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Product Carbon Footprint Analysis

For Smart Home Hub (sdfmwjpdrg)

Protocol Data (Accounting Standard): GHG
Protocol

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Disclaimer: This report is generated based on available data, industry standards, and specified parameters. While efforts have been made to ensure accuracy, the actual environmental impact may vary depending on real-world conditions and the precision of input data. This report serves as an estimate for sustainability assessment and strategic planning.

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1. Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for the "Smart Home Hub" (sdfmwjpdrg) manufactured by EcoInnovate Solutions (vrvyeinoke). Conducted by Dr. Eleanor Vance (xogiqilyzn), Senior Sustainability Consultant, this analysis adheres strictly to the GHG Protocol, including the 2026 Land Sector and Removals (LSR) Standard and stringent Scope 3 coverage requirements. The total Cradle-to-Gate (factory_gate) with Use and End-of-Life phases PCF for one functional unit of the Smart Home Hub is estimated to be **24.41 kg CO2e**. The primary emission hotspots identified are the Use Phase, followed by Production Energy and Material Acquisition.

2. Methodology Adherence to GHG Protocol

This Product Carbon Footprint (PCF) analysis is conducted in full accordance with the Greenhouse Gas (GHG) Protocol Product Standard. The methodology systematically follows a five-step approach to ensure comprehensive and accurate emissions accounting.

2.1. GHG Protocol Categorization

- **Scope 1 (Direct Emissions):** Emissions from sources owned or controlled by EcoInnovate Solutions (vrvyeinoke) at the production facility (e.g., fuel combustion in company vehicles or stationary sources).
- **Scope 2 (Purchased Energy Emissions):** Indirect emissions from the generation of purchased electricity

consumed by Ecolnnovate Solutions (vrvyeinoke) at the production facility.

- **Scope 3 (Value Chain Emissions):** All other indirect emissions both upstream and downstream in the product's value chain, including material extraction, transportation, product use, and end-of-life treatment. This report ensures at least 95% coverage for Scope 3 reporting, as per the evolving 2026 requirements.

2.2. 2026 Land Sector and Removals (LSR) Standard Update

The analysis incorporates the principles of the 2026 Land Sector and Removals (LSR) Standard. While specific land-use change data for individual components were not provided, the conceptual framework for accounting for biogenic carbon flows and removals is acknowledged and applied where relevant data becomes available in future iterations. For the current analysis, primary focus remains on industrial process emissions and energy-related emissions.

2.3. Methodology Steps

1. Define Scope:

- **Functional Unit:** 1.0 unit of the Smart Home Hub (sdfmwjpdrg).
- **System Boundary:** Cradle-to-Gate (factory_gate), encompassing raw material acquisition, manufacturing, distribution, use phase, and end-of-life.
- **Geographic Scope:** Final Production Country: China; Supply Chain Focus: Europe Focused (for distribution and potentially use phase).
- **Accounting Standard:** GHG Protocol Product Standard.
- **Allocation:** Emissions are allocated directly to the functional unit based on mass and energy consumption. Co-product allocation is not applicable for this single product analysis.

2. Map Lifecycle (LCI Inventory Stages):

- Raw Material Acquisition & Pre-processing (Upstream)
- Manufacturing (Core Processes)
- Transportation (Upstream & Downstream)
- Use Phase (Product in operation)

- End-of-Life Treatment (Disposal, Recycling)
3. **Collect Data (Primary/Secondary Data Points):** Primary data (BOM, energy usage) provided by EcoInnovate Solutions (vrvyeinoke) and supplemented by secondary, industry-average emission factors (e.g., from Ecoinvent/DEFRA).
 4. **Calculate Emissions:** Activity data multiplied by relevant emission factors to quantify CO2e emissions for each lifecycle stage.
 5. **Review & Report:** Identification of emission hotspots, assessment of data reliability, and presentation of findings.
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3. Detailed Breakdown of Materials and Energy Inputs

3.1. Detailed Bill of Materials (BOM) Analysis

The following Bill of Materials (BOM) for the Smart Home Hub (sdfmwjpdrg) was provided as "mzxedzpo". The specific values for Quantity, Emission Factor, and Total Carbon for each item have been directly incorporated into the material impact calculations.

ID	Description	Category	Process	Qty (kg)	Unit	Emission Factor (kg CO2e/kg)	Total Carbon (kg CO2e)
M001	Aluminum Casing	Metal	Extrusion	0.20	kg	7.0	1.400
M002	Recycled ABS Plastic Enclosure	Plastic	Injection Molding	0.15	kg	1.5	0.225
M003	Copper Wire	Metal	Drawing	0.05	kg	4.0	0.200
M004		Electronics	Assembly	0.08	kg	18.0	1.440
Total Material Mass:						0.58 kg	3.315 kg CO2e

ID	Description	Category	Process	Qty (kg)	Unit	Emission Factor (kg CO2e/kg)	Total Carbon (kg CO2e)
	PCB with Components						
M005	Packaging (Recycled Cardboard)	Packaging	Converting	0.10	kg	0.5	0.050
Total Material Mass:						0.58 kg	3.315 kg CO2e

3.2. Energy Inputs for Production

- **Final Production Country:** China
- **Energy Intensity (kWh/unit):** 25 kWh/unit (dfsqetplls)
- **Renewable Energy Usage:** 60% (hekipiwkzp)

This implies 40% of the energy consumed for production is sourced from the conventional grid mix in China.

3.3. Logistics Data

- **Primary Transport Mode:** Ocean Freight (bulk) from China to Europe.
- **Secondary Transport Mode:** Road Freight (Heavy Goods Vehicle) within Europe to the factory.
- **Transport Distance (Upstream):**
 - Ocean Freight (China to Europe): 20,000 km (part of gluijovlmr)
 - Road Freight (Europe Hub to Factory): 500 km (part of gluijovlmr)
- **Last-Mile Delivery Channel:** Road Freight (Light Commercial Vehicle) (Delivery Type)
- **Last-Mile Delivery Distance (Estimated):** 50 km

3.4. Use Phase Data

- **Product Lifespan:** 7 years (hqyqdskmng)

- **Energy Consumption in Use:** 8 kWh/year (lptnjdqugh)

3.5. End-of-Life (EoL) Scenarios

- **Recyclability Percentage:** 85% (exzdsugtnn)
 - **Circular/Take-back Programs:** Company-operated take-back and refurbishment program in key markets (ttjxqiyply). This program is expected to significantly reduce landfill burden and promote material circularity.
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4. Calculation of Emissions (Activity * Emission Factor = CO2e)

Emissions are calculated based on the activity data from Section 3 and relevant industry-standard emission factors. All emission factors used are expressed in kg CO2e.

4.1. Emission Factors Used (Illustrative & Industry-Standard)

- **Electricity (China Grid Average):** 0.70 kg CO2e/kWh (Based on 2022 provincial average, noting regional variations).
- **Electricity (European Average Grid Mix for Use Phase):** 0.25 kg CO2e/kWh (Approximate EU average, considering the product is sold in Europe).
- **Ocean Freight (Container Ship):** 0.005 kg CO2e/tkm (for bulk goods, represents an average for long-haul).
- **Road Freight (Heavy Goods Vehicle - HGV):** 0.08 kg CO2e/tkm (for primary road transport).
- **Road Freight (Light Commercial Vehicle - LCV, Last Mile):** 0.20 kg CO2e/tkm (for last-mile delivery, reflecting lower load factors).
- **End-of-Life (Disposal/Incineration):** 0.10 kg CO2e/kg (for non-recycled waste, general mixed waste assumption).

4.2. Emissions by Scope and Lifecycle Stage

4.2.1. Scope 3 - Upstream Emissions

- **Materials Acquisition (from BOM):**
 - Total Material Carbon: 3.315 kg CO₂e
- **Transportation (Upstream):**
 - Total Product Mass: 0.58 kg = 0.00058 tonnes
 - **Ocean Freight (China to Europe):** 0.00058 t * 20,000 km * 0.005 kg CO₂e/tkm = 0.058 kg CO₂e
 - **Road Freight (Europe Hub to Factory):** 0.00058 t * 500 km * 0.08 kg CO₂e/tkm = 0.0232 kg CO₂e
 - Total Upstream Transportation: 0.058 + 0.0232 = 0.0812 kg CO₂e

4.2.2. Scope 1 & 2 - Production Emissions (Factory Gate - China)

- Energy Intensity: 25 kWh/unit
- Renewable Energy Usage: 60%
- Non-renewable energy: 25 kWh * (1 - 0.60) = 10 kWh/unit
- China Grid Emission Factor: 0.70 kg CO₂e/kWh
- **Production Emissions:** 10 kWh/unit * 0.70 kg CO₂e/kWh = 7.00 kg CO₂e

4.2.3. Scope 3 - Downstream Emissions

- **Transportation (Last-Mile Delivery):**
 - Total Product Mass: 0.58 kg = 0.00058 tonnes
 - Last-Mile Distance: 50 km
 - LCV Emission Factor: 0.20 kg CO₂e/tkm
 - **Last-Mile Delivery Emissions:** 0.00058 t * 50 km * 0.20 kg CO₂e/tkm = 0.0058 kg CO₂e
- **Use Phase:**
 - Product Lifespan: 7 years
 - Energy Consumption in Use: 8 kWh/year
 - Total Energy in Use: 7 years * 8 kWh/year = 56 kWh
 - European Average Grid Emission Factor: 0.25 kg CO₂e/kWh
 - **Use Phase Emissions:** 56 kWh * 0.25 kg CO₂e/kWh = 14.00 kg CO₂e

- **End-of-Life (EoL):**

- Total Product Mass: 0.58 kg
- Recyclability Percentage: 85%
- Mass to disposal (non-recycled): $0.58 \text{ kg} * (1 - 0.85) = 0.087 \text{ kg}$
- Disposal Emission Factor: 0.10 kg CO₂e/kg
- **EoL Disposal Emissions:** $0.087 \text{ kg} * 0.10 \text{ kg CO}_2\text{e/kg} = 0.0087 \text{ kg CO}_2\text{e}$
- The 85% recyclability and the company's take-back programs (ttjxqiyply) represent significant avoided emissions due to material recovery and reuse. While not quantified as a negative emission in this cradle-to-gate plus use/EoL approach, this significantly reduces the overall environmental burden compared to a 100% disposal scenario.

4.3. Total Product Carbon Footprint (PCF) Summary

Lifecycle Stage	Scope	Emissions (kg CO ₂ e)
Materials Acquisition	Scope 3 (Upstream)	3.315
Upstream Transportation	Scope 3 (Upstream)	0.0812
Production Energy	Scope 1 & 2	7.000
Last-Mile Delivery	Scope 3 (Downstream)	0.0058
Use Phase	Scope 3 (Downstream)	14.000
End-of-Life (Disposal)	Scope 3 (Downstream)	0.0087
TOTAL PRODUCT CARBON FOOTPRINT (per 1.0 unit)		24.41 kg CO₂e

5. Review & Report

5.1. Emission Hotspots

The analysis reveals the following major emission hotspots for the Smart Home Hub (sdfmwjpdrg):

- **Use Phase (14.00 kg CO2e / 57.3%):** This is the most significant contributor to the PCF, primarily due to the energy consumption over the product's 7-year lifespan. This highlights the importance of energy-efficient design and the carbon intensity of the electricity grid in the regions where the product is used.
- **Production Energy (7.00 kg CO2e / 28.7%):** Despite 60% renewable energy usage, the remaining grid electricity in China still contributes substantially due to its carbon intensity. Further investment in on-site renewables or sourcing certified renewable energy credits could reduce this.
- **Materials Acquisition (3.315 kg CO2e / 13.6%):** The embodied emissions in raw materials, particularly the PCB with components and aluminum, represent a notable impact. Exploring lower-carbon alternative materials and increasing recycled content are key strategies here.

5.2. Reliability Statement

This report's calculations are based on the provided primary data and illustrative secondary industry-standard emission factors (e.g., from Ecoinvent/DEFRA and other reputable sources), which align with the GHG Protocol's requirements. The use of specific BOM values (mzxedzpo), transport distances (gluijovlmr), and energy consumption figures (dfsqetpils, hekipiwkzp, hqyqdsksmmg, lptnjdqugh) enhances the accuracy. However, variations in real-world operational efficiencies, specific supplier data, and dynamic grid emission factors could influence the final PCF. The 95% Scope 3 coverage target has been met by systematically including all identified value chain stages.