CARBONCALCPCF.COM • PRODUCT LCA DASHBOARD

Nylon 6 (Polyamide 6) Virgin Resin

Functional Unit: 1.0 kg | Boundary: Cradle-to-Factory Gate | Production: Germany

Standard: GHG Protocol • 2026 LSR

TOTAL PRODUCT CARBON FOOTPRINT

6.712 kg CO_2e

± 99.4% Mass & Energy Inventory Captured

CARBON INTENSITY

6.71 kg/kg

European Benchmark modern N_2O catalytic abatement

DOMINANT PRECURSOR

78.7%

Caprolactam monomer (5.28 kg CO_2e)

SCOPE 3 EXPOSURE

93.3%

Exceeds GHG Protocol >95% boundary coverage

CORE OPERATIONS

0.45 kg CO_2e

Scope 1 (Steam) + Scope 2 (German Grid)

Lifecycle Stage Emissions Breakdown

Cradle-to-Factory Gate (1.0 kg PA6)

Caprolactam Synthesis (Upstream Tier 1)
1.025 kg molten precursor • Raschig/HPO catalytic route

5.279 kg CO_2e
78.65%

Thermal Steam & Direct Heating (Scope 1)
2.85 MJ natural gas boiler (88% eff) + off-gas VOC

0.172 kg CO_2e
2.56%

Process Electricity & District Heat (Scope 2)
0.680 kWh (German residual grid @ 375 g/kWh) + 0.35 MJ heat

0.277 kg CO_2e
4.13%

Inbound Chemical Logistics (Scope 3, Cat 4)
150.0 km road freight • Euro VI heated tanker truck

0.016 kg CO_2e
0.24%

Auxiliary Inputs, WTT Fuels & Waste Treatment
DI water, N_2 drying gas, packaging & oligomer incineration

0.968 kg CO_2e
14.42%

Downstream Delivery, Use & End-of-Life
Excluded under Cradle-to-Factory Gate accounting boundary

0.000 kg CO_2e
N/A (Gate)

GHG Protocol Scope Split

ISO 14067 Compliant



Scope 3 (Upstream Value Chain)	**6.263 kg (93.3%)**
Scope 2 (Purchased Electricity/ Steam)	**0.277 kg (4.1%)**
Scope 1 (Direct Boiler & Process)	**0.172 kg (2.6%)**
2026 LSR Biogenic & Removals	0.000 kg (0.0%)

Mass vs. Carbon Disparity

Impact Decoupling

Life Cycle Input	Physical Mass	Relative Carbon Footprint
Caprolactam	1.025 kg (19.4%)	5.279 kg CO_2e **78.7%**
Demineralized Water	4.200 kg (79.5%)	0.012 kg CO_2e **0.18%**
Energy Utilities	0.68 kWh / 2.85 MJ	0.449 kg CO_2e **6.69%**
Packaging & Additives	0.068 kg (1.1%)	0.972 kg CO_2e **14.4%**

Sustainability Insights

2026 Audit Ready

✓ **Caprolactam Synthesis is the Critical Hotspot (78.7%)**

The catalytic conversion of benzene to cyclohexane and nitric acid oxidation accounts for 5.28 kg CO_2e. Secondary and tertiary N_2O catalytic destruction at the precursor plant is essential to keep factors near 5.15 kg CO_2e/kg.

✓ **Scope 3 Dominance (93.3% Value Chain)**

Over 93% of the product carbon footprint lies outside direct factory smokestacks. Scope 3 upstream completeness was evaluated at 99.4%, fully satisfying the new GHG Protocol ≥95% threshold.

✓ **2026 LSR Standard: Zero Biogenic Removal Offset**

Because virgin PA6 granulate utilizes 100% fossil aromatics, biogenic carbon is verified at 0.00 kg C/kg with zero land-use change (dLUC/sLUC) credits claimed.

Decarbonization Roadmap

Reduction Pathways

-3.20 kg CO_2e / kg

Shift to Recycled or Bio-Based Caprolactam

Transition to chemically depolymerized post-industrial fishing nets (depolymerized PA6) or bio-cyclohexanone feedstocks to slash precursor emissions by 45–60%.

-0.23 kg CO_2e / kg

Dedicated Renewable Power Purchase Agreement (PPA)

Replacing the German residual grid factor (0.375 kg/kWh) with bundled wind/solar PPAs eliminates 91% of Scope 2 emissions for the polymerization extruder and drying loops.

-0.01 kg CO_2e / kg

Electrified Logistics on 150 km Tanker Corridor

Transitioning precursor liquid road transport to battery-electric heavy-duty vehicles (e-HGVs) reduces transport emissions by ~80%.

carboncalcpcf.com • Verified Cradle-to-Gate Life Cycle Assessment (LCA)

Data Quality Rating: **1.16 / 5.0 (Very High)** • IPCC AR6 GWP-100 • Ecoinvent v3.10 • Published Nov 2026