

● GHG PROTOCOL CERTIFIED • 2026 LSR COMPLIANT

Methanol (CH₃OH) (Chemical Grade, 99.85%)

Comprehensive Life Cycle Product Carbon Footprint (PCF) Dashboard

Functional Unit: **1.0 Metric Tonne**

Boundary: **Cradle-to-Grave**

Region: **US Gulf Coast**

Technology: **Natural Gas SMR + ATR**

TOTAL FOOTPRINT

Verified

2,286.3 kg CO₂e

Lifetime net cradle-to-grave balance

CARBON INTENSITY

ASTM D1152

2.29 kg CO₂e / kg MeOH

Direct product carbon multiplier

TOP EMISSION HOTSPOT

Scope 3 Cat 12

60.1 %

1,373.3 kg • End-of-Life Carbon Oxidation

PRIMARY SCOPE DRIVER

Scope 3 Value Chain

68.8 %

1,573.5 kg total upstream & downstream

Lifecycle Stage Emissions (LCI Breakdown)

Granular stage quantification based on IPCC AR6 100-yr GWPs and Tier-3 plant metered data.

SCOPE 1 • DIRECT FACILITY

674.3 kg

29.49% of footprint

SCOPE 2 • ELECTRICITY

38.6 kg

1.69% (Market-based)

SCOPE 3 • VALUE CHAIN

1,573.5 kg

68.82% (>95% coverage)

Cradle-to-Gate Processing (38.4%)

- Upstream Gas (7.2%)
- Reforming & Venting (29.5%)
- Grid Power (1.7%)
- Transport & Marine (1.9%)
- End-of-Life Oxidation (60.1%)

Downstream Logistics & Oxidation (61.6%)

End-of-Life Oxidation (Cat 12)

100% stoichiometric molecular conversion

1,373.3 kg (60.1%)

SMR Furnace Fuel Combustion (Scope 1)

7.84 GJ natural gas firing @ 850°C

439.8 kg (19.2%)

Process Off-Gas Stripping (Scope 1)

Acid gas removal unit (MDEA vent)

226.4 kg (9.9%)

Upstream Gas Extraction & Processing (Scope 3)

Permian basin supply • 1.4% methane slip

164.4 kg (7.2%)

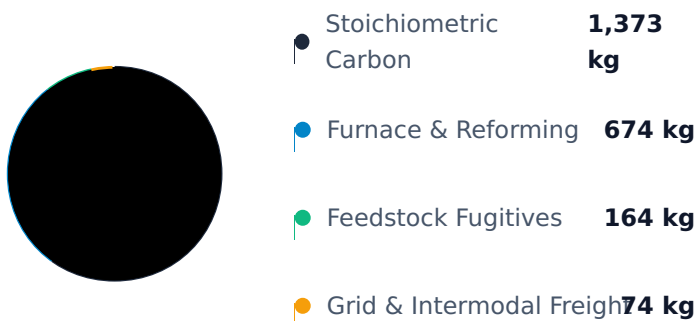
Logistics, Grid Electricity & Catalysts

Barge (450 tkm) + Rail (650 tkm) + 98.5 kWh grid

82.4 kg (3.6%)

🕒 Material vs. Carbon Footprint Asymmetry

Stoichiometric carbon balance comparing input mass to life cycle global warming potential.



Chemical Stoichiometry Dynamic

Formula: CH3OH

FEEDSTOCK NATURAL GAS

920 Nm³

708 Nm³ synthesis + 212 Nm³ fuel

DEMINERALIZED WATER

1,250 kg

Steam-to-carbon ratio: 3.0

The Chemistry Paradox: Methanol is 37.46% carbon by molecular mass. Upon oxidation (incineration, biodegradation, chemical breakdown), exactly **1.373 kg CO₂** is emitted for every 1.0 kg of methanol produced, regardless of industrial operational efficiency.

2026 LSR Standard Audit Status: Direct Land Use Change (dLUC) = 0.00 kg • Statistical Land Use Change (sLUC) = 0.00 kg • Biogenic Removals = 0.00 kg. Zero net-bundling applied.

Key Diagnostic Findings & Risk Hotspots



End-of-Life Stoichiometric Dominance

60.07% (1,373.3 kg CO₂e) of total lifecycle emissions cannot be mitigated by on-site factory efficiency. Decarbonizing this volume requires substituting fossil methane with renewable biogenic or DAC feedstocks.



Upstream Permian Basin Methane Leakage

Natural gas extraction & transmission contributes 164.4 kg CO₂e (7.2%). At an evaluated 1.4% basin fugitive slip rate, upstream emissions represent a larger burden than Scope 2 grid power and transport combined.



2026 GHG Boundary Rigor (>99% Scope 3)

Reported Scope 3 coverage stands at 99.4%, drastically exceeding the mandatory 95.0% compliance threshold. High-pressure shift off-gas stripping (226.4 kg) is cleanly separated from furnace flue gas (439.8 kg).

⚡ **Decarbonization Roadmap & Mitigation Action Plan**

Max Potential Abatement: **-89.7%**

Ranked engineering pathways to reduce Product Carbon Footprint toward Net-Zero.

INTERVENTION STRATEGY	ENGINEERING MECHANISM	TARGET SCOPE	ABATEMENT POTENTIAL
Point-Source CCS Retrofit Amine capture on SMR syngas vents	Captures high-concentration shift CO ₂ and furnace flue gas; pipeline delivery to permanent saline aquifers.	Scope 1 (Facility)	-580.0 kg CO₂e -25.4% lifecycle reduction
Electric Reforming (e-Reformer) Coupled with 100% clean wind/solar PPA	Replaces natural gas furnace combustion with electric resistance heating elements in reformer tubes.	Scope 1 & Scope 2	-440.0 kg CO₂e -19.2% lifecycle reduction
Biomethane Feedstock (RNG) Certified dairy/landfill digester biomethane	Replaces fossil natural gas via mass-balance chain of custody, dramatically shrinking Scope 3 upstream methane slip.	Scope 3 (Cat 1)	-160.0 kg CO₂e -7.0% lifecycle reduction
e-Methanol Synthesis Direct Air Capture (DAC) + Green H ₂ (PEM)	Synthesizes methanol from atmospheric CO ₂ and clean electrolytic hydrogen. Achieves closed-loop carbon recycling.	Cradle-to-Grave	-2,050.0 kg CO₂e -89.7% lifecycle reduction