MIDOR Refinery

Organizational GHG Inventory

Operational Control Approach

Base Year 2025

About this Report

MIDOR Refinery's first comprehensive greenhouse gas inventory report for base year 2025

Standards & Compliance

This inventory has been prepared in conformance with:

✓ **ISO 14064-1:2018 —** Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals

✓ **ISO 14069:2013 —** Guidance for the application of ISO 14064-1

✓ **GHG Protocol Corporate Accounting and Reporting Standard —** World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD)

Reporting Approach & Boundary

Consolidation Method: Operational Control

Language: English

GWP Set: IPCC AR6 (Sixth Assessment Report), 100-year time horizon

Scopes Included in this Inventory

Scope 1

Direct GHG Emissions

All direct emissions from sources within MIDOR's operational control boundary, including:

- Stationary combustion (heaters, boilers, incinerators)
- Process emissions (H_2 production, catalyst regeneration, etc.)
- Fugitive emissions (storage tanks, loading, refrigerants)
- Mobile combustion (vehicles, forklifts)
- Flaring

Scope 2

Indirect GHG from Energy

Emissions from purchased electricity only. Suppliers:

- **MIDELEC** (primary supplier)
- **National Grid** (backup supply)

Method: Location-based (market-based to be developed)

Scope 3

Other Indirect Emissions

Two categories included:

- **Category 7:** Employee Commuting
- **Category 11:** Use of Sold Products (combustion of refined products sold)

Assurance

Note: This inventory has not yet been externally assured. A placeholder section (Appendix E) is included for future third-party verification statements.

Report Prepared By

Ahmed Mohamed Sabri

Amr Hassan Abu Mady

Tareq Mohamed Salama

Ahmed Adel Mabrouk

Disclaimer

This report contains forward-looking statements regarding emission reduction targets and initiatives. Actual results may differ materially from projections due to various factors including operational changes, regulatory requirements, technological developments, and economic conditions.

⚠️ **Data Note:** This report contains dummy placeholder values marked "to be replaced" throughout. All emission factors, activity data, and calculations are illustrative and must be updated with actual measured data before publication or official reporting.

Section 1: MIDOR at a Glance

Understanding our refinery operations and emission footprint

Site Overview

Figure 1-1: MIDOR Refinery geographical footprint and site layout

Operational Profile

Crude Throughput

160,000

Energy Sources

2

Barrels per Stream Day (BPSD)

MIDELEC (primary) + National Grid (backup)

📦

Main Products

8+

LPG, Gasoline, Jet, Diesel, Fuel Oil, Coke, Sulfur

Main Product Slate

Product	Description	Markets
LPG	Liquefied Petroleum Gas	Domestic & Regional
Gasoline	Motor gasoline (various grades)	Domestic
Jet Fuel / Kerosene	Aviation turbine fuel	Exported
Diesel (ULSD)	Ultra-low sulfur diesel	Domestic (portion exported)
Fuel Oil	Heavy fuel oil	Industrial / Marine
Petroleum Coke	From delayed coking unit	Industrial
Sulfur	Elemental sulfur recovery	Industrial / Fertilizer
Asphalt	Road construction material	Domestic

Table 1-1: MIDOR refinery main products and market destinations

Refinery Complexes & Process Units

🔧 Crude / Vacuum Distillation

⚗️ Catalytic Reforming

U_01, U_17 — Primary fractionation and separation

U_04 CCR/Platformer, U_07 Penex/Isomerization — Octane enhancement

🧪 Hydrotreating Complex

U_02/03, U_08, U_18, U_19, U_20 — Sulfur and contaminant removal

💨 Hydrogen Production

U_09, U_21 SMR — Steam methane reforming for hydrogen supply

♨️ Delayed Coking

U_11 (incl. Cell 3) — Bottom-of-barrel upgrading

🔥 Sulfur Recovery

U_13, U_22 SRU/Amine — Acid gas treatment and elemental sulfur production

⚙️ Utilities

U_37 Boilers, substations — Steam, power, cooling water, air

🔥 Flare & Offsites

Flare system, tank farm, marine terminal — Safety relief and storage

Section 2: Principles & Governance

Foundation of our GHG inventory management

Inventory Principles

Our GHG inventory adheres to the five core principles of ISO 14064-1 and the GHG Protocol:

1. Relevance

All significant emission sources have been identified and included. Boundary reflects operational control and material activities.

2. Completeness

All applicable Scope 1 sources included. Scope 2 covers all purchased electricity. Scope 3 includes Categories 7 and 11.

3. Consistency

Methods and boundaries defined for multi-year tracking. Recalculation policy established for base year adjustments.

4. Accuracy

Data sourced from calibrated meters, DCS/PI systems, lab analysis, and invoices. Uncertainty assessed per category.

5. Transparency

All methods, data sources, emission factors, assumptions, and exclusions documented and disclosed in this report.

Roles & Responsibilities

Role	Responsibility
Inventory Manager	Overall coordination, data compilation, calculation oversight, reporting
Process Engineers	Activity data collection from units (fuel consumption, production rates, stack tests)
Laboratory	Fuel composition analysis (GC, calorific values, carbon content)
Maintenance	Refrigerant tracking, equipment records, LDAR program data
Procurement	Electricity invoices, diesel fuel purchases, mobile fuel records
HSE Department	QA/QC oversight, regulatory compliance, external reporting
Management	Strategic review, target setting, approval of inventory and public disclosure

Table 2-1: GHG inventory roles and responsibilities

Data Flow & Quality Control

> Data Flow Summary: Activity data → Unit engineers → Centralized database → Emission calculations → QC review → Management approval → External reporting

Quality Assurance / Quality Control (QA/QC)

- **Meter Calibration:** All flow meters and analytical instruments on annual calibration schedule
- **Data Validation:** Cross-checks between DCS, PI historian, and manual logs
- **Calculation Review:** Independent verification of emission factors and formulas
- **Peer Review:** Internal technical review before finalization
- **Change Control:** Documented process for methodology or boundary changes
- **Archiving:** All source data, calculations, and supporting documents retained for 7 years

Section 3: Boundaries

Defining our organizational and operational boundaries

Organizational Boundary

Consolidation Approach: Operational Control

MIDOR accounts for 100% of GHG emissions from operations over which it has full authority to introduce and implement operating policies, health, safety, and environmental policies.

> **Operational Control Defined:** MIDOR has operational control over all facilities within the refinery fence line. This includes all process units, utilities, storage, flare systems, and on-site mobile equipment.

Operational Boundary: Scope Overview

Scope 1: Direct GHG Emissions

All direct emissions from sources owned or controlled by MIDOR within the refinery boundary.

Category	Sources Included	Status
Stationary Combustion	Heaters, boilers, incinerators fired with fuel gas, fuel oil, diesel	✓ Included
Flaring	Continuous and emergency flare emissions (measured via flow meter)	✓ Included
Process Emissions	H_2 production (SMR), catalyst regeneration, coke drum steaming, SRU tail gas oxidation	✓ Included
Fugitive Emissions	Storage tanks (breathing/working losses), product loading, wastewater CH_4/N_2O, refrigerant leaks, CO_2 fire extinguishers	✓ Included
Mobile Combustion	On-site vehicles: forklifts, fire trucks, maintenance vehicles, shuttle buses (diesel)	✓ Included

Table 3-1: Scope 1 emission sources

Scope 2: Indirect Emissions from Purchased Energy

Emissions from purchased electricity consumed by MIDOR.

Energy Type	Supplier	Method	Status
Electricity	MIDELEC (primary)	Location-based	✓ Included
Electricity	National Grid (backup)	Location-based	✓ Included
Steam	Self-generated (not purchased)	N/A	Scope 1

Table 3-2: Scope 2 energy sources

> Market-Based Method: Not currently applied. MIDOR does not yet purchase contractual instruments (renewable energy certificates, power purchase agreements). Market-based accounting will be implemented when such instruments are acquired.

Scope 3: Other Indirect Emissions

Selected categories of value chain emissions.

Category	Description	Status
Cat. 7: Employee Commuting	Emissions from employee travel between home and workplace	✓ Included
Cat. 11: Use of Sold Products	Combustion of refined products sold (gasoline, diesel, jet fuel, LPG, fuel oil, coke)	✓ Included
All other Scope 3 categories	Purchased goods, capital goods, waste, business travel, etc.	Not yet quantified

Table 3-3: Scope 3 categories

Exclusions & Rationale

The following sources or activities are explicitly excluded from this inventory:

- **Biomass CO_2:** Minimal to zero biomass use; if present in future, will be separately tracked per ISO 14064-1
- **Scope 3 Cat. 1-6, 8-10, 12-15:** Not yet quantified; future inventories may expand coverage
- **Downstream leased assets:** MIDOR does not lease assets to third parties
- **Land use change:** No land use change activities within reporting period

⚠️ Exclusions list is subject to annual review. Any material category excluded must be justified based on relevance and materiality thresholds.

Section 4: Methods & Factors

Quantification approaches and emission factors

GHG Gases Included

This inventory quantifies the following greenhouse gases, expressed as carbon dioxide equivalent (CO_2e):

Gas	Chemical Formula	GWP (AR6, 100-yr)	Primary Sources at MIDOR
Carbon Dioxide	CO_2	1	Combustion, process (SMR, SRU)
Methane	CH_4	27.9	Combustion slip, fugitives, wastewater
Nitrous Oxide	N_2O	273	Combustion, wastewater
Hydrofluorocarbons	HFCs	Variable (hundreds to thousands)	Refrigerants (if present)

Table 4-1: GHG gases and global warming potentials (Source: IPCC AR6, 2021)

⚠️ GWP values are from IPCC AR6 (latest). These must be applied consistently throughout the inventory.

Quantification Methods Register

The following table summarizes the calculation approach for each emission category:

Source Category	Method Type	Activity Data Source	Emission Factor Reference
Fuel Gas Combustion	Carbon mass balance	DCS flow meters, lab GC analysis	API Compendium / Site-specific
Fuel Oil Combustion	Fuel consumption × EF	Tank level / invoices	API Compendium

Source Category	Method Type	Activity Data Source	Emission Factor Reference
Diesel Combustion	Fuel consumption × EF	Fuel receipts / vehicle logs	IPCC 2006
Flaring	Flow meter + composition + DRE	Flare header flow meter, GC	EPA AP-42 / DRE 99.9%, CH_4 slip 0.01%
H_2 Production (SMR)	Process mass balance	H_2 production rate, natural gas feed	Stoichiometric + combustion
Catalyst Regeneration	Coke burn-off mass balance	Coke-on-catalyst, regen rate	Site-specific / Stack test
Storage Tanks	EPA TANKS or API Chapter 7	Tank dimensions, throughput, product properties	EPA / API
Product Loading	EPA AP-42 factors	Loading volumes, product vapor pressure	EPA AP-42
Wastewater	IPCC guidelines	COD/BOD load, flow rate, treatment type	IPCC 2006 Vol. 5
Refrigerants	Mass balance (purchases - disposals)	Maintenance logs, refrigerant receipts	IPCC AR6 GWPs
Mobile Combustion	Fuel consumption × EF	Fuel logs per vehicle type	IPCC 2006 / DEFRA
Purchased Electricity	Consumption × Grid EF (location-based)	Electricity invoices (MWh)	Supplier-specific or national grid average
Use of Sold Products	Product sold × End-use combustion EF	Sales invoices (volume/mass)	IPCC / EPA / Product LHV & carbon content

Table 4-2: Methods register for GHG quantification

Key Equations

Scope 1: Stationary Combustion

$$CO_2 = Fuel\_consumed \times Carbon\_fraction \times (44/12) \times Oxidation\_factor$$
$$CH_4 = Fuel\_consumed \times EF\_CH4 \times GWP\_CH4$$

```
N₂O = Fuel_consumed × EF_N2O × GWP_N2O
Total_CO₂e = CO₂ + CH₄_as_CO₂e + N₂O_as_CO₂e
```

Scope 2: Purchased Electricity

```
Scope2_emissions = Σ (MWh_supplier × EF_supplier)
```

Scope 3 Category 11: Use of Sold Products

```
Cat11_emissions = Σ (Product_sold × Use-phase_EF_product)
```

Electricity Emission Factors (Location-Based)

Supplier	Emission Factor (tCO_2e/MWh)	Source	Status
MIDELEC	0.55	Placeholder (supplier data pending)	TO BE REPLACED
National Grid	0.60	Placeholder (national average estimate)	TO BE REPLACED

Table 4-3: Electricity grid emission factors

Missing Data & Estimation

Where primary data is unavailable, the following hierarchy is applied:

1. **Use prior year data** (if operational conditions similar)
2. **Engineering estimates** (process modeling, mass balance)
3. **Conservative assumptions** (upper-bound estimates to avoid underreporting)
4. **Industry averages** (API, CONCAWE, peer refineries with similar configurations)

All estimations are clearly documented in the activity-to-method mapping (Appendix C).

Section 5: Results Overview

MIDOR's 2025 GHG footprint at a glance

Total Organizational Footprint

Total Inventory

37.05

Million tCO_2e

Scope 1

1.80

Million tCO_2e (4.9%)

Scope 2

0.25

Million tCO_2e (0.7%)

Scope 3

35.00

Million tCO_2e (94.4%)

Context: Scope 3 Category 11 (use of sold products) dominates the footprint, which is typical for refineries. Scope 1+2 (operational control emissions) total 2.05 $MtCO_2e$.

Emissions by Scope

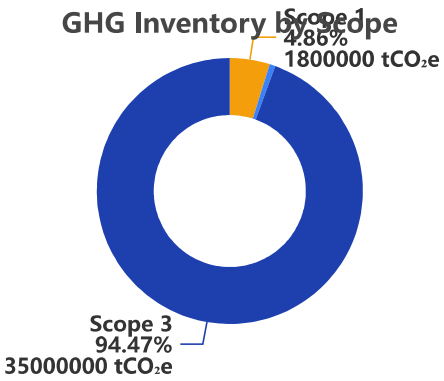

Figure 5-1: GHG inventory distribution by scope

⚠️ All values are dummy placeholders and must be updated with actual 2025 data.

Key Insights

- ✓ Direct operational emissions (Scope 1+2) represent ~5.6% of total footprint
- ✓ Use of sold products (Scope 3 Cat. 11) accounts for 94.4% — inherent to refining business model
- ✓ Stationary combustion is the largest Scope 1 category (~65%)
- ✓ Electricity sourcing from MIDELEC + National Grid backup accounts for all Scope 2
- ✓ Employee commute (Scope 3 Cat. 7) is minimal at ~0.03 $MtCO_2e$

Section 6: Scope 1 — Direct Emissions

Detailed breakdown of MIDOR's direct GHG emissions

Scope 1 Summary

Total Scope 1: 1,800,000 tCO_2e

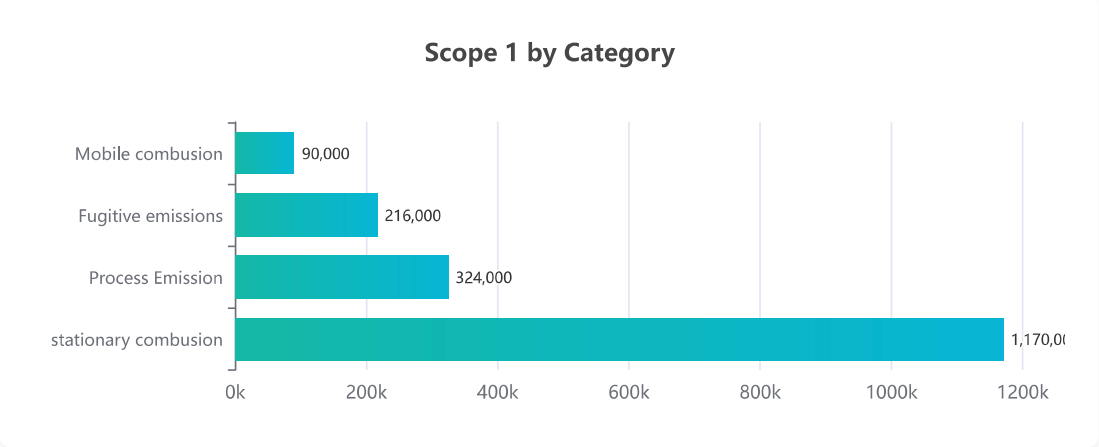

Figure 6-1: Scope 1 emissions by category

Category Breakdown

Category	Emissions (tCO_2e)	% of Scope 1	Number of Sources
Stationary Combustion	1,170,000	65.0%	20 sources
Process Emissions	324,000	18.0%	6 sources
Fugitive Emissions	216,000	12.0%	9 sources
Mobile Combustion	90,000	5.0%	4 vehicle categories

Table 6-1: Scope 1 emissions by category

Top Emission Sources

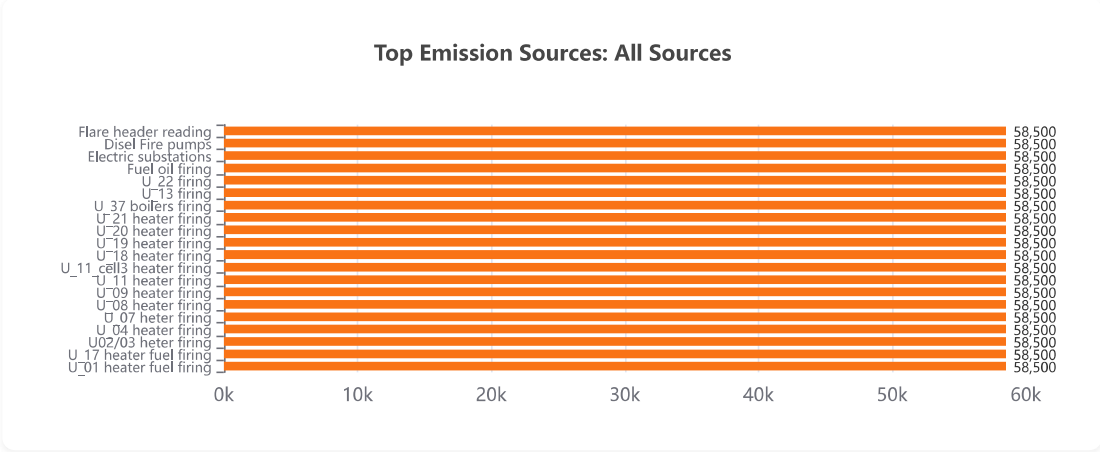

Figure 6-2: Top 20 Scope 1 emission sources (heat map)

Stationary Combustion Details

Fired heaters and boilers account for the majority of Scope 1 emissions. Key units include:

- **U_01 Crude Heater:** High throughput crude distillation heater
- **U_04 CCR Platformer:** Catalyst regeneration with combustion component
- **U_11 Delayed Coker:** Heaters plus coke drum steaming
- **U_09 & U_21 H_2 Plants:** SMR furnaces with process CO_2
- **U_37 Boilers:** Central steam generation
- **U_13 & U_22 Incinerators:** Tail gas and amine regeneration

GHG Composition (Scope 1)

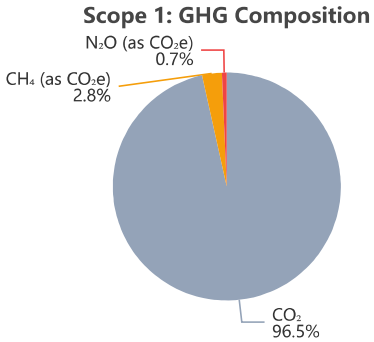

Figure 6-3: Scope 1 GHG composition (CO_2, CH_4, N_2O as CO_2e)

Gas breakdown:

- CO_2: ~96.5% (from combustion and process sources)
- CH_4 (as CO_2e): ~2.8% (combustion slip, fugitives, wastewater)
- N_2O (as CO_2e): ~0.7% (combustion, wastewater)

Process Emissions Highlights

Process Unit	Emission Source	Emissions (tCO_2e)
U_09 H_2 Plant	SMR process CO_2 + furnace combustion	54,000
U_21 H_2 Plant	SMR process CO_2 + furnace combustion	54,000
U_04 Catalyst Regeneration	Coke burn-off on platinum catalyst	54,000
U_11 Coke Drum Steaming	Residual hydrocarbon release during steaming	54,000
U_13 SRU	Tail gas oxidation to SO_2 and CO_2	54,000
U_22 SRU	Tail gas oxidation to SO_2 and CO_2	54,000

Table 6-2: Process emission sources (dummy allocations)

Fugitive Emissions Details

Fugitive emissions arise from non-point releases throughout the refinery:

- **Storage Tanks:** Breathing and working losses from crude, product tanks (LPG, naphtha, kerosene, diesel)
- **Product Loading:** Truck loading displacement emissions
- **Wastewater Treatment:** CH_4 and N_2O from biological treatment (U_54/55)
- **Refrigerant Leaks:** HFC losses from air conditioning systems
- **Fire Extinguishers:** CO_2 discharge from testing/use

Section 7: Scope 2 — Purchased Electricity

Indirect emissions from energy consumption

Scope 2 Summary

Total Scope 2 (Location-Based): 250,000 tCO_2e

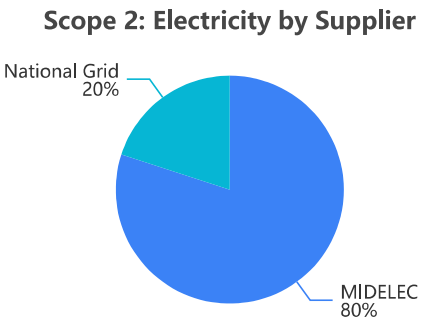

Figure 7-1: Scope 2 emissions by electricity supplier

Electricity Consumption & Emissions

Supplier	Consumption (MWh)	Emission Factor (tCO_2e/MWh)	Emissions (tCO_2e)	% of Scope 2
MIDELEC	363,636	0.55	200,000	80%
National Grid	83,333	0.60	50,000	20%
TOTAL	446,969	-	250,000	100%

Table 7-1: Scope 2 electricity consumption and emissions (location-based method)

⚠️ Emission factors are placeholders. Actual supplier-specific or national grid emission factors must be obtained from:

- Direct supplier disclosure (MIDELEC)

- National authority (Egyptian Electricity Holding Company or equivalent)
- IEA / UNFCCC national inventory reports

Location-Based vs. Market-Based

Current Approach: Location-Based
Emissions calculated using the average emission factor of the grid(s) from which electricity is consumed.

Market-Based (Future):
When MIDOR procures contractual instruments such as:

- Renewable Energy Certificates (RECs)
- Power Purchase Agreements (PPAs) with specific generators
- Supplier-specific emission rate contracts

Market-based Scope 2 will be calculated and reported alongside location-based.

Electricity Intensity

Electricity consumption per unit of crude processed:

446,969 MWh / 2,920 kton crude = 153 MWh / kton crude

This metric will be tracked annually to monitor energy efficiency improvements.

Section 8: Scope 3 — Value Chain Emissions

Indirect emissions from employee commuting and use of sold products

Scope 3 Summary

Total Scope 3: 35,000,000 tCO_2e

Category	Emissions (tCO_2e)	% of Scope 3
Category 7: Employee Commuting	30,000	0.09%
Category 11: Use of Sold Products	34,970,000	99.91%
TOTAL	35,000,000	100%

Table 8-1: Scope 3 emissions by category

Category 7: Employee Commuting

Total: 30,000 tCO_2e

Calculated based on employee survey data (source: Administration — Ayman Sabry).

Methodology: Number of employees × Average commute distance × Work days per year × Emission factor by transport mode

⚠️ Actual employee commute data (headcount, distances, modes) to be collected via HR survey.

Category 11: Use of Sold Products

Total: 34,970,000 tCO_2e

Emissions from combustion of refined products sold by MIDOR. This is the single largest category in the inventory, inherent to the refining business model.

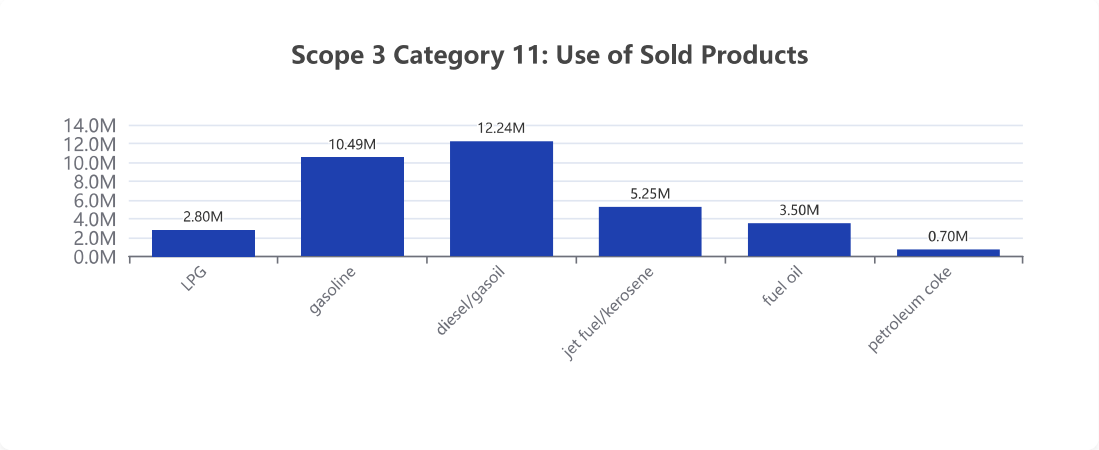

Figure 8-1: Scope 3 Category 11 emissions by product

Product-Level Emissions (Use Phase)

Product	Emissions (tCO_2e)	% of Cat. 11
Diesel / Gasoil	12,239,500	35.0%
Gasoline	10,491,000	30.0%
Jet Fuel / Kerosene	5,245,500	15.0%
Fuel Oil	3,497,000	10.0%
LPG	2,797,600	8.0%
Petroleum Coke	699,400	2.0%
TOTAL	34,970,000	100%

Table 8-2: Use of sold products emissions by product type

⚠️ Emissions calculated using:

- **Activity data:** Annual sales volumes (to be sourced from commercial/logistics department)
- **Emission factors:** Product-specific combustion EFs based on carbon content and lower heating value
- **References:** IPCC 2006 Guidelines, EPA, or product-specific lab analysis

Scope 3 Expansion Plans

Future inventories will consider additional Scope 3 categories:

- Category 1: Purchased goods and services (chemicals, catalysts)

- Category 2: Capital goods (major equipment, construction)
- Category 3: Fuel and energy-related activities (upstream crude extraction, transmission losses)
- Category 4: Upstream transportation and distribution
- Category 5: Waste generated in operations
- Category 6: Business travel

Section 9: Intensities & Trends

Performance metrics and multi-year tracking

Carbon Intensity Metrics

To enable year-over-year comparison and industry benchmarking, MIDOR tracks the following intensity metrics:

Carbon Intensity (Crude)

702.05

tCO_2e / kton crude

Carbon Intensity (Fired Duty)

0.0308

tCO_2e / GJ

Figure 9-1 & 9-2: Carbon intensity KPIs with trend sparklines

Intensity Calculation Details

Intensity 1: Emissions per Crude Input

Formula: (Scope 1 + Scope 2) / Crude throughput

Numerator: 2,050,000 tCO_2e

Denominator: 2,920 kton crude processed (160,000 BPSD × 365 days)

Result: **702.05 tCO_2e / kton crude**

Intensity 2: Emissions per Fired Duty

Formula: Scope 1 / Total fired duty

Numerator: 1,800,000 tCO_2e

Denominator: 58,400,000 GJ (sum of heater and boiler fired duties)

Result: **0.0308 tCO_2e / GJ**

⚠️ Denominators are dummy values. Actual crude throughput and fired duty figures must be obtained from:

- Crude throughput: Monthly refinery operating reports
- Fired duty: Process simulation or DCS-integrated heat duty calculations per heater/boiler

Baseline Year Establishment

2025 = **Base Year** for MIDOR's GHG inventory. All future inventories will compare against this baseline.

Base year intensity metrics will serve as KPIs for tracking decarbonization progress.

Trend Tracking (Multi-Year)

As MIDOR develops a time-series dataset (2025, 2026, 2027...), the following trend analyses will be included:

- Absolute emissions trends by scope and category
- Intensity metric trends
- Correlation with production changes, energy efficiency projects, and mitigation initiatives

> **Data Quality Improvement:** Year-over-year, MIDOR will refine data collection methods, reduce uncertainties, and expand monitoring coverage (e.g., real-time flare meters, LDAR programs).

Section 10: Base Year & Recalculation Policy

Ensuring consistency and comparability over time

Base Year Selection

Base Year: 2025

Rationale: 2025 is MIDOR's first comprehensive GHG inventory year. It represents a typical operational year with:

- ✓ Full refinery operations at ~160,000 BPSD
- ✓ Complete data collection systems in place
- ✓ No major structural changes (turnarounds, unit additions) planned during the year
- ✓ Availability of activity data, emission factors, and supporting documentation

Recalculation Triggers

MIDOR will recalculate the base year inventory if any of the following occur:

Trigger	Description	Significance Threshold
Structural Change	Merger, acquisition, divestiture, or closure of a major unit	>5% change in base year emissions
Boundary Change	Change in operational control, addition/removal of facilities	>5% change in base year emissions
Calculation Method Change	Updated emission factors, improved measurement (e.g., stack tests replacing defaults)	>5% change in category emissions
Data Error Discovery	Identification of significant error in base year data	>5% change in base year emissions
Policy/Standard Update	Updated GWPs (new IPCC report), regulatory requirement change	As required by standard

Table 10-1: Base year recalculation triggers

Recalculation Process

Process Flow:

1. Identify trigger event and assess materiality (>5% test)
2. Document reason for recalculation
3. Recalculate base year emissions using updated data/methods
4. Recalculate all subsequent years for consistency
5. Disclose recalculation in inventory report with clear explanation
6. Archive both original and recalculated inventories
7. Obtain management approval before publication

Significance Threshold

5% Threshold: MIDOR applies a 5% materiality threshold for recalculation triggers. Changes below this threshold are generally not considered material enough to warrant base year recalculation, but are noted in annual reports.

Transparency & Disclosure

All base year recalculations will be fully disclosed in subsequent inventory reports, including:

- Reason for recalculation
- Nature of the change (structural, methodological, data error)
- Impact on base year emissions (absolute and percentage)
- Impact on intensity metrics

Section 11: Uncertainty & Quality

Assessing data quality and estimation confidence

Uncertainty Assessment

Uncertainty exists in all GHG inventories due to measurement limitations, estimation methods, and emission factor variability. MIDOR assesses uncertainty both quantitatively (where possible) and qualitatively.

Quantitative Uncertainty Estimates

Emission Category	Emissions (tCO_2e)	Uncertainty (±% at 95% CI)	Lower Bound	Upper Bound
Stationary Combustion	1,170,000	±8%	1,076,400	1,263,600
Flaring	(included in combustion)	±15%	-	-
Process Emissions	324,000	±12%	285,120	362,880
Fugitive Emissions	216,000	±30%	151,200	280,800
Mobile Combustion	90,000	±10%	81,000	99,000
Scope 1 TOTAL	1,800,000	±10%	1,620,000	1,980,000
Scope 2 Electricity	250,000	±5%	237,500	262,500
Scope 3 Cat. 11	34,970,000	±15%	29,724,500	40,215,500

Table 11-1: Uncertainty estimates by category (dummy values)

⚠️ Uncertainty values are illustrative. Actual uncertainty should be calculated using:

- IPCC Tier 1 or Tier 2 uncertainty methods
- Monte Carlo simulations for complex sources
- Manufacturer specs for meters and instruments

- Published uncertainty ranges for emission factors

Qualitative Data Quality Ratings

Emission Source	Activity Data Quality	Emission Factor Quality	Overall Rating
Fuel Gas Combustion	High (metered, GC analyzed)	High (site-specific carbon balance)	✅ High
Fuel Oil / Diesel	High (invoiced, metered)	Medium (generic API factors)	🟡 Medium
Flaring	Medium (flow meter installed but requires calibration)	Medium (assumed DRE 99.9%)	🟡 Medium
H_2 Production	High (production metered, feed metered)	High (stoichiometry + measured)	✅ High
Storage Tanks	Medium (throughput known, some estimation)	Low (EPA/API models, not site-specific)	🔴 Low-Medium
Refrigerants	Low (incomplete tracking)	High (IPCC GWPs)	🔴 Low
Wastewater CH_4/N_2O	Medium (flow known, COD estimated)	Low (default IPCC factors)	🔴 Low-Medium
Purchased Electricity	High (invoiced MWh)	Low (grid EF placeholder)	🟡 Medium
Use of Sold Products	High (sales invoices)	Medium (generic combustion EFs)	🟡 Medium

Table 11-2: Qualitative data quality assessment

Improvement Actions

To reduce uncertainty and improve data quality, MIDOR plans the following actions:

Priority	Action	Target Source	Expected Impact
High	Increase fuel gas GC analysis frequency	Stationary combustion	Reduce uncertainty from ±8% to ±5%

Priority	Action	Target Source	Expected Impact
High	Install/calibrate flare flow meters	Flaring	Replace estimation with continuous monitoring
High	Implement LDAR program with OGI cameras	Fugitive emissions	Quantify leaks, reduce uncertainty ±30% → ±15%
Medium	Conduct storage tank emission modeling (TANKS)	Tank fugitives	Site-specific estimates vs. generic factors
Medium	Implement refrigerant tracking system	Refrigerant leaks	Accurate mass balance, compliance with F-gas regulations
Low	Measure wastewater CH_4 emissions (chamber test)	Wastewater treatment	Replace default IPCC with measured values
High	Obtain supplier-specific grid EFs	Scope 2 electricity	Replace placeholders with actual disclosed factors

Table 11-3: Data quality improvement roadmap

Section 12: Mitigation Roadmap

Pathway to reducing MIDOR's carbon footprint

Strategic Commitment

MIDOR is committed to managing and reducing its GHG emissions through a combination of energy efficiency, renewable energy, process optimization, and innovation.

Decarbonization Principles:

- ✓ Measure and track emissions transparently
- ✓ Prioritize energy efficiency and operational excellence
- ✓ Invest in renewable energy and low-carbon alternatives
- ✓ Innovate in processes and technologies
- ✓ Engage employees and stakeholders in sustainability goals

Mitigation Initiatives Timeline

2025

Energy Management System (ISO 50001)

Monitoring baseline

2026

Solar PV Installation (5 MW)

~8,000 tCO_2e/yr

2027

Waste Heat Recovery

~12,000 tCO_2e/yr

2028

Fleet Electrification

~3,000 tCO_2e/yr

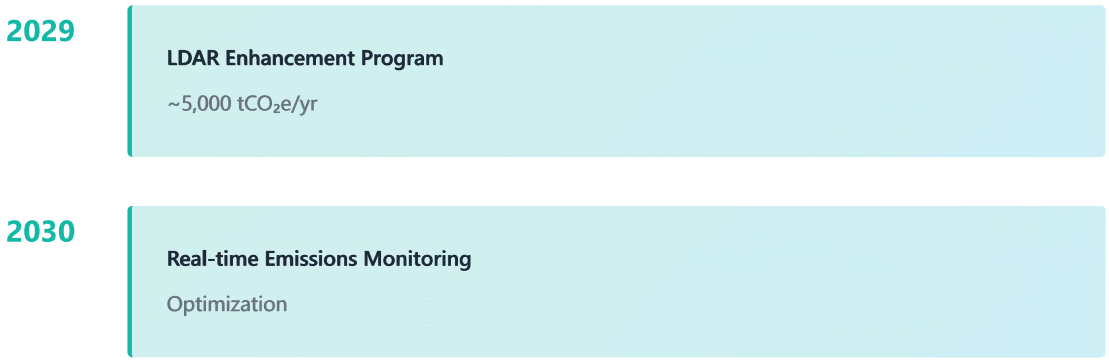

Figure 12-1: MIDOR's mitigation roadmap (2025-2030)

Initiative Details

1. Energy Management System (ISO 50001) — 2025

Description: Implement a certified energy management system to systematically monitor, analyze, and optimize energy consumption across the refinery.

Expected Impact: Establish baseline and identify 5-10% energy savings opportunities over time.

2. Solar PV Installation (5 MW) — 2026

Description: Install 5 MW of rooftop and ground-mounted solar photovoltaic panels on non-critical areas (warehouses, admin buildings, parking).

Expected Impact: ~8,000 tCO_2e/year Scope 2 reduction (assuming ~8,000 MWh/year generation at 0.55 tCO_2e/MWh grid factor).

3. Waste Heat Recovery — 2027

Description: Install heat exchangers to recover waste heat from hot flue gases and process streams for preheating or steam generation.

Expected Impact: ~12,000 tCO_2e/year Scope 1 reduction (reduced fuel gas consumption in heaters/boilers).

4. Fleet Electrification — 2028

Description: Replace diesel forklifts and light vehicles with electric alternatives. Install EV charging infrastructure.

Expected Impact: ~3,000 tCO_2e/year Scope 1 reduction (mobile combustion), with tradeoff of increased Scope 2.

5. LDAR Enhancement Program — 2029

Description: Upgrade leak detection and repair (LDAR) program with optical gas imaging (OGI) cameras, quarterly surveys, and rapid repair protocols.

Expected Impact: ~5,000 tCO_2e/year Scope 1 reduction (fugitive CH_4 emissions).

6. Real-time Emissions Monitoring — 2030

Description: Deploy continuous emission monitoring systems (CEMS) on major stacks and integrate with DCS for real-time GHG tracking and optimization.

Expected Impact: Enable dynamic process optimization; quantification improvement rather than direct reduction, but facilitates operational decisions to minimize emissions.

Cumulative Reduction Potential

Initiative	Reduction (tCO_2e/yr)	% of Scope 1+2 Baseline
Solar PV (Scope 2)	8,000	0.4%
Waste Heat Recovery (Scope 1)	12,000	0.6%
Fleet Electrification (Scope 1)	3,000	0.15%
LDAR Enhancement (Scope 1)	5,000	0.25%
TOTAL	**28,000**	**~1.4%**

Table 12-1: Mitigation initiative summary

⚠️ Reduction estimates are preliminary. Detailed engineering studies and business case analyses will refine these projections before implementation.

Long-Term Ambitions

Beyond 2030, MIDOR will explore:

- **Hydrogen as a fuel:** Transitioning fired heaters from fuel gas to low-carbon or green hydrogen
- **Carbon capture (CCUS):** Evaluating CO_2 capture from SMR hydrogen plants and large heaters
- **Renewable power purchase agreements (PPAs):** Procuring renewable electricity to reduce Scope 2
- **Circular economy:** Waste-to-energy, co-processing of plastics, bio-feedstock integration
- **Advanced process control:** AI/ML-driven optimization for real-time energy and emission minimization

Appendix A: Glossary & Abbreviations

Term / Abbreviation	Definition
API	American Petroleum Institute
AR6	IPCC Sixth Assessment Report (2021)
BPSD	Barrels Per Stream Day (refinery throughput)
CCR	Continuous Catalyst Regeneration (platformer unit)
CEMS	Continuous Emissions Monitoring System
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent (all GHGs expressed as CO_2)
DCS	Distributed Control System
DEFRA	UK Department for Environment, Food & Rural Affairs
DRE	Destruction and Removal Efficiency (flares)
EF	Emission Factor
EPA	U.S. Environmental Protection Agency
GC	Gas Chromatography (analytical method)
GHG	Greenhouse Gas
GJ	Gigajoule (energy unit)
GWP	Global Warming Potential

Term / Abbreviation	Definition
HFC	Hydrofluorocarbon (refrigerant)
IPCC	Intergovernmental Panel on Climate Change
ISO 14064-1	International standard for organizational GHG inventories
kton	Kiloton (1,000 metric tons)
LDAR	Leak Detection and Repair
LHV	Lower Heating Value
LPG	Liquefied Petroleum Gas
Mt	Million metric tons (Megatons)
MWh	Megawatt-hour (electricity unit)
N_2O	Nitrous Oxide
OGI	Optical Gas Imaging (leak detection technology)
PI	OSIsoft PI System (process data historian)
PPA	Power Purchase Agreement
QA/QC	Quality Assurance / Quality Control
Scope 1	Direct GHG emissions from owned/controlled sources
Scope 2	Indirect GHG emissions from purchased energy
Scope 3	Other indirect GHG emissions in the value chain
SMR	Steam Methane Reforming (hydrogen production)
SRU	Sulfur Recovery Unit
tCO_2e	Metric tons of carbon dioxide equivalent
ULSD	Ultra-Low Sulfur Diesel

Appendix B: Equations & Emission Factors

Detailed Calculation Equations

Stationary Combustion (Fuel Gas)

CO_2 = Fuel_volume (Nm^3) × Carbon_content (kg C/Nm^3) × (44/12) × Oxidation_factor

Where:
- Carbon_content from GC analysis and molecular weight calculation
- Oxidation_factor = 0.995 (default, or measured)
- 44/12 = molecular weight ratio CO_2/C

CH_4 = Fuel_volume × EF_{CH_4} (kg CH_4/Nm^3) × GWP_{CH_4} (27.9)
N_2O = Fuel_volume × EF_{N_2O} (kg N_2O/Nm^3) × GWP_{N_2O} (273)

Flaring

CO_2 = Flare_gas_volume × Carbon_content × (44/12) × DRE
CH_4_slip = Flare_gas_volume × CH_4_fraction × (1 - DRE) × GWP_{CH_4}

Where:
- DRE = Destruction and Removal Efficiency = 0.999 (99.9%)
- CH_4_slip accounts for uncombusted methane

Storage Tank Losses (API Method)

Breathing_losses = V_vapor × ρ_vapor × N_cycles
Working_losses = (Throughput / Turnover) × ρ_vapor × (1 - η_control)

Where:
- V_vapor = tank vapor space volume
- ρ_vapor = vapor density (function of temperature, vapor pressure)
- N_cycles = annual atmospheric pressure/temperature cycles
- η_control = vapor recovery efficiency (if VRU installed)

Emission Factor Reference Table

Source	Emission Factor	Unit	Reference	Status
Refinery Fuel Gas (CO_2)	Site-specific (from GC)	kg CO_2/Nm^3	Lab analysis	TO BE MEASURED
Refinery Fuel Gas (CH_4)	0.00001	kg CH_4/Nm^3	API Compendium	DEFAULT
Refinery Fuel Gas (N_2O)	0.0000001	kg N_2O/Nm^3	IPCC 2006	DEFAULT
Fuel Oil (CO_2)	77.4	kg CO_2/GJ	IPCC 2006 Table 1.3	DEFAULT
Diesel (CO_2)	74.1	kg CO_2/GJ	IPCC 2006 Table 1.3	✓ IPCC
Natural Gas (CO_2)	56.1	kg CO_2/GJ	IPCC 2006 Table 1.3	✓ IPCC
Gasoline (use-phase)	69.3	kg CO_2/GJ	IPCC 2006	✓ IPCC
Diesel (use-phase)	74.1	kg CO_2/GJ	IPCC 2006	✓ IPCC
Jet Fuel (use-phase)	71.5	kg CO_2/GJ	IPCC 2006	✓ IPCC
LPG (use-phase)	63.1	kg CO_2/GJ	IPCC 2006	✓ IPCC
Petroleum Coke (use-phase)	97.5	kg CO_2/GJ	IPCC 2006	✓ IPCC

Table B-1: Emission factors used in this inventory

⚠️ All emission factors marked "TO BE MEASURED" or "DEFAULT" must be replaced with site-specific or supplier-disclosed values before final publication.

Appendix C: Activity-to-Method Mapping

This appendix provides a detailed cross-reference between emission activities (from MIDOR activities.xlsx) and the quantification methods applied.

Scope 1 Activity Mapping

Activity	Sub-Activity	Method	Data Source	Classification
Heaters/boilers fuel gas firing	U_01 heater fuel firing	Carbon mass balance	DCS flow meter + GC	Stationary Combustion
Heaters/boilers fuel gas firing	U_17 heater fuel firing	Carbon mass balance	DCS flow meter + GC	Stationary Combustion
Incinerator firing	U_13 firing	Carbon mass balance	DCS flow meter + GC	Stationary Combustion
Flare header reading	-	Flow meter + DRE 99.9%	Flare flow meter + GC	Stationary Combustion (Flaring)
H_2 production	U_09 production	Process mass balance	H_2 metering + NG feed	Process Emission
Catalyst regeneration	-	Coke burn-off calculation	Catalyst circulation rate, coke-on-catalyst	Process Emission
Storage tanks breathing & working losses	Crude Tanks	EPA TANKS or API Ch. 7	Tank dimensions, throughput, lab analysis	Fugitive Emission
Waste water unit CH_4/N_2O release	U_54/55	IPCC wastewater method	Flow, COD/BOD, treatment type	Fugitive Emission
Refrigerant leaks	All air conditioners	Mass balance (purchases - disposals)	Maintenance logs	Fugitive Emission

Activity	Sub-Activity	Method	Data Source	Classification
Diesel	Forklifts	Fuel consumption × EF	Fuel receipts	Mobile Combustion

Table C-1: Sample activity-to-method mapping (full mapping includes all 48 activities)

⚠️ Complete mapping table to be generated from "MIDOR activities.xlsx" with all 48 activities listed. Any activity classified as "pending" requires method assignment before final calculation.

Appendix D: Data Sources & QC Checks

Data Source Register

Data Type	Source System / Document	Responsible Party	Frequency
Fuel gas flow rates	DCS / PI Historian	Process Engineers (per unit)	Continuous (hourly average)
Fuel gas composition	Laboratory GC analysis reports	Laboratory	Weekly (minimum)
Fuel oil / diesel consumption	Storage tank level changes + invoices	Procurement	Monthly
Electricity consumption	Utility invoices (MIDELEC, National Grid)	Procurement / Utilities	Monthly
Product sales volumes	Commercial invoices / logistics records	Commercial Department	Monthly
Flare gas flow	Flare header flow meter	Process Engineers	Continuous (to be installed/calibrated)
Refrigerant inventory	Maintenance logs, purchase receipts	Maintenance Department	Quarterly
Mobile fuel consumption	Vehicle fuel logs, receipts	Fleet Manager	Monthly

Table D-1: Data sources and collection responsibilities

QC Checks Performed

- ✓ **Mass Balance Checks:** Total crude input vs. product output + losses (~±2% closure expected)
- ✓ **Energy Balance:** Fuel consumed vs. heater/boiler duty (thermal efficiency check)
- ✓ **Comparison to Prior Year:** Flag any category change >20% year-over-year for investigation
- ✓ **Peer Review:** Calculations independently verified by second engineer

✓ **Instrument Calibration:** All critical meters calibrated annually (certificates on file)

✓ **Data Completeness:** Check for missing months or gaps in time-series data

Document Retention

All supporting documentation for this inventory is archived for a minimum of 7 years, including:

- Activity data files (DCS exports, PI queries, invoices)
- Emission factor references (journal articles, EPA documents, API guides)
- Calculation spreadsheets with version control
- QC checklists and peer review sign-offs
- Meeting minutes and management approvals

Appendix E: Placeholder for Future Assurance

This section is reserved for third-party verification or assurance statements when MIDOR pursues external audit of its GHG inventory.

Assurance Levels

ISO 14064-3 and ISO 14065 define assurance for GHG inventories:

- **Limited Assurance:** Verifier confirms no material misstatements found (negative assurance)
- **Reasonable Assurance:** Verifier provides positive confirmation that inventory is free of material misstatement (higher rigor)

Future Assurance Plan

MIDOR plans to seek third-party verification for the 2026 inventory (covering base year 2025 data), with the following scope:

- ✓ Scope 1 and Scope 2 emissions (Scope 3 Cat. 11 optional depending on stakeholder interest)
- ✓ Limited assurance level initially; reasonable assurance in future years
- ✓ Accredited verifier (ISO 14065 or equivalent)
- ✓ Site visit including data room review, interviews, and spot-checks of meters/instruments

Benefits of Assurance:

- Enhanced credibility for stakeholders (investors, customers, regulators)
- Identification of data quality improvements
- Compliance with voluntary or mandatory reporting schemes (e.g., CDP, EU ETS if applicable)
- Preparation for future carbon markets or border adjustment mechanisms

Sample Assurance Statement Format

[PLACEHOLDER FOR THIRD-PARTY VERIFICATION STATEMENT]

Example Content:
"[Verifier Name], an independent verification body accredited to ISO 14065, was engaged by MIDOR Refinery to provide limited assurance over its GHG inventory for the year 2025. Our verification was conducted in accordance with ISO 14064-3:2019. Based on our procedures, nothing has come to our

attention that causes us to believe that the GHG statement is not prepared, in all material respects, in accordance with ISO 14064-1:2018 and the GHG Protocol Corporate Standard."

End of Report

MIDOR Refinery — Organizational GHG Inventory (Base Year 2025)

Operational Control Approach

Conformant with ISO 14064-1:2018 and GHG Protocol Corporate Standard

How to Update This Report Next Year:

1. Update "MIDOR activities.xlsx" with new activity data
2. Update emission factors in assets/js/data.js
3. Regenerate data allocation using Python script
4. Refresh year references (2025 → 2026) throughout HTML
5. Print to PDF and distribute

Report generated: 2025 | Document version: 1.0 | All data placeholder pending actual 2025 data collection