



Office of Transport and
Traffic Policy and Planning

Study of the Policy to **Reduce Energy Consumption** in the **Land Transport Sector**



Executive Summary Report

presented by



PSK Consultants Co., Ltd.



Thammasat University
Research and Consultancy Institute

October 2023

ACKNOWLEDGEMENT



With heartfelt gratitude, the Office of Transport and Traffic Policy and Planning (OTP) acknowledges the invaluable contributions of all agencies involved in the preparation, assessment, and formulation of the policy on reducing energy consumption in the road transport sector. The successful completion of this report would not have been possible without your unwavering support.

This report meticulously summarizes the data collection and analysis undertaken to gain a comprehensive understanding of the energy consumption landscape in the road transport sector. The findings serve as a solid foundation for the development of effective policies and measures aimed at curbing energy consumption and mitigating pollution. The successful implementation of these measures will undoubtedly yield positive ramifications for the environment and the nation's economy.

We extend our deepest appreciation to all those who have lent their support to the cause of reducing energy consumption in the road transport sector. Your dedication to creating a sustainable future for Thailand is truly inspiring.

*Together,
we can forge change
; our united
reduction
in energy use
is the key
to Thailand's
transportation
sustainability.*

ABSTRACT

A study of the policy to reduce energy consumption in the land transport sector, an empirical study was conducted to assess the energy efficiency of vehicles, evaluate energy consumption potential, examine the associated impacts, and formulate energy reduction policies. The study was carried out in the Greater Bangkok metropolitan area. It was observed that the predominant mode of transportation for the majority of the population was private automobiles, specifically gasoline-powered internal combustion engine vehicles, which are a primary contributor to air pollution and environmental issues.

The study tested the fuel efficiency of vehicles using 65 samples to use the vehicle fuel efficiency coefficient in the ASIF equation, which is a guideline for assessing energy use and emissions in road transport of various measures, including: (1) Restrictions on the time and space for truck transportation (2) Promotion of the use of electric buses (3) Promotion of the use of electric vehicle technology (4) Changes in travel patterns.

The results of these measures are a reduction in energy use of 11,177 kilotons of oil equivalent (ktoe), a reduction in greenhouse gas emissions of 30.05 million tons of carbon dioxide equivalent (MtCO_{2e}), and a reduction in PM_{2.5} emissions of 366.57 tons of PM_{2.5} (Ton PM_{2.5}) in 2033.

Furthermore, the study has developed an action plan to reduce energy consumption in the land transport sector of Thailand, with measures divided into three periods: short-term (2023-2027), medium-term (2028-2032), and long-term (2033-2037) to provide the government with information and guidance for systematic energy reduction.

This study is important for the sustainable development of Thailand as it will help to save energy, reduce greenhouse gas emissions, and reduce air pollution.



OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP)

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“STUDY OF THE POLICY TO REDUCE ENERGY CONSUMPTION IN THE LAND TRANSPORT SECTOR”



BY OFFICE OF TRANSPORT AND TRAFFIC POLICY AND PLANNING (OTP)

In Thailand, the Land transport sector consumes a significant amount of energy, accounting for approximately 33,607 ktoe in 2019, accounting for 40% of total energy consumption in 2019. This has led to the emergence of air pollution issues. Consequently, there is a pressing need to drive improvements in the design and standards of passenger vehicles and fuel sources, aiming to transform transportation into an environmentally friendly and safe mode of travel (Green and Safe Transport).

INTRODUCTION



Land Transport Sector Consumed 33,607 ktoe (40%) of Total Energy in 2019

1

Air Pollution Issues

2

Improvement of Passenger Vehicle Designs and Fuel Standards




3

Testing the Energy Efficiency of Vehicles' Energy Utilization



The Office of Transportation and Traffic Policy and Planning (OTP) has "Study of the Policy to Reduce Energy Consumption in the Land Transport Sector" to support the country's 20-year transportation development strategy (2018-2037) and the national strategic plan (2018-2037). The project emphasizes the importance of data collection by testing the energy efficiency of various types of vehicles to determine appropriate energy transition strategies within the country's land transport sector.

OBJECTIVE

- 1 To assess the potential of energy consumption from land vehicles in Thailand. 
- 2 To study the positive and negative impacts of different types of energy use in the land transport sector of Thailand. 
- 3 To formulate a policy/plan to reduce energy consumption in the land transport sector of Thailand. 

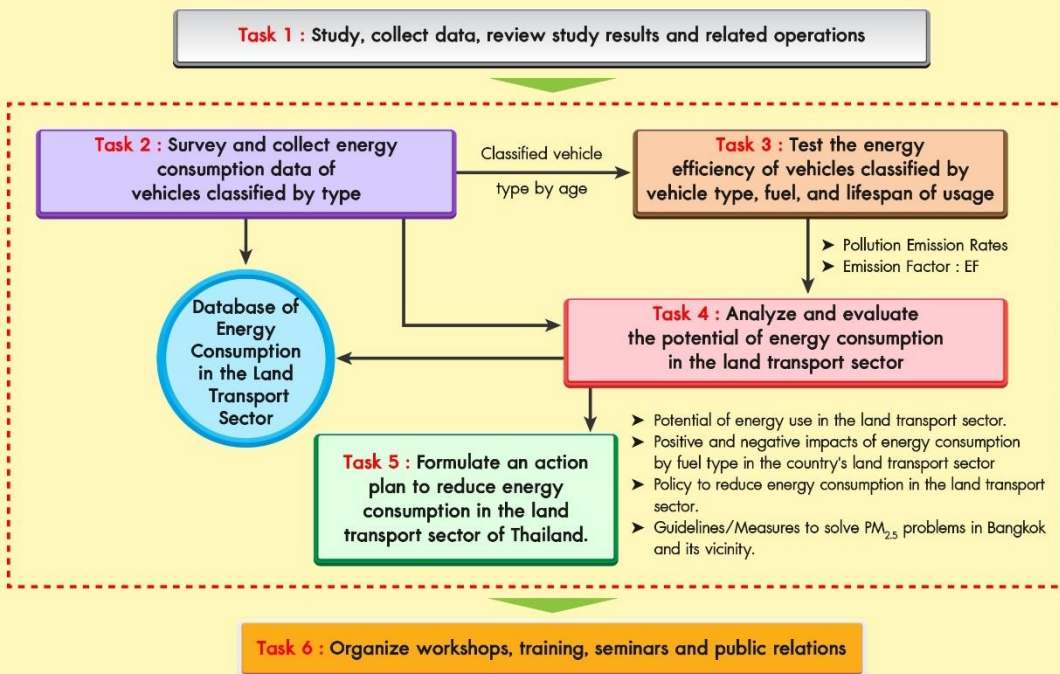
 Implementation Period:

1st Jul 2021
31st Oct 2023

 Study Area:

Bangkok Metropolitan Region (BMR)

SCOPE OF THE STUDY



EXPECTED STUDY OUTCOMES



STUDY, DATA COLLECTION, REVIEW OF STUDY RESULTS AND RELATED OPERATIONS



RELATED POLICIES AND PLANS

Plans and Strategies Related to the Project on Energy Use in Land Transport Sector in Support of Thailand's Socio-economic and Environmental Development within the Specified Timeframe. The focus is on fostering sustainable and environmentally friendly growth, promoting the development of renewable energy, eco-friendly economic growth, sustainable logistics and transportation systems, and reducing greenhouse gas emissions to contribute to global climate mitigation efforts. The Aspiration is for Thailand to Contribute to Collaborative Sustainable Development at Both National and International Levels.

- 1 **Thailand's National Strategy (2018 - 2037):** Strategic Plan for Sustainable Growth and Development
- 2 **Master Plan under Thailand's National Strategy:** Focus on Infrastructure Development and Sustainable Growth
- 3 **12th National Economic and Social Development Plan (2017 - 2022):** Plan for Sustainable and Environmentally Friendly Growth
- 4 **13th National Economic and Social Development Plan (2023 - 2027):** Focus on Electric Vehicles and Low-Carbon Circular Economy
- 5 **Sustainable Development Goals of the United Nations (SDGs):** Global Goals on Clean Energy, Infrastructure, and Sustainable Cities
- 6 **Ministry of Transport's Strategic Plan 2017 - 2021:** Focus on Environmental and Comprehensive Development
- 7 **Department of Land Transport's Strategic Plan 2016 - 2021 (2017 Revision):** Enhancing Efficiency and Environmental Friendliness
- 8 **Thailand's Transport Infrastructure Development Strategy and Plan 2015 - 2022:** Focus on Road Infrastructure and Connectivity with Neighbor Countries
- 9 **3rd Thailand Logistics Development Plan (2017 - 2021):** Providing Value in the Supply Chain
- 10 **Operational Plan for the Development of Thailand's Logistics System (2023-2027):** Elevating Standards and Adding Value to the Supply Chain
- 11 **20-Year Development Strategies for Thailand's Transportation System (2018 - 2037):** Environmentally Friendly and Energy-Efficient Transportation
- 12 **Long Term Integrated Energy Plan (TIEB) 2018 - 2037:** Measures for Sustainable Living and Efficient Energy Utilization
- 13 **Energy Efficiency Plan 2018 - 2037 (Energy Efficiency Plan 2018: EEP 2018):** Reducing Energy Consumption by 30%
- 14 **National Energy Reform Plan (2017 - 2022):** Enhancing the Efficiency of Renewable Energy Utilization
- 15 **Alternative Energy Development Plan 2018 - 2037 (AEDP2018):** Focus on Renewable Energy and Reducing the Use of Biofuels



DATA, STUDY REPORTS, RESEARCH REPORT AND OTHER RELATED DOCUMENTS

Reviewing data on energy and land transportation practices that meet high standards from various countries is crucial in developing a sustainable transportation system and mitigating the impacts of climate change in Thailand.

1 Project to Develop a Master Plan for Sustainable Transport System Development and Climate Change Reduction.	2 Project to Facilitating the Development of Ambitious Transport Mitigation Actions (TRANSfer III).	3 Reviewing Data from Various Countries, such as Measures to Reduce Vehicle Emissions in Urban Areas, Promoting the Use of Electric and Biofuel Vehicles, and Policies to Reduce GHG Emissions from the Transportation Sector.
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- 16 **Action Plan of Thai Electric Vehicle Association:** Promoting the Adoption and Production of Electric Vehicles for Environmental Benefits
- 17 **Nationally Determined Contribution (NDC):** Reducing Greenhouse Gas Emissions in Thailand
- 18 **Participatory Goals as Defined by the Country (2nd Update Nationally Determined Contribution):** Targets for Persistent Greenhouse Gas Emission Reduction
- 19 **Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (Revised Version):** To reduce greenhouse gas emissions and achieve zero greenhouse gas emissions targets
- 20 **Electric Vehicle (EV) development plan of the country of the National Electric Vehicle Policy Committee:** Promoting the Adoption and Production of Electric Vehicles
- 21 **Electricity Infrastructure Development Plan to Support Thailand's Electric Vehicles:** Plan for Supporting Electric Vehicles in Thailand
- 22 **Thailand Greenhouse Gas Reduction Roadmap 2021 - 2030:** Measures to Reduce Air Pollution
- 23 **Transport Sector's Greenhouse Gas Reduction Action Plan 2021 - 2030:** Strategies for Greenhouse Gas Emission Reduction
- 24 **Action Plan for Driving the National Agenda "Solving the Problem of Particulate Matter Pollution":** Measures for Controlling and Reducing Pollution
- 25 **Rail System Development Plan:** Plan for Constructing Various Railway Routes in the Country

RELEVANT REGULATIONS AND LAWS

- ◆ Act of the Land Traffic Management Committee, B.E. 2521.
- ◆ Enhancement and Conservation of Environmental Quality Act, 1992.
- ◆ standards and studies on air emissions from vehicles

- ◆ Excise tax.
- ◆ Announcement of the Excise Department on the criteria and conditions of passenger cars or public cars with not more than 10 seats, energy-saving type hybrid electric vehicle and electric powered vehicle.



The Regulations and Laws Governing Energy Use in the Land Transport Sector of Thailand, encompassing traffic regulations, taxation, and emission standards to promote the adoption of environmentally friendly energy sources and reduce vehicle-generated pollution.



SUMMARY OF ENERGY CONSUMPTION IN THE LAND TRANSPORT SECTOR & SURVEY OF TRAVEL BEHAVIOR

Accumulated Registered Vehicle Data



Registered Vehicles Grew by
4.56% Annually
from Dec 31, 2010, to Dec 31, 2020

Preferred Car Types by Majority



Internal Combustion Engine (ICE)
Cars Powered by **Gasoline**



Most **Under 6 Years Old**



Over 150,000 Kilometers
Driven



Average Monthly Refueling
Expenses: **1,001 - 3,000 Baht**

The People's Travel Patterns



The Majority of Respondents Age
Between **23-32 Years.**



Top Choice for Travel -
Personal Cars

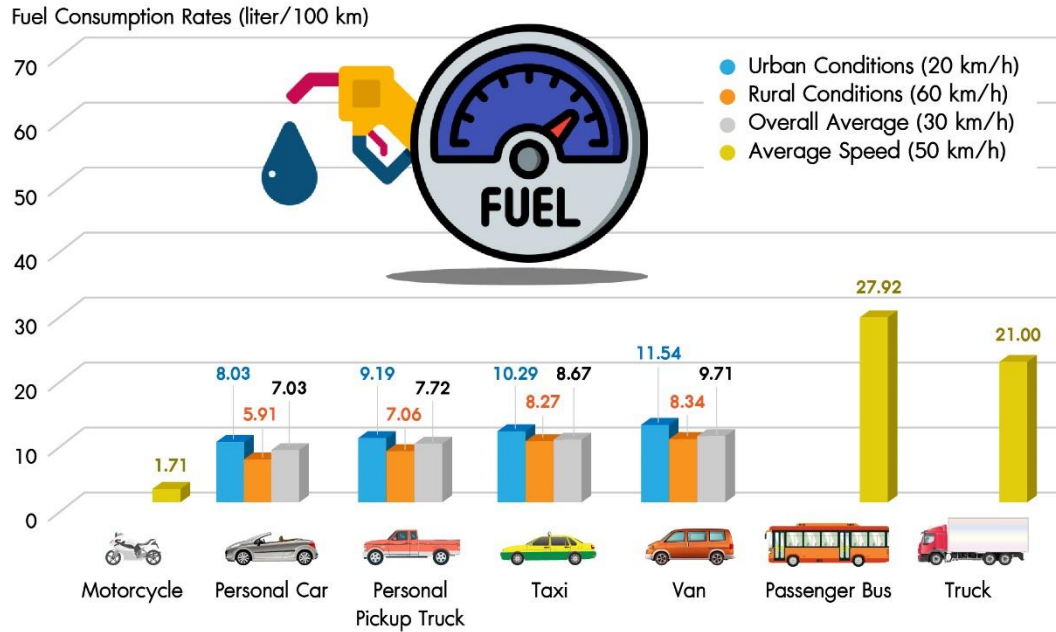
This information is valuable for decision-making and promoting efficient energy policies in the land transport sector of Thailand. It can be used to plan and improve transportation systems and vehicle development policies in the future, to support energy-efficient policies in the land transport sector in Thailand.



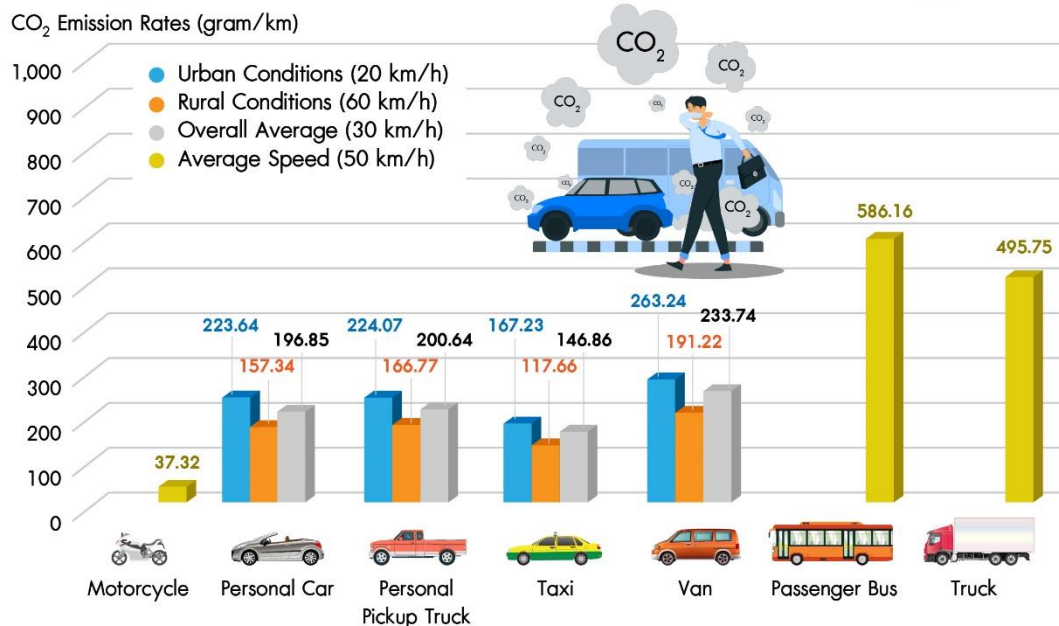
Results of Vehicle Energy Efficiency Tests by Fuel Type, Vehicle Type and Vehicle Age



Fuel Consumption Rates at Speeds of 20, 30, 50 and 60 km/h



Pollutant Emission Rates (CO₂) at Speeds of 20, 30, 50 and 60 km/h





THE STUDY AIMS TO ANALYZE AND ASSESS THE POTENTIAL OF ENERGY UTILIZATION IN THE LAND TRANSPORT SECTOR

Comprehensive Overview of Analysis and Evaluation of Energy Potential in Land Transport Sector

Task 3 : Test the energy efficiency of vehicles classified by vehicle type, fuel, and lifespan of usage

- Results of energy consumption by vehicle and fuel types
- Emission factor : EF
- Pollution emission factor - PM_{2.5} CO NO_x and SO_x

Lab test results regarding the standard of driving cycle



Task 4 : Analyze and evaluate the potential of energy consumption in the land transport sector

Sub-Topic	Method	Output
4.1 Analyze energy use problems in the land transport sector for use in assessing the potential of energy use in the land transport sector.	Lab Test	Fuel Economy (FE) and Emission Factor (EF)
4.2 Study and assess the positive and negative impacts of energy consumption by type to be used to determine guidelines for adapting suitable energy use in the country's land transport sector to support the development of future fuels.	Risk Assessment and SWOT Analysis	Trend and recommendation for formulating Policy to Reduce Energy Consumption in the Land Transport Sector
4.3 Study the impact of presence and absence of trucks transport (truck prohibition) in Bangkok and its vicinity according to different other measures specified by the Government.	ASIF approach in base case and measure case using Emission Factor	Formulate Policy to Reduce Energy Consumption in the Land Transport Sector
4.4 Study the effects of public bus transport in Bangkok and its vicinity.	ASIF approach in base case and measure case using Emission Factor	Formulate Policy to Reduce Energy Consumption in the Land Transport Sector
4.5 Study the effects and measures to solve PM _{2.5} problems in Bangkok and its vicinity.	Analysis using Emission Factor	Guidelines to solve PM _{2.5} problems in Bangkok and its vicinity.

Task 5 : Formulate an action plan to reduce energy consumption in the land transport sector of Thailand

The analysis of energy consumption issues in the land transport sector for the purpose of evaluating the potential of energy utilization in land transport.

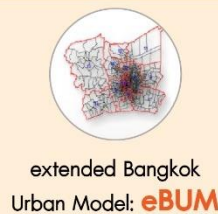
- ❖ Using SWOT analysis: Analyzing strengths, weaknesses, opportunities, and threats:
 - Gasoline and Diesel Fuel
 - Natural Gas as a Vehicle Fuel (Natural gas driven internal combustion engines)
 - Liquefied Natural Gas (LNG) as Vehicle Fuel and Supply Challenges: Case Study of Italy
 - Electric Vehicles (EVs)
- ❖ Therefore, the results of this analysis serve as critical factors in determining measures to reduce energy consumption, greenhouse gas emissions, and air pollution emissions.



Methods for Analyzing and Assessing Energy Use Potential in Land Transport Sector



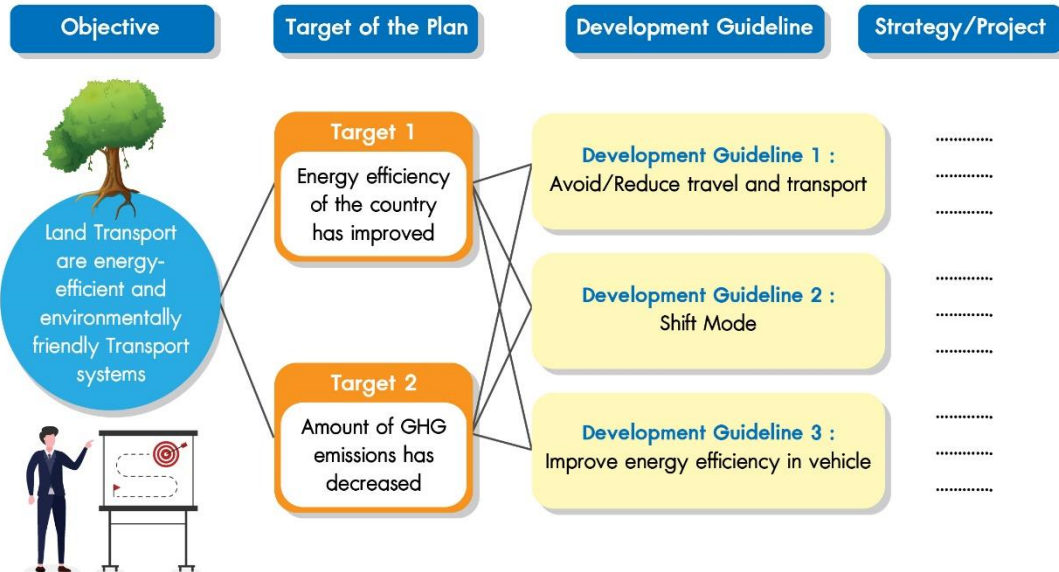
The **ASIF** (Activity-Structure-Intensity-Fuel) principle for calculating CO₂ emission rates can be summarized in the ASIF equation.



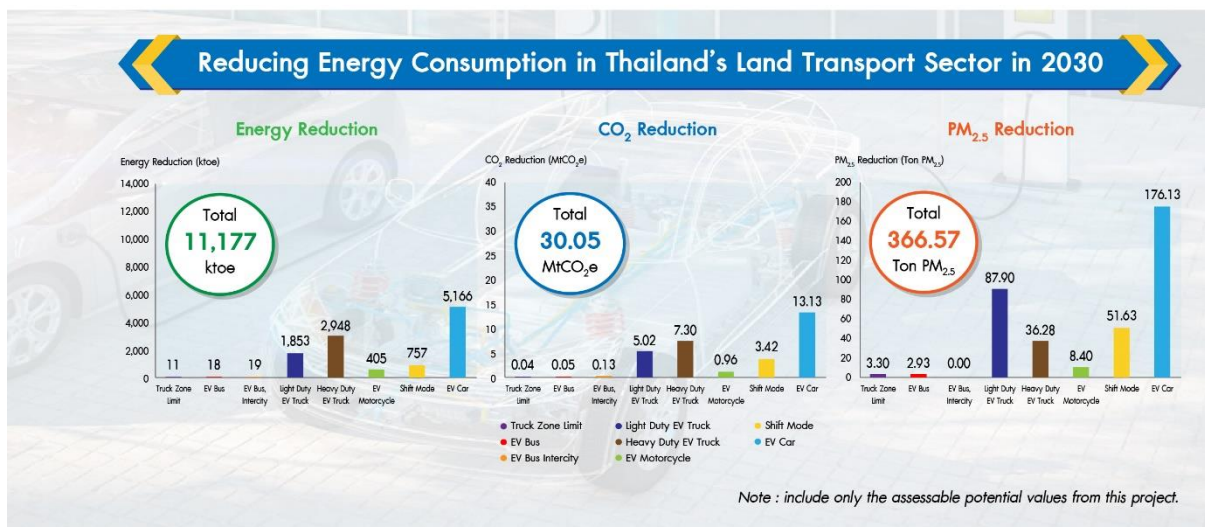
FORMULATION OF AN ACTION PLAN TO REDUCE ENERGY CONSUMPTION IN LAND TRANSPORT SECTOR OF THAILAND (2023 - 2037)



An Action Plan to Reduce Energy Consumption in Land Transport Sector of Thailand (2023 - 2037) aims to enhance energy efficiency and reduce greenhouse gas emissions through strategies involving travel avoidance, mode shift, vehicle energy efficiency improvements, and supporting energy efficiency and emission reduction measures. The plan sets targets to increase energy efficiency and reduce greenhouse gas emissions in the land transport sector. Monitoring and evaluation will be conducted to assess the plan's effectiveness during the designated period from 2023 to 2037.



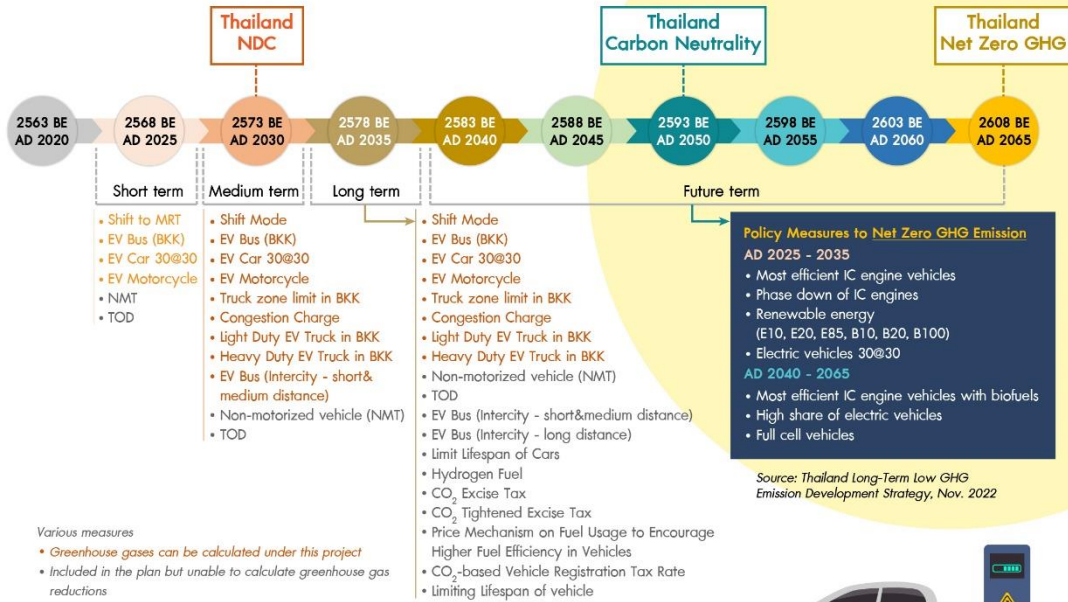
The measures to reduce energy consumption and greenhouse gas (GHG) and PM_{2.5} emissions in the land transport sector in the year 2030 involve various strategies. These strategies include promoting electric vehicles (EV Car), transitioning diesel buses to electric buses (EV Bus), implementing truck zone limits in certain areas, and transforming freight transportation from roads to rails, aiming to efficiently reduce GHG and PM_{2.5} emissions. The plan emphasizes support and efforts to achieve Carbon Neutrality and Net Zero Emission in the future.





MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN THE LAND TRANSPORT SECTOR

GHG Timeline for Mitigation Measures in Transport Sector



Various measures

- Greenhouse gases can be calculated under this project
- Included in the plan but unable to calculate greenhouse gas reductions



The plan to reduce energy consumption in Thailand's land transport sector is an operational strategy aimed at efficiently reducing energy consumption. It is divided into three phases: short-term (2023 - 2027), medium-term (2028 - 2032), and long-term (2033 - 2037). The objective is to provide the government with data and guidelines for systematically and continuously reducing energy consumption in Thailand's land transport sector, as well as to enhance positive environmental impacts in the long run. Each phase will implement measures tailored to the specific timeframe, such as promoting the use of alternative energy sources in the short-term, researching and developing new technologies in the medium-term, and promoting structural changes in the long-term transport system to achieve the goal of successfully reducing energy consumption in Thailand's land transport sector.



GUIDELINES FOR MONITORING AND EVALUATING THE REDUCTION OF ENERGY CONSUMPTION IN THAILAND'S LAND TRANSPORT SECTOR

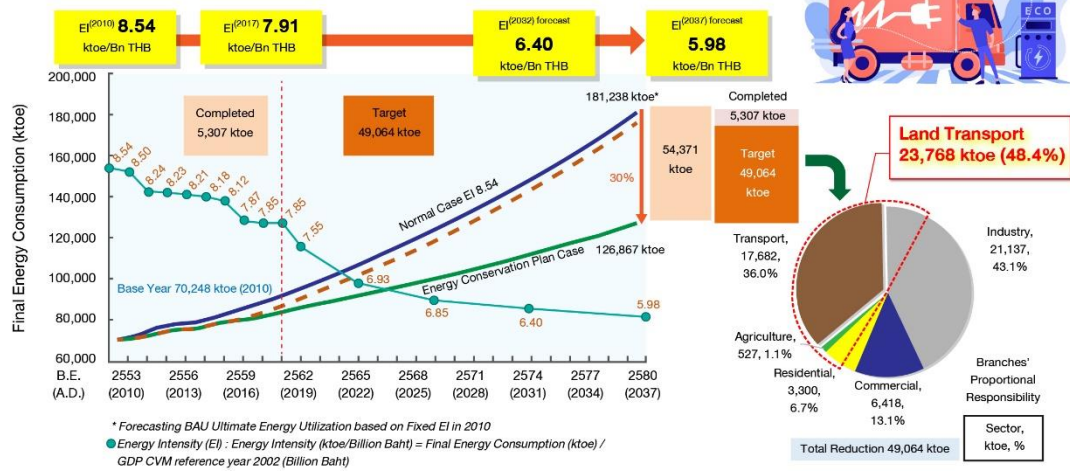


Relevant agencies can utilize the specified indicators and measurement criteria to track progress and assess the success of energy and greenhouse gas (GHG) reduction initiatives in Thailand's land transport sector. Regular monitoring and reporting of results should be conducted to raise awareness of the progress and effectiveness of the implemented action plans in this regard.

Indicator 1: Energy Intensity (EI) (ktoe/billion baht)

Criteria: At the end of the year 2037, if energy use in the land transport sector is lower than or equal to 23,768 ktoe will be considered successful in reducing energy use in the transportation sector.

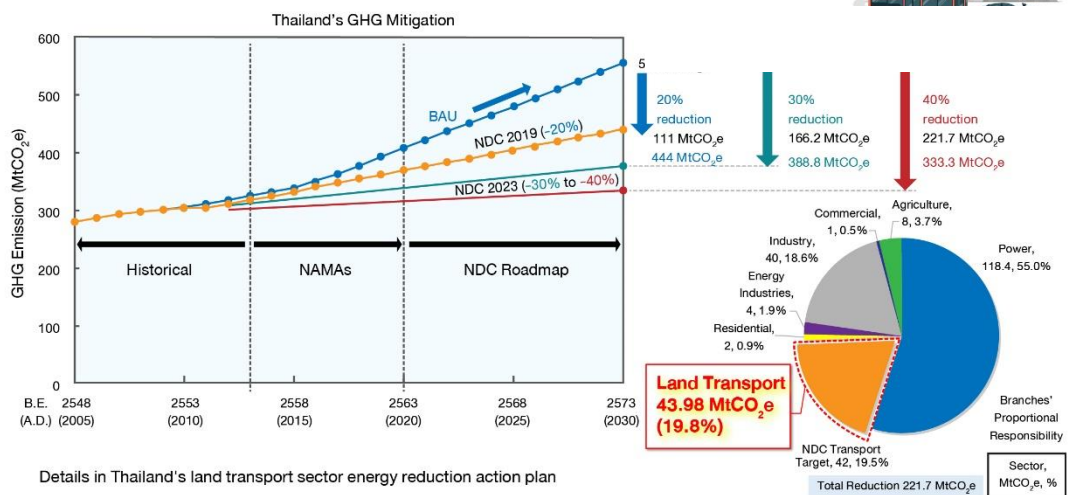
Target and Potential of Energy Intensity (EI) Reduction in the Land Transport Sector



Indicator 2: GHG Emissions from Business-As-Usual Scenario (MtCO₂e)

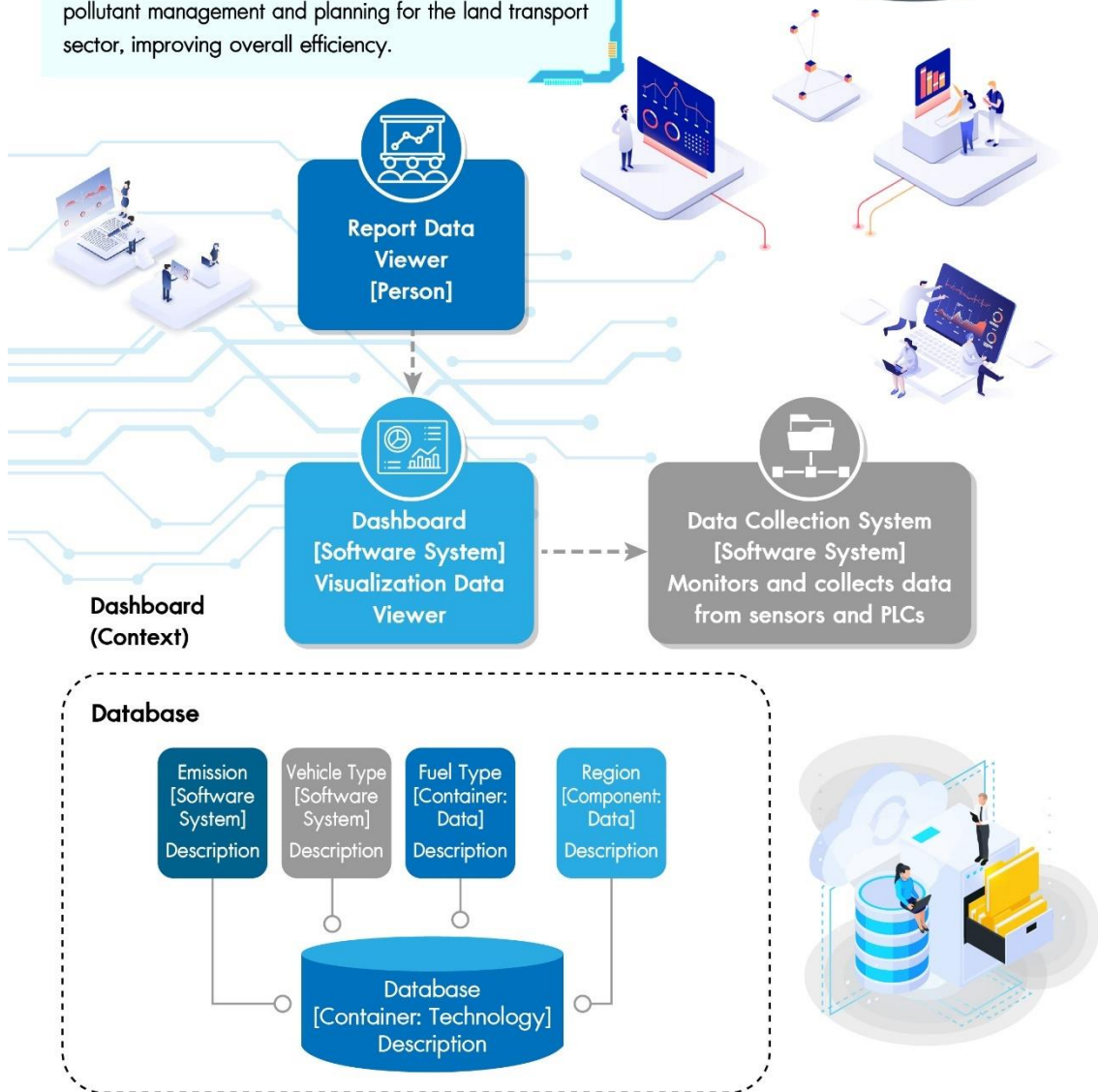
Criteria: At the end of the year 2030, if it's possible to reduce GHG in the land transport sector to 43.98 MtCO₂e or less is considered successful in reducing GHG emissions in the transportation sector.

Target and Potential of Greenhouse Gas (GHG) Emissions Reduction from Business-As-Usual Scenario (MtCO₂e) in the Land Transport Sector



PREPARATION OF ENERGY CONSUMPTION DATABASE OF LAND TRANSPORT SECTOR

The land transport sector's energy use database is a system that employs a Bottom-Up Approach to assess the energy consumption and pollutant emissions of each vehicle type. It utilizes statistical data on the accumulated registered vehicles categorized by vehicle types for the calculations. The system provides a web application that enables relevant authorities and stakeholders to import, record, edit, and visualize the data on the servers of the relevant authority. This facilitates effective energy and pollutant management and planning for the land transport sector, improving overall efficiency.



Chapter 1 Introduction

1.1 Principle and Rationale

In Thailand, there is a growing trend in the use of energy in the transportation sector, resulting in air pollution problems. Therefore, the Ministry of Transport has initiated the "Study of the Policy to Reduce Energy Consumption in the Land Transport Sector" project to collect data and establish guidelines for future energy usage changes. This project aims to achieve safe and environmentally friendly transportation goals. (Figure 1.1-1)



Source: Ministry of Transport Thailand (2023)

Figure 1.1-1 Conceptual Transport System Development

1.2 Objective

- (1) To assess the potential of energy consumption from land vehicles in Thailand.
- (2) To study the positive and negative impacts of different types of energy use in the land transport sector of Thailand.
- (3) To formulate a policy/plan to reduce energy consumption in the land transport sector of Thailand.

1.3 Scope of Study

The scope of the study comprehensively covers the examination and analysis of energy utilization in the land transport sector in Thailand and other countries. This includes a thorough assessment of energy consumption levels, energy efficiency, and the impacts associated with energy utilization. Additionally, it encompasses the development of a realistic action plan to reduce energy consumption in the land transport sector of Thailand.

1.4 Expected Results from the Study

- 1) An action plan to reduce energy consumption in land transport sector of Thailand.
- 2) Solution guidelines to the problem of PM2.5 in Bangkok and its vicinity.

1.5 Implementation Period and Study Area

The project has an implementation period of 28 months. The study area is Bangkok and its vicinity.

Chapter 2 Study, data collection, review of study results and related operations

The study of the policy to reduce energy consumption in the land transport sector is consistent with Thailand's policies and plans at both national and international levels, covering economic, social, and environmental aspects. The goal is to reduce energy consumption and pollution in the road transport sector.

Relevant policies and plans include:

- National Strategy (2018 - 2037)
 - Emphasizing sustainable development with consideration for the environment and energy.
- 12th National Economic and Social Development Plan (2017 – 2022)
 - Focusing on sustainable and potential-driven national development while considering environmental and energy factors.
- Thailand's Transport Infrastructure Development Strategy and Plan 2015 - 2022
 - Concentrating on efficient and sustainable land transportation systems.
- 3rd Thailand Logistics Development Plan (2017 - 2021)
 - Prioritizing efficient and sustainable logistics systems.
- 20-Year Development Strategies for Thailand's Transportation System (2018 - 2037)
 - Concentrating on efficient and sustainable land transportation systems.
- Long-Term Integrated Energy Plan (TIEB) 2018 - 2037
 - Focusing on efficient and sustainable energy use.
- Energy Efficiency Plan 2018 - 2037 (Energy Efficiency Plan 2018: EEP 2018)
 - Emphasizing energy conservation and reduction.
- Thailand Greenhouse Gas Reduction Roadmap 2021 - 2030
 - Focusing on reducing greenhouse gas emissions.

Furthermore, the study is also in alignment with research reports and other relevant documents, both domestically and internationally, including regulations and laws pertinent to the subject matter. This demonstrates that the study is comprehensive and covers all relevant dimensions. This will be beneficial in formulating policies and effective measures to reduce energy consumption in Thailand's land transport sector.

Chapter 3 Surveying and Collecting Energy Consumption Data of Vehicles Classified by Type

This study collects and surveys current data on energy use in the road transport sector to update and enhance the data for use in developing policies and measures to reduce energy consumption and pollution in the road transport sector.

3.1 Data Collection of Energy Consumption of the Land Transport Sector Classified by Fuel Type and Vehicle Type

In Thailand, the majority of registered vehicles are motorcycles (74.98%), and most of them use gasoline (70.4%). Gasoline-powered vehicles are mostly aged between 2 and 7 years and 8 and 15 years. Thailand applies the Euro 4 emission standard for vehicles.

■ Vehicle Type



Figure 3.1.1-1 Accumulative registered cars according to the Motor Vehicle Act 1979as of December 31, 2020

■ Fuel Type

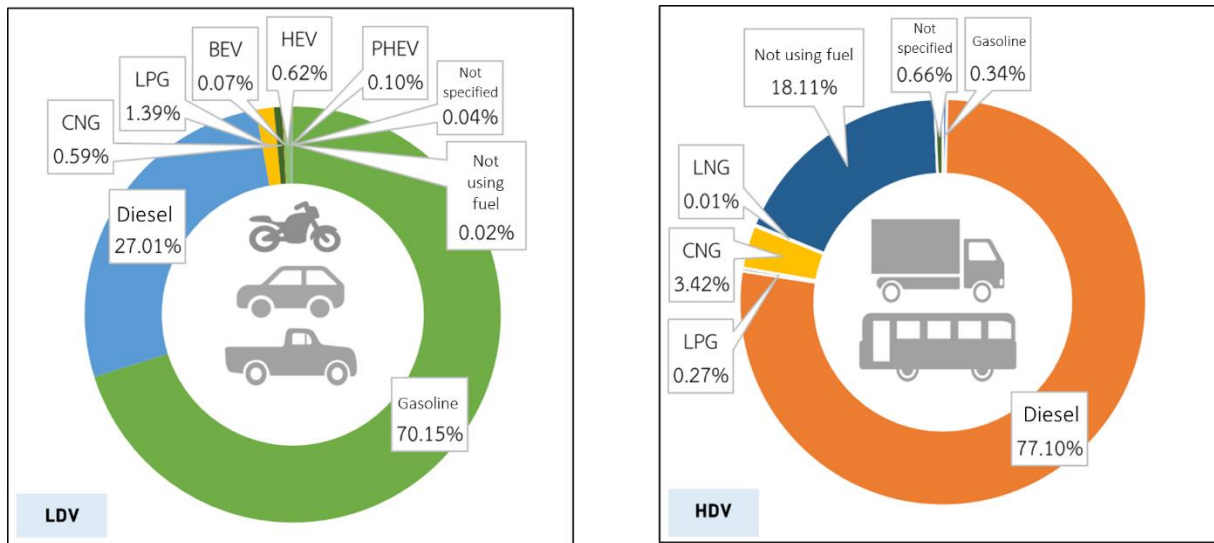


Figure 3.1.1-2 Fuel Type
 , Accumulated registered cars according
 to the Motor Vehicle Act 1979 as of December 31, 2020
 , and accumulated registered vehicles
 under the Land Transport Act 1979 as of December 31, 2020

■ Vehicle Age

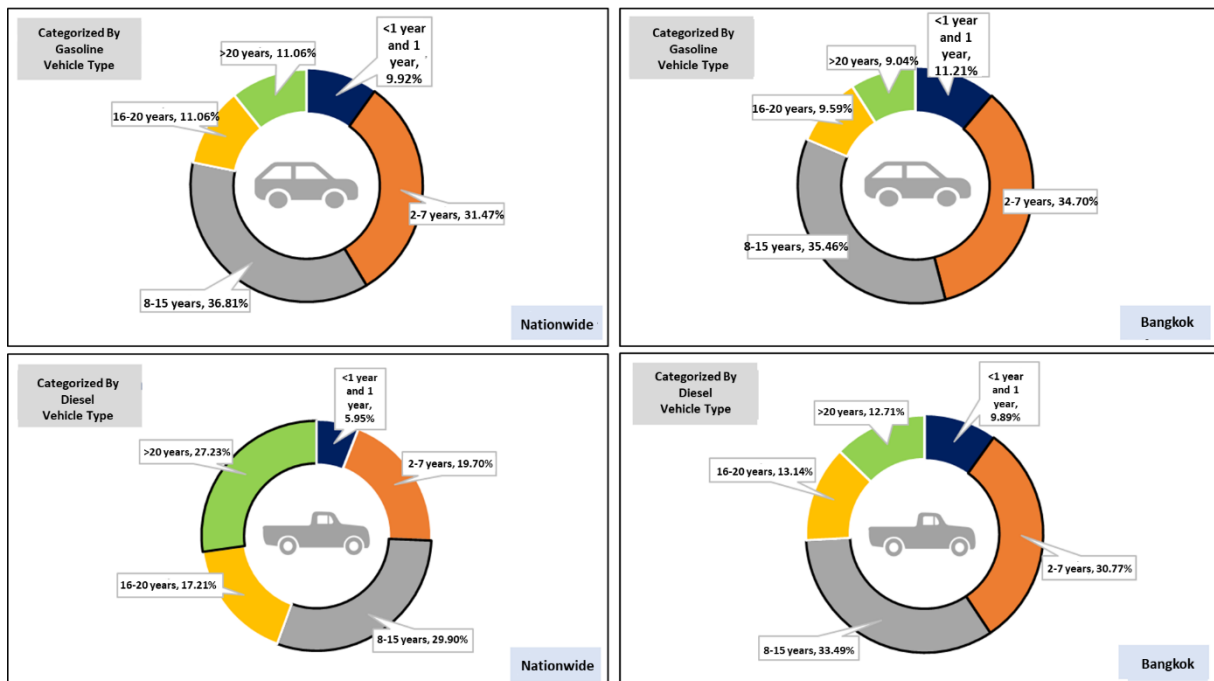


Figure 3.1.1-3 Vehicle Age
 , Accumulative registered vehicles according
 to the Motor Vehicle Act 1979 as of December 31, 2020

3.2 The collection of additional energy usage data from the existing data of the land transportation sector to improve its currentness and comprehensiveness.

In current times, the issues arising from the survey data on the use of vehicles and transportation habits of the population can be summarized as follows:

- The majority of survey respondents are in the age range of 23 to 32 years and reside mainly in the Bangkok metropolitan area and its suburbs, with Bangkok being the most predominant residential province.
- The travel patterns of survey respondents reveal that the majority use personal cars as their regular mode of transportation, followed by public transportation systems.
- A significant proportion of survey respondents own vehicles, accounting for up to 67.73%.
- Personal cars owned by the survey respondents are predominantly internal combustion engine (ICE) vehicles using gasoline as fuel.
- Pickup trucks owned by the survey respondents are mostly internal combustion engine (ICE) vehicles using diesel fuel.
- Motorcycles owned by the survey respondents are predominantly internal combustion engine (ICE) vehicles with fuel injection systems, using gasoline as fuel.

When comparing the survey results on vehicle usage and travel habits of the population with data from the Department of Land Transport, it is evident that the data aligns in terms of the types of fuels used for personal cars, pickup trucks, and motorcycles.

Based on these survey findings, it reflects the current travel behavior of the population, with the majority of survey respondents regularly using personal cars as their primary mode of transportation. This is one of the contributing factors to air pollution and traffic congestion issues. Therefore, relevant authorities should implement measures to encourage the public to use public transportation services more frequently. This could include improving the convenience and coverage of public transportation systems and setting accessible fare rates, among other initiatives.


3.3 Preparation of Energy Consumption Database of Land Transport Sector

A comprehensive database of energy consumption and emissions from all land transport vehicles in Thailand is presented in a dashboard format, classified by vehicle type and fuel type, for the country as a whole and for Bangkok and its vicinity, on an annual basis.

Chapter 4 Vehicle Energy Efficiency Testing

Classified by Fuel Type and Age of Vehicle

This study conducted tests of vehicle fuel efficiency in a vehicle performance laboratory (lab test) and standardized field tests. The vehicles were categorized based on their fuel types and age of operation. A total of 65 vehicle samples were included in the study, comprising (1) motorcycles, (2) personal-use cars, (3) personal-use passenger vehicles, (4) personal-use trucks, (5) vans, (6) trucks, and (7) buses.

Vehicle Type	Number	Vehicle Age			
		2-7 Years	8-15 Years	16-20 Years	> 20 Year
 Motorcycle Benzene		2-5 Years	6-15 Years	> 15 Year	
- Benzene 95/Gasohol 95/91	6	2	2	2	
 Personal Car					
- Personal Car, Benzene 95	3	1	1	1	-
- Personal Car, Gasohol 95/91	3	1	1	-	1
- Personal Car, E20	3	1	1	1	-
- Personal Car, Diesel (B7/B10)	3	1	1	1	-
 Passenger Car (Taxi)					
- Passenger Car (taxi), NGV	4	2	2	Limit lifespan to 10 years	
- Passenger Car (taxi), LPG	4	2	2	Limit lifespan to 10 years	
 Personal Truck (Pick-up)					
- Benzene 95	1			1	
- Gasohol 95/91	3	1	1	1	-
- Diesel B7/B10	6	2	2	1	1
 Van					
- Van, Benzene 95/NGV	3	1	2	Release from usage	
- Van, Gasohol 95/91	3	1	1	1	-
- Van, Diesel B7/B10	3	1	1	1	-
 Truck					
- Truck, Benzene 95 *	-	-	-	-	-
- Truck, Diesel B7 B10 B20	9	3	3	3	-
- Truck, LPG / NGV	2	1	1	-	-
 Bus					
- Bus, Benzene 95 *	-	-	-	-	-
- Bus, LPG / NGV	3	1	1	1	-
- Bus, Diesel B7 B10 B20	6	2	2	2	-
Total	65				65

Note : * There is no sample group of trucks and bus using benzene 95 because the proportion is very small.

Figure 4-1 Number of Vehicles Used for Testing in this Project

The results of the efficiency testing of vehicle energy consumption include the following:

- (1) Fuel consumption rate (kilometer/liter).
- (2) Carbon dioxide emissions rate (CO₂).(gram/kilometer)

These are illustrated in Figures 4-2 and 4-3.

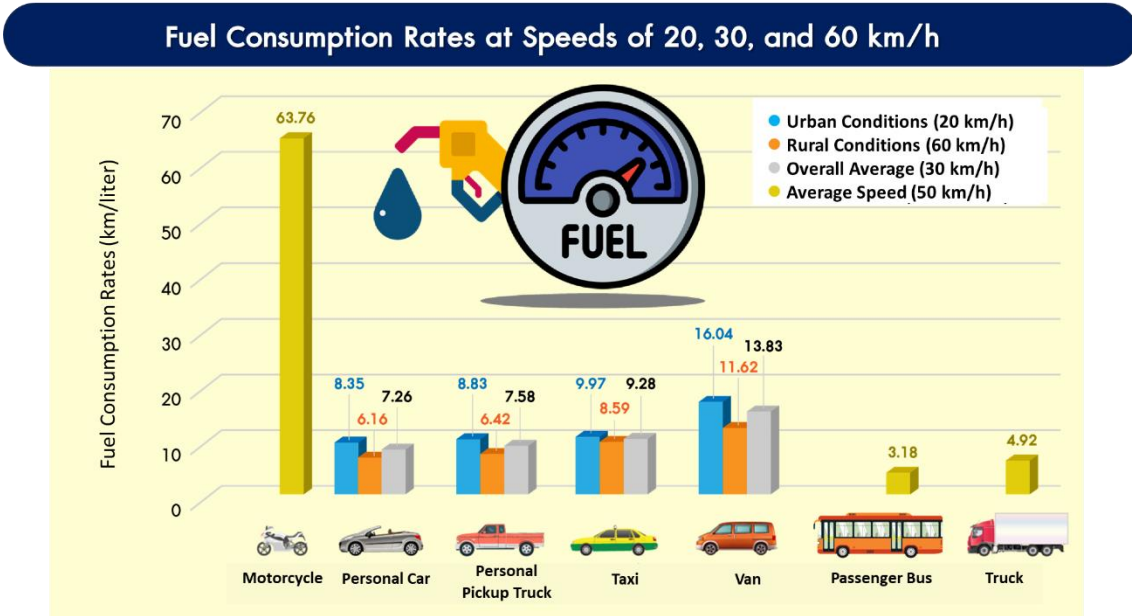


Figure 4-2 Fuel consumption rate (kilometer per liter) , averaged at speeds of 30 and 60 kilometers per hour

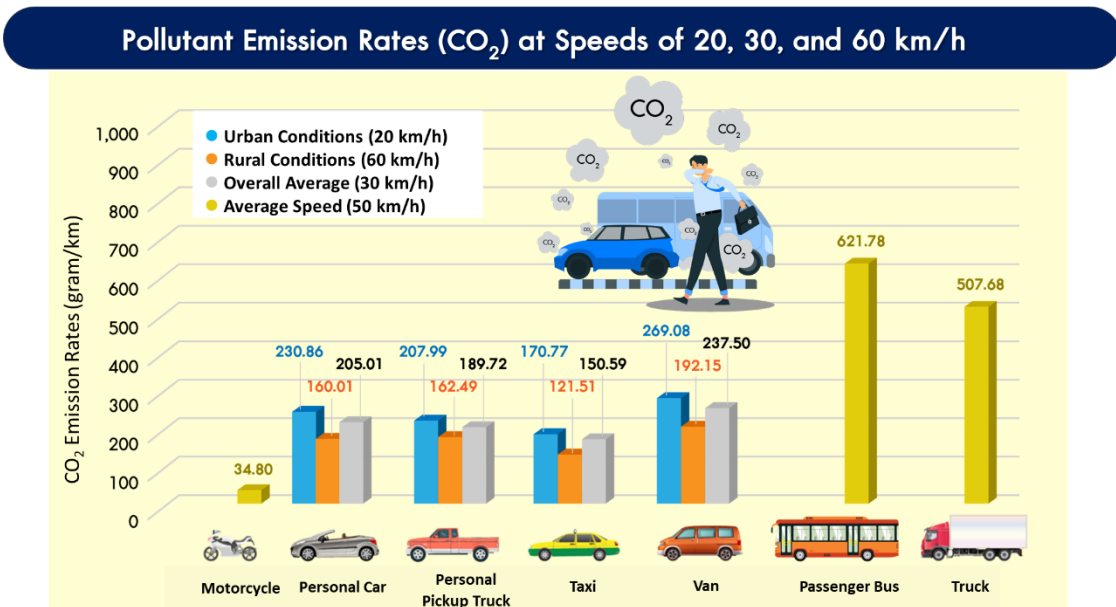


Figure 4-3 Carbon dioxide emissions rate (CO₂). (gram per kilometer) , averaged at speeds of 30 and 60 kilometers per hour

Chapter 5 Analysis and Evaluation of Energy Potential in Land Transport Sector

The land transport sector is an important sector for the development of the country's economy and society. However, energy use in this sector has been increasing steadily, leading to energy and environmental problems. Therefore, studies have been conducted to assess the impact and measures used to analyze and assess the energy potential of the land transport sector.

The measures used to analyze and assess the energy potential of the land transport sector include:

1. Restrictions on the time and space for truck transportation
2. Promotion of the use of electric buses
3. Collection of road tolls in congested areas
4. Promotion of the use of electric vehicle technology
5. Changes in travel patterns

These measures will help to reduce traffic congestion, reduce vehicle emissions, and reduce energy use in the road transport sector.

The selection of appropriate measures must take into account various factors, such as traffic conditions, infrastructure, travel behavior of the public, and technology.



5.1 Analysis and Assessment of Energy Potential

Methods for studying the analysis and evaluation of energy use potential in the land transport sector include:

(1) ASIF Principle (Activity-Structure-Intensity-Fuel)

The ASIF principle is an analysis method in the form of a Bottom-Up Method. It is a technique for estimating CO₂ emissions from the actual travel demand and can be measured as a fundamental factor. The ASIF equation, as shown in Figure 5.1-1, is as follows:

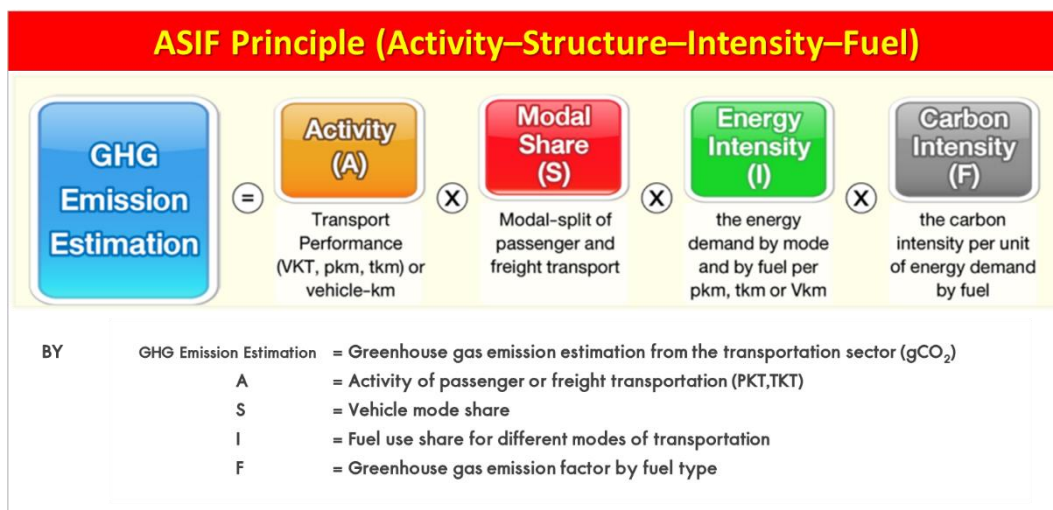
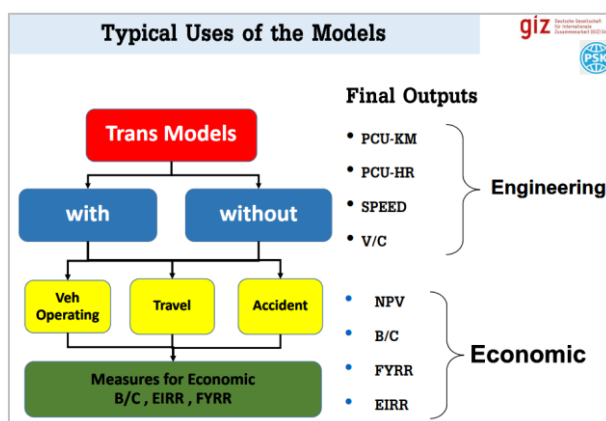


Figure 5.1-1 ASIF Principle (Activity-Structure-Intensity-Fuel)

(2) extended Bangkok Urban Model: eBUM

The eBUM model can be used to study and analyze various issues related to urban development, such as urban expansion, infrastructure development, transportation, climate change, and environmental impacts. In this study, the model is used to forecast traffic, such as travel demand, which is then calculated in the ASIF equation.



Source: GIZ & PSK (2014), Progress on Design of an MRV System for Transport sector in Thailand, http://conference.tgo.or.th/download/tgo_or_th/seminar/presentation/2014/Jul/MRV_II/04_MRV_for_Transport_System_in_Thailand_OTP.pdf

รูปที่ 5.1-2 การใช้งานทั่วไปของแบบจำลอง eBUM

5.2 Utilizing the A-S-I Approach for Categorizing Measures in the Land Transport Sector

The ASIF equation is a tool used to assess greenhouse gas emissions from the road transport sector. The project analyzes and evaluates the potential for reducing energy use, greenhouse gas emissions, and PM2.5 emissions through the A-S-I Approach or “avoid-shift-improve” which is a set of measures aimed at developing an efficient and sustainable transport system. These measures are divided into three main approaches, as shown in the following table.

Table 5.2-1 Categorizing Land Transport Measures through A-S-I Approach

Measure	A-S-I Approach		
	Avoidance or reduction of travel (Avoid/Reduce)	Changing transportation behavior (Shift/Maintain)	Improving or developing vehicle fuel efficiency (Improve)
1 Restrictions on the time and space for truck transportation	✓		
2 Promotion of the use of electric buses			✓
3 Collection of road tolls in congested areas	✓		
4 Promotion of the use of electric vehicle technology			✓
5 Changes in travel patterns		✓	

Note: The aforementioned measures were selected for the purpose of assessing the energy efficiency of road transport.

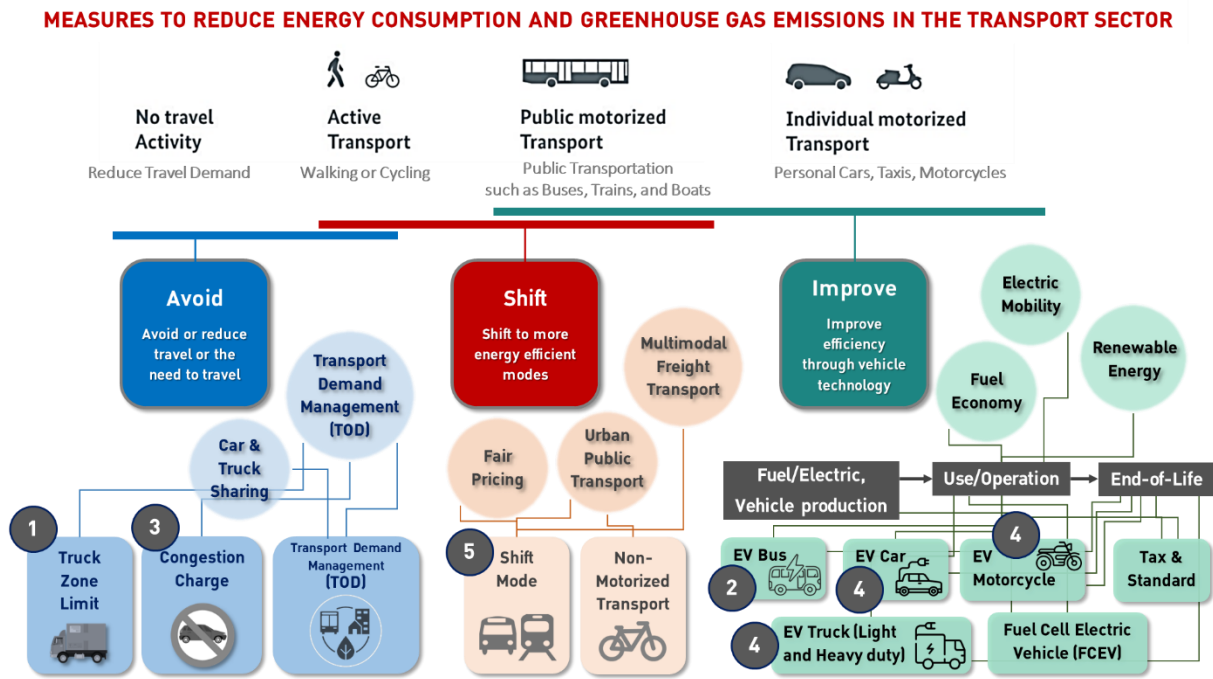


Figure 5.2-1 Measures to Reduce Energy Consumption and Greenhouse Gas Emissions in the Land Transport Sector

5.3 Evaluation results of the energy use potential of the road transport sector

The potential for energy saving, greenhouse gas reduction, and PM_{2.5} reduction in road transport sector in 2030 is shown in Figure 5.2-1.

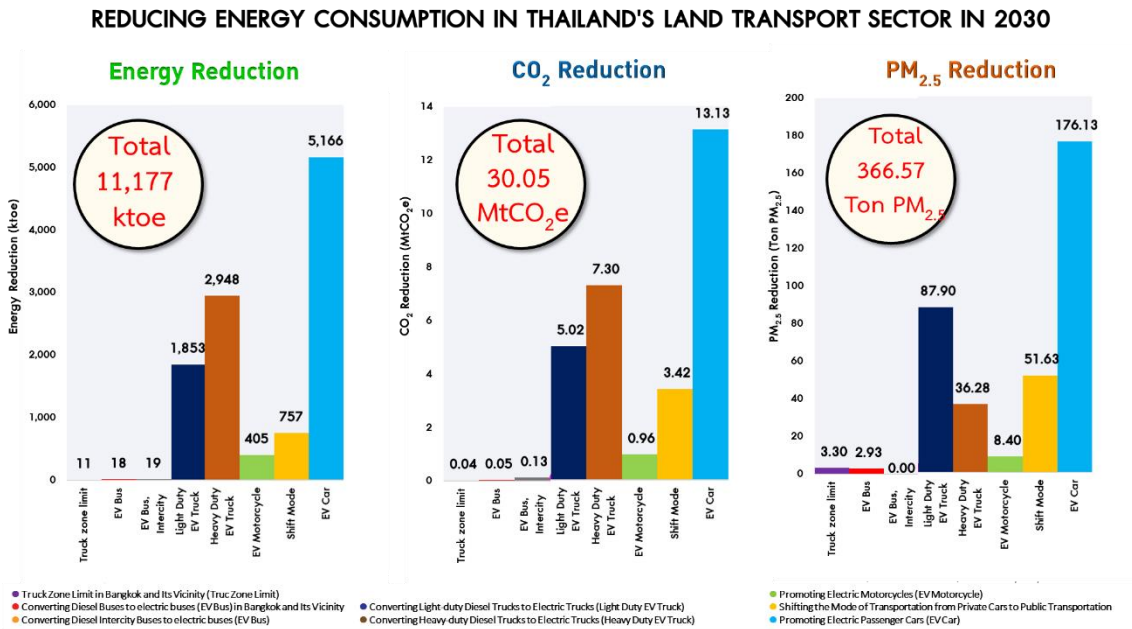


Figure 5.3-1 The potential for energy saving, greenhouse gas reduction, and PM_{2.5} reduction in land transport sector in 2030

5.4 Summary of the Results of Testing and Evaluation of Energy Consumption in the Land Transport Sector

The ASIF (Activity-Structure-Intensity-Fuel) equation is a framework for assessing energy use and emissions in road transportation. The ASIF equation focuses on the use of variables I (fuel consumption rate) and F (CO₂ emission rate), which are derived from laboratory and field analysis, for energy efficiency assessment.

The ASIF equation is used to estimate greenhouse gas emissions (GHG emissions) and categorizes measures through the A-S-I Approach or "avoid-shift-improve," which is a sustainable transportation principle. The main goals are to reduce energy use, reduce greenhouse gas emissions, and reduce PM_{2.5} emissions for the road transport sector. The project evaluated the energy efficiency potential of several measures, as follows:

- (1) Restrictions on the time and space for truck transportation
- (2) Promotion of the use of electric buses
- (3) Promotion of the use of electric vehicle technology
- (4) Changes in travel patterns

The results of these measures are a reduction in energy use of 11,177 kilotons of oil equivalent (ktoe), a reduction in greenhouse gas emissions of 30.05 million tons of carbon dioxide equivalent (MtCO_{2e}), and a reduction in PM_{2.5} emissions of 366.57 tons of PM_{2.5} (Ton PM_{2.5}) by 2030.

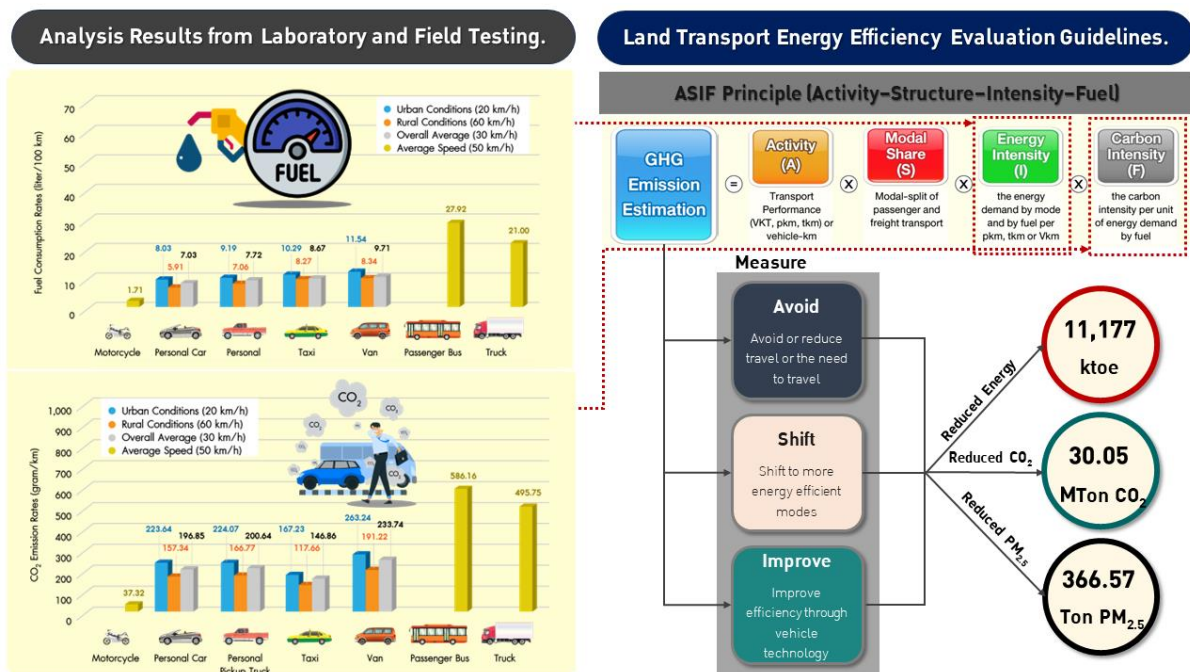


Figure 5.4-1 Relationship Between Energy Efficiency Test Result, the ASIF Equation, and ASI Measures in Relation to Energy and Pollution Evaluation in 2030

Chapter 6 Formulation of An Action Plan to Reduce Energy Consumption in Land Transport Sector of Thailand

In formulating an action plan to reduce energy consumption in the land transport sector of Thailand, the work will be divided into 2 parts: the consistency of the national policy and the essence of the action plan to reduce energy consumption in the land transport sector of Thailand as details follows;

- The alignment of national policies
 - National Strategy (1st Level Plan)
 - Master plan under national strategy (2nd level plan)
 - Related 3rd Level Plan

The Level of Plans

In accordance with the Cabinet resolution dated March 12, 2019, requires government agencies to revise Level 3 plans within their responsibilities, as stipulated by the Cabinet resolution dated December 4, 2017, to align with the National Strategy and the Master Plan under the National Strategy in order to support the implementation of Level 1 and Level 2 plans to achieve their defined objectives.



Figure 6-1 The alignment of national policies with the three-level planning framework

➤ Overview of the Action Plan to Reduce Energy Consumption in the Land Transport Sector (2023 -2037)

1. Objective

Land transport are energy-efficient and environmentally friendly transport systems that can enhance a country's logistics performance competitiveness.

2. Indicators and Target Values

2.1) Target

- 1) Energy efficiency of the country has improved.
- 2) Amount of GHG emissions has decreased.

2.2) Target Value

- 1) Energy Intensity (EI) (ktoe/billion Baht)
- 2) Amount of GHG emissions from BAU (MtCO₂e)

2.3) Indicator

- 1) Energy Intensity (EI) (ktoe/billion Baht)
- 2) Amount of GHG emissions from BAU (MtCO₂e)

Table 6-1 Target Value and Indicator of the Action Plan to Reduce Energy Consumption in the Land Transport Sector (2023 -2037)

Target	Indicator	Target Value		
		2023 - 2027	2028 - 2032	2033 - 2037
Energy efficiency of the country has improved	Energy Intensity (EI) (ktoe/billion Baht)	6.93 ktoe/billion Baht	6.45 ktoe/billion Baht	5.98 ktoe/billion Baht
Amount of GHG emissions has decreased from BAU	Amount of GHG emissions from BAU (MtCO ₂ e)	Reduce at least 15 – 20 percent for BAU	Reduce at least 30 – 40 percent for BAU	Reduce at least 30 – 40 percent for BAU

2.4) Development guideline

- 1) Development guideline 1 : Avoid/Reduce travel and transport (Avoid/Reduce)
- 2) Development guideline 2 : Shift mode of travel and transport (Shift/Maintain)
- 3) Development guideline 3 : Improve energy efficiency in vehicle (Improve)

The Importance of Developing the Action Plan

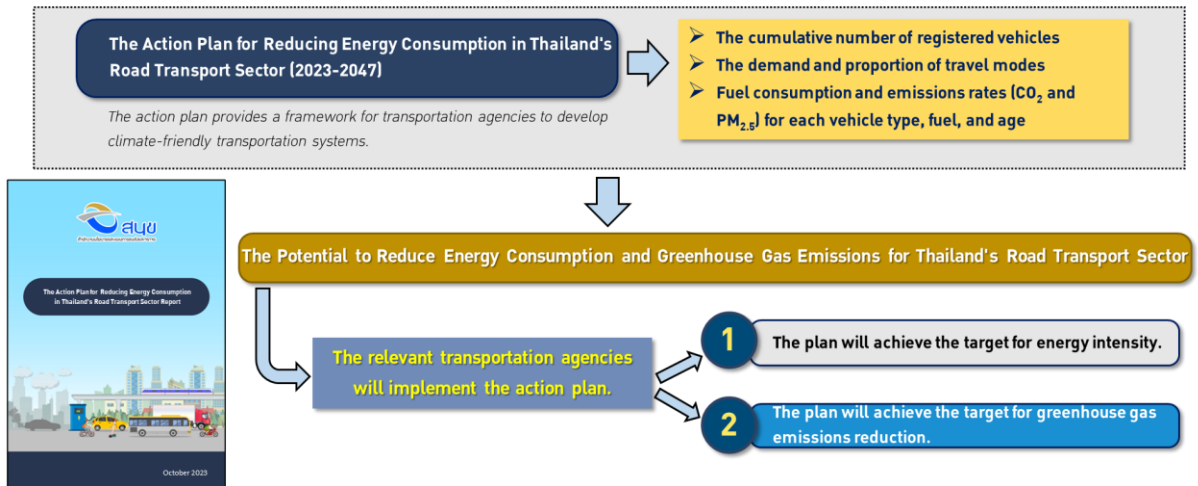


Figure 6-2: The Importance of Developing an Action Plan

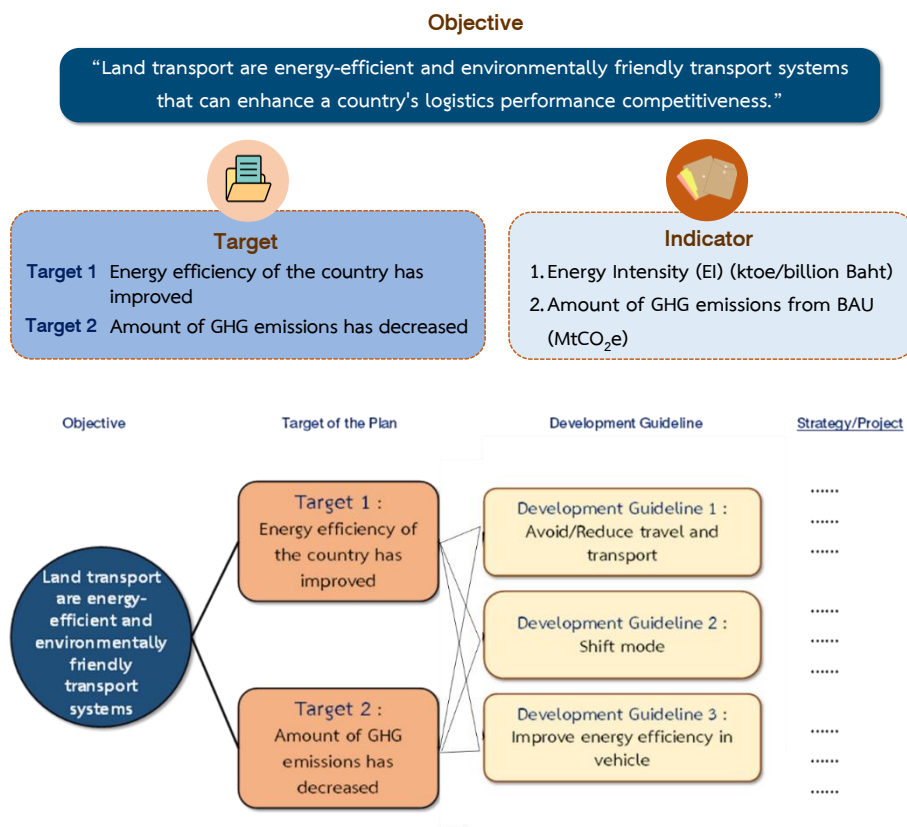


Figure 6-3: Objectives, Goals, and Development Guidelines of an Action Plan

3. Strategy/Project

3.1 Avoid/Reduce travel and transport (Avoid/Reduce) (Development guideline 1)

- 1) Truck Zone Limit in Bangkok and Its Vicinity
- 2) Car Sharing, Carpooling, and Truck Sharing
- 3) Transit-Oriented Development (TOD) around Mass Transit Stations

3.2 Shift mode of travel and transport (Shift/Maintain) (Development guideline 2)

- 1) Shifting the mode of transportation from private cars to public transportation
- 2) Promoting non-motorized transportation
- 3) Promoting multimodal transportation

3.3 Improve energy efficiency in vehicle (Improve) (Development guideline 3)

- 1) Converting diesel buses to electric buses (EV Bus) in Bangkok and Its Vicinity
- 2) Converting light-duty diesel trucks to electric trucks (Light Duty EV Truck)
- 3) Converting heavy-duty diesel trucks to electric trucks (Heavy Duty EV Truck)
- 4) Promoting electric passenger cars (EV Car)
- 5) Promoting electric motorcycles (EV Motorcycle)
- 6) Converting intercity buses to electric buses (EV Bus)
- 7) Promoting hydrogen fuel cell vehicles (FCEV)
- 8) Excise tax based on CO₂ emissions
- 9) Taxation Rates for Vehicle Usage and Registration Based on Carbon Emission Rates
- 10) Vehicle Lifespan Limitation Measures and Management of End-of-Life Vehicle
- 11) Minimum Energy Performance Standard for Vehicles (Vehicle Emission Standards)
- 12) Promotion of Fuel Quality Standards and Emission Standards
for New Vehicles (Euro 5 - 6)

Strategies/Projects under development guideline and responsible organization agencies as shown in **Table 6-2**

Table 6-2 The Action Plan to Reduce Energy Consumption in the Land Transport Sector (2023 - 2037)

Development Guideline	Strategy		Responsible Agency	Support Agency	Timeline			2030			2050		
					Short Term 0-5 Years (2023-2027)	Medium Term 6-10 Years (2028-2032)	Long Term 11-15 Years (2033-2037)	Energy Reduction (ktoe)	CO ₂ Reduction (MtCO ₂ e)	PM _{2.5} Reduction (Ton PM _{2.5})	Energy Reduction (ktoe)	CO ₂ Reduction (MtCO ₂ e)	PM _{2.5} Reduction (Ton PM _{2.5})
Development Guideline 1: Avoid/Reduce Travel and Transport (Avoid/Reduce)	Strategy 1.1	Truck Zone Limit in Bangkok and Its Vicinity	BMA RTP	DOH PRD DLT OTP				10.75	0.04	3.30	51.98	0.19	15.72
	Strategy 1.2	Car Sharing, Carpooling, and Truck Sharing	DLT DSI	BMA Private-Sector OTP									
	Strategy 1.3	Transit-Oriented Development (TOD) around Mass Transit Stations	DPW DCD	BMA OTP DRT SRT MRTA Airports DOH MD CAAT									
Development Guideline 2: Shift Mode of Travel and Transport (Shift/Maintain)	Strategy 2.1	Shifting the mode of transportation from private cars to public transportation	DLT BMTA SRT MRTA MD PAT	BMA OTP				756.81	3.42	51.63	2,436.13	9.50	138.45
	Strategy 2.2	Promoting non-motorized transportation	BMA Municipality	DLT BMTA SRT MRTA MD DPW OTP									
	Strategy 2.3	Promoting multimodal transportation	BMA OTP	DLT DRT SRT MRTA MD PAT AOT Airports									
Development Guideline 3: Improve Energy Efficiency in Vehicle (Improve)	Strategy 3.1	Converting diesel buses to electric buses (EV Bus) in Bangkok and Its Vicinity	BMTA OTP	DLT				18.26	0.05	2.93	18.26	0.05	2.93
	Strategy 3.2	Converting light-duty diesel trucks to electric trucks (Light Duty EV Truck)	OTP DED	DLT DEDE				1,853.00	5.02	87.90	3,030.00	10.97	106.70
	Strategy 3.3	Converting heavy-duty diesel trucks to electric trucks (Heavy Duty EV Truck)	OTP	DLT DEDE				2,948.00	7.30	36.28	6,656.00	28.13	46.66
	Strategy 3.4	Promoting electric passenger cars (EV Car)	OTP EPPO DED	DLT OIE.				5,166.00	13.13	176.13	11,726.00	39.22	207.43
	Strategy 3.5	Promoting electric motorcycles (EV Motorcycle)	OTP EPPO DED	DLT OIE.				405.00	0.96	8.40	1,051.00	3.86	7.67
	Strategy 3.6	Converting intercity buses to electric buses (EV Bus)	Transport Company OTP	DLT				19.34	0.13	0.004			
	Strategy 3.7	Promoting hydrogen fuel cell vehicles (FCEV)	EPPO DOEB DEDE	OTP									
	Strategy 3.8	Excise tax based on CO ₂ emissions	DED	OIE. DLT TISI PCD OTP				5,576.00	13.94	209.10			
	Strategy 3.9	Taxation Rates for Vehicle Usage and Registration Based on Carbon Emission Rates	DLT	OIE. DED TISI PCD OTP									
	Strategy 3.10	Vehicle Lifespan Limitation Measures and Management of End-of-Life Vehicle	DLT PCD DIW	OTP									
	Strategy 3.11	Minimum Energy Performance Standard for Vehicles (Vehicle Emission Standards)	OIE. DED	PCD DEDE OTP									
	Strategy 3.12	Promotion of Fuel Quality Standards and Emission Standards for New Vehicles (Euro 5 - 6)	TISI PCD	DOEB DEDE DLT OTP									
Total Potentials of Land Transport Sector								16,753.22	43.98	575.67	24969.37	91.91	525.55

Note: The potential numerical evaluations can be derived from this project, and the orange color represents the reference numbers from the NDC transportation branch.

The Transport Action Plan aims to reduce energy consumption and greenhouse gas emissions in road transport sector in Thailand. The road transport sector has the potential to reduce energy consumption by 16,753 ktoe and greenhouse gas emissions by a total of 43.98 MtCO₂e. The sector also has the potential to reduce PM_{2.5} emissions by a total of 575.67 Ton PM_{2.5} (Figure 6-4). The measures that reduce energy consumption and greenhouse gas emissions the most are the promotion of electric vehicles (EV Car) and the change of travel patterns to reduce the use of private cars. There are also other measures proposed in the Action Plan to support the reduction of energy consumption and greenhouse gas emissions, and to achieve carbon neutrality and net zero emissions in the future (Figure 6-5).

REDUCING ENERGY CONSUMPTION IN THAILAND'S LAND TRANSPORT SECTOR IN 2030

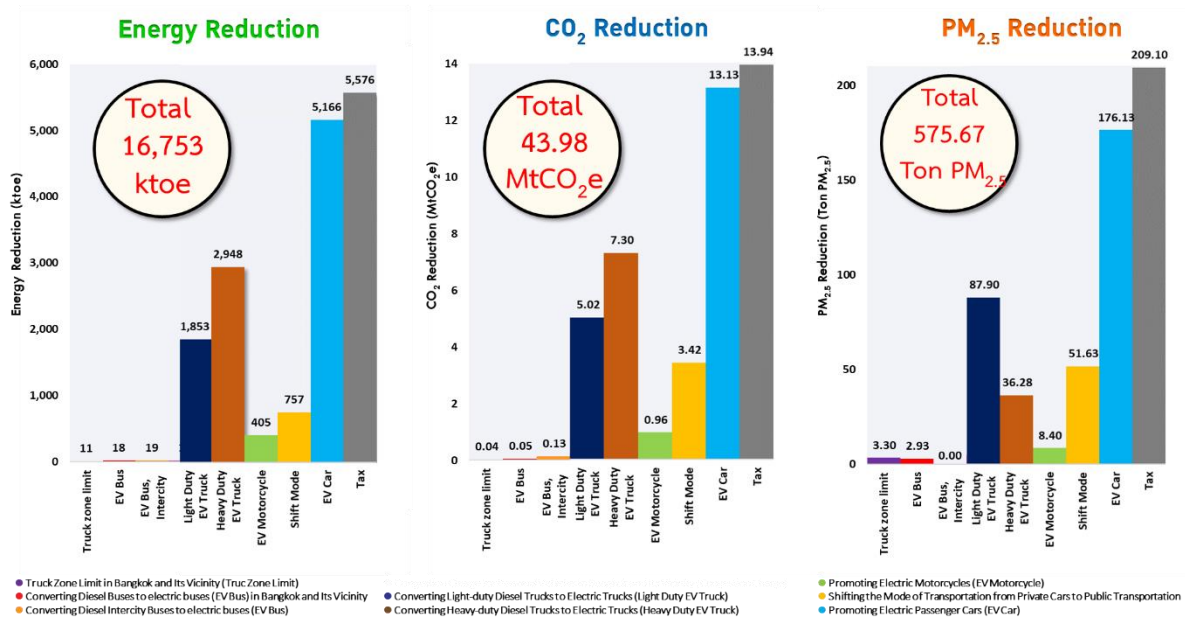


Figure 6-4 Potential for Energy, GHG, and PM2.5 Reduction in Land Transport Sector 2030

4. Potentials to reduce GHG emissions and future measures to achieve Carbon Neutrality and Net Zero Emission

The Action Plan to Reduce Energy Consumption in the Land Transport Sector serves as a roadmap for efficiently reducing energy consumption in the country's land transport sector. Its purpose is to provide guidance and targets for the government in driving energy reduction initiatives in the land transportation sector. The plan sets out three phases for implementing measures: short-term (2023 – 2027), mid-term (2028 - 2032), and long-term (2033 - 2037) as illustrated in Figure 6-5.

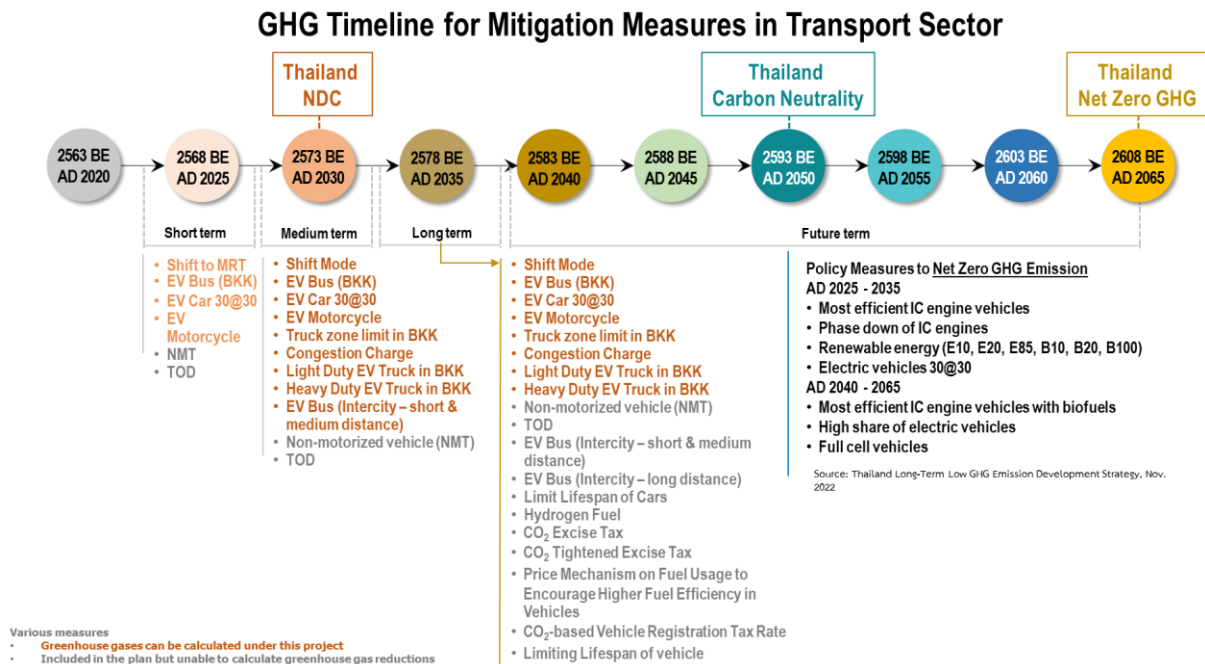


Figure 6-5 Timeframe for Implementing GHG Reduction Measures in Land Transport Sector

5. Monitoring and evaluation approach

If relevant agencies implement this action plan, they will play a role in enabling organizations to reduce energy consumption and greenhouse gas emissions in the land transportation sector, as assessed within the action plan. This will help achieve the targets for energy intensity and contribute to energy security. It will also contribute to the goal of reducing greenhouse gas emissions, leading to sustainable growth in a climate-friendly society. The following indicators are the monitoring and evaluation guidelines for tracking progress.

➤ **Indicator 1** Energy Intensity (EI) (ktoe/billion Baht)

If the relevant agencies implement the measures outlined in the Action Plan, it will be possible to reduce energy consumption in the overall land transport sector by 23,768 ktoe. This will contribute to achieving the target of reducing final energy consumption/GDP ratio to 1.33 ktoe/billion baht, compared to the overall ratio of 0.67 ktoe/billion baht in 2037 as shown in Figure 6-6.

$$\begin{aligned}
 \text{Energy Intensity (EI)} &= \frac{\text{Final energy consumption (ktoe)}}{\text{GDP (billion Baht)}} \\
 &= \frac{23,768}{17,888.83} \quad \text{ktoe (reduction)} \\
 &= 1.33 \quad \text{billion Baht (forecast @ 2573)} \\
 &= 1.33 \quad \text{ktoe/billion Baht}
 \end{aligned}$$

Guidelines for Monitoring and Evaluation

Indicator 1: Energy Intensity (EI) (thousand metric tons of oil equivalent per billion baht)

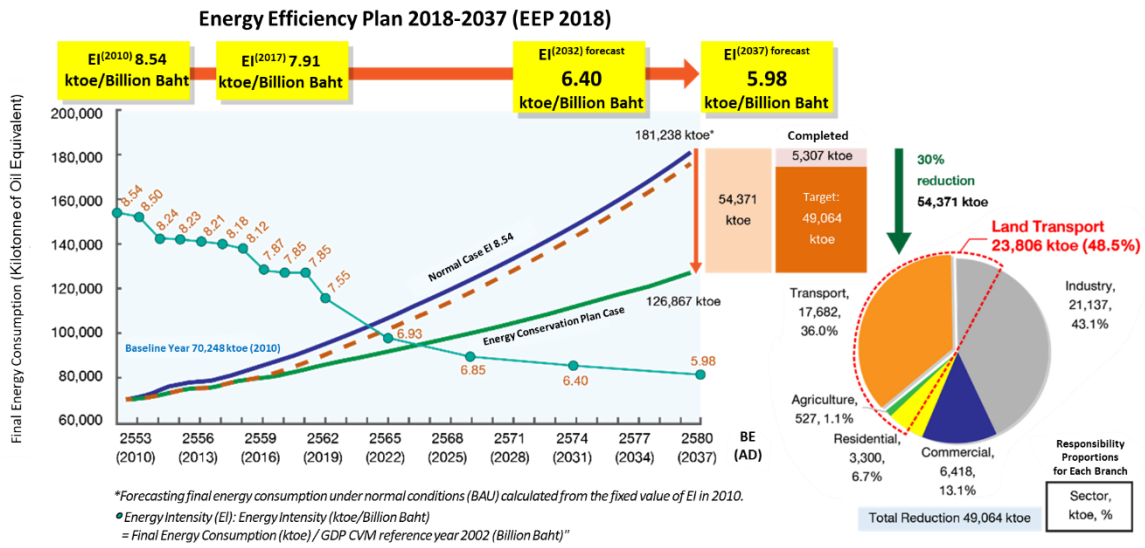


Figure 6-6 Target and potential to reduce Energy Intensity (EI) in land transport sector.

➤ **Indicator 2** Amount of GHG emissions from BAU (MtCO₂e)

If the relevant agencies implement the measures outlined in the Action Plan, it will be possible to reduce greenhouse gas emissions in the overall land transportation sector by 43.98 MtCO₂e. This will contribute to achieving the country's target of reducing greenhouse gas emissions by 19.8 % from the total emissions of 40% or a reduction of 221.7 MtCO₂e from the BAU in 2030 as shown in Figure 6-7.

Guidelines for Monitoring and Evaluation

Indicator 2: Expected greenhouse gas emissions under business-as-usual conditions (million metric tons of carbon dioxide)

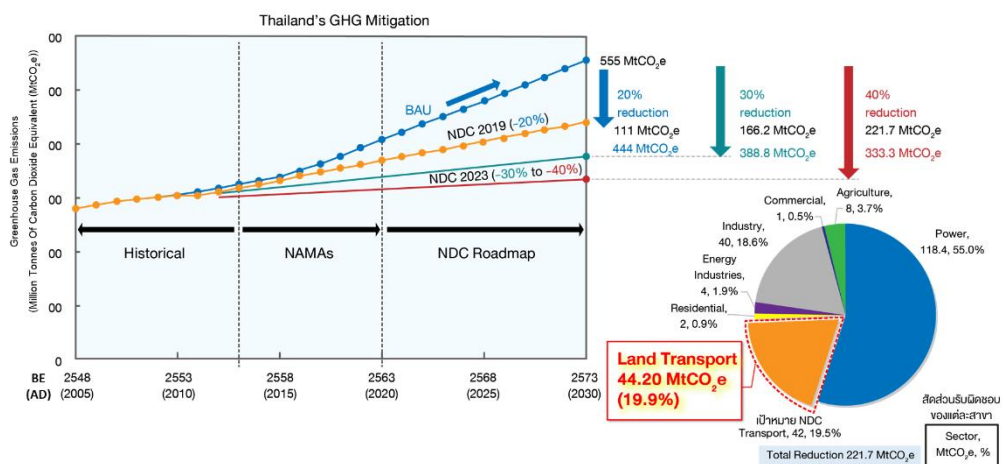


Figure 6-7 Target and potential to reduce GHG emissions from BAU (MtCO₂e) in land transport sector).

Details are in the Action Plan to Reduce Energy Consumption in Land Transport Sector of Thailand

Chapter 7 Organization of Workshops, Training, Seminars and Public Relations

The study involved a series of meetings, workshops, seminars, and public relations activities, with the participation of various agencies. The following are summaries of the details:

7.1 Organization of Workshops

This study included a workshop to promote knowledge development and exchange, as well as to gather feedback and suggestions from OTP and relevant agencies.

7.1.1 1st Workshop

November 25, 2022

- Policies to reduce energy and greenhouse gas emissions in road transport to address climate change.
- Guidelines for testing the energy efficiency of vehicles and changing energy use in the land transport sector.
- Vehicle emission standards and energy reduction from vehicle efficiency data.

7.1.2 2nd Workshop

June 17, 2023

- Policies to Increase Energy Efficiency and Reduce Carbon Emissions in Road Transportation in Thailand Towards Carbon Neutrality and Net Zero Emissions
- Impact Assessment of Electric Vehicles and Public Transportation on Energy Consumption and Greenhouse Gas Emissions Through Focus Group Discussions

7.2 Training for Knowledge Transfer

7.2.1 1st Knowledge Transfer Training

March 24, 2023

- Directions for Policies and Measures to Reduce Energy Consumption and Pollution in Road Transport

7.2.2 2nd Knowledge Transfer Training

August 3 - 4, 2023

- Directions for the Development of Thailand's Automotive Industry to Reduce Energy Consumption and Pollution in Road Transport

7.3 Seminar to Present Study Results

September 22, 2023

- Presentation of study results to relevant stakeholders to obtain feedback for appropriate report revision.

7.4 Support and Preparation of Relevant Academic Technical Recommendations, Knowledge/Knowhow Transfer, and Technology Transfer

1. The project produced two technical recommendations:

- Report No. 1: Assessment of the impact of electric vehicle technology and public transportation on energy use and greenhouse gas emissions in the transportation sector.
- Report No. 2: Congestion charge measures in congested areas.

2. The project transferred knowledge and technology related to the study to enhance the knowledge, understanding, skills, and work performance of the Department of Transport (DOT) officials in two rounds of consultation and knowledge sharing:

- Round 1: February 28, 2023
 - Importance and development of emission factors (EF) in the transportation sector for policies and measures to reduce energy use and pollution in road transportation.
- Round 2: March 8, 2023
 - Guidelines for using emission factors (EF) in the development of policies to reduce energy use and greenhouse gas emissions in the road transportation sector.

3. Technology/knowledge transfer and technology transfer related to the study:

- June 2, 2022
 - To enhance the understanding, skills, and work performance of DOT officials at the Vehicle Emission Measurement Laboratory in Thanyaburi District, Pathum Thani Province.

7.5 Project Public Relations

Consultants have conducted public relations for the project and prepared public relations media that continuously create a good image throughout the project period once a month and completed consisting of:

- 1) Project public relations website
- 2) Public relations via social media, leaflets, public relations for the project every month throughout the project
- 3) Video presentation of the project, length of not less than 5 minutes, dubbed in Thai and subtitles (Subtitle) English, 2 titles, etc



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