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Product Carbon Footprint Report

**for
rigythupko**

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Protocol Data (Accounting Standard): GHG Protocol

Disclaimer: This report is generated based on available data and industry standards, providing an estimate of the product's carbon footprint. The accuracy is dependent on the completeness and quality of input data.

Product Carbon Footprint Analysis: rigythupko

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Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for 'rigythupko', manufactured by 'wughnllkky'. Conducted by Senior Sustainability Consultant oyrnmmltvm, this analysis adheres strictly to the GHG Protocol and incorporates the 2026 Land Sector and Removals (LSR) Standard updates, aiming for at least 95% coverage for Scope 3 emissions. The assessment covers the entire product lifecycle from material acquisition to end-of-life, providing a comprehensive understanding of its environmental impact. Key insights highlight emission hotspots across the supply chain, production, use, and end-of-life phases, offering actionable recommendations for emission reduction.

1. Scope Definition

This Product Carbon Footprint (PCF) analysis establishes the foundational parameters for assessing the

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greenhouse gas (GHG) emissions associated with 'rignythupko'.

- **Functional Unit:** The functional unit for this analysis is defined as 1.0 unit of 'rignythupko'. This provides a standardized reference for quantifying and comparing environmental impacts.
- **System Boundary:** The system boundary is set as 'factory_gate'. This includes all upstream activities from raw material extraction, processing, manufacturing of components (cradle-to-gate), inbound logistics, and the production processes at the manufacturing facility. Additionally, for a comprehensive view and to achieve 95% Scope 3 coverage, the analysis extends to include outbound logistics, the product's use phase, and its end-of-life (cradle-to-grave).
- **Geographic Scope:** The final production country is China. The supply chain focus for upstream materials and components is Europe. This dual focus allows for an assessment of both local production impacts and international supply chain footprints.
- **Allocation:** Emissions are allocated directly to the functional unit (1.0 unit of 'rignythupko'). Where shared processes or facilities are involved, standard mass-based or economic allocation methods are applied to ensure a fair distribution of environmental burdens.
- **Accounting Standard:** The assessment strictly adheres to the GHG Protocol, categorizing emissions into Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (all other indirect emissions in the value chain).

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2. Lifecycle Mapping (LCI Inventory Stages) & 3. Data Collection

The lifecycle of 'rigythupko' has been mapped, and data collected across all relevant stages, including material acquisition, manufacturing, transportation, use, and end-of-life.

2.1. Material Acquisition & Manufacturing (Upstream - Scope 3)

The detailed Bill of Materials (BOM) for 'rigythupko' has been utilized for high-accuracy material impact calculation. The emissions for each material are derived from the provided 'Total Carbon' values, which are calculated based on the quantity and specific emission factor. Industry-standard emission factors from sources like Ecoinvent and DEFRA are implicitly or explicitly incorporated within these provided 'Total Carbon' values and emission factors.

Detailed Bill of Materials (BOM) for riygthupko:

ID	Description	Category	Process	Qty	Unit	Emission Factor (kg CO2e/ Unit)	Total Carbon (kg CO2e)
MAT001	Aluminium Casing	Metal	Casting	0.5	kg	6.7	3.35
MAT002	Plastic Components	Plastic	Injection Molding	0.2	kg	2.1	0.42
MAT003	Circuit Board	Electronics	Assembly	0.1	unit	15.0	1.50
MAT004	Packaging Cardboard	Paper	Processing	0.05	kg	0.9	0.045

Total Material Emissions: 5.315 kg CO₂e

2.2. Production Phase (Direct & Purchased Energy - Scope 1 & 2)

The production of 'rigythupko' takes place in China. Energy consumption and renewable energy usage are critical data points for this phase.

- **Energy Intensity (kWh/unit):** 50 kWh/unit
- **Renewable Energy Usage:** 40%
- **China National Average Electricity Grid Emission Factor:** 0.6205 kg CO₂e/kWh (2023 data)

This means 40% of the energy consumed is from renewable sources (assumed to be zero emissions), and 60% is from the grid.

2.3. Transportation (Upstream & Downstream - Scope 3)

Logistics data, covering both inbound (supplier to factory gate) and outbound (factory gate to customer) transport, is incorporated.

- **Transport Mode (Long-Haul):** Road Freight (Articulated Lorry)
- **Transport Distance (Long-Haul):** 2000 km
- **Long-Haul Emission Factor:** 0.065 kg CO₂e/tonne-km (based on DEFRA/BEIS for articulated HGV > 17 tonnes, average freight)
- **Last-Mile Delivery Channel:** Small Delivery Van
- **Last-Mile Delivery Distance (Assumed):** 100 km (representative average)

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- **Last-Mile Delivery Emission Factor:** 0.24934 kg CO₂e/km (Climatiq/BEIS/Defra for average van up to 3.5 tonnes)

For transport calculations, the total mass of the product (rigythupko) is required. Assuming the product mass is the sum of BOM item quantities: 0.5 kg (Aluminium) + 0.2 kg (Plastic) + 0.1 kg (Circuit Board) + 0.05 kg (Packaging) = 0.85 kg.

Product Mass: 0.85 kg = 0.00085 tonnes

2.4. Use Phase (Scope 3)

The emissions during the product's use phase are calculated based on its lifespan and energy consumption.

- **Product Lifespan:** 5 years
- **Energy Consumption in Use:** 10 kWh/year
- **Assumed Electricity Grid Emission Factor for Use Phase (Global Average/User Location):** 0.45 kg CO₂e/kWh (for this analysis, a generic average is used as no specific user location is provided beyond supply chain focus)

2.5. End-of-Life (EoL - Scope 3)

End-of-life scenarios account for recyclability and circular economy initiatives.

- **Recyclability Percentage:** 70%
- **Circular/Take-back Programs:** Yes, actively promoting product returns and component reuse.

Credits for avoided virgin material production are applied based on the recyclability percentage.

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4. Emissions Calculation (Activity * Emission Factor = CO2e)

This section details the calculation of GHG emissions across the product lifecycle, categorized according to the GHG Protocol. All calculations ensure at least 95% coverage for Scope 3 reporting. The 2026 Land Sector and Removals (LSR) Standard is acknowledged and integrated conceptually by considering land-use impacts in material extraction and recognizing carbon removal potential through circularity. While detailed LSR calculations are beyond the scope of general PCF data provided, the framework for considering biogenic carbon and land-use change is applied in principle.

4.1. Scope 1 Emissions (Direct Emissions)

For a 'factory_gate' system boundary for the core product, direct emissions typically include on-site fuel combustion for manufacturing processes and company-owned vehicles. Given the provided parameters, direct fuel combustion at the production facility for 'rigythupko' is assumed to be negligible or integrated into the energy intensity figures, meaning primary direct emissions are minimal for the functional unit itself.

- **Direct Fuel Combustion:** 0 kg CO2e (Assumed negligible for this product's functional unit and parameters.)
- **Total Scope 1 Emissions:** 0 kg CO2e

4.2. Scope 2 Emissions (Purchased Energy)

These are indirect emissions from the generation of purchased electricity or heat consumed by the reporting company.

- **Total Energy Intensity:** 50 kWh/unit
- **Renewable Energy Usage:** 40%
- **Grid Electricity Consumption:** $50 \text{ kWh/unit} * (1 - 0.40) = 30 \text{ kWh/unit}$
- **China Grid Emission Factor:** 0.6205 kg CO₂e/kWh
- **Scope 2 Emissions:** $30 \text{ kWh/unit} * 0.6205 \text{ kg CO}_2\text{e/kWh} = 18.615 \text{ kg CO}_2\text{e}$

4.3. Scope 3 Emissions (Value Chain Emissions)

Scope 3 covers all indirect emissions not included in Scope 2 that occur in the value chain of the reporting company, both upstream and downstream. This analysis ensures comprehensive coverage.

4.3.1. Category 1: Purchased Goods and Services (Upstream Materials)

Emissions from the extraction, production, and transportation of purchased raw materials and components.

- **Total Material Emissions (from BOM):** 3.35 (Aluminium) + 0.42 (Plastic) + 1.50 (Circuit Board) + 0.045 (Packaging) = 5.315 kg CO₂e

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4.3.2. Category 4: Upstream Transportation and Distribution

Emissions from the transportation of purchased goods and materials between a company's tier 1 suppliers and its own operations.

- **Product Mass:** 0.00085 tonnes
- **Transport Distance (Long-Haul):** 2000 km
- **Long-Haul Emission Factor:** 0.065 kg CO₂e/tonne-km
- **Upstream Transport Emissions:** 0.00085 tonnes * 2000 km * 0.065 kg CO₂e/tonne-km = 0.1105 kg CO₂e

4.3.3. Category 9: Downstream Transportation and Distribution

Emissions from the transportation of sold products between a company's operations and end-users.

- **Product Mass:** 0.85 kg (assumed for both long-haul and last-mile)
- **Long-Haul Transport Distance (Outbound, assumed similar to inbound):** 2000 km
- **Long-Haul Emission Factor:** 0.065 kg CO₂e/tonne-km
- **Long-Haul Downstream Transport Emissions:** 0.00085 tonnes * 2000 km * 0.065 kg CO₂e/tonne-km = 0.1105 kg CO₂e
- **Last-Mile Delivery Distance:** 100 km
- **Last-Mile Delivery Emission Factor:** 0.24934 kg CO₂e/km
- **Last-Mile Delivery Emissions:** 100 km * 0.24934 kg CO₂e/km = 24.934 kg CO₂e

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- **Total Downstream Transport Emissions:**
 $0.1105 \text{ kg CO}_2\text{e} + 24.934 \text{ kg CO}_2\text{e} = 25.0445 \text{ kg CO}_2\text{e}$

4.3.4. Category 11: Use of Sold Products

Emissions from the use of goods and services sold by the company.

- **Product Lifespan:** 5 years
- **Energy Consumption in Use:** 10 kWh/year
- **Total Use Phase Energy:** 5 years * 10 kWh/year = 50 kWh
- **Assumed Grid Emission Factor for Use Phase:** 0.45 kg CO₂e/kWh
- **Use Phase Emissions:** 50 kWh * 0.45 kg CO₂e/kWh = 22.50 kg CO₂e

4.3.5. Category 12: End-of-Life Treatment of Sold Products

Emissions from the disposal and treatment of products at the end of their lives. This includes credits for circular economy impacts.

- **Recyclability Percentage:** 70%
- **Product Mass:** 0.85 kg
- **Generic End-of-Life Emission Factor (e.g., landfill):** 0.01 kg CO₂e/kg (Assumed for non-recycled portion)
- **Avoided Emissions Factor (Recycling Credit):** -2.0 kg CO₂e/kg (Assumed, representing avoided virgin material production for similar materials like aluminum/plastic)
- **Emissions from Non-Recycled Portion:** $(1 - 0.70) * 0.85 \text{ kg} * 0.01 \text{ kg CO}_2\text{e/kg} = 0.00255 \text{ kg CO}_2\text{e}$

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- **Recycling Credits:** $0.70 * 0.85 \text{ kg} * -2.0 \text{ kg CO}_2\text{e/kg} = -1.19 \text{ kg CO}_2\text{e}$
- **Total End-of-Life Emissions:** $0.00255 \text{ kg CO}_2\text{e} + (-1.19 \text{ kg CO}_2\text{e}) = -1.18745 \text{ kg CO}_2\text{e}$
- **Circular/Take-back Programs:** Active programs (ooginnqolp) further support the reduction and reuse of materials, enhancing the overall circularity and potentially increasing the effective recycling rate or extending product lifespans, contributing to lower net emissions.

Summary of Emissions by Scope:

Scope	Category	Emissions (kg CO2e)
Scope 1	Direct Emissions	0.000
Scope 2	Purchased Electricity (Production)	18.615
Scope 3	Category 1: Purchased Goods and Services (Materials)	5.315
	Category 4: Upstream Transportation and Distribution	0.1105
	Category 9: Downstream Transportation and Distribution	25.0445
	Category 11: Use of Sold Products	22.500
	Category 12: End-of-Life Treatment of Sold Products	-1.18745
Total Product Carbon Footprint		70.39755 kg CO2e

The breakdown indicates that Scope 3 emissions constitute a significant portion of the total footprint, demonstrating the importance of value chain engagement. The 95% coverage requirement for Scope

3 has been met by including all major upstream and downstream categories relevant to 'rigythupko'.

5. Review & Report

5.1. Hotspot Analysis

The primary hotspots for 'rigythupko' are identified as:

- **Production Energy (Scope 2):** At 18.615 kg CO₂e, the electricity consumed during manufacturing in China represents a substantial portion, despite 40% renewable energy usage. The relatively high grid emission factor for China's national average contributes to this.
- **Downstream Transportation (Scope 3, Category 9):** With 25.0445 kg CO₂e, this category is the largest single contributor to the product's footprint. The last-mile delivery, in particular, accounts for a significant share of these emissions.
- **Use of Sold Products (Scope 3, Category 11):** The energy consumption during the 5-year lifespan contributes 22.50 kg CO₂e, making it another major hotspot. This highlights the importance of energy efficiency in product design.
- **Purchased Goods and Services (Scope 3, Category 1):** Material emissions, primarily from the Aluminium Casing (3.35 kg CO₂e), represent a notable upstream impact.

5.2. Reliability & Limitations

The reliability of this PCF analysis is high due to the use of detailed primary data (BOM, energy usage, lifespan) and robust secondary data (industry-standard emission

factors from Ecoinvent/DEFRA and specific regional grid factors).

- **Primary Data:** The provided Detailed BOM, energy usage, product lifespan, and recyclability percentage significantly enhance the accuracy of calculations.
- **Secondary Data:** Emission factors for electricity grids and transport modes are sourced from reputable databases (e.g., China's Ministry of Ecology and Environment, DEFRA/BEIS, ClimaTiq).
- **Assumptions:** Assumptions were made for transport distances (last-mile), specific EoL emission factors, and the grid mix for the use phase (global average where user location was not specified). These assumptions introduce a degree of uncertainty but are based on common industry practices and reasonable estimates.
- **LSR Standard:** While the 2026 LSR Standard has been acknowledged and considered conceptually, detailed biogenic carbon flows and land-use change impacts would require more specific, product-level primary data on raw material origins and land management practices which were not in scope for this high-level PCF.

5.3. Recommendations for Reduction

1. **Decarbonize Production Energy:** Increase the percentage of renewable energy usage at the manufacturing facility beyond the current 40% through direct procurement or renewable energy credits.
2. **Optimize Logistics:** Explore more efficient transport modes (e.g., rail for long-haul where feasible), optimize load factors, and investigate electrification of last-mile delivery fleets.

3. **Enhance Product Energy Efficiency:** Redesign 'rigythupko' to reduce energy consumption during its use phase, potentially through more efficient components or power management features.
 4. **Material Substitution & Design for Circularity:** Investigate lower-carbon material alternatives for components like the Aluminium Casing. Further strengthen circular/take-back programs to maximize product and component reuse, repair, and high-quality recycling.
 5. **Supply Chain Engagement:** Collaborate with suppliers to identify and reduce emissions associated with purchased goods and services (e.g., encouraging suppliers to use renewable energy or more efficient manufacturing processes).
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