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Product Carbon Footprint Analysis: BYD Atto 3

Protocol Data (Accounting Standard): GHG Protocol

Prepared for: [Client Name/Internal Use]

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Executive Summary

This report presents a high-detail Product Carbon Footprint (PCF) analysis for one unit of the BYD Atto 3 electric vehicle, adhering to the Greenhouse Gas (GHG) Protocol. The analysis employs a "factory_gate" system boundary, focusing on a hypothetical final production in the Netherlands with a predominantly Europe-focused supply chain for key components. Given the theoretical nature of this analysis without access to proprietary primary data, industry averages and representative emission factors (conceptually derived from databases like Ecoinvent/DEFRA) have been utilized. The assessment categorizes emissions into Scope 1, 2, and 3, incorporating the latest 2026 Land Sector and Removals (LSR) Standard update and aiming for at least 95% coverage for Scope 3 reporting, as per 2026 requirements. The primary objective is to identify major emission hotspots within the manufacturing phase of the BYD Atto 3 and provide a robust framework for understanding its climate impact prior to operational use.

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1. Define Scope

1.1 Functional Unit

The functional unit for this Product Carbon Footprint (PCF) analysis is **1.0 unit of a BYD Atto 3 electric vehicle**. This represents a single, fully assembled vehicle ready to leave the manufacturing facility.

1.2 System Boundary

The system boundary is defined as **"factory_gate" (Cradle-to-Gate)**. This includes all processes from the extraction of raw materials, through their processing, component manufacturing, sub-assembly, and final assembly of the BYD Atto 3, up to the point it exits the final assembly plant. It specifically excludes the vehicle\'s use phase (e.g., electricity consumption during driving), end-of-life treatment, and any upstream activities related to infrastructure (e.g., factory construction).

1.3 Geographic Scope

- **Final Production Country:** Netherlands (assumed for this analysis, acknowledging that BYD\'s primary manufacturing is typically in China). This assumption influences the electricity grid mix and localized logistics.
- **Supply Chain Focus:** Europe Focused. This implies that efforts have been made to source materials and components from within Europe where feasible, affecting transportation distances and regional emission factors for upstream processes. Where European specific data is not available, global averages or typical manufacturing locations (e.g., for battery materials) are assumed.

1.4 Accounting Standard

This PCF analysis strictly adheres to the **GHG Protocol**. Emissions are categorized into Scope 1 (direct emissions from owned or controlled sources), Scope 2 (indirect emissions from the generation of purchased energy), and Scope 3 (all other indirect emissions in the value chain).

1.5 Allocation

Allocation of emissions from multi-output processes is primarily based on **mass allocation** where co-products are present. For energy consumption, direct attribution to the product unit is sought. Where specific allocation data for complex supply chains is unavailable, conservative estimates based on industry averages are applied.

2. Map Lifecycle (LCI Inventory Stages)

The lifecycle mapping for the BYD Atto 3 within the "factory_gate" boundary covers several key stages, each contributing to the overall carbon footprint. The BYD Atto 3 uses a Blade Battery, which is a Lithium Iron Phosphate (LFP) chemistry type. The extended range version typically has a 60.48 kWh battery capacity. The kerb weight for the Atto 3 Standard Range is approximately 1680 kg, with other sources mentioning 1750 kg in context. For this analysis, a representative kerb weight of 1700 kg is assumed.

2.1 Raw Material Extraction & Pre-processing

This initial stage encompasses the mining or harvesting of raw materials and their primary processing into forms usable by manufacturers. Key materials include:

- **Metals:** Iron ore (for steel), bauxite (for aluminium), lithium, nickel, manganese, cobalt (though LFP batteries used in Atto 3 are cobalt-free), graphite, copper, and other minor metals for electronic components.
- **Plastics:** Crude oil and natural gas (for various polymers like polypropylene, polyurethane, polyamide, HDPE, PVC).
- **Silicon:** For semiconductors and electronic components.
- **Other Materials:** Glass, rubber, textiles, fluids, and chemicals.

2.2 Component Manufacturing

This stage involves the fabrication of various parts and sub-assemblies from the processed raw materials.

- **Battery Cell & Pack Production:** A highly energy-intensive process involving the synthesis of cathode and anode materials (Lithium Iron Phosphate, Graphite for Atto 3), slurry mixing, coating, drying, cell assembly, electrolyte filling, and initial charging cycles (formation processes). This also includes the production of battery casings, often aluminium.
- **Body-in-White Production:** Stamping, welding, and forming of steel and aluminium sheets for the vehicle chassis and frame. Electric vehicles typically incorporate more aluminium for lightweighting to offset battery weight.

- **Powertrain Components:** Manufacturing of electric motors, inverters, and drive units, primarily from metals (steel, copper, aluminium).
- **Interior Components:** Fabrication of seats (vegan leather in Atto 3), dashboards, trim, and other cabin elements from plastics, textiles, and minor metals.
- **Electronics & Wiring:** Production of printed circuit boards, wiring harnesses (copper), infotainment systems, sensors, and other electronic modules.
- **Tires & Glass:** Manufacturing of tires from rubber and reinforcing materials, and glass for windows and windshields.

2.3 Vehicle Assembly

The final assembly of all manufactured components into the complete BYD Atto 3 vehicle. This includes:

- **Body Shop:** Welding and joining of major structural components.
- **Paint Shop:** Application of primers, basecoats, and clearcoats, which is typically a very energy-intensive process.
- **General Assembly:** Installation of powertrain, interior, electronics, wheels, and other finishing touches.
- **Testing & Quality Control:** Final checks and functional testing before the vehicle is deemed ready for shipment.

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3. Collect Data (Primary/Secondary Data Points)

For this theoretical, high-detail PCF analysis, primary data from BYD\'s specific production facilities in the Netherlands (hypothetical) and European supply chains are not available. Therefore, a combination of secondary data points, industry benchmarks, and reasonable assumptions are used, conceptually aligning with data sources like Ecoinvent and DEFRA. These assumptions are critical for estimating material quantities and associated emissions.

3.1 Assumed Material Inputs for BYD Atto 3 (Extended Range, ~1700 kg Kerb Weight)

Based on industry averages for electric vehicles and the BYD Atto 3\'s specifications:

Material Category	Estimated Quantity (kg)	Justification/Reference
Steel (incl. AHSS)	850	Typical modern car uses ~900 kg steel; EVs leverage AHSS for lightweighting, reducing overall steel quantity but increasing specialized steel usage.
Aluminium	290	EVs contain 250-300 kg of aluminium, projected to increase to ~310 kg for European BEVs by 2026. Critical for lightweighting and battery housing.
Plastics & Composites	200	Plastics account for ~10% of vehicle weight, EVs use ~45% more plastic than ICE vehicles. Average car contains ~193-208 kg of plastics.
Lithium-Ion Battery Pack (60.48 kWh LFP)	420	BYD Atto 3 uses a 60.48 kWh LFP Blade Battery. The battery pack weight is stated as ~420 kg (925.94 lb).
Copper	60	EVs use significantly more copper (around 53 kg) for wiring, motors, and battery connections.
Glass	40	General industry estimate for vehicle glazing.
Rubber (Tires, Seals, etc.)	50	Estimate for tires and various rubber components.
Other Metals & Materials	- (~90 kg residual)	Includes rare earth elements, precious metals in electronics, fluids, textiles, and other minor components to reach the assumed 1700 kg kerb weight.
Total Estimated Kerb Weight	**~1700 kg**	

3.2 Assumed Energy Inputs for Manufacturing (per unit)

Energy consumption in EV manufacturing is significant, particularly for battery production.

- **Electricity:** Used extensively across all manufacturing stages, from material processing to assembly, heating, cooling, and operating machinery. Battery cell production and environmental control in dry rooms are particularly electricity-intensive.
    - Battery Production: 50-150 kWh electricity per kWh of battery capacity. For a 60.48 kWh battery, this implies ~3024 - 9072 kWh. Using an average of 100 kWh/kWh battery capacity would be ~6048 kWh.
    - Vehicle Assembly: Estimated at 10-25% of the energy used in battery manufacturing.
    - Total vehicle production (excluding raw material mining/refining, but including general assembly): A study found 41.8 MJ/kg (approx. 11.6 kWh/kg) for vehicle production, with mining and material production representing 68% of total consumption. For a 1700 kg car, this equates to around 19,720 kWh for the vehicle body and assembly, plus a significant amount for materials.
- **Natural Gas/Heat:** Used for heating processes (e.g., metal forming, paint drying ovens) and facility heating.
- **Fuel (Logistics):** Diesel or other fuels for transporting raw materials, components, and finished vehicles (within the "factory_gate" scope, this typically covers inbound logistics).

For calculation purposes, we will assume a total electricity consumption of **~10,000 kWh** per vehicle for assembly and immediate component manufacturing (excluding deep upstream material extraction, which is captured in emission factors), and **~2,000 kWh equivalent** in natural gas for heat and other direct processes at the assembly plant. Upstream energy for material production is embedded within material emission factors.

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

Emissions are calculated by multiplying the activity data (e.g., quantity of material, energy consumed) by relevant emission factors. The calculation is categorized according to the GHG Protocol\'s Scope 1, 2, and 3. Illustrative emission factors (EFs) are used, conceptually representing values found in databases like Ecoinvent v3.10 and DEFRA, adjusted for a European context where applicable.

4.1 Illustrative Emission Factors (Conceptual Ecoinvent/DEFRA Values, Europe Focused)

Input/Activity	Unit	Emission Factor (kg CO2e/unit)	Source Concept
Lithium-Ion Battery (LFP) Production	kWh (battery capacity)	70	Ecoinvent/Industry Avg. (40-100 kgCO2e/kWh for LFP, Europe-focused grid mix)
Steel (Primary, low-alloyed)	kg	1.8	Ecoinvent (Primary Steel, Electric Arc Furnace, EU-Avg)
Aluminium (Primary, alloy)	kg	8.5	Ecoinvent (Primary Aluminium AlMg3, EU-Avg)
Plastics (Avg. Polypropylene/ Polyurethane)	kg	3.5	Ecoinvent/Industry Avg. (Various plastics, EU-Avg)
Copper (Primary)	kg	4.0	Ecoinvent (Primary Copper, EU-Avg)
Glass Production	kg	1.0	Industry Avg.
Rubber Production	kg	2.0	Industry Avg.
Electricity (European Grid Mix)	kWh	0.28	Ecoinvent/IEA (EU-27 Avg. electricity grid mix for 2026, projected)

Input/Activity	Unit	Emission Factor (kg CO2e/unit)	Source Concept
Natural Gas (combustion)	kWh (energy content)	0.20	Ecoinvent/DEFRA (Natural Gas combustion)
Road Transport (Heavy Goods Vehicle, Euro VI)	tkm	0.1	Ecoinvent/DEFRA (Average European road freight)
Sea Transport (Ocean Freight)	tkm	0.01	Ecoinvent/DEFRA (Average global ocean freight)

4.2 Emission Calculation by GHG Scope

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

For a "factory_gate" boundary focused on assembly in the Netherlands, Scope 1 emissions primarily stem from on-site combustion of fuels (e.g., natural gas for heating/processes, fuel for company-owned vehicles on site).

- **On-site Natural Gas Combustion:** Assume 2,000 kWh of natural gas directly consumed at the assembly plant per vehicle.
    - 2,000 kWh * 0.20 kg CO2e/kWh = 400 kg CO2e
- **On-site Vehicle Fleet:** Assume minimal direct fuel consumption for internal logistics within the plant boundary (e.g., forklifts). For simplicity, this is often negligible compared to larger sources and can be integrated into facility energy, or estimated separately. For this analysis, assumed to be negligible and included in general facility energy where applicable.

Total Estimated Scope 1 Emissions: 400 kg CO2e

Scope 2 Emissions (Indirect Emissions from Purchased Energy)

Scope 2 emissions arise from the generation of purchased electricity for the final assembly plant in the Netherlands.

- **Purchased Electricity for Assembly:** Assume 10,000 kWh of electricity consumed directly by the assembly plant per vehicle.
    - 10,000 kWh * 0.28 kg CO2e/kWh = 2,800 kg CO2e

Total Estimated Scope 2 Emissions: 2,800 kg CO2e

Scope 3 Emissions (All Other Indirect Emissions in the Value Chain)

Scope 3 constitutes the largest portion of emissions for a "factory_gate" PCF, encompassing all upstream activities from raw material extraction to component manufacturing and transportation to the final assembly plant. We aim for at least 95% coverage as per 2026 requirements.

Scope 3 Category (Upstream)	Activity Data	Emission Factor (kg CO2e/unit)	Calculated CO2e (kg)	Notes
Purchased Goods & Services: Materials				
Lithium-Ion Battery (LFP) Production (60.48 kWh)	60.48 kWh	70 kg CO2e/kWh	4,233.6	Largest hotspot, includes mining, processing, cell & pack assembly.
Steel Production (Primary)	850 kg	1.8 kg CO2e/kg	1,530.0	Includes iron ore mining, steelmaking process.
Aluminium Production (Primary)	290 kg	8.5 kg CO2e/kg	2,465.0	Includes bauxite mining, alumina refining, smelting.

Scope 3 Category (Upstream)	Activity Data	Emission Factor (kg CO2e/ unit)	Calculated CO2e (kg)	Notes
Plastics & Composites Production	200 kg	3.5 kg CO2e/kg	700.0	Includes crude oil/gas extraction, polymerization.
Copper Production (Primary)	60 kg	4.0 kg CO2e/kg	240.0	Includes copper ore mining, refining.
Glass Production	40 kg	1.0 kg CO2e/kg	40.0	Includes raw material extraction, melting, forming.
Rubber Production	50 kg	2.0 kg CO2e/kg	100.0	Includes raw material (natural/ synthetic rubber) processing.
Upstream Transportation & Distribution				
Inbound Logistics (Avg. EU Road Freight)	1700 kg * 500 km (avg. dist) = 850 tkm	0.1 kg CO2e/tkm	85.0	Assumed average distance for EU-sourced components.
Inbound Logistics (Global Sea Freight)	420 kg (battery) * 10,000 km = 4200 tkm	0.01 kg CO2e/tkm	42.0	Assumed battery originating from outside Europe (e.g., Asia).
Waste Generated in Operations				
Manufacturing Waste (Steel scrap)	5% of steel input = 42.5 kg	-0.1 kg CO2e/kg	-4.25	Credit for recycling/

Scope 3 Category (Upstream)	Activity Data	Emission Factor (kg CO2e/ unit)	Calculated CO2e (kg)	Notes
				avoided primary production.
Manufacturing Waste (Aluminium scrap)	5% of aluminium input = 14.5 kg	-0.5 kg CO2e/kg	-7.25	Credit for recycling/ avoided primary production.
Manufacturing Waste (Plastics, other)	2% of total materials ~30 kg	2.5 kg CO2e/kg	75.0	Emissions from landfill/ incineration for non-recyclable waste.

Total Estimated Scope 3 Emissions: 9,474.1 kg CO2e

Summary of Product Carbon Footprint (PCF)

GHG Scope	Estimated CO2e (kg)	Percentage of Total
Scope 1 (Direct Emissions)	400.0	3.4%
Scope 2 (Purchased Energy)	2,800.0	24.0%
Scope 3 (Value Chain)	9,474.1	72.6%
Total PCF (factory_gate)	**12,674.1 kg CO2e**	**100%**

The total estimated Product Carbon Footprint for one BYD Atto 3 (60.48 kWh battery) at the factory gate, based on the defined scope and assumptions, is approximately **12,674.1 kg CO2e**.

4.3 2026 Land Sector and Removals (LSR) Standard Update

The GHG Protocol\'s Land Sector and Removals (LSR) Standard was released on January 30, 2026, and officially takes effect on January 1, 2027. This standard provides crucial requirements and guidance for accounting for land sector emissions (such as land use change, land management, and biogenic products) and CO2 removals.

For a "factory_gate" PCF of a vehicle, direct land-use change emissions from the manufacturing facility itself in the Netherlands would typically be minimal or negligible, assuming the factory is built on existing industrial land and not on recently converted natural ecosystems. However, the LSR Standard\'s implications extend to Scope 3 emissions, particularly for purchased goods and services. Upstream land-use change and land management activities associated with the extraction and processing of raw materials (e.g., mining for metals that might involve deforestation, or sourcing of biogenic materials if any were used) within the supply chain would be considered under the LSR Standard.

In this theoretical analysis, while specific land-use data for each raw material\'s origin is unavailable, the Scope 3 calculations conceptually integrate the upstream impacts, including those that would fall under the LSR Standard, by using comprehensive emission factors. For a real-world application, a deeper dive into the supply chain\'s land footprint would be essential to fully comply with the LSR Standard, especially for materials sourced from regions with high deforestation risk or significant agricultural activities. The standard also covers CO2 removals, which would be relevant if any carbon capture technologies were integrated into the manufacturing process or if biogenic carbon sequestration was directly part of the product\'s lifecycle (e.g., bio-based components with certified sequestration). For this PCF, no direct removals are currently accounted for within the factory_gate boundary.

4.4 Scope 3 Compliance (95% Coverage)

As per the 2026 requirements, this report aims for at least 95% coverage for Scope 3 reporting. The breakdown above includes the major material components (battery, steel, aluminium, plastics, copper, glass, rubber) and key transportation aspects, which collectively represent the dominant share of upstream emissions for a vehicle\'s manufacturing phase. Minor components, indirect services, and capital goods are generally considered less significant contributors within the "factory_gate" boundary for this type of product. The detailed inclusion of battery production, metal production, and plastics manufacturing accounts for the vast majority of the vehicle\'s mass and energy-intensive processes, thereby ensuring a high level of Scope 3 coverage.

5. Review & Report

5.1 Emission Hotspots

The analysis clearly identifies the following major emission hotspots for the BYD Atto 3 at the "factory_gate" boundary:

1. **Lithium-Ion Battery Production (Scope 3):** Representing the largest single contributor, accounting for approximately 33.4% of the total PCF. This is due to the energy-intensive nature of raw material extraction, refining (e.g., lithium, graphite), and the complex cell and pack assembly processes. The choice of an LFP battery, while generally having a lower footprint than NMC/NCA types, still drives significant emissions.
2. **Primary Aluminium Production (Scope 3):** Accounting for about 19.4% of the total PCF. The high energy demand for smelting bauxite into primary aluminium makes this a significant hotspot, especially given the increased use of aluminium in EVs for lightweighting.
3. **Purchased Electricity for Assembly (Scope 2):** Contributing around 22.1% of the total PCF. The carbon intensity of the electricity grid in the assumed Netherlands production country, and in the supply chain for component manufacturing, directly impacts this figure. Decarbonization of the energy supply is crucial here.
4. **Primary Steel Production (Scope 3):** Representing about 12.1% of the total PCF, driven by the substantial quantity of steel still used in vehicle construction, even with lightweighting efforts.

5.2 Reliability and Limitations

The reliability of this PCF analysis is subject to several limitations inherent in a theoretical assessment:

- **Data Availability:** This report relies on secondary data, industry averages, and publicly available specifications for the BYD Atto 3 and general EV manufacturing. Access to specific, proprietary primary data from BYD\'s actual supply chain and manufacturing facilities would significantly enhance accuracy.
- **Geographic Specificity:** While a "Netherlands final production" and "Europe-focused supply chain" were specified, precise, granular emission factors for every component from exact European suppliers were not available. General European average emission factors have

been used where specific regional data was lacking. For battery production, global averages or typical production regions (e.g., Asia) are often assumed due to the globalized supply chain.

- **Assumptions:** Quantities of materials, energy consumption benchmarks, and transportation distances are based on reasonable industry assumptions. Actual figures may vary.
- **Dynamic Nature:** Emission factors and manufacturing processes are constantly evolving. This report reflects current understanding and projected factors for 2026.
- **Functional Unit Scope:** The "factory_gate" boundary deliberately excludes the use phase and end-of-life, which represent significant portions of a vehicle\'s total lifecycle emissions. This report is therefore not a full "cradle-to-grave" assessment.

5.3 Recommendations for Emission Reduction

To reduce the Product Carbon Footprint of the BYD Atto 3, efforts should focus on the identified hotspots:

1. **Battery Supply Chain Decarbonization:** Prioritize sourcing LFP batteries manufactured using renewable energy. Support R&D into lower-impact battery chemistries and advanced recycling processes that significantly reduce emissions from raw material extraction and production.
2. **Green Materials Sourcing:** Increase the use of low-carbon steel (e.g., green steel produced with hydrogen) and recycled aluminium in the vehicle body and components. Engage with suppliers to ensure transparency and drive decarbonization efforts in their respective industries.
3. **Renewable Energy at Manufacturing Facilities:** Ensure that both the final assembly plant in the Netherlands and key component manufacturing facilities (especially those for energy-intensive materials like aluminium and steel) are powered by 100% renewable electricity.
4. **Lightweighting and Material Efficiency:** Continuously optimize vehicle design to reduce overall material consumption, especially for high-impact materials. Improve manufacturing process efficiency to minimize waste.
5. **Optimized Logistics:** Streamline the supply chain to reduce transportation distances and prioritize lower-emission transport

modes (e.g., rail, sea freight powered by greener fuels) for inbound logistics.

This analysis provides a foundational understanding for BYD to strategically target emission reductions within the production phase of the Atto 3, aligning with global sustainability goals and regulatory expectations.
