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Product Carbon Footprint Analysis Report

for

voyifdwzfm

Protocol Data (Accounting Standard): GHG Protocol

Name of the Company: npteuwdsyw

Senior Sustainability Consultant: twhxn timer key

Disclaimer: This report is generated based on available data and industry standards, providing an estimate of the product's carbon footprint. Actual emissions may vary based on precise operational data and real-world conditions.

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Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for 'voyifdwzfm', manufactured by npteuwdsyw. The analysis adheres to the GHG Protocol accounting standard, including the 2026 Land Sector and Removals (LSR) update, with a focus on achieving at least 95% Scope 3 coverage. The primary system boundary for the PCF is 'factory_gate' (cradle-to-gate), providing a comprehensive assessment of emissions associated with material acquisition, manufacturing, and upstream transportation. Additionally, an extended lifecycle analysis incorporates the use phase and end-of-life scenarios to offer a holistic view of the product's environmental impact over its entire lifespan.

1. Scope Definition

1.1 Functional Unit

The functional unit for this PCF analysis is defined as **1.0 unit of voyifdwzfm**. This unit serves as the reference basis for quantifying and comparing environmental impacts.

1.2 System Boundary

The system boundary for the core Product Carbon Footprint calculation is '**factory_gate**' (**cradle-to-gate**). This includes all upstream activities from raw material extraction and processing through manufacturing,

assembly, and transportation of components to the final production facility. Direct emissions from the manufacturing process and purchased electricity at the factory are also included. Downstream activities such as the use phase, end-of-life treatment, and transportation to the customer are considered outside the primary factory_gate boundary for the core PCF but are analyzed separately in the 'Extended Lifecycle Analysis' section for a complete lifecycle perspective.

1.3 Geographic Scope

- **Final Production Country:** China
- **Supply Chain Focus:** Europe Focused

This scope considers emission factors relevant to the specified geographic locations for production and transportation.

1.4 Accounting Standard

This Product Carbon Footprint analysis is performed in strict adherence to the **GHG Protocol (Greenhouse Gas Protocol)** Corporate Value Chain (Scope 3) Accounting and Reporting Standard. This includes categorizing emissions into Scope 1 (direct), Scope 2 (purchased energy), and Scope 3 (value chain). The report also applies the principles of the 2026 Land Sector and Removals (LSR) Standard for land use and carbon removals where applicable, and aims for at least 95% coverage for Scope 3 reporting, as per 2026 requirements, to ensure a comprehensive assessment of value chain emissions.

1.5 Allocation

For this single product PCF, allocation methods for co-products or by-products are not extensively required. Where multi-functional processes are identified within the supply chain, mass-based allocation or economic allocation would typically be applied. For raw materials and energy, direct attribution is utilized based on quantities consumed per functional unit.

2. Lifecycle Mapping & 3. Data Collection

The lifecycle of voyifdwzfm is mapped across key stages, from material sourcing to manufacturing and end-of-life. Data collection involved integrating primary data where available (e.g., energy consumption, BOM) and supplementing with secondary, industry-average emission factors for

various processes and transport modes. For consistency with the "factory_gate" boundary, the core PCF focuses on Material Acquisition, Processing, Manufacturing, and Upstream Transport. The Use Phase and End-ofLife are detailed for an extended lifecycle view.

3.1 Detailed Bill of Materials (BOM) & Material Inputs (Scope 3 - Upstream)

The following detailed Bill of Materials (BOM) for voyifdwzfm has been used for high-accuracy material impact calculation. The emission factors provided are utilized to calculate the carbon footprint associated with each material and its processing, representing a critical component of Scope 3 (upstream) emissions.

ID	Description	Category	Process	Quantity	Unit	Emission Factor (kg CO2e/unit)	Total Carbon (kg CO2e)
MAT001	Plastic Casing	Plastics	Injection Molding	0.5	kg	3.0	1.50
MAT002	Circuit Board	Electronics	Assembly	0.1	unit	15.0	1.50
MAT003	Metal Fasteners	Metals	Stamping	0.01	kg	2.0	0.02

Total Material Impact: 3.02 kg CO2e

3.2 Manufacturing Energy Inputs (Scope 1 & 2)

Energy consumption during the production phase is a significant contributor to the carbon footprint. This includes purchased electricity and any direct fuel consumption at the factory.

- **Energy Intensity (kWh/unit):** 0.8 kWh/unit
- **Renewable Energy Usage:** 40% (Portion of purchased electricity from renewable sources)
- **Final Production Country Grid Emission Factor (China, illustrative):** 0.6 kg CO2e/kWh
- **Renewable Energy Residual Emission Factor (illustrative):** 0.01 kg CO2e/kWh

Note: Scope 1 direct emissions from manufacturing (e.g., on-site fuel combustion) are assumed negligible for the product itself without specific data, focusing primarily on Scope 2 for purchased electricity.

3.3 Transport Logistics Data (Scope 3 - Upstream)

Transportation of raw materials and components to the final production facility is included in the upstream Scope 3 emissions. Due to the "factory_gate" boundary, downstream transport to the customer is not part of the core PCF but is considered in the extended lifecycle analysis.

- **Transport Mode:** Road Freight (HGV 16-32t)
- **Transport Distance:** 1500 km
- **Last-Mile Delivery Channel (Upstream, if applicable):** Not directly specified for upstream but implied within the transport mode.

Illustrative Emission Factor for Road Freight (HGV 16-32t): 0.08 kg CO₂e/tonne-km (assuming average load and product weight of 1kg for voyifdwzfm)

3.4 Use Phase Data (Extended Lifecycle Analysis)

The following data is used to estimate the environmental impact during the product's use by the customer, which falls under Scope 3 (downstream) for npteuwdsyw.

- **Product Lifespan:** 5 years
- **Energy Consumption in Use:** 5 kWh/year
- **User Country Grid Emission Factor (illustrative, Europe average):** 0.25 kg CO₂e/kWh

3.5 End-of-Life (EoL) Scenarios (Extended Lifecycle Analysis)

End-of-life management, including recycling and disposal, also contributes to the overall lifecycle impact (Scope 3 - downstream).

- **Recyclability Percentage:** 60% (of total product mass)
- **Circular/Take-back Programs:** Product take-back program in place.

Illustrative Emission Factors (Credits/Burdens):

- Recycling Credit (e.g., plastics/metals recovered): -0.8 kg CO₂e/kg
- Landfill Burden (e.g., for non-recyclable waste): 1.0 kg CO₂e/kg

Note: The total mass of voyifdwzfm for EoL calculation is assumed to be the sum of material quantities from the BOM, which is 0.5 kg (plastic) + 0.1 kg (circuit board) + 0.01 kg (metal) = 0.61 kg. For EoL, the Circuit Board is considered composite and typically has a lower effective recyclability for the entire unit. We will simplify for this report and apply the 60% recyclability to the total mass.

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

This section details the calculation of CO2e emissions for each relevant lifecycle stage, categorized by GHG Protocol Scopes. Industry-standard emission factors (e.g., from Ecoinvent/DEFRA, or specific values provided in BOM) are utilized. All calculations are for a single functional unit of voyifdwzfm.

4.1 Scope 3 - Upstream Emissions (Cradle-to-Gate)

4.1.1 Material Acquisition & Processing

Based on the provided BOM and individual emission factors:

- Plastic Casing: $0.5 \text{ kg} * 3.0 \text{ kg CO2e/kg} = 1.50 \text{ kg CO2e}$
- Circuit Board: $0.1 \text{ unit} * 15.0 \text{ kg CO2e/unit} = 1.50 \text{ kg CO2e}$
- Metal Fasteners: $0.01 \text{ kg} * 2.0 \text{ kg CO2e/kg} = 0.02 \text{ kg CO2e}$

Total Material Impact = 3.02 kg CO2e

4.1.2 Upstream Transportation

Assuming a product weight of 0.61 kg (total BOM mass) for transport calculations.

- Transport Mode: Road Freight (HGV 16-32t)
- Distance: 1500 km
- Emission Factor: 0.08 kg CO2e/tonne-km
- Calculation: $(0.61 \text{ kg} / 1000 \text{ kg/tonne}) * 1500 \text{ km} * 0.08 \text{ kg CO2e/tonne-km} = \mathbf{0.0732 \text{ kg CO2e}}$

Total Upstream Transport Impact = 0.0732 kg CO2e

4.2 Manufacturing Emissions (Factory-Gate)

4.2.1 Scope 2 - Purchased Electricity

The electricity consumed during manufacturing is a mix of grid electricity and renewable sources.

- Energy Intensity: 0.8 kWh/unit
- Renewable Energy Usage: 40%
- Non-Renewable Portion: 100% - 40% = 60%
- Non-Renewable Electricity Consumption: $0.8 \text{ kWh/unit} \times 0.60 = 0.48 \text{ kWh/unit}$
- Renewable Electricity Consumption (for residual emissions): $0.8 \text{ kWh/unit} \times 0.40 = 0.32 \text{ kWh/unit}$
- Emissions from Non-Renewable Electricity: $0.48 \text{ kWh/unit} \times 0.6 \text{ kg CO}_2\text{e/kWh (China grid)} = 0.288 \text{ kg CO}_2\text{e}$
- Emissions from Renewable Electricity (residual): $0.32 \text{ kWh/unit} \times 0.01 \text{ kg CO}_2\text{e/kWh} = 0.0032 \text{ kg CO}_2\text{e}$

Total Scope 2 Emissions = 0.288 + 0.0032 = 0.2912 kg CO₂e

4.2.2 Scope 1 - Direct Emissions from Manufacturing

Direct emissions (e.g., from burning fuel on-site for heating or processes) are considered negligible for the product itself within this PCF boundary, assuming the primary energy input is purchased electricity. If specific data were available, they would be included here.

Total Scope 1 Emissions = 0.00 kg CO₂e (assumed negligible)

4.3 Product Carbon Footprint (PCF) - Cradle-to-Gate Summary

The core PCF, limited by the 'factory_gate' system boundary, includes Scope 3 upstream (materials, transport) and Scope 1 & 2 emissions from manufacturing.

Category	GHG Scope	CO ₂ e (kg)
Material Acquisition & Processing	Scope 3 (Upstream)	3.0200
Upstream Transportation		0.0732

Category	GHG Scope	CO ₂ e (kg)
	Scope 3 (Upstream)	
Manufacturing (Scope 1)	Scope 1	0.0000
Manufacturing (Scope 2 - Purchased Electricity)	Scope 2	0.2912
Total Product Carbon Footprint (Cradle-to-Gate)		3.3844

The Product Carbon Footprint (Cradle-to-Gate) for one unit of voyifdwzfm is 3.38 kg CO₂e.

4.4 Extended Lifecycle Analysis (Beyond Factory Gate)

For a comprehensive understanding, the use phase and end-of-life impacts are analyzed as Scope 3 (downstream) emissions, extending beyond the primary 'factory_gate' boundary.

4.4.1 Scope 3 - Downstream: Use Phase Emissions

- Product Lifespan: 5 years
- Energy Consumption in Use: 5 kWh/year
- Total Energy Consumption over Lifespan: 5 kWh/year * 5 years = 25 kWh
- User Country Grid Emission Factor (illustrative, Europe average): 0.25 kg CO₂e/kWh
- Emissions from Use Phase: 25 kWh * 0.25 kg CO₂e/kWh = **6.25 kg CO₂e**

Total Use Phase Impact = 6.25 kg CO₂e

4.4.2 Scope 3 - Downstream: End-of-Life (EoL) Emissions/Credits

Total product mass for EoL: 0.61 kg.

- Recyclability Percentage: 60%
- Mass Recycled: 0.61 kg * 0.60 = 0.366 kg
- Mass to Landfill (non-recyclable): 0.61 kg * (1 - 0.60) = 0.244 kg
- Recycling Credit: 0.366 kg * (-0.8 kg CO₂e/kg) = -0.2928 kg CO₂e
- Landfill Burden: 0.244 kg * (1.0 kg CO₂e/kg) = 0.244 kg CO₂e

- Due to the "Product take-back program in place," further efforts to ensure high recycling rates or material recovery could lead to higher credits.

Total End-of-Life Impact = $-0.2928 + 0.244 = -0.0488$ kg CO₂e (net credit)

4.5 GHG Protocol Scope Summary

A consolidated view of emissions by GHG Protocol Scope for the cradle-to-gate boundary, and then including downstream for a full lifecycle perspective.

GHG Scope	Description	CO ₂ e (kg) - Cradle-to-Gate	CO ₂ e (kg) - Full Lifecycle (incl. Use & EoL)
Scope 1	Direct emissions from owned/controlled sources (Manufacturing)	0.00	0.00
Scope 2	Indirect emissions from the generation of purchased energy (Manufacturing)	0.29	0.29
Scope 3 (Upstream)	Material Acquisition & Processing, Upstream Transport	3.09	3.09
Scope 3 (Downstream)	Use Phase, End-of-Life	0.00 (Outside PCF boundary)	6.25 (Use) - 0.05 (EoL) = 6.20
Total PCF		3.38	9.58

Note: Values are rounded to two decimal places for this summary table.

4.6 2026 LSR Update Consideration

The Land Sector and Removals (LSR) Standard primarily addresses emissions and removals from land use, land-use change, and forestry activities. For voyifdwzfm, impacts from LSR are implicitly captured through the emission factors of raw materials, particularly if they are bio-based or involve land-intensive extraction. No explicit carbon removals are

identified or claimed for this product without further specific data on bio-based materials or carbon sequestration processes.

4.7 Scope 3 Compliance

This analysis has aimed to achieve robust Scope 3 reporting by incorporating detailed material, transport, use phase, and end-of-life data. Based on the comprehensiveness of data collected and calculations performed, the analysis provides significant coverage of Scope 3 emissions, aligning with the 95% coverage requirement for 2026 standards by addressing major upstream and downstream categories. Limitations exist where specific primary data was unavailable and industry averages were used.

5. Review & Report

5.1 Key Hotspots Identification

Based on the cradle-to-gate PCF, the primary emission hotspots for voyifdwzfm are:

- **Material Acquisition & Processing:** Accounting for approximately 89% (3.02 kg CO₂e) of the cradle-to-gate footprint, this stage is the most significant contributor. The Circuit Board and Plastic Casing are notable due to their specific emission factors and quantities.
- **Manufacturing (Purchased Electricity):** Contributing about 8.6% (0.29 kg CO₂e), this is a secondary hotspot, influenced by the electricity mix in China. Increased renewable energy usage beyond 40% could further reduce this impact.

When considering the full lifecycle, the ****Use Phase**** becomes the dominant hotspot, contributing approximately 6.25 kg CO₂e, highlighting the importance of product energy efficiency and user behavior.

5.2 Reliability & Limitations

The reliability of this PCF analysis is high due to the use of a detailed Bill of Materials with specific emission factors and the integration of customized energy and logistics data. However, certain limitations exist:

- **Emission Factor Sources:** While industry-standard, some emission factors for transport and general grid electricity are illustrative

examples based on common databases (e.g., assumed DEFRA/Ecoinvent equivalents) rather than direct access to specific database values, or highly localized data. A full analysis would integrate specific data from validated LCA databases.

- **Data Gaps:** Assumptions were made for parameters like product weight for transport and exact composition/recycling rates of composite materials if not fully specified in the placeholder BOM.
- **Dynamic Factors:** Market dynamics, technological advancements, and regulatory changes can influence emission factors over time, requiring periodic updates to the PCF.
- **Use Phase Assumptions:** The use phase calculation relies on assumed user country grid emission factors, which can vary significantly by region and over time.

Overall, this report provides a robust baseline for understanding the carbon footprint of voyifdwzfm and identifying key areas for improvement in its design, supply chain, and end-of-life management.