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Product Carbon Footprint (PCF) Analysis

for Basin

Protocol Data (Accounting Standard): GHG Protocol

Disclaimer: This report is generated based on available industry data, recognized standards, and reasonable assumptions for illustrative purposes. Actual emissions may vary based on specific operational details and primary data collection.

Generated Date: April 20, 2026

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Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for a single unit of "Basin," conducted in accordance with the GHG Protocol standards. The analysis adopts a cradle-to-gate (factory_gate) system boundary, focusing on emissions associated with material acquisition, manufacturing, and upstream transportation. The final production country is Indonesia, with a significant portion of the supply chain originating from Europe. Key findings highlight emission hotspots across material production and manufacturing energy, providing a foundation for targeted decarbonization strategies. This assessment also integrates the principles of the 2026 Land Sector and Removals (LSR) Standard and ensures comprehensive Scope 3 coverage.

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1. Define Scope

The initial step in this PCF analysis for "Basin" involved clearly defining the parameters to ensure a consistent and comparable assessment.

- **Functional Unit:** 1.0 unit of Basin. This unit serves as the reference basis for all quantified environmental impacts.
- **System Boundary:** factory_gate (cradle-to-gate). This boundary encompasses all lifecycle stages from raw material extraction, processing, and manufacturing, up to the point where the finished "Basin" product leaves the manufacturing facility in Indonesia. Downstream stages such as product use, distribution to end-users, and end-of-life are excluded from this specific PCF analysis but would be relevant for a full corporate lifecycle assessment.

- **Geographic Scope:**
  - **Final Production Country:** Indonesia. Emissions associated with manufacturing operations (e.g., energy consumption, direct emissions) are attributed to Indonesia\'s regional context.
  - **Supply Chain Focus:** Europe Focused. A significant portion of raw materials and sub-components are assumed to be sourced from European suppliers, necessitating the inclusion of international transportation emissions.
- **Accounting Standard:** GHG Protocol. This analysis strictly adheres to the Greenhouse Gas Protocol\'s Corporate Accounting and Reporting Standard and the Corporate Value Chain (Scope 3) Accounting and Reporting Standard. Emissions are categorized into Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (all other indirect emissions in the value chain).
- **Allocation:** For this single product PCF, direct allocation of emissions to the functional unit is applied. In cases of co-production or shared processes, relevant allocation rules (e.g., mass-based, economic-based) would typically be employed, but for a singular product unit, this is simplified.

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

The lifecycle mapping for "Basin" outlines the key stages from raw material acquisition to its exit from the factory gate. Data collection involved a combination of hypothetical primary data for manufacturing operations and secondary data (industry-standard emission factors) for upstream material production and transportation.

Detailed Breakdown of Materials and Energy Inputs (per 1.0 unit of Basin)

For the purpose of this illustrative report, "Basin" is assumed to be a generic manufactured product, possibly an electronic component or device, requiring various materials and energy inputs.

Material Inputs (Upstream, Europe Sourced, transported to Indonesia)

Material	Quantity (kg)	Description	Source Region	Data Type
ABS Plastic	0.20	Casing and structural components. Acrylonitrile Butadiene Styrene (ABS) is a common thermoplastic polymer known for its strength and impact resistance.	Europe	Secondary (Industry Average)
Aluminum (Primary)	0.10	Internal frame and heat dissipation components. Primary aluminum production is highly energy-intensive.	Europe	Secondary (Industry Average)
Copper	0.05	Wiring, printed circuit board (PCB) traces, and electrical connectors. Copper production involves mining and refining.	Europe	Secondary (Industry Average)
Silicon (Electronics Grade)	0.01	Semiconductor chipsets and integrated circuits. High-purity silicon production is energy and resource-intensive.	Europe	Secondary (Industry Average)
Cardboard Packaging	0.03	Primary product packaging, including inserts and external box.	Europe	Secondary (Industry Average)

Energy Inputs (Manufacturing in Indonesia)

Energy Type	Quantity (kWh/ unit)	Description	Source Region	Data Type
Electricity	1.50	Consumed during assembly, testing, molding, and general facility operations.	Indonesia (Grid Mix)	Secondary (Country Grid Average)

Transportation Inputs

Transport Stage	Mode	Distance (km)	Weight (tonne)	Description	Data Type
Upstream Material Transport (Europe to Indonesia)	Ocean Freight (Container Ship)	15,000	0.00039 (for 1 unit of Basin)	Shipment of all raw materials from Europe to the manufacturing facility in Indonesia. Assumes consolidated freight.	Secondary (Industry Average)
Factory-to-Gate Distribution (Indonesia)	Road Freight (HGV)	500	0.00039 (for 1 unit of Basin)	Local road transportation from the factory to a regional distribution hub in Indonesia.	Secondary (Industry Average)

Land Sector and Removals (LSR) Standard (2026 Update): While direct land use change for the manufacturing facility itself is considered negligible within this "factory_gate" boundary, the GHG Protocol\'s new Land Sector and Removals (LSR) Standard, taking effect January 1, 2027, is relevant for upstream activities. This standard provides methods to quantify and report land emissions (e.g., from agriculture, land use change) and CO_2 removals (land-based or technological) in the value chain. For the materials sourced

in this analysis (e.g., cardboard, specific metals), a detailed LSR assessment would ideally trace their origins to evaluate any associated land use change emissions, which would fall under Scope 3, Category 1 (Purchased Goods and Services). The accompanying guidance for the LSR Standard is anticipated in Q2 2026, which will offer more practical direction for implementation. For this PCF, we acknowledge its relevance for future, more granular Scope 3 assessments of agricultural and forestry-derived materials.

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

Emissions were calculated by multiplying the activity data (quantities of materials, energy, and transport) by relevant industry-standard emission factors. Emissions are categorized according to the GHG Protocol into Scope 1, Scope 2, and Scope 3. We aim for at least 95% coverage for Scope 3 reporting, considering the factory_gate boundary.

Emission Factors Used

Activity	Emission Factor (EF)	Unit	Source (Illustrative)
ABS Plastic Production	3.125311	kg CO2e / kg material	Ecoinvent / Climatiq (Europe)
Primary Aluminum Production	14.77	kg CO2e / kg material	OpenCO2.net (Industry Average)
Copper (Primary) Production	4.10	kg CO2e / kg material	CarbonChain (Average Primary Production)
Silicon (Electronics Grade) Production	15.00	kg CO2e / kg material	Industry Average (Illustrative, based on typical ranges for high-purity silicon)
Cardboard Packaging Production	1.00	kg CO2e / kg material	Industry Average (Illustrative)

Activity	Emission Factor (EF)	Unit	Source (Illustrative)
Electricity (Indonesia Grid Mix)	0.7177	kg CO2e / kWh	Scopes Data / Climatiq (Indonesia, 2020)
Ocean Freight (Container Ship)	0.016142	kg CO2e / tonne-km	BEIS / Climatiq (UK average)
Road Freight (HGV >20t)	0.092	kg CO2e / tonne-km	GLEC / Climatiq (Europe average)

Calculated Emissions by Scope (per 1.0 unit of Basin)

Scope 1 Emissions (Direct Emissions from Owned/Controlled Sources)

For a "factory_gate" system boundary, Scope 1 emissions would typically include direct emissions from on-site fuel combustion (e.g., boilers, owned vehicles) or process emissions not already covered by upstream material EFs. For the hypothetical "Basin" manufacturing in Indonesia, we assume no significant direct Scope 1 process emissions that are not embedded in purchased materials or energy. If, for instance, the factory had its own diesel generators not covered by grid electricity, or if it conducted chemical processes with direct GHG releases, those would be accounted for here. For this analysis, we assume negligible direct Scope 1 emissions at the factory beyond what is captured in Scope 2 (electricity generation) and Scope 3 (material production).

Source	Activity Data	Emission Factor	CO2e (kg)
Direct On-site Combustion / Process Emissions	Assumed negligible for this product\'s factory_gate analysis.	-	0.00
Total Scope 1 Emissions			**0.00**

Scope 2 Emissions (Indirect Emissions from Purchased Energy)

These are indirect emissions from the generation of purchased electricity consumed by the manufacturing facility in Indonesia.

Source	Activity Data	Emission Factor	CO2e (kg)
Purchased Electricity (Indonesia)	1.50 kWh	0.7177 kg CO2e / kWh	1.0766
Total Scope 2 Emissions			**1.08**

Scope 3 Emissions (Indirect Emissions from Value Chain)

Scope 3 emissions include all other indirect emissions occurring in the value chain. For a "factory_gate" PCF, this primarily covers upstream categories. We aim for at least 95% coverage as per 2026 requirements, focusing on the most material categories.

Scope 3 Category	Source	Activity Data	Emission Factor	CO2e (kg)
Category 1: Purchased Goods and Services (Material Production)	ABS Plastic	0.20 kg	3.125311 kg CO2e / kg	0.6251
	Aluminum (Primary)	0.10 kg	14.77 kg CO2e / kg	1.4770
	Copper (Primary)	0.05 kg	4.10 kg CO2e / kg	0.2050
	Silicon (Electronics Grade)	0.01 kg	15.00 kg CO2e / kg (Illustrative)	0.1500
	Cardboard Packaging	0.03 kg	1.00 kg CO2e / kg (Illustrative)	0.0300
Category 4: Upstream Transportation and	Ocean Freight (Europe to Indonesia)	0.00039 tonne * 15,000 km	0.016142 kg CO2e / tonne-km	0.0944

Scope 3 Category	Source	Activity Data	Emission Factor	CO2e (kg)
Distribution (Material Transport)	Road Freight (Factory to Distribution Hub, Indonesia)	0.00039 tonne * 500 km	0.092 kg CO2e / tonne-km	0.0180
Total Scope 3 Emissions				**2.60**

Note: The 2026 LSR Update for land use and carbon removals primarily applies to agricultural emissions and CO2 removal technologies. For manufactured goods like "Basin", its impact is most relevant in the upstream supply chain for materials derived from biological sources (e.g., wood for cardboard, or if bioplastics were used). The emission factors used here for materials already encompass their cradle-to-gate impact, which implicitly includes land use changes where applicable, but a granular LSR assessment would require specific primary data on the land management practices for each material.

Total Product Carbon Footprint (PCF) for Basin (factory_gate)

Scope	Total CO2e (kg)	Percentage of Total PCF
Scope 1	0.00	0.0%
Scope 2	1.08	29.4%
Scope 3	2.60	70.6%
TOTAL PCF per 1.0 unit of Basin	**3.68**	**100.0%**

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5. Review & Report

Emission Hotspots

The PCF analysis for "Basin" reveals clear emission hotspots:

- **Material Production (Scope 3, Category 1):** This category accounts for the majority of the PCF (70.6%). Specifically, the production of primary aluminum (1.477 kg CO2e) and ABS plastic (0.6251 kg CO2e) are significant contributors, largely due to their energy-intensive manufacturing processes. Primary aluminum production, for instance, has a high emission factor of 14.77 kg CO2e/kg.
- **Purchased Electricity (Scope 2):** Manufacturing electricity consumption in Indonesia contributes significantly (29.4%) due to the grid\'s reliance on fossil fuels, with an emission factor of 0.7177 kg CO2e/kWh.
- **Transportation (Scope 3, Category 4):** While essential, the transportation of materials from Europe to Indonesia, and then locally within Indonesia, represents a smaller but still notable portion of the total PCF. Ocean freight is relatively efficient per tonne-km compared to road freight.

Reliability and Limitations

The reliability of this PCF is good for the defined system boundary and functional unit, adhering to GHG Protocol standards. However, certain limitations apply:

- **Secondary Data Reliance:** This report heavily relies on secondary (industry average) emission factors from databases like Ecoinvent and DEFRA. While these are widely accepted, actual emissions could vary with specific supplier data (primary data).
- **Geographic Specificity of EFs:** While efforts were made to use region-specific EFs (e.g., Indonesia electricity grid mix), some material EFs are European averages, which may not perfectly reflect global production variations if materials were sourced from other regions.
- **LSR Standard (2026) Integration:** The LSR Standard\'s full impact for upstream agricultural/forestry products would require

more granular, farm- or forest-specific data, which is beyond the scope of this generic analysis. The current analysis conceptually integrates it by acknowledging its relevance for Scope 3 material sourcing.

- **Factory_Gate Boundary:** The exclusion of the use phase and end-of-life impacts (Scope 3, Categories 9, 10, 11, 12) means the reported PCF is not a full cradle-to-grave assessment. For products with high use-phase energy consumption or significant end-of-life impacts, these stages can dominate the total lifecycle footprint.

Recommendations for Reduction

- **Material Decarbonization:** Prioritize engaging with suppliers for ABS plastic and aluminum to understand their decarbonization efforts, or explore alternative lower-carbon materials (e.g., recycled content for aluminum, bio-based or recycled plastics).
- **Renewable Energy Procurement:** Work with the Indonesian manufacturing facility to procure renewable energy or invest in on-site renewable energy generation to reduce Scope 2 emissions, considering Indonesia\'s efforts to increase renewable energy share.
- **Supply Chain Optimization:** Optimize logistics to minimize transport distances and utilize more efficient modes (e.g., rail over road where feasible in Europe, larger vessels for ocean freight).
- **Product Design for Circularity:** Although outside the current boundary, consider product design for extended lifespan, repairability, and recyclability to address downstream emissions in future assessments.
- **Enhanced Data Collection:** Implement systems for collecting primary data from key suppliers and manufacturing processes to improve the accuracy and specificity of future PCF analyses.
