GlobalEPD
A VERIFIED ENVIRONMENTAL DECLARATION

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Environmental
Product
Declaration

Polymer Modified Bitumens

EN ISO 14025:2010
EN 15804:2012+A1:2013

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REPSOL

REPSOL LUBRICANTES Y ESPECIALIDADES, S.A.

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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European Standard EN 15804:2012+A1:2013 serves as the basis for the PCR
Independent verification of the Declaration and data, according to Standard EN ISO 14025:2010 ☐ Internal ☒ **External**
Verification body AENOR Confía

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 plays a proactive role in building a better future by developing smart energies. It is an integrated, highly diversified company that covers a wide range of businesses, from more classical ones such as exploration, refining, and fuel sale and distribution, to others such as LPG (a world leader) and new energies (wind power, etc.).

Repsol Lubricantes y Especialidades S.A. is a Repsol group company that develops, produces, and markets lubricants, specialised products, and asphalt bitumens and their derivatives.

1.2. Scope of the Declaration

This environmental product declaration describes the environmental information regarding the life-cycle of polymer modified bitumens manufactured by REPSOL in 2018 at its production plants in Puertollano (Ciudad Real, Spain) and Gajano (Cantabria, Spain).

The main purpose of these products is to act as a binding component that gives cohesion to bituminous asphalt mixes and is primarily responsible for their properties.

1.3. Life-cycle and compliance

This EPD has been developed and verified in accordance with Standards UNE-EN ISO 14025:2010 and UNE-EN 15804:2012+A1:2014.

This environmental declaration includes the following life-cycle stages: A1 to A3.

This EDP includes the life-cycle stages shown in table 1. This EDP is of the cradle-to-gate type.

This EPD may not be comparable with those developed in other Programs or according to different reference documents; in particular, it may not be comparable with EPDs not developed and verified in accordance with the Standard UNE-EN 15804.

Similarly, EPDs may not be comparable if the origin of the data is different (for example, databases), not all relevant information modules are included, or they are not based on the same scenarios.

Product stage	A1	Raw material supply	X
	A2	Transport to factory	X
	A3	Manufacturing	X
Const.	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			

Table 1. System boundaries. Information modules considered.

2 The product

2.1. Identification of the product

These are mixes of conventional bitumens, polymers, and other compounds (CPC 33500) that improve some of their characteristics. Modification with polymers, in addition to the materials involved, has a very important influence on the mixing process (shearing system/time/temperature).

These products are governed by the criteria in standard UNE-EN 14023:2010, which describes the production control process for polymer modified bitumens and, with this, of obtaining the CE Marking.

Most of these modified bitumens are produced using a proprietary reticulation system that provides a microscopically homogeneous structure and ensures its stability in storage.

Modified bitumens make it possible to manufacture bituminous mixes with enhanced mechanical and functional properties, thereby adapting roads to increased traffic conditions and the greater requirements arising from this increase, which leads to greater durability and savings on maintenance costs.

The use of polymers provides a notable improvement in the properties of the bitumens. In particular:

- Increase in the ring and ball test temperature.
- Lower thermal susceptibility.
- Increase of penetration grade.
- Increase in plasticity range.
- Increase in viscosity.
- Greater elastomericity.
- Better performance at low temperatures.
- Greater resistance to ageing.

Polymer Modified Bitumens are mainly used to manufacture bituminous mixes that are subject to heavy traffic loads. In particular, their use is advisable in mixes applied in wearing courses.

2.2. Product features

Those described in article 212 on Polymer Modified Bitumens of the PG-3 General Technical Specifications for Road and Bridge Works, corresponding to the types of polymer modified bitumens that are used in Spain and that meet the requirements of standard UNE-EN 14023:2010.

2.3. Product composition

The following table shows the main components of the product.

Substance	**Content**	Units
Bitumen	94-95	%
Polymer	3-6	%
Additives	0.35-0.40	%

Table 2. Main product components

None of the raw materials used to produce this product are on the Candidate List of Substances of Very High Concern (SVHC) for Authorisation or subject to any other regulation.

3 LCA Information

3.1. Life cycle assessment

The LCA report was drawn up by ReMa- INGENIERÍA, S.L., using data provided by RLESA on the polymer modified bitumens production process at the different plants. Subsequently, the data were entered into the LCAmanager tool developed by SIMPPLE to obtain the various impact values from the Ecoinvent database v3.6 and CML method characterisation factors (September 2016 revision). All this information was included in the "LCA report on conventional bitumen, polymer modified bitumen, bitumens with end-of-life tyre crumb rubber and bituminous emulsions – REPSOL. v5. 26 June 2020".

The LCA study followed the recommendations and met the requirements of international standards ISO 14040:2006 and ISO 14044:2006, in addition to the standards corresponding to the basic product category rules for construction products, UNE EN 15804, and type III of the environmental labelling standard UNE EN ISO 14025.

3.2. Functional/declared unit

The declared unit was defined as: **"1 tonne of polymer modified bitumen".**

3.3. Reference service life (RSL)

Not applicable.

3.4. Allocation and cut-off criteria

Bitumen is a co-product of the oil refining process. To evaluate the environmental impact of bitumen, a method must be determined for allocating the impacts of the production chain to bitumen and other co-products: liquefied petroleum gas, gasoline, kerosene, diesel, heavy fuel oil, etc. The refinery receives crude oil from various sources and, after several distillation stages, refinery flows are obtained that will be used to produce bituminous materials, among other products. When assigning the energy consumption associated with the production of refinery flows, the methodology described in the document "The EUROBITUME Life-cycle inventory for bitumen. Version 3.0. December 2019" was followed.

As indicated in that study, the distillation process is governed by thermodynamic principles that determine the change of state (from liquid to gas), and most of the energy needed by the distillation process is used to provide the enthalpy of vaporization, to change the distillate fractions from the liquid phase to gas (enthalpy of vaporisation). This energy is recovered as the enthalpy of condensation when the distillates condense further up the distillation column and are collected using heat exchangers. Bitumen is a residual flow and its state does not change during the distillation process. The approach taken in this study was to consider only the heat required to raise the temperature of the bitumen molecules contained in the crude oil, using the specific heat capacity of bitumen to determine the amount of energy required to raise the temperature of the crude oil bitumen fraction to 175ºC. A conservative estimate of 90% efficiency was used for the heat exchanger and the energy consumption was adjusted as a result.

The following procedure was followed to assign the loads for the use of recycled materials and the recycling of waste: the recycling of waste from one process that is reused in a different productive process is assigned to the cycle of the second product.

More than 95% of all energy and material inputs and outputs to and from the system were included in this cradle-to-gate LCA study.

3.5. Representativeness, quality and selection of data

To conduct the study of the upstream stages (crude oil extraction and transport) data were used from the document "THE EUROBITUME LIFE-CYCLE INVENTORY FOR BITUMEN VERSION 3.0. December 2019" and the reports of the International Association of Oil & Gas Producers (IOGP) for the period 2013-2017.

To conduct the study of the bitumen production process used to manufacture polymer modified bitumens, data for 2018 relating to the REPSOL (Puertollano and Cartagena, Spain) and Petronor (Bilbao, Spain) refineries and the RLESA polymer modified bitumen production plants in Puertollano (Ciudad Real, Spain) and Gajano (Cantabria, Spain) were used.

The precision and accuracy of the data entered into the databases used (Ecoinvent v3.6) were evaluated by the authors and the degree of uncertainty obtained was acceptable for the purposes of this report. In addition, the data collected or calculated by the authors of this study are considered to have a low level of uncertainty, since they refer to manufacturing information that was supplied and explained in detail by the company's managers.

To evaluate the quality of the primary data on the production of the declared product, semi-quantitative data quality assessment criteria were followed (data quality rating or DQR), as proposed by the European Union in its Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF) Guide.

The following table shows the data quality rating (DQR) used to identify the quality level.

Overall data quality rating (DQR)	Overall data quality level
≤ 1.6	Excellent quality
1.6 to 2.0	Very good quality
2.0 to 3.0	Good quality
3.0 to 4.0	Reasonable quality
> 4.0	Poor quality

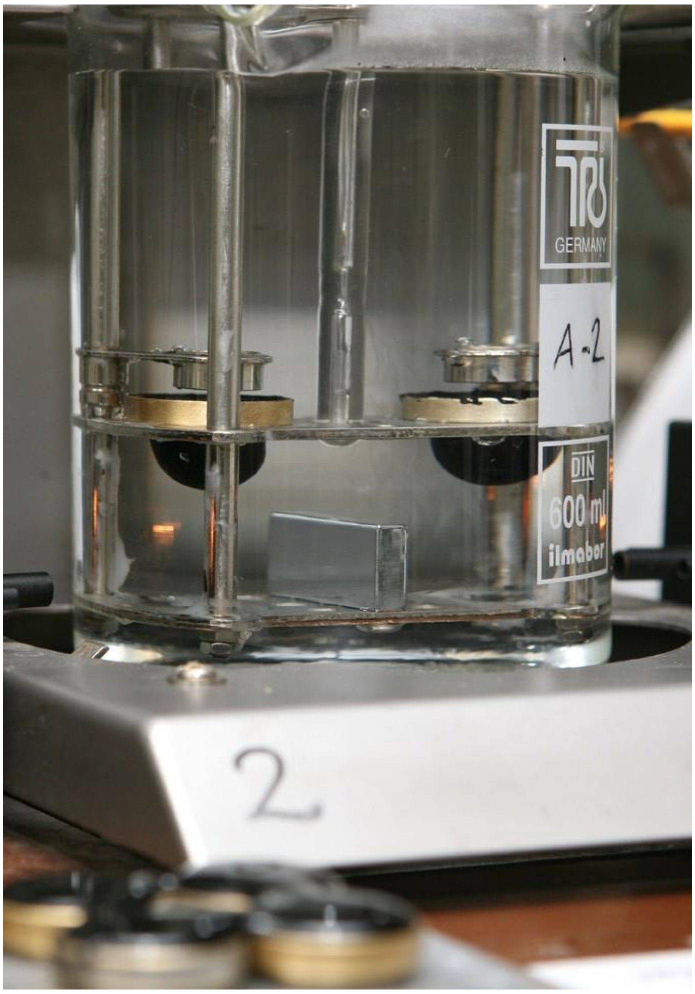
Overall data quality rating based on the data quality score obtained

The overall quality of the data was calculated by adding together the quality score obtained on each of the quality criteria and dividing it by the total number of criteria. The score for each of the criteria varies from 1 to 5, with 1 being the highest quality and 5 the worst.

The results obtained for each of the criteria are as follows:

- Technological representativeness (TeR): Very good, score 1.
- Geographical representativeness (GR): Very good, score 1.
- Time-related representativeness (TiR): Very good, score 1.
- Completeness (C): Very good, score 1.5.
- Precision/uncertainty (P): very low, score 1.5.
- Methodological appropriateness and consistency (M): Reasonable, score 3.

According to these results, the data quality rating (DQR) obtained is equal to 1.5, which indicates that the quality of the data used is excellent.

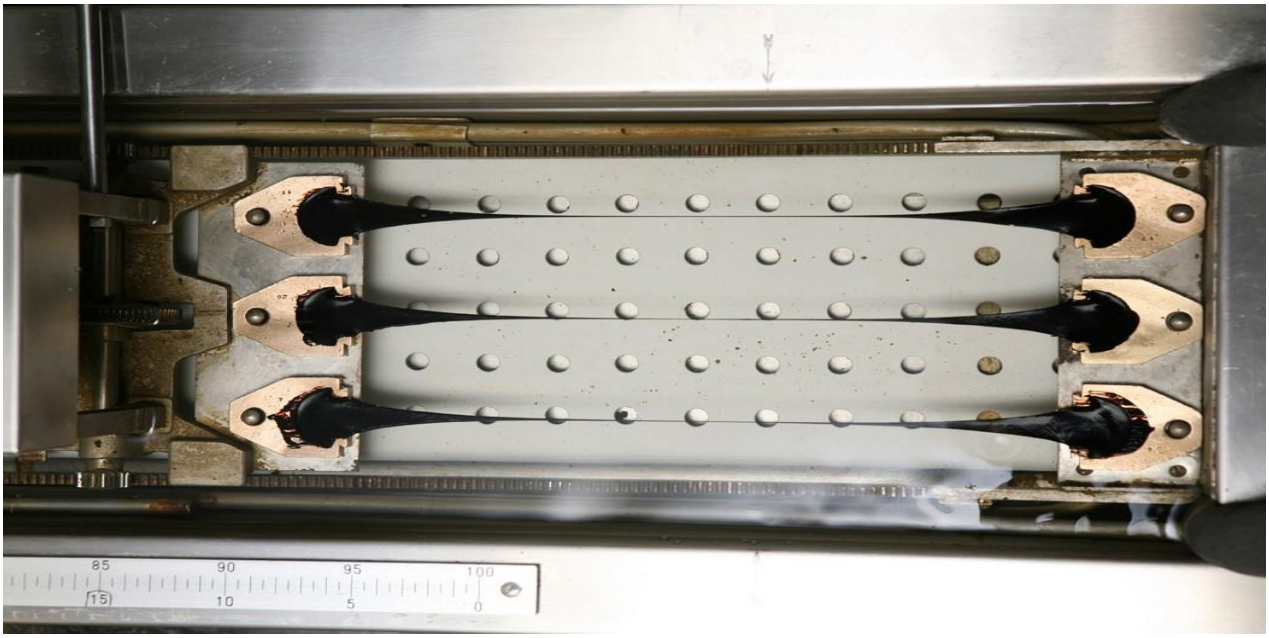


3.6. Other rules for calculation and hypotheses

This EPD describes the average behaviour of a set of products. The results presented in this document are representative of an "average polymer modified bitumen" product. These average results were calculated as the average of the data regarding the bitumens manufactured in 2018 at the plants in Puertollano (Ciudad Real, Spain) and Gajano (Cantabria, Spain), weighted according to the amounts manufactured at each plant.

To check 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, obtaining a maximum of 20%. There are no universal criteria for stating that a coefficient is "low" or "high", although in practice values of less than 30 or 40% tend to be considered low, between these figures and approximately 80% are considered moderate, and the dispersion is considered to be quite high when they exceed 120 or 140%.

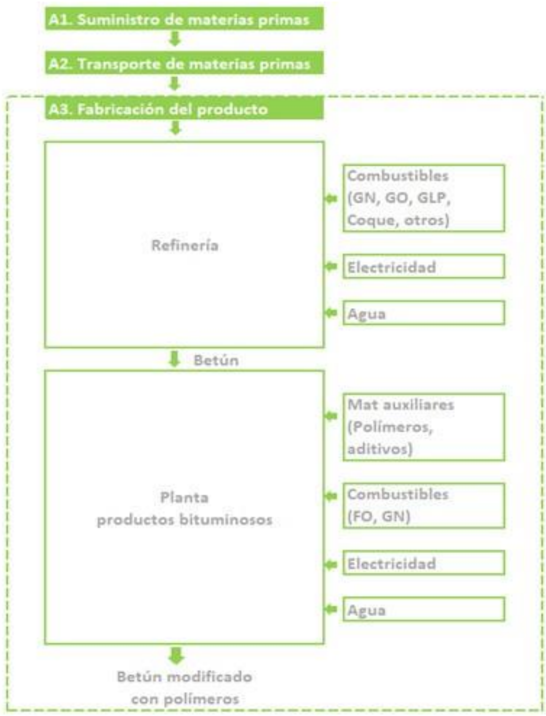
Therefore, in light of these results, it can be stated that the dispersion is generally low; therefore the representativeness is high. The results for each of the products and the coefficient of variation can be found in section 5 of this declaration.



4 System boundaries, scenarios and additional technical information

The scope of this study was defined as cradle to gate, covering only the manufacturing module (extraction and preparation of raw materials, production of polymer modified bitumens and transport between these stages).

Figure 1. Stages studied



4.1. Processes prior to manufacture (upstream) and product manufacture (A1-A3)

A1 Production of raw materials

The crude oil extraction data used in this study are based on data from the International Association of Oil & Gas Producers (IOGP), provided in the document "The EUROBITUME Life-cycle inventory for bitumen. Version 3.0. December 2019" and supplemented by Ecoinvent datasets for secondary processes.

The crude oil extraction data are an average of the data for the years 2013–2017, extracted from the IOGP Environmental Performance Indicators reports.
The IOGP data include the following operations, among others:

- Drilling (exploration, evaluation and production drilling);
- Extraction and separation of crude oil and gas (primary production).
- Primary crude oil processing (separation of water, stabilisation
- Transport of crude oil by pipeline to storage facilities;
- Loading of crude oil tankers at sea from primary production;

- Onshore crude oil storage connected to primary production facilities by pipeline;
- Transport of gas to the processing plant
- (offshore/onshore);
- High sea support and reserve vessels;
- Mining activities related to hydrocarbon
- extraction.

A2 Transport

The crude oils used in European bitumen production are mainly transported to refineries by ship. The exception is crude oil from the former Soviet Union, which is partly transported by pipeline. This study presumes that the crude oil from this region is transported from the Samara region to the Baltic Sea by the Baltic Pipeline System (BPS) and then from the Baltic Sea to the ARA region by ship.

For transport by oil pipeline and ship, oil pipeline company data were used from the document "The EUROBITUME Life-cycle inventory for bitumen. Version 3.0. December 2019" was followed.

A3 Product manufacturing

REFINERY

The crude oils received at the refinery are heated and enter the atmospheric distillation column. The residue from atmospheric distillation is subject to a second distillation in a vacuum column to produce paving-grade bitumen. The refinery produces a wide range of petroleum derivatives, and bitumen is a minor product compared to others

POLYMER MODIFIED BITUMEN PLANT

Polymer modified bitumens are manufactured at special plants that have been adapted to manufacturing these products. The main raw material is penetration bitumen, a specific one for each type of polymer modified bitumen. It is supplied to the PMB manufacturing plant either by pipeline directly to the tank where it is mixed with other components, as is the case at the Puertollano plant, or by tanker, as at the Gajano plant.

Once the bitumen has reached the right temperature as defined in a specific formula that has been previously validated in the laboratory, the polymer is added along with the correct additives that will incorporate the polymer into the bitumen matrix and ensure it is homogeneous and stable in storage. To achieve this bitumen-polymer compatibility, shearing mills are used to ensure that all the components are combined together in a homogenous mixture. The mixing and shearing time is defined in the product formula, as are the proportions of each of the components.

After the mixing process, the different types of modified bitumen are stored in insulated tanks until they are loaded into tankers to be supplied to bituminous mix manufacturing plants or to manufacture other bituminous products such as modified bituminous emulsions.

Prior to loading, the properties of each lot of bitumen such as penetration, softening point and elastic recovery, among others, are analysed in accordance with the CE Marking requirements in standard UNE EN 14023:2010.

In addition to the initial checks made at the manufacturing plant, there is a scheduled and documented quality control system to ensure that all product characteristics meet the corresponding standards.

4.2. Transport and construction process(A4-A5)

Modules A4-A5 not evaluated.

4.3. Use linked to the building's structure

Modules B1-B5 not evaluated.

4.4. Use linked to the building's operation

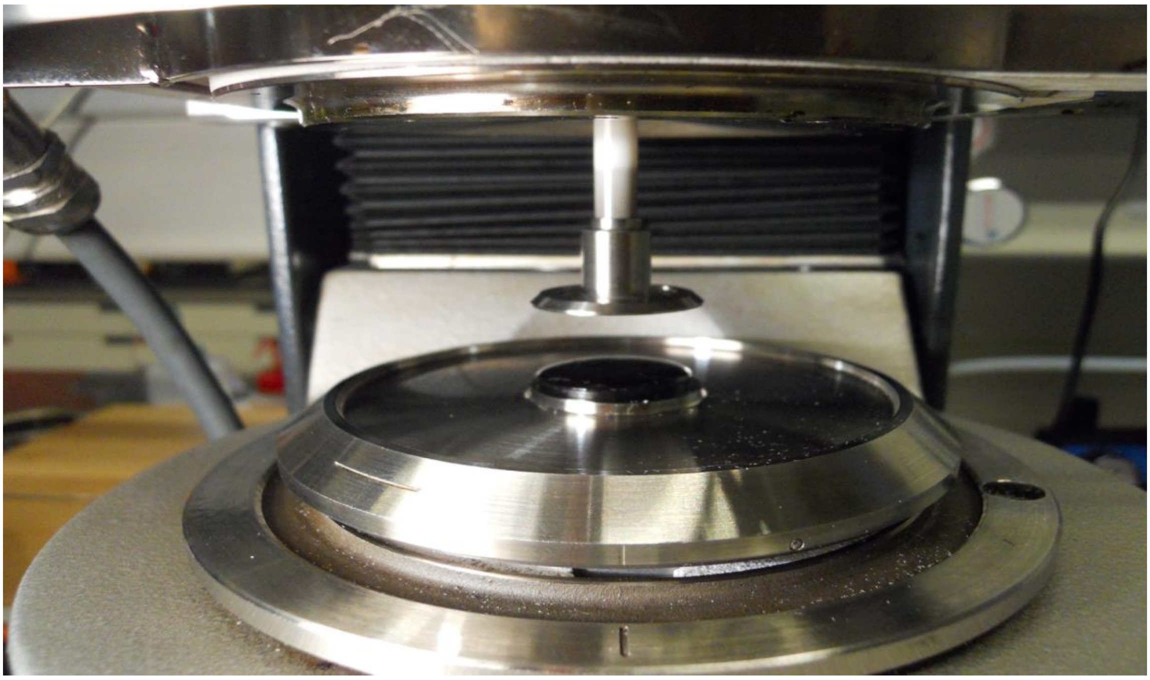
Modules B6-B7 not evaluated.

4.5. End-of-life

Modules C1-C4 not evaluated.

4.6. Benefits and loads beyond the building system boundaries

Module D not evaluated.



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.

	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP	3,94E+02	2,67E+01	4,45E+01	4,65E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
ODP	3,13E-05	5,71E-06	4,09E-06	4,11E-05														
AP	2,40E+00	6,43E-01	3,45E-01	3,39E+00														
EP	2,46E-01	9,81E-02	5,56E-02	4,00E-01														
POCP	9,73E-02	1,39E-02	9,76E-03	1,21E-01														
ADPE	2,11E-04	2,07E-05	1,55E-05	2,48E-04														
ADFP	4,75E+04	3,46E+02	2,94E+02	4,82E+04														

GWP [kg CO2 eq]	Global warming potential
ODP [kg CFC-11 eq]	Ozone depletion potential
AP [kg SO2 eq]	Acidification potential of soil and water
EP [kg $(PO_4)^{3-}$ eq]	Eutrophication potential
POCP [kg ethylene eq]	Photochemical ozone creation potential
ADPE [kg Sb eq]	Abiotic depletion potential for non-fossil resources (ADP-elements)
ADPF [MJ]	Abiotic depletion potential for fossil resources (ADP-fossil fuels)

Table 2. Parameters describing the environmental impacts defined in Standard UNE-EN 15804

Coefficient of variation

Polymer modified bitumens are produced at the Puertollano and Gajano plants. The following table shows the results corresponding to the environmental impacts of the polymer modified bitumens from each plant and the coefficient of variation of the results:

Impact category	Average polymer modified bitumen	Puertollano polymer modified bitumen	Gajano polymer modified bitumen	Coefficient of variation (%)
GWP	4.65E+02	4.34E+02	5.20E+02	9.25
ODP	4.11E-05	3.90E-05	4.50E-05	7.30
AP	3.39E+00	3.20E+00	3.73E+00	7.82
EP	4.00E-01	3.36E-01	5.10E-01	21.75
POCP	1.21E-01	1.15E-01	1.32E-01	7.02
ADPE	2.48E-04	2.30E-04	2.79E-04	9.88
ADPF	4.82E+04	4.78E+04	4.90E+04	1.24

Variability/Dispersion. Polymer modified bitumen

	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	4,01E+01	5,03E+00	1,43E+01	5,94E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PERM	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PERT	4,01E+01	5,03E+00	1,43E+01	5,94E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PENRE	7,79E+03	3,96E+02	2,94E+02	8,46E+03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PENRM	4,36E+04	0,00E+00	0,00E+00	4,36E+04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PENRT	5,14E+04	3,96E+02	2,94E+02	5,21E+04	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
SM	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
RSF	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
NRSF	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
FW	8,33E+00	1,57E-02	2,32E-01	8,58E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE

PERE	[MJ]	Use of renewable primary energy, excluding renewable primary energy resources used as raw materials
PERM	[MJ]	Use of renewable primary energy used as raw materials
PERT	[MJ]	Total use of renewable primary energy
PENRE	[MJ]	Use of non-renewable primary energy, excluding non-renewable primary energy resources used as raw materials
PERNRM	[MJ]	Use of non-renewable primary energy resources used as raw materials
PERNRT	[MJ]	Total use of non-renewable primary energy resources
SM	[MJ]	Use of secondary materials
RSF	[MJ]	Use of renewable secondary fuels
NRSF	[MJ]	Use of non-renewable secondary fuels
FW	[m³]	Net use of freshwater resources

Table 3. Parameters describing resource use

	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	5,24E-02	4,18E-04	1,72E-02	7,00E-02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
NHWD	2,74E+00	3,03E-01	6,44E-01	3,68E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
RWD	2,07E-03	3,18E-03	1,49E-03	6,75E-03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
CRU	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
MFR	0,00E+00	0,00E+00	1,48E-01	1,48E-01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
MER	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
EE	0,00E+00	0,00E+00	1,82E+01	1,82E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
EET	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE

HWD	*[kg]*	Hazardous waste disposed of
NHWD	*[kg]*	Non-hazardous waste disposed of
RWD	*[kg]*	Radioactive waste disposed of
CRU	*[kg]*	Components for re-use
MFR	*[kg]*	Materials for recycling
MER	*[kg]*	Materials for energy recovery
EE	*[kg]*	Exported energy
EET	*[kg]*	Exported energy (thermal)

Table 4. Parameters describing output flows and waste categories

6 Additional environmental information

Recycling of bituminous materials

According to the Austroads "Asphalt Recycling Guide", in general, 100% of the materials recovered from damaged road surfaces can be reused, either for the site where they were generated, for another road surface (the more usual practice), or on other construction sites.

Asphalt road surfaces can be reused in two ways: at plants manufacturing new hot mixes, a process which involves removing the bituminous layers from old roads using grinding or demolition in order to transport the material to a manufacturing centre, where it is stored, characterised and possibly processed until it meets certain size, humidity, etc., conditions. Subsequently, after treatment, this material is incorporated into the new mix in different percentages depending on the capacity of the plant. Alternatively, it is mixed while hot with virgin aggregates, new bitumen and/or rejuvenating agents to obtain a composite bituminous mix that is laid and compacted on-site as if it were a conventional mix, providing the same performance.

One way to use the material from roads is to apply it while cold using a bituminous emulsion as a binding agent. This technique also has the advantage of making it possible to reuse 100% of the recycled material extracted directly from the road surface without the need to transport it to a plant or heat the material before applying it again, which helps eliminate the use of both virgin materials and fuels.

Recycling materials during the road construction and repair process is the best option to reduce the consumption of new materials and, at the same time, the exploitation of quarries. Recycling bituminous layers and taking advantage of the binding agent that they contain reduces bitumen consumption. In addition, the volumes of waste disposed of – which would otherwise require a physical space for storage and lead to waste management costs – are also reduced.

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Table of contents

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