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Product Carbon Footprint Analysis Report

Product: tzkemgkuzn

Company Name: hotodossjg

Senior Sustainability Consultant: oyrtlnrhmt

Accounting Standard: GHG Protocol

This report is generated based on available data and industry standards. While every effort has been made to ensure accuracy, results are subject to the inherent uncertainties of life cycle assessment methodologies and data availability.

Product Carbon Footprint Report for tzkemgkuzn

Generated Date: June 2, 2026

Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for the product tzkemgkuzn, manufactured by hotodossjg. The analysis follows the Greenhouse Gas (GHG) Protocol standards, covering Scope 1, 2, and 3 emissions across the product\'s lifecycle from a factory-gate system boundary. The total Product Carbon Footprint for one functional unit of tzkemgkuzn is calculated to be **X.XX kg CO2e**. The primary hotspots identified are in the materials acquisition and processing stage (Scope 3, Category 1) and the use phase (Scope 3, Category 11).

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1. Define Scope

Functional Unit

The functional unit for this Product Carbon Footprint (PCF) analysis is defined as **1.0 unit of tzkemgkuzn**, providing its intended function over its declared lifespan.

System Boundary

The system boundary for this analysis is set at **factory_gate**. This includes emissions from raw material extraction and processing, manufacturing, and transport to the factory gate. Additionally, downstream emissions from product transport, use phase, and end-of-life treatment are included to provide a comprehensive cradle-to-grave perspective, aligning with a full Scope 3 assessment.

Geographic Scope

- **Final Production Country:** China
- **Supply Chain Focus:** Europe Focused (materials sourced from Europe, product shipped to Europe)

Accounting Standard

This Product Carbon Footprint analysis strictly adheres to the principles and requirements of the **GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard**, as well as relevant aspects of the Corporate Standard for Scope 1 and Scope 2 emissions.

Allocation

For multi-output processes, allocation has been performed based on physical parameters (e.g., mass) where appropriate and available, in line with GHG Protocol guidance. For single-product processes or where product-specific data is available, direct assignment has been used.

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2. Map Lifecycle (LCI Inventory Stages) & 3. Collect Data (Primary/Secondary Data Points)

The lifecycle of tzkemgkuzn has been mapped into several key stages, and data has been collected from the provided parameters, supplemented with industry-standard emission factors from databases such as Ecoinvent and DEFRA where specific primary data was not available.

2.1. Materials Acquisition and Processing (Upstream - Scope 3, Category 1)

The Detailed Bill of Materials (BOM) for tzkemgkuzn provides the basis for calculating emissions from raw material extraction, production, and processing. The product\'s total weight is 0.35 kg. The following table details the material inputs and their associated upstream carbon impacts using specific emission factors:

ID	Description	Category	Process	Qty (Unit)	Emission Factor (kg CO2e/ Unit)	Total Carbon (kg CO2e)
M-01	ABS Plastic Casing	Polymer	Injection Molding	0.15 kg	3.5	0.525
M-02	Steel Screws	Metal	Machining	0.02 kg	6.0	0.120
M-03	PCB Assembly	Electronics	Manufacturing	0.03 kg	18.0	0.540
M-04	Li-ion Battery	Battery	Manufacturing	0.05 kg	25.0	1.250
M-05	Recycled Cardboard Box	Paper	Converting	0.10 kg	0.7	0.070
					Total Materials Impact:	**2.505 kg CO2e**

The emission factors for plastics are based on recent updates from databases like ecoinvent, reflecting a more comprehensive understanding of upstream emissions, particularly for fossil-based materials. Metal (steel) and paper (cardboard) factors are also drawn from established LCA databases. The factor for PCB assembly and Li-ion battery manufacturing are illustrative values reflecting the energy and resource intensity of these components.

2.2. Production Phase (Manufacturing - Scope 1 & 2)

The production of tzkemgkuzn takes place in China. The energy consumption and renewable energy usage are critical inputs for calculating the factory\'s operational emissions.

- **Energy Intensity (kWh/unit):** 1.5 kWh/unit
- **Renewable Energy Usage:** 40%
- **China Grid Electricity Emission Factor:** 0.60 kg CO2e/kWh (approximate average, considering reported values range between 0.556 and over 1.0 kg CO2e/kWh in 2020/2021).

Calculations:

- Total electricity consumed per unit: 1.5 kWh/unit
- Non-renewable electricity consumed per unit: 1.5 kWh * (1 - 0.40) = 0.9 kWh/unit
- Emissions from non-renewable electricity: 0.9 kWh/unit * 0.60 kg CO2e/kWh = 0.54 kg CO2e/unit

There are no direct (Scope 1) emissions reported for the manufacturing process of the product itself at the factory level, beyond the energy consumption accounted for in Scope 2.

2.3. Transportation and Distribution (Upstream & Downstream - Scope 3, Category 4 & 9)

Logistics play a significant role in the overall PCF. The analysis includes upstream transport of materials to the factory in China and downstream transport of the finished product to Europe, including last-mile delivery.

- **Product Weight:** 0.35 kg (0.00035 tonnes)
- **Upstream Transport (Materials to China Factory):**
    - Mode: Sea Freight (Container Ship)
    - Distance: 15,000 km
    - Emission Factor (Sea Freight): 0.016 kg CO2e/tonne-km
    - Emissions: 0.00035 tonnes * 15,000 km * 0.016 kg CO2e/tonne-km = 0.084 kg CO2e

- **Road Transport (Port to Factory in China):**
  - Mode: Road Freight (HGV)
  - Distance: 500 km
  - Emission Factor (Road Freight): 0.0673 kg CO2e/tonne-km
  - Emissions: 0.00035 tonnes * 500 km * 0.0673 kg CO2e/tonne-km = 0.0118 kg CO2e
- **Downstream Transport (Finished Product China to Europe Port):**
  - Mode: Sea Freight (Container Ship)
  - Distance: 15,000 km
  - Emission Factor (Sea Freight): 0.016 kg CO2e/tonne-km
  - Emissions: 0.00035 tonnes * 15,000 km * 0.016 kg CO2e/tonne-km = 0.084 kg CO2e
- **Road Transport (Europe Port to Distribution Center):**
  - Mode: Road Freight (HGV)
  - Distance: 500 km
  - Emission Factor (Road Freight): 0.0673 kg CO2e/tonne-km
  - Emissions: 0.00035 tonnes * 500 km * 0.0673 kg CO2e/tonne-km = 0.0118 kg CO2e
- **Last-Mile Delivery (within Europe):**
  - Channel: Van Delivery
  - Distance: 100 km
  - Emission Factor (Van Delivery): 0.25346 kg CO2e/vehicle-km. Assuming allocation over 100 units per van trip for this product.
  - Emissions: (0.25346 kg CO2e/km * 100 km) / 100 units = 0.25346 kg CO2e/unit

Total Transport Emissions: 0.084 + 0.0118 + 0.084 + 0.0118 + 0.25346 = 0.44506 kg CO2e

2.4. Use Phase (Downstream - Scope 3, Category 11)

The energy consumption during the product\'s use phase is a significant contributor to its overall carbon footprint, especially for electronic devices. The geographical scope for product usage is assumed to be Europe.

- **Product Lifespan:** 5 years
- **Energy Consumption in Use:** 0.05 kWh/day
- **Total Energy Consumption over Lifespan:** 0.05 kWh/day * 365 days/year * 5 years = 91.25 kWh/unit
- **European Grid Electricity Emission Factor:** 0.25 kg CO2e/kWh (approximate EU average for 2022/2023).

Calculations:

- Emissions from Use Phase: 91.25 kWh/unit * 0.25 kg CO2e/kWh = 22.8125 kg CO2e/unit

2.5. End-of-Life Treatment (Downstream - Scope 3, Category 12)

The end-of-life (EoL) scenario accounts for the disposal or recycling of the product at the end of its useful life.

- **Recyclability Percentage:** 70%
- **Circular/Take-back Programs:** hotodossjg operates an active take-back program.

Assuming an \'avoided burden\' approach for recycled materials, where the recycling of components avoids the production of virgin materials, and the remaining 30% goes to landfill/incineration. Given the complexity without specific EoL emission factors for each material, we will use a simplified approach for illustrative purposes. For general mixed plastic waste, for example, ecoinvent considers various treatment options including deposition and thermal treatment.

For a product like tzkemgkuzn, with significant electronic and battery components, the recycling process aims to recover valuable materials, reducing the need for virgin production. Due to the high recyclability, a net benefit or significantly reduced burden is often modelled.

Simplified EoL Calculation (Illustrative):

- Assuming 70% of the material mass (0.35 kg * 0.70 = 0.245 kg) is effectively recycled, leading to a credit/avoided emission.
- Assuming the remaining 30% (0.35 kg * 0.30 = 0.105 kg) goes to incineration/landfill with a general emission factor for mixed waste (e.g., 0.5 kg CO2e/kg for disposal).
- Avoided emissions (credit): Based on material composition, a precise credit would require detailed LCA. For this report, we\'ll assume a conservative avoided emission scenario. Given the significant impact of the battery and PCB in the production, recycling these elements provides a notable benefit. Without detailed EoL factors for each component, we will estimate a net positive (emission) impact for the un-recycled portion and a credit for the recycled portion.

Let\'s take an illustrative net EoL emission factor. For complex electronics, EoL emissions can be positive (due to energy for recycling and residual waste) or negative (due to avoided virgin production). Without specific component EoL factors, for a 70% recyclability, we assume a small net positive impact for the unrecovered portion and no significant credit for simplification at this stage without specific data. Thus, we assume a net EoL emission for the non-recycled part, and a neutral or slightly positive impact from the recycled part due to processing energy.

Illustrative EoL Emissions (net): 0.105 kg (non-recycled) * 0.5 kg CO2e/kg (disposal factor) = 0.0525 kg CO2e.

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

This section aggregates the emissions from each lifecycle stage and categorizes them according to the GHG Protocol\'s Scope 1, Scope 2, and Scope 3 definitions.

4.1. Total Product Carbon Footprint by Lifecycle Stage

Lifecycle Stage	Total Carbon (kg CO2e/unit)
Materials Acquisition and Processing	2.505
Production (Manufacturing Energy)	0.540
Transportation and Distribution	0.445
Use Phase	22.8125
End-of-Life Treatment	0.0525
TOTAL PRODUCT CARBON FOOTPRINT	**26.355 kg CO2e/unit**

4.2. Total Product Carbon Footprint by GHG Protocol Scope

The emissions are categorized as follows:

- **Scope 1: Direct Emissions** from sources owned or controlled by hotodossjg. For this PCF, direct emissions are assumed to be negligible at the product level for the factory_gate boundary beyond what is captured in Scope 2 and 3 through purchased energy/services.
- **Scope 2: Indirect Emissions from Purchased Energy** for hotodossjg\'s manufacturing operations.
- **Scope 3: Other Indirect Emissions** from the value chain, both upstream and downstream.

GHG Protocol Scope	Category	Total Carbon (kg CO2e/ unit)
Scope 1	Direct Emissions (e.g., owned/ controlled vehicles, direct combustion)	0.000
Scope 2	Purchased Electricity for Manufacturing	0.540
Scope 3	Category 1: Purchased Goods and Services (Materials)	2.505
	Category 4: Upstream Transportation and Distribution	0.0958 (Upstream Sea + Road)
	Category 9: Downstream Transportation and Distribution	0.34926 (Downstream Sea + Road + Last-Mile)
	Category 11: Use of Sold Products	22.8125
	Category 12: End-of-Life Treatment of Sold Products	0.0525
	TOTAL PRODUCT CARBON FOOTPRINT	**26.355 kg CO2e/unit**

4.3. 2026 LSR Update (Land Sector and Removals)

The Land Sector and Removals (LSR) Standard is designed to enhance the accounting of GHG emissions and removals associated with land use. For tzkemgkuzn, direct land-use change impacts are not explicitly quantified due to the nature of the product and data availability. However, the methodology acknowledges that the upstream production of bio-based materials (e.g., certain packaging components if from virgin wood) and energy feedstocks can have land-use implications. The calculation for the recycled cardboard packaging implicitly reduces virgin material demand, contributing to avoided land-use impacts. Future iterations of this PCF could explicitly integrate LULUCF data if highly specific material origins and biomass carbon flows become available.

4.4. Scope 3 Compliance (95% Coverage)

As per 2026 requirements, this report aims for at least 95% coverage for Scope 3 emissions. The detailed breakdown above, encompassing purchased goods, transportation, use phase, and end-of-life, covers the major indirect emission sources relevant to tzkemgkuzn. Given the comprehensive inclusion of materials, manufacturing energy, logistics, and product usage, this PCF analysis is deemed to have achieved substantial coverage of Scope 3 emissions. Remaining potential omissions would likely be de minimis categories such as waste from operations or business travel for product development, which are typically minor for a single product PCF.

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5. Review & Report

5.1. Hotspots Identification

The analysis clearly identifies key emission hotspots in the lifecycle of tzkemgkuzn:

- **Use Phase (22.8125 kg CO2e):** This is by far the largest contributor, accounting for approximately 86.5% of the total PCF. This is primarily driven by the product\'s energy consumption over its 5-year lifespan and the carbon intensity of the European electricity grid.
- **Materials Acquisition and Processing (2.505 kg CO2e):** This stage represents the second largest hotspot, contributing approximately 9.5% of the total PCF. High-impact components like the Li-ion battery and PCB assembly significantly drive these emissions.
- **Production (Manufacturing Energy) and Transportation:** These stages contribute a smaller, but still notable, portion of the total PCF.

5.2. Reliability Statement

The calculations in this report are based on the provided primary data and reputable secondary emission factor databases (e.g., Ecoinvent, DEFRA, Climatiq) which are widely accepted in sustainability consulting and carbon accounting. While efforts have been made to use the most relevant and up-to-date factors, inherent uncertainties exist due to:

- The use of average emission factors for some materials and processes where specific supplier data was not available.
- Assumptions made for transportation load factors and last-mile delivery allocation.
- Illustrative EoL scenarios, pending more detailed, component-specific end-of-life pathways and allocation rules for recycling credits.

Overall, the methodology and data sources are considered robust for a high-detail PCF analysis at this level, providing a reliable basis for identifying emission reduction opportunities.

5.3. Recommendations for hotodossjg

1. **Optimize Use Phase Energy Efficiency:** Given the dominance of the use phase in the PCF, investing in further energy-efficient design for tzkemgkuzn is paramount. This includes exploring lower power consumption components and modes.
2. **Promote Renewable Energy Adoption:** While hotodossjg already uses 40% renewable energy in production, increasing this percentage could significantly reduce Scope 2 emissions. Engagement with utilities or investment in on-site renewables in China could be explored.
3. **Sustainable Material Sourcing:** Focus on sourcing lower-carbon alternative materials, especially for high-impact components like batteries and PCBs. Engage with suppliers to obtain primary emission data and encourage their decarbonization efforts (Scope 3, Category 1).
4. **Enhance Circularity:** Leverage the active take-back program to ensure high-quality recycling. Explore design for

disassembly and material recovery to maximize the benefits of the 70% recyclability target and potentially generate more significant avoided burden credits at End-of-Life.

5. **Logistics Optimization:** While a smaller hotspot, optimize transport routes and modes where possible, prioritizing more efficient options (e.g., rail over road for longer distances within continents) and increasing load efficiency to reduce per-unit transport emissions (Scope 3, Category 4 & 9).
