Office of Transport and Traffic Policy and Planning

Study on Baseline Data Formulation and Tracking of Greenhouse Gas Emission Reduction from Vehicle Energy Efficiency Improvement Measures

Executive Summary Report

presented by

PSK Consultants Co., Ltd.

December 2025

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Preface

In light of the rising trend of greenhouse gas emissions in Thailand's transport sector and the country's challenging greenhouse gas reduction targets, it is imperative to implement systematic operations to achieve these goals. Consequently, the Office of Transport and Traffic Policy and Planning (OTP) has undertaken the "Study on Baseline Data Preparation and Tracking of Greenhouse Gas Emission Reduction from Vehicle Energy Efficiency Improvement Measures."

The project comprises three main objectives: (1) To establish baseline data for plans and projects within the vehicle energy efficiency improvement measures group and the transport and logistics system efficiency improvement measures group; (2) To develop a Measurement, Reporting, and Verification (MRV) system for plans and projects within the aforementioned groups ; and (3) To analyze and evaluate the reductions in energy consumption, greenhouse gases, and Particulate Matter (PM2.5) resulting from plans and projects within the vehicle energy efficiency improvement measures group and the transport and logistics system efficiency improvement measures group.

The Office of Transport and Traffic Policy and Planning (OTP) sincerely hopes that the data and findings obtained from this study will be beneficial to relevant agencies for application in planning, monitoring, and evaluating operations. This will ultimately contribute to the successful advancement of a sustainable and environmentally friendly transport system for the nation.

Every Route, Together ... Towards Sustainable Transport for Thailand

Office of Transport and Traffic Policy and Planning (OTP)
Ministry of Transport
December 30, 2025

Abstract

Global warming and climate change affect every nation, leading to the establishment of the "Paris Agreement" to foster cooperation in reducing greenhouse gases. At the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow, United Kingdom, Thailand announced a target to reduce greenhouse gas emissions by 30 to 40 percent, or approximately 167 to 222 million tonnes of carbon dioxide equivalent, by the year 2030. Subsequently, at the 30th Conference of the Parties (COP30) in Belém, Federative Republic of Brazil, the target was adjusted to achieve net zero greenhouse gas emissions by the year 2050.

Regarding the target for the year 2030, Thailand must reduce greenhouse gas emissions from 555 million tonnes of carbon dioxide equivalent to 370.19 million tonnes of carbon dioxide equivalent. The Ministry of Transport is responsible for a reduction of 45.61 million tonnes of carbon dioxide equivalent, accounting for 8.2 percent of the national target. Notably, the transport sector emitted greenhouse gases amounting to 34 percent, or 81.6 million tonnes of carbon dioxide equivalent, in 2023. Therefore, sustainable and eco-friendly transport serves as a primary mechanism for achieving these goals.

The Office of Transport and Traffic Policy and Planning (OTP) conducted this study with the objective of establishing baseline data by applying the ASIF Framework, which is an international standard for calculation. In this framework, A stands for transport activity volume, S stands for the proportion of vehicle modes and fuel types, I stands for energy efficiency, and F stands for the greenhouse gas emission coefficient. This was achieved by processing data from various agencies and field surveys alongside the development of a Measurement, Reporting, and Verification (MRV) system for five key measures. These measures include electric vehicle promotion and energy efficiency, inter-city transport and logistics modal shift, and the development of Andaman coastal ports. Additionally, the study covers the construction of new runways at Suvarnabhumi Airport and the efficiency improvement of cargo handling equipment at Laem Chabang Port.

The assessment results in 2023 indicated that the transport sector successfully reduced greenhouse gas emissions by 4.27 million tonnes of carbon dioxide equivalent due to the expansion of personal electric vehicles. However, when compared to the national target, a further reduction of 3.69 million tonnes of carbon dioxide equivalent is required. Consequently, this study suggests guidelines for integrated cooperation from all sectors. The Government Sector must accelerate the establishment of energy efficiency standards, Low Emission Zones, and carbon tax measures. Simultaneously, the Private Sector must focus on technology development and the transition to electric vehicles. Finally, the Public Sector must adjust behavior by opting for public transport and energy-efficient vehicles to achieve the net zero target in the future.

Keywords: Greenhouse Gas Reduction, Transport Sector, ASIF Framework, MRV System, Energy Efficiency Measures

Office of Transport and Traffic Policy and Planning (OTP)

Ministry of Transport

December 30, 2025

Acknowledgements

The project **<u>"Study on Baseline Data Formulation and Tracking of Greenhouse Gas Emissions Reduction from Vehicle Energy Efficiency Improvement Measures"</u>** successfully achieved its objectives. All sectors, including government agencies, state enterprises, the private sector, and people, provided gracious support and cooperation by supplying necessary data and participating in various operational stages.

The Office of Transport and Traffic Policy and Planning (OTP) expresses its sincere gratitude to all data-owning agencies across every sector. They kindly compiled and verified the accuracy of statistics and baseline data regarding transport, energy, and the environment. These elements constitute essential factors for establishing baseline data and developing an effective tracking and assessment system.

The Office also extends its appreciation to the experts, specialists, and representatives from various agencies who dedicated their time to participate in seminars, workshops, and training sessions to exchange knowledge and provide beneficial policy recommendations. Furthermore, the Office conveys special thanks to people and road users who cooperated in responding to questionnaires and participating in the project's public relations activities. Their data and opinions played a vital role in ensuring the completeness of the study results and reflecting actual conditions.

The Office of Transport and Traffic Policy and Planning (OTP) sincerely hopes that relevant agencies and the public will beneficially utilize the data and findings derived from this study. They can use this document as a reference and practical guideline to collectively drive Thailand towards a low-carbon society and sustainably achieve the country's greenhouse gas reduction targets.

Office of Transport and Traffic Policy and Planning (OTP)

Ministry of Transport

December 30, 2025

Table of Contents

List of Figures

List of Tables

Global Warming: From Global Crisis to Thailand's Response Measures

The Problem: The Global Warming Crisis and Its Worldwide Impact

Global Warning Signs: Intensifying Severity Annually

The world is currently confronting various repercussions, such as rising sea levels, storms, floods, and wildfires. These serve as indicators that global warming is an urgent matter requiring immediate attention.

Thailand: The Crisis of Droughts and Floods

Thailand must contend with increasingly severe droughts and floods, which pose a significant threat to the national economy and the citizens' quality of life.

Solutions: From Global Cooperation to National Action

The Paris Agreement

This serves as an international framework for cooperation wherein all nations collectively implement measures to limit the rise in global temperatures.

Thailand's Awareness and Implementation of Solutions

In recognition of the global warming crisis, Thailand has established national guidelines for the reduction of greenhouse gas emissions to participate in addressing this critical issue.

Thailand's Greenhouse Gas Reduction Goals

2015: The Start of Cooperation
The "Paris Agreement" was established at the COP21 conference in Paris, France, to cooperate on reducing global greenhouse gases.

2021: First Goal Announcement
At the COP26 conference in Glasgow, UK, Thailand announced its goal to reduce greenhouse gases by 30-40% (167–222 $MtCO_2e$) by the year 2030.

2025: Raising the Goal
At the upcoming COP30 conference in Belém, Brazil, Thailand plans to adjust its Net Zero Greenhouse Gas target to be reached sooner, by 2050. This falls under Thailand's Second Nationally Determined Contribution (NDC 3.0).

2030: First Major Milestone
The target year to achieve the 30-40% reduction measures (166.5–222 $MtCO_2e$), reducing emissions from 555 $MtCO_2e$ down to 370.19 $MtCO_2e$.

2050: Net Zero Goal
The target year for Thailand to achieve Net Zero Greenhouse Gas Emissions.

What is NDC?

NDC stands for Nationally Determined Contributions.
It refers to the goals and obligations that each country announces to the United Nations regarding the reduction of greenhouse gas emissions. The goals shown in the timeline above represent Thailand's NDCs.

The Important Role of the Transport Sector

The transport sector accounts for 34% of national greenhouse gas emissions, or 81.6 $MtCO_2e$, in 2023.

The Ministry of Transport is responsible for reducing 8.2% of total emission reduction targets, or 45.61 $MtCO_2e$, by 2030.

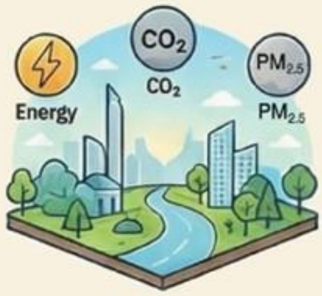
Key mechanisms towards the goal of transitioning vehicles to be environmentally friendly, and promoting public transport systems are the core essentials.

To achieve these goals, the Office of Transport and Traffic Policy and Planning (OTP) has conducted the "Study on Baseline Data Preparation and Tracking of Greenhouse Gas Emission Reduction from Vehicle Energy Efficiency Improvement Measures"

Objectives

(1) Establish baseline data

(2) Develop Monitoring, Reporting, and Verification (MRV) system



(3) Analyze and assess results of energy use reduction for GHG and $PM_{2.5}$

Scope of Work

Review data and policy reports on relevant indicators

Survey data and vehicle types

Apply Bottom-Up calculation approach for analysis and assessment

Develop tools and guidelines for assessing energy use and GHG reduction

Methodology for Energy Use and Greenhouse Gas (GHG) Emissions Assessment

This study uses a Bottom-up approach to analyze and evaluate energy use reduction and greenhouse gas mitigation in the transport sector. The analysis is divided into passenger transport and freight transport, using the ASIF framework to calculate greenhouse gas emissions (GHG Emission Estimation = A × S × I × F).

GHG Emission Estimation	=	Activity (A)	X	Modal Share (S)	X	Energy Intensity (I)	X	Carbon Intensity (F)
		Transport Performance (VKT, pkm, tkm) or vehicle-km		Modal-split of passenger and freight transport		The energy demand by mode and by fuel per pkm, tkm or Vkm		The carbon intensity per unit of energy demand by fuel

ASIF: Key Framework for Tracking Greenhouse Gas Reduction in the Transport Sector

A - Activity

- Number of vehicles
- Volume of freight and passenger transport
- Average travel distance

S-Share

- Share of different activities, such as:
  Share of vehicle types
  Share of fuel types used

Baseline Data

Used as the starting point for tracking and evaluating greenhouse gas reduction in the transport sector.

I - Intensity

- Data on energy efficiency improvements, such as: Fuel consumption rates of different vehicle types

F - Factor

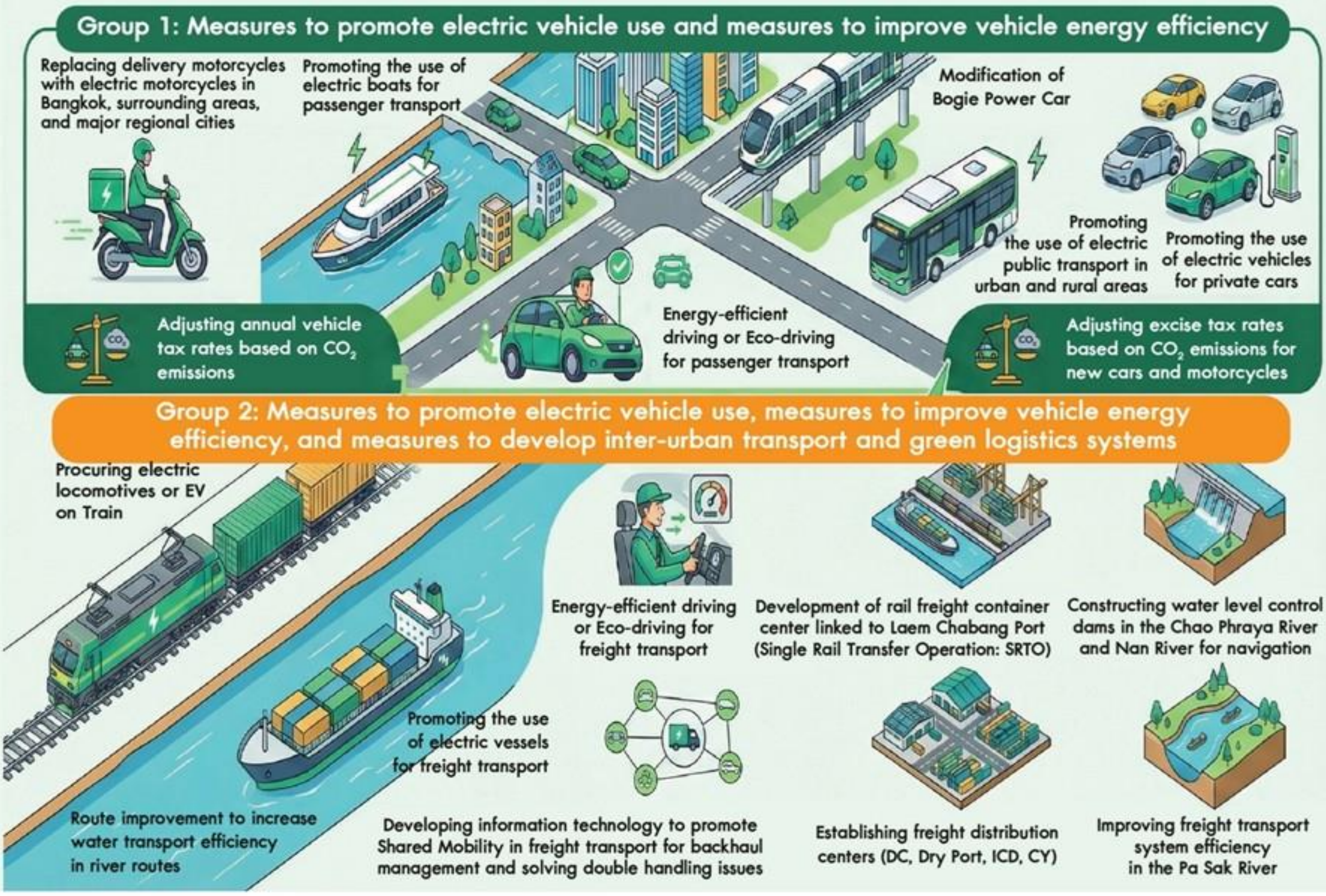
- Emission factors based on IPCC (Intergovernmental Panel on Climate Change) standard guidelines

Data Sources
Data collected from transportation surveys and various agencies, such as the Department of Land Transport, State Railway of Thailand, Marine Department, and Airports of Thailand Public Company Limited.

Practical Outputs
Development of assessment guidelines and calculation tools in Excel Spreadsheet format to enable agencies to monitor results independently.

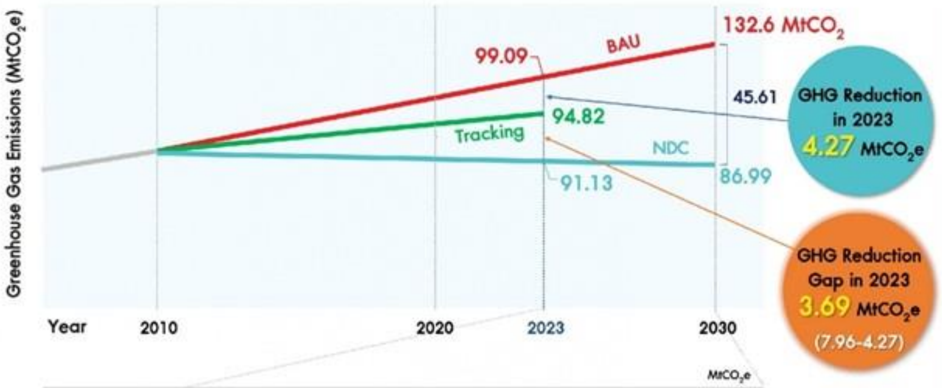
Scope of Measures Assessed in the Study

The assessment of greenhouse gas emission reduction covers implementation under 2 groups of measures:



Summary of Greenhouse Gas Reduction Assessment Under the Study Measures as of 2023

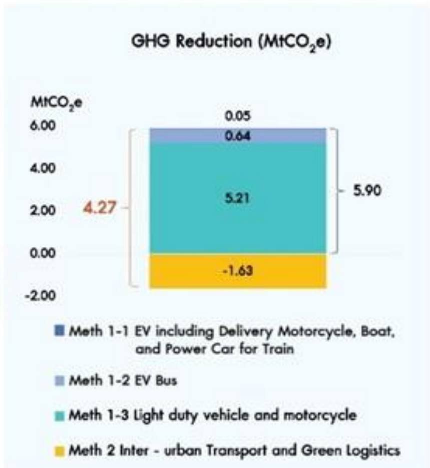
Greenhouse Gas Emission Trends 2010 - 2030



$MtCO_2e$

	2023	2024	2025	2026	2027	2028	2029	2030
BAU	99.09	103.43	107.17	111.78	116.58	121.60	126.82	132.60
Tracking	94.82							
NDC	91.13	90.57	89.20	89.33	89.17	88.80	88.27	86.99

Greenhouse Gas Reduction Results by Measure as of 2023



Assessment results in 2023 found that greenhouse gas emissions were reduced by 4.27 $MtCO_2e$ from the expansion of personal electric vehicles (Measure Group 1).
However, when compared to the NDC target, an additional reduction of 3.69 $MtCO_2e$ is still required.

Assessment Results of Greenhouse Gas Reduction in 2023

Scope of measures assessed under the study covers measures in 2 measure groups:

5.90 $MtCO_2e$
(Results from Measure Group 1)

–

1.63 $MtCO_2e$
(Results from Measure Group 2)

=

4.27 $MtCO_2e$
(Net Reduction)

Measure Group 1 : Promotion of Electric Vehicles and Improved Energy Efficiency (Reduced 5.90 $MtCO_2e$)

Measures promoting personal electric vehicles (Measure Groups 1-3)

- Highest energy efficiency
  Reduced greenhouse gas emissions: 5.21 $MtCO_2e$

Promotion of electric public buses (Measure Groups 1-2)

- Reduced greenhouse gas emissions: 0.64 $MtCO_2e$

Promotion of motorcycles using cleaner fuels such as LPG or electricity (Measure Groups 1-1)

- Reduced greenhouse gas emissions: 0.05 $MtCO_2e$

Overall in 2023, greenhouse gas emissions were reduced by 4.27 $MtCO_2e$ from personal electric vehicles. However, the freight and logistics sector continues to face challenges, leading to an upward trend in emissions.

Measure Group 2: Development of Inter-Urban Transport System and Logistics (Increased 1.63 $MtCO_2e$)

Greenhouse gas emissions increased by **1.63 $MtCO_2e$**

Why are greenhouse gas emissions increasing ? (In the Freight Transport Sector)

The main cause is the increase in Vehicle Kilometers Traveled (VKT) in freight transport, which continues to rise in line with economic growth.

Meanwhile, the trucking business is not willing to upgrade their current vehicles to more energy-efficient ones.

The electric truck business is not yet ready for commercial use due to limitations in driving range and infrastructure.

The electric truck business is not yet ready for commercial use due to limitations in driving range and infrastructure.

Example Measures (That Face Challenges in the Freight Transport Sector)

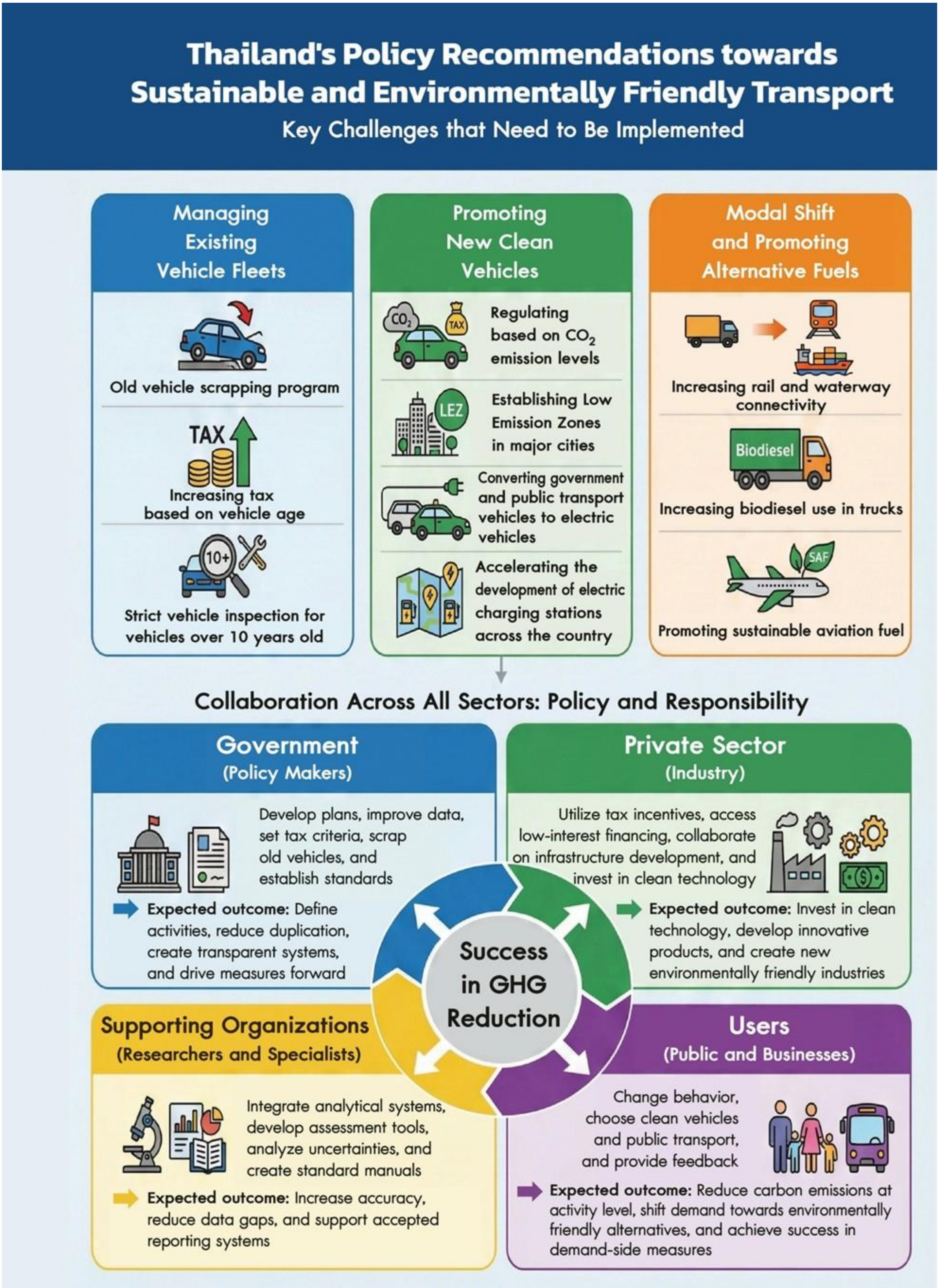
- Measures to promote commercial electric vehicles
- Measures to shift freight transport modes

Other Supporting Measure Groups

Development of Andaman Coastal Ports (Measure Group 3) Reduced greenhouse gas emissions: 0.01 $MtCO_2e$

Construction of Runways 3 and 4 at Suvarnabhumi Airport (Measure Group 4) Reduced greenhouse gas emissions: 0.04 $MtCO_2e$

Improving Equipment Efficiency at Laem Chabang Port (Measure Group 5) Reduced greenhouse gas emissions: 0.01 $MtCO_2e$


Thailand's Policy Recommendations towards Sustainable and Environmentally Friendly Transport
Key Challenges that Need to Be Implemented
Managing Existing Vehicle Fleets
Old vehicle scrapping program
TAX
Increasing tax based on vehicle age
10+
Strict vehicle inspection for vehicles over 10 years old
Promoting New Clean Vehicles
CO_2
TAX
Regulating based on CO_2 emission levels
LEZ
Establishing Low Emission Zones in major cities
Converting government and public transport vehicles to electric vehicles
Accelerating the development of electric charging stations across the country
Modal Shift and Promoting Alternative Fuels
Increasing rail and waterway connectivity
Biodiesel
Increasing biodiesel use in trucks
SAF
Promoting sustainable aviation fuel
Collaboration Across All Sectors: Policy and Responsibility
Government
(Policy Makers)
Develop plans, improve data, set tax criteria, scrap old vehicles, and establish standards
Expected outcome: Define activities, reduce duplication, create transparent systems, and drive measures forward
Private Sector
(Industry)
Utilize tax incentives, access low-interest financing, collaborate on infrastructure development, and invest in clean technology
Expected outcome: Invest in clean technology, develop innovative products, and create new environmentally friendly industries
Success in GHG Reduction
Supporting Organizations
(Researchers and Specialists)
Integrate analytical systems, develop assessment tools, analyze uncertainties, and create standard manuals
Expected outcome: Increase accuracy, reduce data gaps, and support accepted reporting systems
Users
(Public and Businesses)
Change behavior, choose clean vehicles and public transport, and provide feedback
Expected outcome: Reduce carbon emissions at activity level, shift demand towards environmentally friendly alternatives, and achieve success in demand-side measures

Introduction

1. PRINCIPLES AND RATIONALE

Thailand's Nationally Determined Contribution (NDC) Action Plan on Greenhouse Gas Emission Reduction, 2021 - 2030 (Transport Sector)

The Cabinet, during its meeting on May 23, 2017, passed a resolution approving Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021 - 2030 (NDC Roadmap on Mitigation 2021 - 2030). This roadmap serves as a strategic framework to achieve the country's greenhouse gas emission reduction targets. Furthermore, the Cabinet assigned relevant ministries to develop sector-specific Action Plans on Greenhouse Gas Emission Reduction to ensure the fulfillment of the established goals.

Greenhouse Gas Emission Reduction Targets and Implementation

Ministry of Transport's Responsibility

The Ministry of Transport is responsible for a greenhouse gas emission reduction target of 31 million tonnes of carbon dioxide equivalent ($MtCO_2e$), which accounts for 30 percent of the national target.

Mitigation Potential

The Office of Transport and Traffic Policy and Planning (OTP) has developed the Thailand's Nationally Determined Contribution (NDC) Action Plan on Greenhouse Gas Emission Reduction, 2021 - 2030 (Transport Sector) and assessed the greenhouse gas (GHG) mitigation potential under the Action Plan, which is expected to reduce emissions by 35.42 million tonnes of carbon dioxide equivalent ($MtCO_2e$).

Thailand's Commitment from COP26

During the 26th United Nations Climate Change Conference (COP26) held in Glasgow, United Kingdom, on November 1, 2021, Thailand declared its commitment to enhancing its greenhouse gas emission reduction targets under the Nationally Determined Contribution (NDC). The target has been increased from 20 - 25 percent to 30 - 40 percent, equivalent to approximately 167 - 222 million tonnes of carbon dioxide equivalent (MtCO2e) by 2030.

Unconditional NDC

Domestic greenhouse gas reduction efforts of 30 percent

Conditional NDC

If the country receives support for greenhouse gas reduction from abroad, whether through financial support, technology transfer, capacity building from international cooperation, and appropriate mechanisms under the Convention, it could enhance its greenhouse gas reduction efforts to 40 percent.

Revision of Targets and Implementation Guidelines

Subsequently, the Thailand's 2nd Updated NDC Action Plan (2021 - 2030) revised the mitigation target for the transport sector to 45.61 $MtCO_2e$

- Subsequently, the Thailand's 2nd Updated NDC Action Plan (2021 - 2030) revised the mitigation target for the transport sector to 45.61 $MtCO_2e$. Therefore, to ensure that the Ministry of Transport achieves its designated mitigation targets and that Thailand fulfills its national commitments, it is essential to establish Baseline data, develop Measurement, Reporting, and Verification (MRV) systems, and assess the greenhouse gas emission reduction of activities and programs under the Action Plan on Greenhouse Gas Emission Reduction (2021 - 2030) for the Transport Sector. These efforts must integrate all relevant activities, plans, and projects in alignment with the Updated NDC Action Plan, reflecting the increased national ambition declared at COP26, which requires continuous implementation across all measures to ensure these objectives are fully met.

Alignment with National Policies and Plans

This study is aligned with:

- National Strategy (2018 - 2037)
- Master Plan under the National Strategy (2023 - 2037) (Revised Edition)
- The 13th National Economic and Social Development Plan (2023 - 2027)
- Thailand's Logistics Development Action Plan (2023 - 2027)
- 20-Year Transport System Development Strategy (2018 - 2037)
- Transport Action Plan (2023 - 2027)
- Sustainable Development Goals (SDGs)
- Key Government Policies
- Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021 - 2030 (NDC Roadmap on Mitigation 2021 - 2030)

In addition, this study aims to support the achievement of national targets for greenhouse gas emission reduction and to enhance climate change resilience, in accordance with the commitments declared by Thailand at COP26.

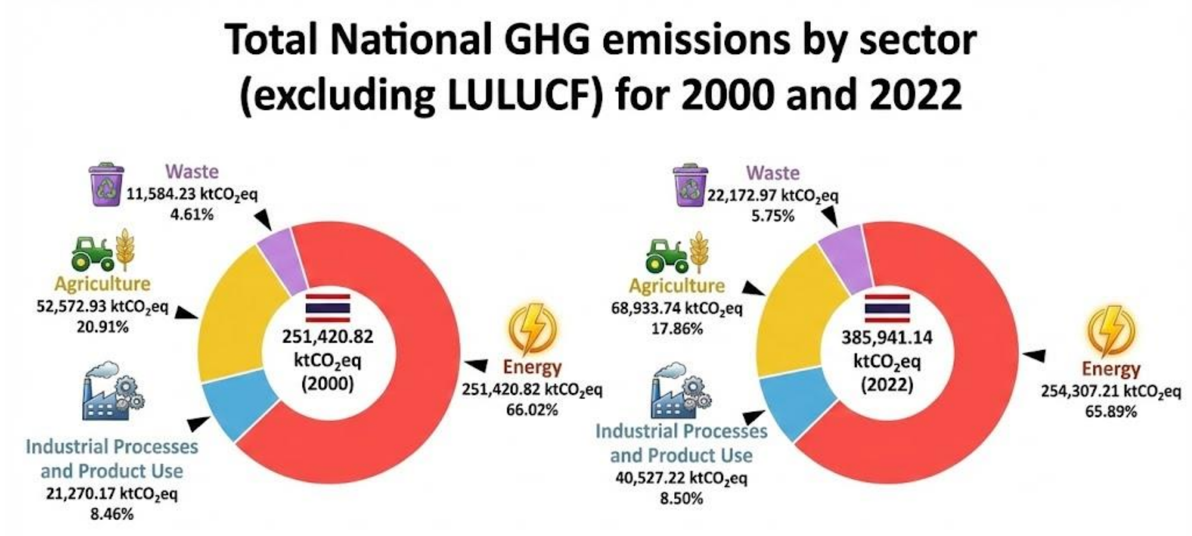
Thailand's Greenhouse Gas Emission Situation

According to Thailand's First Biennial Transparency Report (BTR1), the national greenhouse gas inventory reveals that:

> Total national greenhouse gas emissions (excluding Land Use, Land-Use Change, and Forestry: LULUCF) increased from **251,420.82 GgCO_2e** in 2000 to **385,941.14 GgCO_2e** in 2022.
>
> This represents an average annual growth rate of **1.97 percent**.

01	02	03
Net CO_2 Removal	**Net GHG Emissions**	**Average Growth Rate**
Net removal of CO2 increased from 45,321.86 GgCO_2e in 2000 to 107,901.43 GgCO_2e in 2022.	Consequently, Net GHG emissions increased from 206,098.92 GgCO_2e in 2000 to 278,039.71 GgCO_2e in 2022.	The average annual growth rate was **1.37 percent**, respectively.

Details are shown in **Figure 1**



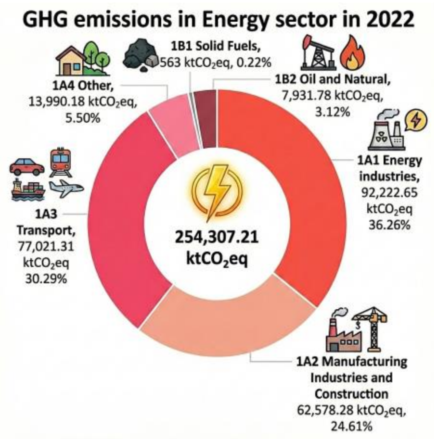
Source: Ministry of Natural Resources and Environment. (2024). Thailand's First Biennial Transparency Report: BTR1 (pp. 2-4). https://www.dcce.go.th/datacenter/2880/

Figure 1 Greenhouse Gas Emissions Inventory by Sector for Years 2000 and 2022 (Excluding Forestry and Land Use)

Thailand's Greenhouse Gas Mitigation: The Pivotal Role of the Transport Sector

Between 2000 and 2022, the primary source of greenhouse gas emissions in Thailand came from the Energy sector, which increased from 165,993.49 ktCO2e, representing 66.02 percent of total emissions in 2000, to 254,307.21 ktCO2e, declining slightly to 65.89 percent in 2022.

Most greenhouse gas emissions in the Energy sector resulted from fuel combustion, particularly in subsector 1A1 Energy Industries, which emitted approximately 92,222.65 ktCO2e, accounting for 36.26 percent of total energy sector emissions. Meanwhile, emissions from the Transport sector amounted to 77,021.31 ktCO2e, representing 30.29 percent, the Manufacturing Industries and Construction sector contributed 62,578.28 ktCO2e, or 24.61 percent, and Other Sectors accounted for 13,990.18 ktCO2e, or 5.50 percent, respectively. Details are shown in **Figure 2.**



Source: Ministry of Natural Resources and Environment. (2024). Thailand's First Biennial Transparency Report: BTR1 (pp. 2-15). https://www.dcce.go.th/datacenter/2880/

Figure 2 Greenhouse Gas Emissions Inventory for the Energy Sector for Years 2000 and 2022 (Excluding Forestry and Land Use))

Enhancement of Thailand's Greenhouse Gas Reduction Targets

From Thailand's commitment to addressing climate change at COP26 held in the United Kingdom in November 2021, Thailand announced a significant enhancement of its Nationally Determined Contribution (NDC) targets to the global community. By 2030, Thailand aims to increase its greenhouse gas reduction target from 20 - 25 percent to 30 - 40 percent from a business-as-usual baseline scenario. Given that Thailand's projected greenhouse gas emissions under business-as-usual conditions are estimated at approximately 555 million tons of carbon dioxide equivalent ($MtCO_2e$).

Therefore, to achieve this new and ambitious target, the country must increase its reduction efforts from the previous requirement of at least 111 $MtCO_2e$ to 167 - 222 $MtCO_2e$. The Cabinet approved Thailand's NDC Roadmap on Mitigation 2021-2030, which serves as the operational framework for achieving the country's NDC targets. The Cabinet assigned relevant ministries to develop action plans for reducing greenhouse gas emissions within their respective agencies.

Ministry of Transport

Responsible for reducing greenhouse gas emissions by 31 $MtCO_2e$

Representing 27 percent of the national greenhouse gas reduction potential

National Overall Potential

The NDC Roadmap has a combined potential to reduce greenhouse gas emissions by up to 115.6 $MtCO_2e$

Distribution by Sector

- Energy and Transport sectors: 113 $MtCO_2e$
- Waste Management sector: 2 $MtCO_2e$
- Industrial Processes sector: 0.6 $MtCO_2e$

The Critical Role of the Transport Sector and Greenhouse Gas Reduction Targets

Furthermore, the transport sector plays a crucial role in helping Thailand achieve its greenhouse gas reduction targets by 2030. The greenhouse gas reduction target for the transport sector has been revised upward from 31 $MtCO_2e$ to **"45.61 $MtCO_2e$"** through energy efficiency improvement measures in transportation (Figure 3). This will be accomplished through key measures including promotion of electric vehicles, improvement of energy efficiency, development of urban transportation systems, enhancement of intercity and freight transportation, as well as development of alternative energy sources and infrastructure, in order to lead toward sustainable development of the country.

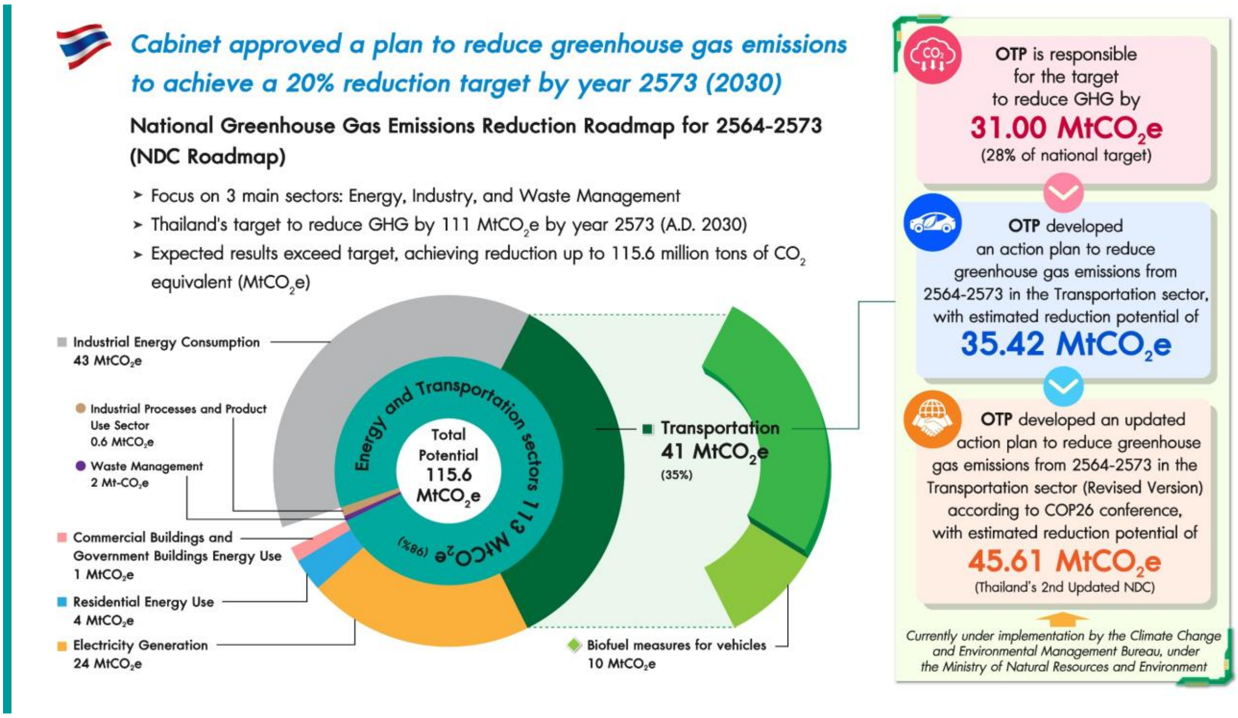
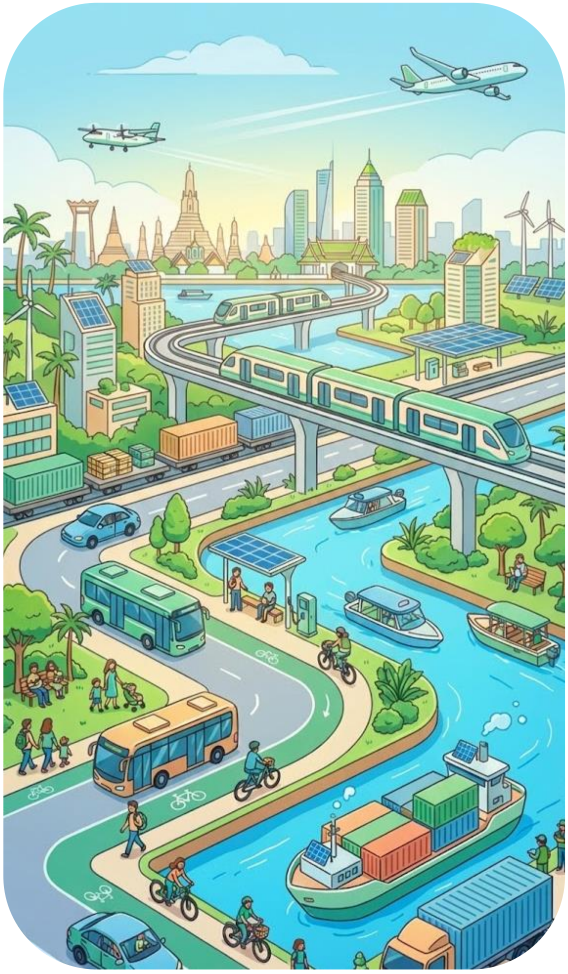


Figure 3 Thailand's NDC Roadmap on Mitigation 2021-2030
and Greenhouse Gas Reduction Target in the Transportation Sector

Summary of Principles and Rationale

The principles and rationale can be summarized as follows:

1. Thailand has set a goal to reduce greenhouse gas emissions as committed at COP26, aiming to reduce greenhouse gas emissions by 30-40 percent by 2030, equivalent to approximately 167-222 million tons of carbon dioxide equivalent.
2. The Cabinet approved Thailand's NDC Roadmap on Mitigation 2021-2030 to serve as the operational framework for achieving the aforementioned targets.
3. The Ministry of Transport has been assigned responsibility for reducing greenhouse gas emissions by 31 million tons of carbon dioxide equivalent, representing 30 percent of the national target.
4. The Office of Transportation and Traffic Policy and Planning (OTP) has developed an Action Plan for Reducing Greenhouse Gas Emissions in the Transportation Sector, which is estimated to achieve a reduction of 35.42 million tons of carbon dioxide equivalent.
5. Subsequently, the greenhouse gas reduction target for the transportation sector has been revised upward to 45.61 million tons of carbon dioxide equivalent.
6. To achieve the aforementioned targets, it is necessary to establish baseline data, conduct monitoring, reporting, and verification (MRV), and continuously assess the quantity of greenhouse gas emissions reduction from various activities and programs.
7. The transport sector is a significant source of greenhouse gas emissions, accounting for as high as 34 percent of total carbon dioxide emissions from energy use in 2023.
8. This initiative aligns with the country's national strategy and various development plans, including the Sustainable Development Goals.



- **Necessity of the Study:** This study was conducted to prepare analytical data and policy recommendations necessary for the Ministry of Transport's decision-making in determining the direction, measures, and implementation guidelines for greenhouse gas reduction in an efficient manner and in accordance with the national policy framework. Additionally, it supports Thailand in meeting its international commitments as expressed to the global community.

2. OBJECTIVES

Given the increasing trend of greenhouse gas emissions from Thailand's transportation sector and the country's challenging greenhouse gas reduction targets, there is a critical need for systematic implementation to achieve these goals. This project has three main objectives:

1. To establish baseline data for projects and programs in the group of measures for improving energy efficiency of vehicles and the group of measures for improving the efficiency of transportation and logistics systems.

2. To develop a system for monitoring, reporting, and verification (MRV) for projects and programs in the group of measures for improving energy efficiency of vehicles and the group of measures for improving the efficiency of transportation and logistics systems.

3. To analyze and assess the reduction in energy consumption, greenhouse gas emissions, and fine particulate matter (PM2.5) from projects and programs in the group of measures for improving energy efficiency of vehicles and the group of measures for improving the efficiency of transportation and logistics systems.

3. PROJECT RESULTS

The project results are as follows:

1. Comprehensive and accurate baseline data, including transportation data, transportation volumes by vehicle type, transportation modes and travel patterns, and the volume of greenhouse gas emissions from the transportation sector.

2. An efficient MRV (monitoring, reporting, and verification) system that can be used to track and accurately measure greenhouse gas emissions.

3. Policy recommendations and measures for the transportation and logistics sector to reduce environmental impact, reduce energy consumption, reduce greenhouse gas emissions, and reduce PM2.5 levels in the transportation sector.

4. STUDY PERIOD AND STUDY AREA

Study Period

The study period is 540 days from the date of contract signing

July 10, 2024 - December 31, 2025.

Study Area

The study area covers all of Thailand, focusing on analyzing and developing all forms of transportation systems to reduce energy consumption and greenhouse gas emissions. It comprises:

Land Transport

Main highways and secondary routes, mass transit systems in major cities, and road freight transport

Rail Transport

Main railway lines connecting regions, railway projects, and urban rail transit

Water Transport

Shipping routes, river transport, and major commercial ports

Air Transport

Airports and air cargo distribution centers

Multi-modal Transport Hubs

Integrated passenger stations and freight distribution and logistics centers

This comprehensive study covering all transport modes will promote the development of an integrated transport system that reduces energy consumption and greenhouse gas emissions efficiently, taking into account the connectivity between different transport modes to create a sustainable transport system that serves the needs of all sectors throughout the country.

- Furthermore, studies for each transport mode will be conducted with the development of Measurement, reporting, and verification (MRV) guidelines appropriate to each measure or project, enabling systematic tracking and assessment of energy consumption and greenhouse gas emission reductions. This information will be crucial for the continued development of sustainable transport and logistics policies.

5. PROJECT WORK PLAN, PROGRESS AND PROJECT MANAGEMENT

The work plan within the study scope has been divided into 6 work phases during the entire 540-day study period, as shown in **Figure 4.**

During the entire 540-day implementation period, the consultant has planned the work into 6 phases as follows:

- **Part 1:** Literature review, data collection, and review of related studies and operations (Days 1-90): Duration of 90 days
- **Part 2:** Baseline data establishment and data survey (Days 31-240): Duration of 210 days, comprising:
    - Baseline data establishment for assessing greenhouse gas reduction in the transport sector (2.1): 30 days
    - Survey for collecting vehicle stock (VS) data nationwide and average travel distance (Vehicle Kilometers of Travel: VKT) data for all vehicle types in the project, including road transport (2.2): 90 days
    - Survey and data collection on goods types, distances, and vehicle types, divided by six regions throughout the country—North, Northeast, Central, East, West, and South—including rail, water, and truck transport (2.3): 90 days
- **Part 3:** Analysis and assessment (Days 181-360): Duration of 180 days, comprising:
    - Analysis and assessment using relevant models to analyze vehicle energy consumption in the transport system under the group of measures for improving energy efficiency of transport and logistics systems (3.1): 60 days
    - Energy savings calculated before and after implementation of vehicle energy efficiency measures and transport and logistics system efficiency improvement measures (3.2): 60 days
    - Analysis and assessment of energy consumption, greenhouse gas emissions, and fine particulate matter ($PM_{2.5}$) reduction from changes in freight transport modes according to the country's main production standards, using goods type, distance, and vehicle type data divided by regions for rail, water, and truck transport obtained from surveys and data from other relevant sources (3.3): 60 days
- **Part 4:** Development of assessment guidelines for energy consumption, greenhouse gas emissions, and fine particulate matter ($PM_{2.5}$) reduction (Days 301-480): Duration of 180 days. This phase analyzes the potential for energy consumption reduction and assesses the effectiveness of greenhouse gas emissions and $PM_{2.5}$ reduction from projects and programs in the group of measures for improving vehicle energy efficiency and the group of measures for improving transport and logistics system efficiency, using a monitoring, reporting and verification (MRV) system.
- **Part 5:** Tracking of energy efficiency performance, greenhouse gas emissions reduction, and PM2.5 reduction (Days 391-540): Duration of 150 days
- **Part 6:** Meetings, training, seminars, and public relations (Days 1-540): Throughout the entire project period, as detailed in **Figure 4.**

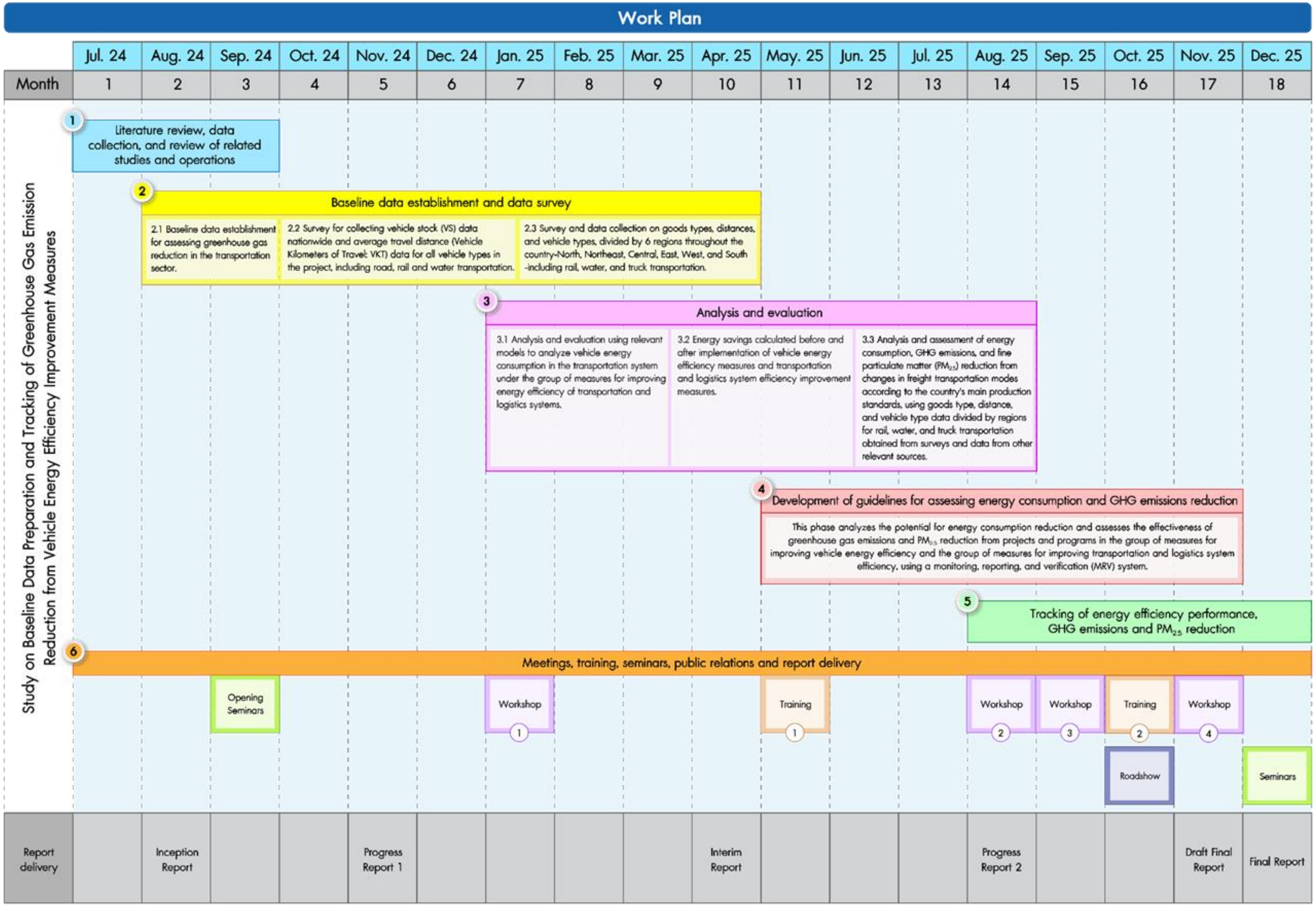


Figure 4 Project Work Plan

Chapter 1
Literature Review, Data Collection, and Review of Related Studies and Operations

The study for establishing baseline data and tracking greenhouse gas reduction from vehicle energy efficiency improvement measures aligns with various policies and programs, such as the National Strategy (2018 - 2037), the Master Plan under the National Strategy (2023 - 2037) (Amended Version), the 13th National Economic and Social Development Plan (2023 - 2027), the Action Plan for Developing Thailand's Logistics System 2023-2027, the 20-Year Transport System Development Strategy (2018-2037), Thailand's NDC Roadmap on Mitigation 2021 - 2030, Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS) (Revised Version), the 2nd Updated Nationally Determined Contribution (2nd Updated NDC), the National Energy Plan, the Electric Vehicle Development Plan, and the Sustainable Development Goals (SDGs). Research reports, studies, manuals, guidelines, and related documents from both domestic and international sources, as well as relevant regulations, requirements, and/or laws are reviewed as follows:

1. Transport and Logistics Category

Related plans and policies include the National Strategy 2018 - 2037 (Strategic Issue 4.2.4) which promotes transport and logistics industries and services, the Master Plan under the National Strategy 2023 - 2037 (Issue 7), and the 13th National Economic and Social Development Plan which promotes logistics system development and enhances competitiveness, as well as the Action Plan for Developing Thailand's Logistics System 2023 - 2027 which promotes efficient and environmentally-friendly energy use in the logistics system.

2. Energy Category

Related plans and policies include the National Strategy 2018 - 2037 (Strategic Issue 4.5) which emphasizes energy security development and promotion of environmentally-friendly energy use, the Alternative Energy and New Energy Development Plan 2015 - 2036 which promotes electric vehicle (EV) use, the National Energy Plan, and the Electric Vehicle Development Plan which focus on reducing energy intensity and improving energy efficiency in the transport sector.

3. GHG and Environmental Category

Related plans and policies include Thailand's NDC Roadmap on Mitigation 2021-2030 and the Action Plan for Reducing Greenhouse Gas Emissions of Thailand in the Transport Sector 2021 - 2030, which focus on reducing greenhouse gas emissions from transport through energy efficiency improvement measures, as well as Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS) and the Nationally Determined Contribution (NDC) which aim to reduce greenhouse gas emissions and achieve carbon neutrality in the transport sector.

4. Fine Particulate Matter ($PM_{2.5}$) Category

Related plans and policies include the Action Plan for Reducing Greenhouse Gas Emissions of Thailand in the Transport Sector 2021 - 2030, which identifies the potential for $PM_{2.5}$ reduction in the transport sector.

Summary of Relevant Plans, Policies, Guidelines and Laws Aligned with the Project Study

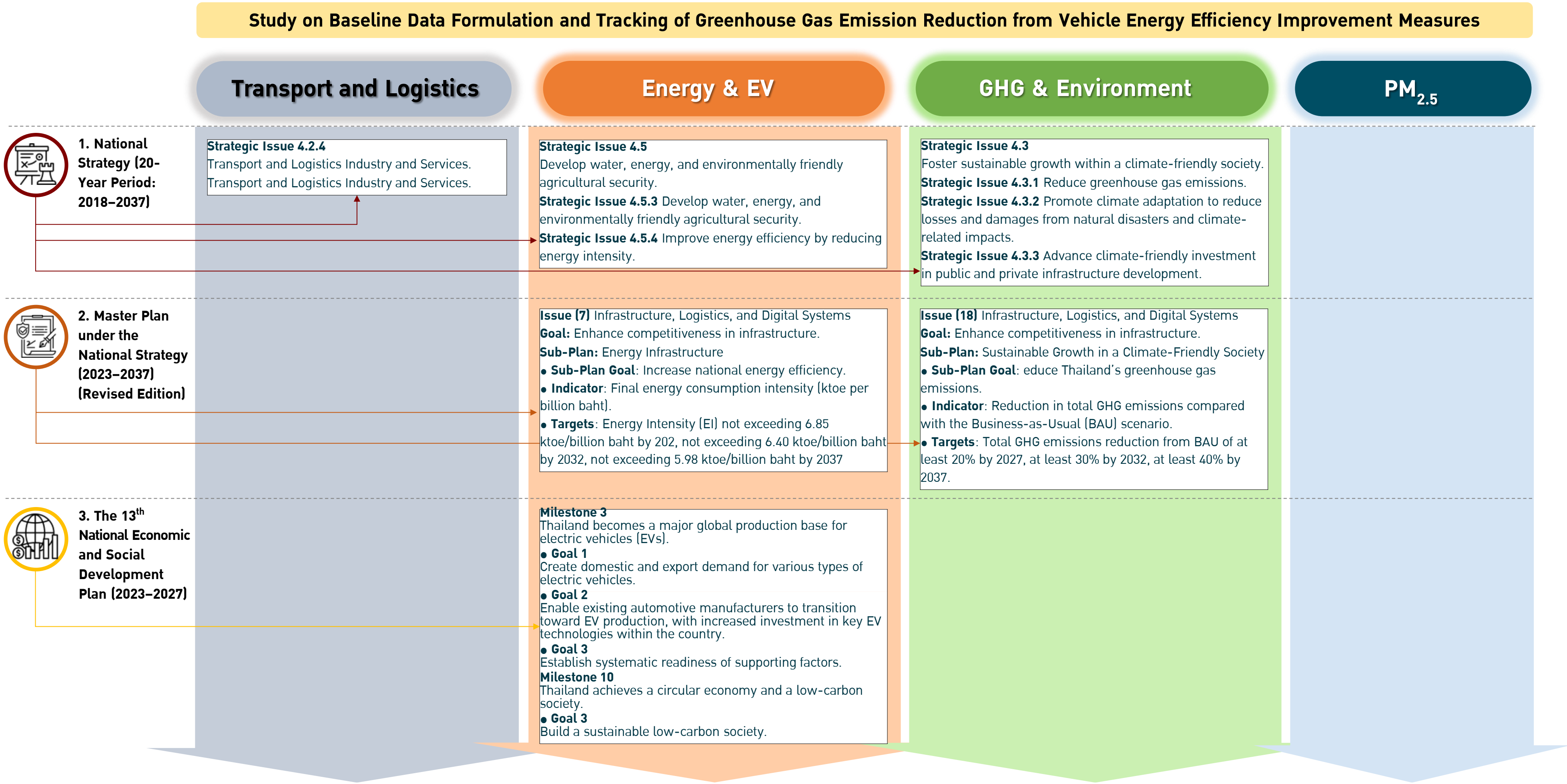


Figure 5 Linkage Between Level 1 and Level 2 Plans Aligned with the Study for Baseline Data Establishment and Tracking of Greenhouse Gas Reduction from Vehicle Energy Efficiency Improvement Measures and Policies

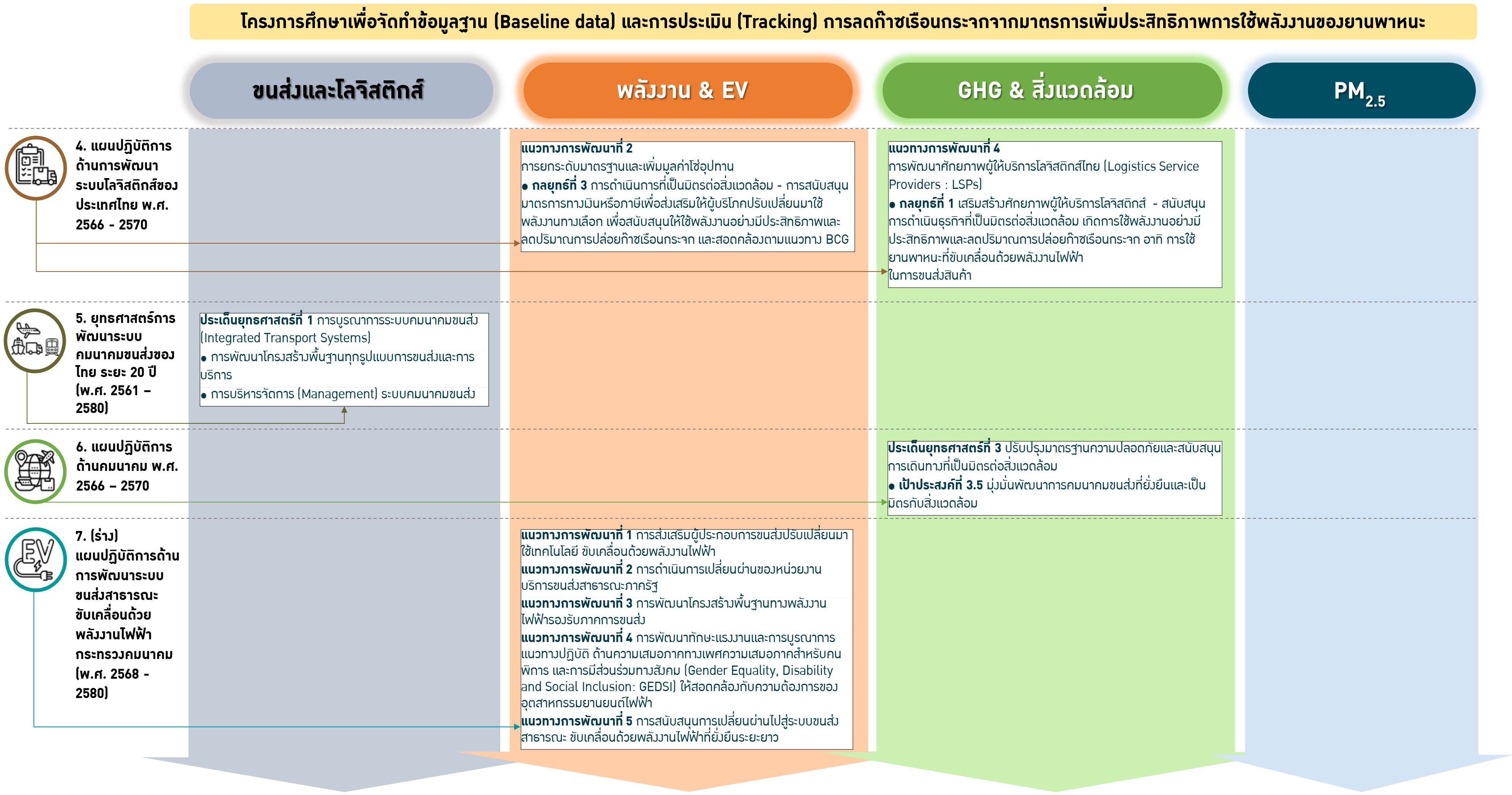


Figure 6 Linkage Between Level 3 Plans Aligned with the Study for Baseline Data Establishment and Tracking of Greenhouse Gas Reduction from Vehicle Energy Efficiency Improvement Measures and Policies

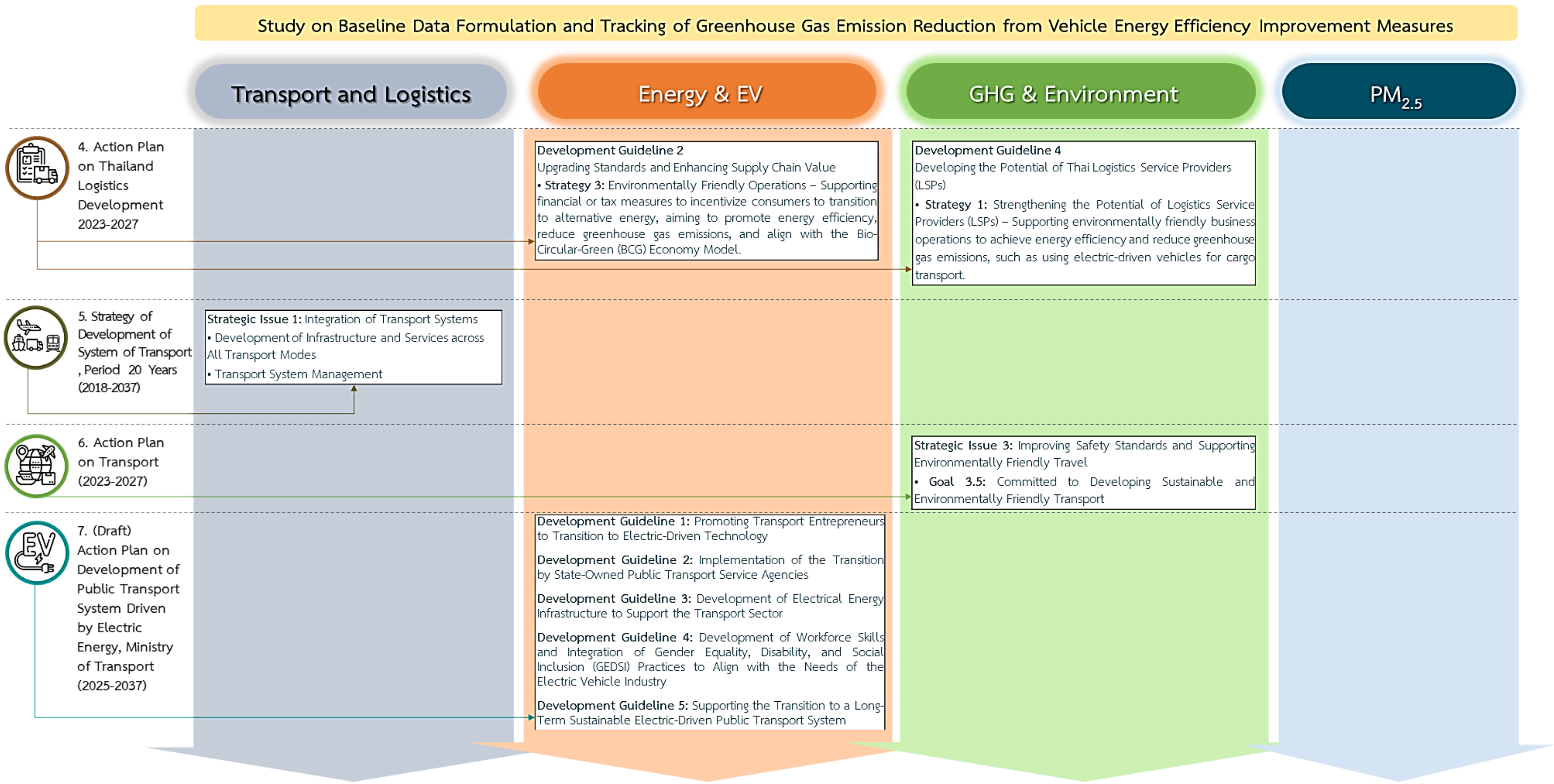


Figure 6 Linkage Between Level 3 Plans Aligned with the Study for Baseline Data Establishment and Tracking of Greenhouse Gas Reduction from Vehicle Energy Efficiency Improvement Measures and Policies (Cont.)

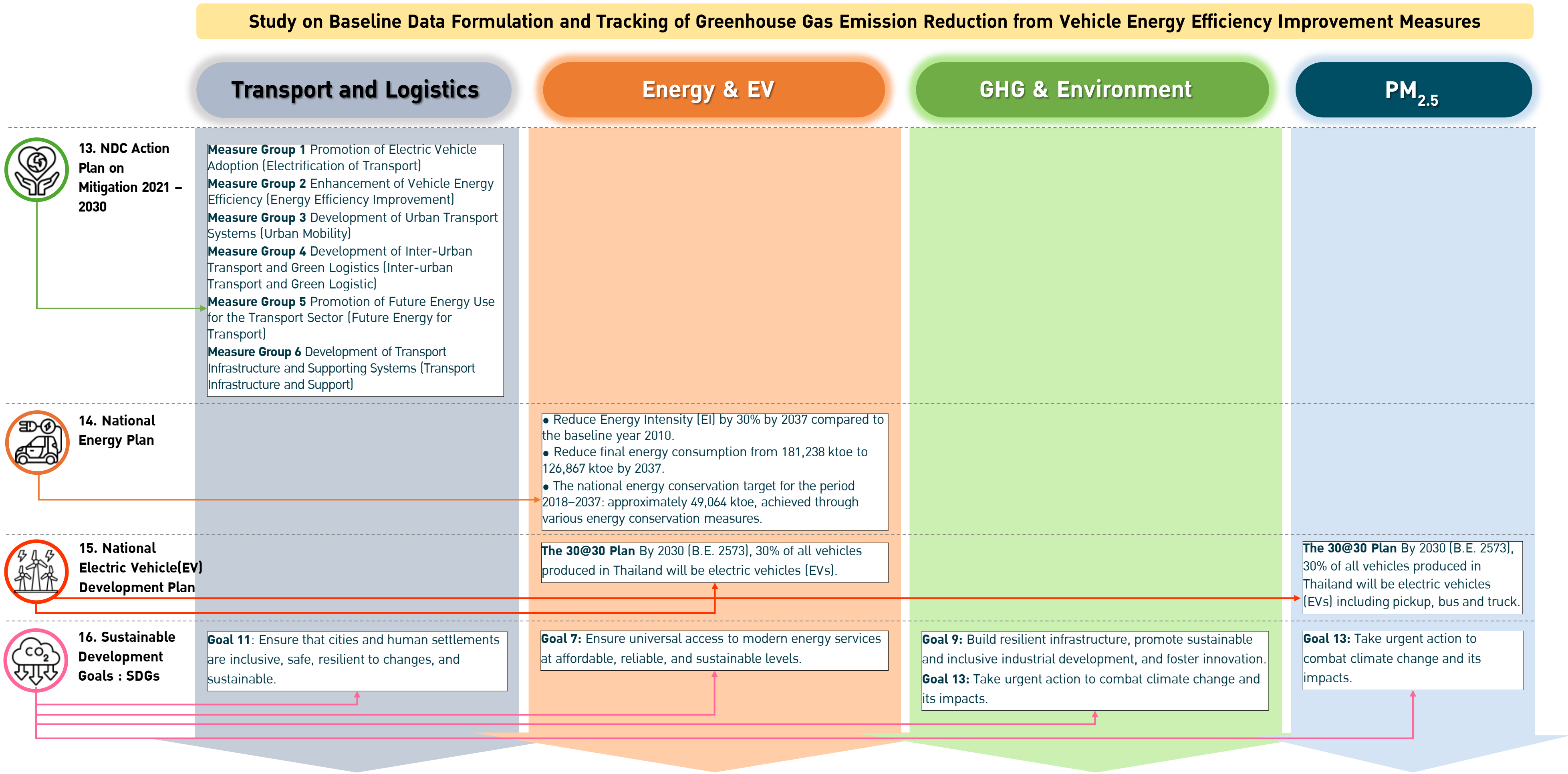


Figure 6 Linkage Between Level 3 Plans Aligned with the Study for Baseline Data Establishment and Tracking of Greenhouse Gas Reduction from Vehicle Energy Efficiency Improvement Measures and Policies (Cont.)

Linkage Between the Study and Review of Research Reports and Guidelines

In linking the project for establishing baseline data and tracking greenhouse gas reduction from vehicle energy efficiency improvement measures with the review of research reports and various guidelines, as illustrated in **Figure 7**, the linkage can be divided into four main areas: Energy and EV, GHG and Environment, PM2.5, and MRV methodology.

1 Energy and EV Category

Energy-related reports such as IEA Energy Efficiency Reports (2020-2023) and European Commission Guidelines on Energy Efficiency will be linked to the study of energy efficiency in transportation systems, such as reduced energy consumption from the use of electric vehicles and energy efficiency improvement measures in the transport sector's energy network.

2 GHG and Environmental Category

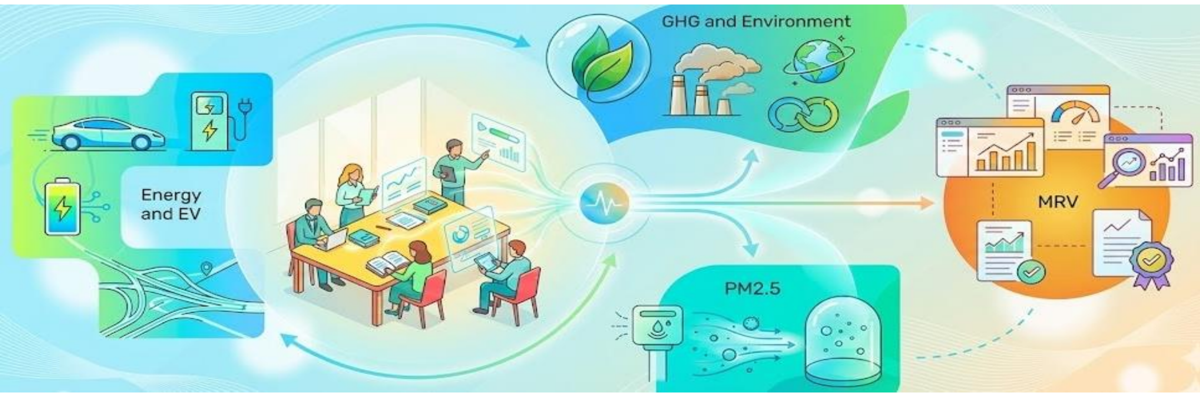
Reports on the EU Strategy on Sustainable and Smart Mobility and Green Economy assessment in the transport sector (Greening the Blue Economy) will assist in assessing the impact of greenhouse gas emission reduction from improved energy efficiency in the transport sector, along with measures to promote environmental sustainability.

3 $PM_{2.5}$ Category

Focus is placed on assessing the impact of pollution emissions from vehicles, such as fine particulate matter ($PM_{2.5}$) emissions. While there are no research reports directly related in **Figures 9**, they can be linked to the adoption of EV technology and the reduction of fossil fuel consumption.

4 MRV Methodology Category (Measurement, Reporting, and Verification)

Reports such as EPA Guidebook for Energy Efficiency, UNFCCC guidelines on preparation for the enhanced transparency framework of the UNFCCC, and UN Habitat MRV guidelines will serve as guidance for verification, assessment, and reporting of greenhouse gas emission reduction, which is important for tracking and confirming the results of vehicle energy efficiency improvement measures.



Linkage Between Legal Issues, Announcements , and Acts and the Project

The project for establishing baseline data and tracking greenhouse gas reduction from vehicle energy efficiency improvement measures aligns with various laws, announcements, and acts, as illustrated in **Figure 8**, as follows:

Transport and Logistics Category

The relevant law and regulation aligned with the project is the Land Traffic Act, B.E. 2522 (1979), which is the primary law controlling the registration and operation of vehicles. This is linked to the establishment of baseline data to assess the types and quantities of vehicles in the transport and logistics system.

Energy and EV Category

The relevant laws and regulations aligned with the project are the Energy Conservation Promotion Act, B.E. 2550 (2007) and the announcements of the Ministry of Energy in 2023 regarding the promotion and control of electric vehicle use, which are laws and measures supporting the use of clean energy in the transport system.

Additionally, there are related announcements including the Customs Department Announcement No. 97/2566 on criteria and procedures for customs duty exemption for electric vehicle components or battery-powered vessels (announced on June 16, 2023) and the Ministerial Regulation Determining Excise Tax Rates (No. 23), B.E. 2565 (2022), related to the reduction of energy consumption from fossil fuels, which will be linked to the analysis of greenhouse gas reduction in this project.

GHG and Environmental Category

The relevant laws and regulations aligned with the project are the National Environmental Quality Promotion and Conservation Act, B.E. 2535 (1992) and the Public Health Act, B.E. 2535 (1992), which are laws supporting pollution reduction and environmental quality improvement. Additionally, there are acts and royal decrees linked to assessing greenhouse gas emission reduction from energy efficiency improvement measures in vehicles, including:

- Draft Climate Change Act, B.E. [year to be determined]
- Royal Decree Providing Exemptions from Taxation Under the Tax Code (No. 514), B.E. 2554 (2011)
- Royal Decree Providing Exemptions from Taxation Under the Tax Code (No. 760), B.E. 2566 (2023)

PM2.5 Category

The relevant laws and regulations aligned with the project are the Land Traffic Act, B.E. 2522 (1979) and announcements from the National Environmental Quality Commission, B.E. 2565 (2022), regarding air quality standards, which will be linked to the tracking and assessment of PM2.5 pollution emissions from vehicles, as well as the Draft Clean Air Management Act, B.E. [year to be determined].

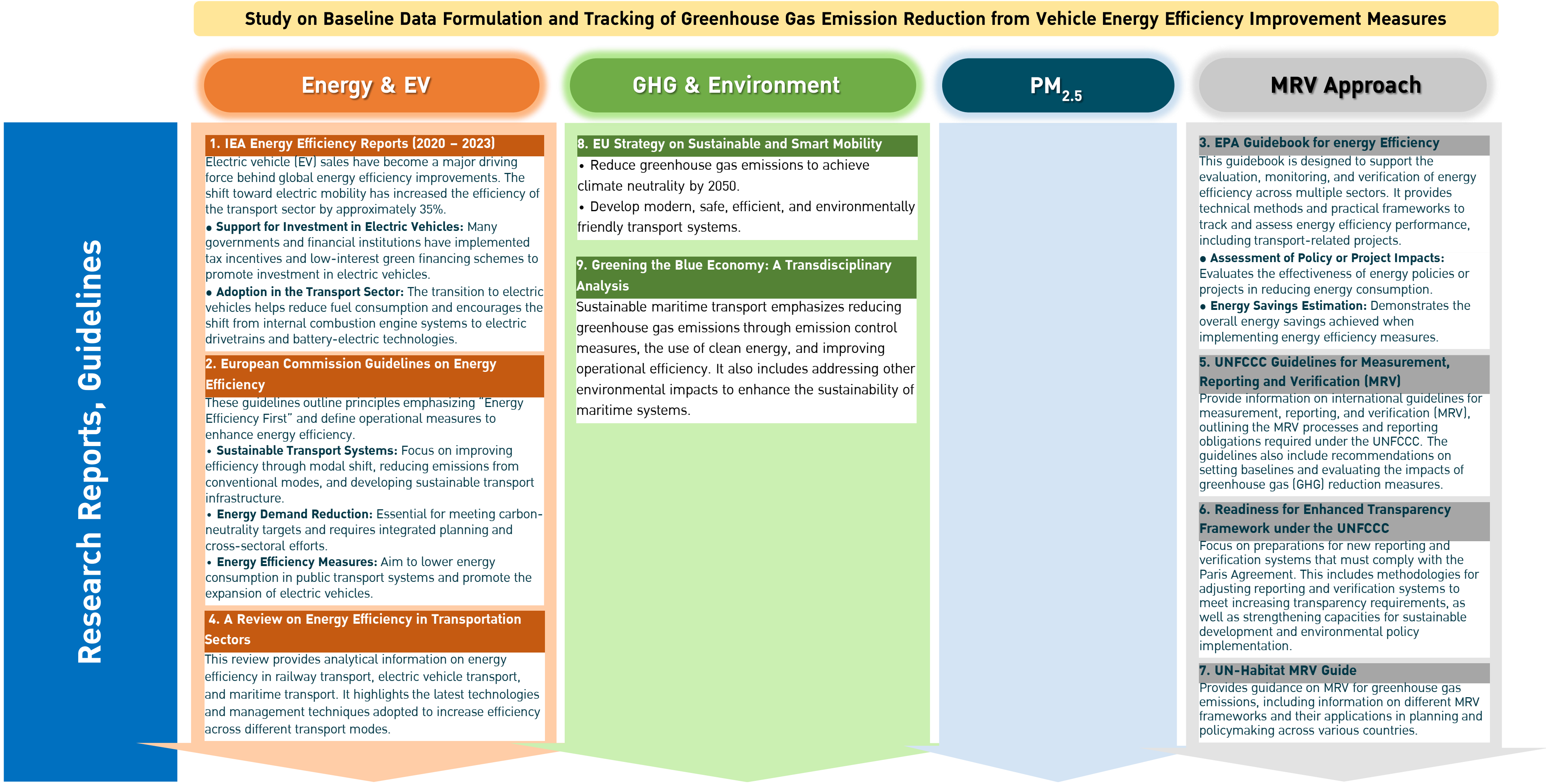


Figure 7 Linkage Between Research Reports and Guidelines and the Project for Baseline Data Establishment and Tracking of Greenhouse Gas Reduction from Vehicle Energy Efficiency Improvement Measures

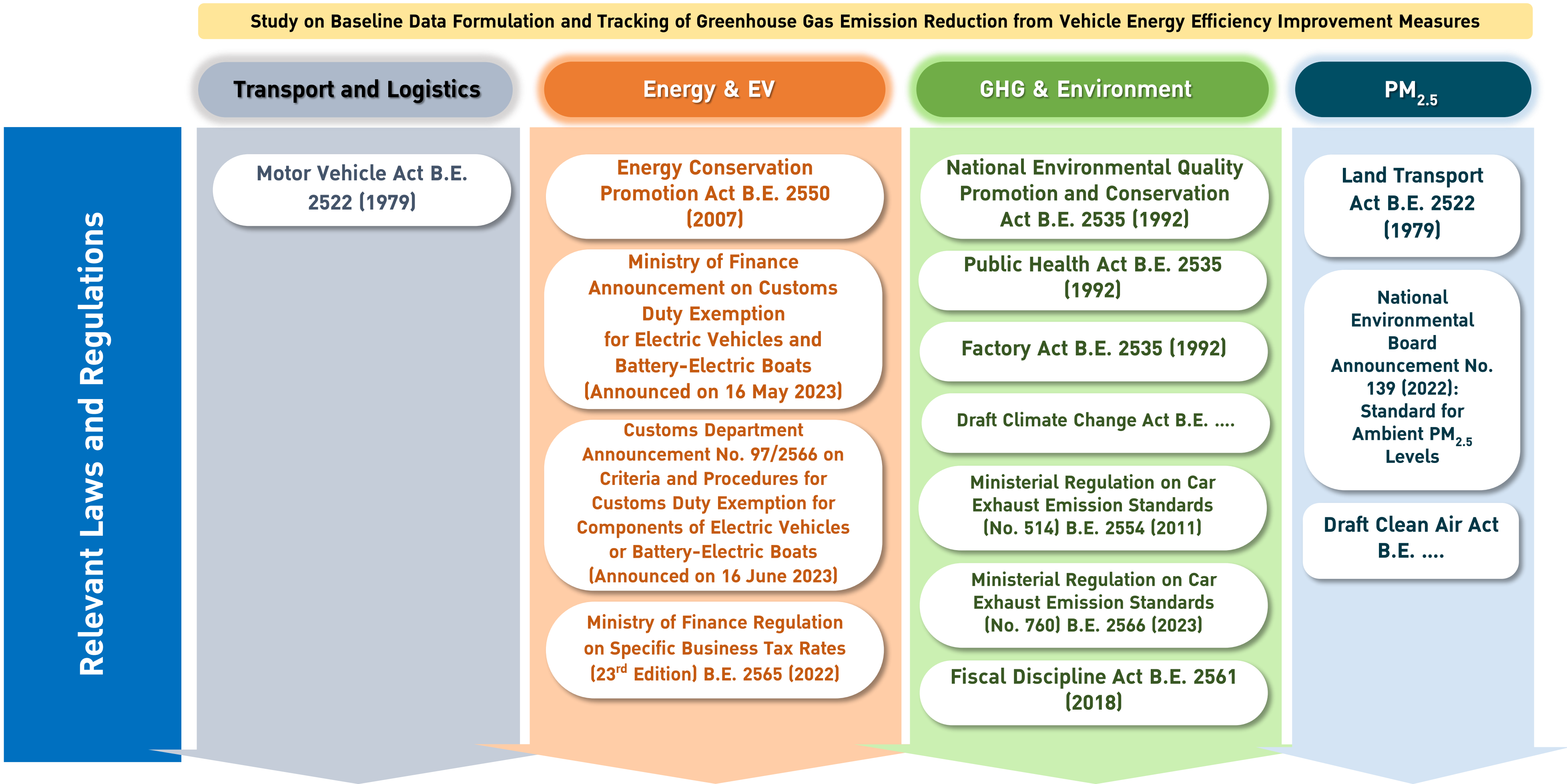


Figure 8 Linkage Between Legal Issues, Announcements, and Acts and the Project for Baseline Data Establishment and Tracking of Greenhouse Gas Reduction from Vehicle Energy Efficiency Improvement Measures

Chapter 2
Baseline Data Establishment and Data Survey

2.1 Data Survey For Information Collection

The data survey plan for this study divided the survey teams into 3 teams to conduct surveys on the number of vehicles (Vehicle Stock: VS) throughout the country and data on average travel distance (Vehicle Kilometers of Travel: VKT) for road vehicles, comprising:

Survey for Passenger Origin-Destination Data	Survey for Freight Transport Data	Survey for Freight Truck Origin-Destination
To collect origin-destination data (Origin-Destination Survey: OD) from road vehicle drivers	Followed by surveys and data collection on goods types, distances, and vehicle types for road vehicles	To collect origin-destination data (Origin-Destination Survey: OD) from freight truck drivers

Survey Areas

In the survey, the survey areas (Zones) were divided into four areas, as shown in **Figure 9**

Survey Team Assignment

Each team is stationed in each Zone at the respective survey points, as shown in **Table 1**

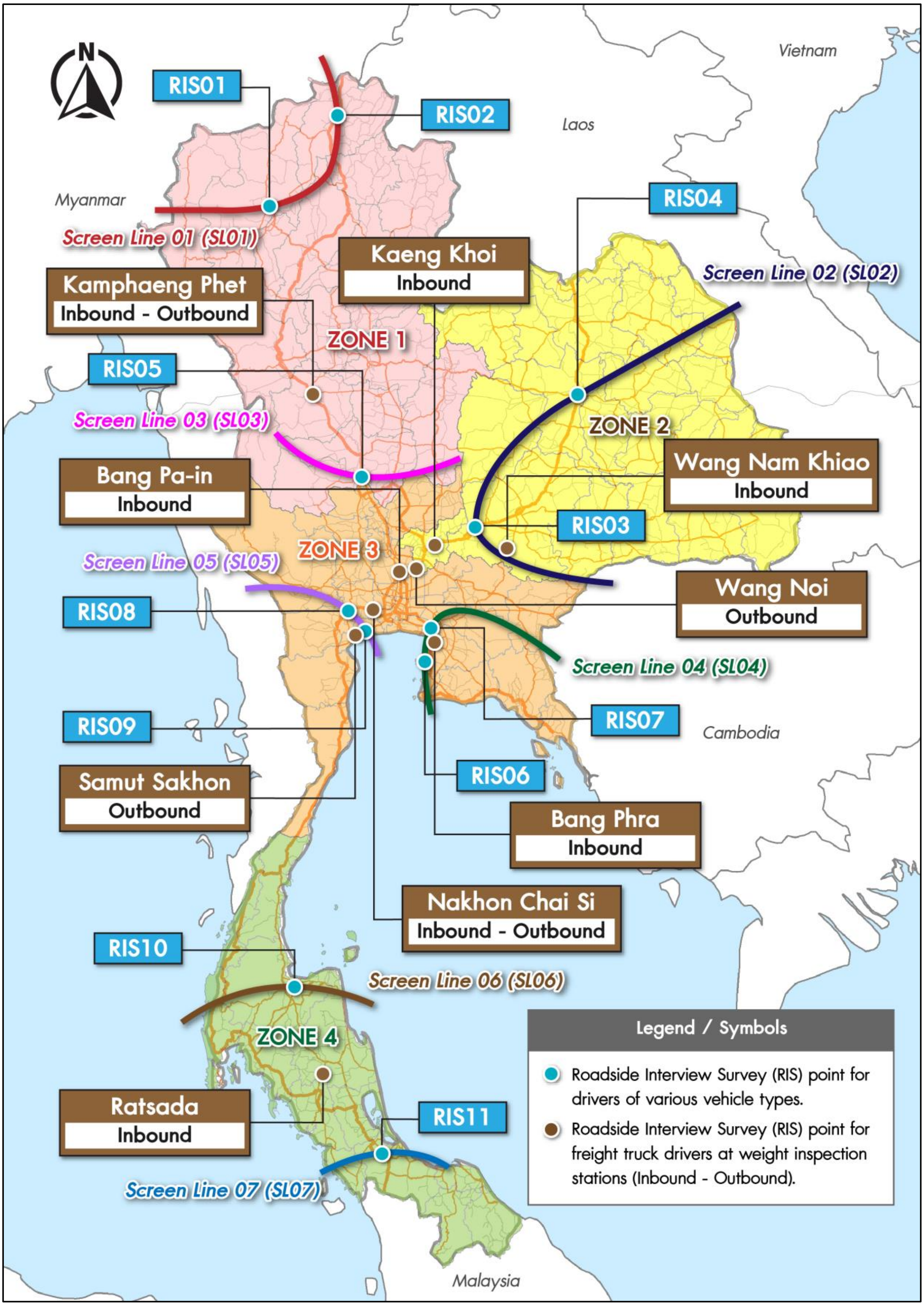


Figure 9 Map Showing Survey Points for Data Collection Divided by Survey Area (Zone)

Table 1 Details of Each Survey Team for Data Collection Divided by Survey Area (Zone)

Survey Team	Zone	Survey Point Details	Number of Survey Staff	Number of Samples
Team 1	Zone 1 (Northern Region)	MB01: Highway 1141 (Don Chian - Chiang Mai): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		MB02: Highway 1 (Mae Korn Junction - Huai Plu): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		MB05: Highway 1 (Hang Nai Nong Khaem - Ban Wha): 24 hours	30 people divided into 3 time periods (10 people per period)	-
		RIS01: Highway 1141 (Don Chian - Chiang Mai)	24 people divided into 2 time periods (12 people per period)	400
		RIS02: Highway 1 (Mae Korn Junction - Huai Plu)	24 people divided into 2 time periods (12 people per period)	400
		RIS05: Highway 1 (Hang Nai Nong Khaem - Ban Wha)	24 people divided into 2 time periods (12 people per period)	400
		RIS12: Weighing Station: Kamphaengphet (Entrance-Exit)	24 people divided into 2 time periods (12 people per period)	400
	Zone 2 (Northeastern Region)	MB03: Highway 2 (Bo Thong - Mueang): 24 hours	30 people divided into 3 time periods (10 people per period)	-
		MB04: Highway 2 (Khon Kaen - Hin Lad): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		RIS03: Highway 2 (Bo Thong - Mueang)	24 people divided into 2 time periods (12 people per period)	400
		RIS04: Highway 2 (Khon Kaen - Hin Lad)	24 people divided into 2 time periods (12 people per period)	400
		RIS13: Weighing Station: Wang Nai Khiao (Entrance)	24 people divided into 2 time periods (12 people per period)	400
		RIS14: Weighing Station: Kaeng Khoi (Entrance)	24 people divided into 2 time periods (12 people per period)	400
Team 2	Zone 3 (Central, Eastern, and Western Regions)	MB06: Highway 3 (Bo Thong - Mueang): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		MB07: Highway 7 (Phichit - Nong Khaeng Khok): 24 hours	30 people divided into 3 time periods (10 people per period)	-
		MB08: Highway 4 (Phra Pathom - Sa Kaew Khration): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		MB09: Highway 35 (Saphan Khaam Mae Nam Tha Chin West Bank - Na Khok): 24 hours	30 people divided into 3 time periods (10 people per period)	-
		RIS06: Highway 3 (Bo Thong - Mueang)	24 people divided into 2 time periods (12 people per period)	400
		RIS07: Highway 7 (Phichit - Nong Khaeng Khok)	24 people divided into 2 time periods (12 people per period)	400
		RIS08: Highway 4 (Phra Pathom - Sa Kaew Khration)	24 people divided into 2 time periods (12 people per period)	400
		RIS09: Highway 35 (Saphan Khaam Mae Nam Tha Chin West Bank - Na Khok)	24 people divided into 2 time periods (12 people per period)	400
		RIS15: Weighing Station: Bang Pa In (Entrance)	24 people divided into 2 time periods (12 people per period)	400
		RIS16: Weighing Station: Wang Noi (Exit)	24 people divided into 2 time periods (12 people per period)	400
		RIS17: Weighing Station: Bang Phra (Entrance)	24 people divided into 2 time periods (12 people per period)	400
		RIS18: Weighing Station: Nakhon Chai Si (Entrance-Exit)	24 people divided into 2 time periods (12 people per period)	400
		RIS19: Weighing Station: Samut Sakhon (Exit)	24 people divided into 2 time periods (12 people per period)	400
Team 3	Zone 4 (Southern Region)	MB10: Highway 420 (Suratthani Ring Road): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		MB11: Highway 4287 (Khuan Lang - Hat Yai): 14 hours	20 people divided into 2 time periods (10 people per period)	-
		RIS10: Highway 420 (Suratthani Ring Road)	24 people divided into 2 time periods (12 people per period)	400
		RIS11: Highway 4287 (Khuan Lang - Hat Yai)	24 people divided into 2 time periods (12 people per period)	400
		RIS20: Weighing Station: Ratchada (Entrance)	24 people divided into 2 time periods (12 people per period)	400
Total Number of Samples				8,000

2.2 Summary of Traffic Volume Survey Results by Vehicle Type

Based on the above survey results, an analysis of the overall national traffic volume was conducted, as shown in **Figure 10**. The key findings can be summarized as follows:

Proportion of Vehicle Types by Traffic Survey Locations on Road Sections (Mid-Block Survey: MB)

Traffic volume surveys conducted at mid-block locations in several provinces nationwide indicate that the composition of vehicles using road sections varies by area.

Overall Proportion of Vehicles Used for Travel (%)

Analysis of vehicle usage data shows that private passenger cars account for the largest share of total travel demand.

Average Number of Vehicles by Region (Vehicles)

When considering the average number of vehicles by region, it was found that each region exhibits distinct travel and vehicle usage characteristics.

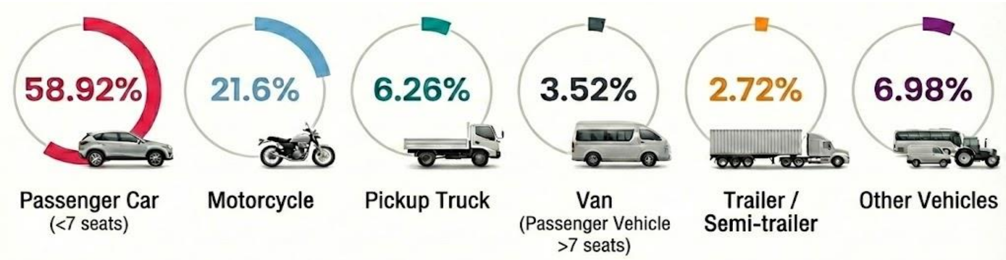
1) Proportion of Vehicle Types by Traffic Survey Locations on Road Sections (Mid-Block Survey: MB)

Traffic volume surveys conducted at mid-block locations across multiple provinces reveal that vehicle composition differs by region. In the eastern region, passenger cars with fewer than 7 seats account for a relatively high proportion, followed by the northern region, where both private passenger cars and motorcycles are widely used. In the southern region, motorcycles are the dominant mode of transport, reflecting urban characteristics with shorter travel distances.

In contrast, the eastern region—particularly provinces such as Chonburi—shows a higher proportion of trucks and trailers compared to other regions, as the area serves as a major industrial and freight transportation hub. Meanwhile, traffic in **the central and northeastern regions** is more diverse, especially in provinces such as Nakhon Ratchasima and Khon Kaen, where private passenger cars, trucks, and buses are commonly used for interprovincial travel.

2) Overall Proportion of Vehicles Used for Travel (%)

Analysis of the vehicle usage data indicates that travel by private passenger cars with fewer than 7 seats represents the largest share of total traffic volume, accounting for 58.92% of all surveyed vehicles.



Passenger Car (<7 seats)
Represent the highest proportion of the total surveyed traffic volume

Motorcycle
The most commonly used vehicles in small cities and areas with dense traffic

Pickup Truck
Used for freight transport and service activities

Van (Passenger Vehicle >7 seats)
Include buses and public passenger vans

Motorcycles represent the second largest share, accounting for 21.6%, as they are commonly used in small urban areas and locations with congested traffic conditions. Meanwhile, pickup trucks and passenger vehicles with more than 7 seats account for 6.26% and 3.52%, respectively.

- Large trucks (6-10 wheels), trailers, and semi-trailers each account for less than 5% of the total traffic volume, indicating that the overall road traffic composition remains primarily focused on personal travel rather than freight transportation.

3) Average Traffic Volume by Region (vehicles)

When considering the average vehicle volume by region, it was found that:

Eastern Region	Northern Region	Southern Region
The eastern region has the highest volume of passenger cars with fewer than 7 seats, particularly at survey locations in Chonburi Province, where the number of passenger cars exceeds 36,000 vehicles per hour.	In the northern region, particularly at survey locations in Chiang Mai Province, the number of passenger cars exceeds 28,000 vehicles per hour, and motorcycle usage is also found to be high.	The southern region has a higher level of motorcycle usage than other regions. At survey locations in Songkhla and Surat Thani Provinces, motorcycle volumes exceed 24,000 vehicles per hour.

Freight Transport

Pickup trucks and other freight vehicles record relatively high traffic volumes at survey locations in Nakhon Pathom, Chonburi, and Nakhon Sawan Provinces, as these corridors serve as major freight transport routes to other regions and function as regional logistics and freight distribution centers.

Study on Baseline Data Formulation and Tracking of Greenhouse Gas
Emission Reduction from Vehicle Energy Efficiency Improvement Measures

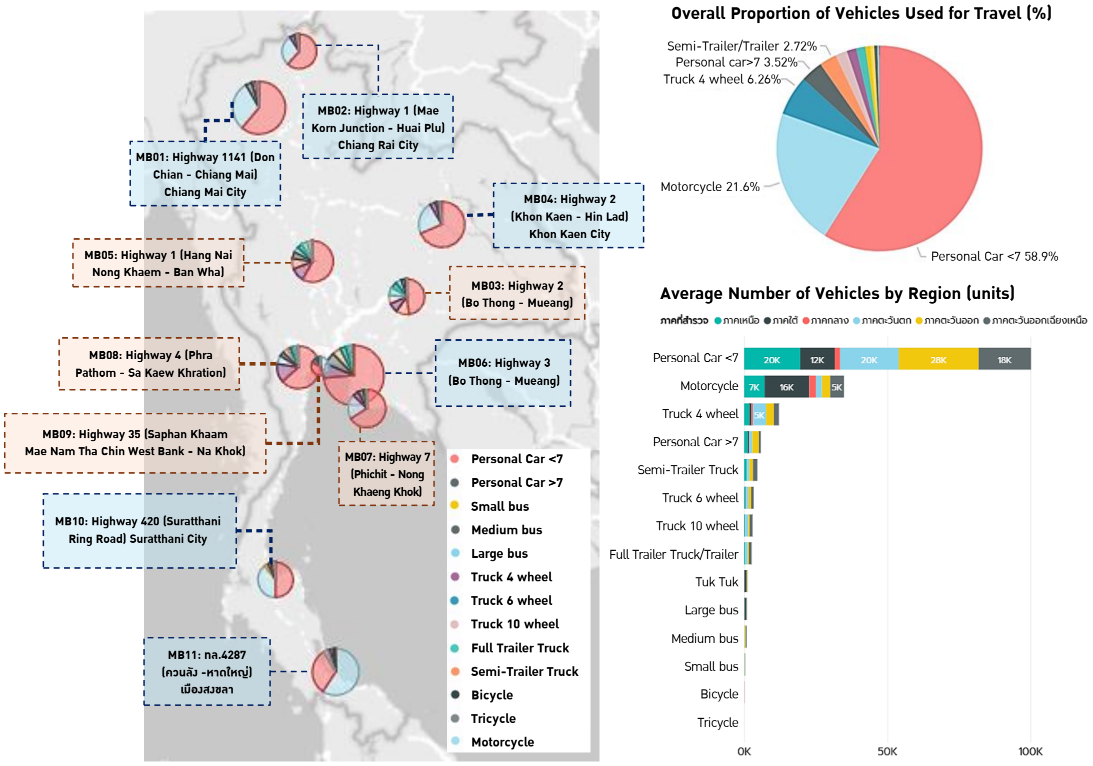


Figure 10 Summary of Survey Results on Traffic Volume by Vehicle Type

Passenger Roadside Interview Survey (Passenger - RIS) on Highways

The Passenger Roadside Interview Survey (Passenger - RIS) on highways is conducted to collect data on vehicle usage by road users. The collected data include **vehicle type, fuel type, fuel consumption rate, trip length, average vehicle kilometers traveled (VKT), vehicle age, and origin-destination (O - D)**, which are key parameters for analyzing and assessing energy consumption reduction and greenhouse gas mitigation in the transport sector.

Vehicle Types, Shares, and Fuel Usage

This section presents information on vehicle types, vehicle shares, and fuel usage based on a total of **8,172 roadside interview samples** obtained from the passenger road travel survey.

- Passenger Car (<7 seats)

Account for 39.95% of total trips and represent the most frequently used vehicle type.

- Motorcycle and Motorized Three-Wheeler

Account for 19.52% of total trips and are mainly used in urban areas and for short-distance travel.

- Pickup Truck

Account for 25.24% of total trips and are commonly used for long-distance travel.

- Van (Passenger Vehicle >7 seats)

Account for 6.92% of total trips and are primarily used for group travel.

The results indicate a strong reliance on **Passenger Cars and Pickup Trucks** for long-distance and interregional travel. Major origins and destinations are concentrated in Bangkok, Chonburi, Khon Kaen, Chiang Mai, Phuket, Songkhla, and Surat Thani, which are major urban centers and key economic areas of the country.

The third group consists of motorcycles and motorized three-wheelers, accounting for 19.52% of total trips. These vehicles are commonly used in urban areas and for short-distance travel, such as in Bangkok, Chiang Mai, and Phuket. Vans (passenger vehicles with more than 7 seats) account for 6.92% of total trips and mainly serve long-distance group travel.

In addition, intercity public transport vehicles include small buses (4-wheel) accounting for 2.59%, medium buses (6-wheel) accounting for 2.03%, and large buses, which operate primarily on corridors connecting major cities with secondary cities, such as the Bangkok-Khon Kaen, Bangkok-Chiang Mai, and Bangkok-Hat Yai routes.

In summary, road passenger travel patterns in Thailand continue to rely predominantly on private vehicles, including passenger cars and pickup trucks, while public buses and motorcycles continue to play an important role on major corridors and within urban areas, as shown in **Figure 10**

Origin-Destination (O - D) Travel Volumes

Based on nationwide road passenger travel data, it was found that the main corridors with the highest travel demand are oriented along the north - south axis.

Major Origin Provinces (Top 5)

1. Bangkok (11.75%)
2. Chonburi (10.83%)
3. Surat Thani (9.94%)
4. Songkhla (9.25%)
5. Chiang Mai (8.62%)

Major Destination Provinces (Top 5)

1. Chonburi (10.56%)
2. Bangkok (10.35%)
3. Surat Thani (9.94%)
4. Chiang Mai (8.82%)
5. Songkhla (8.8%)

These provinces are major urban areas with significant economic activities, tourism functions, and regional transport hubs. Most trips are intra-provincial in nature; therefore, interprovincial travel is not strongly reflected in destination data, except for Bangkok, as shown in **Figures 10 to 12**.

Average Vehicle Age and Travel Distance

Average Vehicle Age by Vehicle Type

Based on the survey of average vehicle age classified by vehicle type, it was found **that motorcycles and motorized three-wheelers record the highest average age, at 29.5 years,** reflecting long-term and continuous utilization within the local transport system. In contrast, large buses have an average vehicle age of approximately 10.7 years, while passenger vans (passenger vehicles with more than 7 seats) show a relatively high average age of 15.0 years, indicating extended service life.

Meanwhile, pickup trucks (light trucks) and small buses (4-wheel buses) have an average vehicle age of approximately 8.0 - 8.6 years, which is considered to be within an efficient operational lifespan. Motorcycles used for delivery purposes exhibit the lowest average age, at approximately 6 years, indicating a higher proportion of newer vehicles within this vehicle category. Details of the average vehicle age by vehicle type are summarized below.

Large Public Buses
The average vehicle age is **10.7 years**, with CNG/NGV and diesel as the primary fuel types.

Small Public Buses (4-wheel buses)
The average vehicle age is **8.6 years**. These vehicles mainly use E20, gasoline 95, and diesel, reflecting a relatively high turnover rate and shorter service life.

Passenger Cars with More Than 7 Seats (Vans)
The average vehicle age is approximately 15.0 years, with common fuel types including gasohol 95, LPG, and CNG/NGV.

Pickup Trucks (Private Light Trucks)
The average vehicle age is **8.2 years**, with diesel and gasohol as the dominant fuel types.

Passenger Cars with Not More Than 7 Seats
The average vehicle age is **10 years**, using a wide range of fuels, including gasoline 91, gasohol 91, E20, and LPG.

Motorcycles and Motorized Tricycles
This group has the highest average age at **29.5 years**, particularly those using gasohol 95, followed by diesel and electric vehicles.

Commercial Motorcycles (Delivery)
These vehicles have the lowest average age, approximately **6.0 years**, with E20, diesel, and gasoline 95 as the main fuel types.

- Overall, vehicles used in public transport and commercial operations tend to have a longer service life, as shown in Figure 14 This finding provides important baseline information to support policy planning for the transition toward clean energy vehicles as well as future vehicle fleet management.

Average Trip Length by Vehicle Type

Based on the analysis of average trip length by vehicle type, the key findings are summarized as follows:

- Passenger vehicles with more than 7 seats
  - Record the longest average trip length, at 368.3 km, particularly those using Gasoline 95
  - Commonly used for inter-provincial and inter-regional travel, such as:
    - Bangkok - Khon Kaen
    - Bangkok - Chiang Mai
- Large buses
  - Have an average trip length of 319.3 km
  - Primarily operate on long-distance inter-provincial and inter-regional routes, for example:
    - Bangkok - Prachuap Khiri Khan
    - Bangkok - Chiang Mai
- Passenger vans (vehicles with more than 7 seats) using diesel
  - Average trip length of 294.0 km
  - Reflect group travel and cross-regional operations
- Medium buses (6-wheel buses)
  - Average trip length of 232.0 km
- Pickup trucks (personal light trucks)
  - Average trip length of 238.6 km
- Motorcycles and motorized three-wheelers
  - Used mainly for short-distance travel
  - Average trip length of only 58.5 km
  - Consistent with usage in urban areas and nearby communities

In addition, the data were further disaggregated by fuel type. The results indicate that **diesel and Gasoline 95** are predominantly used by vehicles traveling long distances, such as large buses and passenger vans. In contrast, electric power and E85 fuel are generally used by smaller vehicles operating over shorter travel distances.

Average Annual Vehicle Kilometers Traveled (VKT)

When considering the average annual **Vehicle Kilometers Traveled (VKT) (km/year)** disaggregated by vehicle type, it was found that:

53,110 km/year
Large buses

Have the highest average VKT (km/year), primarily using CNG as fuel, reflecting their predominant use for long-distance and interprovincial travel.

33,400 km/year
Passenger cars with more than 7 seats (Vans)

Have the second highest average VKT (km/year), primarily using diesel fuel, which is consistent with their frequent use for long-distance travel.

35,000 km/year
Small buses (4-wheel)

Have an average VKT (km/year) of 35,000 km, primarily using CNG as fuel, reflecting their predominant use for long-distance and interprovincial travel.

5,600 km/year
Motorcycles and motorized three-wheelers

Have the lowest average VKT (km/year), primarily using E20 fuel, which is consistent with their use for short-distance travel within urban and community areas.

Pickup trucks (personal pickup vehicles)

CNG-fueled vehicles
have an average VKT of 21,100 km/year.

Diesel-fueled vehicles
have a higher average VKT of 24,600 km/year.

These vehicles are commonly used for both commercial purposes and passenger travel.

In terms of fuel-type analysis, vehicles using **CNG and diesel** exhibit noticeably higher average travel distances than other fuel groups, particularly large buses and vans. This is consistent with the widespread use of CNG and diesel in vehicles intended for long-distance travel and heavy-duty operations.

In contrast, vehicles using alternative energy, such as **electricity and E20**, tend to have lower average travel distances, especially private vehicles operating within urban areas, as illustrated in **Figure 14**.

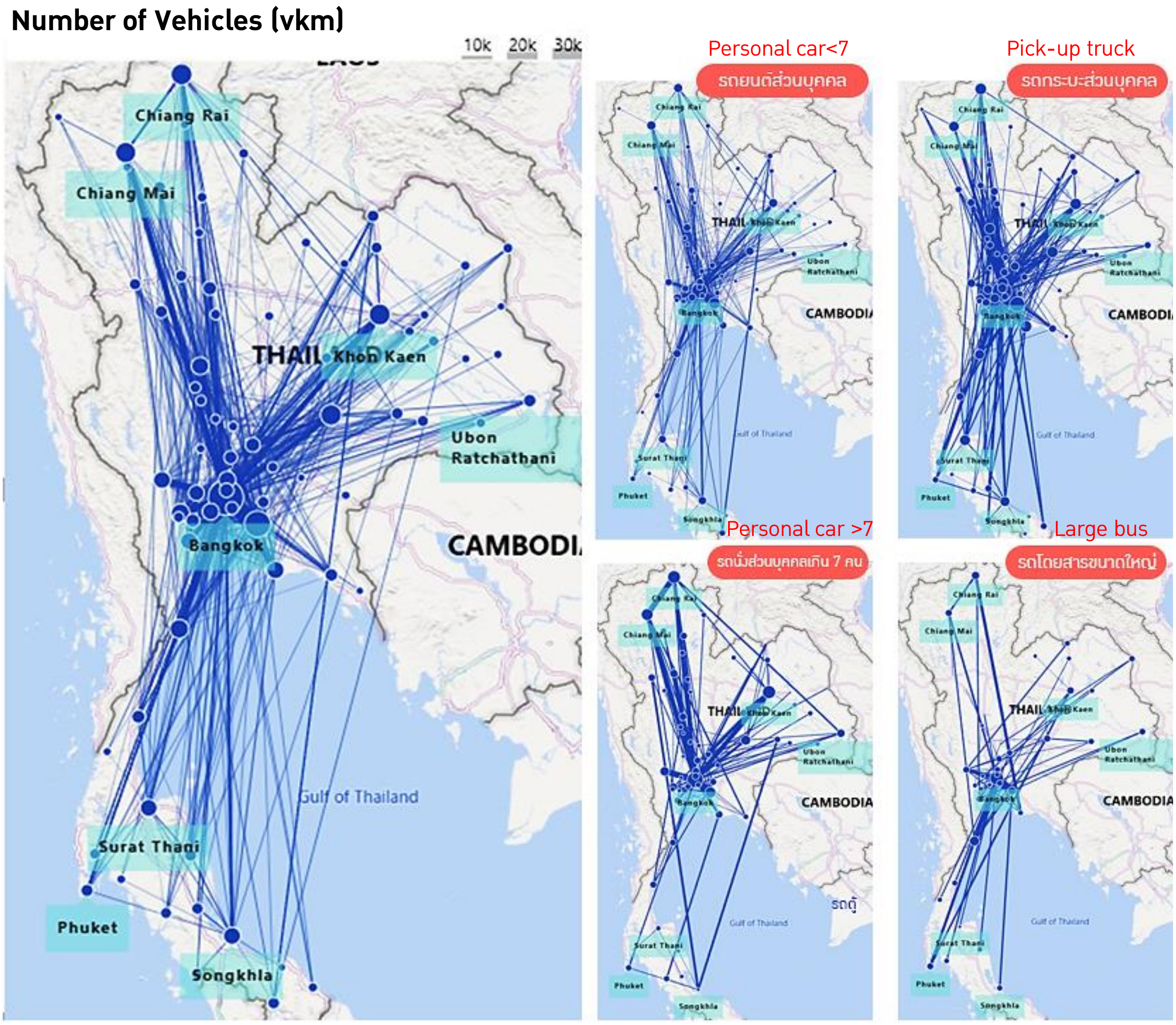


Figure 11 Origin - Destination of Road Passenger Travel Divided by Vehicle Type Used for Travel (From Project Survey)

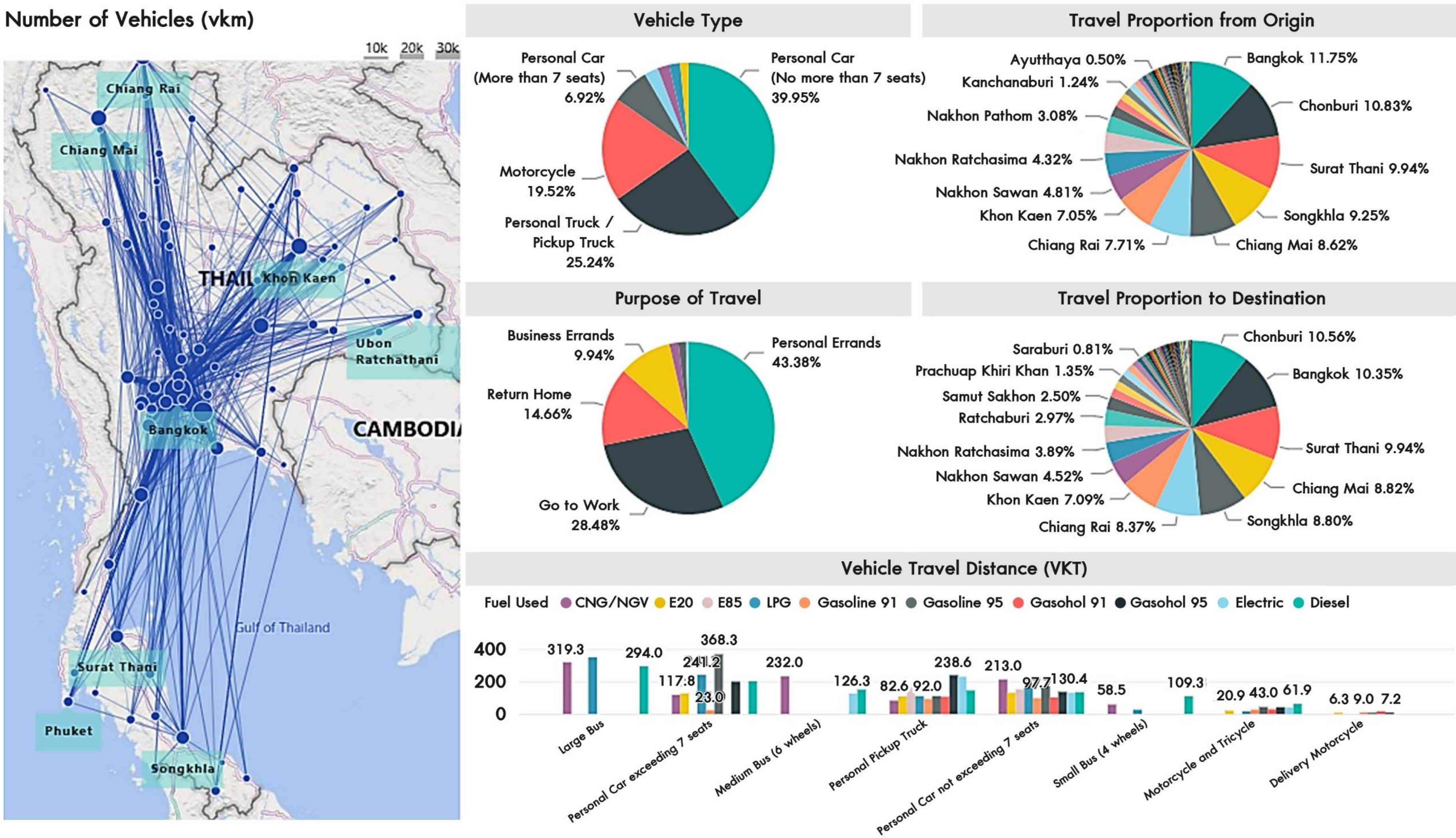


Figure 12 Origin - Destination and Average Travel Distance on Roads Divided by Vehicle Type (From Project Survey)

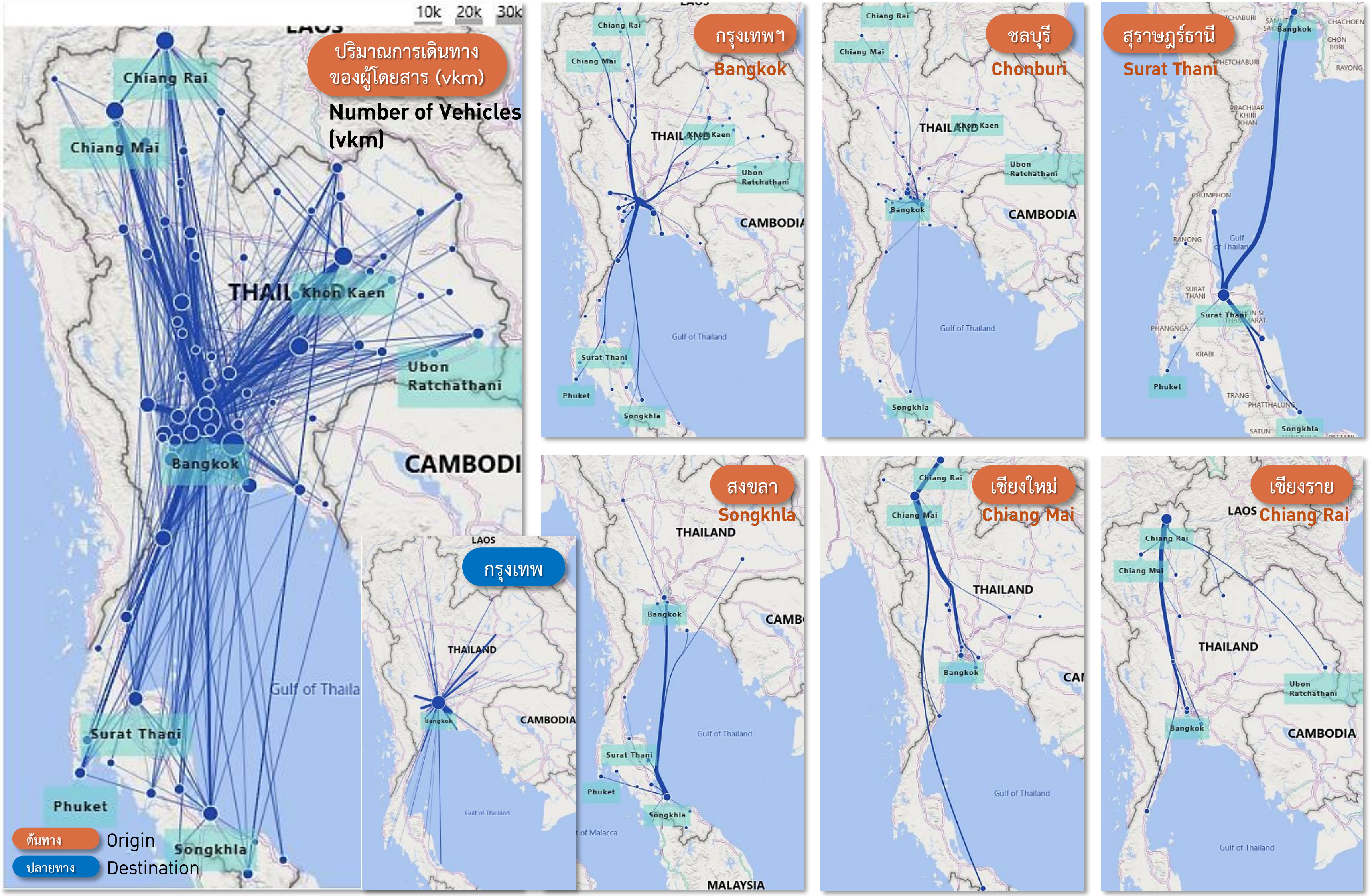


Figure 13 Origin - Destination of Road Travel, Ranked by Provinces with the Highest Travel Volumes (From the Project Survey)

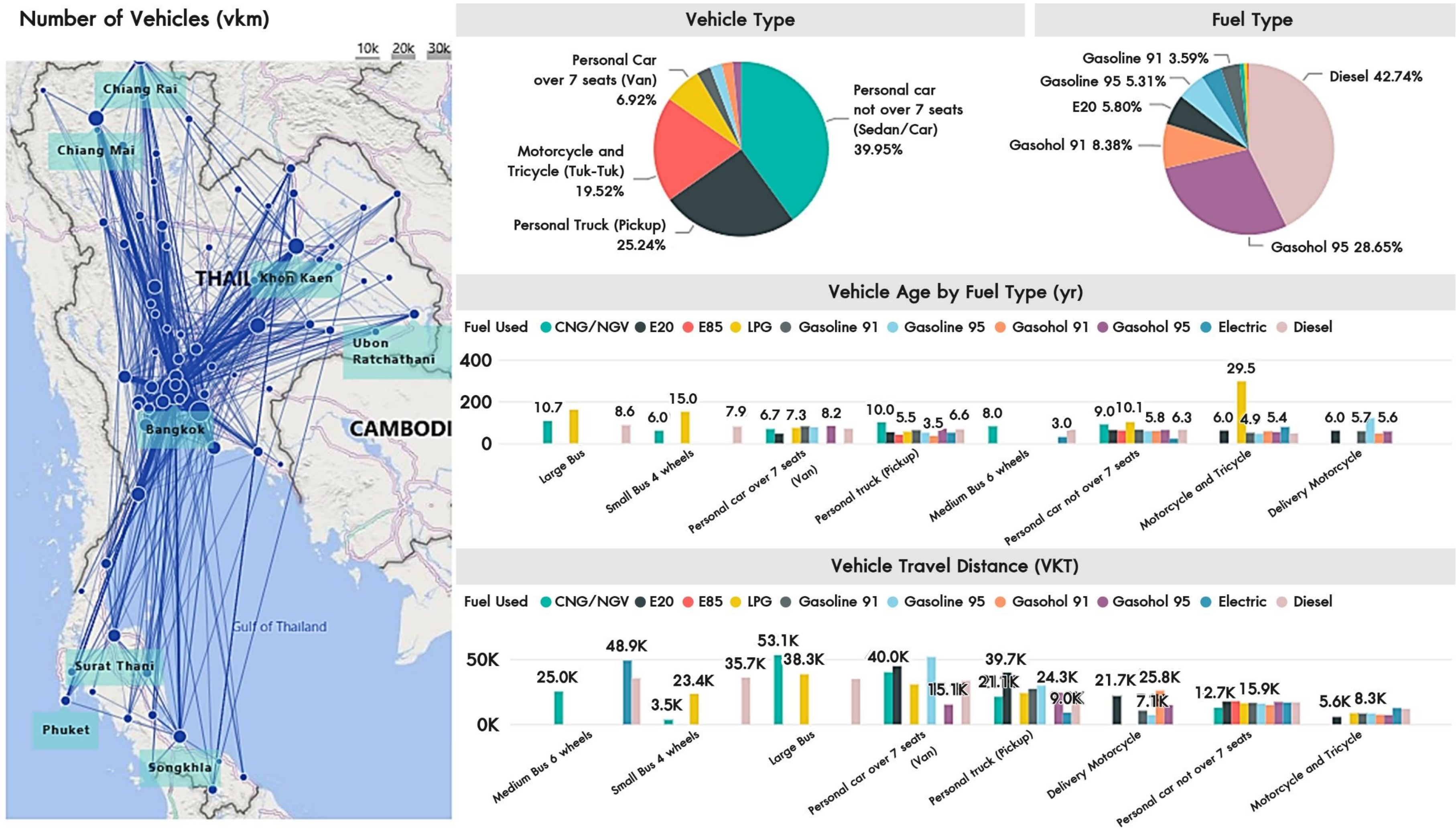


Figure 14 Origin - Destination of Road Travel Ranked by Provinces with Highest Travel Volume (From Project Survey)

2.3 Baseline Data for Assessment

In assessing greenhouse gas (GHG) emission reductions from each mitigation measure, it is necessary to rely on baseline data obtained from surveys, together with secondary data from relevant agencies, in order to accurately and comprehensively calculate the GHG emission reductions attributable to each measure.

- **Table 2** presents details of the key datasets required for the calculations, including data obtained from project surveys and data compiled from relevant agencies.

The datasets comprise the following elements:

- Parameter name
- Unit
- Definition
- Data source

ASIF Framework for Parameter Classification

The parameters have been classified in accordance with the calculation approach under the ASIF framework, as follows:

1	2
Activity: A Refers to the level of activity.	**Share: S** Refers to the share of fuel use or technology adoption.
3	**4**
Intensity: I Refers to energy-use efficiency.	**Factor: F** Refers to the greenhouse gas emission factor.

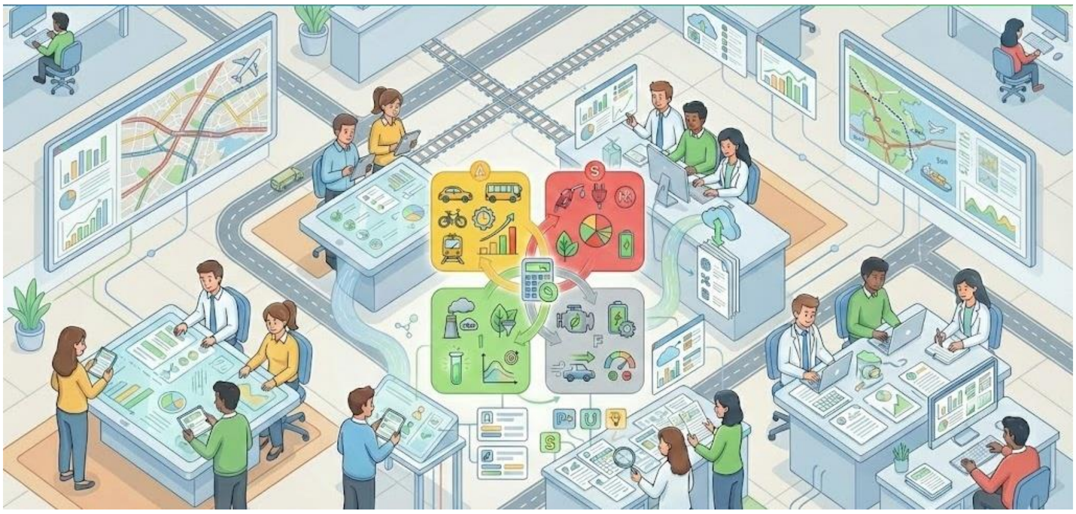


Table 2 Data from Surveys and Relevant Agencies for Calculations

Parameter	Unit	Definition	Data Source
Activity Data (A)			
Number of Vehicles	vehicles/year	Number of registered vehicles accumulated	Department of Land Transport
Road Freight Volume	thousand tons/year	Volume of goods transported by trucks of all types at the national level	Department of Land Transport, Department of Highways, Department of Rural Roads
Number of Passengers	persons/year, person-trips/year	Number of passengers traveling by road and water	Port Authority, Department of Highways
Water Freight Volume	thousand tons/year	Volume of goods transported by river and coastal vessels	Port Authority
Average Distance per Passenger Trip	km/trip	Average distance per passenger trip by water	
Number of Vehicles	vehicles/year	Number of diesel locomotives	State Railway of Thailand
Rail Freight Volume	thousand tons/year	Volume of goods transported by intercity trains	
Number of Flights Landing per Year	flights/year	Number of domestic flights landing at Suvarnabhumi Airport	Airports of Thailand Public Company Limited
Landing and Take-off (LTO) Time Average per Aircraft	minutes/trip	Landing and Take-off (LTO) time at Suvarnabhumi Airport	
Vehicle Kilometers Traveled (VKT)	kilometers/year, kilometers/trip	Average distance of freight transport vehicles by type, for calculating energy intensity according to the ASIF framework intensity component	Department of Land Transport, Project surveys (Road and Rural Roads)
Tonne-Kilometer (TKM)	tonne-kilometers/year	Indicator of actual freight transport work of the country, calculated from freight volume multiplied by average distance, an important factor for calculating greenhouse gas emissions according to the ASIF framework	Department of Land Transport, Department of Highways, Department of Rural Roads, State Railway of Thailand, Port Authority
Average Vehicle Travel Distance	km/year	Average distance traveled by vehicles	Project for the preparation of baseline data and assessment of greenhouse gas reduction from energy efficiency improvement measures for vehicles, Road
Occupancy Rate	persons	Average number of passengers on vehicles (Occupancy Rate: OCC) by vehicle type	
Number of Cargo Handling Equipment and Machinery	units/pieces	Number of machinery and equipment used for cargo handling within the port	Single Rail Transfer Operator (SRTO), Laem Chabang Port Container Railway Transport Center
Average Operating Hours of Cargo Handling Equipment and Machinery per Year	hours/year	Average operating hours of machinery and equipment used for cargo handling within the port	Single Rail Transfer Operator (SRTO), Laem Chabang Port Container Railway Transport Center

Table 2 Data from Surveys and Relevant Agencies for Calculations (Cont.)

Parameter	Unit	Definition	Data Source
Data on Travel Mode Share and Technology Type (S)			
Technology Type	%	Number of accumulated vehicles classified by vehicle technology type (ICE, HEV, PHEV, BEV) and fuel type	Department of Land Transport
Travel Mode Share	%	Types of vessels by fuel type	Port Authority of Thailand
Travel Mode Share	%	Types of trains by fuel type	State Railway of Thailand
Transport Mode Share	%	Proportion of freight transport service usage classified by transport mode, representing the Structure component in the ASIF framework showing the distribution of freight transport systems at the national level	Calculated from Tonne-Kilometer (TKM) of each transport mode compared to the national total
Travel Mode Share	%	Proportion of travel mode shift	Project on the Feasibility Study and Survey Design for the Improvement of Manao Pier and Khlong Lad Pier, Phang Nga Province, Port Authority 2019
Data on Energy Use Efficiency (I)			
Fuel Consumption Rate for Landing and Take-off	liters/minute	Fuel consumption rate (Fuel Economy) by aircraft type and fuel type	European Environment Agency (EEA)
Energy Intensity	%	Proportion of different fuel types used in each freight transport mode, representing the Intensity component in the ASIF framework covering diesel, gasoline, natural gas, electricity, and alternative energy	Department of Energy Business, Office of Energy Policy and Planning, Department of Alternative Energy Development and Efficiency, Energy Regulatory Commission
Share of Biofuel	%	Proportion of biofuel	Thailand's Energy Balance Report, Department of Alternative Energy Development and Efficiency, Ministry of Energy 2023
Conversion Factor	MJ/l, MJ/kg	Unit conversion value for energy quantity heat	Department of Alternative Energy Development and Efficiency, Ministry of Energy 2023
Energy Use Rate / Fuel Use Efficiency	L/pkm, kWh/pkm, km/L, km/kg, km/kWh	Fuel economy (Fuel Economy) efficiency by vehicle type and fuel type	Project for the preparation of baseline data and assessment (Tracking) of greenhouse gas reduction from energy efficiency improvement measures for vehicles, Road; Office of Energy Policy and Planning; Department of Pollution Control; Industrial Economic Office (Ecosticker)
Energy Use Rate per Operating Hour	liters/hour or kW	Energy consumption rate of machinery and equipment used for cargo handling by machinery and equipment type and fuel type	Project surveys (Road, Rural Roads, State Railway, Port Authority), Single Rail Transfer Operator (SRTO), Laem Chabang Port Container Railway Transport Center

Table 2 Data from Surveys and Relevant Agencies for Calculations (Cont.)

Parameter	Unit	Definition	Data Source
Data on Greenhouse Gas Emission Value (F)			
Emission Factor Coefficient	kgCO2/TJ, kgCO2/kW-h, kgCO2/L	Greenhouse gas emission coefficient of various fuels and energy sources, representing the Fuel component in the ASIF framework showing the amount of greenhouse gas per unit of energy	2006 IPCC Guidelines for National Greenhouse Gas, Office of Energy Policy and Planning, Department of Pollution Control, European Environment Agency (EEA)

Technical Data Analysis Approach for Fuels and Vehicles in the Transport Sector

Under this study, an analytical approach has been established based on technical data on fuels and vehicles, to serve as a basis for calculating and comparing energy use potential in the transport sector.

Energy Content	CO_2 Emission Factors by Energy Type for Each Fuel Type	Greenhouse Gas and $PM_{2.5}$ Emission Factors

The data include energy content values and CO_2 emission factors by energy type for each fuel, as well as greenhouse gas and $PM_{2.5}$ emission factors, which are essential for systematically assessing the energy and environmental impacts of mitigation measures in the transport sector.

Data Collection Process

Primary Fuels Used in Thailand

- Gasoline 95
- Diesel
- LPG
- CNG

Blended Biofuels

- Gasohol 91
- Gasohol 95
- E20
- E85

In this study, data on the energy content of each fuel type were collected to calculate energy consumption and greenhouse gas emissions in the transport sector. The analysis considered primary fuels used in the country, such as Gasoline 95, diesel, LPG, and CNG, as well as blended biofuels, including Gasohol 91, Gasohol 95, E20, and E85.

- **Importance of the Data:** These data are essential for converting actual fuel consumption into energy equivalent units (ktoe), enabling systematic assessment and comparison of energy efficiency across different fuel types. In addition, CO_2 emission factors are specified to support the analysis of overall greenhouse gas emissions from the transport sector, as presented in **Table 3.**

Table 3 Energy Content and CO_2 Emission Factors by Energy Type

Conversion Factor (MJ/ unit)				
Gasoline 95 (l)	Gasohol 91 (l)	Gasohol 95 (l)	E20 (l)	E85 (l)
31.48	28.33	28.33	25.18	4.72
Diesel B7 (l)	LPG (l)	NGV/CNG (kg)	Aviation Fuel (l)	
36.42	26.62	37.92	34.53	
Emission Factor ($kgCO_2/TJ$)				
Gasoline 95	Gasohol 91	Gasohol 95	E20	E85
69,300	69,300	69,300	69,300	69,300
Diesel B7	LPG	NGV/CNG	Electricity ($kgCO_2/kWh$)	Aviation Fuel
74,100	63,100	56,100	0.94	70,000
Unit conversion value for thermal energy content to crude oil equivalent (MJ/toe)				41,840

Equation for calculating crude oil equivalent (ktoe)

$$\text{Crude oil equivalent (ktoe)} = \frac{\text{PKM}_{\text{by vehicle type and fuel}}\ (\text{person-km/year}) \times \text{Conversion factor}_{\text{by fuel type}}\ (\text{MJ/l})}{[\text{OCC}_{\text{by vehicle type}}\ (\text{persons}) \times \text{FE}_{\text{by vehicle type and fuel}}\ (\text{km/l}) \times 41{,}840\ (\text{MJ/toe}) \times 1{,}000\ (\text{toe/ktoe})}$$

For assessing air pollution impacts from fuel use in the transport sector, emission factors for fine particulate matter ($PM_{2.5}$) have been developed, classified by road vehicle type and fuel type, to calculate the amount of fine particulate emissions from fuel combustion in the travel activities of each vehicle type. The main classification groups include passenger cars, pick-up trucks, freight trucks, and buses, to ensure assessment results reflect the actual operating characteristics of each vehicle type, referenced from the research project "Source Apportionment of Pollution from Internal and External Sources Affecting Fine Particulate Matter Concentrations in Bangkok" conducted by the National Research Council of Thailand (NRCT), 2022 and EEA Guidebook 2022. This data is an essential foundation for analyzing impacts on air quality and public health, as shown in **Table 4.**

Furthermore, data on fine particulate matter ($PM_{2.5}$) emissions for other transport modes, including rail and water transport systems, has been compiled to assess pollution emissions from non-road transport activities. These are based on EEA Guidebook 2023 and EEA Guidebook 2019, which are internationally recognized guidelines. The data covers locomotive types, switching locomotives, electric-powered railcars, and vessels, as shown in **Table 4.**

Table 4 Pollutant Emission Factors ($PM_{2.5}$) Classified by Vehicle Type

Vehicle Type	Emission Factor ($PM_{2.5}$) (g/km)			
	Gasoline 95	Diesel	CNG	LPG
Motorcycle	0.0079	-	-	-
Passenger Car	0.0012 (0.0011)[1]	0.0145 (0.0182)[1]	0.0012	0.0012
Pick-up Truck	-	0.0203 (0.0168)[1]	-	-
Small Bus[2]	-	0.3620	0.0012	-
Medium Bus[2]	-	0.3620	0.0012	-
Large Bus[2]	-	0.4790 (0.3207)[1]	0.0012 (0.0018)[1]	-
4-wheel Truck	-	0.1260	0.0012	-
6-wheel Truck	-	0.2794	0.0012	-
10-wheel Truck	-	0.1695 (0.1426)[1]	0.0012 (0.0021)[1]	-
Truck with Trailer	-	0.1800	0.0012	-
Semi-truck	-	0.2534	0.0012	-
Vehicle Type	**Emission Factor ($PM_{2.5}$) (kg/ton fuel)**			
	Diesel			
Line-haul locomotives[3]	1.1			
Shunting locomotives[3]	2			
Railcars[3]	1			
Boats[4]	0.911			

Note:

The assessment analysis primarily applies $PM_{2.5}$ emission factors (EFs) from the research project *"Source Apportionment of Air Pollution from Internal and External Sources Affecting $PM_{2.5}$ Concentrations in Bangkok Metropolitan Area"* conducted by the National Research Council of Thailand (NRCT), 2022. This study was selected as the main reference because it is a Thailand-based research project with a larger number of on-road vehicle emission tests than other studies and provides the most comprehensive level of detail. Only the $PM_{2.5}$ EF for buses is adopted from the EEA, as the NRCT report does not disaggregate emission factors by bus type.

Road transport $PM_{2.5}$ emission factors are referenced from the NRCT (2022) study, applying assumptions based on the average vehicle fleet in Thailand. Given that Thailand's emission standards for light-duty vehicles (LDVs) are generally higher than those for heavy-duty vehicles (HDVs), Euro 3 standards are assumed for LDVs and Euro 1 standards for HDVs. In addition, $PM_{2.5}$ is assumed to account for approximately 94% of total PM emissions.

References:

[1] *Study on Policies for Reducing Energy Consumption in the Road Transport Sector* (Office of Transport and Traffic Policy and Planning: OTP, 2023).
[2] EEA Guidebook 2022, Table 3-24.
[3] EEA Guidebook 2023, Tables 3-2 to 3-4.
[4] EEA Guidebook 2019, Table 3-7.

Chapter 3
Analysis and Assessment Results

3.1 Quantity of Vehicles by Type and Age (VS)

The analysis of the number of vehicles in the transport system applies a stock turnover model to track vehicle inflows and outflows on an annual basis. The vehicle stock in the system, $V_{stock,i}(t)$, is calculated as the product of annual new vehicle sales, $V_{sale,i}(v)$, and the survival rate, $\phi_i(k)$, which represents the probability that a vehicle of type *i* remains in the system after reaching age *k*.

In addition, vehicles are disaggregated by fuel type and technology using the sales share parameter, $\Psi_{i,j}(v)$, reflecting policy-related factors such as the 30@30 target, the adoption of new technologies, and the availability of energy infrastructure.

➢ Key Data for Model Development

The key data used for model development are derived from historical vehicle registration records obtained from the Department of Land Transport. An example of the cumulative number of registered vehicles nationwide, disaggregated by fuel type and vehicle age for the year 2024, is presented for analytical purposes.

The survival rates are subsequently calibrated and adjusted to follow an inverse S-shaped curve according to vehicle type.

Outputs

The results of the analysis are the remaining vehicle stock in the transport system, denoted as $V_{stock,i,j}(t)$, disaggregated by vehicle type, fuel type, and vehicle age. These outputs serve as essential baseline inputs for subsequent analyses of vehicle kilometers traveled (VKT) and fuel efficiency (FE).

3.2 Vehicle Kilometers Traveled: VKT

The average annual vehicle kilometers traveled (VKT) is a key variable reflecting the level of vehicle usage. In general, VKT tends to decrease as vehicles age. Accordingly, the following equation is applied in this model:

$$VKT_{veh,i,j}(k) = \alpha_{i,j}\, k^{\beta_{i,j}} \times VKT_{veh,i,j}(0)$$

where $\beta_{i,j} < 0$.

This equation represents an inverse relationship between vehicle age and the average annual distance traveled. Subsequently, the average VKT of the entire vehicle stock, $VKT_{stock,i,j}(t)$, is calculated by weighting the VKT of vehicles at each age by the number of vehicles remaining in the system in each year. The database used for the analysis is based on roadside interview (RIS) surveys covering both passenger and freight transport, which provide the initial values of $VKT_{veh,i,j}(0)$ as well as observed vehicle usage. Vehicle kilometers traveled (VKT) by vehicle type are presented in Table 5

Table 5 Vehicle Kilometers Traveled (VKT) (km/vehicle) by Vehicle Type

Transport Type	Baseline Data from the Model	Data Used for Tracking Assessment[◎]
Road (Vehicle Kilometers Traveled)		
Private Cars		
Gasoline Based	17,539	17,056
Diesel Based	21,618	16,857
LPG	15,134	16,087
CNG	24,757	12,683
HEV	20,446	17,056
PHEV	25,529	17,056
BEV	19,512	16,765
Private Pickup Trucks		
Gasoline Based	16,216	29,398
Diesel Based	21,365	25,464
LPG	22,539	23,909
CNG	31,376	26,892
HEV	20,762	-
PHEV	24,770	-
BEV	20,762	9,000[#]
Trucks		
<6-wheel truck	53,163	38,094
Large truck (10 wheels and above)	53,163	52,237
Trailer truck/ Semi-trailer truck	53,163	52,699
Buses		
Diesel	40,353	35,126[#]
CNG	40,353	35,126[#]
Motorcycle		
Gasoline Based	8,643	7,305
BEV	8,643	7,305
Public Motorcycle		
Gasoline Based	21,608	19,184[#]
BEV	21,608	19,184[#]
Rail (Diesel Railcar Operating Distance)		
Electric Power Bogies		
Diesel Railcar	11,575,000	11,419,297
Air-Conditioned Diesel Railcar	6,542,000	6,281,547
Electric Diesel Railcar	-	-
Locomotives		
Low Horsepower Diesel Locomotive	659,456	699,381
High Horsepower Diesel Locomotive	24,569,834	24,161,950
Electric Locomotive	0	-
Waterway (Vehicle Kilometers Traveled)		
Electric Passenger Boats		
Chao Phraya Express Boat	10.10	9.89
Saen Saep Canal Boat	3.32	3.02
Motor Ferry	0.40	0.41
Tour Boat (River)	32.00	31.0
Tour Boat (Sea)	140.00	141.0
Cargo Ships		
River Cargo Ship	137.38	137.38
Coastal Cargo Ship	325.35	325.35

Note: [◎] The data used for this evaluation is primarily derived from the project's own survey. [#]However, in cases where specific data points were unavailable, information was supplemented by other surveys conducted within the same year or a comparable timeframe, as well as data from relevant agencies, to ensure appropriate analysis and evaluation.

3.3 Vehicle Energy Efficiency (Fuel Economy: FE)

Vehicle energy efficiency (Fuel Economy: FE) is another key factor that directly affects energy consumption. In this model, FE is defined on a per-vehicle basis in terms of vehicle-kilometers per megajoule (km/MJ). A **degradation factor, $\eta_{\{i,j\}}(k)$**, is applied to reflect the decline in energy efficiency as vehicles age.

Average FE calculation

The average FE of the vehicle fleet is calculated using a weighted average based on the number of vehicles in each age group. Initial FE values are obtained from the RIS survey results and standard data from the Thai Industrial Standards Institute (TISI). For example, gasoline passenger cars have an FE of approximately 16.87 km/L, battery electric vehicles (BEVs) have an FE of approximately 6.41 km/kWh, and gasoline pickup trucks have an FE of approximately 17.93 km/L.

- **Standard Unit Conversion:** All values are consistently converted to km/MJ using the lower heating value (LHV) of fuels, in order to ensure comparability and standardized input into the modeling framework.

Table 6 Vehicle Energy Efficiency (FE) by Fuel Type

Transport Mode	Fuel Type	Baseline Data from the Model	Data Used for Tracking Assessment®
Road Transport		km/L or km/kg* or km/kWh**	km/L or km/kg* or km/kWh**
Passenger Cars			
Gasoline Based	Gasoline	12.83	17.10
	Ethanol	8.78	11.70
Diesel Based	Diesel	16.43	15.70
	Biodiesel	16.43	15.70
LPG	LPG	11.733	16.67
CNG	CNG*	10.09	8.90
Hev[1]	Gasoline	21.62	21.90
	Ethanol	18.36	18.60
Phev[1]	Gasoline	20.58	39.68
	Ethanol	17.48	33.71
Bev[1]	Electricity**	6.10	9.12
Private Pickup Trucks			
Gasoline Based	Gasoline	13.02	17.87
	Ethanol	8.91	12.23
Diesel Based	Diesel	14.73	14.94
	Biodiesel	14.73	14.94
LPG	LPG	12.20	18.00
CNG	CNG*	9.75	11.89
Hev[1]	Gasoline	19.14	N/A
	Ethanol	16.26	N/A
Phev[1]	Gasoline	23.33	N/A
	Ethanol	19.82	N/A
Bev[1]	Electricity**	6.10	7.00
Trucks			
Medium Trucks (6 Wheels)	Diesel	5.56	5.85
	Biodiesel	5.56	5.85
	CNG*	4.70	6.21
	Electricity**	3.05	3.05#
Heavy Trucks (10 Wheels And Above)	Diesel	5.56	4.50
	Biodiesel	5.56	4.50
	CNG*	4.70	4.54
	Electricity**	3.05	3.05#
Trailer / Semi-Trailer Trucks	Diesel	5.56	3.42
	Biodiesel	5.56	3.42
	CNG*	4.70	3.37
	Electricity**	3.05	3.05#
Buses			
	Diesel	4.10	4.10
	Biodiesel	4.10	4.10
	CNG*	4.27	3.30
	Electricity**	9.00	8.30#
Motorcycle			
Gasoline Based	Gasoline	41.74	55.13
	Ethanol	28.56	37.72
BEV	Electricity**	16.50	16.50#
Public Motorcycle			
Gasoline Based	Gasoline	41.74	51.41
	Ethanol	28.56	35.18
BEV	Electricity**	16.50	16.50#

Note: ® Data used for the assessment are primarily based on the project survey. For entries marked with #, where data are not available from the project survey, data from other surveys conducted in the same year or in a similar period are used instead.

[1] Data from the Thai Industrial Standards Institute (TISI).

* CNG - km/kg.

** Electricity - km/kWh.

Table 6 Vehicle Energy Efficiency (FE) by Fuel Type (cont.)

Transport Mode	Fuel Type	Baseline Data from the Model	Data Used for Tracking Assessment[®]
Rail Transport		L/km or kWh/km*	L/km or kWh/km*
Electric Multiple Units (Emu)			
Diesel Railcars	Diesel	0.60	0.58
	Biodiesel	0.60	0.58
Air-Conditioned Diesel Railcars	Diesel	0.60	0.59
	Biodiesel	0.60	0.59
Electric Trains	Electricity*	-	-
Locomotives			
Low-Horsepower Diesel Locomotives	Diesel	3.50	3.92
	Biodiesel	3.50	3.92
Low-Horsepower Diesel Locomotives	Diesel	3.50	2.62
	Biodiesel	3.50	2.62
Electric Locomotives	Electricity*	-	-
Water Transport			
Electric Passenger Vessels		L/pkm or kWh/pkm*	L/pkm or kWh/pkm*
Chao Phraya Express Boats	Diesel	0.0055	0.0055
	Biodiesel	0.0055	0.0055
	Electricity*	0.0500	0.0500
Saen Saep Canal Boats	Diesel	0.0055	0.0055
	Biodiesel	0.0055	0.0055
	Electricity*	0.0500	0.0500
Ferry Boats	Diesel	0.0055	0.0055
	Biodiesel	0.0055	0.0055
	Electricity*	0.0500	0.0500
Tourist Boats (River)	Diesel	0.0055	0.0055
	Biodiesel	0.0055	0.0055
	Electricity*	0.0500	0.0500
Tourist Boats (Sea)	Diesel	0.0055	0.0055
	Biodiesel	0.0055	0.0055
	Electricity*	0.0500	0.0500
Cargo Vessels		L/tkm or kWh/tkm*	L/tkm or kWh/tkm*
Inland Cargo Vessels	Diesel	0.015	0.015
	Biodiesel	0.015	0.015
	Electricity*	-	-
Coastal Cargo Vessels	Diesel	0.015	0.015
	Biodiesel	0.015	0.015
	Electricity*	-	-

Note: ® Data used for the assessment are obtained from relevant agencies.

* CNG - km/kg

** Electricity - km/kWh

Chapter 4

Development of Guidelines for Assessing Reductions in Energy Consumption, Greenhouse Gas Emissions and Fine Particulate Matter ($PM_{2.5}$)

Guidelines for Assessing Energy Consumption and Greenhouse Gas Emissions

The guidelines for assessing energy consumption and greenhouse gas emissions are based on the principles of the MRV system and comprise two analytical approaches: 1) a top-down method and 2) a bottom-up method.

Differences in analytical results between the two approaches

Top-Down Method	Bottom-up Method
The top-down method provides results at the overall national transport system level. However, it does not allow for the disaggregation of greenhouse gas emissions by vehicle type or specific study area. As a result, it is not suitable for concretely evaluating transport policies, as it cannot clearly identify which policies effectively reduce greenhouse gas emissions or the magnitude of such reductions.	In contrast, the bottom-up method provides disaggregated results by vehicle type within a defined study area and can distinguish between passenger transport and freight transport. Therefore, it is more suitable for evaluating transport policies in a concrete and policy-relevant manner.

Key Indicators for the Transport Sector Measurement, Reporting And Verification (MRV) System

The indicators are categorized into three main components:

Top-down calculations	Bottom-up calculations	Further useful statistics for analysis

Greenhouse gas emissions can be assessed using both the top-down approach (based on energy data) and the bottom-up approach (based on transport activity data). In addition, relevant economic and social indicators are recommended to support the analysis of long-term emission trends in a comprehensive and accurate manner, as illustrated in **Figure 15**.

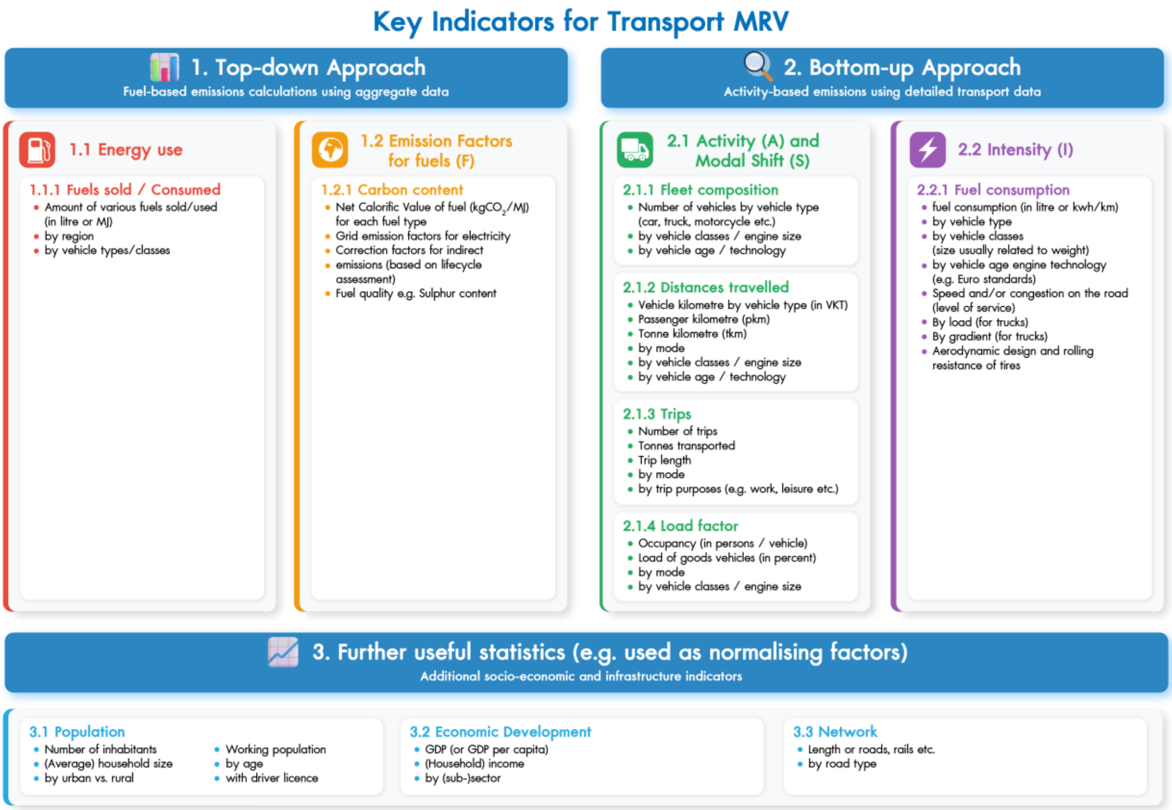
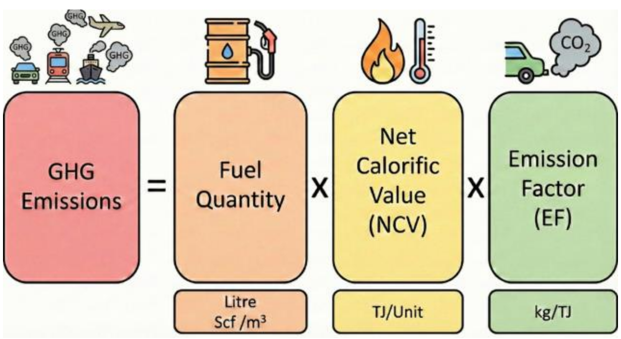


Figure 15 Key Indicators for the Transport Sector Measurement, Reporting and Verification (MRV) System

Details of the analytical approaches used to calculate CO_2 emissions are described as follows:

1) Top-Down Method

The top-down approach is a method for directly estimating CO_2 emissions based on the volume of fuel sales within the study area. These data are compiled and maintained by the Department of Energy Business, Ministry of Energy. CO_2 emissions from fuel combustion can be calculated using Equation (1), as shown below:



....(1)

where: GHG emission = CO_2 Emissions (kg)

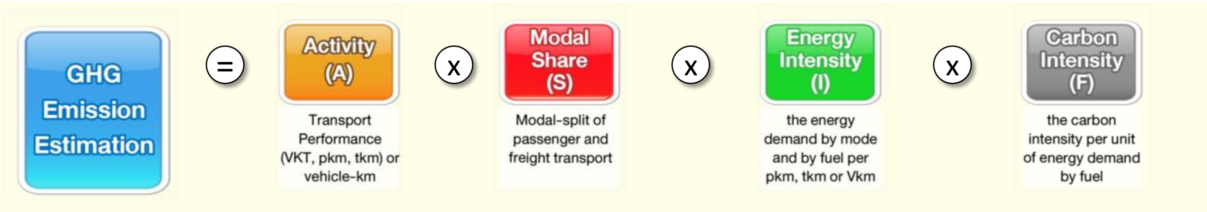
Fuel Quantity = Annual Fuel Sales (liters)

NCV = Net Calorific Value (TJ)

EF = Greenhouse Gas Emission Factor of Fossil Fuels (kg CO_2/ TJ)

2) Bottom-Up Method

The bottom-up approach is an indirect method for estimating CO_2 emissions, primarily based on actual and measurable travel demand. It applies the **ASIF framework (Activity-Structure-Intensity-Fuel)** to calculate CO_2 emission levels. The ASIF formulation for estimating CO_2 emissions is expressed in **Equation (2)** as follows:



	[A]	[S]	[I]	[F]
$kgCO_2$ $ktCO_2$ $MtCO_2$		Mode of transport Type of technology Type of fuel	Energy intensity of:	Carbon content of fuel ($kgCO_2$/TJ):
	Vehicle = vkm		Vehicle = L/vkm, kg/vkm, kWh/vkm, MJ/vkm	Gasoline = 69,300 Diesel = 74,100 LPG = 63,1000 CNG = 56,100
	Passenger = pkm		Passenger = L/pkm, kg/pkm, kWh/pkm, MJ/pkm	
	Freight = tkm		Freight = L/tkm, kg/tkm, kWh/tkm, MJ/tkm	Conversion Factor (MJ/l หรือ MJ/kg) Gasoline = 31.48 Diesel = 36.42 LPG = 26.62 CNG = 37.92

..... (2)

where: GHG emission = CO_2 emissions (kg)

A = Transport Activity for Passengers or Freight (PKT, TKT)

S = Mode or Vehicle Type Share

I = Energy Intensity of Different Transport Modes

Fi = CO_2 Emissions by Energy Type

Details of the analytical components in the above equation are summarized as follows:

1) Estimation of travel demand in the study area (A and S)

The calculation of Activity (A) and Structure (S) focuses on estimating travel demand within the study area, with the objective of determining the Vehicle Kilometers Traveled (VKT) for each transport mode, as shown in **Equation (3).**

Subsequently, Passenger Kilometers Traveled (PKT) are calculated using the average occupancy for each vehicle type, as presented in **Equation (4)**.

	VKTi	=	Vehicle Kilometers Traveled for transport mode *i*	
	VKTi	**=**	**Total $Trip_s$ x S_i x $AvgDIST_i$**	..... (3)
where	Total Trips	=	Total Number of Trips within the Study Area	
	S_i	=	Share of transport mode *i*	
	$AvgDIST_i$	=	Average travel distance	
	PKT_i	=	Passenger Kilometers Traveled (PKT) for transport mode *i*	
	PKT_i	**=**	**VKT_i x $AvgOCC_i$**	..... (4)
where	$AvgOCC_i$	=	Average Vehicle Occupancy for Each Vehicle Type	

2) Energy Intensity by Transport Mode (I)

The variable I (Modal Energy Intensity) represents the energy intensity of different transport modes. The data for this component are derived from the fuel type shares by vehicle category, based on cumulative vehicle registration statistics compiled by the Department of Land Transport (DLT). The DLT records vehicle registrations by fuel type, including gasoline, diesel, LPG, CNG, electricity, non-fuel (trailers), and hybrid vehicles.

3) CO_2 emissions by energy type (F)

The variable F (Carbon Content of Fuels) is based on default values provided in the calculation tool. For example, passenger cars and taxis are assumed to have fuel economy values of 13 km/L for gasoline and 15 km/L for diesel; motorcycles (two-wheeled vehicles) are assumed to have a gasoline fuel economy of 60 km/L; and public buses are assumed to have fuel economy values of 3 km/L for gasoline and 3 km/L for diesel.

Chapter 5
Tracking Assessment of Energy Efficiency, Greenhouse Gas Reduction, and Fine Particulate Matter ($PM_{2.5}$) Reduction

5.1 Guidelines for Assessing Energy Consumption, Greenhouse Gas Emissions, and Fine Particulate Matter ($PM_{2.5}$)

The consultant shall conduct an analysis of the potential for reducing energy consumption and shall assess the performance of reducing greenhouse gas emissions using the Measurement, Reporting, and Verification (MRV) system and fine particulate matter ($PM_{2.5}$) of programs or projects within the energy efficiency improvement measures group for vehicles and the efficiency improvement measures group for transport and logistics systems. This includes the following:

1) Measures for Promoting the Use of Electric Vehicles (Electrification of Transport), including:

1.1) Procurement of electric trains (EV on Train)
1.2) Conversion of electric powered bogies
1.3) Promotion of electric public transport vehicles in urban and non-urban areas
1.4) Promotion of electric vehicles in the personal vehicle group
1.5) Conversion of motorcycle courier services to electric motorcycles in Bangkok, metropolitan areas, and major provincial cities
1.6) Promotion of electric vessels for passenger transport
1.7) Promotion of electric vessels for cargo transport

2) Measures for Improving Vehicle Efficiency (Energy Efficiency Improvement), including:

2.1) Adjustment of annual vehicle tax rates according to CO_2 emission quantities
2.2) Adjustment of excise tax rates according to CO_2 emission quantities for new automobiles and motorcycles
2.3) Energy-efficient driving (Eco-driving) for both cargo and passenger transport

3) Measures for Developing Inter-urban Transport and Green Logistics Systems, including:

3.1) Development of a container transport center via railway linked to Laem Chabang Port (Single Rail Transfer Operation: SRTO)
3.2) Establishment of Distribution Centers (DC), Dry Ports, Inland Container Depots (ICD), and Container Yards (CY)
3.3) Construction of dams to raise water levels in the Chao Phraya River and Nan River for navigation
3.4) Improving the efficiency of cargo transport systems in the Ping River
3.5) Route improvement to enhance the efficiency of waterway transport on river routes
3.6) Development of information technology to promote Shared Mobility in cargo transport for managing empty vehicle returns (Backhaul Management) and resolving the Double Handling problem
3.7) Development of coastal ports

4) Measures for Developing Transport Infrastructure and Support, including:

4.1) Construction of runways 3 and 4 at Suvarnabhumi Airport
4.2) Development of Map Ta Phut Industrial Port Phase 3

In conducting the MRV (Measurement, Reporting and Verification) assessment under the transport sector, it is necessary to regroup the measures to reduce redundancy in reporting greenhouse gas emission reduction results (CO_2). This is particularly important in cases where certain measures have overlapping objectives or impacts, such as the promotion of electric vehicles in various forms or tax measures that affect vehicles overall. If each measure were assessed separately, double counting could occur, which would result in inaccurate data reported to national or international agencies. Therefore, it is necessary to adjust the greenhouse gas assessment guidelines through regrouping and to establish specific methodologies that are appropriate to the characteristics of each measure group.

This approach not only makes the assessment of energy use reduction and CO_2 reduction potential more clear, but also provides benefits for the development of models and indicators that are appropriate to the context of each measure group. This enables efficient, transparent monitoring, evaluation, and reporting of data that can be verified retroactively according to MRV principles, and it also complies with the reporting requirements of national and international environmental and climate change agencies.

The grouping of all nineteen measures into five measure groups with five methodologies (**Figure 16**) is presented below. Each group has distinct methodologies determined according to the type of measures and the key data necessary for assessing relevant CO_2 emission reductions.

<u>Methodology 1</u>

1-1 Measure Group for Promoting the Use of Electric Vehicles (Electrification of Transport)

1.1 Conversion of motorcycle courier services to electric motorcycles in Bangkok, metropolitan areas, and major provincial cities

1.2 Promotion of electric vessels for passenger transport

1.3 Conversion of electric powered bogies

1-2 Measure Group for Promoting the Use of Electric Vehicles (Electrification of Transport) and Measures for Improving Vehicle Efficiency (Energy Efficiency Improvement) - Public Transport Vehicles

1.4 Promotion of electric public transport vehicles in urban and non-urban areas

1.5 Energy-efficient driving (Eco-driving) for passenger transport

1-3 Measure Group for Promoting the Use of Electric Vehicles (Electrification of Transport) and Measures for Improving Vehicle Efficiency (Energy Efficiency Improvement) - Light-duty Vehicles

1.6 Promotion of electric vehicles in the personal vehicle group

1.7 Adjustment of annual vehicle tax rates according to CO_2 emission quantities

1.8 Adjustment of excise tax rates according to CO_2 emission quantities for new automobiles and motorcycles

Methodology 2

Measure Group for Promoting the Use of Electric Vehicles (Electrification of Transport), Measures for Improving Vehicle Efficiency (Energy Efficiency Improvement), and Measures for Developing Inter-urban Transport and Green Logistics Systems

2.1 Procurement of electric trains (EV on Train)
2.2 Promotion of electric vessels for cargo transport
2.3 Energy-efficient driving (Eco-driving) for cargo transport
2.4 Development of information technology to promote Shared Mobility in cargo transport for managing empty vehicle returns (Backhaul Management) and resolving the Double Handling problem
2.5 Development of a container transport center via railway linked to Laem Chabang Port (Single Rail Transfer Operation: SRTO)
2.6 Establishment of Distribution Centers (DC), Dry Ports, Inland Container Depots (ICD), and Container Yards (CY)
2.7 Construction of dams to raise water levels in the Chao Phraya River and Nan River for navigation
2.8 Improving the efficiency of cargo transport systems in the Ping River
2.9 Route improvement to enhance the efficiency of waterway transport on river routes

Methodology 3

Measure Group for Developing Inter-urban Transport and Green Logistics Systems

Development of Andaman coastal ports

Methodology 4

Measure Group for Developing Transport Infrastructure and Support

Construction of runways 3 and 4 at Suvarnabhumi Airport

Methodology 5

Measure Group for Developing Transport Infrastructure and Support

Improvement of cargo handling equipment at Laem Chabang Port

Note: The development of Map Ta Phut Industrial Port Phase 3 does not have MRV assessment guidelines established. MRV assessment guidelines have been added for the measure to improve cargo handling equipment at Laem Chabang Port.

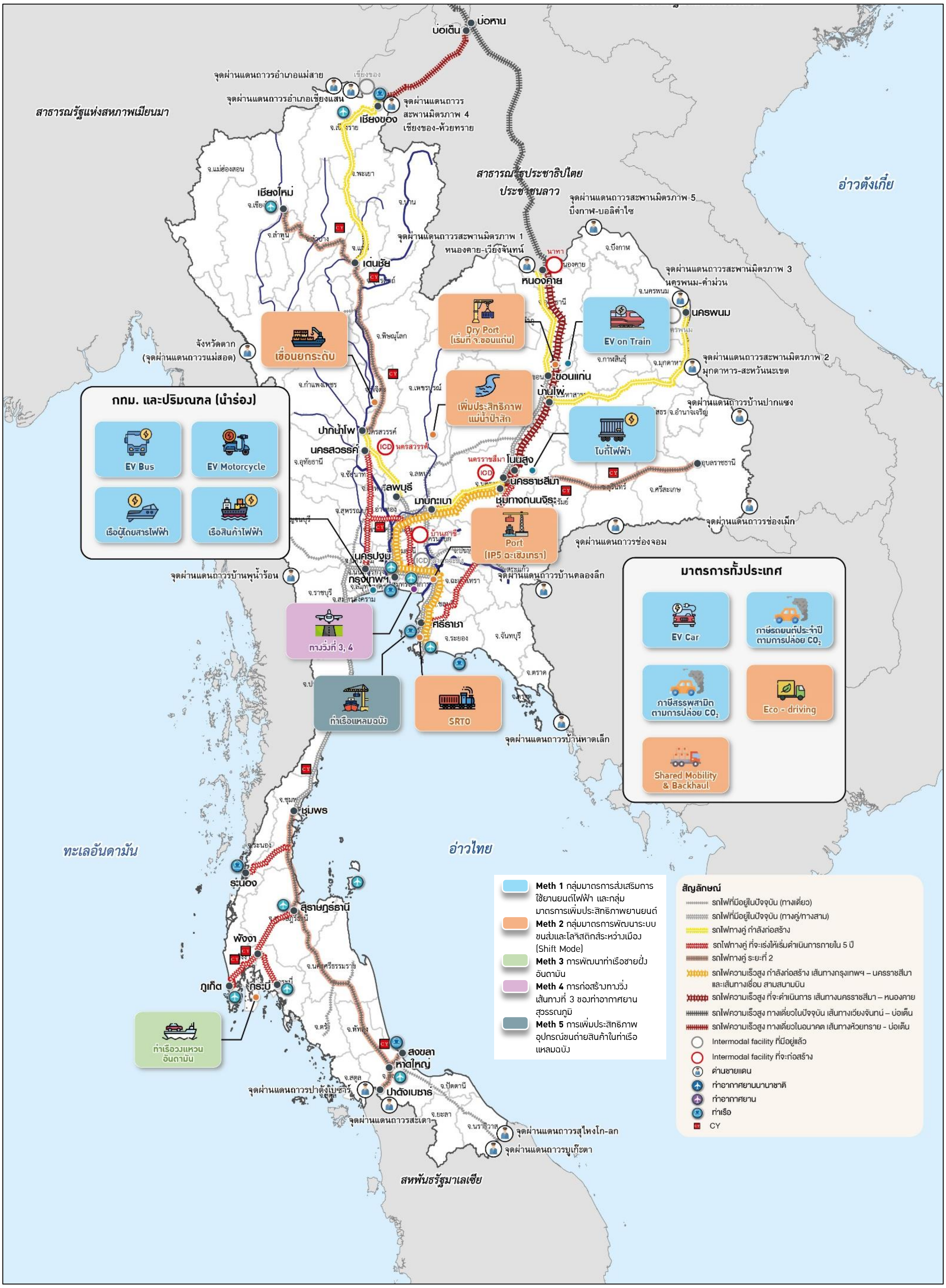


Figure 16 Scope of MRV Assessment for Projects in the Transport Sector

5.2 Summary of Assessment Results on Reductions in Energy Consumption, Greenhouse Gas Emissions, and Fine Particulate Matter ($PM_{2.5}$) by Measure Group

The summary of assessment results on reductions in energy consumption, greenhouse gas emissions, and fine particulate matter (PM2.5) by measure group is presented in **Table 7**.

Table 7 Summary of Energy Use, Greenhouse Gas, and $PM_{2.5}$ Reduction by Transport Measures

Methodology	Measure Name	Energy Reduction (ktoe)	GHG Reduction ($MtCO_2e$)	$PM_{2.5}$ Reduction (Ton $PM_{2.5}$)
Meth #1	**Measure Groups: Electrification of Transport and Energy Efficiency Improvement**	**2,306.73**	**5.90**	**-82.86**
	1-1 Electrification of Transport	**18.53**	**0.05**	**5.28**
	1.1 Conversion of delivery motorcycles to electric motorcycles in Bangkok Metropolitan Area, its vicinity, and major regional cities	17.65	0.05	4.43
	1.2 Promotion of electric passenger boats	0.41	0.00	0.40
	1.3 Retrofit of power cars to electric bogies	0.47	0.00	0.45
	1-2 Electrification of Transport and Energy Efficiency Improvement - Public Transport	**231.82**	**0.64**	**309.65**
	1.4 Promotion of electric public buses in urban and intercity areas	231.82	0.64	309.65
	1.5 Eco-driving for passenger transport			
	1-3 Electrification of Transport and Energy Efficiency Improvement - Light-duty Vehicles	**2,056.39**	**5.21**	**-397.80**
	1.6 Promotion of electric vehicles for private passenger cars	2,056.39	5.21	-397.80
	1.7 Revision of annual vehicle tax rates based on CO_2 emissions			
	1.8 Revision of excise tax rates based on CO_2 emissions for new cars and motorcycles			
Meth #2	**Electrification of Transport, Energy Efficiency Improvement, and Inter-urban Transport and Green Logistics**	**-522.71**	**-1.63**	**813.31**
	• Procurement of electric locomotives (EV on Train)	-522.71	-1.63	813.31
	• Promotion of electric vessels for freight transport			
	• Eco-driving for freight transport			
	• Development of information technology systems to promote shared mobility for freight transport, including backhaul management and reduction of double handling			
	• Development of rail-based container transport centers connecting Laem Chabang Port (Single Rail Transfer Operation: SRTO)			
	• Establishment of distribution centers (DC), Dry Ports, Inland Container Depots (ICD), and Container Yards (CY)			
	• Construction of elevated river structures in the Chao Phraya and Nan Rivers to support navigation			
	• Enhancement of freight transport efficiency in the Pa Sak River			
	• Improvement of river routes to increase the efficiency of inland water transport			
Total (Meth #1 - Meth #2)		**1,784.02**	**4.27**	**730.45**
Meth #3	**Inter-urban Transport and Green Logistics**			
	• Development of Andaman coastal ports	2.26	0.01	0.19
Meth #4	**Transport Infrastructure and Support**			
	• Construction of Runways 3 and 4 at Suvarnabhumi Airport	13.69	0.04	1.25
Meth #5	**Transport Infrastructure and Support**			
	• Enhancement of cargo handling equipment efficiency at Laem Chabang Port	1.35	0.01	2.90
Total (Meth #3 - Meth #4)		**17.29**	**0.06**	**4.34**

Based on the assessment of transport sector measures supporting reductions in energy consumption, greenhouse gas (GHG) emissions, and fine particulate matter (PM2.5), the results indicate that the measure group with the highest mitigation potential is the Electrification of Transport combined with Energy Efficiency Improvement under Methodology #1. This group is estimated to reduce energy consumption by 2,306.77 ktoe, reduce GHG emissions by 5.90 $MtCO_2e$, and result in an increase in PM2.5 emissions of 82.86 tons, with the most significant contribution coming from the promotion of electric vehicles in the private passenger car segment. However, the GHG reduction achieved under this measure group is lower than projected in the NDC, mainly due to the lower-than-expected uptake of electric pickup trucks compared with the NDC assumptions (based on the 30@30 plan), as well as higher-than-anticipated travel distances for certain vehicle categories.

In contrast, Methodology #2, which integrates logistics and inter-urban transport measures, is not projected to achieve reductions in energy consumption, GHG emissions, or PM2.5 in the year 2023 due to multiple contributing factors. In particular, measures under the Inter-urban Transport and Green Logistics group and Energy Efficiency Improvement measures involving modal shift show negative net impacts on energy use and GHG emissions. This outcome is primarily attributed to an increase in the number of trucks with six wheels or fewer relative to the baseline scenario. These vehicles exhibit higher energy efficiency than other truck types, but their increased numbers, together with longer average travel distances across several truck categories, result in higher overall GHG emissions. In addition, the market penetration of electric trucks remains below NDC expectations (based on the 30@30 plan). Other contributing factors include the absence of electric locomotive deployment and a decline in the share of rail freight transport compared with the target scenario, with rail transport volumes under the project case falling below those in the baseline. These findings highlight the challenges associated with planning freight transport and logistics systems that effectively support green transport objectives in the future.

For project-based measures under Methodology #4, the construction of additional runways at Suvarnabhumi Airport yields only limited reductions in energy consumption and pollutant emissions, with estimated reductions of approximately 13.69 ktoe in energy consumption, 0.06 $MtCO_2e$ in GHG emissions, and 4.34 tons of PM2.5. The assessment of the Andaman coastal port development project will commence after 2028.

Overall, the combined results across all measure groups underscore the potential of system-level measures and clean technologies in supporting sustainable development goals and reducing environmental impacts in Thailand’s transport sector.

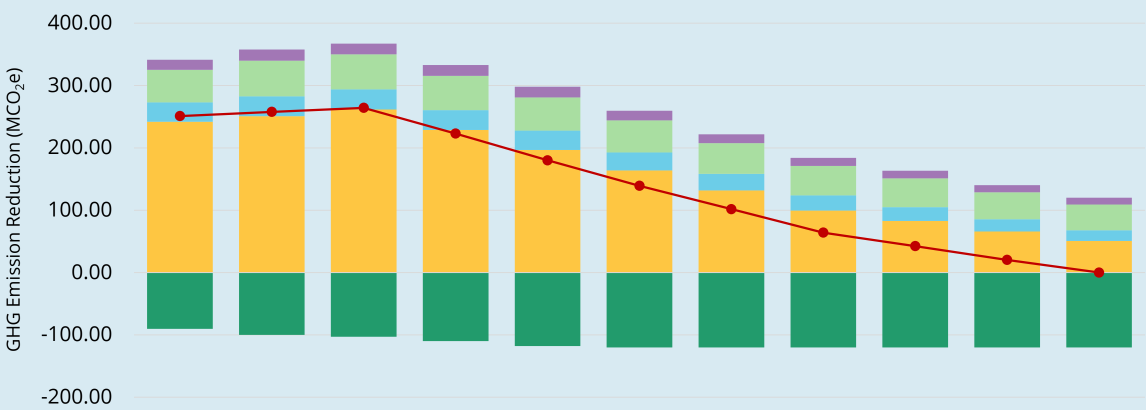
5.3 Overall Summary of Assessment Results on Energy Use, Greenhouse Gas Emissions, and Fine Particulate Matter ($PM_{2.5}$) in the Transport Sector

Overall summary of assessment results on energy use, greenhouse gas emissions, and fine particulate matter (PM2.5) in the transport sector.

5.3.1 Review of Greenhouse Gas Reduction Potential from Transport Sector Measures

In studying the potential for reducing greenhouse gas emissions in the transport sector to achieve the goals of the revised Long-Term Low Emission Development Strategy (LT-LEDS), the analysis encompasses energy use and greenhouse gas emission projections in the domestic transport sector. This includes road transport, rail transport, water transport, and air transport. The analysis covers all energy sources used in the transport sector, including gasoline, diesel, natural gas, liquefied petroleum gas, biofuels, and electricity. Greenhouse gases included in the analysis are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

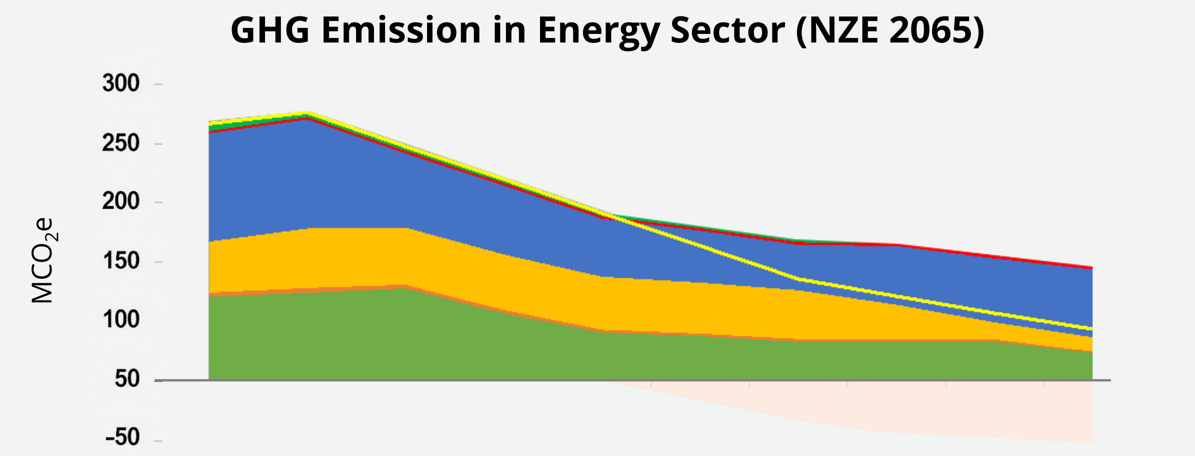
Based on the revised Long-Term Low Emission Development Strategy (LT-LEDS), carbon neutrality is targeted for 2050 and net-zero greenhouse gas emissions for 2065. To achieve these goals, each economic sector has been assigned specific greenhouse gas emission quantities for each year. The energy sector is required to limit emissions to no more than 228.63 $MtCO_2e$ and 99.48 $MtCO_2e$ in 2030 and 2050, respectively, as shown in **Figure 17.** When considering the energy sector specifically, the transport sector must limit emissions to no more than 90.2 $MtCO_2e$ in 2030 and 38.5 $MtCO_2e$ in 2050, respectively, as shown in **Figure 18.**



	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065
Waste	16.00	18.00	17.17	17.39	17.19	15.37	14.19	13.07	12.33	11.58	10.84
Agriculture	52.17	57.00	56.23	55.07	53.09	51.51	49.13	47.15	46.17	43.19	41.20
LUCF	31.07	32.00	32.17	31.90	31.03	28.86	26.65	24.39	22.06	19.69	17.28
Energy	242.02	250.77	261.62	228.63	196.77	163.84	131.80	99.48	82.81	65.81	50.69
LU/LUCF	-90.26	-100.0	-103.0	-110.0	-118.0	-120.0	-120.0	-120.0	-120.0	-120.0	-120.0
Net Emission	250.99	257.77	264.19	222.99	180.08	139.18	101.77	64.09	42.37	20.27	0.00

Source: Office of Natural Resources and Environmental Policy and Planning and Thammasat University (2022)

Figure 17 Scenario Projection of Greenhouse Gas Emissions toward the Net Zero Emission 2065 Target

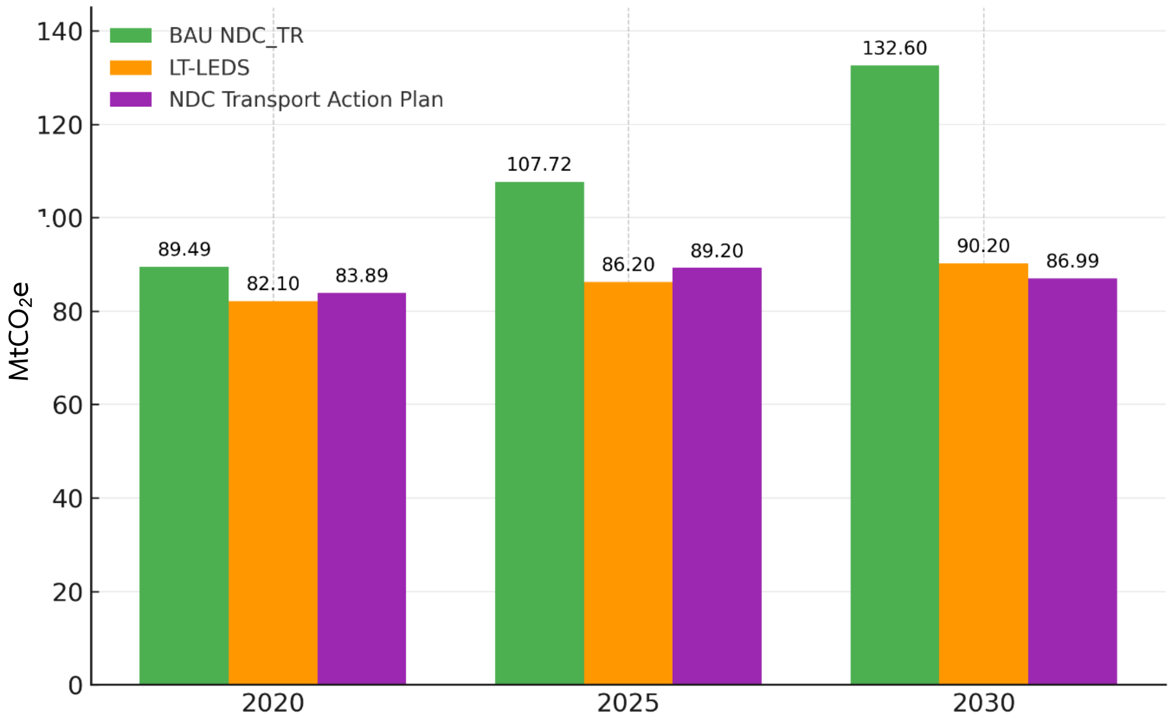


	2000	2025	2030	2035	2040	2045	2050	2055	2060	2065
Agriculture	7.2	4.3	4.3	3.8	3.2	2.9	2.8	0.1	0.1	0.0
Commercial	2.4	2.5	2.4	2.4	2.5	2.6	2.8	2.9	2.9	3.0
Power	105.5	106.4	72.2	67.4	56.5	50.5	44.3	57.3	62.5	66.2
Industry	49.7	57.8	55.8	53.7	51.6	49.6	47.5	33.2	16.7	13.9
Residential	3.9	4.4	3.7	3.2	2.6	2.5	2.5	2.4	2.2	1.5
Transport	82.1	86.2	90.2	66.3	47.4	43.7	38.5	38.6	38.3	27.4
CCS+BECCS	0.0	0.0	0.0	0.0	0.0	-20.1	-38.8	-51.7	-56.8	-61.3
Net	250.8	261.6	228.6	196.8	163.8	131.7	99.6	82.8	65.9	50.7

Source: Office of Natural Resources and Environmental Policy and Planning and Thammasat University (2022)

Figure 18 Scenario Projection of Greenhouse Gas Emissions
in the Energy Sector toward the Net Zero Emission 2065 Target

Comparison of greenhouse gas emissions under the Business-as-Usual (BAU) scenario according to Thailand's Nationally Determined Contribution (NDC) roadmap, greenhouse gas emission targets according to the revised Long-Term Low Emission Development Strategy (LT-LEDS), and the greenhouse gas reduction action plan in the transport sector (NDC Action Plan) reveals the following: In 2030, according to the LT-LEDS plan, greenhouse gas emissions from the transport sector are set not to exceed 90.20 $MtCO_2e$, which is equivalent to <u>setting a greenhouse gas reduction target of 42.4 $MtCO_2e$</u> compared to the BAU scenario. Based on the assessment of energy use and greenhouse gas emissions from the implementation of measures under the NDC Action Plan, it was found that greenhouse gas emissions would be approximately 86.99 $MtCO_2e$, or <u>reduction of 45.61 $MtCO_2e$ in greenhouse gas emissions</u> compared to the BAU scenario. This performance is <u>3.21 $MtCO_2e$ higher than the target set under the LT-LEDS plan</u>. Details of the greenhouse gas reduction potential of each measure group are presented in **Figure 20** and **Table 8.**



Source: Consultant, 2023

Figure 19 Comparison of Greenhouse Gas Emissions in the Transport Sector under the Business-as-Usual Scenario for the Nationally Determined Contribution (BAU NDC_TR), the Long-Term Low Emission Development Strategy (LT-LEDS) and the Nationally Determined Contribution Transport Action Plan (NDC Transport Action Plan)

Table 8 Greenhouse Gas Mitigation Potential of the Transport Sector by Measure Group

Measures	GHG Reduction Potential ($MtCO_2e$)									
	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573
(1) Measures for Promoting the Use of Electric Vehicles (Electrification of Transport)	6.21	5.64	6.27	7.40	10.65	13.38	16.48	19.89	23.59	28.29
(2) Measures for Improving Vehicle Efficiency (Energy Efficiency Improvement)	4.14	4.03	4.60	5.41	6.95	8.10	9.37	10.72	12.15	13.94
(3) Measures for Developing Urban Transport Systems (Urban Mobility)	0.65	0.59	0.62	0.70	0.91	1.05	1.21	1.37	1.55	1.78
(4) Development of Inter-urban Transport and Green Logistics Systems (Inter-urban Transport and Green Logistics)	0.58	0.52	0.55	0.63	0.82	0.94	1.08	1.23	1.39	1.60
รวม	11.59	10.78	12.04	14.14	19.33	23.47	28.13	33.21	38.67	45.61

5.3.2 Assessment Results of Energy Use Reduction, Greenhouse Gas Emissions Reduction, and Fine Particulate Matter ($PM_{2.5}$) Reduction from Measures in the Transport Sector

Based on the project analysis and assessment, the assessment results on energy use reduction, greenhouse gas emissions reduction, and fine particulate matter ($PM_{2.5}$) reduction from measures in the transport sector can be summarized as presented in **Table 9, 10, 11.**

Table 9 Summary Assessment of GHG Emissions from Transport Sector Measures

Greenhouse Gas Emissions ($MtCO_2e$)

Measure	Baseline Case	Project Case	NDC Case	GHG Reduction	Expected Reduction	Gap
(1) Electric Vehicles & Energy Efficiency	69.84	63.94	65.04	5.90	4.80	1.10
(2) Electric Vehicles, Energy Efficiency & Inter-urban Logistics	29.25	30.88	26.09	-1.63	3.17	-4.80
(3) Andaman Coastal Ports Development	0.01	0.01		0.01		
(4) Suvarnabhumi Airport Runway 3 & 4	0.10	0.06		0.04		
(5) Laem Chabang Port Equipment	0.03	0.02		0.01		
Total	99.24	94.90	91.13	4.33	7.96	-3.69

Table 10 Summary Assessment of Energy Consumption from Transport Sector Measures

Energy Consumption (ktoe)

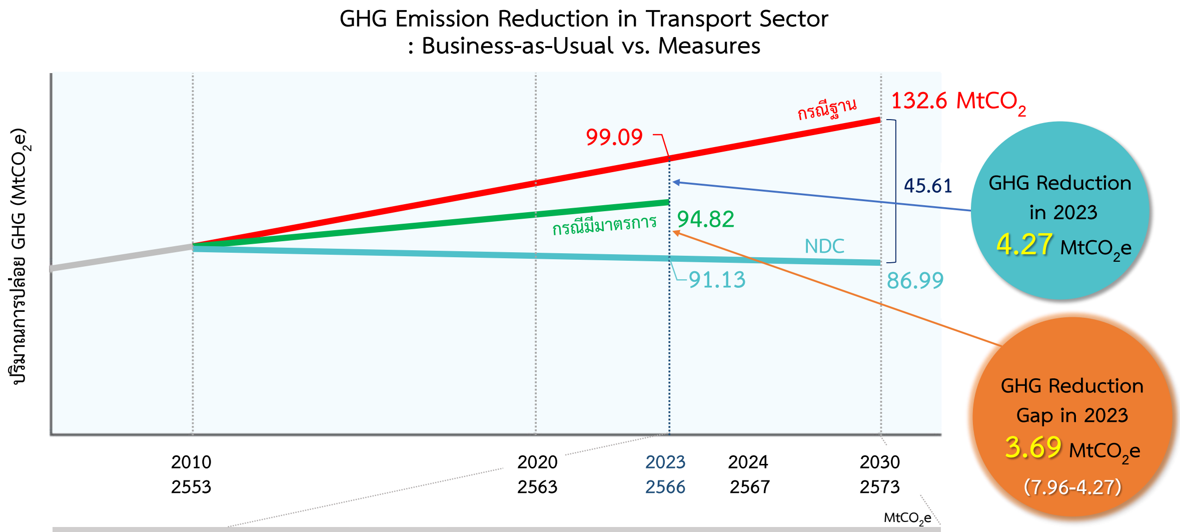
Measure	Baseline Case	Project Case	NDC Case	Energy Reduction	Expected Reduction	Gap
(1) Electric Vehicles & Energy Efficiency	25,411.38	23,104.64	23,993.47	2,306.73	1,417.91	888.83
(2) Electric Vehicles, Energy Efficiency & Inter-urban Logistics	10,199.13	10,721.84	9,104.56	-522.71	1,094.57	-1,617.28
(3) Andaman Coastal Ports Development	5.22	2.96		2.26		
(4) Suvarnabhumi Airport Runway 3 & 4	32.08	18.39		13.69		
(5) Laem Chabang Port Equipment	11.16	9.81		1.35		
Total	35,658.96	33,857.65	33,098.03	1,801.31	2,512.47	-728.45

Table 11 Summary Assessment of PM2.5 Reduction from Transport Sector Measures

$PM_{2.5}$ Emissions (Ton $PM_{2.5}$)

Measure	Baseline Case	Project Case	NDC Case	$PM_{2.5}$ Reduction	Expected Reduction	Gap
(1) Electric Vehicles & Energy Efficiency	7,146.79	7,229.65	7,210.56	-82.86	-63.77	-19.09
(2) Electric Vehicles, Energy Efficiency & Inter-urban Logistics	9,569.08	8,755.76	9,097.61	813.31	471.47	341.85
(3) Andaman Coastal Ports Development	0.43	0.24		0.18		
(4) Suvarnabhumi Airport Runway 3 & 4	2.93	1.68		1.25		
(5) Laem Chabang Port Equipment	6.94	4.03		2.90		
Total	16,726.15	15,991.36	16,308.17	734.79	407.70	322.76

Based on the assessment of transport sector measures supporting reductions in energy consumption, greenhouse gas emissions (GHG), and fine particulate matter ($PM_{2.5}$), the combined measures under Methodology #1 and Methodology #2 can reduce energy consumption by 1,784.02 kilotonnes of oil equivalent (ktoe), reduce GHG emissions by 4.27 million tonnes of carbon dioxide equivalent ($MtCO_2e$), and reduce PM2.5 emissions by 730.45 tonnes. The baseline scenario shows GHG emissions of 99.09 $MtCO_2e$, compared with 95.62 $MtCO_2e$ under the project scenario and 91.13 $MtCO_2e$ under the Nationally Determined Contribution (NDC) scenario, indicating that additional transport sector measures are still required to further reduce GHG emissions by 3.69 $MtCO_2e$ in order to achieve the national NDC target, as summarized in **Figure 20**.



$MtCO_2e$

	2023	2024	2025	2026	2027	2028	2029	2030
BAU	99.09	103.43	107.17	111.78	116.58	121.60	126.82	132.60
Tracking	94.82	95.28P						
NDC	91.13	90.57	89.20	89.33	89.17	88.80	88.27	86.99

Figure 20 Reduction in Greenhouse Gas (GHG) Emissions
from Transport Sector Measures

The study, analysis, and assessment of transport sector measures indicate that they comprehensively cover all actions under NDC Action Plan on Mitigation 2021 - 2030 (Transport Sector, Revised Version) and the revised Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS), with methodological completeness, accuracy, and traceability, based on a system-based approach that avoids double counting. These results provide a solid foundation for defining the scope and implementation pathways toward achieving Carbon Neutrality by 2050 and Net Zero Emissions by 2065, and for effectively supporting the policy decision to accelerate the national Net Zero target by 15 years from 2065 to 2050.

The assessment further confirms that high-potential measures—particularly Electrification of Transport, Energy Efficiency Improvement, and the adoption of Future Energy—require strong and active participation from the private sector, together with appropriate economic instruments and fiscal measures to incentivize behavioral change in travel patterns and investment in clean technologies. Meanwhile, measures related to energy efficiency, urban transport system development, and inter-urban transport and logistics require sustained investment and close integration of transport policies and plans to ensure that greenhouse gas reduction outcomes are achieved as expected.

Regarding fine particulate matter ($PM_{2.5}$), the tracking assessment indicates that transport sector measures can significantly reduce $PM_{2.5}$ emissions. Baseline $PM_{2.5}$ emissions were 16,726.15 tons and decreased to 15,991.36 tons under the project scenario, representing a total reduction of 734.79 tons. The measures with the greatest $PM_{2.5}$ reduction potential are policy-based measures under Methodology #2, including Electrification of Transport, Energy Efficiency Improvement, and Inter-urban Transport and Green Logistics, which together reduce $PM_{2.5}$ by up to 813.31 tons. This is followed by Methodology #1-2, focusing on electrification and energy efficiency in public transport, achieving a reduction of 309.65 tons. These results reflect the effectiveness of such measures in directly reducing major pollution sources, particularly fuel combustion from on-road vehicles—especially diesel use in commercial transport such as trucks—as well as reducing travel activity through improved logistics efficiency, including reduced empty trips, congestion mitigation, and enhanced transport efficiency. In contrast, project-based infrastructure measures with localized impacts, such as Andaman coastal port development, runway construction at Suvarnabhumi Airport, and efficiency improvements in cargo-handling equipment at Laem Chabang Port, show relatively limited $PM_{2.5}$ reductions (approximately 0.18 - 2.90 tons) due to their confined scope. Overall, the assessment highlights that accelerating the transition to cleaner vehicle technologies, improving energy efficiency, and optimizing logistics systems to reduce average vehicle kilometers traveled (VKT) are the most effective approaches for reducing $PM_{2.5}$, while infrastructure measures should be designed to directly reduce diesel fuel use and actual travel distances to enhance future $PM_{2.5}$ reduction potential.

In this regard, the consultant has assessed greenhouse gas emissions under the baseline scenario for measures included in the NDC Action Plan for the period 2024 - 2030, as presented in **Table 12**

Table 12 Assessment of greenhouse gas emissions under the baseline scenario ($MtCO_2e$) for measures in NDC Action Plan in 2024 - 2030

Measure	2567	2568	2569	2570	2571	2572	2573
	2024	2025	2026	2027	2028	2029	2030
Meth 1 Electrification of Transport and Energy Efficiency Improvement	**69.86**	**76.24**	**77.84**	**79.45**	**81.12**	**82.82**	**84.61**
Meth 1.1 Conversion of delivery motorcycles to electric motorcycles in Bangkok Metropolitan Area, its vicinity, and major regional cities	0.13	0.12	0.12	0.13	0.13	0.13	0.13
Meth 1.2 Promotion of electric passenger boats	0.08	0.08	0.08	0.08	0.09	0.09	0.09
Meth 1.3 Retrofit of power cars to electric bogies	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Meth 1.4 - 1.5 Electrification of Transport and Energy Efficiency Improvement - Public Buses	3.37	3.54	3.73	3.92	4.14	4.36	4.60
Meth 1.6 - 1.8 Electrification of Transport and Energy Efficiency Improvement - Light-duty Vehicles	71.88	72.47	73.88	75.29	76.74	78.22	79.77
Meth 2 Electrification of Transport, Energy Efficiency Improvement, and Inter-urban Transport and Green Logistics	**30.08**	**30.83**	**31.67**	**32.60**	**33.60**	**34.69**	**35.84**
Total	105.55	107.07	109.51	112.05	114.72	117.52	120.45

Based on the assessment of greenhouse gas emissions under the baseline scenario for measures included in the NDC Action Plan during 2024 - 2030 (**Table 12**), greenhouse gas emissions from the transport sector are projected to continuously increase from 99.11 $MtCO_2e$ in 2024 to 120.43 $MtCO_2e$ in 2030. These emissions represent those associated with the key measures under the NDC Action Plan. The baseline emission assessment for measures under the NDC Action Plan for the period 2024 - 2030 has been developed to serve as a reference scenario (Baseline Scenario) for systematic comparison and monitoring of greenhouse gas emission outcomes under the implementation of transport sector measures in subsequent years. This will enable relevant agencies to clearly and transparently evaluate the effectiveness of greenhouse gas mitigation measures, ensuring alignment with the country’s long-term NDC emission reduction targets.

5.3.3 Observations from the Assessment of Energy Consumption Reduction, Greenhouse Gas Emissions and ($PM_{2.5}$) Emissions from Measures in the Transport Sector

Passenger Cars

The comparison between the baseline scenario and the project scenario for passenger cars indicates a significant structural change in the registered vehicle fleet. Under the project scenario, the share of electric vehicles (EVs) and hybrid vehicles increases markedly compared with the baseline scenario, while the proportion of internal combustion engine vehicles, particularly gasoline cars, begins to decline. This reflects the impact of policies promoting electric vehicle adoption and accelerating technological transition in passenger vehicles.

In terms of travel activity, the average vehicle kilometers traveled (VKT) per vehicle per year for passenger cars remains similar across both scenarios for nearly all technologies. This suggests that the project scenario does not significantly reduce overall travel demand. Instead, travel activity shifts from conventional fuel-based vehicles toward lower-emission vehicles, particularly electric and hybrid vehicles.

At the same time, energy efficiency of the registered vehicle fleet improves noticeably under the project scenario across several technologies, especially gasoline vehicles, LPG vehicles and electric vehicles. This improvement reflects the adoption of newer vehicle models, advancements in engine and electric drivetrain technologies, and the combined effect of energy efficiency improvement measures alongside EV promotion policies.

As a result of technological transition, improved energy efficiency, and restructuring of the vehicle fleet, greenhouse gas emissions from passenger cars under the project scenario are significantly lower than those projected under the baseline scenario, even though total travel demand does not decrease. The emission reduction is therefore mainly driven by technological improvements rather than restrictions on travel activities.

In summary, the analysis confirms that measures promoting electric vehicles and improving energy efficiency can effectively reduce greenhouse gas emissions from passenger cars through fleet transformation and reductions in energy intensity per unit of travel distance. This approach represents a key mechanism for steering the transport sector toward long-term decarbonization targets without compromising public mobility access.

Private Freight Vehicles (Private Pickup Trucks)

A comparison of calculation results between the baseline scenario and the project scenario for private freight vehicles (private pickup trucks) reveals dynamics that differ significantly from passenger cars. The structure of the registered vehicle fleet in both scenarios continues to rely predominantly on diesel vehicles. In the baseline scenario, diesel vehicles account for approximately 94% of registered vehicles, increasing to more than 95% under the project scenario. Meanwhile, the share of electric and hybrid vehicles remains very low or almost absent, reflecting technological transition constraints within this vehicle segment.

In terms of travel activity, the average annual VKT per private pickup truck increases significantly under the project scenario compared with the baseline scenario, particularly for gasoline and diesel vehicles. This indicates that real-world usage intensity of pickup trucks is higher than assumed in the baseline scenario. Such a trend aligns with the role of pickup trucks as semi-commercial vehicles supporting logistics activities, goods distribution, and the continuously expanding digital economy.

Although energy efficiency of registered vehicles improves in nearly all technologies under the project scenario—reflecting the adoption of newer vehicle models and improvements in energy-saving technologies—the increase in travel distance per vehicle almost entirely offsets these efficiency gains, resulting in an overall increase in system energy consumption.

Because fleet structure continues to depend primarily on diesel vehicles, combined with increased VKT per vehicle, greenhouse gas emissions from private pickup trucks under the project scenario are clearly higher than those projected in the baseline scenario. This contrasts with passenger cars, where emissions decrease due to technological transition.

In summary, existing EV promotion and energy efficiency improvement measures effectively reduce emissions in passenger cars but remain limited in impact for private pickup trucks, which continue to rely heavily on diesel technology and exhibit increasing usage trends. These findings highlight the need for targeted policies to support decarbonization in semi-commercial vehicle segments, such as development of electric pickup trucks, financial incentives, and stricter energy efficiency standards, to ensure comprehensive emission reduction across all vehicle categories.

Motorcycles

A comparison of energy consumption and greenhouse gas emission results for motorcycles shows that fleet structure in both scenarios remains largely dominated by gasoline-powered motorcycles. However, under the project scenario, electric motorcycles (BEVs) begin to appear in increasing numbers, although their share remains very small compared with the total fleet, reflecting an early stage of technological transition in two-wheel vehicles.

Regarding travel activity, average annual VKT per motorcycle decreases under the project scenario compared with the baseline scenario, indicating a slight reduction in actual usage compared with projections. However, this reduction in VKT is not the primary factor driving emission reduction.

In terms of energy efficiency, motorcycles under the project scenario demonstrate noticeable improvements, particularly gasoline motorcycles, reflecting technological advances in small engines and gradual fleet turnover toward more fuel-efficient models.

As a result of changes in fleet structure, improved energy efficiency, and shifts in travel activity, greenhouse gas emissions from motorcycles under the project scenario decrease by approximately 8% compared with baseline projections.

In summary, emission reductions in the motorcycle segment are primarily driven by improvements in fuel efficiency of gasoline motorcycles, alongside the initial adoption of electric motorcycles, although EV penetration remains small at present. The analysis suggests that energy efficiency standards and accelerated replacement of older vehicles can deliver tangible emission reductions in the short term, while electric motorcycle adoption will play a more significant role in the future.

Freight Trucks (Intercity Transport)

Comparison between the baseline and project scenarios for intercity freight trucks indicates that green logistics and transport system development measures significantly influence freight activity structure. Under the project scenario, total transport activity measured in Vehicle Kilometers Travelled (VKM) decreases relative to the baseline scenario, reflecting improved route efficiency, consolidation of freight trips, and reduced empty running achieved through green logistics policies.

In terms of fleet structure, vehicle category distribution adjusts slightly compared with the baseline scenario, with an increased share of small trucks, a slight reduction in large trucks, and limited growth in trailer and semi-trailer vehicles. These changes reflect improved matching of transport modes to cargo characteristics and transport distances. However, technologically, the fleet remains overwhelmingly dependent on diesel vehicles, accounting for more than 97% in both scenarios, while adoption of EVs and alternative fuels remains minimal.

Energy efficiency improves in certain truck categories under the project scenario, reflecting adoption of newer vehicles and improved load management practices, although energy intensity per kilometer remains high for some vehicle types due to commercial operational requirements.

While reduced transport activity and improved energy efficiency help lower overall energy consumption, continued dependence on fossil fuels—particularly diesel—means that greenhouse gas emissions from intercity freight trucks under the project scenario remain slightly higher than baseline projections.

In summary, although green logistics measures effectively reduce transport activity and improve energy efficiency, these improvements are insufficient to fully offset emissions from diesel-dominated fleets. The analysis highlights the need for complementary measures supporting technological transition toward low-carbon freight vehicles to ensure sustainable long-term emission reductions in freight transport.

Public Transport Buses

Comparison between the baseline and project scenarios for public transport buses shows that EV promotion and energy efficiency improvement measures can produce clear positive impacts on greenhouse gas emission reductions in public transport.

In fleet structure terms, although diesel buses still dominate in both scenarios, the project scenario shows a noticeable increase in electric bus adoption compared with the baseline, while the share of CNG buses declines slightly, reflecting policy-driven technological transition in public transport systems.

In terms of transport activities, the average annual Vehicle Kilometers Traveled (VKT) for public buses in the Project Scenario reflects a slight decrease compared to the Base Case. This decline potentially signifies enhanced scheduling efficiency, which minimizes redundant vehicle operations. Concurrently, the energy efficiency of the bus fleet under the Project Scenario has shown marked improvement; notably, diesel buses exhibit a reduction in energy consumption per unit of distance, driven by the integration of advanced high-efficiency engine technologies.

Combined changes in fleet structure, operational activity, and energy efficiency result in approximately a 20% reduction in greenhouse gas emissions from public buses under the project scenario compared with baseline projections.

The analysis demonstrates that electric bus promotion combined with energy efficiency improvements and eco-driving measures can significantly reduce emissions in public transport in the short to medium term, serving as a key mechanism for moving mass transit toward a low-carbon pathway.

The analysis shows that EV promotion and energy efficiency measures effectively reduce greenhouse gas emissions in passenger cars and public transport systems. However, vehicle segments still heavily dependent on diesel—particularly private pickup trucks and commercial freight trucks—remain major challenges for road transport decarbonization. The study therefore highlights the necessity of targeted policies to accelerate technological transition toward low-carbon freight vehicle technologies alongside improvements in transport efficiency, ensuring comprehensive and sustainable emission reductions across the entire transport sector in the long term.

5.3.4 Project Recommendations

This study has led to important policy recommendations as follows:

5.3.4.1 Policy Recommendations

1) **Development of a Transport Sector Roadmap toward Carbon Neutrality and Net Zero 2050**

   Establishing a national roadmap for the transport sector must integrate the country's key policy frameworks—LT-LEDS (Long-Term Low Emission Development Strategy), NDC (Nationally Determined Contribution), and National Energy Plan—to ensure consistency in both objectives and implementation methods. This ensures all relevant agencies have a unified direction for reducing greenhouse gas emissions from the transport sector. Additionally, an "Inter-Agency Core Committee" should be established to integrate plans, oversee measure implementation, and manage a centralized MRV (Measurement, Reporting and Verification) system using a single standard across all sectors. This ensures that greenhouse gas reduction reporting is transparent and verifiable.

2) **Development of a Centralized Digital Database**

   The analysis and monitoring of greenhouse gas reduction progress requires comprehensive and reliable activity data, particularly key data such as Vehicle Kilometer Travelled (VKT), fuel consumption by type, market penetration rates for new technologies (EV, SAF, Hydrogen Fuel), and CO_2 Emission Factors based on IPCC guidelines. This data should be organized in digital format under a single center to link with analytical modeling systems such as LEAP, eBUM or Cube, and model assumptions and data should be regularly reviewed and updated to reflect continuously changing economic, social and technological conditions.

   Relevant agencies should systematically and continuously develop a national system for collecting data on average vehicle kilometers traveled (VKT), with clearly defined responsibilities among lead agencies for data collection, integration, and management. This should involve agencies responsible for vehicle registration, traffic management, infrastructure, and energy, enabling the establishment of a centralized national VKT database covering all vehicle categories, including private vehicles, commercial vehicles, buses, and motorcycles, across both urban and intercity areas. Data should be disaggregated by fuel type, vehicle technology, vehicle age, geographic area, and time period to accurately reflect actual vehicle usage patterns.

   In addition, data collection systems should integrate multiple data sources, such as odometer readings from annual vehicle inspections, GPS data from commercial vehicle tracking systems, traffic data from Intelligent Transport Systems (ITS), and field survey data, to enhance database completeness. Standardized procedures for data collection, quality control, and annual updates should be established, alongside linking the VKT database with energy and transport models as well as greenhouse gas Measurement, Reporting, and Verification (MRV) systems. This would allow the data to serve as a reliable reference for policy assessment, infrastructure planning, and long-term monitoring of emission reduction outcomes. The development of a standardized, centralized national digital database system will therefore serve as a key mechanism to support the transport sector’s contribution to achieving the country’s NDC, Carbon Neutrality, and Net Zero targets in a sustainable manner.

3) **Design of Economic and Financial Incentive Measures**

Achieving the Net Zero target requires substantial private sector investment. The government should therefore design appropriate incentive measures such as BOI benefits, Tax Credits for entrepreneurs investing in clean technology, Soft Loans or Green Bonds for carbon reduction projects, and Public-Private Partnership (PPP) mechanisms to share risks and returns. These financial supports should focus on two primary groups: electric vehicle measures (Electrification) and Future Energy (such as SAF and Hydrogen) that require high investment capital and are still in the early stages of development.

4) **Prioritization of Project Pipeline**

To maximize the effectiveness of investments in greenhouse gas reduction measures, a system for evaluating and prioritizing projects according to the cost per ton of CO_2 reduction (Cost per tCO_2e), technical and infrastructure readiness, and alignment with the country's long-term goals should be established. Developing a Project Pipeline will help the government plan budgets efficiently and direct support to projects with the highest environmental returns, while accelerating the collection of baseline data for supporting measures that cannot yet be assessed to expand future greenhouse gas reduction scope.

5) **Integration of Analytical Tools**

Energy and transport policy decisions should be based on information from systematically linked models such as connecting the energy model (LEAP) with transport models (Cube, eBUM) and pollution models (GAINS or MRV Platform) to assess impacts across multiple dimensions—energy, environment, and economics—simultaneously. Additionally, Uncertainty Analysis should be conducted to assess result sensitivity to key assumptions such as energy prices, EV market penetration rates, or changes in vehicle user behavior, to enable flexible and adaptive policy formulation.

6) **Communication and Stakeholder Engagement**

A mechanism for continuous communication with transport and logistics operators is necessary, along with capacity development of government personnel in MRV, environmental economics, and digital technology. The transport sector has numerous stakeholders, from regulatory agencies to logistics operators, vehicle manufacturers, and end consumers. Therefore, establishing a continuous stakeholder engagement mechanism is essential to foster shared understanding of policy direction, create incentives, and enable mutual benefits between the public and private sectors. This should be coupled with developing government personnel capacity in MRV, environmental economics, data modeling, and digital technology to enable efficient data management, result analysis, and policy decision-making.

The assessment of energy use, greenhouse gas emissions, and fine particulate matter ($PM_{2.5}$) in the transport sector demonstrates that important measures such as promoting electric vehicles (Electrification of Transport) and improving vehicle efficiency (Energy Efficiency Improvement) are the highest-potential measures for reducing greenhouse gas emissions and energy consumption. Meanwhile, infrastructure measures, urban transport system development, and inter-urban logistics systems play an important role in reducing air pollution, particularly fine particulate matter ($PM_{2.5}$), which directly impacts public quality of life. All implemented measures can reduce energy consumption by 1,784.02 ktoe, reduce greenhouse gas emissions by 4.27 $MtCO_2e$, and reduce $PM_{2.5}$ by 734.79 tons. However, the assessment also identifies a remaining gap of approximately 3.69 $MtCO_2e$ in GHG reduction that requires additional measures and policy integration to achieve the country's NDC and LT-LEDS targets.

Achieving Carbon Neutrality and Net Zero Emission by 2050 requires cooperation from all sectors—government, private sector, and citizens—as well as structural support such as appropriate economic instruments, tax measures, digital technology, and investment in clean technology to drive Thailand's transport sector toward a sustainable low-carbon system in the future.

Additionally, developing a centralized digital database, linking energy-transport-pollution models, and maintaining continuous communication with stakeholders will serve as important mechanisms to enhance the efficiency of the country's greenhouse gas management system. This study therefore not only reflects policy results but also provides empirical evidence of Thailand's potential to transition to a Low-Carbon Transport System that supports sustainable economic development, while serving as a crucial foundation to drive the country toward achieving Carbon Neutrality and Net Zero Emission targets effectively and robustly.

5.3.4.2 Recommendations for Additional Measures to Accelerate Greenhouse Gas Reduction in the Transport Sector

Thailand has strengthened its climate ambition under the Nationally Determined Contribution (NDC) by setting a target to reduce national greenhouse gas emissions by 30-40% by 2030. This elevation of ambition places significant responsibility on the transport sector to achieve substantial emissions reduction. According to the Updated NDC, the transport sector is assigned a reduction target of 45.61 $MtCO_2e$ by 2030, most of which must come from two core measures: Electrification, targeting a reduction of 28.29 $MtCO_2e$, and Energy Efficiency, targeting 13.94 $MtCO_2e$. Other supporting measures—such as rail systems, mass transit, logistics system development, and infrastructure improvements—collectively contribute only 3.38 $MtCO_2e$, far lower than the core measures. This indicates clearly that achieving the transport-sector NDC target by 2030 requires EV promotion and improved vehicle efficiency to serve as the centerpiece of Thailand's mitigation strategy, with other measures playing complementary roles.

In 2023, implementation of NDC transport measures resulted in an emissions reduction of 4.27 $MtCO_2e$, representing 53.6% of the annual target (7.96 $MtCO_2e$). This reflects progress that is *"near the target"*, although gaps remain that must be accelerated to align with the NDC pathway toward 2030. Monitoring results indicate progress in some sub-sectors, especially private passenger vehicles, which are transitioning towards EVs and high-efficiency models. However, several sub-sectors remain behind target, necessitating additional supportive and reformative actions to enhance future mitigation performance. Key observations include:

- **Number of EVs and high-efficiency vehicles** Although EV and high-efficiency vehicle adoption in *private passenger cars* is on track, commercial vehicles—such as pickup trucks, buses, trucks, and motorcycles—show significantly lower adoption rates. This limits overall sectoral mitigation potential due to challenges in vehicle pricing, technological readiness, and inadequate charging and maintenance infrastructure in upcountry provinces.

- **Modal shift** Private cars remain the dominant mode of travel in urban areas, while trucks remain central to freight transport. As a result, shifting transport to rail or waterways yields limited effect. Water transport continues to face infrastructure and capacity constraints, while the rail transport system, despite network expansion, requires time to truly induce modal shift due to the need for improved **network connectivity** and competitive **total logistics costs** relative to road transport.

Overall, despite Thailand achieving a mitigation level close to its 2023 target, substantial gaps remain—particularly in commercial vehicle transition and systemic transport reforms. Modal shift measures have yet to reduce reliance on private cars and trucks significantly. This underscores the need to strengthen policies, technologies, and infrastructure to unlock greater mitigation potential. The following recommendations are therefore proposed:

➢ New Vehicles

To achieve Thailand's NDC target, the share of Electric Vehicles (EVs) and high-efficiency vehicles must increase rapidly across all categories, particularly those with low transition rates such as pickup trucks, heavy trucks, buses, and motorcycles. These groups consume large amounts of energy and account for a major share of transport emissions. Recommended measures include:

- Implement and enforce Fuel Economy Standards / CAFE Standards covering all vehicle types, including light and heavy trucks, to push manufacturers to supply more efficient models.
- Reform the excise tax structure to be CO_2-based to improve price competitiveness of EVs and fuel-efficient cars.
- Designate Low Emission Zones (LEZs) in Bangkok and major cities to restrict high-polluting vehicles and stimulate area-based EV demand.
- Mandate EV/HEV transition in the public sector, including government fleets, public transport vehicles, and municipal buses.
- Accelerate charging infrastructure development, along with EV fleet-service platforms for logistics and mass transit to reduce operating costs and improve practical usability.

These measures would significantly accelerate EV adoption in slower-transition segments and shift the new-vehicle market toward low-emission technologies throughout the decade.

➢ In-use Vehicles

Thailand's existing fleet is dominated by older internal combustion vehicles with long service lives and outdated technologies, making them major emission sources. Systematic management of older vehicles is therefore essential:

- Implement Vehicle Retirement / Scrappage Programs to incentivize the removal of old vehicles and replacement with EVs or high-efficiency vehicles through subsidies, discounts, or tax credits.
- Increase annual vehicle taxes based on age (Age-based tax), with higher rates for high-polluting vehicles to reflect environmental externalities.

- Strengthen annual vehicle inspection and maintenance (I/M) programs, particularly for vehicles older than 10 years, with higher fees for vehicles that fail to meet standards.

These actions will meaningfully reduce emissions from the current fleet and produce short- to medium-term mitigation benefits.

➢ Promotion of Biofuels

Biofuels remain an important mitigation option for internal combustion vehicles, especially for groups that are difficult to electrify. Key proposals include:

- Increase biodiesel blending ratios (e.g., B20/B100) for hard-to-abate segments such as long-haul trucks and tractor-trailers.
- Prepare for next-generation (advanced) biofuels, ensuring compatibility with future vehicle technologies.
- Expanding the role of biofuels will enable immediate emissions reductions during the transition toward low-carbon mobility, particularly for vehicles unable to switch to EVs in the short term.

5.3.4.3 Recommendations from the Project: Policy and Accelerated Measures Framework to Achieve Transport Sector NDC Targets (2026 - 2030)

Achieving greenhouse gas emission reduction targets in the transport sector under the NDC framework requires electric vehicle promotion and energy efficiency improvements to serve as the core pillars of the decarbonization strategy, as these measures offer the highest mitigation potential prior to 2030. However, progress to date has largely been concentrated in the private passenger car segment, while commercial vehicles—one of the sector’s major emission sources—have experienced slower-than-expected technological transition.

At the same time, the existing vehicle fleet remains a dominant source of emissions in the short term. Measures addressing older vehicles and improving operational efficiency therefore play a crucial role in achieving emission reductions before 2030, alongside green logistics measures and modal shift strategies that function as longer-term supporting mechanisms.

Accordingly, the policy framework is designed as a phased implementation approach across Phases 1-3 to accelerate short-term emission reductions, establish foundations for technological transition in the medium term, and strengthen structural measures in alignment with the pathway toward achieving NDC targets by 2030.

Phase 1: Accelerating Short-Term Results and Establishing Regulatory Foundations (2026 - 2027)

In the initial phase of advancing toward transport sector NDC targets, Thailand should focus on generating rapid emission reductions while establishing clear and consistent regulatory frameworks governing the vehicle market. Measures in this phase should prioritize improving efficiency of new vehicles while addressing emissions from vehicles already in operation, which currently represent the primary emission sources.

First, fuel economy and greenhouse gas emission standards for vehicles (Fuel Economy Standard or Corporate Average Fuel Economy—CAFE standards) should be rapidly introduced and enforced across all vehicle categories, including pickup trucks and freight trucks, providing clear technological direction for future vehicle development. At the same time, excise tax structures should be adjusted based on CO_2 emissions to reflect environmental costs and enhance long-term competitiveness of electric and energy-efficient vehicles.

Second, spatial and public-sector measures should stimulate demand for low-emission vehicles. Gradual implementation of Low Emission Zones (LEZ) in Bangkok and other major cities should be accompanied by public procurement policies requiring government agencies and public transport systems to progressively transition toward EVs and high-efficiency vehicles, thereby acting as lead markets and building confidence within the private sector.

Third, measures addressing vehicles already in use should be accelerated to deliver short-term emission reductions. This includes implementation of vehicle retirement or scrappage programs targeting older and highly polluting vehicles, alongside stricter annual vehicle inspection regimes and age-based vehicle taxation reforms that incentivize fleet renewal toward higher-efficiency or electric vehicles.

In addition, expanded use of biofuels in vehicle segments that cannot immediately transition to EV technology, particularly long-haul freight trucks should be promoted during the transition period to achieve immediate emission reductions within appropriate sustainability frameworks.

Overall, Phase 1 represents a period of “immediate emission reduction acceleration” while establishing structural market rules that shape long-term vehicle technology development. If effectively implemented, this phase can close early emission reduction gaps along the NDC pathway and establish a strong foundation for scaling measures in subsequent phases.

Phase 2: Commercial-Scale Expansion and Infrastructure Support for Transition (2028 - 2029)

Following regulatory and acceleration measures introduced in Phase 1, Phase 2 should focus on expanding transition efforts toward commercial vehicle segments, which represent the largest emission sources in the transport sector but currently show slower adoption of low-emission technologies. Reducing upfront investment costs and perceived risks for operators becomes the central policy priority in this stage.

Key measures should include tailored support packages for pickup trucks, freight trucks, and buses, such as Total Cost of Ownership (TCO)-based incentives, low-interest financing, and risk-sharing mechanisms supporting fleet EV investments. Public procurement should continue serving as a demand catalyst within commercial vehicle markets. At the same time, accelerated deployment of charging infrastructure at logistics hubs, bus depots, and major freight corridors is essential to support practical commercial EV operations.

Regarding operational efficiency, green logistics initiatives should move beyond pilot programs toward large-scale implementation, focusing on reducing empty trips, increasing load consolidation, and developing intelligent transport management platforms while improving rail-road-water connectivity at strategic logistics nodes to further reduce emissions from transport activities.

Simultaneously, measures addressing existing vehicles including scrappage programs, age-based taxation adjustments, and stricter inspections—should continue to ensure short-term emission reductions proceed alongside technological transition in new vehicle fleets.

In summary, Phase 2 represents a period of "expanding transition into the commercial sector" while building infrastructure necessary to support low-carbon transport systems, enabling significant emission reductions during the latter part of the decade.

Phase 3: Structural Policy Reinforcement and Closing the Gap to 2030 Targets

As the NDC target year approaches, transport policies should evolve from incentive-driven approaches toward stronger structural regulatory frameworks that accelerate both vehicle fleet transition and travel behavior adjustments in line with emission reduction pathways.

Fuel economy and CO_2 emission standards for new vehicles should be progressively tightened according to established roadmaps, while Low Emission Zones should expand in geographic coverage and enforcement strength across major urban areas, effectively restricting high-emission vehicle operations through stronger regulatory mechanisms.

Economic instruments such as emission-based taxes and fees should be more clearly implemented to reflect actual greenhouse gas emissions, reducing competitiveness of fossil-fuel vehicles and accelerating transition toward low-emission alternatives. Revenues from these mechanisms should be reinvested to support transition efforts among low-income groups and small operators to ensure a just and equitable transition.

During this phase, sustainable biofuels should continue supporting vehicle segments not yet ready for EV transition, alongside preparation for deployment of long-term alternative low-carbon fuel technologies.

In summary, Phase 3 represents a stage of "locking in policy achievements" to close emission reduction gaps before 2030 through strengthened standards and price signals while establishing a foundation for continuous transport sector decarbonization beyond 2030.

Figure 21 Policy Recommendations for Thailand's Low-Carbon Transport Transition

5.4 Support Measures Recommendations

Support Measures for reducing greenhouse gas emissions from Thailand's transport sector serve as important mechanisms to drive the transition toward a Low-Carbon Transport System in concrete terms. The proposed measures cover financial dimensions (Financial Measures), fiscal measures (Fiscal Measures), tax policy (Tax Policy), and various promotion mechanisms (Promotion Mechanisms), with each measure designed to be interconnected and mutually reinforcing to achieve maximum results.

The support measures framework comprises four main groups:

- **Electric Vehicle Promotion** includes purchase subsidies, excise tax exemption or reduction, annual tax reduction, charging infrastructure support, and corporate income tax incentives.
- **Energy Efficiency Improvement** comprises fuel efficiency standards, research and development support, hybrid vehicle promotion, vehicle retrofit support, and vehicle scrappage programs.
- **Freight Transport and Logistics Development** covers rail and water transport promotion, digital logistics system support, green distribution center promotion, low-carbon freight vehicle support, and green logistics standard development.
- **Infrastructure and Support System Development** includes EV charging network development, mass transit system development, multimodal transport infrastructure development, non-motorized transport infrastructure development, and intelligent transport system development.

Integration among all measures combined with participation from all sectors is the key to successfully and sustainably reducing greenhouse gas emissions from the transport sector. Investment in these measures not only reduces greenhouse gas emissions but also creates economic opportunities, develops industry, and improves people's quality of life simultaneously. The details of the support measures are presented in the following sections.

(1) Electric Vehicle Promotion

The transition from internal combustion engine vehicles to electric vehicles is a primary strategy with high potential for reducing greenhouse gas emissions from the transport sector. This significant transformation requires strong support measures to overcome various barriers including cost, infrastructure, and consumer acceptance. Support measures for electric vehicle promotion must cover both the supply side and demand side to create an ecosystem that facilitates sustainable growth of the electric vehicle market, taking into account the diversity of user groups such as general consumers, the business sector, and government agencies, in order to ensure measures are effective and accessible to all groups.

Table 13 Support Measures for Electric Vehicle Promotion

Measure	Details	Target Group	Implementation Mechanism	Expected Outcomes
Purchase Subsidy	Direct financial subsidies to reduce the purchase price of electric vehicles for consumers, potentially differentiated by vehicle type and battery capacity	General consumers, Business operators	Subsidy payments through manufacturers or dealers to reduce retail prices, or cash rebates to buyers after vehicle registration	Increase acceptance and purchase rates of electric vehicles among general consumers; reduce the price gap between electric vehicles and conventional vehicles
Excise Tax Exemption/ Reduction	Reduction or exemption of excise tax on electric vehicles to lower retail prices and create price differentiation compared to internal combustion engine vehicles	General consumers, Business operators	Collection of excise tax at a lower rate or exemption according to specified tax structure, potentially differentiated by vehicle size and type	Significantly reduce retail prices of electric vehicles; stimulate market demand and increase price competitiveness
Annual Tax Reduction	Assessment of annual vehicle tax at lower rates for electric vehicles to reduce long-term ownership costs	Electric vehicle owners	Establishment of special annual tax rates for electric vehicles that are significantly lower than conventional vehicles	Reduce long-term ownership costs of electric vehicles; increase economic value of electric vehicle ownership
Charging Infrastructure Support	Financial subsidies or tax incentives for installation of charging stations in both public and private locations	Charging station operators, Building owners, Government agencies	Allocation of budget support for installation, tax deductions for investments, and facilitation of permit procedures	Increase the number and distribution of charging stations; reduce range anxiety concerns; build consumer confidence in electric vehicle use
Corporate Income Tax Incentive	Corporate income tax deductions for investment in electric vehicles for business operations and domestic electric vehicle manufacturing	Business operators, Companies, Vehicle manufacturers	Allow expenses for purchasing electric vehicles or investments in domestic production to be deducted from taxable income at higher rates than conventional vehicles	Stimulate private sector investment in electric vehicles; promote development of domestic electric vehicle manufacturing industry

(2) Energy Efficiency Improvement

Development and enhancement of vehicle efficiency is another important strategy for reducing greenhouse gas emissions from the transport sector. Although the transition to electric vehicles is a long-term goal, many internal combustion engine vehicles will continue to operate during the transition period. Improving the efficiency of these vehicles is therefore critical for reducing greenhouse gas emissions in the short and medium term. Additionally, developing modern vehicle technology helps enhance the competitiveness of Thailand's automotive industry in the global market.

Support measures in this area cover promotion of research and development of new technology, establishment of higher efficiency standards, and support for the application of energy-saving technology in existing vehicles. Implementation in this area must align with global technology trends and the readiness of the domestic industry to achieve sustainable development and international market competitiveness.

Table 14 Support Measures for Energy Efficiency Improvement

Measure	Details	Target Group	Implementation Mechanism	Expected Outcomes
Fuel Efficiency Standards	Establishment of minimum fuel efficiency standards for new vehicles sold in the country, with progressively stricter targets	Vehicle manufacturers, Vehicle importers	Issuance of regulations and specifications defining efficiency standards; inspection and certification of standards before distribution	Reduce fuel consumption and GHG emissions from new vehicles; stimulate manufacturers to develop higher efficiency technology
Research and Development Support	Provision of research funds and tax incentives for research and development of energy-efficient vehicle technology, alternative fuel technology, and modern energy management systems	Research institutions, Universities, Vehicle manufacturers	Allocation of state research budgets; tax deductions for R&D expenses; support for public-private collaboration	Accelerate development of environmentally friendly vehicle technology; strengthen the country's research and development capacity
Hybrid Vehicle Promotion	Tax benefits and subsidies for hybrid vehicles as a transition option toward full electric vehicles	General consumers, Business operators	Special excise tax rates for hybrid vehicles; partial subsidies to reduce purchase prices	Expand energy-efficient vehicle options for consumers; reduce GHG emissions during the transition period
Vehicle Retrofit Support	Financial subsidies or low-interest loans for installation of energy-saving equipment or emission reduction devices in existing vehicles, such as fuel management systems and emission filters	Vehicle owners, Transport operators	Establishment of vehicle retrofit support fund; provision of special interest rate loans through financial institutions	Extend the efficient operational life of existing vehicles; reduce emissions from currently operating vehicles
Vehicle Scrappage Program	Compensation or special discounts for replacing old, low-efficiency vehicles with new high-efficiency or clean energy vehicles	Old vehicle owners	Establishment of vehicle exchange program; provision of compensation or discounts under specified conditions; cooperation with manufacturers and dealers	Accelerate withdrawal of old, low-efficiency vehicles from use; significantly reduce GHG emissions and air pollution

(3) Freight Transport and Logistics Development

The freight transport and logistics system plays a crucial role in greenhouse gas emissions from the transport sector, particularly long-distance road transport and urban goods transportation. Improving the efficiency of the logistics system not only helps reduce greenhouse gas emissions but also reduces transport costs and enhances business competitiveness. Development of Green Logistics is therefore both an economic opportunity and environmental impact reduction pursued simultaneously.

Support measures in this area focus on promoting high-efficiency, low-carbon transport modes, developing modern logistics management systems, and promoting the use of digital technology in freight management. Implementation must consider the diversity of cargo types, transport distances, and the needs of operators in different sectors to ensure measures are appropriate and practically applicable in the business sector.

Table 15 Support Measures for Freight Transport and Logistics Development

Measure	Details	Target Group	Implementation Mechanism	Expected Outcomes
Rail and Water Transport Promotion	Tax benefits and subsidies for operators transitioning from road transport to rail or water transport for long distances	Freight transport operators, Logistics operators	Subsidies for costs of shifting transport modes; reduced fees for rail and water transport services; development of connecting infrastructure	Reduce GHG emissions from long-distance freight transport; alleviate highway congestion; improve overall transport efficiency
Digital Logistics System Support	Financial subsidies and tax incentives for investment in digital logistics management systems, cargo tracking systems, and intelligent route planning platforms	Logistics operators, Freight transport operators	Establishment of fund supporting digital system development; tax deductions for technology investments; development of government central platform	Increase vehicle and route planning efficiency; reduce empty trips and unnecessary distances; reduce GHG emissions and operating costs
Green Distribution Center Promotion	Tax benefits and financial support for development of distribution centers using clean energy, with efficient management systems and low-carbon vehicles	Warehouse operators, Logistics operators	Land and building tax reductions for green-certified distribution centers; support for renewable energy system installation	Reduce GHG emissions from distribution center operations; improve warehouse and distribution efficiency; reduce unnecessary short-distance transport
Low-Carbon Freight Vehicle Support	Subsidies and tax incentives for purchasing electric trucks, alternative fuel trucks, and high-efficiency freight vehicles	Freight transport operators, Logistics companies	Purchase subsidies for low-carbon vehicles; excise tax and annual tax exemption or reduction; support for alternative fuel infrastructure	Increase proportion of low-carbon freight vehicles in logistics system; reduce GHG emissions from freight transport; improve urban air quality
Green Logistics Standard Development	Development and promotion of green logistics standards for the business sector, with certification and benefits for complying operators	All types of logistics operators	Development of standards and guidelines; certification of complying operators; special privileges for participation in state programs	Establish environmental-friendly logistics operation standards; increase transparency and credibility of Thai logistics system; promote green logistics image

(4) Infrastructure and Support System Development

Appropriate infrastructure and effective support systems are critical factors for successful reduction of greenhouse gas emissions from the transport sector. Infrastructure development not only supports the transition to a low-carbon transport system but also must promote environmentally friendly travel and transport modes. Investment in infrastructure therefore provides the essential foundation to enable other measures to be implemented efficiently and sustainably.

Support measures in this area cover development of infrastructure for clean energy vehicles, improvement of public transport systems, development of connected travel networks, and creation of support systems necessary for the transition to a low-carbon transport system. Implementation requires long-term planning and coordination among relevant agencies to ensure integrated development consistent with the country's development direction.

Table 16 Support Measures for Infrastructure and Support System Development

Measure	Details	Target Group	Implementation Mechanism	Expected Outcomes
EV Charging Network Development	Investment in creating an EV charging station network covering urban and inter-urban areas, including development of fast-charging stations on major routes	EV users, General public	Allocation of government budget for public charging stations; public-private collaboration for investment and management; establishment of technical standards and requirements	Provide user confidence in EV charging availability; remove infrastructure barriers to EV adoption; increase EV acceptance rate
Mass Transit System Development	Investment in expansion and improvement of mass transit systems, including development of electric train systems, commuter rail, and clean energy public transport	Urban and suburban residents	Allocation of government budget for mass transit infrastructure; provision of concessions and incentives to private investors; development of long-term master plan	Reduce private vehicle use in urban areas; reduce GHG emissions and air pollution; alleviate traffic congestion; improve public quality of life
Multimodal Transport Infrastructure	Development of connection points between different transport modes such as Park and Ride facilities, efficient transfer stations, and last-mile travel systems	Public transport users, General public	Investment in creating connection points and facilities; development of integrated information and payment systems; urban planning supporting multimodal travel	Increase convenience of public transport use; promote transition from private vehicles to public transit; reduce GHG emissions from travel
Non-Motorized Transport Infrastructure	Construction and improvement of pedestrian paths, cycling routes, and safe public spaces supporting walking and cycling	Urban residents, Tourists	Budget allocation for walking and cycling infrastructure development; establishment of safety and design standards; integration with public transit systems	Promote zero-emission short-distance travel; improve public health and quality of life; reduce GHG emissions from short-distance travel; create environmentally friendly cities
Intelligent Transport System Development	Investment in intelligent traffic management systems, real-time travel information systems, and digital platforms for travel planning	All transport users, Relevant agencies	Budget allocation for technology system development; procurement and installation of sensing and data processing equipment; development of open data platforms for developers	Improve efficiency of existing infrastructure use; reduce travel time and congestion; reduce GHG emissions from fuel-intensive congested traffic

Proposed Support Measures to Drive a Low-Carbon Society:

4 Key Strategic Approaches for Thai Transport

ELECTRIC VEHICLE (EV) PROMOTION

Bridging the Price Gap with Subsidies
Direct financial subsidies for consumers and businesses reduce retail price, making EVs competitive.

Major Tax Exemptions & Reductions
Excise tax exemptions and significant annual vehicle tax reductions lower long-term cost of ownership.

Building the Charging Ecosystem
Financial support and tax incentives for charging station operators and building owners to increase national charging network density.

Corporate Investment Incentives
Businesses get corporate income tax deductions for investing in EV fleets or establishing domestic manufacturing.

ENERGY EFFICIENCY IMPROVEMENT

Stricter Fuel Efficiency Standards
Mandatory minimum fuel efficiency standards push manufacturers toward higher-efficiency technologies.

R&D and Innovation Support
State research budgets and tax deductions allocated to develop modern energy management and alternative fuel systems.

Hybrid Vehicles as a Transition Tool
Special excise tax rates and partial subsidies for hybrids to reduce emissions while EV infrastructure matures.

Vehicle Scrappage & Retrofitting
Old, low-efficiency vehicles phased out via scrappage discounts; existing fleets improved with retrofit subsidies.

FREIGHT TRANSPORT AND LOGISTICS DEVELOPMENT

Shifting from Road to Rail & Water
Tax benefits and reduced fees encourage logistics operators to move long-distance cargo via lower-emission modes.

Digitalized Logistics Management
Subsidies for digital tracking and intelligent route planning platforms eliminate empty trips and reduce unnecessary travel.

Green Distribution Centers
Warehouse operators receive land and building tax reductions for green certifications and renewable energy systems.

Decarbonizing the Heavy Fleet
Subsidies and tax incentives target electric trucks and high-efficiency freight vehicles to improve urban air quality.

INFRASTRUCTURE AND SUPPORT SYSTEM DEVELOPMENT

Public-Private Charging Networks
Government budgets and private concessions develop fast-charging stations on major routes to eliminate "range anxiety."

Mass Transit & Multimodal Hubs
Expanding electric train systems and 'Park and Ride' facilities make public transit more convenient than private vehicle use.

Non-Motorized Transport (NMT)
Construction of safe pedestrian paths and cycling routes promotes zero-emission short-distance travel and improves public health.

Intelligent Transport Systems (ITS)
Real-time traffic management platforms reduce congestion by optimizing traffic flow and providing open data for planning.

Chapter 6
Seminars, Training, Workshops, Public Relations and Communication and Report Submission

Under the Study on Baseline Data Formulation and Tracking of Greenhouse Gas Emission Reduction from Vehicle Energy Efficiency Improvement Measures, activities have been implemented by the Office of Transport and Traffic Policy and Planning, Ministry of Transport, from July 10, 2024, to December 31, 2025. The work focuses primarily on reducing greenhouse gas emissions from the transport sector to support Thailand's Nationally Determined Contribution (NDC) targets and the achievement of Carbon Neutrality.

This implementation emphasizes building knowledge, understanding, and driving collaboration from all sectors, including government agencies, the private sector, and the general public. The organized activities encompass technology transfer and innovation related to clean energy vehicles to promote sustainable transport. Additionally, consultations have been conducted to develop a Measurement, Reporting and Verification (MRV) system for the transport sector, along with information dissemination through social media and exhibitions to raise public awareness about environment-friendly travel.

Regarding main activities, the study has organized four types of activities: project dissemination seminars, knowledge transfer training sessions, workshops, and roadshow exhibitions. These activities have been designed to align with the objectives for systematically reducing greenhouse gas (GHG) emissions from the transport sector.

For public relations, the study has implemented activities through various channels, starting with the development of online media covering important content on sustainable transport and environment-friendly travel, followed by campaigns to promote greenhouse gas reduction behaviors. Furthermore, collaboration has been established with the Royal Thai Army Radio and Television (Channel 5) for producing news scoops and special reports, as well as coordination with social media influencers including Green Civil Channel, ECOLIFE Channel, and Poocao Channel to disseminate content about pollution reduction and public transport usage to broader target audiences through platforms including YouTube, TikTok, Facebook, and Instagram.

In terms of academic outputs, the study has prepared technical papers and delivered all six progress reports completely on schedule. The results from this implementation have enhanced personnel capabilities and concretely supported the implementation of various measures, which will lead to effectively and sustainably achieving greenhouse gas reduction targets from Thailand's transport sector in accordance with the country's international commitments.

Details of the various activities implemented under the study are comprehensively presented in the following summary table of meetings, training sessions, seminars, public relations activities, and report submissions.

Driving Thailand Toward Sustainable Transport

Summary of Meetings, Training, Seminars, Public Relations, and Report Submission

Goals and Key Activities

Supporting the National Greenhouse Gas Reduction Goal

To achieve Nationally Determined Contributions (NDCs) and Carbon Neutrality targets.

4 Key Driving Activities

Seminars | Training Sessions | Workshops | Roadshow Exhibition

Developing Measurement, Reporting, and Verification (MRV) Systems

Establishing transparent and reliable standards for the transport sector.

Communication and Public Relations Strategy

Multi-Channel Communication

Covering online media, television (Channel 5), and campaign activities.

Collaborating with Influencers to Expand Awareness

Disseminating content via YouTube, TikTok, Facebook, and Instagram.

Complete Delivery of Academic Outputs

Submission of 6 progress reports and technical recommendations as scheduled.

Table 17 Summary of Meetings, Training Sessions, Seminars, Public Relations Activities, and Report Submission

Category	Activity / Event	Implementation Date	Venue / Dissemination Channel	Key Content	Participants / Quantity
Seminars for Project Dissemination	1st Project Dissemination Seminar: Project Orientation Seminar	September 23, 2024	Mayfair A Grand Ballroom, The Berkeley Hotel Pratunam, Bangkok	Presented the conceptual framework and plan for establishing greenhouse gas baseline data for the transport sector in collaboration with network agencies	113 people
	2nd Project Dissemination Seminar: Study Results Presentation Seminar	December 24, 2025	Phayathai 4 Room, 6th Floor, Eastin Grand Hotel Phayathai, Bangkok	Summarized study results and the MRV system for five main transport measures, with policy recommendations for national greenhouse gas reduction	112 people
Knowledge Transfer Training Sessions	1st Knowledge Transfer Training Session	May 29-30, 2025	**Lecture:** Kantary Bay Hotel, Rayong **Site Visit:** SAIC Motor-CP Co., Ltd. and Wangchan Valley	Enhanced knowledge on MRV system techniques and observed EV manufacturing innovations and intelligent transport systems in the EEC area.	47 people
	2nd Knowledge Transfer Training Session	October 16-17, 2025	**Lecture:** Mida Resort Kanchanaburi **Site Visit:** Ban Huay Saphan Community and Srinagarind Dam, Kanchanaburi	Transferred knowledge on green transport management to support low-carbon tourism and studied clean energy structures.	46 people
Workshops	1st Workshop	January 20, 2025	Siam Hall, Eastin Grand Hotel Phayathai	Practiced Life Cycle Assessment (LCA) of EVs compared to ICE vehicles to analyze environmental impacts in the transport sector.	55 people
	2nd Workshop	August 22, 2025	Wasukri Room, Amari Bangkok Hotel	Defined MRV system criteria for transport mode shift measures and green logistics systems.	49 people
	3rd Workshop	November 6, 2025	Jamjuree Ballroom, Pathumwan Princess Hotel	Analyzed trends in future transport technologies and prepared for relevant regulatory readiness.	56 people
	4th Workshop	November 20, 2025	Phayathai 1 Room, Eastin Grand Hotel Phayathai	Practiced calculating and verifying GHG and PM 2.5 reductions in transport projects of various agencies.	59 people
Public Relations through Social Media (Facebook)	Set 1: Project background and significance	July 30, 2024	Facebook Page of the Project (Link: https://www.facebook.com/otpbaselinedata/)	Disseminated project objectives and scope to create awareness regarding low GHG transport.	1 set
	Set 2: Energy consumption trends in Thailand	August 19, 2024		Presented energy statistics and air pollution situations from national transport activities.	1 set
	Set 3: Importance of baseline data for GHG reduction assessment in the transport sector	September 16, 2024		Explained the importance of baseline data for the accuracy of evaluating transport GHG reduction measures.	1 set
	Set 4: Choosing electric vehicles for a sustainable energy future	October 11, 2024		Promoted the transition to clean energy and the significance of EVs in reducing environmental impacts.	1 set
	Set 5: Carbon offsetting through tree planting	October 24, 2024		Provided knowledge on carbon offsetting from transport through green space expansion and urban carbon capture.	1 set
	Set 6: Selecting urban travel methods to reduce CO_2	November 6, 2024		Suggested practical energy-saving transport guidelines for daily life GHG reduction goals.	1 set
	Set 7: $PM_{2.5}$ and the transport sector	December 25, 2024		Analyzed the relationship between air pollution and key transport activities to communicate to the public.	1 set
	Set 8: Reducing $PM_{2.5}$ through vehicle maintenance	January 23, 2025		Compiled engine care techniques for transport efficiency and reduction of particulate matter from exhaust.	1 set
	Set 9: Sources of $PM_{2.5}$ from vehicles	February 10, 2025		Classified particulate matter caused by tire and brake friction in transport, beyond exhaust pollution.	1 set

Table 17 Summary of Meetings, Training Sessions, Seminars, Public Relations Activities, and Report Submission (Cont.)

Category	Activity / Event	Implementation Date	Venue / Dissemination Channel	Key Content	Participants / Quantity
	Set 10: Understanding carbon tax	March 7, 2025		Presented carbon tax policies and financial incentives for GHG reduction in transport.	1 set
	Set 11: Differences among electric vehicle types	April 21, 2025		Compared environmental performance and GHG reduction of different types of EVs in the transport system.	1 set
	Set 12: Electric public passenger boats as sustainable alternatives	May 22, 2025		Presented low-carbon water transport systems friendly to the ecosystem to create broad awareness.	1 set
	Set 13: Six advantages of mass transit electric trains	June 27, 2025		Analyzed the role of rail systems in reducing traffic congestion and GHG volume in the Bangkok area.	1 set
	Set 14: Benefits of double-track railways	July 20, 2025		Communicated the potential increase in rail freight transport for energy security and national GHG reduction.	1 set
	Set 15: Greenhouse gas reduction measures from transport that everyone can participate in	August 29, 2025		Summarized sustainable transport measures under Thailand's GHG reduction action plan.	1 set
	Set 16: Understanding the Green Port concept	September 30, 2025		Defined guidelines for sustainable port management and pollution reduction through clean technology in water transport.	1 set
	Set 17: Green Airport for sustainable aviation	October 30, 2025		Provided knowledge on upgrading airports to international standards and reducing greenhouse gases.	1 set
	Set 18: Important terminology for assessing greenhouse gas reduction in the transport sector	November 25, 2025		Compiled definitions and technical terms for monitoring and evaluating transport GHG reduction measures.	1 set
	Set 19: Thailand's transport sector greenhouse gas reduction technologies under NDC 3.0	December 11, 2025		Presented innovation directions and integrated action plans according to Thailand's new GHG reduction milestones.	1 set
Campaign Activities through Social Media (Facebook)	Campaign "Simple Daily Actions That Help the World Reduce Greenhouse Gas"	September 4-18, 2024	Project Facebook Page	Photo-sharing activity to promote greenhouse gas reduction behaviors in transport and daily life	1 item
	"Green Transport Bingo Challenge" Activity	October 16, 2024	Project Facebook Page	Online bingo game encouraging public transport use, cycling, and walking instead of private cars	1 item
Exhibition and Project Public Relations (Roadshow)	Exhibition and Project Public Relations (Roadshow)	October 3-4, 2025	Benjakitti Park Museum Building (Benjakitti Park)	Campaign to raise awareness about sustainable transport and promote public transport use to reduce global warming	338 people
News Scoops and Special Reports on Television	1st News Scoop/Special Report: Roadshow Event on Sustainable Transport to Reduce Global Warming	October 3-4, 2025	Channel 5 Television and online media	Reported Roadshow event atmosphere and in-depth information about the transport sector greenhouse gas reduction project objectives	1 Episode
	2nd News Scoop/Special Report: In-depth Interview with OTP Director on Transport Sector Greenhouse Gas Reduction	November 25-26, 2025		In-depth interview with OTP Director regarding Green Transport strategy and sustainable development plans	1 Episode
Project Public Relations through Influencers on Social Media	Green Civil Channel: "Where does $PM_{2.5}$ in Bangkok come from, and how can we help reduce dust?"	March 4, 2025	YouTube, TikTok, Facebook, Instagram	Analyzed pollution sources from the transport sector and presented clean transport technology alternatives to reduce $PM_{2.5}$.	1 item
	Green Civil Channel: "Touring Suan Prem Pracha Wanarak, accessible by Red Line train"	October 30, 2025		Campaigned for using Mass Rapid Transit to connect to green spaces to reduce private car use and increase mass transit efficiency.	1 item

Table 17 Summary of Meetings, Training Sessions, Seminars, Public Relations Activities, and Report Submission (Cont.)

Category	Activity / Event	Implementation Date	Venue / Dissemination Channel	Key Content	Participants / Quantity
	Green Civil Channel: "Red buses are changing to cool air-conditioned EV buses"	November 7, 2025		Publicized the transition strategy to EV Buses to reduce GHG in the public transport sector.	1 item
	ECOLIFE Channel: "Which type of car suits us?"	August 21, 2025		Provided comparative data on the environmental performance of various vehicle types to promote clean transport choices.	1 item
	ECOLIFE Channel: "Traffic jams, pollution, bad air solved by Congestion Charges"	October 29, 2025		Presented the congestion charge measure to manage transport demand and reduce road pollution.	1 item
	ECOLIFE Channel: "Double-track trains: Not just faster, but taking Thailand to a sustainable future"	November 6, 2025		Analyzed the importance of double-track railways in reducing GHG and increasing national rail efficiency.	1 item
	Poocao Channel: "First time riding an electric boat together"	August 22, 2025		Tested and presented the experience of using electric passenger boats to promote pollution-free water transport.	1 item
	Poocao Channel: "What's the fastest way to get to Yaowarat?"	October 28, 2025		Compared the speed and value of using rail systems to incentivize the public to change transport behaviors.	1 item
	Poocao Channel: "Taking my sister to try new activities everyone must try"	November 3, 2025		Promoted Active Mobility and using bicycles to connect to transport stations for individual-level GHG reduction.	1 item
Technical Papers and Knowledge Transfer	Topic 1: Comparison of Lifecycle GHG Emissions between ICE Vehicles and EVs in Thailand	December 23, 2025	Office of Transport and Traffic Policy and Planning (OTP)	Analyzed and compared GHG emissions of vehicles in Thailand throughout their lifespan to support EV usage.	79 people
	Topic 2: Projection of GHG Emissions under the "NDC Action Plan on Mitigation 2021 - 2030, Transport Sector (Revised Edition)"	December 23, 2025		Projected future transport sector GHG emission trends according to national goals.	79 people
	Topic 3: Review of GHG Reduction Potential under the "NDC Action Plan on Mitigation 2021 - 2030, Transport Sector (Revised Edition)"	December 23, 2025		Reviewed the capability of transport sector measures to identify effective guidelines for achieving national GHG reduction.	79 people
Report Submission	Submission of 6 Reports over 540 days	July 9, 2024, - December 31, 2025	Office of Transport and Traffic Policy and Planning (OTP)	- Submitted 6 complete phases comprising: Inception Report, Progress Report, Interim Report, Draft Final Report, and Final Report. - Including Executive Summary in Thai-English, Assessment Guidelines Manual, Technical Recommendation Report, Presentation Video, and complete digital data media.	6 Phases