogeneration (CHP): For combined production of electricity and steam at the refinery, allocation is based on exergy content.

Refinery "overhead" and utilities: General energy use (lighting, crude storage, dewatering/desalting), as well as waste, water use and discharge, are allocated by energy in the base case, and by mass in the sensitivity analysis.

Waste management in the refinery: Follows ISO 14044:2006, 4.3.4.3, and applies to the treatment of refinery waste and the end of life of included infrastructure. A cut-off approach (100:0) is used: incoming recycled materials arrive "clean" (without prior burdens), and no credits are granted for scrap/recyclable material leaving at end of life. Given the uncertainty of generic waste-treatment data, energy recovery credits from incineration are excluded from the ILCD-published datasets.

As for the **bitumen plants**, mass allocation has been applied.

3.5. Representativeness, quality, and selection of data.

For the study of the upstream stages (extraction, crude oil transport, and refining), data from the document “THE EUROBITUME LIFE-CYCLE ASSESSMENT 4.0 FOR BITUMEN. March 2025” were used.

For the study of the conventional bitumen production process, data from RLESA’s bitumen production plants located in Puertollano (Ciudad Real, Spain), Cartagena (Murcia, Spain), Gajano (Cantabria, Spain), and Mangualde (Viseu Dão-Lafões, Portugal) for the year 2022 were used.

For secondary data, the Ecoinvent 3.10 database was employed and modelled with SimaPro 9.6.0.1. All data correspond to a Spain 2022 geographic context. The results presented are representative of conventional bitumens, expressed as a production-weighted average.

The precision and accuracy of the data entered in the databases used (Ecoinvent v3.10) have been assessed by their authors and found to have an acceptable level of uncertainty for the intended purpose of this report. Furthermore, the data collected or calculated by the authors of this study are considered to have a low degree of uncertainty, as they refer to plant information supplied and explained in detail by the company’s responsible personnel.

To assess the quality of the primary data for the production of the declared product, the semi-quantitative Data Quality Rating (DQR) criteria proposed by the European Union in its Product Environmental Footprint (PEF) and Organization Environmental Footprint (OEF) Guide have been followed.

The following table shows the Data Quality Rating (DQR) scores used to identify the quality level.

Overall data quality score (DQR)	Overall data quality level
≤ 1,6	«Excellent quality»
1,6 a ≤ 2,0	«Very good quality»
2,0 a ≤ 3,0	«Good quality»
3 a ≤ 4,0	«Reasonable quality»
> 4	«Insufficient quality»

Overall data quality level based on the obtained Data Quality Rating (DQR) score

Overall data quality was calculated by summing the scores obtained for each quality criterion and dividing by the total number of criteria. Each criterion is scored from 1 to 5, where 1 is the highest quality and 5 the lowest.

Results by criterion:

- Technological representativeness (TeR): Good, score 2.
- Geographical representativeness (GR): Good, score 2.
- Temporal representativeness (TiR): Good, score 2.
- Completeness (C): Excellent, score 1.5.
- Precision/uncertainty (P): Excellent, score 1.5.
- Methodological appropriateness and consistency (M): Reasonable, score 3.

According to these results, the Data Quality Rating (DQR) is 2, which indicates that the quality level of the data used is very good.

3.6. Cut-off criteria.

In this LCA study, more than 95% of all material and energy inputs and outputs of the system have been included, excluding those data that are unavailable or not quantified. The excluded data are the following:

- Channelled atmospheric pollutants generated in combustion stages that are not measured or not covered by the applicable legislation.
- The production of machinery, industrial equipment and facilities, due to the difficulty of inventorying all the assets involved, and because the LCA community considers that their environmental impact per unit of product is low compared to the other processes that are included. Moreover, the databases used do not include these processes, so their inclusion would require additional effort beyond the scope of this study.

3.7. Other rules for calculation and hypotheses.

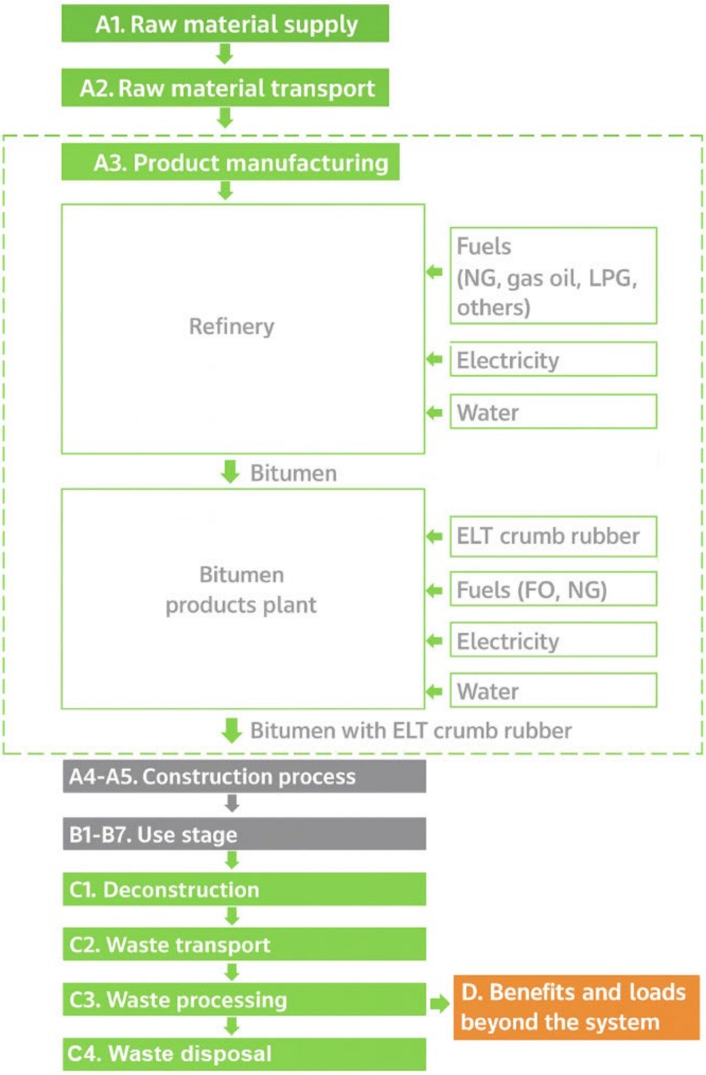
This EPD expresses the average performance of a group of products. The results presented in this document are representative of an "average bitumen with crumb rubber from end-of-life tyres." These averages were calculated as the mean of data for bitumens manufactured in 2022 at the Puertollano plant (Ciudad Real, Spain).

To verify the representativeness of the average results, the coefficient of variation was calculated by dividing the standard deviation by the arithmetic mean of the impact category results for the products from each plant, generally obtaining values below 10%. There are no universal criteria for judging whether a coefficient value is "low" or "high," although in practice values below 30–40% are often considered low, values between those figures and approximately 80% are considered moderate, and when values exceed 120–140% the dispersion is regarded as quite high.

stated that dispersion is generally low, and the representativeness is high.

4. SYSTEM BOUNDARIES, SCENARIOS AND ADDITIONAL TECHNICAL INFORMATION.

As this is a cradle-to-gate with options study (A1–A3, C, D), the following life cycle modules are included: A1 (Raw material supply), A2 (Transport to the manufacturing plant), A3 (Manufacturing), C1 (Deconstruction/Demolition), C2 (Transport of waste), C3 (Waste processing), C4 (Disposal) and Module D (Benefits and loads beyond the system boundary).



4.1. Pre-manufacturing (upstream processes).

For the study of the upstream stages (extraction, crude oil transport, and refining), data from “THE EUROBITUME LIFE-CYCLE ASSESSMENT 4.0 FOR BITUMEN. March 2025” were used.

<u>**A1 Raw material supply.**</u>

Crude oil extraction data include, among others, the following operations:

- **Production and processing at source** of the crude oil up to the point where it is ready for further processing.

- **Extraction technologies:** a mix of conventional (onshore and offshore drilling) and unconventional (oil sands and in-situ production), selected by country of origin.
- **Energy and auxiliaries** from the background system associated with that production (electricity, thermal energy and process steam, on-site/internal transport, and other energy carriers).

A2 Transport.

The transport of extracted crude from the oil field to the refinery has been modelled as a combination of pipelines and marine tanker transport.

REFINERY.

Atmospheric distillation: The crude received at the refinery is heated and fed into the atmospheric distillation column, where light fractions (LPG, naphtha, kerosene, gas oils) are separated, along with an atmospheric residue that proceeds to the next stage.

Vacuum distillation: The atmospheric residue is distilled under vacuum to avoid thermal cracking and to obtain vacuum gas oils and a **vacuum residue (bitumen),** which remains at the bottom of the column.

Storage at the refinery: Bitumen is stored in heated, insulated tanks; on average at ~170 °C.

4.2. Product manufacturing.

PLANT FOR BITUMEN WITH CRUMB RUBBER FROM END-OF-LIFE TYRES.

Tyres are first shredded and, after removing other components such as metals and fibres, a granulate (powder) of 5–8 mm is obtained.

This powder contains rubber which, when incorporated into the bitumen, imparts elastic properties not present in conventional penetration-grade bitumens.

Manufacturing is carried out in dedicated plants at the temperature defined in the formula previously validated in the laboratory, as are the proportions of each component according to the product to be manufactured. Mixing is performed using a vigorous high-shear process to obtain a storage-stable product, together with appropriate temperatures that enable proper homogenisation.

In addition to high-shear mixing, there is a recirculation stage to achieve the highest possible degree of homogenisation of the final product.

The different products manufactured are stored in temperature-controlled, agitated tanks and dispatched in tankers to asphalt-mix plants.

Before being placed on the market, product properties are tested (penetration and softening point) to ensure compliance with the specifications in OC 21/2007 and OC 21bis/2009.

Beyond these initial controls at the manufacturing plant, a planned and documented quality-control system is in place to ensure compliance with all product specifications.

4.3. End-of-life stage.

For the study of the end-of-life stages:

C1: Includes the material and energy consumption required for demolition of the pavement containing the products at the end of their service life. End-of-life parameters for asphalt mixtures are taken from ASEFMA.

C2: At end of life, the product is transported by road an average of 50 km to the waste management site using EURO 5 trucks (16–32 t).

C3–C4: End-of-life values for asphalt mixtures are taken from ASEFMA. The waste scenario considered assumes:

- 53.5% by mass is processed at a plant to obtain secondary material for new mixes.
- 27.0% by mass is used as aggregate or similar.
- 19.5% by mass of the removed product is sent to landfill for disposal.

Table 4. Parameters for modules C1–C4

Parameter	Value (per declared unit)
Collection process	1,000 kg collected separately; 0 kg collected as mixed waste
Recovery system	535 kg to recycling; 270 kg to reuse; 0 kg to energy recovery
Disposal	**195 kg** to final disposal
Scenario assumptions (transport)	Waste transported by **EURO 5, 16–32 t trucks** — **average distance: 50 km** from the worksite to waste management facilities

4.4. Benefits and loads beyond the system (Module D).

The potential for reuse and recycling is included as net loads and benefits related to the secondary material recovered when it leaves the product system, by calculating material substitution effects for the net outgoing flow from the product stage.

5. DECLARATION OF ENVIRONMENTAL PARAMETERS DERIVED FROM THE LCA AND LCI.

The estimated impact results are relative and do not indicate the final value for the impact categories, nor do they refer to threshold values, safety margins or risks.

Table 5. Potential environmental impacts. 1t of bitumen with crumb rubber from end-of-life tyres (ELT).

Parameters	Units	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	kg CO2 eq	4,98E+02	8,25E+00	2,65E+01	5,33E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	7,47E-01	7,97E+00	1,63E+01	6,05E+00	-2,72E+02
GWP-fossil	kg CO2 eq	5,16E+02	8,25E+00	2,65E+01	5,50E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	7,43E-01	7,97E+00	0,00E+00	2,10E+00	-2,71E+02
GWP-biogenic	kg CO2 eq	-1,81E+01	2,21E-03	6,32E-06	-1,81E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	4,00E-03	4,70E-04	1,63E+01	3,95E+00	-1,06E+00
GWP-luluc	kg CO2 eq	4,66E-01	4,26E-04	8,19E-05	4,66E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	2,28E-04	1,56E-04	0,00E+00	5,66E-05	-1,36E-01
ODP	kg CFC11 eq	7,20E-07	1,78E-07	5,79E-10	8,98E-07	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	1,28E-08	1,72E-07	0,00E+00	1,39E-08	-4,66E-09
AP	mol H+ eq	1,68E+00	1,25E-02	1,11E-01	1,80E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	2,44E-03	1,99E-02	0,00E+00	8,94E-03	-8,85E-01
EP-freshwater	kg P eq	5,25E-04	1,29E-05	3,62E-07	5,38E-04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	1,75E-05	6,26E-06	0,00E+00	1,20E-06	-2,23E-04
EP-marine	kg N eq	4,34E-01	3,55E-03	5,84E-02	4,96E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	7,81E-04	7,64E-03	0,00E+00	4,86E-03	-2,29E-01
EP-terrestrial	mol N eq	4,75E+00	3,99E-02	6,40E-01	5,43E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	8,17E-03	8,07E-02	0,00E+00	4,19E-02	-2,51E+00
POCP	Kg NMVOC eq	2,01E+00	2,51E-02	1,50E-01	2,19E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	3,30E-03	3,22E-02	0,00E+00	1,27E-02	-1,04E+00
ADP-minerals& metals [2]	kg Sb eq	1,08E-04	1,13E-06	1,33E-08	1,09E-04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	1,07E-06	2,75E-07	0,00E+00	4,13E-08	-5,23E-05
ADP-fossil [2]	MJ	4,43E+04	1,17E+02	3,67E-01	4,44E+04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	8,99E+00	1,05E+02	0,00E+00	1,14E+01	-2,35E+04
WDP [2]	m^3 depriv.	1,79E+01	1,05E-01	1,22E+00	1,92E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	2,11E+00	9,60E-02	0,00E+00	1,99E-02	-3,79E+00

GWP - total: Global warming potential (total); **GWP - fossil:** Global warming potential from fossil sources; **GWP - biogenic:** Biogenic global warming potential; **GWP - LULUC:** Global warming potential from land use and land-use change; **ODP:** Stratospheric ozone depletion potential; **AP:** Acidification potential (accumulated exceedance); **EP - freshwater:** Eutrophication potential (fraction of nutrients reaching the freshwater compartment); **EP - marine:** Eutrophication potential (fraction of nutrients reaching the marine compartment); **EP - terrestrial:** Eutrophication potential (accumulated exceedance); **POCP:** Photochemical ozone formation potential (tropospheric ozone); **ADP - minerals & metals:** Abiotic depletion potential for non-fossil resources (minerals & metals); **ADP - fossil:** Abiotic depletion potential for fossil resources; **WDP:** Water deprivation potential (user) — deprivation-weighted water consumption. **NR:** Not relevant

Table 6. Additional potential environmental impacts — 1 t of bitumen with crumb rubber from end-of-life tyres (ELT).

Parameter	Units	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	2,58E-05	8,07E-08	2,41E-07	2,62E-05	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	4,84E-08	5,27E-07	0,00E+00	2,34E-07	-1,38E-05
IRP [1]	kBq U235 eq	7,39E+00	1,56E-02	9,98E-05	7,41E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	1,17E-02	1,69E-02	0,00E+00	2,49E-02	-3,90E+00
ETP-fw [2]	CTUe	2,73E+04	5,59E+00	1,88E-01	2,73E+04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	4,35E+00	4,69E+01	0,00E+00	7,08E+00	-1,46E+04
HTP-c [2]	CTUh	5,28E-07	7,71E-09	5,79E-11	5,35E-07	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	1,77E-09	5,47E-10	0,00E+00	5,79E-11	-2,57E-07
HTP-nc [2]	CTUh	1,37E-05	9,40E-09	7,39E-11	1,37E-05	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	5,33E-09	5,62E-08	0,00E+00	3,02E-09	-7,31E-06
SQP [2]	-	2,83E+02	6,07E+00	1,93E-01	2,89E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	4,22E-01	2,01E-01	0,00E+00	3,42E+01	-1,51E+02

PM: Potential disease incidence due to particulate matter emissions; **IRP:** Ionizing radiation — human health (human exposure efficiency relative to U-235); **ETP-fw:** Ecotoxicity — freshwater (comparative toxic unit for ecosystems); **HTP-c:** Human toxicity — cancer effects (comparative toxic unit for humans); **HTP-nc:** Human toxicity — non-cancer effects (comparative toxic unit for humans); **SQP:** Soil quality potential index. **NR:** Not relevant

Notice 1: This impact category primarily addresses the potential effects of low-dose ionizing radiation on human health from the nuclear fuel cycle. It does not consider effects from potential nuclear accidents or occupational exposure from the disposal of radioactive waste in underground facilities. Ionizing radiation potential from soil due to radon or from certain construction materials is also not measured by this parameter.

Notice 2: The results for this environmental impact indicator should be used with caution, as uncertainties are high and experience with this parameter is limited.

Table 7. Resource use — 1 t of bitumen with crumb rubber from end-of-life tyres (ELT).

Parameters	Units	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	MJ	3,10E+02	4,38E-01	3,00E-02	3,11E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	3,77E-01	2,78E-01	0,00E+00	1,07E+00	-1,23E+02
PERM	MJ	5,96E+02	0,00E+00	0,00E+00	5,96E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	9,04E+02	4,38E-01	3,00E-02	9,05E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	3,77E-01	2,78E-01	0,00E+00	1,07E+00	-1,23E+02
PENRE	MJ	7,38E+03	1,24E+02	3,91E-01	7,51E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	4,29E-01	8,92E+00	0,00E+00	5,51E-01	-3,63E+03
PENRM	MJ	3,80E+04	0,00E+00	0,00E+00	3,80E+04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	9,15E+00	9,74E+01	0,00E+00	1,17E+01	-1,98E+04
PENRT	MJ	4,53E+04	1,24E+02	3,91E-01	4,55E+04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	9,58E+00	1,06E+02	0,00E+00	1,23E+01	-2,35E+04
SM	kg	4,48E+01	0,00E+00	0,00E+00	4,48E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	7,81E-01	3,85E-03	2,84E-02	8,13E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	5,25E-02	4,44E-03	0,00E+00	3,63E-03	-4,27E-01

PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw materials; **PERM:** Use of renewable primary energy resources used as raw materials; **PERT:** Total use of renewable primary energy resources; **PENRE:** Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; **PENRM:** Use of non-renewable primary energy resources used as raw materials; **PENRT:** Total use of non-renewable primary energy resources; **SM:** Use of secondary material; **RSF:** Use of renewable secondary fuels; **NRSF:** Use of non-renewable secondary fuels; **FW:** Net use of fresh water resources. **NR:** Not relevant

Table 8. Output flows and waste categories — 1 t of bitumen with crumb rubber from end-of-life tyres (ELT).

Paramters	Units	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	kg	3,11E-03	7,87E-04	3,66E-02	4,05E-02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	5,85E-05	6,99E-04	0,00E+00	7,63E-05	-4,61E-05
NHWD	kg	5,71E+00	1,76E-02	1,49E-03	5,72E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	7,81E-02	5,22E-03	0,00E+00	1,95E+02	-2,74E+00
RWD	kg	4,19E-02	1,04E-05	6,52E-08	4,20E-02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	8,72E-06	9,08E-06	0,00E+00	1,32E-05	-2,25E-02
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,01E+02
MFR	kg	1,36E+00	0,00E+00	6,89E-01	2,04E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,69E+02
MER	kg	7,33E-01	0,00E+00	0,00E+00	7,33E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	-3,93E-01
EE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

HWD: Hazardous waste disposed; **NHWD:** Non-hazardous waste disposed; **RWD:** Radioactive waste disposed; **CRU:** Components for reuse; **MFR:** Materials for recycling; **MER:** Materials for energy recovery; **EE:** Exported energy. **NR:** Not relevant

Table 9. Biogenic carbon content — 1 t of bitumen with crumb rubber from end-of-life tyres (ELT)

Parámetro	Unidades	
Biogenic carbon content in the product	Kg C	5,51E+00
Biogenic carbon content in the packaging	Kg C	0,00E+00

6. ADDITIONAL ENVIRONMENTAL INFORMATION.

Recycling of bituminous materials
According to Austroads' *Asphalt Recycling Guide*, in general, **100%** of the materials recovered from deteriorated pavements can be reused—either on the same project where they are generated, in another pavement (the most common practice), or in other construction works.

There are two main routes for reusing asphalt pavement materials:

- **Hot recycling in mixing plants:** The bituminous layers of aged pavements are removed by milling or demolition and transported to an asphalt plant, where the material is stockpiled, characterised, and, if needed, processed to meet specific size and moisture requirements. The treated material is then incorporated into new hot mixes at varying percentages depending on plant capability, and blended with virgin aggregates, new bitumen and/or rejuvenating agents. The resulting composite bituminous mix is laid and compacted as a conventional mix, achieving comparable performance.
- **Cold recycling (in-place or plant) with bituminous emulsion:** Another route is cold application using a bituminous emulsion as the binder. This technique offers the added advantage of potentially reusing **100%** of the recycled material extracted directly from the pavement, without transporting it to a plant and without heating the material for reapplication—thereby reducing the use of both virgin materials and fuels.

Recycling materials in road construction and rehabilitation is the best approach to lower the consumption of new materials while reducing quarrying. By recycling bituminous layers and making use of the binder they contain, bitumen consumption is decreased. It also reduces landfill volumes—thus lowering the space required for disposal—and cuts the associated management costs.

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