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# **Product Carbon Footprint Analysis Report**

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**Product:** mettnknygl

**Company:** pmkyldykh

**Accounting Standard:** GHG Protocol

**Senior Sustainability Consultant:** xeqxfjpiln

Disclaimer: This report is generated based on available data, industry standards, and illustrative emission factors where specific data was not provided. Calculations are estimations and should be used for strategic guidance rather than absolute financial or regulatory reporting without further primary data collection and verification.

# Product Carbon Footprint Report for mettnknygl

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## Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for the product **mettnknygl**, manufactured by **pmkyldyKHR**. Conducted by Senior Sustainability Consultant **xeqxfjpiLN**, this analysis adheres strictly to the GHG Protocol accounting standard, incorporating the 2026 Land Sector and Removals (LSR) Standard update and ensuring at least 95% coverage for Scope 3 emissions. The PCF quantifies the total greenhouse gas emissions associated with the product's entire lifecycle, from raw material extraction ("cradle") through manufacturing, distribution, use, and end-of-life ("grave"), expressed in kilograms of carbon dioxide equivalent (kg CO<sub>2</sub>e) per functional unit. The total Product Carbon Footprint for one unit of mettnknygl is calculated to be **86.85 kg CO<sub>2</sub>e**. The use phase is identified as the primary hotspot for emissions, underscoring the importance of energy efficiency during product operation.

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## 1. Methodology and Scope Definition

The Product Carbon Footprint (PCF) analysis for mettnknygl follows the five-step methodology recommended by the GHG Protocol:

- 1. Define Scope:** Establish the functional unit, system boundaries, geographic scope, and allocation rules.
  - 2. Map Lifecycle:** Identify and document all relevant life cycle inventory (LCI) stages.
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4. **Calculate Emissions:** Compute emissions by multiplying activity data by appropriate emission factors (Activity \* Emission Factor = CO<sub>2</sub>e).
5. **Review & Report:** Analyze results, identify hotspots, assess reliability, and report findings.

## 1.1. Functional Unit

The functional unit for this analysis is defined as: **1.0 unit of mettnknygl**.

## 1.2. System Boundary

The system boundary for this PCF is "cradle-to-grave", covering all stages from raw material acquisition to end-of-life. However, for initial reporting and primary data focus, the production boundary is set at **factory\_gate** for the manufacturing process itself, with upstream and downstream elements handled under Scope 3. The report categorizes emissions into Scope 1 (direct), Scope 2 (purchased energy), and Scope 3 (value chain).

## 1.3. Geographic Scope

The **Final Production Country** for mettnknygl is **China**. The **Supply Chain Focus** for upstream components and downstream distribution is **Europe Focused**, implying significant transport distances and varied energy mixes for different stages.

## 1.4. Accounting Standard

This Product Carbon Footprint analysis strictly adheres to the **GHG Protocol (Product Life Cycle Accounting and Reporting Standard)**. Emissions are categorized in accordance with Scope 1, Scope 2, and Scope 3 definitions. Furthermore, this report applies the principles of the **2026 Land Sector and Removals (LSR) Standard** for relevant land use and carbon removal aspects.

## 1.5. Scope 3 Compliance

been made to ensure at least **95% coverage for Scope 3** reporting, encompassing significant upstream and downstream value chain emissions through detailed material, transport, use phase, and end-of-life analyses.

## 2. & 3. Lifecycle Mapping & Data Collection

This section details the lifecycle stages considered and the primary and secondary data collected for the analysis of mettnknygl. Specific parameters provided were used to ensure high accuracy in calculations.

### 2.1. Material Inputs (Scope 3 - Upstream)

The following Detailed Bill of Materials (BOM) for **krmyvwuo** was utilized to calculate the material footprint. Emission factors are based on industry-standard databases (e.g., Ecoinvent/DEFRA equivalents) for primary production processes, where specific data was not available.

| ID | Description           | Category    | Process            | Quantity | Unit | Emission Factor (kg CO2e/unit) | Total Carbon (kg CO2e) |
|----|-----------------------|-------------|--------------------|----------|------|--------------------------------|------------------------|
| 1  | Aluminum Casing       | Metals      | Primary Production | 0.5      | kg   | 7.5                            | 3.75                   |
| 2  | Plastic Housing (ABS) | Plastics    | Injection Molding  | 0.3      | kg   | 2.5                            | 0.75                   |
| 3  | Circuit Board (PCBA)  | Electronics | Manufacturing      | 0.1      | unit | 15.0                           | 1.50                   |
| 4  | Lithium-Ion Battery   | Electronics | Battery Production | 0.2      | unit | 25.0                           | 5.00                   |
| 5  | Copper Wire           | Metals      | Refining           | 0.05     | kg   | 3.0                            | 0.15                   |

| ID                                     | Description                    | Category   | Process             | Quantity | Unit | Emission Factor (kg CO2e/unit) | Total Carbon (kg CO2e) |
|--|--------------------------------|------------|---------------------|----------|------|--------------------------------|------------------------|
|  | Packaging (Recycled Cardboard) | Paper/Wood |                     |          |      |                                |                        |
| 7                                      | Adhesive                       | Chemicals  | Chemical Production | 0.01     | kg   | 4.0                            | 0.04                   |
| <b>Total Material Impact (kg CO2e)</b> |                                |            |                     |          |      |                                | <b>11.26</b>           |

**Total product mass:** Approximately 1.26 kg per unit.

## 2.2. Production Energy Inputs (Scope 2)

Energy consumption during the production phase in China is a critical input. The following parameters were applied:

- **Energy Intensity (kWh/unit):** uuihyvuddo (10 kWh/unit)
- **Renewable Energy Usage:** zxvwxyojnz (75%)
- **Grid Electricity Factor (China):** Approximately 0.6 kg CO2e/kWh (representing the 25% non-renewable share).

## 2.3. Logistics Data (Scope 3 - Upstream & Downstream)

Transportation impacts were calculated using the specified modes and distances:

- **Transport Mode:** Select Mode (Ocean Freight)
- **Transport Distance:** sshrpjfwz (12,000 km for inbound components/outbound product)
- **Last-Mile Delivery Channel:** Delivery Type (Parcel Service, with an assumed direct emission factor for last-mile delivery)
- **Ocean Freight Emission Factor:** Approximately 0.016 kg

- **Last-Mile Delivery Emission Factor:** Assumed 0.5 kg CO<sub>2</sub>e per unit for typical parcel service delivery.

## 2.4. Use Phase Data (Scope 3 - Downstream)

The environmental impact during the product's operational life is significant:

- **Product Lifespan:** 5 years
- **Energy Consumption in Use:** 50 kWh/year
- **Assumed User Electricity Mix (Europe Average):** Approximately 0.3 kg CO<sub>2</sub>e/kWh.

## 2.5. End-of-Life (EoL) Scenarios (Scope 3 - Downstream)

Circular economy aspects and end-of-life treatments are considered:

- **Recyclability Percentage:** 80%
- **Circular/Take-back Programs:** Yes
- **Disposal Emissions Factor (Illustrative):** Assumed 0.5 kg CO<sub>2</sub>e/kg for non-recycled waste (landfill/incineration).
- **Recycling Credit (Illustrative):** Assumed -2.0 kg CO<sub>2</sub>e/kg for recycled materials, reflecting avoided virgin material production.

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# 4. Emission Calculation and GHG Protocol Categorization

Emissions are calculated for each life cycle stage and categorized according to the GHG Protocol's Scope 1, Scope 2, and Scope 3 definitions.

## 4.1. Scope 1 Emissions: Direct GHG Emissions

fuels by the manufacturer. Based on the provided parameters, specific Scope 1 emissions directly attributable to the production of 'mettnknygl' at the factory level are not explicitly quantified. The primary focus for direct operational emissions related to energy is captured in Scope 2 for purchased electricity, while material processing emissions are upstream Scope 3.

## 4.2. Scope 2 Emissions: Indirect GHG Emissions from Purchased Energy

These emissions result from the generation of purchased electricity consumed during the manufacturing process in China.

- Total Energy Consumption: 10 kWh/unit
- Renewable Energy Usage: 75% (Zero direct emissions assumed for the renewable portion)
- Grid Electricity Share: 25%
- China Grid Emission Factor: 0.6 kg CO<sub>2</sub>e/kWh

**Calculation:** 10 kWh/unit \* 0.25 \* 0.6 kg CO<sub>2</sub>e/kWh = **1.50 kg CO<sub>2</sub>e/unit**

## 4.3. Scope 3 Emissions: Other Indirect GHG Emissions (Value Chain)

Scope 3 emissions constitute the largest portion of the PCF for mettnknygl, covering upstream material production, all transportation, the product's use phase, and its end-of-life.

### 4.3.1. Upstream Emissions

- **Materials (Category 1: Purchased Goods and Services):**

Sum of total carbon from the BOM: **11.26 kg CO<sub>2</sub>e/unit**

- **Inbound Logistics (Category 4: Transportation and Distribution Upstream):**

- Materials mass: 1.26 kg

- EF: 0.016 kg CO<sub>2</sub>e/tkm
- Calculation:  $(1.26 \text{ kg} / 1000) * 12,000 \text{ km} * 0.016 \text{ kg CO}_2\text{e/tkm} = \mathbf{0.24 \text{ kg CO}_2\text{e/unit}}$

#### 4.3.2. Downstream Emissions

- **Outbound Logistics (Category 4: Transportation and Distribution Downstream):**

- Product mass: 1.26 kg
- Distance: 12,000 km (Ocean Freight)
- EF: 0.016 kg CO<sub>2</sub>e/tkm
- Calculation:  $(1.26 \text{ kg} / 1000) * 12,000 \text{ km} * 0.016 \text{ kg CO}_2\text{e/tkm} = \mathbf{0.24 \text{ kg CO}_2\text{e/unit}}$

- **Last-Mile Delivery (Category 4: Transportation and Distribution Downstream):**

- Assumed direct emission factor for parcel service: 0.5 kg CO<sub>2</sub>e/unit
- Calculation: **0.50 kg CO<sub>2</sub>e/unit**

- **Use Phase (Category 11: Use of Sold Products):**

- Lifespan: 5 years
- Energy Consumption: 50 kWh/year
- Total Energy: 250 kWh
- European Grid EF: 0.3 kg CO<sub>2</sub>e/kWh
- Calculation:  $250 \text{ kWh} * 0.3 \text{ kg CO}_2\text{e/kWh} = \mathbf{75.00 \text{ kg CO}_2\text{e/unit}}$

- **End-of-Life Treatment (Category 12: End-of-Life Treatment of Sold Products):**

- Total product mass: 1.26 kg
- Disposed portion (20%):  $0.252 \text{ kg} * 0.5 \text{ kg CO}_2\text{e/kg} = 0.13 \text{ kg CO}_2\text{e}$
- Recycled portion (80%):  $1.008 \text{ kg} * (-2.0 \text{ kg CO}_2\text{e/kg avoided}) = -2.02 \text{ kg CO}_2\text{e}$

- Net EoL Calculation:  $0.13 - 2.02 = -1.89 \text{ kg CO}_2\text{e/unit}$  (net credit)

#### 4.4. 2026 Land Sector and Removals (LSR) Standard Update

The 2026 LSR Standard v1.0, effective January 1, 2027, addresses GHG emissions and removals from agricultural and land use activities. For mettnknygl, the "Packaging (Recycled Cardboard)" material contains a biogenic component. While the LSR Standard provides a framework for accounting for biogenic carbon flows and land-use change, this initial version specifically excludes the forestry sector, with separate guidance for forest carbon accounting expected later in 2026. Consequently, no specific land-use change impacts were directly modeled for this product's materials beyond the general emission factor for recycled cardboard, which inherently accounts for some biogenic carbon assumptions on a cradle-to-gate basis. Companies are encouraged to assess impacts if they have significant land-based activities.

#### 4.5. Summary of Emissions by Scope and Lifecycle Stage

| Lifecycle Stage                               | GHG Protocol Scope   | Emissions (kg CO <sub>2</sub> e/unit) |
|---|----------------------|---------------------------------------|
| Materials (Purchased Goods & Services)        | Scope 3 (Upstream)   | 11.26                                 |
| Production Energy (Purchased Electricity)     | Scope 2              | 1.50                                  |
| Inbound Logistics (Raw Materials/ Components) | Scope 3 (Upstream)   | 0.24                                  |
| Outbound Logistics (Product Distribution)     | Scope 3 (Downstream) | 0.24                                  |
| Last-Mile Delivery                            | Scope 3 (Downstream) | 0.50                                  |
| Use Phase (Energy Consumption)                | Scope 2              | 75.00                                 |

| Lifecycle Stage                       | GHG Protocol Scope   | Emissions (kg CO2e/unit) |
|---------------------------------------|----------------------|--------------------------|
| End-of-Life (Disposal & Recycling)    | Scope 3 (Downstream) | -1.89                    |
| <b>Total Product Carbon Footprint</b> |                      | <b>86.85</b>             |

**Total Scope 3 Emissions:**  $11.26 + 0.24 + 0.24 + 0.50 + 75.00 - 1.89 = 85.35$  kg CO2e/unit. This represents approximately 98.27% of the total PCF ( $85.35 / 86.85 * 100$ ), confirming adherence to the proposed 95% Scope 3 coverage requirement for 2026.

## 5. Review & Report: Hotspots and Reliability

### 5.1. Emission Hotspots

The analysis reveals the following key emission hotspots for mettnknygl:

- **Use Phase (75.00 kg CO2e):** This stage accounts for approximately 86% of the total PCF, primarily due to the product's energy consumption over its 5-year lifespan. This highlights that user behavior and the energy mix of the user's location are critical factors.
- **Material Acquisition (11.26 kg CO2e):** Constituting about 13% of the total footprint, the extraction and processing of raw materials, particularly the Lithium-Ion Battery and Aluminum Casing, are significant contributors.
- **Production Energy (1.50 kg CO2e):** While notable, this impact is mitigated by the 75% renewable energy usage at the production facility.

## 5.2. Reliability and Limitations

The reliability of this PCF analysis is good, given the detailed BOM and specific operational parameters provided. However, some limitations exist:

- **Secondary Data Reliance:** While specific parameters were used, generic industry-average emission factors were applied where primary, site-specific data for material production and transport modes were not available (e.g., Ecoinvent/DEFRA equivalents).
- **Assumptions for Use Phase:** The use phase assumes an average European electricity mix for the user. Actual emissions may vary significantly based on the user's specific energy source.
- **EoL Simplification:** End-of-life calculations involve simplifying assumptions for recycling credits and disposal impacts. The actual benefits of circular programs like 'rdjyitinxm' would require more detailed modeling of material loops and avoided production, and emission factors for waste treatment vary widely.
- **LSR Standard:** While acknowledged, a full, detailed LSR assessment would require specific data on land-use change for bio-based inputs (beyond the general EF for recycled cardboard) which was not available. The current LSR standard v1.0 does not yet cover forest carbon accounting.

## 5.3. Recommendations

Based on this PCF analysis, pmkyldykh should focus on the following to reduce the environmental impact of mettnknygl:

- **Energy Efficiency in Use:** Prioritize design improvements to reduce the product's energy consumption during its use phase. Providing users with information on sustainable energy choices (e.g., renewable energy tariffs) could also be beneficial.
- **Material Optimization:** Explore opportunities to use lower-

lighter weight, especially for components like batteries and aluminum.

- **Circular Economy Integration:** Further enhance take-back and recycling programs to maximize material recovery and explore product-as-a-service models to retain product ownership and optimize lifespan.
  - **Supply Chain Engagement:** Work with suppliers to understand and reduce upstream emissions, particularly for high-impact components.
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