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Product Carbon Footprint (PCF) Analysis Report

For the Product: wevqqgfkhx
(Smart Home Hub)

Company Name: mzzztrktge

Senior Sustainability Consultant:
xpgerpxihw

Accounting Standard: GHG
Protocol

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available data and industry standards,
including specific parameters provided by the

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This high-detail Product Carbon Footprint (PCF) analysis has been performed for the product 'wevqqgfkhx' (Smart Home Hub), manufactured by mzzztrktge. The assessment strictly adheres to the Greenhouse Gas (GHG) Protocol, incorporating recent 2026 updates for land sector emissions and enhanced Scope 3 reporting requirements.

1. Executive Summary

This report quantifies the cradle-to-grave carbon footprint of the 'wevqqgfkhx' Smart Home Hub, revealing key emission hotspots across its lifecycle. The total carbon footprint for the functional unit of 1.0 unit is calculated to be approximately 15.59 kgCO₂e. The most significant contributions stem from the use phase, followed by material acquisition and production energy. Implementing circular economy principles and improving supply chain efficiency are crucial for mzzztrktge to further reduce its environmental impact.

2. Methodology

The PCF analysis followed the five core steps of the GHG Protocol Product Standard:

1. Define Scope

- **Functional Unit:** 1.0 unit of 'wevqqgfkx' (Smart Home Hub).
- **System Boundary:** Cradle-to-grave. While the primary production boundary for manufacturing is "factory_gate" (China), the analysis extends to cover downstream transportation, use phase, and end-of-life treatments to provide a comprehensive lifecycle assessment.
- **Geographic Scope:** Final Production Country: China; Supply Chain Focus: Europe Focused (for raw material origins and distribution to end-users).
- **Allocation:** Emissions are allocated directly to the functional unit based on mass and energy consumption. Recycling benefits are accounted for using an avoided burden approach at the end-of-life stage.
- **Accounting Standard:** This analysis strictly adheres to the GHG Protocol Product Life Cycle Accounting and Reporting Standard. Emissions are categorized into Scope 1 (direct emissions), Scope 2 (purchased energy), and Scope 3 (value chain emissions).

2. Map Lifecycle (LCI Inventory Stages)

The lifecycle of the 'wevqqgfkhx' Smart Home Hub was mapped into the following stages:

- **Material Acquisition & Pre-processing:** Extraction, processing, and manufacturing of raw materials.
- **Manufacturing/Production:** Assembly of components into the final product at the factory in China.
- **Transportation & Distribution:** Upstream transport of raw materials to the factory, and downstream transport of finished goods to distribution centers and end-users.
- **Use Phase:** Energy consumption during the product's operational lifespan.
- **End-of-Life (EoL):** Disposal (landfill) and recovery (recycling/refurbishment) processes.

3. Collect Data (Primary/Secondary Data Points)

Data was collected based on client-provided parameters and supplemented with industry-standard emission factors where primary data was unavailable or unspecified. The Detailed Bill of Materials (BOM) was used for material impact calculation.

Detailed Breakdown of Materials and Energy Inputs:

ID	Description	Category	Process	Qty	Unit	Emission Factor (kgCO2e/unit_qty)	Total Carbo (kgCO
1		Plastics		0.3	kg	3.5	1.05

ID	Description	Category	Process	Qty	Unit	Emission Factor (kgCO2e/unit_qty)	Total Carbo (kgCO
	ABS Plastic Casing		Injection Molding				
2	Printed Circuit Board (PCB)	Electronics	Fabrication	0.05	unit	25.0	1.25
3	Lithium-ion Battery	Electronics	Manufacturing	0.02	kg	18.0	0.36
4	Copper Wiring	Metals	Extrusion	0.01	kg	5.0	0.05
5	Electronic Components (Chips)	Electronics	Assembly	0.01	unit	50.0	0.50
6	Packaging (Cardboard)	Paper/ Wood	Converting	0.1	kg	1.5	0.15

Total Product Weight: Approximately 0.49 kg (excluding packaging from product weight for transport calculations where applicable).

Production Energy Data:

- **Energy Intensity (kWh/unit):** 18 kWh/unit [cite: ulmhggnied]
- **Renewable Energy Usage:** 60% [cite: guhwuxpfpw]
- **Non-renewable energy consumption:** 18 kWh/unit * (1 - 0.60) = 7.2 kWh/unit.
- **Electricity Grid Emission Factor (China):** 0.577 kgCO2e/kWh

Logistics Data:

- **Upstream Transport (Raw Materials from Europe to China):**
 - **Mode:** Ocean Freight (Container Ship) [cite: Select Mode]
 - **Distance:** 12,000 km [cite: yjyonkiffw]
 - **Emission Factor (Ocean Freight):** 0.016 kgCO₂e/tonne-km
- **Downstream Transport (Finished Goods from China to European Distribution Centers):**
 - **Mode:** Road Freight (Heavy Goods Vehicle) [cite: Select Mode]
 - **Distance:** 800 km [cite: yjyonkiffw]
 - **Emission Factor (Road Freight):** 0.09 kgCO₂e/tonne-km (estimated average)
- **Last-Mile Delivery Channel (to end-user):**
 - **Type:** Parcel Delivery Service (Diesel Van) [cite: Delivery Type]
 - **Assumed Distance:** 100 km
 - **Emission Factor (Last-Mile Delivery):** 0.15 kgCO₂e/tonne-km (estimated average)

Use Phase Data:

- **Product Lifespan:** 7 years [cite: opfqrhlhze]
- **Energy Consumption in Use:** 5 kWh/year [cite: kmyzeuwlij]
- **Electricity Grid Emission Factor (Europe - for use phase):** 0.25 kgCO₂e/kWh (estimated average for generic European market)

End-of-Life (EoL) Data:

- **Recyclability Percentage:** 70% (of product weight) [cite: hleehiyrwn]
- **Circular/Take-back Programs:** Manufacturer-operated take-back program for electronic waste, component harvesting for refurbishment [cite: zvmringgyt]. This indicates an intent to maximize material recovery and reuse.
- **Landfill Emission Factor (for residual waste):** 0.8 kgCO₂e/kg (estimated average for mixed electronics waste)
- **Recycling Benefit Factor:** A 40% reduction in emissions compared to virgin material production for the recycled portion.

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

Emissions were calculated for each lifecycle stage and categorized according to the GHG Protocol.

A. Material Acquisition & Pre-processing (Scope 3, Category 1 - Purchased Goods and Services)

Based on the Detailed Bill of Materials (BOM):

- ABS Plastic Casing: 1.05 kgCO₂e
- Printed Circuit Board (PCB): 1.25 kgCO₂e
- Lithium-ion Battery: 0.36 kgCO₂e
- Copper Wiring: 0.05 kgCO₂e
- Electronic Components (Chips): 0.50 kgCO₂e
- Packaging (Cardboard): 0.15 kgCO₂e

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Total Material Emissions: 3.36 kgCO₂e

B. Manufacturing/Production (Factory Gate)

- **Production Energy (Scope 2 - Purchased Electricity):**
 $7.2 \text{ kWh/unit (non-renewable)} * 0.577 \text{ kgCO}_2\text{e/kWh (China grid)} = 4.15 \text{ kgCO}_2\text{e}$
- **Manufacturing Waste (Scope 3, Category 5 - Waste Generated in Operations):**
Assuming 5% manufacturing waste of total product weight ($0.49 \text{ kg} * 0.05 = 0.0245 \text{ kg}$).
 $0.0245 \text{ kg} * 0.5 \text{ kgCO}_2\text{e/kg (generic landfill EF)} = 0.01 \text{ kgCO}_2\text{e}$

Total Production Emissions (Scope 2 & 3): 4.16 kgCO₂e

C. Transportation & Distribution

Product Weight: 0.49 kg (0.00049 tonnes)

- **Upstream Transport (Ocean Freight):**
 $0.00049 \text{ tonnes} * 12,000 \text{ km} * 0.016 \text{ kgCO}_2\text{e/tonne-km} = 0.09 \text{ kgCO}_2\text{e (Scope 3, Category 4)}$
- **Downstream Transport (Road Freight):**
 $0.00049 \text{ tonnes} * 800 \text{ km} * 0.09 \text{ kgCO}_2\text{e/tonne-km} = 0.04 \text{ kgCO}_2\text{e (Scope 3, Category 9)}$
- **Last-Mile Delivery (Parcel Van):**
 $0.00049 \text{ tonnes} * 100 \text{ km} * 0.15 \text{ kgCO}_2\text{e/tonne-km} = 0.01 \text{ kgCO}_2\text{e (Scope 3, Category 9)}$

Total Transportation & Distribution Emissions: 0.14 kgCO₂e

D. Use Phase (Scope 3, Category 11 - Use of Sold Products)

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- **Total Energy Consumption:** $5 \text{ kWh/year} * 7 \text{ years} = 35 \text{ kWh}$

- **Use Phase Emissions:** $35 \text{ kWh} * 0.25 \text{ kgCO}_2\text{e/kWh (Europe grid)} = 8.75 \text{ kgCO}_2\text{e}$

Total Use Phase Emissions: 8.75 kgCO₂e

E. End-of-Life (EoL) (Scope 3, Category 12 - End-of-Life Treatment of Sold Products)

Product Weight: 0.49 kg

- **Weight Recycled:** $0.49 \text{ kg} * 0.70 = 0.343 \text{ kg}$
- **Weight to Landfill:** $0.49 \text{ kg} * (1 - 0.70) = 0.147 \text{ kg}$
- **Landfill Emissions:** $0.147 \text{ kg} * 0.8 \text{ kgCO}_2\text{e/kg} = 0.12 \text{ kgCO}_2\text{e}$
- **Recycling Credit (Avoided Virgin Production):**
Average material EF = $3.36 \text{ kgCO}_2\text{e} / 0.49 \text{ kg} = 6.86 \text{ kgCO}_2\text{e/kg}$.
Avoided emissions for recycled weight = $0.343 \text{ kg} * 6.86 \text{ kgCO}_2\text{e/kg} * 0.40 \text{ (40\% reduction)} = -0.94 \text{ kgCO}_2\text{e}$

Net End-of-Life Emissions: 0.12 kgCO₂e (landfill) - 0.94 kgCO₂e (recycling credit) = -0.82 kgCO₂e

Overall Product Carbon Footprint Summary by Scope:

Scope	Category	Emissions (kgCO ₂ e)
Scope 1	Direct Emissions (negligible for this PCF)	0.00
Scope 2	Purchased Electricity (Production)	4.15
Total Product Carbon Footprint (kgCO₂e)		15.59

Scope	Category	Emissions (kgCO ₂ e)
Scope 3	Category 1: Purchased Goods and Services (Materials)	3.36
	Category 4: Upstream Transportation and Distribution	0.09
	Category 5: Waste Generated in Operations (Manufacturing)	0.01
	Category 9: Downstream Transportation and Distribution	0.04
	Category 11: Use of Sold Products	8.75
	Category 12: End-of-Life Treatment of Sold Products	-0.82
Total Product Carbon Footprint (kgCO₂e)		15.59

The total Product Carbon Footprint for one unit of 'wevqqgfkx' is **15.59 kgCO₂e**.

5. Review & Report (Hotspots and Reliability)

Emission Hotspots:

- **Use Phase:** Representing approximately 56% of the total PCF (8.75 kgCO₂e), the energy consumption during the product's 7-year lifespan is the most significant hotspot. This highlights the importance of energy efficiency during product operation and promoting renewable energy sources for end-users.

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- **Production Energy (Scope 2):** At approximately 27% of the total PCF (4.15 kgCO₂e), the electricity consumed during manufacturing in China is a substantial contributor. Increasing the use of

renewable energy at production facilities beyond the current 60% would significantly reduce this impact.

- **Material Acquisition (Scope 3, Category 1):** Materials account for approximately 22% of the total PCF (3.36 kgCO₂e), indicating the importance of sustainable material choices, lightweighting, and sourcing materials with lower embedded carbon.

Reliability & Data Quality:

The analysis leveraged specific primary data provided for the Bill of Materials, production energy customization, transport distances, product lifespan, and use-phase energy consumption, enhancing accuracy. Secondary emission factors were used from reputable sources (e.g., IMO, national grid averages, industry averages) for transport, energy, and waste, where specific primary data was not available. The inherent variability in secondary data introduces a degree of uncertainty, however, the comprehensive nature of the calculation aims to provide a robust estimate.

The inclusion of circular economy impacts through recyclability and take-back programs provides a more holistic view of the product's environmental performance.

2026 GHG Protocol Updates Adherence:

- **Land Sector and Removals (LSR) Standard:** As of January 30, 2026, the LSR Standard was released, becoming effective January 1, 2027. This report acknowledges the LSR Standard, which provides accounting requirements for land emissions and CO₂ removals, building on existing GHG Protocol standards. Given that '\wevqqgfkx\' is an electronic product, direct application of the

LSR Standard for its own operations may be limited. However, future analyses should investigate upstream supply chain impacts related to land use for raw material extraction if relevant (e.g., mining of specific metals) to align with the LSR standard's applicability to land-based activities in the value chain.

- **Scope 3 Compliance (95% Coverage):** The GHG Protocol's 2026 revisions propose a requirement for at least 95% coverage of required Scope 3 emissions for compliance. This report covers major Scope 3 categories including purchased goods and services, upstream and downstream transportation, waste generated in operations, use of sold products, and end-of-life treatment. These categories are expected to encompass the vast majority of the value chain emissions, aligning with the intent of the 95% coverage threshold and demonstrating a high level of completeness.

Recommendations:

- **Energy Efficiency in Use:** Invest in R&D to reduce the power consumption of the Smart Home Hub during its operational phase, as this is the largest emission hotspot.
- **Renewable Energy Sourcing:** Collaborate with manufacturing partners in China to increase the share of renewable energy powering production facilities.
- **Material Optimization:** Explore alternative, lower-carbon materials for components and packaging, and investigate opportunities for recycled content integration.
- **Logistics Optimization:** Continuously optimize transportation routes, modes, and load factors to minimize freight emissions.

- **Circular Economy Integration:** Further develop and promote take-back and refurbishment programs to maximize material value and extend product lifespan, reducing the need for virgin materials.
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