GREENHOUSE GAS (GHG) EMISSIONS

2024 BASELINE

ALONG THE NORTHERN CORRIDOR ROUTES IN KENYA, UGANDA, AND RWANDA

MAY 2025

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Acknowledgements

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List of Abbreviations

ADT	Average Daily Traffic
ASIF	Activity, Structure, Intensity, Fuel
BAU	Business-As-Usual
BC	Black Carbon
CCAC	Climate and Clean Air Coalition
CO_2	Carbon Dioxide
EVs	Electric Vehicles
GHG	Greenhouse Gases
HCVs	Heavy Commercial Vehicles
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
LDTs	Light-Duty Trucks
MCVs	Medium Commercial Vehicles
MGR	Meter Gauge Railway
$MMtCO_2e$	Million Metric Tonnes of CO_2 Equivalent
NCEM	Northern Corridor GHG Emission Model
NCTTCA	Northern Corridor Transit and Transport Coordination Authority
NDCs	Nationally Determined Contributions
NO_x	Nitrous Oxides
PM10	Particulate Matter (10 micrometres or less)
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VKT	Vehicle Kilometres Travelled

Executive Summary

The Northern Corridor, a vital multimodal trade artery connecting the Port of Mombasa to Burundi, the Democratic Republic of Congo (DRC), Kenya, Rwanda, South Sudan, and Uganda, handled 40.992 million metric tonnes of cargo in 2024, up from 24.875 million tons in 2014, reflecting a 5.1% annual growth rate over the past decade (Port of Mombasa, 2024; Northern Corridor Transport Observatory, 2024). Road freight dominates this throughput, accounting for over 85%, This 2024 baseline survey aimed to quantify greenhouse gas (GHG) emissions from commercial trucks across Kenya, Rwanda, and Uganda. The survey establishes an essential benchmark of 2.92 million metric tonnes of CO_2 equivalent (MMtCO_2e) and 19,740 tonnes of pollutants (NO_x, PM10, BC), supporting the Northern Corridor Green Freight Strategy 2030's objectives of a 10% CO_2 intensity reduction by 2030 and net-zero emissions by 2050, while meeting UNFCCC Paris Agreement Article 13 transparency requirements.

Employing the Northern Corridor GHG Emission Model (NCEM), aligned with IPCC guidelines, the survey integrates data from 26,790 daily truck trips across 17 stations and a stratified sample of 3,260 vehicles. Key findings include:

Emissions

In 2024, road freight emissions reached 3.76 MMtCO_2e, with selected corridor routes in Kenya accounting for 2.59 MMtCO_2e (68.88%), Uganda 0.83 MMtCO_2e (22.07%), and Rwanda 0.34 MMtCO_2e (9.04%).

Traffic Dynamics

Heavy Commercial Vehicles (HCVs, 5–6 axles) constitute 59% of traffic (15,735 vehicles/day), with Kenya leading at 15,583 vehicles/day (58%), followed by Uganda (7,443, 28%) and Rwanda (3,764, 14%). Of sampled trucks, 45% (1,467) were empty, aligning with Strategy estimates of up to 70% empty return trips due to trade imbalances

Emission Hotspots

Mombasa-Nairobi (1.58 MMtCO_2e, 60.91% of Kenya's total), Nairobi-Malaba (0.93 MMtCO_2e, 35.85% of Kenya Total),

Malaba/Busia-Kampala (0.35 MMtCO_2e, 42% of Uganda's total), Busia/Malaba–Elegu: 0.26 MMtCO_2e (31%, of Uganda total) and Kigali–Rusizi (84% (0.28 MMtCO_2e) account for 90% of corridor emissions, consistent with prior high-intensity route assessments (NCTTCA, 2021).

Pollutants

Total pollutant emissions reached 19,740 tonnes/year, with NO_x comprising over 94%, followed by PM10 (~5%) and BC (~1%), reflecting diesel dependency. Kenya contributes 15,271 tonnes/year (77%), Uganda 3,682 tonnes/year (19%), and Rwanda 786 tonnes/year (4%), with Kigali-Rusizi adding 549 tonnes/year (70% of Rwanda's total).

This baseline underpins the Green Freight Strategy 2030's vision of a net-zero corridor by 2050, targeting a 10% reduction in CO_2 emissions intensity and a 12% decrease in pollutants (PM10, BC, NO_x) by 2030 from 2024 levels. Recommended actions include accelerating modal shifts through Standard Gauge Railway (SGR) electrification (aiming for 20%-60% rail share by 2030), enforcing Euro 4 vehicle standards, deploying electric trucks with regional charging infrastructure, and reducing empty trips via logistics hubs. These measures align with national Nationally Determined Contributions (NDCs)—Kenya (32%), Rwanda (38%), Uganda (29% reduction by 2030). Progress will be tracked via the Northern Corridor Emissions Index addressing data gaps identified in the Northern Corridor Green Freight Strategy.

This survey represents a foundational step toward sustainable freight transport, balancing the corridor's economic growth with environmental imperatives amidst growth in trade volumes.

1. Introduction

1.1 Background on the Northern Corridor

The Northern Corridor serves as a multimodal transport corridor connecting the Kenyan maritime Port of Mombasa to the hinterland nations of Burundi, the Democratic Republic of Congo (DRC), Rwanda, South Sudan, and Uganda. Encompassing road, rail, pipeline, and inland waterway transport, its infrastructure includes the Port of Mombasa, inland ports, inland container depots, an extensive road network, weighbridges, and border crossings. Established under the Northern Corridor Transit Agreement in 1985 and revised in 2007 as the Northern Corridor Transit and Transport Agreement, the framework initially comprised 11 protocols. In 2020, a 12th protocol was added to address environmental sustainability, reflecting growing concerns over transport-related impacts.

The Northern Corridor Transit and Transport Coordination Authority (NCTTCA) oversees the agreement's implementation, tasked with facilitating trade and mobility, transforming the corridor into a development hub through investment stimulation, and promoting strategies for economic and social advancement while prioritizing environmental sustainability. The Port of Mombasa, the corridor's primary gateway, has seen significant trade growth over the past decade. Cargo throughput increased from 24.875 million metric tonnes in 2014 to 40.992 million metric tonnes in 2024, a compound annual growth rate (CAGR) of 5.1% Transit traffic to neighbouring countries rose from 7.199 million tons to 13.88 million tons over the same period (CAGR 6.3%), while container traffic grew from 1.012 million TEUs to 2.005 million TEUs, a CAGR of 7.1%. This escalation, with road freight handling over 85% of throughput, underscores the corridor's critical role and the associated environmental challenges.

To address its environmental mandate, the NCTTCA, in collaboration with the Climate and Clean Air Coalition (CCAC), United Nations Environment Programme (UNEP), and United Nations Conference on Trade and Development (UNCTAD), developed the Northern Corridor Green Freight Program (2017–2021). A review of this strategy identified gaps, including deficiencies in sustainable infrastructure, limited specialized expertise, and low public awareness. In response, an extraordinary Northern Corridor Executive Committee meeting in Nairobi in 2020 amended the agreement to incorporate mitigation measures for transport's environmental impacts and climate change effects on infrastructure. Building on this, the NCTTCA, with CCAC, UNEP, and Smart Freight Centre support, updated the program into the Northern Corridor Green Freight Strategy 2030.

The 2030 Strategy focuses on establishing baseline GHG emission levels along the Northern Corridor to track its implementation, targeting emissions from trucks plying the corridor routes. While countries are mandated to report comprehensive national GHG inventories through their Nationally Determined Contributions (NDCs) as per UNFCCC Paris Agreement Article 13(7), the NCTTCA's effort enhances precision for the transport sector within these national frameworks. Article 13(7) requires parties to submit:

- **A national inventory of anthropogenic GHG emissions by sources and removals by sinks, using IPCC-accepted good practice methodologies;**
- **Information to track progress toward NDCs under Article 4 (UNFCCC).**

The NCTTCA initiated this process by assessing corridor-level emissions in Kenya, Rwanda, and Uganda, with plans to extend to remaining member States, using an IPCC-derived measurement tool. This complements national efforts under the Paris Agreement's Article 14 (paragraphs 2 and 3), which mandates a global stock take starting in 2023, recurring every five years, to guide NDC updates and enhance climate cooperation. Member States report bottom-up inventories via the ASIF (Activity, Structure, Intensity, Fuel) methodology (AfDB, 2009), comparing future emissions against baselines to evaluate NDC effectiveness through periodic surveys.

Currently, Northern Corridor states estimate emissions using activity data and sector-specific emission factors (e.g., fuel consumption for transport), though reliance on assumptions limits precision. By directly measuring transport emissions along the corridor, the NCTTCA enhances data accuracy, supporting national reporting. The road network spans about 2,712 km: 567 km (Burundi), 4,162 km (DRC), 1,328.6 km (Kenya), 1,039.4 km (Rwanda), 3,543 km (South Sudan), and 2,072 km (Uganda). Road conditions in Kenya, Rwanda, and Uganda, detailed in Table 1, reflect infrastructure quality influencing emissions and efficiency.

The road conditions for the Northern Corridor roads in Kenya, Rwanda and Uganda are shown in table 1 below.

Table 1: Select Northern Corridor Road Conditions

Country	Excellent	Good	Fair	Poor	Total (km)
Kenya	38%	37%	8%	17%	1,201
Rwanda	46%	34%	20%	0%	977
Uganda	23%	19%	35%	23%	2,163

1.2 Introduction to Greenhouse Gases

Greenhouse gases (GHGs) include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor, and industrial fluorinated gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Naturally occurring GHGs, including CO_2, CH_4, N_2O, and water vapor, are essential components of Earth's atmosphere. In contrast, fluorinated gases are entirely human-made, originating from industrial processes. Human activities such as industrialization, agriculture, and transportation increase the concentration of naturally occurring GHGs. Transport along the Northern Corridor, which handled 40.992 million metric tonnes of cargo in 2024 (Port of Mombasa, 2024), plays a significant role due to its reliance on diesel-powered freight.

The greenhouse effect is a natural process where shortwave solar radiation passes through the atmosphere and warms Earth's surface. At night, the surface emits longwave radiation, which GHGs absorb, slowing its release into space. This process regulates atmospheric temperatures by reducing the rate of planetary cooling. However, elevated GHG concentrations from human activities intensify this effect, leading to global warming and exacerbating climate change.

Rising GHG levels from industrial growth, agricultural practices, and transportation have trapped additional heat, causing global temperatures to rise. This has led to severe climate consequences, including erratic weather patterns, extreme droughts, floods, heatwaves, and ocean acidification. Recent climate events highlight this trend. In September 2023, Australia experienced severe heatwaves, while torrential rains flooded Libya. In October 2023, New York faced extreme flooding, and strong winds battered Europe. Asia recorded unprecedented heat in November 2023. In April 2024, the United States endured earthquakes, tornadoes, and storms exceeding 50 miles per hour. July 2024 became the warmest July on record (World Meteorological Organization, 2024). Within the Northern Corridor, climate-related infrastructure damages cost $83 million annually (NCTTCA, 2023), underscoring the region's vulnerability.

Unmitigated global warming poses severe environmental and ecological threats, affecting human and animal life across member States. In response, the NCTTCA developed the Northern Corridor Green Freight Strategy 2030 to monitor GHG emissions from freight transport. With road freight accounting for 85% of the corridor's cargo movement, this strategy implements measures to reduce anthropogenic emissions, supporting national climate goals and fostering a sustainable future for the region.

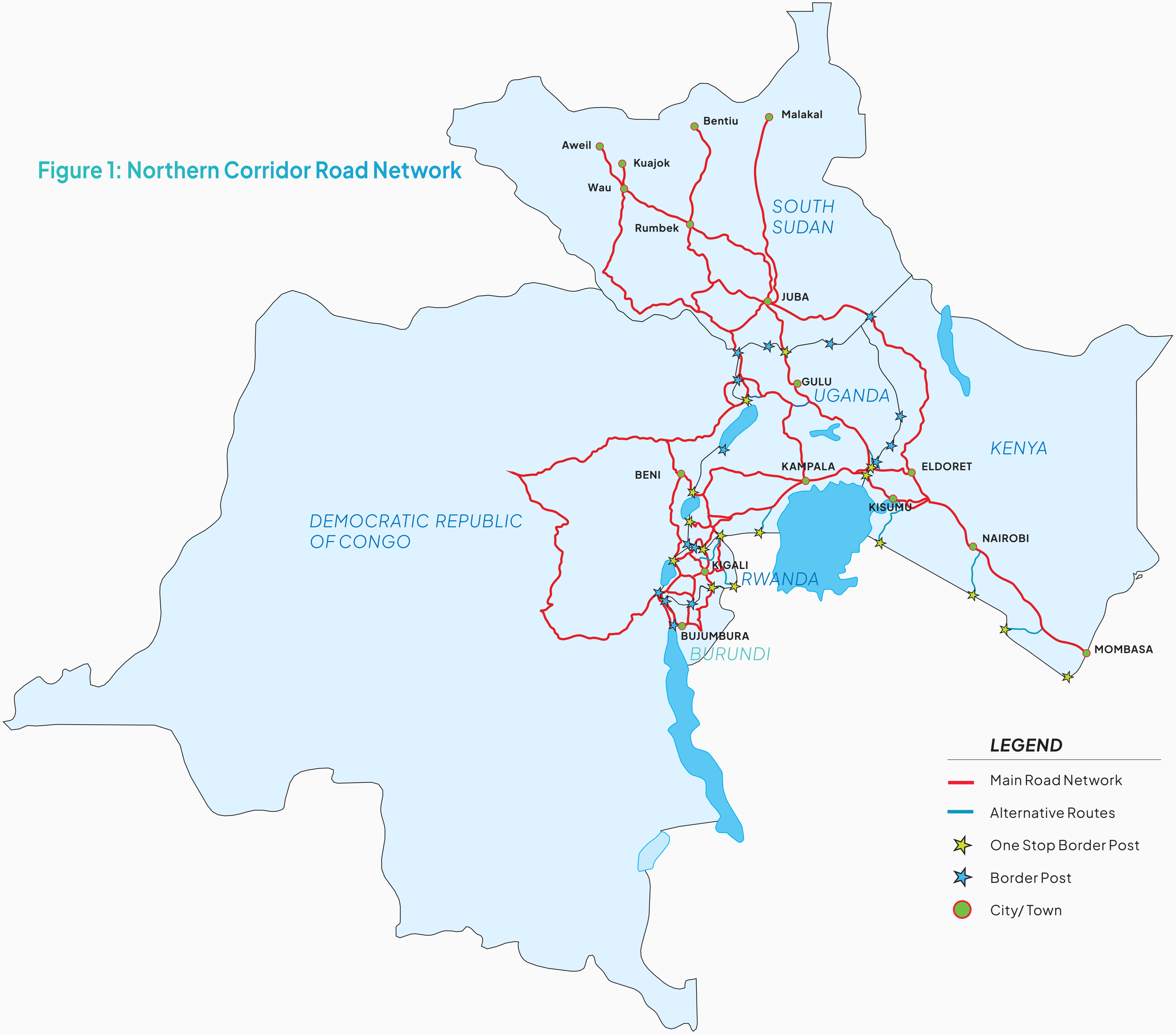
1.3 Objectives of the baseline survey

The 2024 baseline survey aimed to establish a GHG emissions baseline for the road freight sector (commercial trucks) along the Northern Corridor in Kenya, Rwanda, and Uganda, providing corridor-specific data to support member States in tracking emission trends and evaluating the effectiveness of mitigation measures within their Nationally Determined Contributions (NDCs). While national governments are responsible for comprehensive NDC reporting under the UNFCCC Paris Agreement, the Northern Corridor Transit and Transport Coordination Authority (NCTTCA) contributes by focusing on emissions from this critical trade corridor, which handled 40.992 million metric tonnes of cargo in 2024 (Port of Mombasa, 2024). This baseline, aligned with the Northern Corridor Green Freight Strategy 2030's long-term goal of achieving carbon neutrality by 2050, enables assessments of investment returns, future emissions projections, and the ongoing implementation of the Strategy's targets, including a 10% CO_2 intensity reduction by 2030.

Specifically, the survey sought to:

- **Tally by class all commercial trucks** passing through designated stations along the Northern Corridor in Kenya, Rwanda, and Uganda, establishing a comprehensive traffic profile.
- **Collect vehicle activity data,** including truck category, origin-destination, maximum loaded weight, actual weight, and fuel consumption for loaded and return trips, to characterize operational patterns.
- **Determine the average fuel required to transport one tonne of cargo per kilometer** across various Northern Corridor route sections in Kenya, Rwanda, and Uganda, quantifying transport efficiency.
- **Quantify and project GHG emissions** from commercial trucks along the Northern Corridor in these member States, providing a foundation for regional emissions analysis and Strategy implementation tracking.
- **Identify potential GHG emission reductions** and propose climate change mitigation initiatives tailored to the corridor, supporting member States' sustainability efforts and the Strategy's objectives.
- **Develop a GHG data collection and reporting framework** to enable regular monitoring of corridor emissions performance, assess the impact of mitigation initiatives over time, and track progress toward the Northern Corridor Green Freight Strategy 2030's goals.

Figure 1: Northern Corridor Road Network



1.4 Scope of the study

The Northern Corridor is a critical economic artery for East and Central Africa, facilitating trade through its multimodal transport network linking the Port of Mombasa to Burundi, the Democratic Republic of Congo (DRC), Rwanda, South Sudan, and Uganda.

In 2024, the corridor handled 40.992 million metric tonnes of cargo, up from 35.98 million metric tonnes in 2023, reflecting a 5.1% annual growth rate. The road freight sector dominates cargo movement, accounting for approximately 85% of the total volume through the Port of Mombasa, significantly contributing to greenhouse gas (GHG) emissions along its 12,707 km network, as outlined in Section 1.1. This 2024 baseline survey focuses on quantifying GHG emissions from commercial trucks plying Northern Corridor routes in Kenya, Rwanda, and Uganda, providing corridor-specific data to support member States' national reporting under the UNFCCC Paris Agreement and Nationally Determined Contributions (NDCs). By establishing this baseline, the survey supports the Northern Corridor Green Freight Strategy 2030's implementation, enabling ongoing monitoring of emissions trends, mitigation effectiveness, and progress toward the Strategy's targets, including a 10% CO_2 intensity reduction by 2030 and carbon neutrality by 2050.

1.4.1 Green House Gases Reported

The Northern Corridor Transit and Transport Coordination Authority (NCTTCA) employed its GHG emissions estimation tool—the Northern Corridor GHG Emission Model (NCEM)—to quantify emissions from commercial trucks along the Northern Corridor, primarily to track the implementation of the Northern Corridor Green Freight Strategy 2030. This 2024 baseline survey focused on Carbon Dioxide (CO_2), Nitrous Oxides (NO_x), Particulate Matter (PM10), and Black Carbon (BC), reflecting the predominant emissions from diesel-powered freight vehicles, which handle over 85% of the corridor's 40.992 million metric tonnes of annual cargo throughput (Port of Mombasa, 2024). Total GHG emissions are reported in metric tonnes of CO_2 equivalent ($MtCO_2e$), providing a standardized measure of climate impact for monitoring progress toward the Strategy's targets, including a 10% CO_2 intensity reduction by 2030 and carbon neutrality by 2050.

While the Intergovernmental Panel on Climate Change (IPCC) recommends reporting a comprehensive range of GHGs for national inventories—including CO_2, Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3)—the NCEM prioritizes CO_2, NO_x, PM10, and BC due to their dominant contribution to road freight emissions in the region and the availability of reliable, localized emission factors. Other GHGs, such as CH_4 and N_2O, are emitted in trace amounts from diesel combustion and lack sufficiently precise regional emission factors for quantification in this context. This targeted approach ensures accuracy and relevance for corridor-specific mitigation strategies, while also contributing, as a secondary benefit, to member States' broader national reporting efforts under the UNFCCC Paris Agreement and Nationally Determined Contributions (NDCs).

1.4.2 GHG Emissions Sector

The 2024 GHG baseline survey focuses on the road freight sector along the Northern Corridor, targeting emissions from commercial trucks to support tracking the implementation of the Northern Corridor Green Freight Strategy 2030. It considers three key vehicle categories—Light-Duty Trucks (LDTs), Medium Commercial Vehicles (MCVs), and Heavy Commercial Vehicles (HCVs)—which collectively handle over 85% of the corridor's 40.992 million metric tonnes of annual cargo throughput (Port of Mombasa, 2024). These categories, defined by axle count and load capacity, are critical to emissions profiles: Heavy Commercial Vehicles (HCVs, particularly 5–6 axles) dominate traffic, accounting for approximately 59%, and are major contributors to the baseline's 3.76 MMtCO_2e due to their role in long-haul freight, while Light-Duty Trucks (LDTs, about 30%) and Medium Commercial Vehicles (MCVs, roughly 11%) support regional distribution. This focus enables targeted mitigation strategies, such as modal shifts and efficiency improvements, to achieve the Strategy's targets of a 10% CO_2 intensity reduction by 2030 and carbon neutrality by 2050. Detailed traffic data and emissions quantification are presented in subsequent sections following the survey methodology.

1.4.3 Geographic Location

Given the extensive geographic coverage of the Northern Corridor across its member States—Burundi, DRC, Kenya, Rwanda, South Sudan, and Uganda—the 2024 GHG emissions survey was designed in phases to ensure comprehensive data collection. The initial phase focused on quantifying emissions from the road freight sector (commercial trucks) in Kenya, Rwanda, and Uganda t0 track the implementation of the Northern Corridor Green Freight Strategy 2030.

This corridor-specific baseline, covering select sections the of road network enables monitoring of emissions trends and mitigation progress toward the Strategy's targets, including a 10% CO_2 intensity reduction by 2030 and carbon neutrality by 2050.

1.4.3.1 Kenya

In Kenya, the Northern Corridor trunk road originates from Mombasa running through Nairobi to Busia through Kisumu and to Malaba through Eldoret. Arterial routes radiate from the main route to Taita Taveta at Voi, to Namanga at Athi River, and to Isebania at Ahero. For Kenya, reporting is done on three route sections of Mombasa -Nairobi, Nairobi-Malaba and Mau Summit-Busia with traffic data collected at five weighbridges; Mariakani, Athi River, Gilgil, Webuye, and Busia, as shown in the table 2 below.

Table 2: GHG Survey Stations in Kenya

Survey Station	Routes Covered	Traffic Type
Mariakani	Traffic to/from Mombasa	All trucks from Mombasa
Athi River	Traffic to/from Namanga, Mombasa, Nairobi	Trucks from Nairobi, Mombasa, and cross-border with Tanzania
Gilgil	Traffic to/from Nairobi and beyond	Trucks from Mombasa and Nairobi
Webuye	Traffic to/from Malaba	Trucks from Mombasa, Nairobi, Nakuru, Eldoret
Busia	Traffic to/from Busia	Trucks from Mombasa, Nairobi, Nakuru, , Kisumu

1.4.3.2 Rwanda

In Rwanda, the survey was conducted along the Gatuna-Kigali-Rubavu/Rusizi/Nemba/Akanyaru Haut routes at Gatuna, Cyanika, Rubavu, Shyorongi, Huye and Rusizi targeting traffic to and from Uganda, DRC and Burundi. Traffic from Tanzania was also captured on some routes.

The reporting for Rwanda covers Gatuna-Kigali, Kigali-Rusizi, Cyanika-Rubavu and Musanze-Kigali route sections with data collected at the following stations below shown in table 3 below:

Table 3: GHG Survey Stations in Rwanda

Survey Station	Routes Covered	Traffic Type
Gatuna Border	Traffic to/from Uganda	Trucks heading to Kigali and beyond
Musanze	Internal traffic and cross-border flows	Trucks from Gatuna, Rubavu, Rusizi
Rubavu	Cross-border traffic to and from Kigali, Uganda, and DRC	Trucks from Kigali, Uganda, DRC, local and cross-border
Cyanika	Cross-border traffic between Rwanda and Uganda, and local traffic	Trucks to and from Kigali, Uganda, DRC, local and cross-border
Rusizi	Cross-border traffic between Rwanda, Burundi and DRC, and local traffic	Trucks to and from Kigali, Burundi, DRC, local and cross-border
Huye	Cross-border traffic between Rwanda, Burundi and DRC, and local traffic	Trucks to and from Kigali, Burundi, DRC, local and cross-border

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1.4.3.3 Uganda

Uganda has the most extensive routes from Malaba/Busia – Kampala – Katuna/Mirama Hills/Kyanika borders with Rwanda; to Bunagana/Mpondwe border with DRC; and Malaba – Tororo - Soroti – Gulu – Elegu border with South Sudan and to Goli/Paidha/ Vurra borders with DRC.

For GHG emissions reporting, the route sections covered are Malaba/Busia-Kampala, Kampala-Lukaya, Lukaya-Mbarara, Mbarara-Mpondwe, Mbarara-Katuna, Mbarara-Kyanika and Busia/Malaba-Elegu. The survey was carried out at Malaba, Mbale, Magamaga, Lukaya, Mbarara and Mpondwe.

Table 4: GHG Survey Stations in Uganda

Survey Station	Routes Covered	Traffic Type
Malaba	Cross-border trucks from Kenya to Uganda	Trucks crossing through Malaba and Busia
Mbale	Cross-border trucks from Kenya to Uganda enroute to South Sudan and DRC through its northeast borders	Trucks crossing through Malaba/ Busia and local origins
Magamaga	Traffic excluding Tororo and those before Magamaga	Trucks from Malaba/Busia, Kampala, and Jinja
Lukaya	Traffic through Kampala and other local Uganda routes	Trucks to and from Malaba/Busia/ Kampala and local origins in Uganda
Mbarara	Traffic from Lukaya, local Uganda routes	Trucks from within Uganda
Mpondwe Border	Cross-border trucks to and from Uganda to DRC	Trucks crossing Mpondwe/ Kasindi border

The survey employed two modules: a tallying module, counting all commercial trucks with a maximum load capacity of 3.5 tons and above plying Northern Corridor routes, and a vehicle activity module, recording truck classification, maximum and actual weights, origin-destination, and fuel consumption for specific trips. This data collection is crucial for managing and reducing emissions from the road freight sector, aligning with national, regional, and UNFCCC guidelines, and supporting the ongoing implementation of the Northern Corridor Green Freight Strategy 2030.

2. Approaches and Methodology

2.1 Introduction

The methodology for this baseline survey was designed to provide a robust and data-driven assessment of greenhouse gas (GHG) emissions along the Northern Corridor routes in Kenya, Uganda, and Rwanda. Anchored in a transport observatory framework, the study integrated primary data collection through real-time vehicle tracking, fuel consumption surveys, and emission factor modeling with secondary data from relevant government agencies and industry reports. A combination of geospatial analysis, traffic volume monitoring, and stakeholder consultations ensured a comprehensive evaluation of emission patterns across different transport modes and corridor segments. This approach not only quantified emissions but also established benchmarks for future policy interventions aimed at decarbonizing freight and passenger transport within the corridor.

2.2 GHG Emission estimation approaches

To determine the GHG emission from the transport sector, the Energy (Input-based) Approach and the Activity (output-based) Approach can be adopted.

A. The Energy (Input-based) Approach

In calculating the GHG emission from the Energy (input-based) Approach, also known as the fuel consumption approach, it is necessary to determine the emission factors for the respective GHG gases. For example, the emission factor for CO_2 is estimated from the following equation:

$$EF = CC * \delta * X * \left(\frac{KgCO_2}{\text{Litre of Fuel}} \right) \quad \text{(i)}$$

Where:

CC = carbon content in fuel in mass percentage = 86 % = 0.86 for diesel

δ = fuel density = 0.820 [kg/l] for diesel

X = molecular weight relation for CO_2 = (12 u + (2 × 16 u))/12 u = 44/12

Result for diesel fuel: 0.86 × 0.82 × (44/12) [kg/l] = 2.6 [kg CO_2/liter of fuel].

For a vehicle whose fuel consumptions are known when empty and when fully loaded, the fuel consumption at a specified load factor can be calculated using the following formula:

$$FC_{LF} = FC_{empty} + (FC_{full} - FC_{empty})*LF \quad \text{(ii)}$$

Where:

FC_{LF} = Fuel consumption at the specified load factor (litres per KM)

FC_{empty} = Fuel consumption of empty vehicle

FC_{full} = Fuel consumption of fully loaded vehicle

LF = Specified load factor

The total Carbon dioxide emission is directly related to fuel consumption.

$$TE = FC_{LF} * D * EFco_2 \quad \text{(iii)}$$

Where :

TE = Total Carbon dioxide emission

FCLF = Fuel consumption at specified load factor

D = Distance in Km

$EFco_2$ = Emission factor for fuel (Kilograms of carbon dioxide per litre of fuel)

B. The Activity (output-based) Approach

In the absence of energy data, it is possible to make an estimate of the GHG emission footprint of a transport operation from the amount of work done and the energy consumed per unit of output which can be calculated from output of freight transportation generally measured in ton-kilometres divided by the energy consumed is measured in litres.

2.3 Northern Corridor GHG Emission Estimation Model

The methodology for the 2024 Baseline Survey of Greenhouse Gas Emissions along the Northern Corridor Routes in Kenya, Uganda, and Rwanda was designed to deliver a robust, data-driven assessment of emissions from road freight transport, aligning with the Northern Corridor Green Freight Strategy 2030. The Revised Northern Corridor Emissions Model (NCEM) serves as the cornerstone of this analysis, integrating primary data from vehicle surveys with real-time traffic monitoring to quantify greenhouse gas (GHG) and pollutant emissions. This approach leverages a bottom-up methodology, emphasizing Vehicle Kilometres Travelled (VKT) and distance-based emission factors, ensuring precision for corridor-specific mitigation strategies targeting a 10% CO_2 intensity reduction by 2030 and net-zero emissions by 2050.

The Revised NCEM adopts a distance-based (output-based) approach to estimate GHG and pollutant emissions, focusing on commercial trucks along the Northern Corridor. This method calculates emissions directly from the total distance travelled by each vehicle class, using emission factors expressed in grams per kilometre (g/km). The key steps include:

- Aggregating VKT per vehicle class and load status.
- Calculating weighted emission factors based on Euro standard shares.
- Applying g/km factors for pollutants and kg/L for CO_2.
- Summing across routes to derive totals

Vehicle Kilometres Travelled (VKT)

VKT is determined as the product of total daily traffic (trucks per day), route length (km), and 365 days per year, converted to million km/year.

Fuel Efficiency

This is the average amount of fuel used to transport a unit tonne-kilometre.

$$\textbf{Fuel Efficiency} = \frac{\textbf{Fuel Consumed}_{a,b}}{\textbf{Load * Distance}_{a,b}}$$

Where:

a = fuel type

b = vehicle type (LDT, MCV, HCV)

Fuel Consumption:

Fuel consumption for loaded and empty trips is calculated separately using average fuel efficiency (km/L) for each vehicle class:

$$FC_{a,b} = \frac{VKT_{a,b}}{FE_{a,b}} \text{ (Million L/Year)}$$

Where:

$VKT_{a,b}$ = VKT for loaded or empty trips.

FE_{ab} = Fuel efficiency (km/L), sourced from survey

Loaded and empty VKT are apportioned based on the proportion of empty trucks

Weighted Emission Factors for Pollutants:

The fleet composition is assessed by categorizing trucks according to Euro emission standards (Euro I to Euro VI). The share of trucks in each vehicle class (LDT/2–Axle, MCV-3/4 Axle, HCV-5+/Axle) across these standards is determined from survey data.

Weighted average emission factors (g/km) for PM10, BC, and NO_X are calculated using the share of trucks and TTW emission factors for each Euro standard:

$$EF_{weighted,pollutant,a,b} = \Sigma_{Euro\ std} (EF_{pollutant,Euro\ std} * Share_{Euro\ std})$$

In estimating the considered GHG and pollutant emissions (CO_2, NO_X, PM10, and BC) the following equations were used;

CO_2 Emissions:

Calculated using the total fuel consumption and a CO_2 emission factor of 2.582 kg/L (adjusted for diesel):

$$E_{CO_2} = \Sigma_{a,b} FC_{a,b} * EF_{CO_2} \times 1{,}000 \quad \text{(tonnes)}$$

Where:

$$FC_{ab} = VKT_{Loaded/Empty} \,/\, FE_{ab}$$

Where:

E_{CO_2}	=	Total Carbon Dioxide (CO_2) emission of the corridor (tonnes)
FC_{ab}	=	Total fuel consumption of LDT/MCV/ HCV (Million litres/year)
EF_{CO_2}	=	CO_2 emission factor for fuel (e.g. diesel) (kg/L)
$VKT_{Loaded/Empty}$	=	Vehicle Kilometres Travelled (Km/year)
FE_{ab}	=	Fuel Efficiency (kilometres per litre kmpl)
a	=	fuel type
b	=	vehicle type (LDT, MCV, HCV)

Pollutant Emissions (PM10, BC, NO_x):

$$E_{pollutant} = VKT_{Loaded/Empty} * EF_{weighted,pollutant,Loaded,Empty} \quad \text{“(kg\textbackslash/year)”}$$

Where:

$E_{pollutant}$ = Total emissions of the pollutant (PM10, BC, NO_x) measured in kilograms per year

$VKT_{Loaded/Empty}$ = Vehicle Kilometers Traveled (VKT) for a given category

$EF_{weighted,pollutant,Loaded,Empty}$ = Weighted Emission Factor (EF) for a given pollutant, for loaded vehicle and Empty, measured in grams per kilometer (g/km).

Photo: © Cateyeperspective | Dreamstime.com

Table 5: Northern Corridor GHG Emissions Quantification Template

Section Km											
	Total Daily Traffic	**No of Trucks with Empty Load**	**Average Loading (Tons)**	**Average Fuel Efficiency (kmpl) - Loaded Truck**	**Average Fuel Efficiency (kmpl) - Empty Truck**	**Total Freight Movement (tonne-km)**	**Total Fuel Consumption (Diesel-Liters)**	**Total CO_2 Emissions (Tonnes)**	**Total PM10 Emissions (Kg)**	**Total BC Emissions (Kg)**	**Total NOx Emissions (Kg)**
LDT											
MCV - 3Axle											
MCV-4 Axle											
HCV- 5 & 6 Axle											
HCV- 7 & 8 Axle											
HCV- >8 Axle											
Total											

2.4 Data Collection and Sampling Methods

2.4.1 Sampling methods and sample size

The data collection to feed into the activity-based approach of the GHG emission calculation consisted of two activities namely: -

a) Trucks Tallying

Truck tallying was conducted for all trucks passing through the survey stations, covering both inbound and outbound traffic, to determine the total truck movement.

This was basically conducted to account for all the trucks weighing 3.5 tons and above passing through the survey stations by their classes. This was being done on a 24–hour basis in three shifts to cover the 24 hours.

b) Trucks Activity Module

A stratified random sampling method was used for the truck activity module. Trucks were classified into LDT/2–Axle, MCV-3 Axle, MCV-4 Axle, HCV-5&6 Axle, HCV-7&8 Axle and HCV->8 Axle categories.

This classification was based on the number of axles and truck type, as these factors directly influence the load-carrying capacity and fuel consumption. The stratified random sampling approach ensured that data collection was representative across all truck categories and types, leading to more accurate GHG emission estimations.

The activity module entailed interviewing the truck drivers to establish details on the truck operations including truck classification, origin-destination, maximum load, actual load and fuel consumed during the trip amongst other factors. During the day enumerators collecting data on truck activity sampled the different classes of trucks and interview their drivers to collect data on vehicle activity module for all the stations.

The survey recorded truck movements across Kenya, Rwanda, and Uganda, with the sampled trucks are summarized in Table 6 below.

Table 6: Total Sampled Trucks per Category and Country

Vehicle Class	Kenya	Rwanda	Uganda	Total
HCV->8Axle	4	22	7	33
HCV-5&6Axle	1,426	292	867	2,585
HCV-7&8Axle	23	21	24	68
LDT-2 Axle	181	60	151	392
MCV-3 Axle	64	40	29	133
MCV-4 Axle	25	14	10	49
Total	**1,723**	**449**	**1,088**	**3,260**

2.4.2 Data Collection Tools and Instruments used

The GHG emission data collection from freight transport in Kenya, Rwanda and Uganda was done using structured questionnaires on mobile data collection tool (KoBo toolbox). This tool allows for collection of data in the field using mobile devices such as mobile phones. The choice of this tool was based on its accuracy as it minimizes enumeration errors since data validation can be achieved in real time as data is being collected. The tool is also fast as data does not need to get transcribed from paper to computer before it can be analyzed. Both the truck tallying and vehicle activity data were collected using the Kobo toolbox. The questionnaires for the truck tallying and truck activity survey are as attached in appendix 1

The GHG emission was estimated using the Northern Corridor GHG emission estimation tool based on the IPCC GHG emission accounting guidelines using the activity approach to GHG emission calculation.

2.5 Quality Assurance and Quality Control for Data Collection

The Northern Corridor Transit and Transport Coordination Authority (NCTTCA) utilized its GHG emissions estimation tool to quantify emissions from commercial trucks along the Northern Corridor. This study limited its scope to Carbon Dioxide (CO_2), Nitrous Oxides (NO_x), Particulate Matter (PM10), and Black Carbon (BC), reflecting the predominant emissions from diesel-powered freight vehicles and the availability of reliable local emission factors. Total GHG emissions are reported in metric tonnes of CO_2 equivalent ($MtCO_2e$), providing a standardized measure of climate impact.

While the Intergovernmental Panel on Climate Change (IPCC) recommends reporting a broader range of GHGs for comprehensive accounting—including CO_2, Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3)—the NCTTCA tool prioritizes CO_2, NO_x, PM10, and BC due to their significant contribution to road transport emissions and the region's data constraints. Other GHGs, such as CH_4 and N_2O, though relevant, are emitted in trace amounts from diesel combustion and lack sufficiently localized emission factors for precise quantification in this context. This focused approach ensures accuracy and relevance for Northern Corridor freight-specific mitigation strategies.

Data was cleaned for outliers (e.g., fuel efficiency extremes) and analyzed using the Revised NCEM and cross-checked VKT, fuel consumption, and Euro standard distributions against transport observatory data, ensuring consistency with previous 2018 results.

2.6 Data Capture and Calculation Methodology

The GHG emission calculations were carried out based on Northern Corridor model and are in line with the IPCC guidelines. Based on the model, data required for GHG emission calculations, and its nomenclature is summarized in the table 7 below.

Table 7: List of data required for GHG emission model

Data monitored for GHG emissions model	Nomenclature	Source
Vehicle categorization according to axle	LDT - 2 axles MCV – 3 & 4 axles HGV - 5,6,7,8,9 &10 axles	The vehicles are classified as per the East African Community Vehicle Load Control Act, 2016 and data from the Northern Corridor Transport Observatory
Average annual daily traffic (number of vehicles by category (Light, Medium, and Heavy commercial vehicles))	AADTLDT/MCV/HGV	Survey Data
Length of corridor sections (km)	Length of the corridor	The length of the corridor is sourced from the Northern Corridor Transport Observatory
Average weight of trucks by vehicle category (tonnes)	Average weight of LDT/MCV/HGV	Survey Data
Fuel efficiency data of trucks by vehicle category (km/litre)	FELDT/MCV/HGV	Survey Data
GHGs (CO_2) emission factor of fuel used in trucks ($MtCO_2/TJ$)	CO_2 emission factor of the fuel	Sourced from IPCC guidelines for National Greenhouse Gas Inventories, Volume 2 – Energy, Chapter 3 Mobile Combustion (Page 3.16)
Pollutants (NO_x, PM, BC) emission factor of fuel used in trucks (g/kg of fuel)	Pollutants (NO_x, PM, BC) emission factor	Sourced from EMEP EEA Air Pollutant Emission Inventory Guidebook, 2016, Part B Sectoral guidance chapters, Chapter 1 Energy

2.7 Data Analysis

The activity-based estimation of greenhouse gas (GHG) emissions along the Northern Corridor was conducted using a structured methodology that integrated real-time data collection, stratified random sampling, and statistical data analysis. The analysis focused on quantifying emissions from road freight transport by evaluating truck movements, fuel consumption, and freight volumes. The approach adhered to internationally recognized GHG accounting standards, ensuring accuracy, transparency, and applicability to regional transport policies.

To ensure the integrity and reliability of the collected data, a Quality Assurance and Quality Control (QA/QC) framework was implemented. This involved cross-checking data for inconsistencies, transcription errors, and completeness. The data validation process included consistency checks between survey data and transport observatory data. The dataset was also assessed for outliers, such as extreme fuel consumption values, and necessary corrections were made before analysis

Once cleaned, the data was subjected to statistical analysis to determine the distribution of vehicle types, average loading, fuel efficiency trends, and emission profiles across different corridor sections.

The Northern Corridor GHG emission estimation model (NCEM) was used to compute emissions based on the bottom-up approach. This model calculates emissions using three key variables:

- Vehicle Kilometers Traveled (VKT) – Measured from traffic counts and truck surveys.
- Freight Volume (ton-km) – Derived from truck weights and distances traveled.
- Fuel Efficiency (km/l) – Categorized by truck type and load status (loaded vs. empty).

Emission factors were sourced from internationally recognized datasets such as the IPCC GHG Inventory Guidelines and the EMEP EEA Air Pollutant Emission Inventory Guidebook

3. Findings

3.1 Introduction

The transport sector along the Northern Corridor is pivotal for economic integration and trade facilitation across East Africa. However, it is a significant source of greenhouse gas (GHG) and pollutant emissions, contributing to regional environmental challenges. This technical analysis examines GHG and pollutant emissions from road freight transport in Kenya, Rwanda, and Uganda.

The study examines traffic distribution, fuel efficiency, emissions by vehicle category, and environmental impacts while identifying potential mitigation strategies. The findings will form the baseline for GHG estimation along the Northern Corridor using the Northern Corridor Greenhouse Gas Emissions Estimation Model.

3.2 Summary Findings

The total average daily traffic (ADT) for road freight transport across Kenya, Rwanda, and Uganda is 26,790 vehicles. Kenya leads with 15,583 vehicles/day (58% of total traffic), followed by Uganda with 7,443 vehicles/day (28%), and Rwanda with 3,764 vehicles/day (14%). The dominance of Kenya is largely due to its strategic role as the primary gateway to East Africa via the Port of Mombasa. The bulk of freight movement is handled by Heavy Commercial Vehicles (HCV-5&6 Axle), which represent 59% of total traffic across the three countries.

In Kenya, HCV-5&6 Axle trucks dominate, comprising 65% of the total truck traffic, with Light-Duty Trucks (LDT/2–Axle) accounting for 27%. This reflects a balance between long-haul and short-haul logistics. Kenya's traffic distribution is heavily concentrated along key corridors like Mombasa-Nairobi and Nairobi-Malaba, which correspondingly show the highest GHG emissions at 1.58 $MMtCO_2e$ and 0.93 $MMtCO_2e$, respectively. Kenya's efforts to mitigate emissions include shifting freight from road to rail and investing in electric vehicle infrastructure, aligning with its commitment to a 32% reduction in GHG emissions by 2030.

Rwanda, despite having the lowest ADT, shows a diverse vehicle mix with LDT/2–Axle trucks making up 47% of the total traffic, indicating a strong reliance on smaller vehicles for regional distribution. The Kigali-Rusizi route is the primary contributor to GHG emissions in Rwanda, accounting for 84% of the total 0.34 MMtCO_2e emissions. Rwanda's strategic focus on adopting electric vehicles (EVs) and improving public transportation aligns with its 38% GHG reduction target by 2030.

Uganda's freight transport is characterized by HCV-5&6 Axle trucks, which make up 64% of total traffic, highlighting its role in regional trade. The Malaba/Busia-Kampala route alone accounts for 42% (0.35 MMtCO_2e) of Uganda's total 0.83 MMtCO_2e emissions. Uganda's Nationally Determined Contributions (NDC) target a 29% reduction in GHG emissions by 2030 through measures like railway rehabilitation, fuel efficiency improvements, and the adoption of alternative fuels.

Fuel efficiency varies across vehicle classes and countries. In Kenya, fuel efficiency improves significantly when trucks are empty, particularly in HCV-5&6 Axle and HCV->8 Axle categories. Similar trends are observed in Rwanda and Uganda, underscoring the need for optimized freight logistics to reduce empty trips. Uganda's participation in the Global Fuel Economy Initiative (GFEI) aims to improve fuel economy by 20% by 2040.

Pollutant emissions are highest in Kenya at 15,271.5 tonnes/year, followed by Uganda with 3,682.2 tonnes/year, and Rwanda with 786.6 tonnes/year. In all three countries, Nitrous Oxides (NO_x) constitute over 94% of total pollutants. Major pollution hotspots include the Mombasa-Nairobi corridor in Kenya, Kigali-Rusizi in Rwanda, and Malaba/Busia-Kampala in Uganda.

While Kenya, Rwanda, and Uganda face distinct challenges in managing road freight emissions, regional cooperation and targeted interventions such as modal shifts, fuel efficiency programs, and the adoption of cleaner technologies are essential for meeting climate goals and improving transport sustainability along the Northern Corridor.

	KENYA	RWANDA	UGANDA
CO_2 Emissions 3.76 MMtCO2e	**2.59 MMtCO2e (68.88%)**	**0.34 MMtCO2e (9.04%).**	**0.83 MMtCO2e (22.07%),**
Pollutant Emissions (NO_x, PM10, BC) NO_x is >94%	**15,271.5 tonnes/year.**	**786.6 tonnes/ year.**	**3,682.2 tonnes/ year.**
Total Average Daily Traffic (ADT) 26,790 Vehicles	**15,583** vehicles/ day (58%)	**3,764** vehicles/ day (14%)	**7,443** vehicles/ day (28%)
GHG Emissions Intensive Routes	**1.58 MMtCO2e** (Mombasa-Nairobi) and **0.93 MMtCO2e** (Nairobi-Malaba).	**0.34 MMtCO2e** (84% from Kigali-Rusizi).	**0.83 MMtCO2e** (42% from Malaba/Busia-Kampala).
Vehicle Types Heavy Commercial Vehicles (HCV-5&6 Axle): 59% of total traffic	**HCV-5&6 Axle 65%** of truck traffic	Light-Duty Trucks **LDT/2-Axle 47%** of truck traffic	**HCV-5&6 Axle 64%** of truck traffic
NDC Tagets	**32% reduction** by 2030 through EV infrastructure and rail freight.	**38% reduction** by 2030 via EV adoption and public transit.	**29% reduction** by 2030 through rail rehab and fuel efficiency improvements.

3.3 Average Daily Traffic

The total average daily traffic for road freight transport across the three countries is 26,790 vehicles. The distribution of vehicle classes is detailed in the table below:

Table 8: Average Daily Traffic per Class in Kenya, Rwanda and Uganda

Vehicle Class	Kenya	Uganda	Rwanda	Total
HCV-5&6Axle	10,110	4,775	850	15,735
HCV-7&8Axle	58	121	133	312
HCV->8Axle	13	4	8	25
LDT/2–Axle	4,206	1,953	1,775	7,934
MCV-3Axle	1,065	401	914	2,380
MCV-4Axle	131	189	84	404
Total	**15,583**	**7,443**	**3,764**	**26,790**

Kenya exhibits the highest traffic volume with 15,583 vehicles/day, accounting for 58% of the total annual daily traffic, Uganda 7,443 vehicles/day representing 28% and Rwanda 3,764 vehicles/day representing 14%. Kenya's dominance is attributed to strategic position as the primary gateway to East Africa through the Port of Mombasa.

In Kenya, HCV-5&6 Axle trucks dominate freight movement, representing 65% of total traffic through Kenya and LDT/2–Axle trucks account for 27%, playing a significant role in short-haul and urban logistics.

In Rwanda, LDT/2–Axle trucks make up 47% of the traffic, indicating a reliance on smaller vehicles for domestic and regional distribution while HCV-5&6 Axle trucks represent 23%.

Freight transport through Uganda is characterized by a significant presence of HCV-5&6 Axle trucks (64% of Uganda's traffic), emphasizing the country's role in regional and international trade. LDT/2–Axle trucks contribute 26%, indicating their importance in bridging long-haul and local distribution.

Overall, Heavy Commercial Vehicles (HCV-5&6 Axle) overwhelmingly dominates regional freight with 15,735 vehicles/day (59% of total traffic). Light-Duty Trucks (LDT/2–Axle) represents 30% of total traffic, LDTs are vital for last-mile delivery and regional distribution.

3.4 Percentage of Loaded Trucks

The survey across the three Northern Corridor Member States shows that out of 3,260 sampled trucks, approximately 55% for each country were loaded. This high number of empty trips leads to increased fuel consumption and increased emissions.

3.5 Median age for trucks per class per country

The median age of sampled trucks in Uganda is 7 years, Kenya, 9 years and Rwanda six years significantly lower than the national fleet average of 15 years, as reported in the NDC. While this suggests that newer trucks are being used for major freight routes, the overall fleet remains largely outdated, contributing to higher emissions.

3.6 Kenya

3.6.1 Average Daily Traffic in Kenya

Kenya's movement of goods and people to facilitate economic activities takes place by road, rail, air or water. Seventy-six percent (76%) of freight is transported through the road subsector

Based on the truck traffic at the survey stations, the survey sampled trucks per vehicle class in Kenya as summarized in Table 9.

Table 9: Average Daily Traffic per Class per Station in Kenya

Vehicle Class	Athi River Weighbridge	Busia Weighbridge	Gilgil Weighbridge	Mariakani Weighbridge	Webuye Weighbridge	Total
HCV-5&6Axle	2,153	597	2,630	3,333	1,397	10,110
HCV-7&8Axle	20	5	10	14	9	58
HCV->8Axle	3	5	2	2	1	13
LDT/2–Axle	2,101	409	1,000	520	176	4,206
MCV-3Axle	784	25	152	64	40	1,065
MCV-4Axle	41	5	16	65	4	131
Total	**5,102**	**1,046**	**3,810**	**3,998**	**1,627**	**15,583**

3.6.2 Traffic Distribution per Category

The distribution of truck traffic in Kenya demonstrates a high reliance on containerized and box body trucks, which collectively account for most of the freight movement. Table 10 presents the distribution of different vehicle types along the corridor:

Table 10: Traffic Distribution per Category in Kenya

Vehicle Type	Percentage
Box body truck	29%
Containerized truck	30%
Other	1%
Skeleton truck	10%
Tanker Truck	11%
Tipper	19%

3.6.2 Traffic Distribution per Category

The distribution of truck traffic in Kenya demonstrates a high reliance on containerized and box body trucks, which collectively account for most of the freight movement. Figure 2 presents the distribution of different vehicle types along the corridor:

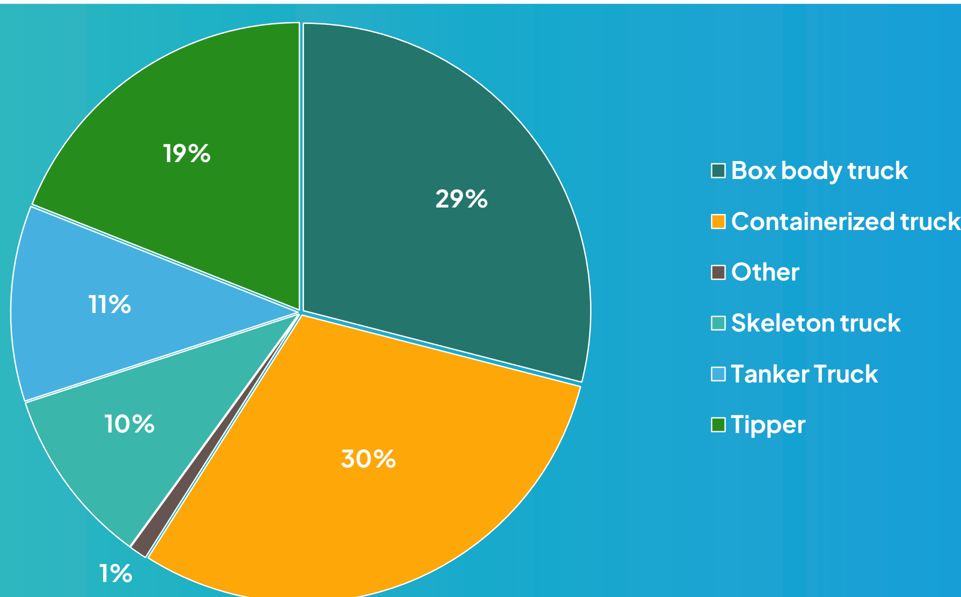

Figure 2: Traffic Distribution per Category in Kenya

3.6.3 Comparative Fuel Efficiency for Loaded and Empty Trucks per Class

Fuel efficiency is a critical factor influencing emissions and transport costs. Table 11 below provides a comparative analysis of fuel efficiency for loaded and empty trucks per vehicle class in Kenya.

Table 11: Comparative Fuel Efficiency for Loaded and Empty Trucks per Vehicle Class in Kenya

Vehicle Class	Average Fuel Efficiency (kmpl) - Loaded Truck	Average Fuel Efficiency (kmpl) - Empty Truck
LDT/ 2–Axle	3.79	4.44
MCV - 3Axle	3.3	4.35
MCV-4 Axle	1.62	2.6
HCV- 5 & 6 Axle	2.07	3.02
HCV- 7 & 8 Axle	2.08	2.65
HCV- >8 Axle	2.13	2.59

From the analysis, it was observed that fuel efficiency improves when trucks are empty, with gains observed across all vehicle classes. HCV- >8 Axle trucks, with an average loading of 56.9 tonnes, maintain a loaded fuel efficiency of 2.13 km/l, slightly higher than the 5 & 6 axle category.

Light-duty and mid-sized commercial vehicles (LDT and MCVs) demonstrate higher efficiency in empty conditions, suggesting opportunities for optimizing freight load balancing.

Heavy Commercial Vehicles (HCVs) show significant fuel consumption variations between loaded and empty states, reinforcing the need for logistics efficiency improvements to minimize empty trips.

The findings underscore the importance of route planning, fuel efficiency programs, and cargo optimization strategies to enhance transport sustainability along the Northern Corridor.

3.6.4 CO_2 Emissions per Road Section

Based on the GHG emission calculation methodology employed and the route sections covered, the estimate GHG emissions for the Mombasa – Nairobi is 1.58 MMtCO_2e, 0.93 MMtCO_2e for Nairobi – Malaba and 0.084 MMtCO2e for the Mau Summit – Busia route section as shown in the Figure 3 below.

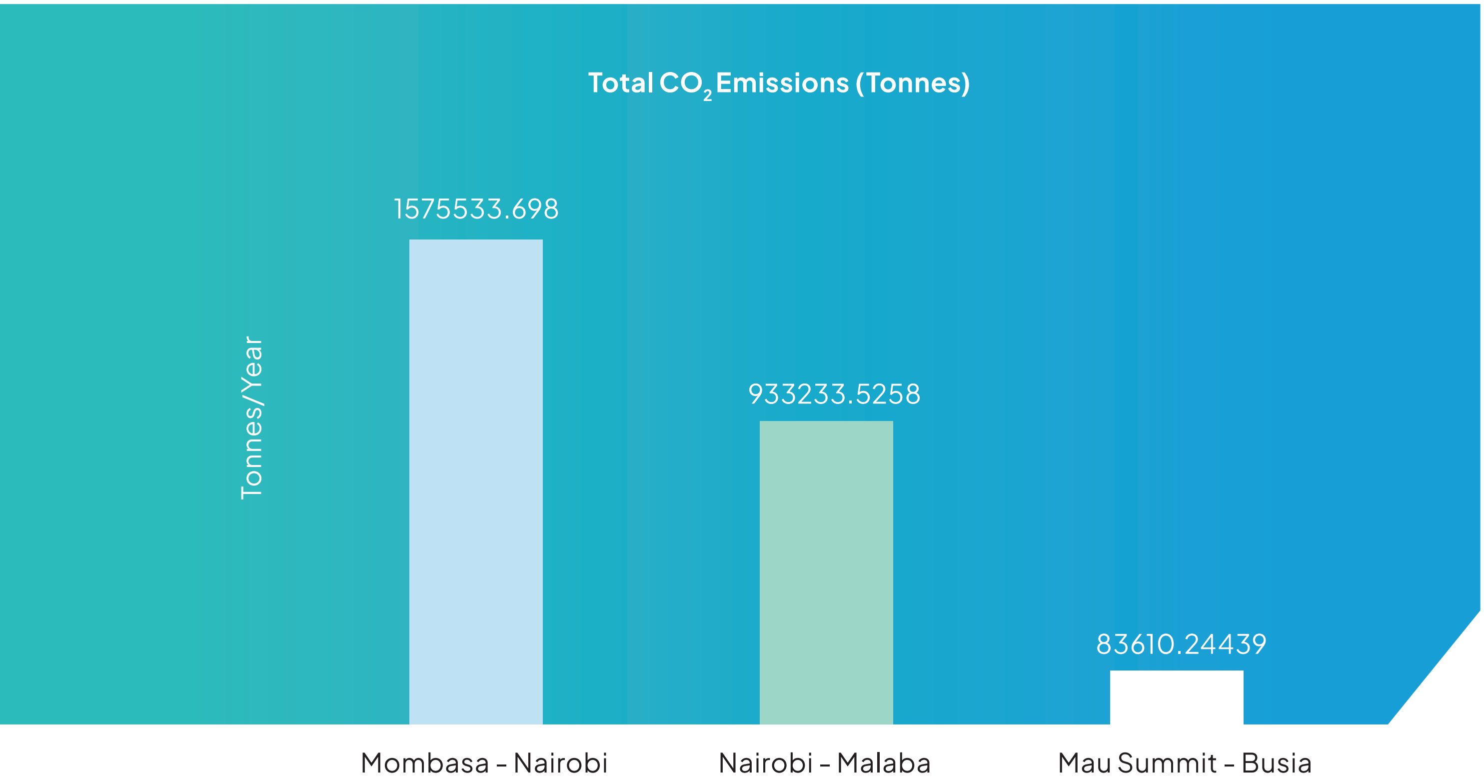

Figure 3: CO_2 Emissions per Road Section in Kenya

Kenya's Nationally Determined Contributions (NDC) report for the transport sector includes a goal to reduce carbon dioxide equivalent ($MtCO_2e$) emissions by 3.46 $MtCO_2e$ by 2030. This goal is part of a broader commitment to lower GHG emissions by 32% by 2030 relative to the business-as-usual scenario of 143 $MtCO_2e$.

Kenya has acknowledged the importance of addressing climate change. As a signatory of the Paris Agreement, Kenya enacted its Climate Change Act in 2016. The act highlights the importance of mainstreaming climate change across all sectors and developing a National Climate Change Action Plan to implement climate change action.

Kenya's NDC commits to Kenya has also put measures in place to promote the shift of passenger and freight from road to rail. The country is also in the process of developing legal and policy frameworks to promote the use of electric vehicles.

3.6.5 Pollutant Emissions

The estimated total quantity of pollutants for the freight transport sector along the Northern Corridor in Kenya is 15,271.5 tonnes/year. The Mombasa - Nairobi route section contributes is 9,081.8 tonnes/year, Nairobi – Malaba 5,276.5 tonnes/year, and Mau Summit – Busia 463.1 tonnes/year. Overall, for Kenya, Nitrous Oxides (NO_x) constitute 94% of all pollutants in quantity while Particulate Matter (PM10) constitutes 5% and Black Carbon (BC) approximately 1% as presented in the figure 4 below.

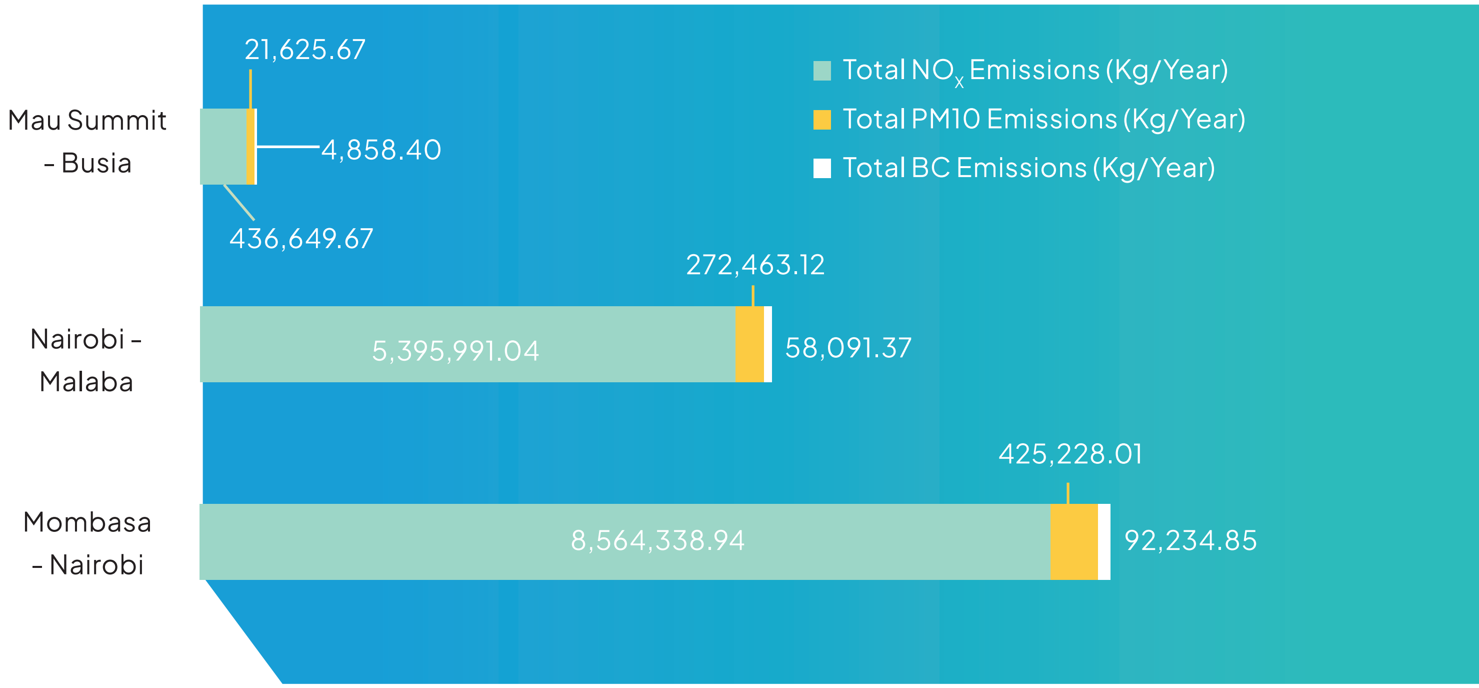

Figure 4: Estimated Total Pollutant Emissions in Kenya

3.7 Rwanda

The transport sector in Rwanda significantly contributes to greenhouse gas (GHG) emissions, driven by its reliance on diesel-powered road freight, which accounted for approximately 0.69 MMtCO$_2$e in 2015 (13% of national emissions; Rwanda NDC, 2020).

Under a Business-As-Usual (BAU) scenario, total emissions are projected to rise from 5.3 MMtCO$_2$e in 2015 to 12.1 MMtCO$_2$e by 2030 due to economic growth and transport expansion.

This 2024 baseline survey quantifies road freight emissions along the Northern Corridor in Rwanda at 0.34 MMtCO$_2$e, with pollutants totaling 786.6 tonnes/year, providing a foundation for Rwanda's target of a 38% reduction (4.6 MMtCO$_2$e) by 2030 through measures like electrification and public transit improvements.

3.7.1 Average Daily Traffic in Rwanda

The analysis of daily traffic volumes in Rwanda provides critical insights into freight movement along major transport corridors.

Rwanda recorded an average daily traffic (ADT) of 3,764 trucks, the lowest among the three countries, reflecting its smaller geographic scope and focus on regional distribution. Table 13 details truck class distribution across key stations:

Table 12 presents the distribution of truck classes at different monitoring stations.

Table 12: Average Daily Traffic per Class per Station in Rwanda

Vehicle Class	Musanze-Kigali	Kigali-Huye	Rubavu Border	Huye-Rusizi	Gatuna Border	Cyanika Border	Total
HCV-5&6 Axle	132	183	135	109	177	114	850
HCV-7&8 Axle	33	13	67	7	7	6	133
HCV->8 Axle	1	1	3	1	1	1	8
LDT/2- Axle	270	738	120	362	30	255	1,775
MCV-3 Axle	73	552	165	68	18	39	914
MCV-4 Axle	15	23	20	14	3	9	84
Total	**524**	**1,510**	**510**	**561**	**236**	**424**	**3,765**

The Kigali-Huye route recorded the highest daily traffic (1,510 trucks), reflecting its strategic importance in domestic and regional trade.

LDT/2–Axle trucks dominate freight movement, making up 47% of the total traffic (1,775 trucks daily), highlighting the reliance on smaller commercial vehicles for cargo distribution.

Heavy Commercial Vehicles (HCV-5&6 Axle) account for 22.6% of total truck movement (850 trucks daily), reinforcing their role in long-haul transport.

Cross-border stations such as Rubavu and Gatuna have lower daily traffic volumes, indicating more localized freight distribution and reduced heavy freight movement across borders.

Trucks queue to weigh at Mbale weighbridge in Uganda

3.7.2 Traffic Distribution per Category

Table 13 provides a breakdown of truck distribution based on vehicle types.

Table 13: Traffic Distribution per Category in Rwanda

Vehicle Type	Daily Count
Box body truck	751
Containerized truck	515
Other	38
Skeleton truck	474
Tanker Truck	182
Tipper	1799

Tipper trucks (1,799 daily) form the largest category, followed by box body trucks (751 daily) and containerized trucks (515 daily).

Skeleton trucks (474 daily) highlight the importance of containerized freight, while tanker truck segment (182 daily) is relatively small.

Tipper trucks (1,799 daily) lead, supporting construction and local goods transport, followed by box body (751 daily) and containerized trucks (515 daily), aligning with Rwanda's domestic freight focus.

Photo: ©Miguel Perfectti | Dreamstime.com

3.7.3 Comparative Fuel Efficiency for Loaded and Empty Trucks per Class

The comparative analysis in Table 14 highlights the variations in fuel efficiency for different truck categories when loaded versus empty.

Table 14: Comparative Fuel Efficiency for Loaded and Empty Trucks per Vehicle Class in Rwanda

	Average Fuel Efficiency (kmpl) – Loaded Truck	Average Fuel Efficiency (kmpl) – Empty Truck
LDT/ 2–Axle	3.76	3.25
MCV - 3Axle	3.07	2.49
MCV-4 Axle	1.62	3.27
HCV- 5 & 6 Axle	1.98	2.68
HCV- 7 & 8 Axle	2.04	1.91
HCV- >8 Axle	1.32	2.59

Light-Duty Trucks (LDT/2–Axle) exhibit the highest loaded fuel efficiency (3.76 km/l), making them more cost-effective for shorter trips and small freight movements.

MCV-4 Axle trucks experience the greatest efficiency gain when empty, improving from 1.62 km/l to 3.27 km/l. This indicates significant fuel savings when operating without cargo.

HCV-7 & 8 Axle trucks show minimal efficiency variation between loaded (2.04 km/l) and empty (1.91 km/l), suggesting a high energy demand regardless of load status.

HCV->8 Axle trucks have the lowest loaded fuel efficiency (1.32 km/l), reinforcing the need for optimized cargo loads and route planning to reduce fuel consumption.

Heavy commercial vehicles (HCVs) benefit significantly from load management strategies, as seen in HCV-5 & 6 Axle trucks improving from 1.98 km/l to 2.68 km/l when empty.

3.7.4 CO_2 Emissions per Road Section

The total estimated GHG emissions from road freight transport along the Northern Corridor in Rwanda amount to 0.34 million metric tonnes of CO_2 equivalent ($MMtCO_2e$). The Kigali–Rusizi route is the predominant contributor, accounting for 84% (0.28 $MMtCO_2e$) of these emissions, highlighting it as a critical area for intervention. Other routes such as Cyanika–Rubavu contribute 8% (0.03 $MMtCO_2e$), Musanze–Kigali accounts for 5% (0.02 $MMtCO_2e$), and Gatuna–Kigali contributes 2% (0.01 $MMtCO_2e$) as shown in the figure 5 below.

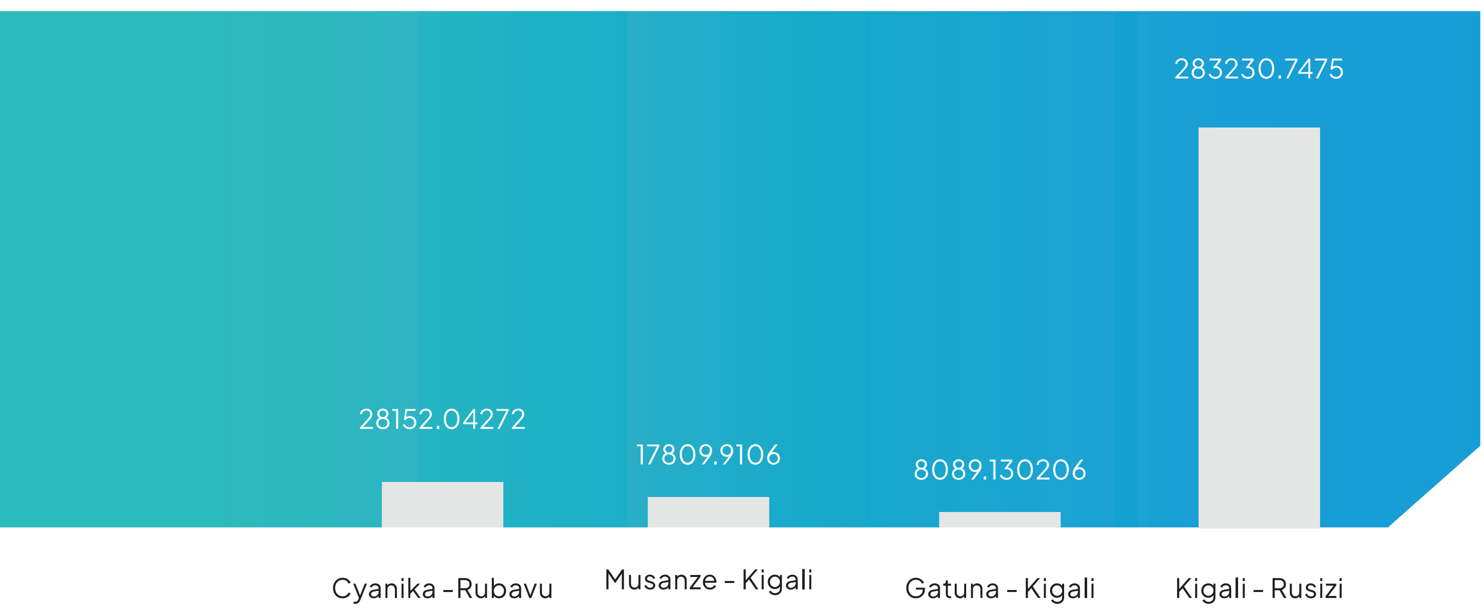

Figure 5: CO_2 Emissions per Road Section in Rwanda

According to Rwanda's Updated Nationally Determined Contribution (NDC) 2020, the transport sector contributed 0.69 MMtCO2e in 2015, reflecting 13% of the total national GHG emissions. Rwanda has committed to a 38% reduction in GHG emissions by 2030 relative to the business-as-usual scenario, with transport being a significant sector in achieving these targets.

3.7.5 Pollutant Emissions

The estimated total quantity of pollutants in Rwanda is 786.6 tonnes/year distributed across Cyanika-Rubavu (119.5 tonnes/year), Musanze-Kigali, (71.5 tonnes/year), Gatuna-Kigali (46.3 tonnes/year) and Kigali - Rusizi (549.3tonnes/year). For all the routes, Nitrous Oxides (NO_X) constitute over 94% of all pollutants in quantity as shown in the figure 6 below.

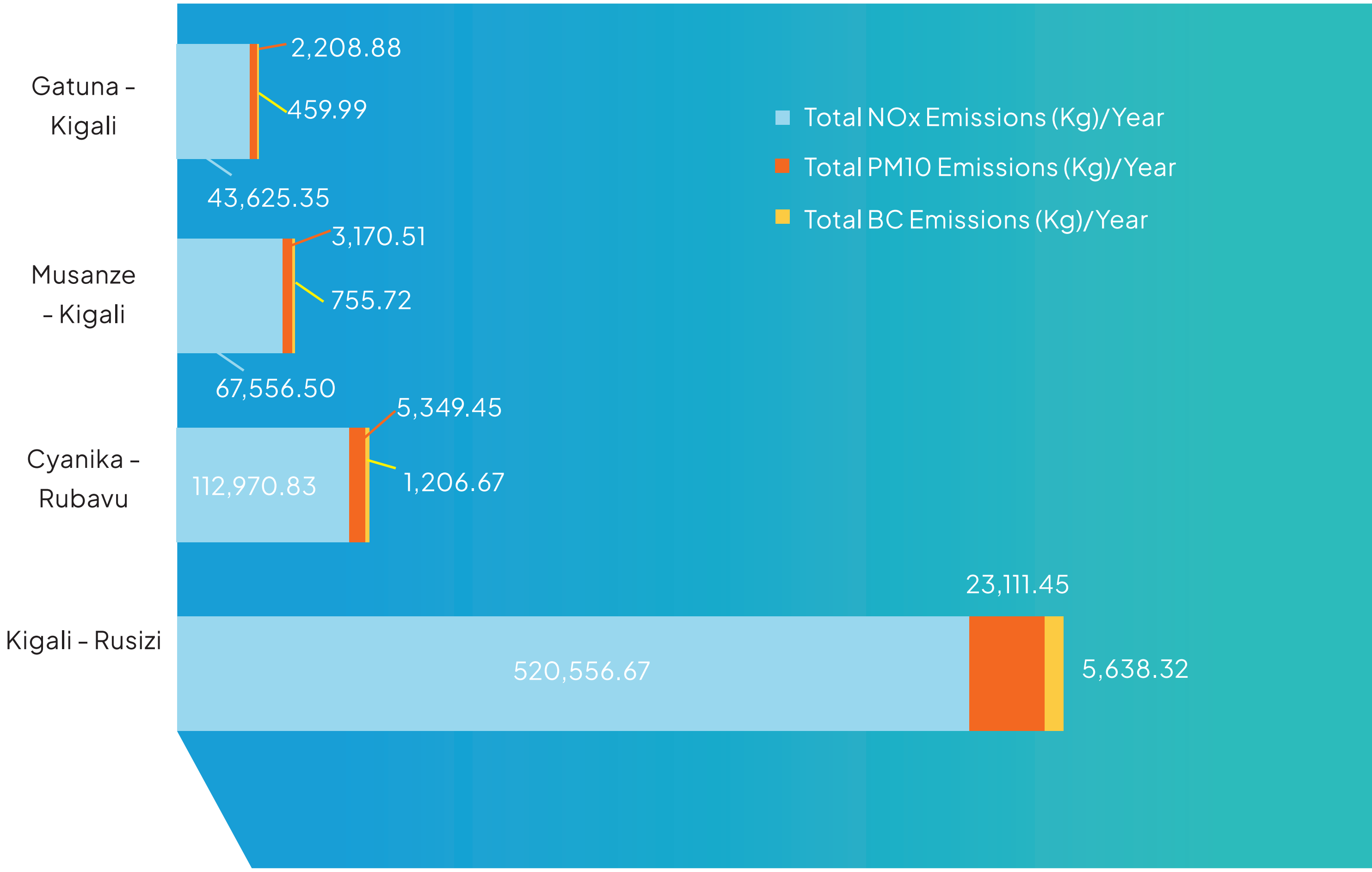

Figure 6: Estimated Total Pollutant Emissions in Rwanda

Data indicates that the Kigali-Rusizi route is the most pollution-intensive, accounting for nearly 70% of total pollutants emissions, followed by the Cyanika-Rubavu and Musanze-Kigali routes. The high levels of Nitrous Oxide (NOx) emissions recorded in major routes highlight the need for a rapid transition to low-emission alternatives, particularly in freight transport.

To meet these targets, Rwanda must implement strategic interventions aimed at curbing transport-related emissions. For freight transport, this includes promoting electric vehicles (EVs) / freight trucks while expanding charging infrastructure to support their adoption. Stricter fuel quality and emissions regulations are essential, including the introduction of biofuels and compressed natural gas (CNG) as cleaner alternatives to diesel. Additionally, stronger vehicle inspection and maintenance programs will help phase out older, high-emission vehicles, while dedicated freight lanes and smart traffic management systems can further enhance fuel efficiency.

3.8 Uganda

The road transport sector in Uganda is the dominant mode of transportation, accounting for over 95% of total freight and passenger traffic (BMAU, 2022). The transport sector remains a dominant contributor to Uganda's greenhouse gas (GHG) emissions, with road transport alone accounting for 84% of total transport energy consumption. This figure far exceeds that of domestic aviation (11%) and rail and water transport (3%), highlighting the country's reliance on road-based freight and passenger transport (Uganda Updated NDC 2022). The heavy dependence on fossil fuel-powered vehicles contributes significantly to rising emissions, particularly in urban centers and along major trade corridors. As Uganda continues to expand its road network and vehicle ownership rates increase, the sector's carbon footprint is expected to rise sharply if no mitigation measures are put in place.

Projections indicate that, under a Business-As-Usual (BAU) scenario, emissions from Uganda's transport sector will more than double from 4.2 $MMtCO_2e$ in 2015 to 9.6 $MMtCO_2e$ by 2030. This escalation underscores the urgent need for low-carbon transport interventions to curb emissions growth. In response, Uganda has committed to an ambitious 24.7% reduction below the BAU scenario by 2030 under its Nationally Determined Contribution (NDC) targets. If the proposed mitigation measures are fully implemented, the sector's emissions could be limited to 6.8 $MMtCO_2e$, marking a 29% reduction from the projected BAU scenario. Achieving these targets will require a strategic shift toward fuel-efficient and alternative energy transport solutions, including electrification of mobility, enhanced public transit systems, and improved fuel efficiency regulations. Additionally, investments in rail and water-based transport alternatives could help reduce road transport dependency, further contributing to Uganda's climate goals while promoting economic sustainability.

Northern Corridor enumerator interviews a driver at Mbale weighbridge in Uganda

3.8.1 Average Daily Traffic in Uganda

The survey captured truck movement at various monitoring stations, with total daily truck counts recorded as follows in table 14 below:

Table 14: Average Daily Traffic per Class per Station in Uganda

Station	HCV-5&6 Axle	HCV-7&8 Axle	HCV->8 Axle	LDT/2-Axle	MCV-3 Axle	MCV-4 Axle	Total
Lukaya	543	22	0	733	112	47	1,458
Magamaga	1,966	27	2	683	120	90	2,889
Malaba Weighbridge	1,069	11	0	7	4	1	1,093
Mbale Weighbridge	800	16	0	201	40	19	1,076
Mbarara	279	13	0	168	83	19	561
Mpondwe Border	118	32	1	160	44	12	367
Total	**4,775**	**121**	**4**	**1,953**	**401**	**189**	**7,443**

3.8.2 Traffic Distribution per Category

Truck movements in Uganda are dominated by box body trucks and containerized trucks, which account for 73% of all truck traffic. The distribution by vehicle type is as follows in table 15:

Table 15: Traffic Distribution per Category in Uganda

Vehicle Type	Daily Count
Box Body Truck	2,361
Containerized Truck	2,167
Skeleton Truck	741
Tanker Truck	986
Tipper	1,126
Other	53

The high presence of containerized and box body trucks underlines Uganda's dependence on imports and exports via road transport, a sector identified in the NDC as critical for emissions reduction through improved vehicle efficiency and modal shift strategies.

3.8.3 Comparative Fuel Efficiency for Loaded and Empty Trucks per Class in Uganda

The survey in Uganda provided two main results- fuel efficiency and proportion of loaded, and empty trips for all the route sections in Uganda as given in table 16 below;

Table 16: Comparative Fuel Efficiency for Loaded and Empty Trucks per Vehicle Class in Uganda

	Average Fuel Efficiency (kmpl) - Loaded Truck	Average Fuel Efficiency (kmpl) - Empty Truck
LDT/ 2–Axle	2.09	2.22
MCV - 3Axle	0.96	2.06
MCV-4 Axle	1.59	1.41
HCV- 5 & 6 Axle	2.02	2.6
HCV- 7 & 8 Axle	2.98	1.78
HCV- >8 Axle	2.68	2.68

Heavy commercial vehicles (HCVs) dominate the sector, with nearly 4,775 daily trips recorded for HCV-5&6 Axle trucks alone. Containerized trucks (2,167 daily) and box body trucks (2,361 daily) account for most freight movement.

Fuel efficiency results highlight the disparities in fuel consumption based on truck load status. On average, heavy commercial vehicles (HCVs) with 5 & 6 axles have a fuel efficiency of 2.02 km/l, whereas empty trucks in the same category reach up to 2.6 km/l. The least fuel-efficient category is MCV-3 Axle trucks, which consume 0.96 km/l when loaded. The government of Uganda has identified fuel economy improvements as a critical measure to cut emissions. Uganda is part of the Global Fuel Economy Initiative (GFEI), which aims to improve fuel economy by 20% by 2040 and 50% by 2070.

3.8.4 CO_2 Emissions per Road Section

The total estimated greenhouse gas (GHG) emissions from road freight transport along the Northern Corridor in Uganda amount to 0.83 million metric tons of CO_2 equivalent ($MMtCO_2e$) as illustrated in the figure below.

The distribution of emissions across key road sections is as follows:

- Malaba/Busia–Kampala: 0.35 $MMtCO_2e$ (42% of total emissions)
- Busia/Malaba–Elegu: 0.26 $MMtCO_2e$ (31%)
- Kampala–Lukaya: 0.07 $MMtCO_2e$ (9%)
- Lukaya–Mbarara: 0.05 $MMtCO_2e$ (6%)
- Mbarara–Cyanika: 0.05 $MMtCO_2e$ (6%)
- Mbarara–Mpondwe: 0.03 $MMtCO_2e$ (4%)
- Mbarara–Katuna: 0.02 $MMtCO_2e$ (2%)

The Malaba/Busia–Kampala and Busia/Malaba–Elegu corridors together contribute 73% of the total emissions, highlighting these as critical areas for targeted interventions to achieve significant emissions reductions.

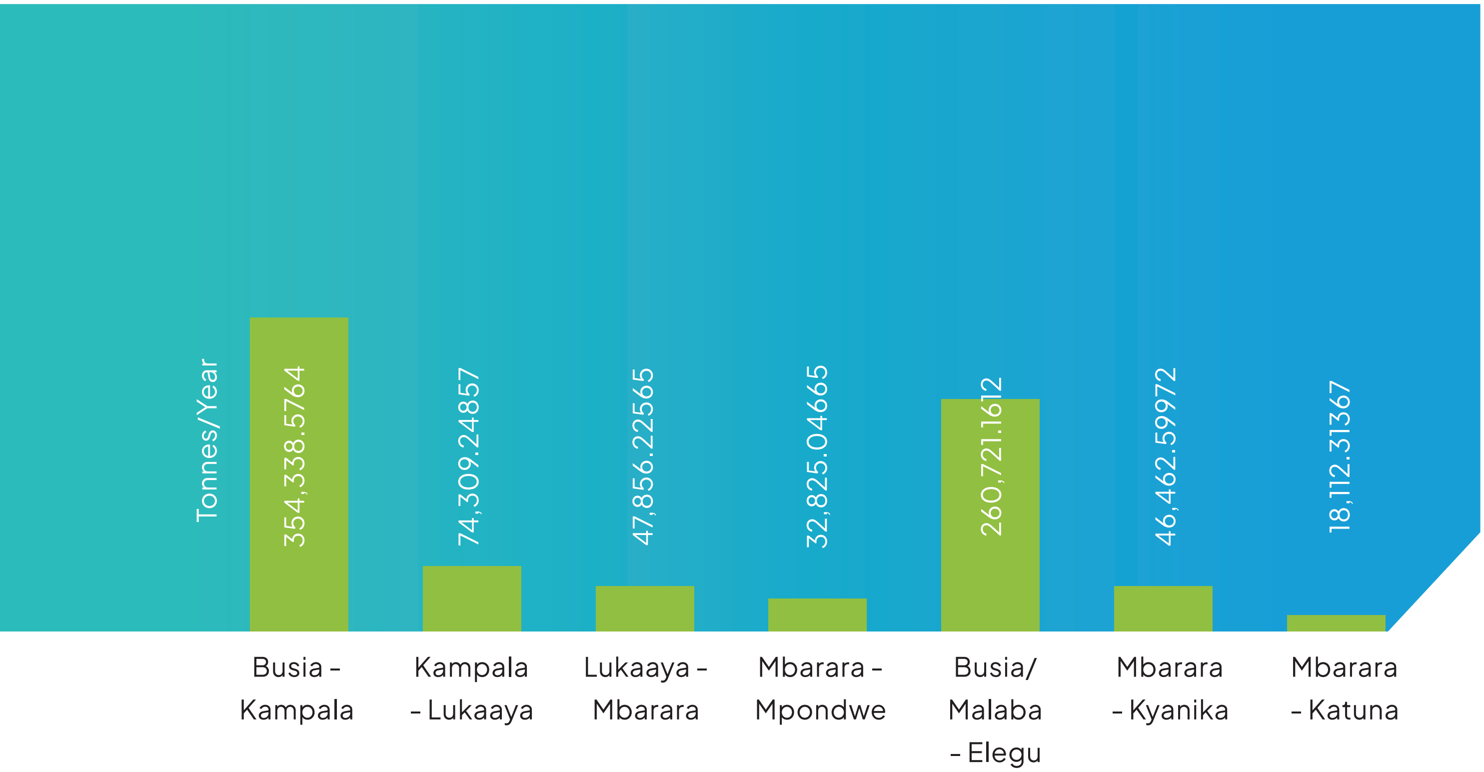

Figure 7: CO_2 Emissions per Road Section in Uganda

Uganda's updated Nationally Determined Contributions (NDC) outlines ambitious mitigation targets for the transport sector, aiming for a 29% reduction in GHG emissions by 2030 compared to a business-as-usual (BAU) scenario. This equates to limiting transport emissions to 6.8 $MtCO_2e$ by 2030, down from a projected 9.6 $MtCO_2e$ under BAU conditions

Key commitments relevant to reducing road freight emissions along the Northern Corridor include:

- Rehabilitation of 634 km of meter gauge railway (MGR) by 2026 to facilitate a modal shift from road to rail for freight, which is more energy-efficient. This is expected to improve diesel locomotive fuel economy by 22% by 2030
- Implementation of 1,412 km of fully electrified standard gauge rail (SGR) by 2050, which, although a longer-term measure, will significantly reduce reliance on road freight in the future
- Fuel Efficiency Improvements: The Global Fuel Economy Initiative (GFEI) targets a 20% improvement in fuel efficiency for road transport by 2030
- Alternative Fuel Adoption: A 1% annual increase in alternative fuel use for road vehicles, with 60% from natural gas, 20% from ethanol (E10), and 20% from biodiesel

Given the emissions profile and NDC targets, the following strategies are recommended to reduce GHG emissions along Uganda's Northern Corridor:

Modal Shift from Road to Rail: Prioritizing the transition of freight from high-emission road sections, particularly Malaba/Busia–Kampala, to rail through expedited completion of SGR and MGR projects.

Fuel Efficiency and Alternative Fuels: Encouraging the adoption of fuel-efficient freight vehicles and promoting the use of natural gas, biodiesel, and ethanol blends. Policies to regulate the import of older, less fuel-efficient vehicles should also be reinforced.

Optimizing Freight Logistics: Implementing logistics optimization tools and practices to reduce empty trips and improve load factors, especially on high-emission routes like Busia/Malaba–Elegu.

Infrastructure Improvements: Upgrading road infrastructure to reduce congestion and improve fuel efficiency, particularly on the Kampala–Lukaya and Lukaya–Mbarara segments.

If fully implemented, Uganda's NDC strategies could result in a significant reduction in road freight emissions along the Northern Corridor. Assuming proportional benefits across major road sections:

- A 20% fuel efficiency improvement could reduce emissions from Malaba/Busia–Kampala by 0.07 $MMtCO_2e$, lowering its contribution to 0.28 $MMtCO_2e$.
- The modal shift to rail could potentially reduce emissions on the Busia/Malaba–Elegu route by 30%, decreasing emissions from 0.26 $MMtCO_2e$ to approximately 0.18 $MMtCO_2e$.
- Combined, these interventions could reduce the total corridor emissions from 0.83 $MMtCO_2e$ to approximately 0.62 $MMtCO_2e$, contributing significantly towards Uganda's 2030 transport sector goals.

3.8.5 Pollutant Emissions

The estimated total quantity of pollutants from road freight transport in Uganda is 3,682.2 tonnes/year. Out of this, 80% of the pollutants were contributed by Malaba/Busia-Kampala 1,644.4 tonnes/year (45%) and Busia/Malaba-Elegu 1,300.7 tonnes/year (35%) route sections. Other sections contributed as follows; Kampala-Lukaya 235.4 tonnes/year (6%), Lukaya-Mbarara 178.9 tonnes/year (5%), Mbarara-Mpondwe 106.8 tonnes/year (3%), Mbarara-Cyanika 124.3 tonnes/year (3%) and Mbarara-Katuna 91.7 tonnes/year (2%). In terms of pollutants category, Nitrous Oxides (NO_X) constituted over 94% of all pollutants in quantity as shown in the figure 8 below.

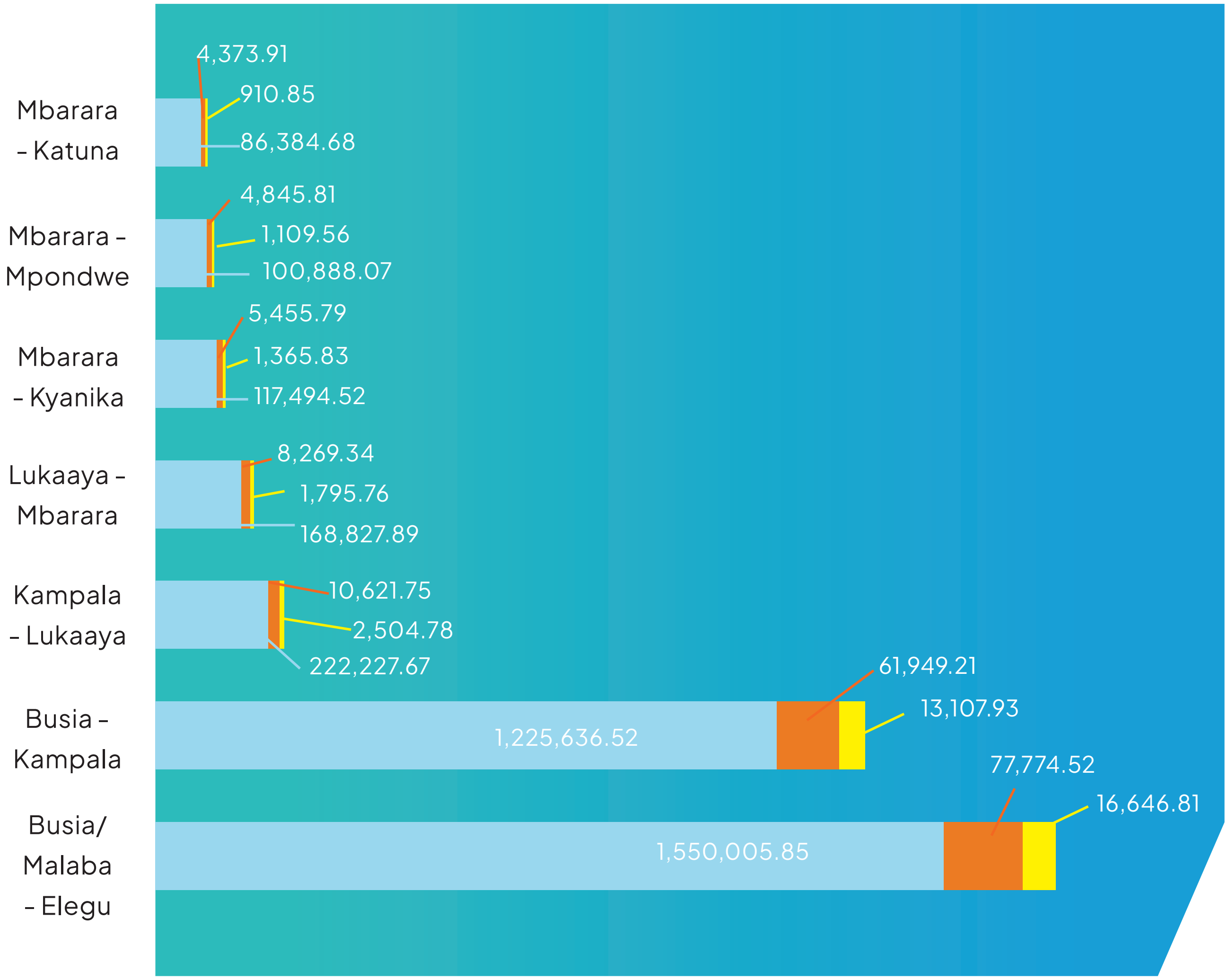

Figure 8: Estimated Total Pollutant Emissions in Uganda

4. Conclusion and Recommendations

Conclusion

The 2024 Baseline Survey of Greenhouse Gas Emissions Along the Northern Corridor Routes in Kenya, Uganda, and Rwanda provides a detailed assessment of emissions from road freight transport, which accounts for 85% of the corridor's 40.992 million metric tonnes of annual cargo throughput in 2024 (Port of Mombasa, 2024). Using the Northern Corridor GHG Emission Model (NCEM), aligned with IPCC guidelines, the survey analyzed data from 26,790 daily truck trips across 17 stations and a stratified sample of 3,260 vehicles, establishing a baseline of 2.92 million metric tonnes of CO_2 equivalent (MMtCO_2e) and 19,740 tonnes of pollutants (NO_x, PM10, BC). This baseline serves as a critical reference for tracking the implementation of the Northern Corridor Green Freight Strategy 2030, targeting a 10% CO_2 intensity reduction by 2030 and net-zero emissions by 2050.

Traffic and Freight Dynamics

The corridor recorded an average daily traffic (ADT) of 26,790 trucks, with Kenya contributing 15,583 vehicles/day (58%), Uganda 7,443 (28%), and Rwanda 3,764 (14%). Heavy Commercial Vehicles (HCVs, 5–6 axles) dominate at 15,735 vehicles/day (59%), driving long-haul freight, while Light-Duty Trucks (LDTs, 2–axles) total 7,934 vehicles/day (30%), supporting regional distribution.

Kenya:

HCV-5&6 axles (10,110 vehicles/day, 65%) and LDTs (4,206 vehicles/day, 27%) lead, with Mombasa-Nairobi (9,095 vehicles/day) as the busiest route, dominated by containerized (30%) and box body trucks (29%), reflecting its trade hub role.

Rwanda

LDTs (1,775 vehicles/day, 47%) prevail, with tipper trucks (1,799 daily) prominent for local freight, while HCV-5&6 axles (850 vehicles/day, 23%) focus on Kigali-Rusizi (2,069 vehicles/day), a key cross-border route.

Uganda

HCV-5&6 axles (4,775 vehicles/day, 64%) and LDTs (1,953 vehicles/day, 26%) dominate, with Malaba/Busia-Kampala (2,887 vehicles/day) as the primary corridor, led by box body (2,361 daily) and containerized trucks (2,167 daily).

Approximately 45% (1,467 of 3,260 sampled trucks) were empty, consistent with Strategy estimates of up to 70% empty trips due to trade imbalances (79% imports vs. 14% exports; NCTTCA, 2023), increasing fuel consumption and emissions.

GHG Emissions

In 2024, road freight emissions reached 3.76 $MMtCO_2e$, with selected corridor routes in Kenya accounting for 2.59 $MMtCO_2e$ (68.88%), Uganda 0.83 $MMtCO_2e$ (22.07%), and Rwanda 0.34 $MMtCO_2e$ (9.04%).

Emission hotspots include:

Kenya:

Mombasa-Nairobi (1.58 $MMtCO_2e$, 60.91% of Kenya's total), Nairobi-Malaba (0.93 $MMtCO_2e$, 35.85% of Kenya Total accounting for 66.8% of emissions from all the route sections surveyed, driven by high traffic (9,095 and 5,435 vehicles/day) and VKT (1,592 and 894 million km/year, respectively). Mau Summit-Busia contributes 0.084 $MMtCO_2e$.

Rwanda:

Kigali-Rusizi (0.28 $MMtCO_2e$, 84%) leads, followed by Cyanika-Rubavu (0.03 $MMtCO_2e$), Musanze-Kigali (0.02 $MMtCO_2e$), and Gatuna-Kigali (0.01 $MMtCO_2e$).

Uganda

Malaba/Busia-Kampala (0.35 $MMtCO_2e$, 42%) and Busia/Malaba-Elegu (0.26 $MMtCO_2e$, 31%) are the largest contributors, with Kampala-Lukaya (0.07 $MMtCO_2e$) and other routes (0.02–0.05 $MMtCO_2e$) reflecting trade corridor intensity.

CO_2 intensity varies by route—39.78 g/tonne-km (Mombasa-Nairobi), 50.18 g/tonne-km (Malaba/Busia-Kampala), and 98.42 g/tonne-km (Kigali-Rusizi)—highlighting efficiency differences due to load factors and distances.

Pollutant Emissions

The corridor emitted 19,740 tonnes/year of pollutants, predominantly NO_x (>94%), followed by PM10 (~5%) and BC (~1%), reflecting diesel reliance. Elevated NO_x levels pose air quality risks, necessitating cleaner fuels and emission controls

Kenya

15,271 tonnes/year (77%), with Mombasa-Nairobi (8,564 tonnes/year) and Nairobi-Malaba (5,396 tonnes/year) as key contributors. NO_x totals 14,297 tonnes/year, PM10 719 tonnes/year, and BC 155 tonnes/year.

Uganda

3,682 tonnes/year (19%), led by Malaba/Busia-Kampala (1,550 tonnes/year) and Busia/Malaba-Elegu (1,226 tonnes/year), with NO_x at 3,466 tonnes/year, PM10 183 tonnes/year, and BC 40 tonnes/year.

Rwanda

786 tonnes/year (4%), with Kigali-Rusizi (549 tonnes/year, 70%) dominating, followed by Cyanika-Rubavu (119 tonnes/year), Musanze-Kigali (72 tonnes/year), and Gatuna-Kigali (46 tonnes/year). NO_x totals 745 tonnes/year, PM10 32 tonnes/year, and BC 7 tonnes/year.

Fuel Efficiency

Kenya: HCV-5&6 axles from 2.07 km/l (loaded) to 3.02 km/l (empty), LDTs from 3.79 to 4.44 km/l.

Rwanda: LDTs from 3.76 km/l (loaded) to 3.25 km/l (empty), HCV->8 axles at 1.32 km/l (loaded).

Uganda: HCV-5&6 axles from 2.02 to 2.6 km/l, MCV-3 axles at 0.96 km/l (loaded).

Strategic Insights

High empty trip rates (45%) and underutilized rail suggest modal shifts (e.g., SGR electrification targeting 20%-60% rail share by 2030) and logistics hubs could reduce emissions by 20–30% on high-intensity routes like Mombasa-Nairobi and Kigali-Rusizi.

Achieving Kenya's 32%, Rwanda's 38%, and Uganda's 29% emission reductions by 2030 is feasible through electrification, Euro 4 standards, and efficiency improvements (e.g., Uganda's GFEI 20% fuel economy goal).

The completed pollutant data enhances baseline accuracy, though rail emissions remain unquantified. Regular GHG monitoring via the Northern Corridor Emissions Index will ensure robust tracking toward net-zero goals.

This baseline highlights the corridor's emission intensity, driven by HCV dominance and inefficiencies, providing a foundation for targeted decarbonization aligned with the Northern Corridor Green Freight Strategy 2030's objectives.

Recommendations

To achieve the Northern Corridor Green Freight Strategy 2030's targets of a 10% CO_2 intensity reduction by 2030 and net-zero emissions by 2050, the following recommendations are proposed:

i). **Capacity Building for Drivers and Truck Owners:** Develop a standardized eco-driving curriculum and training program for truck drivers and owners to optimize fuel consumption, reduce emissions, and enhance safety through techniques like proper acceleration, braking, and route planning.

ii). **Strengthening Vehicle Emission Standards and Regulation:** Adopt and implement Euro 4/IV vehicle emission standards across all Northern Corridor member states to reduce NO_X, PM10, and BC emissions from diesel trucks. Establish uniform vehicle age limits for imported second-hand trucks to prevent the entry of inefficient, high-emission vehicles, and introduce mandatory emissions testing as part of annual licensing requirements for heavy-duty vehicles (HDVs).

iii). **Promoting Green Freight Technologies:** Support pilot projects for alternative fuel vehicles (electric, LNG, hydrogen-powered trucks, and biofuels), offering incentives like tax breaks or subsidies for fleet owners adopting cleaner technologies. Encourage retrofitting existing truck fleets with fuel-saving technologies, such as improved exhaust systems and energy-efficient engines, to lower emissions.

iv). **Enhancing Fuel Quality and Efficiency:** Ensure strict adherence to low-sulphur diesel fuel standards to reduce particulate matter and black carbon emissions, supporting air quality improvements. Train fleet operators on eco-driving techniques to minimize emissions through optimized fuel use, route planning, and load management.

v). **Promoting Modal Shift to Lower-Carbon Transport:** Enhance railway networks and connectivity, prioritizing Standard Gauge Railway (SGR) electrification to shift long-haul freight from road to rail, reducing congestion and GHG emissions. Invest in inland waterway transport and intermodal facilities to provide competitive alternatives to road freight, improving efficiency and reducing emissions. Implement logistics hubs and dry ports to streamline cargo movement, reduce empty truck trips, and optimize load factors on high-emission routes like Mombasa-Nairobi and Malaba/Busia-Kampala.

vi). **Encouraging Electrification of Freight Transport:** Conduct a feasibility study to identify strategic locations for electric truck charging stations along the corridor, ensuring accessibility for regional trade routes. Provide incentives, such as tax benefits, subsidies, or grants, to promote the adoption of electric trucks, supporting Rwanda's and Uganda's electrification strategies.

vii). **Enhancing Climate-Resilient Infrastructure:** Integrate climate adaptation measures into road and rail infrastructure planning to ensure long-term sustainability and resilience against extreme weather, addressing $83 million annual climate damages.

viii). **Strengthening Monitoring, Data Collection, and Policy Coordination:** Continuously track GHG emissions across the corridor using real-time data and satellite monitoring, leveraging the Northern Corridor Emissions Index for annual reporting. Conduct annual GHG data collection along Northern Corridor sections to monitor mitigation measure impacts and track progress toward the Green Freight Strategy 2030's goals.

These recommendations, grounded in the 2024 baseline, support regional cooperation, align with national NDCs, and drive the corridor toward sustainability, ensuring economic growth and environmental stewardship.

5. Annexes

5.1 appendix 1: Data Collection Tools

GHG Accounting

1. Name of the Interviewer:

2. STATION:

- ◯ Mariakani Weighbridge
- ◯ Athiriver Weighbridge
- ◯ Gilgil Weighbridge
- ◯ Webuye Weighbridge
- ◯ Busia Weighbridge
- ◯ Malaba Weighbridge
- ◯ Mbale Weighbridge
- ◯ Magamaga
- ◯ Lukaya
- ◯ Mbarara
- ◯ Mpondwe Border
- ◯ Gatuna Border
- ◯ Cyanika Border
- ◯ Musanze-Kigali/NR2
- ◯ Kigali-Huye/NR1
- ◯ Rubavu Border-Musanze/NR2
- ◯ Huye- Rusizi/NR10

3. Which module are you taking?

- ○ VEHICLE ACTIVITY MODULE
- ○ TALLYING
- ○ VEHICLE ACTIVITY

» MODULE I A: PRELIMINARY

1. Name of the Interviewee:

2. Name of the Company: (check on the truck or NA)

3. Title / position in the company:

4. Contact No / Phone Number:

5. Number Plate of Vehicle:

6. Country where truck is registered: (check plate No)

- ○ Kenya
- ○ Uganda
- ○ Tanzania
- ○ DRC
- ○ Burundi
- ○ Rwanda
- ○ South Sudan
- ○ Other

7. Vehicle Category:

- ◯ LDT/ 2–Axle
- ◯ MCV - 3Axle
- ◯ MCV-4 Axle
- ◯ HCV- 5 & 6 Axle
- ◯ HCV- 7 & 8 Axle
- ◯ HCV- >8 Axle

8. What is the year of manufacture of the vehicle?

9. What is the origin of the journey?

10. What is the destination of the journey?

» MODULE I: B– FUEL CONSUMPTION

11. MODEL:

12. TYPE:

- ◯ Containerized truck
- ◯ Box body truck
- ◯ Skeleton truck
- ◯ Tanker Truck
- ◯ Tipper
- ◯ Other

13. MAX LOAD(TONS)

14. ACTUAL LOAD(TONS)

15. AVERAGE FUEL CONSUMPTION FOR A ROUND TRIP(LITRES)

16. RETURN TRIP EMPTY/LOADED:

- Empty
- Loaded

17. FUEL PROVIDED FOR EMPTY RETURN(LITRES):

18. FUEL PROVIDED FOR LOADED RETURN TRIP(LITRES):

20. AVERAGE SPEED:

TALLYING

1. Direction

- Outbound
- Inbound

2. Type of vehicle

- Containerized truck
- Box body truck
- Skeleton truck
- Tanker Truck
- Tipper
- Other

3. Class of truck tally

- LDT/ 2–Axle
- MCV - 3Axle
- MCV-4 Axle
- HCV- 5 & 6 Axle
- HCV- 7 & 8 Axle
- HCV- >8 Axle

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