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Product Carbon Footprint Analysis Report

Product: Ajax Cleaning Agent

Protocol Data (Accounting Standard): GHG Protocol

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Disclaimer: This report is generated based on available data and industry standards, utilizing illustrative values and reasonable assumptions where specific primary data for "Ajax Cleaning Agent" was not publicly accessible. The calculations are intended to provide a high-detail estimate of the Product Carbon Footprint within the defined scope and boundaries.

Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for one unit of "Ajax Cleaning Agent" (1.0 L), conducted by Senior Sustainability Consultant Remko Weingarten. The analysis strictly adheres to the GHG Protocol, including considerations for the upcoming 2026 Land Sector and Removals (LSR) Standard and ensuring comprehensive Scope 3 coverage. The defined system boundary is "factory gate," focusing on emissions from raw material acquisition through manufacturing and packaging, up to the point the product leaves the factory.

The assessment identifies key emission hotspots across the product\'s life cycle, primarily in the upstream supply chain (Scope 3), particularly in the production of chemical ingredients and packaging materials. Manufacturing operations (Scope 1 and 2) contribute a smaller but still significant portion. This analysis provides a foundation for identifying reduction opportunities and informing more sustainable product development and supply chain management strategies.

1. Define Scope

Functional Unit

The functional unit for this Product Carbon Footprint (PCF) analysis is **1.0 unit (1.0 Litre)** of Ajax Cleaning Agent. This unit represents the quantity of product providing the intended cleaning function.

System Boundary

The system boundary is defined as **"factory_gate" (Cradle-to-Gate)**. This includes all life cycle stages from the extraction and processing of raw materials, manufacturing of intermediate products, production of packaging materials, transportation of these materials to the final production facility, and all manufacturing processes at the factory, up to the point the finished product leaves the factory gate. Downstream stages such as product distribution, retail, use phase, and end-of-life treatment are excluded from this PCF boundary, though their broader relevance to Scope 3 is acknowledged.

Geographic Scope

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

Emission factors and energy mixes are selected to represent European conditions where possible, with a specific focus on the Netherlands for manufacturing energy.

Accounting Standard

This PCF analysis is conducted in accordance with the **GHG Protocol**. Emissions are categorized into Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (all other indirect emissions across the value chain).

Allocation

For multi-output processes or shared facilities, **mass-based allocation** is primarily applied where appropriate. In cases where specific data is unavailable, economic or physical causality principles are considered in the underlying emission factor datasets. For the purpose of this PCF, the emissions of shared factory infrastructure are allocated per unit of product output.

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2. Map Lifecycle (LCI Inventory Stages)

The life cycle of the Ajax Cleaning Agent, within the "factory_gate" boundary, is mapped across the following key stages:

2.1. Raw Material Acquisition & Pre-processing (Upstream - Scope 3, Category 1)

This stage encompasses the extraction of raw materials, their pre-processing, and manufacturing into chemical ingredients.

- **Water:** Sourced from municipal tap water networks.
- **Surfactants:** Production of petroleum-derived (or potentially bio-based) anionic and non-ionic surfactants, involving complex chemical synthesis processes.
- **Solvents (e.g., Ethanol):** Production of ethanol, primarily through fermentation processes.
- **pH Adjusters (e.g., Citric Acid):** Production of citric acid, typically via microbial fermentation.
- **Fragrances:** Synthesis and blending of various aromatic compounds. This is known to be a high-impact category.
- **Colorants:** Production of synthetic dyes and pigments.
- **Preservatives & Other Additives:** Production of various minor chemical components (e.g., anti-foaming agents, stabilizers), often highly concentrated.

2.2. Packaging Production (Upstream - Scope 3, Category 1)

Manufacturing of primary packaging components.

- **HDPE Bottle:** Production of High-Density Polyethylene resin and subsequent blow molding into the bottle shape.
- **PP Cap:** Production of Polypropylene resin and injection molding into the cap.
- **Label:** Production of paper or plastic film for the product label.

2.3. Upstream Transportation (Scope 3, Category 4)

Transportation of all raw materials and packaging components from their respective production sites to the Ajax Cleaning Agent manufacturing facility in the Netherlands. Road transport by Heavy Goods Vehicles (HGV) is assumed for European supply chains.

2.4. Manufacturing at Factory (Direct Operations - Scope 1 & 2)

Processes occurring at the final production site.

- **Mixing & Blending:** Energy consumed for mixing raw ingredients (water, surfactants, solvents, additives) in large tanks.
- **Filling:** Energy consumed for automated filling lines that dispense the liquid into bottles.
- **Capping & Labeling:** Energy for machinery that applies caps and labels.

- **Utilities:** Heating, cooling, lighting, and general facility energy consumption.
- **Waste Generation:** Emissions associated with the treatment and disposal of operational waste (e.g., rejected product, packaging scraps) at the factory. (Scope 3, Category 5).

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3. Collect Data (Primary/Secondary Data Points)

For this detailed PCF analysis, a combination of hypothetical primary data (for quantities) and industry-standard secondary data (for emission factors) is employed.

3.1. Material Inputs per 1.0 Litre of Ajax Cleaning Agent

(Illustrative composition based on typical liquid cleaning agents)

Material	Quantity per 1.0 L Unit	Unit	Source/Notes
Water	850	g	Primary Diluent
Anionic Surfactant	50	g	Cleaning Agent
Non-ionic Surfactant	50	g	Cleaning Agent
Ethanol	20	g	

Material	Quantity per 1.0 L Unit	Unit	Source/Notes
			Solvent/ Disinfectant
Citric Acid	5	g	pH Adjuster/ Chelating Agent
Fragrance	3	g	Scent (Small quantity, high impact)
Colorant	1	g	Appearance
Preservatives/ Other Additives	21	g	Stability, Performance (Generic Placeholder)

3.2. Packaging Inputs per 1.0 Litre Unit

Packaging Component	Quantity per 1.0 L Unit	Unit	Source/ Notes
HDPE Bottle	60	g	Primary Container
PP Cap	5	g	Closure
Label (Paper/ Plastic Film)	2	g	Product Information

3.3. Energy Inputs per 1.0 Litre Unit (Factory Operations)

Energy Type	Quantity per 1.0 L Unit	Unit	Source/Notes
	0.05	kWh	

Energy Type	Quantity per 1.0 L Unit	Unit	Source/Notes
Electricity (Netherlands Grid Mix)			Mixing, Filling, General Operations
Natural Gas (Direct Combustion)	0.001	m^3	Minor Heating/ Steam (Illustrative)

3.4. Transport Data (Upstream)

Transport Segment	Assumed Distance	Unit	Mode	Assumed Load (for materials/ packaging per unit)	Source/ Notes
Raw Materials to Factory	1000	km	HGV	1.0 kg (approximate average per kg of material, considering volume)	European average
Packaging to Factory	500	km	HGV	0.067 kg (total packaging weight)	European average

3.5. Emission Factors (Illustrative, based on Ecoinvent/DEFRA equivalents)

Input/ Activity	Emission Factor (EF)	Unit	Scope	Source/Notes
	0.00001			Based on

Input/ Activity	Emission Factor (EF)	Unit	Scope	Source/Notes
Water (tap water production/ treatment)		kg CO2e/ kg	Scope 3, Cat 1	
Anionic Surfactant Production	2.5	kg CO2e/ kg	Scope 3, Cat 1	Proxy for complex chemical, similar to Non-ionic
Non-ionic Surfactant Production	2.3	kg CO2e/ kg	Scope 3, Cat 1	Ecoinvent v3.10 via Climatiq
Ethanol Production (from fermentation)	1.5	kg CO2e/ kg	Scope 3, Cat 1	Representative value from various sources
Citric Acid Production	10.44	kg CO2e/ kg	Scope 3, Cat 1	Verified by CarbonCloud
Fragrance Production	50.0	kg CO2e/ kg	Scope 3, Cat 1	Illustrative high-impact ingredient factor
Colorant Production	10.0	kg CO2e/ kg	Scope 3, Cat 1	Illustrative factor for synthetic dyes
Preservatives/ Additives Production (generic)	5.0	kg CO2e/ kg	Scope 3, Cat 1	Generic factor for complex chemicals
HDPE Production (cradle-to-gate)	2.2	kg CO2e/ kg	Scope 3, Cat 1	Average based on various sources (e.g.,

Input/ Activity	Emission Factor (EF)	Unit	Scope	Source/Notes
				DEFRA, Idemat)
PP Production (cradle-to-gate)	2.0	kg CO2e/ kg	Scope 3, Cat 1	Assumed similar to HDPE
Label (Paper/ Plastic Film) Production	1.5	kg CO2e/ kg	Scope 3, Cat 1	Proxy for mixed materials
Electricity (Netherlands Residual Mix)	0.382	kg CO2e/ kWh	Scope 2	AIB, 2024 European Residual Mix Report
Natural Gas (Industrial Combustion)	2.0	kg CO2e/ m^3	Scope 1	Representative industrial factor (based on)
Road Transport (HGV, average European)	0.87	kg CO2e/ tonne.km	Scope 3, Cat 4	DEFRA/Idemat
Plastics Waste to Landfill (Factory Operations)	0.033	kg CO2e/ kg	Scope 3, Cat 5	DEFRA

Note: The emission factors presented are illustrative and represent typical industry averages. Actual values can vary significantly based on specific supplier data, manufacturing processes, and energy sourcing.

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

Emissions are calculated for each life cycle stage and categorized according to the GHG Protocol Scopes. The total Product Carbon Footprint for 1.0 Litre of Ajax Cleaning Agent is the sum of these emissions.

4.1. Raw Material Acquisition & Pre-processing (Scope 3, Category 1)

Material	Quantity (kg)	Emission Factor (kg CO2e/kg)	Total Emissions (kg CO2e)
Water	0.850	0.00001	0.0000085
Anionic Surfactant	0.050	2.5	0.125
Non-ionic Surfactant	0.050	2.3	0.115
Ethanol	0.020	1.5	0.030
Citric Acid	0.005	10.44	0.0522
Fragrance	0.003	50.0	0.150
Colorant	0.001	10.0	0.010
Preservatives/ Other Additives	0.021	5.0	0.105
Subtotal Raw Materials:			**0.5872085**

4.2. Packaging Production (Scope 3, Category 1)

Packaging Component	Quantity (kg)	Emission Factor (kg CO2e/kg)	Total Emissions (kg CO2e)
HDPE Bottle	0.060	2.2	0.132
PP Cap	0.005	2.0	0.010
Label (Paper/ Plastic Film)	0.002	1.5	0.003
Subtotal Packaging Materials:			**0.145**

4.3. Upstream Transportation (Scope 3, Category 4)

Transport Segment	Mass (tonne)	Distance (km)	EF (kg CO2e/ tonne.km)	Total Emissions (kg CO2e)
Raw Materials to Factory	0.999*	1000	0.87	0.86913
Packaging to Factory	0.067	500	0.87	0.029145
Subtotal Upstream Transport:				**0.898275**

*Note on Raw Material Transport Mass: Approximated as 1kg total for calculation, but actual mass of ingredients is 0.999kg (850g water + 149g other dry/liquid materials). The 1.0kg is used as a proxy for simplicity as the transport factor is per tonne.km.

4.4. Manufacturing at Factory (Scope 1 & 2)

Activity/ Input	Quantity	Unit	Emission Factor	Unit	Scope	Total Emissions (kg CO2e)
Electricity Consumption	0.05	kWh	0.382	kg CO2e/ kWh	Scope 2	0.0191
Natural Gas Combustion	0.001	m^3	2.0	kg CO2e/ m^3	Scope 1	0.002
Subtotal Factory Operations (Scope 1 & 2):						**0.0211**

4.5. Waste Generated in Operations (Scope 3, Category 5)

Assuming a minimal manufacturing waste of 0.005 kg (e.g., plastic trim, rejected labels) per functional unit disposed to landfill.

Waste Type	Quantity (kg)	EF (kg CO2e/kg)	Total Emissions (kg CO2e)
Plastics Waste to Landfill	0.005	0.033	0.000165
Subtotal Waste from Operations:			**0.000165**

4.6. Total Product Carbon Footprint per 1.0 L Unit

Scope Category	Total Emissions (kg CO2e)	Percentage of Total
Scope 1 (Direct Operations - Natural Gas)	0.002	0.12%
Scope 2 (Purchased Electricity)	0.0191	1.14%
Scope 3, Category 1 (Raw Materials & Packaging)	0.5872085 + 0.145 = 0.7322085	43.76%
Scope 3, Category 4 (Upstream Transportation)	0.898275	53.69%
Scope 3, Category 5 (Waste from Operations)	0.000165	0.01%
TOTAL PCF (Cradle-to-Gate)	**1.6767485**	**100.00%**

The total Product Carbon Footprint for one 1.0 Litre unit of Ajax Cleaning Agent, from Cradle-to-Gate, is approximately **1.68 kg CO2e**.

4.7. GHG Protocol Scope 3 Compliance (2026 Requirements)

As per the 2026 requirements, at least 95% coverage for Scope 3 reporting is crucial. In this factory-gate PCF, the calculated upstream Scope 3 emissions (Categories 1, 4, and 5) account for approximately 97.46% of the total PCF,

demonstrating robust coverage within the defined boundary.

- **Category 1: Purchased goods and services** (Raw materials, Packaging materials)
- **Category 4: Upstream transportation and distribution** (Transport of raw materials and packaging to the factory)
- **Category 5: Waste generated in operations** (Disposal of manufacturing waste)

While this PCF specifically focuses on the factory-gate boundary, a comprehensive corporate Scope 3 inventory would also evaluate downstream categories such as use of sold products (Category 11) and end-of-life treatment of sold products (Category 12). For a cleaning agent, the use phase (e.g., energy for heating water if applicable for dilution) and the end-of-life of the plastic bottle would typically be significant downstream impacts. These are acknowledged but fall outside the defined "factory_gate" PCF boundary.

4.8. 2026 Land Sector and Removals (LSR) Update

The GHG Protocol\'s 2026 Land Sector and Removals (LSR) Standard aims to provide more robust guidance for accounting for land use, land-use change, and carbon removals. For a cleaning agent, direct land-use emissions or removals are generally not significant within the immediate manufacturing process. However, indirect land use impacts could arise from the supply chain of bio-based ingredients (e.g., surfactants derived from agricultural crops) or forestry products for packaging.

In this analysis, while specific LSR data for each raw material was not applied due to the nature of generic emission factors, the principle of accounting for land-related emissions is embedded in the comprehensive cradle-to-gate factors for materials like bio-ethanol or bio-based surfactants, where available. Future analyses would benefit from specific primary data on land-use change associated with the sourcing of any agricultural or forestry-derived inputs.

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5. Review & Report

5.1. Hotspot Identification

The analysis reveals clear emission hotspots for the Ajax Cleaning Agent within its "factory_gate" boundary:

- **Upstream Transportation (Scope 3, Category 4):** This category accounts for the largest share (approximately 53.69%) of the total PCF. The long distances and heavy nature of raw material and packaging transport contribute significantly.
- **Raw Material Acquisition & Pre-processing (Scope 3, Category 1):** Constituting about 43.76% of the total PCF, the production of chemical ingredients is highly emission-intensive. Specifically, fragrance (0.150 kg CO2e) and various surfactants (0.125 kg CO2e for anionic, 0.115 kg CO2e for non-ionic), along with other additives, are major contributors due to their complex chemical synthesis. Citric

acid, despite its small quantity, also shows a relatively high impact per kg.

- **Packaging Production (Scope 3, Category 1):** The production of the HDPE bottle (0.132 kg CO2e) is a notable contributor within the packaging segment.
- **Factory Operations (Scope 1 & 2):** Direct emissions from natural gas (Scope 1) and purchased electricity (Scope 2) contribute a minor portion (approx. 1.26% combined) to the overall PCF, indicating a relatively energy-efficient manufacturing process or a low-carbon electricity grid mix in the Netherlands.

5.2. Reliability Assessment

The reliability of this PCF analysis is assessed as moderate to high, given the reliance on industry-standard secondary emission factors and plausible hypothetical primary data for quantities.

- **Strengths:** Adherence to GHG Protocol, clear system boundaries, detailed breakdown of material and energy inputs, and explicit mention of sources for emission factors. The use of up-to-date regional electricity and natural gas emission factors for the Netherlands enhances accuracy for the manufacturing stage.
- **Limitations:** The primary limitation is the use of generic and assumed data for the precise composition of "Ajax Cleaning Agent" and its specific supply chain. Primary data directly from the manufacturer for ingredient specifications, supplier locations, precise transport modes, and energy consumption would significantly enhance accuracy. Emission

factors for some complex chemical ingredients are based on broader industry averages or proxies.

5.3. Recommendations for Reduction

Based on the identified hotspots, the following recommendations are made:

1. **Supply Chain Decarbonization (Scope 3 Focus):**
    - **Raw Material Sourcing:** Engage with suppliers to understand and reduce the carbon footprint of key ingredients, especially surfactants, fragrances, and other chemical additives. Prioritize suppliers using renewable energy in their production processes or those offering lower-carbon alternatives.
    - **Optimise Logistics:** Explore opportunities to reduce transport distances (e.g., regional sourcing), shift to lower-emission transport modes (e.g., rail or sea over road for longer distances), and optimize load factors for all incoming materials.
    - **Packaging Innovation:** Investigate lightweighting of HDPE bottles or exploring alternative packaging materials with lower embedded carbon (e.g., recycled content plastics, bio-based plastics with verified low impact).
2. **Operational Efficiency (Scope 1 & 2):**
    - **Energy Efficiency:** Continue to invest in energy-efficient machinery and processes at the manufacturing plant.

    - **Renewable Energy Procurement:** Explore further opportunities to procure 100% renewable electricity (e.g., Power Purchase Agreements) and decarbonize heating (e.g., heat pumps, green hydrogen) to further reduce Scope 2 and Scope 1 emissions.
3. **Data Improvement:** Implement systems for collecting primary data for all key inputs and processes to refine future PCF assessments and identify more precise reduction levers.
