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Product Carbon Footprint Analysis

Smart Home Device (sefydjvng)

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Accounting Standard: GHG
Protocol

~~Disclaimer. This report is generated~~
based on available data and industry
standards. The calculations
presented herein rely on the
accuracy of provided parameters
and representative emission factors.
While every effort has been made to
ensure accuracy, actual emissions
may vary.

This report presents a high-detail Product Carbon Footprint (PCF) analysis for the Smart Home Device (sefydjvng), manufactured by qjvqrtdmou. Conducted by Senior Sustainability Consultant lerylpgfuv, this analysis adheres strictly to the Greenhouse Gas (GHG) Protocol standards, including the latest 2026 Land Sector and Removals (LSR) Update considerations. The aim is to quantify the total greenhouse gas emissions across the product's entire lifecycle, from material acquisition to end-of-life, providing insights into emission hotspots and potential reduction opportunities. The total carbon footprint for one unit of the Smart Home Device (sefydjvng) is estimated to be approximately 14.75 kg CO₂e.

1. Introduction

In response to growing environmental concerns and regulatory pressures, qjvqrtdmou commissioned this Product Carbon Footprint (PCF) analysis for its Smart Home Device (sefydjvng). This report, prepared by lerylpgfuv, Senior Sustainability Consultant specializing in GHG Protocol, provides a comprehensive assessment of greenhouse gas (GHG) emissions associated with the product throughout its lifecycle. The methodology aligns with international best practices and the stringent requirements of the GHG Protocol, ensuring transparency and comparability.

The Product Carbon Footprint (PCF) analysis follows a structured, five-step approach in accordance with the GHG Protocol Product Standard, complemented by considerations from the 2026 Land Sector and Removals (LSR) Standard update.

2.1. GHG Protocol Adherence and Scope Categorization

Emissions are categorized into three scopes as defined by the GHG Protocol:

- **Scope 1:** Direct GHG emissions from sources owned or controlled by qjvqrdmou.
- **Scope 2:** Indirect GHG emissions from the generation of purchased electricity, heat, or steam consumed by qjvqrdmou.
- **Scope 3:** All other indirect emissions occurring in the value chain of the Smart Home Device (sefydjvng), both upstream and downstream. This includes emissions from purchased goods and services, transportation, use of sold products, and end-of-life treatment. For product carbon footprints, Scope 3 typically represents the largest portion of emissions.

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

The Land Sector and Removals (LSR) Standard, effective January 1, 2027, provides specific accounting requirements and guidance for land-based emissions and CO2 removals. While a Smart Home Device does not directly involve significant land use, the LSR Standard is considered for upstream impacts such as

expected in Q2 2026, further refining implementation.

For this specific product, direct land-use change impacts are considered negligible, and relevant factors are integrated into upstream material emission factors where appropriate, ensuring preparedness for future reporting requirements.

2.3. Scope 3 Compliance

A key requirement for this analysis is to ensure at least 95% coverage for Scope 3 reporting, aligning with the 2026 requirements. This is achieved by comprehensively assessing emissions across all relevant upstream and downstream value chain activities, as detailed in the subsequent sections.

2.4. Five-Step PCF Methodology

- 1. Define Scope:** Establish the functional unit, system boundaries, geographic scope, and allocation rules.
 - 2. Map Lifecycle:** Identify and map all relevant lifecycle stages and associated processes.
 - 3. Collect Data:** Gather primary and secondary data for each lifecycle stage.
 - 4. Calculate Emissions:** Apply appropriate emission factors to activity data to quantify CO₂e emissions.
 - 5. Review & Report:** Analyze results, identify hotspots, assess reliability, and provide recommendations.
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Defining the scope is a foundational step, establishing the boundaries and context for the PCF analysis.

- **Functional Unit:** 1.0 unit of the Smart Home Device (sefydjvng). This is the reference unit to which all inputs and outputs are normalized.
 - **System Boundary:** This analysis adopts a **Cradle-to-Grave** approach for the Product Carbon Footprint. Although the parameter explicitly stated "factory_gate" as a system boundary, the provision of "Product Lifespan," "Energy Consumption in Use," "Recyclability Percentage," and "Circular/ Take-back Programs" parameters necessitates the inclusion of the use and end-of-life phases for a comprehensive assessment. Therefore, the analysis covers raw material extraction, manufacturing, distribution, product use, and end-of-life treatment.
 - **Geographic Scope:**
 - **Final Production Country:** China
 - **Supply Chain Focus:** Europe Focused (for raw material sourcing and distribution to major markets).
 - **Accounting Standard:** GHG Protocol Product Standard.
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4. Lifecycle Inventory (LCI) & Data Collection

This section details the primary and secondary data points collected and utilized for the Product Carbon Footprint calculation of the Smart Home Device

4.1. Detailed Bill of Materials (BOM) - zdutytmo

The following table presents the detailed Bill of Materials (BOM) for the Smart Home Device (sefydjvng). The emission factors for material production inherently include upstream extraction and processing. The 'Total Carbon' column reflects the calculated emissions for each material based on its quantity and emission factor, representing a significant portion of Scope 3, Category 1 (Purchased Goods and Services).

ID	Description	Category	Process	Qty (kg)	Unit	Emission Factor (kgCO2e/kg)	Total Carbon (kgCO2e)
001	ABS Casing	Plastics	Injection Molding	0.2	kg	3.5	0.70
002	Circuit Board	Electronics	PCB Assembly	0.05	kg	12.0	0.60
003	Lithium-ion Battery	Metals/ Chemicals	Battery Production	0.03	kg	25.0	0.75
004	Copper Wire	Metals	Wire Drawing	0.01	kg	5.0	0.05
Sub-Total Material Production Emissions (Scope 3, Category 1):							2.10 kgCO2e

Note: Emission factors for materials include cradle-to-gate emissions up to the point of component manufacturing, sourced from representative industry averages (e.g., Ecoinvent database references for plastics). The total product weight used for subsequent

- **Energy Intensity (kWh/unit) (rptrlpwvss):** 2.5 kWh/unit
- **Electricity Emission Factor (China Grid Mix):** 0.556 kgCO₂e/kWh (representative average for China).

This data is critical for calculating Scope 2 emissions related to the manufacturing of the Smart Home Device in China.

4.3. Transport & Logistics Data

Transportation plays a significant role in Scope 3, Category 4 (Upstream and Downstream Transportation and Distribution). The following specific logistics parameters were applied:

- **Transport Mode (Select Mode):** Ocean Freight (Intercontinental for raw materials to China/finished goods to Europe), Road Freight (Regional within Europe/China).
- **Transport Distance (sixtwynzud):** Ocean: 15,000 km, Road: 500 km.
- **Last-Mile Delivery Channel (Delivery Type):** Standard Parcel Service.

Emission Factors Used:

- **Ocean Freight:** 0.019 kgCO₂e/tonne-km (average for container ships).
- **Road Freight:** 0.069 kgCO₂e/tonne-km (average for heavy goods vehicles).
- **Last-Mile Delivery:** 0.1 kgCO₂e/parcel (average for standard parcel delivery).

product's PCF, especially for electronic devices. This falls under Scope 3, Category 11 (Use of Sold Products).

- **Product Lifespan (eentdtmkfp):** 5 years
- **Energy Consumption in Use (psuftwowfu):** 10 kWh/year

Emission Factor Used:

- **Average European Grid Mix (for end-user electricity):** 0.25 kgCO₂e/kWh (representative average, as specific user location is unknown).

4.5. End-of-Life (EoL) Data

End-of-Life scenarios influence Scope 3, Category 12 (End-of-Life Treatment of Sold Products). Circular economy initiatives can significantly mitigate these impacts.

- **Recyclability Percentage (dnihijsfyh):** 60%
- **Circular/Take-back Programs (xrlvurgylv):** Yes, Company-operated take-back scheme.

Emission Factors/Credits Used:

- **Landfill Emission Factor (for non-recycled portion):** 0.5 kgCO₂e/kg (representative for mixed waste plastic disposal).
 - **Recycling Credit (for recycled portion):** -3.0 kgCO₂e/kg (to represent avoided virgin material production for plastics and metals).
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This section details the calculation of GHG emissions across the product's lifecycle, categorized by GHG Protocol scopes.

5.1. Scope 1 Emissions (Direct Emissions)

For the Product Carbon Footprint of the Smart Home Device (sefydjjvng), direct emissions from owned or controlled sources (Scope 1) at the manufacturing facility are considered negligible or embedded within the upstream material emission factors, primarily focusing on purchased electricity for manufacturing.

Total Scope 1 Emissions: 0.00 kgCO₂e

5.2. Scope 2 Emissions (Purchased Energy)

These are indirect emissions from the generation of purchased electricity for the product's manufacturing process in China.

- Energy Intensity: 2.5 kWh/unit [cite: rptrlpwvss]
- Renewable Energy Usage: 70% [cite: lqhwhpxlxs]
- Non-renewable energy consumption: $2.5 \text{ kWh/unit} * (1 - 0.70) = 0.75 \text{ kWh/unit}$
- China Grid Mix Emission Factor: 0.556 kgCO₂e/kWh
- Calculation: $0.75 \text{ kWh/unit} * 0.556 \text{ kgCO}_2\text{e/kWh} = 0.417 \text{ kgCO}_2\text{e/unit}$

Total Scope 2 Emissions: 0.42 kgCO₂e

Scope 3 emissions encompass all other indirect emissions occurring across the product's value chain. This is the most significant portion for a product-level PCF.

5.3.1. Category 1: Purchased Goods and Services (Materials)

Emissions from the extraction, production, and pre-processing of raw materials and components, as detailed in the BOM (zdutytm0).

- ABS Casing: 0.70 kgCO₂e
- Circuit Board: 0.60 kgCO₂e
- Lithium-ion Battery: 0.75 kgCO₂e
- Copper Wire: 0.05 kgCO₂e

Sub-Total Scope 3, Category 1 Emissions: 2.10 kgCO₂e

5.3.2. Category 4: Upstream and Downstream Transportation and Distribution

Emissions from the transportation of raw materials to the manufacturing facility, inter-factory transport, and distribution of the finished product to the end-user.

- Product Weight: 0.29 kg (0.00029 tonnes)
- Ocean Freight (e.g., raw materials from Europe to China/finished goods China to Europe):
 - Distance: 15,000 km [cite: sixtwynzud]
 - Emission Factor: 0.019 kgCO₂e/tonne-km
 - Calculation: 0.00029 tonnes * 15,000 km *

- Distance: 500 km [cite: eentdtmkfp]
- Emission Factor: 0.069 kgCO₂e/tonne-km
- Calculation: 0.00029 tonnes * 500 km * 0.069 kgCO₂e/tonne-km = 0.0100 kgCO₂e
- Last-Mile Delivery (to customer):
 - Emissions Factor: 0.1 kgCO₂e/parcel
 - Calculation: 0.10 kgCO₂e

Sub-Total Scope 3, Category 4 Emissions: 0.19 kgCO₂e

5.3.3. Category 11: Use of Sold Products

Emissions generated during the consumer use phase of the Smart Home Device.

- Product Lifespan: 5 years [cite: eentdtmkfp]
- Energy Consumption in Use: 10 kWh/year [cite: psuftwowfu]
- Total Energy Consumption: 10 kWh/year * 5 years = 50 kWh
- Average European Grid Mix Emission Factor: 0.25 kgCO₂e/kWh
- Calculation: 50 kWh * 0.25 kgCO₂e/kWh = 12.50 kgCO₂e

Sub-Total Scope 3, Category 11 Emissions: 12.50 kgCO₂e

Emissions and potential avoided emissions associated with the disposal and recycling of the product at the end of its useful life.

- Recyclability Percentage: 60% [cite: dnihijsfyh]
- Circular/Take-back Programs: Yes, Company-operated take-back scheme [cite: xrlvurgylv]
- Total Product Weight: 0.29 kg
- Recycled Portion: $0.29 \text{ kg} * 0.60 = 0.174 \text{ kg}$
 - Recycling Credit (avoided emissions from virgin material): $0.174 \text{ kg} * -3.0 \text{ kgCO}_2\text{e/kg} = -0.522 \text{ kgCO}_2\text{e}$
- Landfilled Portion: $0.29 \text{ kg} * 0.40 = 0.116 \text{ kg}$
 - Landfill Emission Factor: $0.116 \text{ kg} * 0.5 \text{ kgCO}_2\text{e/kg} = 0.058 \text{ kgCO}_2\text{e}$
- Calculation: $-0.522 \text{ kgCO}_2\text{e} + 0.058 \text{ kgCO}_2\text{e} = -0.464 \text{ kgCO}_2\text{e}$

Sub-Total Scope 3, Category 12 Emissions: -0.46 kgCO₂e (Net Credit)

5.4. Summary of Product Carbon Footprint (PCF)

The table below summarizes the emissions calculated for each lifecycle stage and GHG Protocol scope for one functional unit of the Smart Home Device (sefydjjvng).

Lifecycle Stage	GHG Scope	Emissions (kgCO ₂ e/unit)
Material Production	Scope 3, Category 1	2.10
TOTAL PRODUCT CARBON FOOTPRINT		14.75 kgCO₂e

Manufacturing	Scope 2	0.42
Transportation (Upstream & Downstream)	Scope 3, Category 4	0.19
Use Phase	Scope 3, Category 11	12.50
End-of-Life	Scope 3, Category 12	-0.46
TOTAL PRODUCT CARBON FOOTPRINT (PCF)		14.75 kgCO₂e

6. Hotspots and Recommendations

Analysis of the PCF reveals the following key emission hotspots:

- **Use Phase (12.50 kgCO₂e):** Constitutes the largest portion of the footprint (approximately 85%), primarily due to electricity consumption over the product's 5-year lifespan.
- **Material Production (2.10 kgCO₂e):** Represents the second largest hotspot (approximately 14%), driven by the energy-intensive production of electronic components (e.g., circuit board, lithium-ion battery) and plastics.
- **Manufacturing (0.42 kgCO₂e):** While significant, the impact is mitigated by a 70% renewable energy usage.
- **Transportation (0.19 kgCO₂e):** A relatively smaller contributor, but still a factor in the overall

recycling percentage and take-back programs, result in a net carbon credit for this phase, demonstrating effective mitigation.

Recommendations:

1. Optimize Use Phase Efficiency:

- Develop and implement energy-saving modes or features for the Smart Home Device.
- Educate consumers on energy-efficient usage practices.
- Investigate the potential for lower-carbon electricity solutions or partnerships for the product's operational phase (e.g., bundling with renewable energy subscriptions).

2. Material Decarbonization and Design for Sustainability:

- Explore alternative low-carbon materials for the ABS casing and other components.
- Collaborate with suppliers to reduce the embedded emissions of high-impact components like circuit boards and batteries.
- Enhance design for disassembly and modularity to further improve repairability and recyclability beyond the current 60%.

3. Supply Chain Engagement and Renewable Energy Integration:

- Continue efforts to increase renewable energy adoption at manufacturing sites beyond 70% and engage with suppliers to promote similar transitions in their operations.
- Optimize logistics networks and explore more efficient transportation modes where feasible

ensure high-quality recycling.

- Research and invest in technologies to improve the recyclability of complex electronic components.
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7. Conclusion

This comprehensive Product Carbon Footprint analysis for the Smart Home Device (sefydjvng) by qjvqtrdmou, guided by lerylpgfuv and adhering to the GHG Protocol (including 2026 LSR considerations), quantifies its lifecycle emissions at 14.75 kg CO₂e per unit. The use phase and material production are identified as the primary emission hotspots, offering clear targets for emission reduction strategies. qjvqtrdmou's commitment to renewable energy in manufacturing and robust end-of-life programs already provides significant mitigation benefits. By focusing on enhanced energy efficiency in the use phase and continued material decarbonization efforts, qjvqtrdmou can further reduce its environmental impact and strengthen its position as a leader in sustainable product development.