Product Carbon Footprint Methodology

Methodology behind the product carbon footprint (PCF) figures.

Reference period: 2025 PCF pilot.

1. Overview

AUTODOC's 2025 PCF pilot assessed seven products: a Pirelli summer tyre, RIDEX PLUS engine oil, a RIDEX oil drain seal ring, RIDEX brake pads, a RIDEX car battery, a new RIDEX alternator, and a RIDEX remanufactured (REMAN) alternator. The same methodology was applied to every product; it is set out below and is intended to govern AUTODOC's PCF work going forward, not only the pilot.

The pilot product set was shaped in part by the availability of primary data: where intended suppliers did not return data, comparable products for which primary data could be obtained were substituted, so that each footprint rests on supplier-reported inputs rather than estimates alone.

A key finding of the pilot is the comparison between the new and remanufactured alternator, which demonstrates the carbon advantage of remanufacturing (Section 9).

The footprints were calculated together with **Greenmiles GmbH** (part of the Hamburg Institut Consulting group), an external sustainability consultancy.

2. Standard applied

PCFs were calculated in line with the **GHG Protocol Product Life Cycle Accounting and Reporting Standard**.

3. System boundary — cradle-to-gate

The pilot applies a single, consistent cradle-to-gate boundary across all products.

Included

- Raw-material extraction and pre-processing
- Production / processing
- Packaging
- Treatment of production / process waste arising within the boundary
- Upstream (inbound) logistics, up to the point the finished part reaches AUTODOC

Excluded

- The in-vehicle use phase
- Downstream distribution to the customer
- Finished-product end-of-life

Consumer (B2C) product footprints are often reported cradle-to-grave, and remanufactured products cradle-to-cradle. The pilot deliberately uses cradle-to-gate as a single comparable boundary across all products, and to avoid relying on uncertain use-phase and end-of-life estimates at this stage. AUTODOC intends to extend the boundary as the programme matures.

Process waste vs. end-of-life. The boundary includes the treatment of production / process waste, which is part of cradle-to-gate. It does not include end-of-life treatment of the finished product, which sits beyond the gate and is excluded.

New-versus-remanufactured comparison. Once fitted, the two alternators are functionally equivalent, so their use-phase and downstream emissions are equivalent. The difference between them sits in production — the stage cradle-to-gate captures — so the boundary does not distort the comparison.

4. Declared unit

One finished product, as sold (for the alternators, one finished alternator; for the engine oil, one filled unit as sold).

5. Products assessed

Product	Article	Category
Pirelli Powergy 225/45 R17 94Y summer tyre	—	Tyre (non-private brand)
RIDEX PLUS Active Energy LL FE engine oil	1862O0009P	Engine oil (private brand)
RIDEX oil drain seal ring	135O0029	Seal ring (private brand)
RIDEX brake pad set	402B0029	Brake pads (private brand)
RIDEX car battery	1S0009	Starter battery (private brand)
New RIDEX alternator	4G0557	Alternator (private brand)
RIDEX remanufactured (REMAN) alternator	4G0004R	Remanufactured alternator

6. Data sources

6.1 Primary (supplier) data

Product weight, material composition (bill of materials), production energy, packaging, inbound transport, and process waste were collected directly from suppliers and the remanufacturer through structured questionnaires — a standard questionnaire for new products and a dedicated questionnaire for remanufactured products. Where a supplier maintained its own product PCF, that value was requested directly (see Section 7).

6.2 Secondary emission factors

Activity data was combined with the following databases:

Database	Version	Use in the calculation
ecoinvent	3.11	Background life-cycle inventory for upstream materials, processing, and process-waste treatment
DEFRA / DESNZ	2025	Government GHG conversion factors for freight transport
AIB	2023	European residual-mix and production-mix grid electricity factors

Inbound freight is converted using DEFRA 2025 factors on a tonne-kilometre basis:

Mode (DEFRA 2025)	Factor (kg CO_2e / tkm)
Road freight (truck)	0.891
Container ship	0.0161
Rail	0.0278
Air freight (incl. RF)	0.899

7. Calculation approach and contribution categories

Each product footprint is built up, per declared unit, from the following contribution categories:

Contribution category	What it captures
Raw material	Cradle emissions of the materials making up the finished part (the dominant driver for several products)
Processing	Energy and process emissions of production / reprocessing
Packaging	Materials used to pack the finished part as sold, plus their inbound transport
Process waste	Treatment of production / process waste arising within the cradle-to-gate boundary
Upstream transport	Inbound (upstream) logistics up to receipt at AUTODOC

Primary product footprints. Where a supplier provides its own product PCF, that primary value is used directly rather than modelled from activity data. In the pilot this applies to the Pirelli tyre, for which the supplier provided a cradle-to-gate PCF of 33 kg CO_2e per tyre; AUTODOC added only the inbound transport to AUTODOC (12.68 kg CO_2e), giving the reported 45.68 kg CO_2e and avoiding any double-counting of the supplier's production stages.

8. Key assumptions and data quality

Each PCF combines measured primary data with modelled estimates where primary data was unavailable. The standing conventions are:

Transport

- Inbound distances are calculated using routing tools for road and sea legs, rather than measured shipment records, and converted to emissions on a tonne-kilometre basis.

Packaging

- Packaging weights are taken from supplier data. Where a separate weight is not provided for a product variant, the closest available figure is applied (for example, the alternator's cardboard-box packaging was applied to both the new and remanufactured unit).

Missing primary inputs

- Where a supplier cannot provide a given input — production energy being the most common gap — it is modelled from comparable data and scaled to the product's material composition.
- For the new alternator, whose supplier provided no energy data, processing energy was modelled from the remanufacturer's measured reprocessing energy (0.23 kWh/kg) and scaled for higher new-material content (0.75 kWh/kg).
- Where a modelled input sits behind a category that is not the product's main driver, the footprint is not materially sensitive to it.

Process waste

- Production / process waste is treated within the cradle-to-gate boundary; where a material-level split is unavailable, the reported total is apportioned across materials by mass share.

Data quality

- Each activity-data and emission-factor input is graded (primary / secondary; high / medium) so the basis of each figure is traceable. Material inputs are predominantly primary supplier data; transport and a minority of emission factors are secondary.

9. Remanufactured products — allocation

Remanufactured products are assessed on a cut-off basis: the recovered core enters the system free of its first-life production burden, and only the remanufacturing process is counted — reprocessing energy, replacement parts, transport, packaging, and process waste. This is the standard treatment for remanufactured products and is the principal reason for their lower footprint, as the energy- and emission-intensive original production of the reused core is avoided.

In the pilot this applies to the remanufactured alternator. The reused core (housing, rotor, stator) and the replacement parts are reported separately by the remanufacturer through the dedicated REMAN questionnaire, which collects the weight of reused components and the weight of new components as primary fields. On that basis the replacement parts (new iron, rubber, and plastic, ≈1.86 kg) account for approximately 30% of the 6.2 kg unit, with the reused core making up the balance. The avoided production of the copper-intensive core is what drives the substantially lower footprint; this split is supplier-reported rather than assumed.

10. Results (2025 pilot)

Product	Cradle-to-gate (kg CO_2e)	Principal contributor
RIDEX car battery	54.20	Electrolyte raw material + inbound transport

Product	Cradle-to-gate (kg CO_2e)	Principal contributor
New RIDEX alternator	51.74	Raw material (copper, aluminium)
Pirelli summer tyre	45.68	Supplier PCF + inbound transport
RIDEX PLUS engine oil	12.58	Raw material (base oil, additives)
RIDEX brake pad set	2.69	Raw material
RIDEX REMAN alternator	22.09	Inbound transport (return logistics)
RIDEX oil drain seal ring	0.08	Raw material (copper)

The principal contributor differs by product. The new alternator is raw-material dominated (copper and aluminium account for the bulk of its footprint). The engine oil, brake pads, and seal ring are likewise raw-material dominated. The car battery is split roughly evenly between electrolyte raw material and a long inbound road route. The remanufactured alternator is dominated by inbound transport — its return logistics involve two long road legs — because the cut-off treatment removes most of its raw-material burden.

11. Alternator comparison

The remanufactured alternator's footprint of 22.09 kg CO_2e is approximately 57% lower than the new unit's 51.74 kg CO_2e — a reduction of about 29.65 kg CO_2e per unit. On a per-kilogram basis (both units ≈6.2 kg), this is 3.56 kg CO_2e/kg for the remanufactured unit versus 8.35 kg CO_2e/kg for the new unit.

Notably, the remanufactured unit carries *higher* inbound transport emissions than the new unit (its return logistics are longer), yet it is still 57% lower overall. The saving comes entirely from avoided raw-material production: the cut-off treatment removes the copper-intensive core, cutting raw-material emissions from ≈40 kg CO_2e to ≈3 kg CO_2e. The comparative conclusion is therefore robust — it rests on avoided core production, not on the transport or processing assumptions — even though the absolute remanufactured figure is sensitive to the length of its return-logistics legs.

12. Limitations

These are 2025 pilot figures. The boundary is cradle-to-gate and does not include the use phase or finished-product end-of-life. The principal sources of uncertainty are inbound transport, the new unit's modelled processing energy, and the apportionment of process waste; the comparative conclusion (remanufacturing materially reduces the footprint) is robust to these because the difference is driven by avoided raw-material production.