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Product Carbon Footprint Analysis

Mousepad

Protocol Data (Accounting Standard): GHG Protocol

Name of the Company: carboncalc.online

Regulatory Framework: California SB 253/261

Senior Sustainability Consultant: remko weingarten

Disclaimer: This report is generated based on available data, industry standards, and reasonable assumptions. Precise values would require direct primary data collection from the specific supply chain.

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Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for a standard mousepad, conducted on behalf of carboncalc.online. The assessment adheres to the GHG Protocol standards, with a focus on Scope 1, 2, and 3 emissions, including the application of the 2026 Land Sector and Removals (LSR) Standard where applicable. The analysis is framed within the context of California\'s stringent SB 253 and SB 261 regulatory frameworks, which mandate comprehensive climate disclosures. The goal is to identify key carbon hotspots across the product\'s lifecycle up to the factory gate in Indonesia, with a supply chain focus on Europe, providing actionable insights for emission reduction strategies and compliance readiness.

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1. Define Scope

The scoping phase establishes the foundational parameters for the Product Carbon Footprint (PCF) analysis, ensuring consistency and comparability.

- **Functional Unit:** 1.0 unit of a standard mousepad (approx. 30cm x 25cm x 3mm), capable of providing an ergonomic and precise surface for mouse operation.
- **System Boundary:** Factory-gate. This analysis includes all emissions from raw material extraction, material processing, and manufacturing processes up to the point the finished, packaged mousepad leaves the production facility in Indonesia. Distribution to the end-user is considered Scope 3 but beyond the defined \'factory-gate\' primary

boundary for the core PCF calculation, though its impact will be estimated for holistic Scope 3 coverage.
- **Geographic Scope:**
  - **Final Production Country:** Indonesia
  - **Supply Chain Focus:** Europe Focused (i.e., key raw materials may originate from or be processed in Europe before shipment to Indonesia, or primary markets are in Europe, influencing transport emissions).
- **Accounting Standard:** GHG Protocol Product Standard, specifically addressing Scope 1 (direct emissions), Scope 2 (purchased electricity), and Scope 3 (indirect value chain emissions) categories. The 2026 Land Sector and Removals (LSR) Standard is also considered for any land-use related impacts or carbon removals, though these are typically minimal for conventional mousepads.
- **Regulatory Framework:** California SB 253 (Climate Corporate Data Accountability Act) and SB 261 (Climate-Related Financial Risk Act). This analysis aims to provide data compliant with these regulations, particularly SB 253\'s requirement for companies with revenues exceeding $1 billion to report Scope 1 and 2 emissions by August 2026, and eventually Scope 3. These California regulations are often stricter than federal standards, emphasizing the need for robust and comprehensive data.
- **Allocation:** For a single product PCF, direct allocation methods are applied. Emissions from shared processes or infrastructure are allocated based on mass or economic value relevant to the mousepad\'s production volume.

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2. Map Lifecycle (LCI Inventory Stages)

The lifecycle of a mousepad, from raw material acquisition to the factory gate, involves several stages, each with associated material and energy inputs. Below is a detailed mapping of these stages for a typical mousepad, primarily consisting of a textile surface and a rubber base.

Materials & Components Breakdown:

- **Top Surface (approx. 0.5 mm thick):**
  - **Material:** Polyester Fabric (typically 100% polyester knit or woven textile). Polyester is a synthetic polymer derived from petroleum.

    - **Inputs:** Polyester fibers, dyeing agents, printing inks (solvent-based or water-based, pigments).
- **Base Layer (approx. 2.5 mm thick):**
    - **Material:** Natural Rubber (NR) foam or Styrene-Butadiene Rubber (SBR) foam. NR is latex-derived, SBR is synthetic. For this analysis, we assume SBR for its common industrial use and specific EFs.
    - **Inputs:** SBR polymer, foaming agents, vulcanization chemicals (sulfur, accelerators), fillers (e.g., carbon black, calcium carbonate).
- **Adhesive:**
    - **Material:** Water-based or solvent-based adhesive for laminating the top fabric to the rubber base.
    - **Inputs:** Polymers, solvents (if applicable), additives.
- **Edge Stitching (Optional, but common for durability):**
    - **Material:** Polyester thread.
    - **Inputs:** Polyester fibers, dyes.
- **Packaging:**
    - **Material:** Recycled cardboard sleeve/box, Low-Density Polyethylene (LDPE) plastic film for protection.
    - **Inputs:** Pulp, inks for cardboard; ethylene for LDPE.

Energy Inputs per Stage:

Energy consumption is primarily electricity for machinery, with minor thermal energy use for drying or curing processes.

- **Raw Material Extraction & Processing (Upstream - embedded in material EFs):**
    - Petroleum extraction & refining (for polyester, SBR feedstocks).
    - Polymerization processes (for polyester, SBR).
    - Rubber tapping & latex processing (if natural rubber).
    - Textile fiber spinning, weaving/knitting, dyeing.
    - Cardboard pulping and paper production.
    - Plastic pellet extrusion.
    - Electricity and heat are the main energy carriers.
- **Manufacturing (Indonesia - direct energy):**
    - **Fabric Preparation:** Cutting, printing (using printing machines and curing systems).
    - **Rubber Sheet Production:** Mixing, calendering/forming, foaming, curing.
    - **Lamination:** Applying adhesive, pressing fabric to rubber base.

    - **Finishing:** Die-cutting, edge stitching (if applicable), quality control.
    - **Packaging:** Placing mousepad into protective film and cardboard sleeve/box, sealing.
    - **Energy Type:** Predominantly electricity from the Indonesian grid. Some minor heat might be used for curing adhesives or inks.
- **Transportation (Upstream & Factory-Gate):**
    - Transport of raw materials (polyester pellets, SBR bales, chemicals, packaging materials) to the Indonesian factory. This may involve international shipping (sea freight from Europe/Asia) and local road freight.
    - Transport of finished, packaged mousepads from the factory to the factory gate.
    - **Energy Type:** Diesel fuel for marine vessels and road trucks.

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3. Collect Data (Primary/Secondary Data Points)

For this generic analysis, a combination of estimated primary data (based on typical product specifications) and secondary data (industry-average emission factors) is utilized. Accurate primary data from the specific manufacturer would yield higher precision.

Assumed Primary Data Points (for a standard 30x25cm, 3mm thick mousepad):

- **Mousepad Net Weight:** 230g
    - Polyester Fabric (top): 50g
    - SBR Rubber Foam (base): 180g
- **Adhesive:** 5g (negligible mass, but considered)
- **Printing Ink:** 2g
- **Packaging Weight:** 35g
    - Recycled Cardboard Sleeve: 30g
    - LDPE Film: 5g
- **Manufacturing Energy Consumption (Indonesia Factory):** 0.1 kWh electricity per mousepad (for cutting, laminating, printing, packaging).
- **Transportation Distances (Illustrative):**
    - Polyester pellets (China/Europe to Indonesia): 12,000 km (sea freight)
    - SBR (Thailand/Europe to Indonesia): 8,000 km (sea freight)

- Packaging materials (local Indonesia): 100 km (road freight)
- Finished product from factory to port (Indonesia): 50 km (road freight)

Secondary Data Sources & Emission Factor (EF) Assumptions:

Emission factors are crucial for converting activity data into greenhouse gas emissions. For this analysis, representative industry-standard emission factors, typically sourced from databases like Ecoinvent and DEFRA, are applied. Note: Actual factors would be pulled directly from these databases for a precise study.

Category	Material/ Energy Input	Assumed Emission Factor (kg CO2e / unit)	Source Type (Illustrative)
Materials Production (Scope 3 - Upstream)	Polyester (virgin fiber/ pellet)	4.0 kg CO2e / kg	Ecoinvent / Industry Average
	SBR (Styrene-Butadiene Rubber)	2.5 kg CO2e / kg	Ecoinvent / Industry Average
	Water-based Adhesive	1.0 kg CO2e / kg	Generic / Industry Average
	Printing Ink	5.0 kg CO2e / kg	Generic / Industry Average
	Recycled Cardboard	0.7 kg CO2e / kg	DEFRA / Ecoinvent
	LDPE (plastic film)	2.0 kg CO2e / kg	Ecoinvent / Industry Average
Energy Consumption (Scope 2)	Electricity (Indonesia Grid Mix)	0.7 kg CO2e / kWh	IEA / Local Grid Data
		0.008 kg CO2e / tkm	Ecoinvent / GLEC Framework

Category	Material/ Energy Input	Assumed Emission Factor (kg CO2e / unit)	Source Type (Illustrative)
Transportation (Scope 3 - Upstream)	Sea Freight (container ship)		
	Road Freight (heavy goods vehicle)	0.09 kg CO2e / tkm	DEFRA / GLEC Framework

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

Emissions are calculated by multiplying the activity data (e.g., kg of material, kWh of electricity, tkm of transport) by the corresponding emission factors. These are then categorized according to the GHG Protocol\'s Scope 1, 2, and 3 definitions. The 2026 LSR Update emphasizes the inclusion of land use and carbon removals; for a synthetic product like a mousepad, direct land-use change emissions are typically negligible at the product level, but any bio-based components (e.g., natural rubber) would be assessed for their land-use impacts and potential removals if specific to certified sustainable sources.

Scope 1: Direct Emissions (Company Owned/Controlled Sources)

For a \'factory-gate\' system boundary focusing on product PCF, direct Scope 1 emissions primarily relate to fuel consumption in owned vehicles or on-site fossil fuel combustion for heating/manufacturing. Given the assumed manufacturing process, direct fossil fuel combustion on-site is assumed to be minimal or zero for this product and is typically covered by embedded emissions in electricity generation if purchasing grid electricity. For the purpose of this PCF, significant Scope 1 emissions directly attributable to mousepad production on-site are considered negligible

unless the factory operates its own power generation or uses significant on-site combustion for direct process heat, which is not assumed here.

- **Assumed Scope 1 Emissions:** 0.00 kg CO2e per mousepad (assuming electricity is purchased and no on-site fuel combustion directly for mousepad manufacturing).

Scope 2: Purchased Energy Emissions (Electricity, Heat, Steam)

This includes emissions from the generation of purchased electricity consumed by the mousepad manufacturing facility in Indonesia.

- **Activity:** 0.1 kWh electricity / mousepad
- **Emission Factor:** 0.7 kg CO2e / kWh (Indonesia Grid Mix)
- **Calculation:** 0.1 kWh * 0.7 kg CO2e/kWh = 0.07 kg CO2e
- **Total Scope 2 Emissions:** 0.07 kg CO2e per mousepad

Scope 3: Value Chain Emissions (>95% Coverage as per 2026 Requirements)

Scope 3 encompasses all other indirect emissions from the value chain, both upstream and downstream. For a factory-gate PCF, upstream emissions (raw materials, transport to factory) are dominant.

Upstream Emissions (Cradle-to-Gate excluding factory-direct electricity):

Category	Activity Data	Emission Factor (kg CO2e / unit)	Calculated CO2e (kg CO2e)
Materials Production			
Polyester Fabric	0.05 kg	4.0 kg CO2e / kg	0.200 kg CO2e
SBR Rubber Foam	0.18 kg	2.5 kg CO2e / kg	0.450 kg CO2e
Adhesive	0.005 kg	1.0 kg CO2e / kg	0.005 kg CO2e
Printing Ink	0.002 kg	5.0 kg CO2e / kg	0.010 kg CO2e
Recycled Cardboard	0.03 kg	0.7 kg CO2e / kg	0.021 kg CO2e
LDPE Film	0.005 kg	2.0 kg CO2e / kg	0.010 kg CO2e
Transportation (Raw Materials to Factory)			

Category	Activity Data	Emission Factor (kg CO2e / unit)	Calculated CO2e (kg CO2e)
Polyester (Sea Freight)	0.05 kg * 12,000 km = 0.6 tkm	0.008 kg CO2e / tkm	0.0048 kg CO2e
SBR (Sea Freight)	0.18 kg * 8,000 km = 1.44 tkm	0.008 kg CO2e / tkm	0.0115 kg CO2e
Packaging (Road Freight - Local)	0.035 kg * 100 km = 0.0035 tkm	0.09 kg CO2e / tkm	0.0003 kg CO2e
Finished Product (Road Freight - Factory to Port)	0.265 kg * 50 km = 0.01325 tkm	0.09 kg CO2e / tkm	0.0012 kg CO2e

Total Scope 3 Upstream Emissions: 0.200 + 0.450 + 0.005 + 0.010 + 0.021 + 0.010 + 0.0048 + 0.0115 + 0.0003 + 0.0012 = 0.7138 kg CO2e per mousepad

Considering the factory-gate boundary, these upstream Scope 3 emissions represent the vast majority of the product\'s footprint. Downstream emissions (transport to consumer, use phase, end-of-life) would typically be included for a "cradle-to-grave" assessment, ensuring >95% coverage for total Scope 3 as per future requirements.

Summary of Emissions per Mousepad:

GHG Scope Category	CO2e Emissions (kg CO2e)	Percentage of Total
Scope 1 (Direct)	0.000	0.0%
Scope 2 (Purchased Electricity)	0.070	9.0%
Scope 3 (Upstream Value Chain)	0.714	91.0%
Total Product Carbon Footprint (Factory-Gate)	**0.784**	**100.0%**

5. Review & Report

Hotspots Identification:

Based on the calculations, the primary carbon hotspots for the mousepad at the factory-gate are:

- **Raw Materials Production (Scope 3):** This category dominates, accounting for approximately 85% of the total footprint.
    - The production of SBR rubber foam and polyester fabric are the most significant contributors within materials, due to their energy-intensive manufacturing processes and petrochemical origins.
- **Purchased Electricity (Scope 2):** Manufacturing energy consumption, while a smaller portion, still represents a notable 9% of the footprint, highlighting the importance of grid decarbonization in Indonesia.
- **Transportation (Scope 3):** While essential, transport emissions are relatively low (approx. 2% of total) compared to material production, primarily due to the efficiency of sea freight for bulk raw materials.

Reliability and Data Quality:

The reliability of this PCF analysis is good, given the use of industry-standard emission factors and a clear methodology. However, the accuracy could be significantly enhanced with:

- **Primary Data:** Actual material bills of quantities, energy consumption data, and specific supplier data for raw material production from the mousepad manufacturer.
- **Specific Emission Factors:** Utilizing exact emission factors from Ecoinvent, DEFRA, or other certified databases that precisely match the specific grades and production routes of materials used by the manufacturer.
- **Supply Chain Specificity:** Detailed logistics data (modes, distances, fill rates) for all tiers of the supply chain.

Recommendations for Emission Reduction:

- **Material Substitution:** Explore alternative, lower-carbon materials such as recycled polyester or bio-based rubbers (if performance allows) to reduce upstream material emissions.

- **Supplier Engagement:** Work with material suppliers to understand their decarbonization efforts and procure materials from suppliers with lower embedded emissions or renewable energy use.
- **Energy Efficiency & Renewables:** Implement energy efficiency measures at the Indonesian manufacturing facility and explore options for sourcing renewable electricity (e.g., Green Tariffs, on-site solar) to reduce Scope 2 emissions.
- **Optimized Logistics:** While a smaller hotspot, optimizing freight (e.g., higher container utilization, shorter routes) can offer marginal gains.
- **Design for Circularity:** Consider design changes for easier recycling or extended product life at end-of-life to reduce overall lifecycle impact (beyond factory gate).

Regulatory Context: California SB 253 & SB 261 Compliance

This PCF analysis provides critical data for companies operating under or preparing for California\'s landmark climate disclosure laws:

- **SB 253 (Climate Corporate Data Accountability Act):** Mandates public and private companies with revenues exceeding $1 billion to publicly report their Scope 1 and Scope 2 GHG emissions starting in August 2026 for the 2025 fiscal year, followed by Scope 3 emissions in 2027. This report directly quantifies the Scope 1 and Scope 2 emissions (albeit Scope 1 is negligible for this specific product\'s boundary) and a substantial portion of Scope 3 emissions, aligning with the disclosure requirements. Companies must demonstrate robust data collection and calculation methodologies.
- **SB 261 (Climate-Related Financial Risk Act):** Requires companies with revenues over $500 million to prepare biennial reports disclosing their climate-related financial risks and how they plan to mitigate them. Understanding the PCF of core products like the mousepad allows companies to identify climate-related risks in their supply chain (e.g., carbon pricing on materials, energy price volatility) and integrate this into their financial risk assessments and mitigation strategies.
- **Stricter than Federal Rules:** It is crucial to note that California\'s legislation is often more stringent and comprehensive than existing or anticipated federal regulations, emphasizing the need for a thorough and defensible PCF analysis as presented here. Compliance

with these standards positions carboncalc.online\'s clients at the forefront of climate transparency.