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Addressing Energy Efficiency in the Transport Sector Through Traffic Improvement

Edited by

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This report was prepared by the working group on the 'Addressing Energy Efficiency Through Traffic Improvement' under the Economic Research Institute for ASEAN and East Asia Energy Project. Members of the working group, who represent the participating East Asia Summit countries, discussed and agreed to use certain data and methodologies to assess efficiency improvements in the transport sector. These data and methodologies may differ from those normally used in each country. Therefore, the modelling results presented in this study should not be viewed as official national analyses of the participating countries

Preface

Coping with increasing oil demand is regarded as one of the top policy agendas in East Asia Summit (EAS) countries, since it engenders a variety of concerns for each country, such as a deterioration of oil supply security, fiscal balances, and air quality.

Although several studies have been conducted to address this issue, few have focused on the interrelationship between oil consumption and automobile traffic. This study is unique in that its approach will interconnect energy and traffic policies, and quantify the effect of traffic flow improvement on energy efficiency improvement.

The goal of this study is to provide policy planners in the EAS region suggestions on how to improve energy efficiency in the sector.

I hope this study can bring valuable insights for those involved in this issue.

Ichiro Kutani

Working Group Leader

June 2017

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List of Abbreviations and Acronyms

AI	artificial intelligence
APS	alternative policy scenario
ASEAN	Association of Southeast Asian Nations
BAU	business as usual
BRT	bus rapid transit
BRTR	BRT standard bus
CNG	compressed natural gas
DaCRISS	Study on Integrated Development Strategy for Da Nang City and Its Neighbouring Area Project, Viet Nam
EE&C	energy efficiency and conservation
ERIA	Economic Research Institute for ASEAN and East Asia
ICT	information and communication technology
km	kilometre
km/h	kilometre per hour
MRT	mass rapid transit
Mtoe	million tonnes of oil equivalent
toe	tonne of oil equivalent

Executive Summary

The study first summarized the existing policies in Viet Nam on energy efficiency improvement of the transport sector. The result of the survey showed that although details and degree differ, Viet Nam has implemented the same type of policies as that of Japan and Thailand. In terms of policy execution, strengthening of stakeholders' involvement is critical. It is suggested that such mechanism be implemented so that stakeholders themselves be gainfully engaged in improving traffic for improved energy efficiency, rather than simply imposing government policy.

The quantitative case study for Da Nang City evaluated effects of implementation or delay or both of long-term traffic plans. The study identified that planned bypass highway will differentiate oil consumption by 30% in 2030. While in the city centre, when assuming increasing modal shift from motorbike to automobile, 10 years' delay of development of public transport system will increase oil consumption by 5% in 2030. It appears that the existing blueprint of future traffic system is effective to reduce oil consumption, hence should be implemented immediately.

The study revealed that many challenges remain in reducing oil demand in the transport sector. When addressing these challenges, it is recommended to make active use of information and communication technology (ICT), in which development of technologies and creation of new services are rapidly progressing, for innovative approach to improve energy efficiency in the transport sector.

List of recommended policy actions for Viet Nam

Primary	1	Coordination among stakeholders or government agencies
	2	Analysis of big data on traffic
	3	Education for enhancing human resources
	4	Enhancement of financial resources
Secondary	1	Increase of public transportation
	2	Improvement of fuel economy of vehicle
	3	Fuel switch or alternative fuel: compressed natural gas (CNG) or biofuel

Chapter 1
Introduction

1.1. Background and Objective

In a series of studies since Fiscal Year (FY) 2012, the study team has conducted analyses on how to improve traffic flow for energy efficiency in the transport sector in major cities in East Asia Summit (EAS) region. Traffic problem can be categorized into two, national level and city level. The former represents issues such as rural development and high-speed or large-scale transportation among major cities. The latter represents issues such as urban design, daily commute, and traffic congestion. This study focuses on the latter aspect, city level issues.

From 2012 to 2014, we selected Jakarta in Indonesia as the subject for a case study in the first stage. One of the key findings of our 2-year study is that appropriate forward-looking investment is required in the initial stage of urban development. For instance, in Jakarta, traffic congestion has deteriorated considerably, and measures to improve the situation are limited. Improvement requires greater change in the existing system and massive short-term investment.

The EAS region has many other small- to medium-sized cities that will launch or have just launched explosive urbanization and motorization. Studies from 2015 onwards focus on these small- to medium-sized cities of the Association of Southeast Asian Nations (ASEAN). From the initial development stage of cities, appropriate measures must be implemented gradually to allow these cities to develop sound urban transport systems.

In this light, since FY 2014 we selected Da Nang City in Viet Nam as a subject of case study for the second period to address traffic problems in emerging small and medium-sized cities. From this analysis, we aim to derive policy recommendations applicable to similarly situated cities in the EAS region.

1.2. Rationale

The rationale of this study is derived from the 17th Energy Cooperation Task Force (ECTF) meeting held in Phnom Penh, Cambodia on 5 July 2012. In this meeting, the Economic Research Institute for ASEAN and East Asia (ERIA) explained and proposed new ideas and initiatives for EAS energy cooperation, including strategic use of coal, optimum electric power infrastructure, nuclear power safety management, and smart urban traffic.

The participants exchanged views and agreed to commence proposed new studies. As a result, ERIA formulated a working group for the 'Study on Energy Efficiency Improvement in the Transport Sector through Transport Improvement and Smart Community Development in the Urban Area'. Members from Indonesia, Japan, the Philippines, and Viet Nam are represented in the working group, and the Institute of Energy Economics, Japan (IEEJ) acts as the group's secretariat.

1.3. Work Stream

In FY 2016, we undertook the following steps.

(1) Analysis of the transport energy efficiency policy in Viet Nam at the national level (since national policies also have important implications for the development of transportation systems in domestic cities):
The study organized existing energy efficiency policy for transport sector in Viet Nam. Similar policy information was also gathered for Japan and Thailand to compare and find advantage and disadvantage of policy development in Viet Nam.

(2) Case study of Da Nang City, evaluate the effect or impact of different future scenarios:
Da Nang City had implemented a long-term transport master plan which included the development of bypass road, and bus rapid transit (BRT) and metro system. However, we saw some delay in executing the plan as scheduled. Moreover, we observed a growing number of passenger car ownership and a slowing pace of motorcycle increase. These phenomena may have an impact on future oil demand in the city, hence we quantitatively analyzed the effects of these changes.

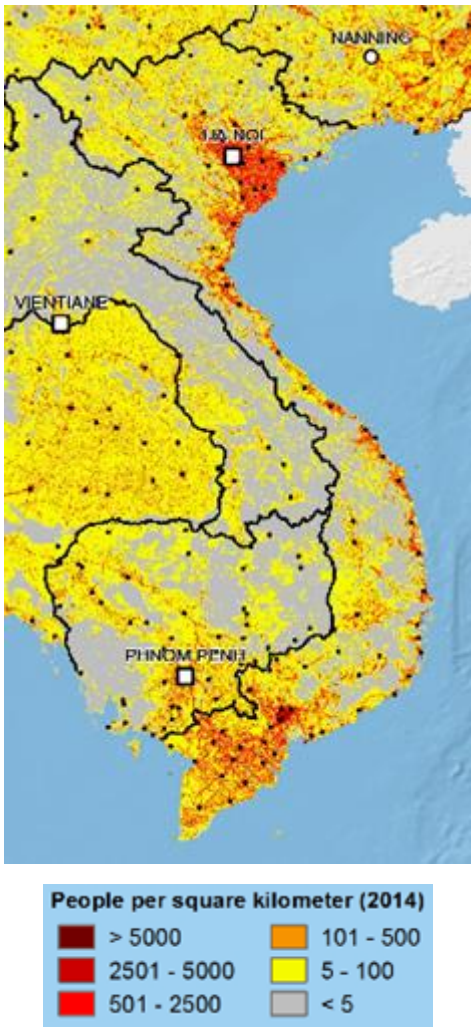
(3) Development of policy recommendation:
With the results from study items (1) and (2), the study identified and proposed policy actions that could help achieve oil demand reduction and sustainable development of transport sector in Viet Nam, as well as Da Nang City.

Chapter 2

Energy Efficiency Policy in Viet Nam

Before proceeding to policy analysis, the report will present an overview of the existing transport system in Viet Nam. As well recognized, Viet Nam is long from north to south. Population and industry are concentrated in Ha Noi City in the north and Ho Chi Minh City in the south. This geographical and demographical characteristic made Viet Nam to develop dense road network around two major cities, while interconnection of transport system between them is rather weak.

Figure 1.1: Population Density



Source: ADB website, Overview Map of GMS Population Distribution 2014

Figure 1.2: Existing and Planned Railways

Source: ADB website, Overview Map of GMS Railways 2012

Figure 1.3: Existing Road Network

Source: ADB website, Overview Map of Vietnam 2012

Figure 1.4: Planned Expressway

Source: Viet Nam Expressway Operation and Maintenance Limited Liability Company, Report on Viet Nam Expressway Development Plan, September 2013 (Bui Dinh Tuan).

2.1. The Current Energy Efficiency and Conservation (EE&C) Policy in Viet Nam

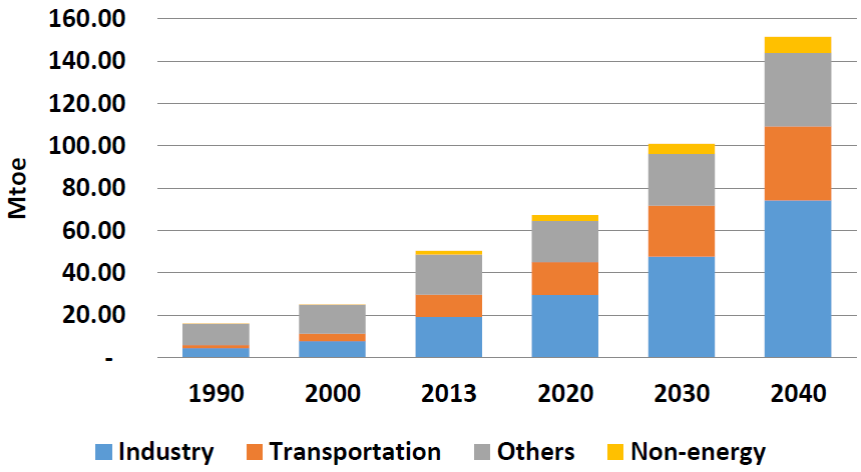
2.1.1. Introduction

(1) Final energy consumption, business as usual (BAU)

Viet Nam's final energy consumption increased at an average annual rate of 5.1% from 1990 to 2013, from 16.1 million tonnes of oil equivalent (Mtoe) to 50.5 Mtoe. The fastest growth occurred in the transport sector (9.2%), followed by the industrial sector (6.5%), and the residential or commercial ('others') sector (2.8%). Non-energy use increased at an average rate of 19.6% per year.

From 2013 to 2040, final energy consumption is projected to increase at an average rate of 4.2% per year under the BAU scenario, driven by strong economic growth, assumed to average 6.0% per year, and population growth of 0.7% per year. The strongest growth in consumption is projected to occur in the industry sector, increasing by 5.1% per year, followed by the transportation sector (4.6%), and the residential or commercial ('others') sector (2.3%). Non-energy use is expected to increase by 5.7% per year.

Figure 2.1: Final Energy Consumption by Sector, BAU Scenario



BAU = business-as-usual; Mtoe = million tonnes of oil equivalent

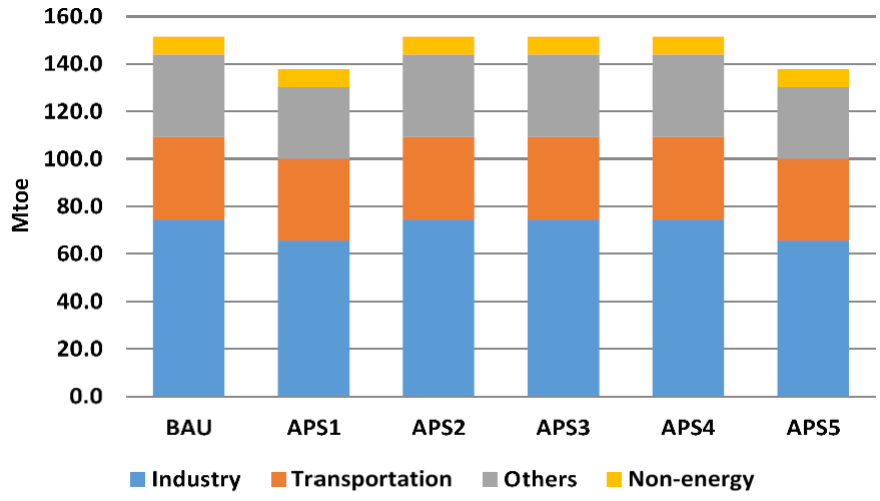
Source: ERIA (2016), *Energy Outlook and Energy Saving Potential in East Asia 2016*.

(2) Energy saving potential

In the Alternative Policy Scenario (APS 5), final energy consumption is projected to increase at a slower rate of 3.8% per year (compared with 4.2% in the BAU), from 50.5 Mtoe in 2013 to 137.8 Mtoe in 2040, mainly because of energy efficiency and conservation measures (APS 1) in the industrial, transport, and residential and commercial ('other') sectors.

APS implies different scenarios which are: (i) energy efficiency and conservation scenario (APS 1); improvement of energy efficiencies in power generation (APS 2); development of renewable energy (APS 3); further development of nuclear power plants (APS 4); and APS 5, a combination of all APSs, from APS 1 to APS 4.

Figure 2.2: Final Energy Consumption by Sector, BAU and APS

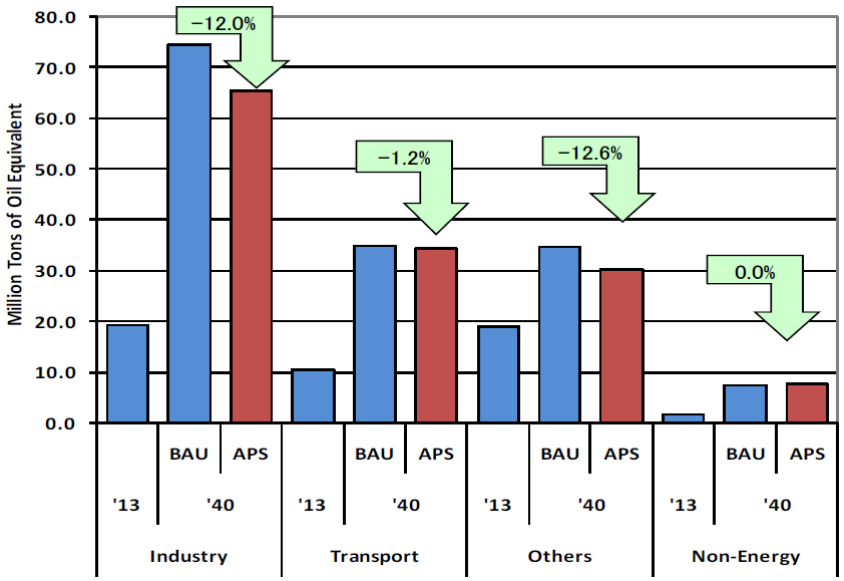


BAU = business-as-usual; APS = alternative policy scenario;Mtoe = million tonnes of oil equivalent.
Source: ERIA (2016).

The bulk of the savings are expected in the residential or commercial ('others') sector, at 4.4 Mtoe, equivalent to a 12.6% reduction, followed by the industry sector with 8.9 Mtoe, equivalent to a 12.0% reduction, and the transportation sector with 0.4 Mtoe, equivalent to a 1.2% reduction.

An improvement in end-use technologies and the introduction of energy management systems are expected to contribute to a slow consumption growth, particularly in the industry, residential and commercial ('others'), and transport sectors.

Figure 2.3: Final Energy Consumption, BAU vs APS



BAU = business-as-usual; APS = alternative policy scenario

Source: ERIA (2016), Energy Outlook and Energy Saving Potential in East Asia 2016.

2.1.2. The current energy efficiency and conservation policies in transport sector in Viet Nam

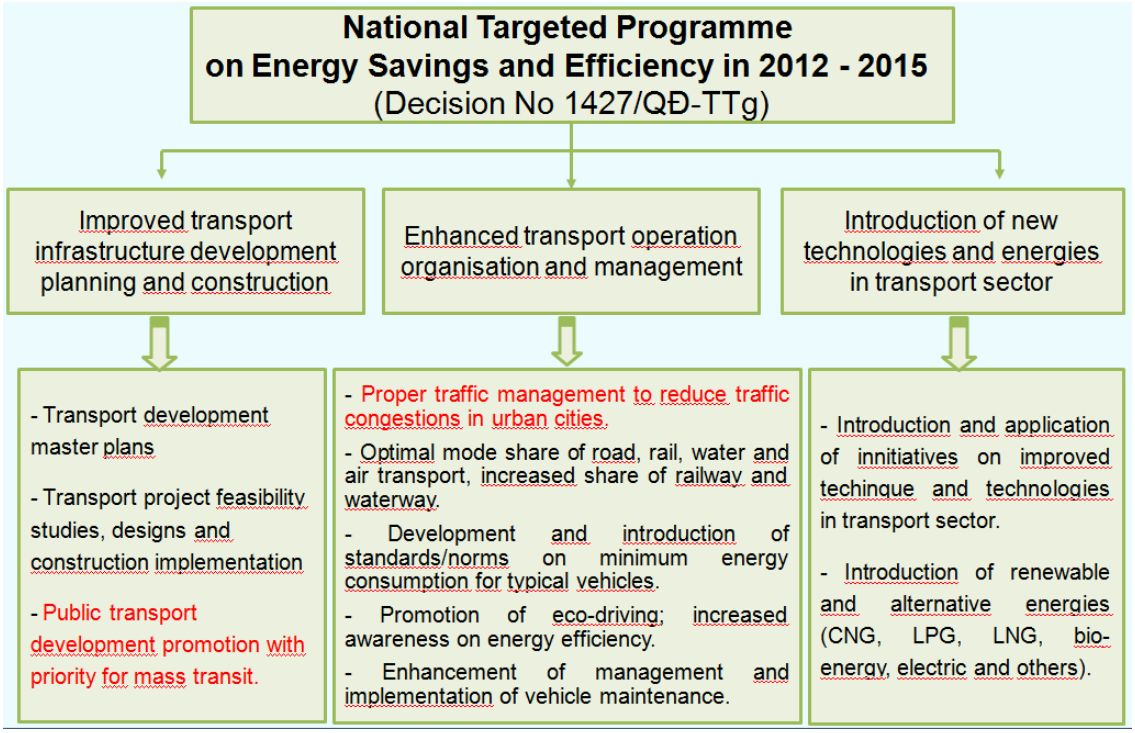
Viet Nam has made initial approaches for energy efficiency and conservation (EE&C) and environmental protection since the 1990s. The comprehensive law on EE&C with 12 Chapters, 48 articles was officially approved on 18 June 2010 and has been in effect since 1 January 2011. Thereafter, various decisions and circulars have been issued.

For example, Prime Minister's Decision No. 355/QD-TTg shows the transport development strategy up to 2020 with a vision to 2030. In this strategy through 2020, specific objectives are enumerated. For urban transport development, it stipulates rational development of urban transport and public transport infrastructure, allocating 16%–26% of land area for urban transport, and rapidly developing bus systems in major cities; quickly investing in bulk public routes, such as elevated railway and subway to accommodate 25%–30% of passenger transport demand, along with controlling the increase of private motorbikes and cars, especially in Hanoi City and Ho Chi Minh City.

Prime Minister's Decision No. 1427/QD-TTg indicates the National Targeted Programme on Energy Savings and Efficiency in 2012–2015. It consists of three pillars: (i) improved transport infrastructure

development and construction; (ii) enhanced transport operation organization and management; (iii) introduction of new technologies and energies in transport sector (Figure 2.4).

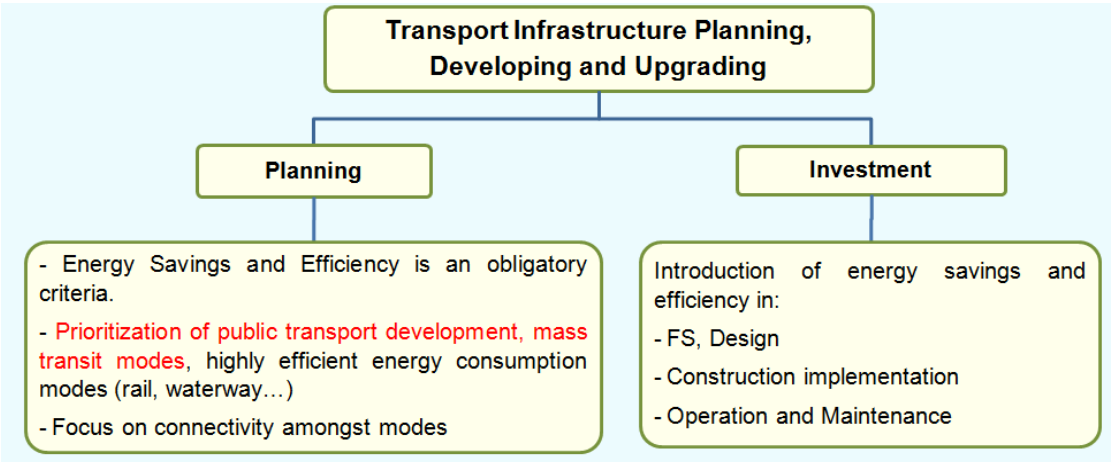
Figure 2.4: National Targeted Programme on Energy Savings and Efficiency in 2012–2015



CNG = compressed natural gas, LNG = liquefied natural gas, LPG = liquefied petroleum gas.
Source: Energy Efficiency and Conservation Office, Viet Nam.

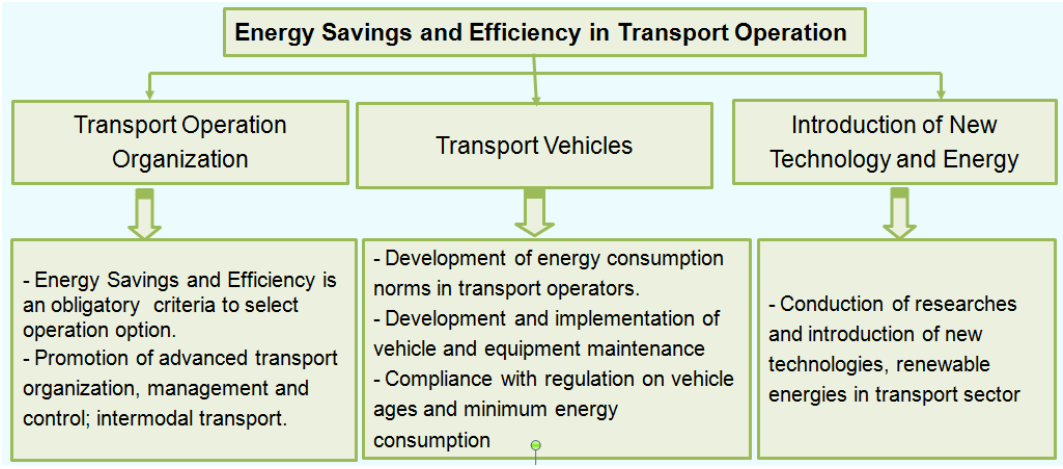
On measures for EE&C, Circular No. 64/2011/TT-BGTVT covers a wide range from infrastructure planning and investment to operation and management. Details are shown in Figures 2.5, 2.6, and 2.7.

Figure 2.5: Measures for Transport Infrastructure Planning, Developing, and Upgrading



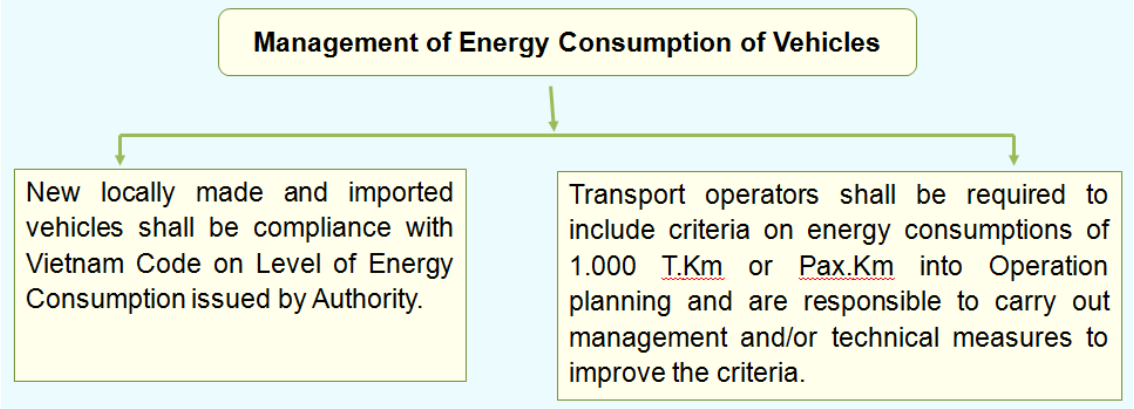
FS = feasibility study.
Source: Energy Efficiency and Conservation Office, Viet Nam.

Figure 2.6: Measures for Transport Operation



Source: Energy Efficiency and Conservation Office, Viet Nam.

Figure 2.7: Measures for Management of Energy Consumption of Vehicles



T.Km = total kilometre, Pax.Km = travel distance of passengers kilometre.
Source: Energy Efficiency and Conservation Office, Viet Nam.

2.2. Comparison of EE&C Policy in Viet Nam, Thailand, and Japan

Energy efficiency and conservation policies in the transport sector in three countries have been introduced at each time according to the development and growth stages of the country. For example, Japan will experience decline in population and low economic growth, while Viet Nam will have a steady population and economy growth. Thailand's situation is at the midpoint of that of the two countries. Thus, the priority of transportation policies a country should take may change from time to time, depending on the economic and social situation of the country.

Thailand especially puts emphasis on eco-labelling and expects a large amount of energy saving effects. On the other hand, Japan is keen on effective logistics to address labour shortages, especially truck drivers. The Japanese government is working on drawing up the next strategic logistics plan. It will incorporate in the next plan commercializing of self-driving technology, which is expected to greatly pare down economic loss of ¥10 trillion due to traffic jam.

In planning future policies, Viet Nam should not only follow other countries' precedents but also introduce policies tailored to its circumstances while referring to advanced examples of the world since urban mobility is transforming faster than ever, with revolutionary transport services altering how people move in cities daily.

The current status of EE&C policy in each country is described in Table 2.1.

Table 2.1: Overview of Major EE&C Policies in Three Countries

Category	Viet Nam	Thailand	Japan
Labelling and tax break for eco-vehicle	• Energy labelling for up to 7-seat cars -New locally made and imported cars: from Jan 2015. -For manufacturers who self-announce their energy consumption: from 1 Jan 2015 to 31 Dec 2016 • Energy labelling for 8-, 9- seat cars -mandatory from Jan 2018	• Eco-sticker for the rate of CO_2 and oil consumption (Starts on 1 Jan 2016) • Approved 97 companies of 2,249 versions of eco-stickers	• Tax reduction for eco-cars and eco-sticker have already been introduced.
Logistics and transportation management	• Adjustment of Transport Development Strategy of Viet Nam up to 2020, Vision to 2030	• Transportation management system demonstration for an efficient logistics management -Train 110 logistics companies • Tracking and initiatives to reduce energy consumption in transport sector -Traffic modelling -Create a data base to collect each car mileage	• Energy Conservation Law covers not only carriers but also shippers (encourages shipper to choose more energy-efficient carrier). • The next comprehensive logistics policy is under formulation.
Eco-driving	• Application of eco-drive program: environment-friendly driving -Taxi in Hanoi (Taxi group) -Trucks in Hanoi & Binh Duong -Training for pupils, students	• Eco-driving training - 4 regions with a total of 400 drivers (2-day training) - Create a network for training centers	• Eco-driving management system (EMS) has been introduced for trucks.

Public transport	• Approval of the scheme on development of public transport by bus, Stage 2012–2020	• DEDE has worked closely with OTP. • Fundamental information on energy saving evaluation - Airport rail link - BTS, MRT	• Low Carbon City Act (Dec 2012) -Promotion of public transport -Opening of new LRT/railway lines and bus routes and improvement of station
Railway improvement	• Railway Development Strategy until 2020 and vision to 2050 • The strategy focuses on upgrading the existing network.	【Double-track】 • DEDE with OTP follows the progress of double-track program • Change of 20 locomotive diesel heads (e.g. electric)	• 'Eco Rail Line Project is in progress, including installation of regenerative power absorbing device.

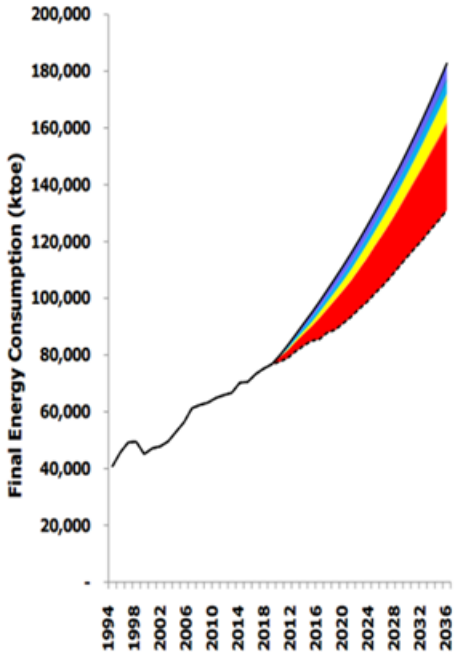
CO_2 = carbon dioxide, DEDE = Department of Alternative Energy Development and Efficiency, BTS = Bangkok Mass Transit System, LRT = light rail transit, MRT = mass rail transit, OTP = Office of Transport and Traffic Policy and Planning.
Source: Study Team.

2.2.1. Features of EE&C policy in Thailand

Thailand has formulated the Energy Efficiency Development Plan (EEDP) 2015–2036. According to the plan, an energy saving of 51,700 kilotonnes of oil equivalent (ktoe) will be realized in 2015–2036, 30,213 ktoe or 58% of which comes from the transport sector. In addition, specific energy saving target values are set for individual policies of the transport sector (Figure 2.8). Tax structure for vehicle and eco- sticker, which is the largest energy-saving contributor, accounts for 45% of the total energy reduction target. The eco-sticker (labelling) system based on carbon dioxide ($CO_{2)}$ emissions and fuel economy was introduced in January 2016, and CO_2 emissions have been reduced since then. The second largest saving is expected to come from railway improvement (double-track) and public transport, which account for approximately 16% of the total energy reduction target.

In promoting policies, Thailand established the EE7 Committee, which consists of government ministries and agencies with crossover cooperation to implement policies and verify results.

Figure 2.8: Summary of Energy Efficiency Development Plan Target by Sector

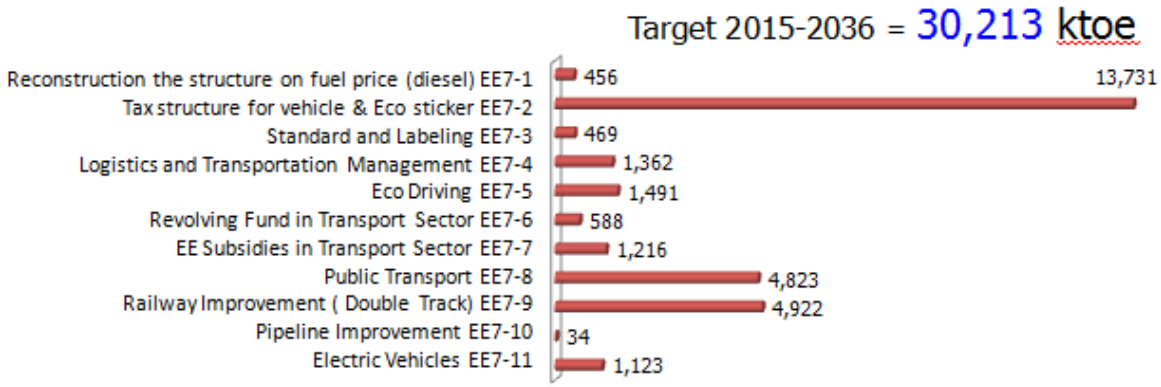


Expected Energy Saving by Economic Sector		Total (ktoe)	Total (%)
EE1	Enforcement of ENCON Act 1992 on energy conservation standards for designated factories and buildings	5,156	10%
EE2	Building Energy Code (BEC) on new buildings	1,166	2.2%
EE3	Energy Labeling on equipment/appliances (HEPs & MEPs)	4,150	8%
EE4	Enforcing Energy Efficiency Resource Standard (EERS) for large energy producers and distributors	500	1%
EE5	Financial Incentives and support for energy performance achievement	9,524	18.4%
EE6	Promoting and encourage to use LED	991	2%
EE7	Energy saving measures in transport sector	30,213	58.4%
EE8	Support the energy efficiency technology research & development	-	-
EE9	Support the human resource development on energy conservation	-	-
EE10	Support the public awareness and behavioral change on energy conservation	-	-
Total		51,700	100%

ktoe = kilotonne of oil equivalent.

Source: Department of Alternative Energy Development and Efficiency, Thailand Energy Efficiency Plan on Transport Sector (Mr. Pichalai)

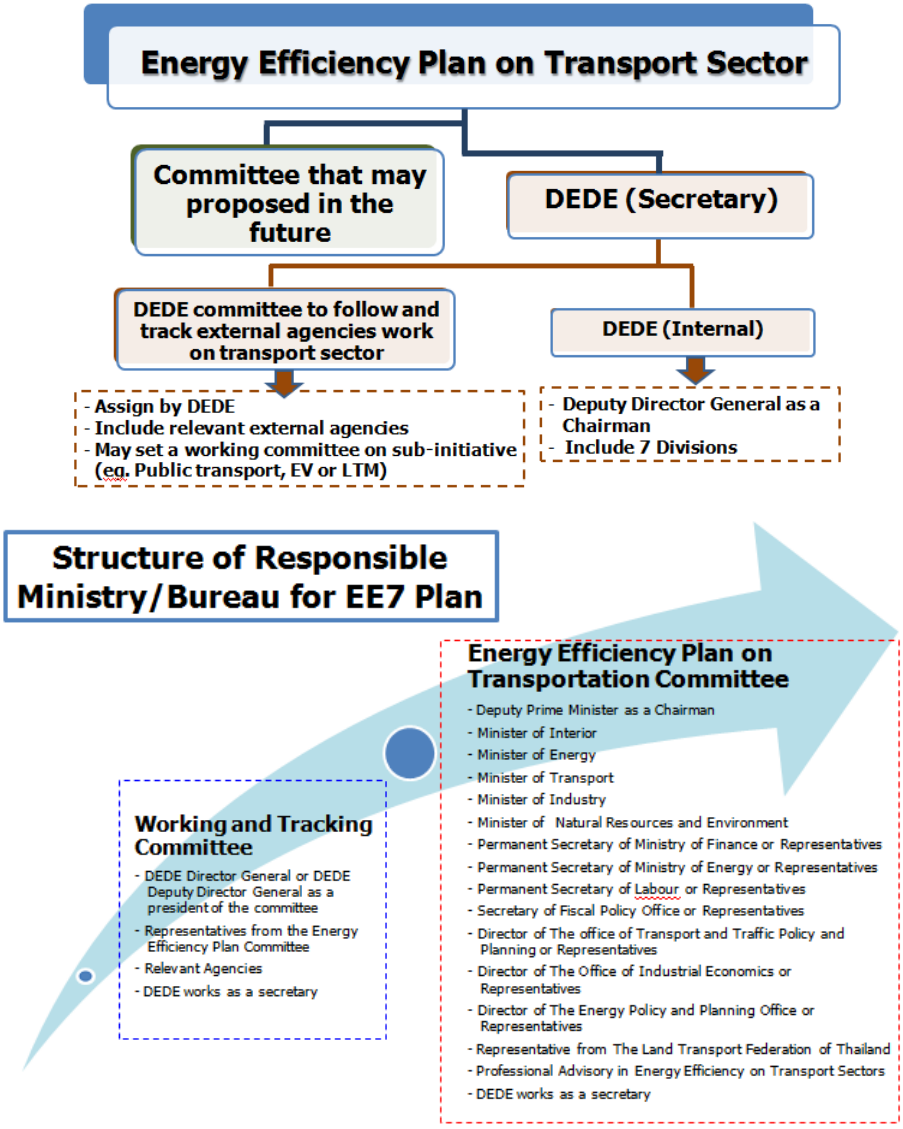
Figure 2.9: Energy Efficiency Plan on Transport Sector Saving Target (2015–2036)



ktoe = kilotonne of oil equivalent.

Source: Department of Alternative Energy Development and Efficiency (year), 'Thailand Energy Efficiency Plan on Transport Sector'.

Figure 2.10: Implementation Structure of EE&C Policy in Thailand



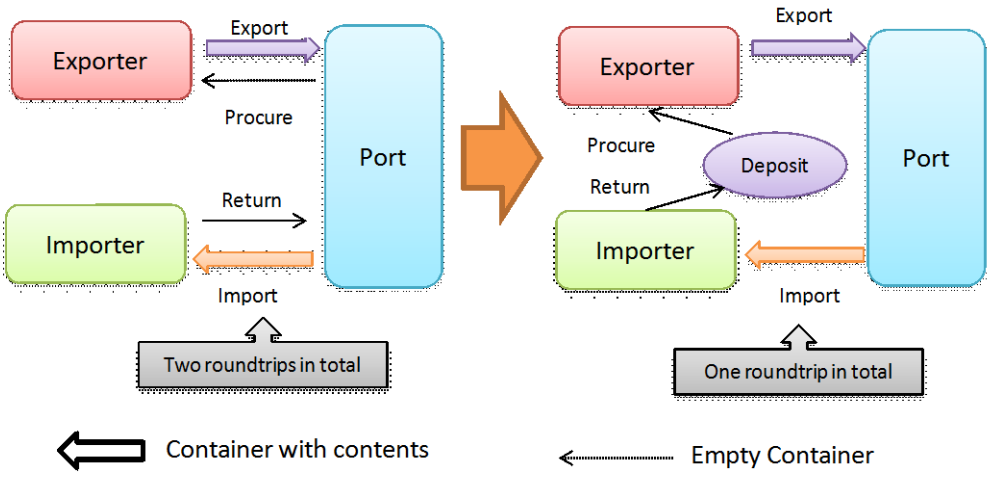
Source: Department of Alternative Energy Development and Efficiency, 'Thailand Energy Efficiency Plan on Transport Sector'.

2.2.2. Features of EE&C policy in Japan

One of the major energy efficiency features in Japan is that the Energy Conservation Law obligates business shippers, as well as transport operators, to make energy conservation efforts. The law is applied to shippers whose annual shipping amount is 30 million ton-kg and more which covers about 850 companies nationwide and about 19% of the total energy consumption of transportation sector. To build more efficient logistics for shippers, container round use (Table 2.2) and joint transportation and delivery (Table 2.3) have now been promoted. The Japanese government has also been formulating the next logistics plan with the cooperation of related ministries in the government. The government will incorporate technological innovation, i.e. ICT, in the policy, and address the problems of energy savings and labour shortages due to declining population.

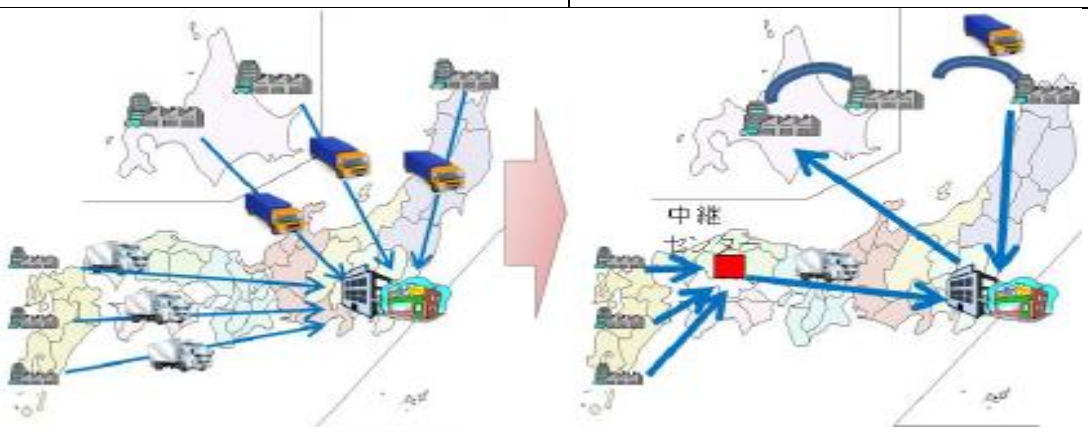
Table 2.2: Promotion of Container Round Use in Japan

Background	Countermeasures
• Inefficiency of maritime container transportation in imports and exports • During import, the container is picked up at the port, transported, and loads unpacked at the import company factory inland, and the empty container is returned to the port. During export, the empty container is picked up at the port, transported, and loads packed at the export company factory inland, and transported to the port and exported; all empty containers are returned to the port.	• Implement a pilot project where export operators can reuse containers used for import without returning them to the port (container round use) • Establish a council by stakeholders, shipping companies, distribution business operators, inland depots, government officials, and other stakeholders to grasp the current situation to solve problems



Source: Ministry of Economy, Trade and Industry, Japan.

Table 2.3: Promotion of Joint Transportation and Delivery in Japan

Background	Countermeasures
• Inefficient transport modes in rural areas • In rural areas, companies carry out shipping individually, so multiple duplicate transports occur with low loading efficiency.	• Construct a mechanism that loads and transports cargoes from small and medium regional enterprises with increased loading efficiency, sharing logistics bases and jointly shipping cargoes of multiple companies • Reduce logistics cost and lead time of regional companies by constructing a joint transportation and delivery model • Realize regional creation by promoting regional joint transportation and delivery model in other regions
	

Source: Ministry of Economy, Trade and Industry, Japan.

2.3. Proposals for Enhancing EE&C in Viet Nam

As an overview of the technology field in the world, artificial intelligence (AI) has been drawing much attention among governments, private enterprises, and research institutes. For the transportation sector, it can be applied in various fields, such as self-driving, traffic signals, and traffic congestion countermeasures.

AI has just come into the practical stage from the demonstration stage. For example, in Japan, 'Smart Bus' using AI is expected to be used in 2018. AI determines the optimum operating time and route based on the number of people desiring to use the bus, and the place and time. It is more efficient and convenient than running a determined route on time. As for AI traffic signals[1], in pilot tests in Pittsburgh, US, the smart traffic management system had impressive results. It reduced travel time by 25% and idle time by over 40%. The researchers also estimated that the system cut

[1] Radar sensors and cameras at each light detect traffic. Sophisticated AI algorithms use the data to build a timing plan that moves all the vehicles it knows about through the intersection in the most efficient way. The computer also sends the data to traffic intersections downstream for planning.

carbon dioxide emissions by 21%. The system could also save cities the cost of road widening or eliminating street parking by boosting traffic throughput[2].

In considering Viet Nam's transportation policy, it is desirable to incorporate the advancement of AI or other cutting-edge technologies. In particular, autonomous vehicles, AI traffic lights, and other devices or countermeasures to eliminate congestion have entered a full-scale introduction stage. Moreover, policy planning involving not only lawmakers but also citizens, businesses, and academia would translate into active participation and full commitment by each participant. Thus, this procedure would pave the way to solving various social problems, such as air pollution, traffic accidents, and high energy cost.

(i) Boosting efficiency in logistics; utilizing automated-driving technology

In Viet Nam, efficiency improvement of truck logistics is expected to have a large energy saving effect. For example, trucks consume more than 80% of total fuel in Da Nang City (Figure 3.6). To improve efficiency in logistics and to tackle traffic congestion, the government will set up a national express network, which consists of 21 routes with length of around 6,400 kilometres (kms). The investment will be focused on building two north–south expressway routes with priority to routes to Hanoi City, Ho Chi Minh City, Da Nang City, and big seaports. Moreover, the Economic Corridor extending to the east, west, north, and south has been promoting mainly through roads, which are responsible for regional logistics. It is essential to strengthen energy saving measures in the logistics field where Viet Nam is expected to deal with increased volume.

To address the challenge, Viet Nam could consider introducing advanced examples of automated-driving technology. In Japan, during the demonstration stage, automated-driving technology for truck platooning[3] has achieved a significant energy saving effect of 16% (Table 2.4). According to Japan's logistic strategy, an efficient distribution of logistics has been actively undertaken under the coordination of ministries and agencies with the government, and truck platooning will be utilized on highway by 2020 (Table 2.5).

Furthermore, autonomous driving system can be applied to BRT which will allow Viet Nam to easily expand BRT transportation volume.

[2] http://spectrum.ieee.org/cars-that-think/robotics/artificial-intelligence/pittsburgh-smart-traffic-signals-will-make-driving-less-boring

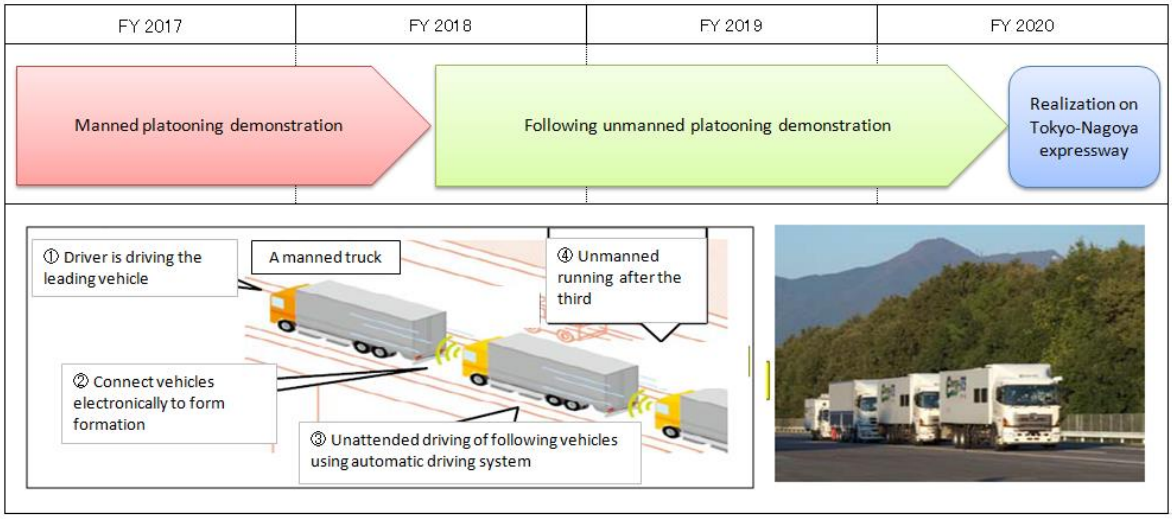
[3] Truck platooning is a driving method in which multiple trucks are driven in a platoon operation.

Table 2.4: R&D for Autonomous Truck Convoys in Japan

<table>
<tr><th>Period</th><th colspan="5">5 Years (2008–2012)</th></tr>
<tr><td>Targets</td><td colspan="5">• Improve fuel economy on highway by reducing running air resistance by proximity distance between vehicles and speed control without waste
• Realize a safe and reliable platooning that can travel even on existing highways</td></tr>
<tr><td>Experiments</td><td colspan="5">• Several driverless vehicles follow a human-driven truck to which they are wirelessly linked.
<table>
<tr><td colspan="2">Type</td><td>・4 heavy trucks
・CACC traveling</td><td>・3 heavy trucks
・Row traveling</td><td>・3 heavy trucks and a light truck
・Row traveling</td><td>・Alone unmanned driving</td></tr>
<tr><td rowspan="2">Spec.</td><td>Max.speed</td><td>80km/h</td><td>80km/h</td><td>80km/h</td><td>50km/h</td></tr>
<tr><td>Inter-vehicle Distance</td><td>30m</td><td>10m</td><td>4m</td><td>–</td></tr>
</table></td></tr>
<tr><td>Achievements</td><td colspan="5">• Realized platoon operations with a distance of 4 metres, achieving energy saving effect of 16.2%
• Platoon operations are applicable for expanding BRT transport volume.</td></tr>
</table>

R&D = research and development.
Source: NEDO Energy ITS Promotion Program, R&D for Autonomous Truck Convoys.

Table 2.5: Roadmap of Truck Platooning in Japan



Source: Prime Minister of Japan and His Cabinet (2017), A Government Council on Investments for the Future, February.

(ii) Traffic flow management; adopt an interactive, collaborative policy planning

Various policies incorporating the latest findings have been introduced to realize a sustainable society where traffic capacity can be increased while maintaining the current road width.

For example, the World Business Council for Sustainable Development (WBCSD) has launched 'Sustainable Mobility Project 2.0' with 15 mobility-related companies and other stakeholders to accelerate progress towards sustainable mobility. Six cities were selected as demonstration cities – Indore (India), Chengdu (China), Bangkok (Thailand), Campinas (Brazil), Lisbon (Portugal), and Hamburg (Germany).

A conventional policy planning, top–down approach, sometimes causes negative reactions from citizens or businesses, and even worse brings about harsh oppositions. To enhance the effectiveness of EE&C, it is crucial to gain an all-in support for the policy from all sectors.

As regards the project in Bangkok, the government developed and implemented the Sathorn Model for the most-heavily travelled Sathorn Street to mitigate traffic congestion and to make traffic flow smooth. Sathorn Model is initiated by WBCSD, Bangkok Metropolitan Administration (BMA), the Ministry of Transport (MOT), and Metropolitan Police Bureau. It has been scaled up by cooperating with Chulalongkorn University with around 110 million Thai baht granted from Toyota Mobility Foundation.

The model is composed of several dozens of policies. The government, private sector, academia, and citizens collaborated among themselves to promote the model effectively. As a result, it has brought noticeable achievements, thus these measures will be expanded across the city (Table 2.6).

Table 2.6: Overview of Sathorn Model Project in Bangkok, Thailand

Project Period	1 year and 9 months (April 2015–December 2016)
Purposes	• Mitigate the severe traffic congestion problem in Bangkok and achieve smooth and efficient movement of people through traffic and demand management, as well as through offer of diverse modes of transportation • Using the high-traffic flow concentration Sathorn district as a model, prepare a roadmap for traffic control for Bangkok as a whole that encompasses the public and private sectors, as well as ordinary citizens • Propose for the implementation of Sathorn Model in other districts.
Steps for collaboration among sectors	• Three steps taken to reach consensus from all sectors, namely government, citizens, businesses, academia; (1) Brainstorming for ideas from all sectors (2) Call for action to communicate with middle management to raise awareness and consider possible solutions (3) Leader forum
Main components	• Four pillars: Park and ride, shuttle bus, information system, traffic management • Evaluation of measures via six key performance indicators: greenhouse gas, energy efficiency, congestion and delay, commuting travel time, air polluting emissions, and comfort and pleasure
Achievements	• The amount of transportation in the peak time in the morning increased by 12.6%, 4691 vehicles per hour. • The average speed increased by 68%, which became 4.8 kms

	• Traffic jams caused by the stops at the traffic lights used to be more than 3 kms but are now within 2 kms

km = kilometre.
Source: Sathorn model website, TOYOTA Mobility Foundation, *Tokyo Shimbun*.

Technological advancement made the achievements possible. Now to address the raising concerns from the public for social challenges, including air pollution and greenhouse gas (GHG) emissions, Viet Nam has good opportunity to introduce innovative policies into the transport sectors in which various critical infrastructure projects are underway. For example, the country plans to construct 1,800 kms of highway connecting Hanoi City and Ho Chi Minh City, the country's largest-scale road yet at a maximum of 10 lanes. The route is expected to change logistics significantly for the entire Indochinese Peninsula.

Chapter 3

Case Study of Da Nang City

A comparison of the estimated modal share and the fuel consumption volume (2017) in Da Nang City would reveal that although the truck trips share only 19% (next to 47% of motorcycles), the fuel consumption volume shares 83% of total volume, and that a highway installation mainly for truck trips is quite effective to reduce not only direct fuel consumption volume caused by traffic flow improvement of trips in and outside Da Nang City but also fuel consumption volume caused by alleviating inside trips congestion in the city centre.

For other trips except for truck trip which moves inside the city using the open road, the following scenarios were examined: (i) planned scenario in the Transport Master Plan[4], (ii) its implementation with delay (10 years) scenario, (iii) car-shift scenario as compared with planned scenario (where the most share is taken by motorcycles), and (iv) implementation delay (10 years) of the public transport development plan in the car-shift scenario (Table 3.5).

Based on the results, we could prove that (i) the fuel consumption volume of the car-shift scenario compared with that of the planned scenario is larger by 50%; (ii) the fuel consumption reduction effect, by shifting from motorcycle to public transport in the planned scenario, is limited; and (iii) the car-shift scenario, by shifting from a car trip to a public transportation trip, will directly lead to alleviating traffic congestion and fuel consumption reduction. Therefore, we need to prepare for this car-shift path process and prevent delay in its implementation, as well as an age of 'Car Affluent Society' on the road, by providing the necessary measures.

3.1. Reviews of the Transport Master Plan of Da Nang City

(1) Da Nang Transport Master Plan

The Da Nang Transport Development Master Plan up to 2020 and Vision to 2030 was officially approved on 28 July 2014 (No.5030/QD-UBND) with the following planning viewpoints:

・To fit the Da Nang SEDP (Socio-Economic Development Plan), Land-use Plan, and General Construction Plans up to 2030 and Vision to 2050

・To develop an integrated, sustainable, and modern transport systems and to provide convenient transport services to meet the travel demand

・To formulate a feasible plan on the basis of scientific measures to satisfy both current and long-term demand

[4] Approval of master plan for public passenger transport by bus in Da Nang City for 2013–2020 and vision to 2030.

・To give priority for public transport development, traffic congestion, and accident alleviation in Da Nang City.

The master plan covers the planning period up to 2020 and vision to 2030. The following are the target indicators for key aspects:

(1) Infrastructure

・To develop the transport infrastructure adequately in an integrated manner with other plans, especially the urban construction plan to meet the indicator that the urban transport land should share 20%–26% of urban construction land

・To increase road density to 3 kms/km^2–5 kms/km^2 in 2020 and 5 kms/km^2–6 kms/km^2 in 2030

・To set public transport network density at 2 kms/km^2–2.5 kms/km^2 urban construction land

・Static transport land to account for 3%–4% of urban construction land.

(2) Public Transport Development

・To prioritize development of public transport to increase the public transport share to 15%–20% in 2020 and 25%–35% in 2030

As a result, the master plan is now composed of the following subsectors as illustrated in Figure 3.1 and Figure 3.2:

・Road Infrastructure Development Plan

・Static Transport Plan

・Intersection and Bridge Plan

・Urban Traffic Management and Operation

・Non-motorized Transport and Pedestrian Promotion

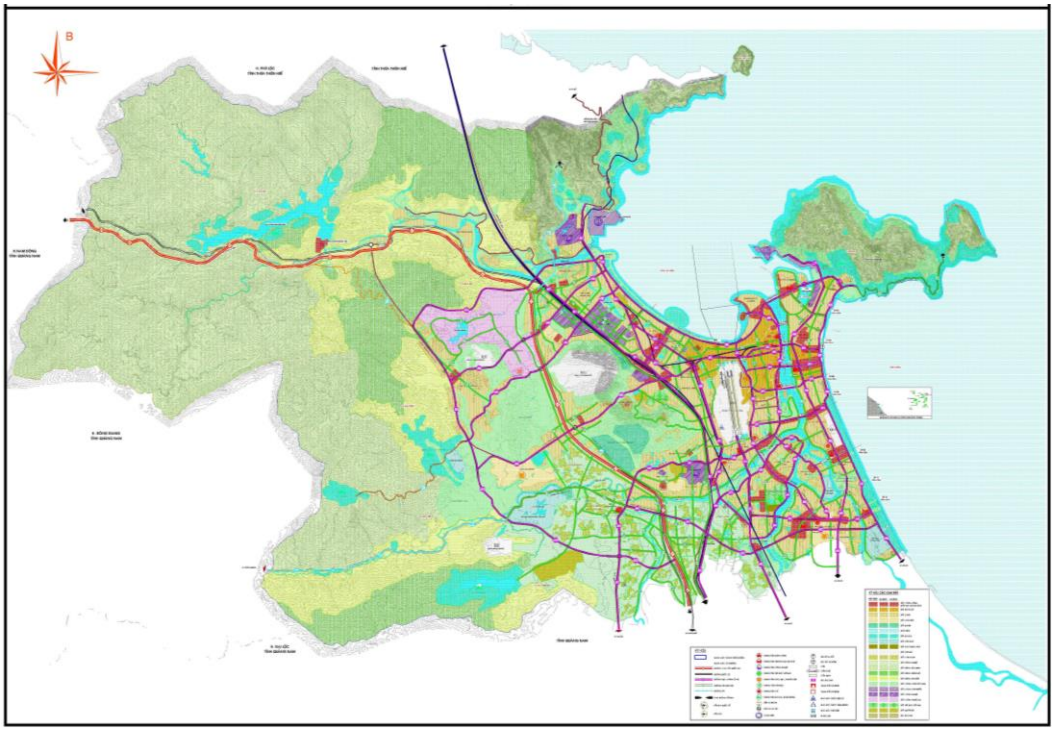
・Public Transport Network Plan

・National Railway Plan

・Waterway Transport Plan

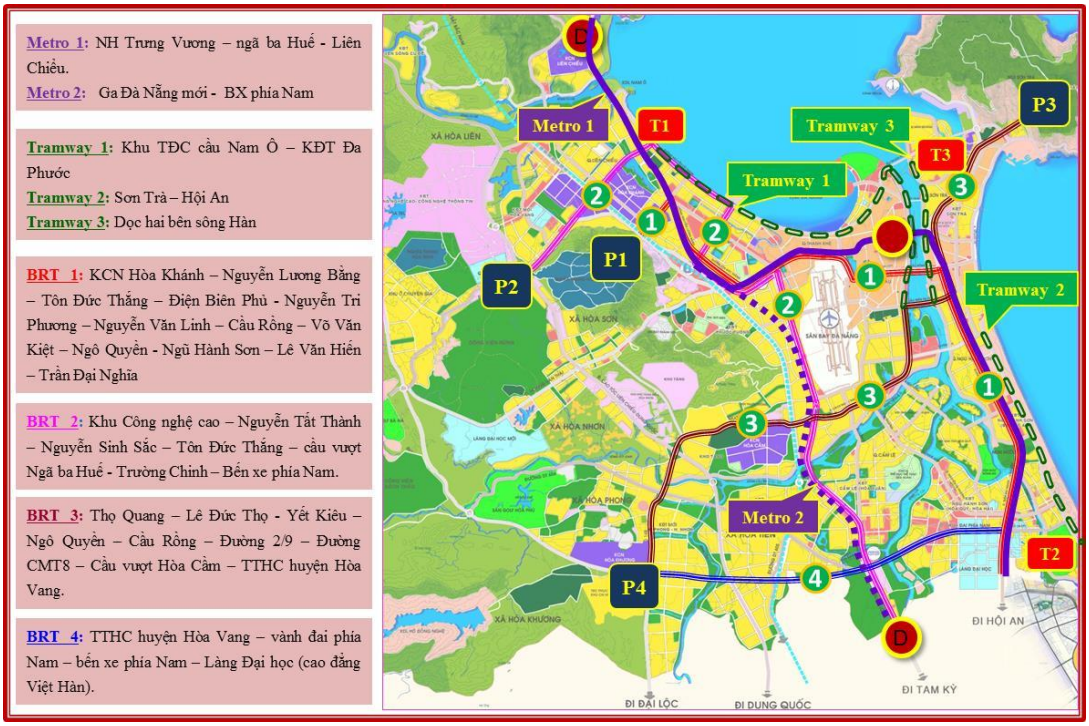
・Air Transport Plan

Figure 3.1: Da Nang Transport Master Plan up to 2020 and Vision to 2030



Source: Da Nang City Government, 2014, Da Nang Transport Development Master Plan up to 2020 and Vision to 2030.

Figure 3.2: Da Nang Public Transport Network Plan up to 2030



Source: Da Nang City Government, 2014, Da Nang Transport Development Master Plan up to 2020 and Vision to 2030.

(2) Implementation Status

The master plan included various plans and projects as summarized in Table 3.1 and 3.2.

Table 3.1: Da Nang Status of Transport Development Plans or Projects

Subsector	Category	Project	Schedule	Status as of May 2017
Road Infrastructure Development Plan	Inter-city Expressway	・ Da Nang–Quang Ngai Expressway: Thuy Loan–Dung Quat Section (6 lanes, 130 kms)	By 2020	On-going (to be completed in 2017)
		・ Da Nang–Quang Ngai Expressway: La Son–Tuy Loan section (2 lanes as initial)	By 2030	On-going
		・ Quang Tri–Da Nang Expressway (4 lanes, 178 kms)	By 2030	Not yet
	National Highways	・ Upgrade of Southern Hai Van Pass Route ・ Upgrade of NH14B: Tien Sa–Tuy Loan (Da Nang)–Thanh May (Quang Nam) ・ Upgrade of NH14G: Tuy Loan (Da Nang)–Dong Giang (Quang Nam)	By 2020/2030 (Not specified)	Partly on-going
	Ring Road	・ Upgrade of Southern, Northern, Western Ring Roads	By 2020/2030 (Not specified)	Partly on-going
	Provincial Road (PR)/District Road (DR)	・ Upgrade of PR601, PR602, PR605, and district roads (DR4, DR8)	By 2020/2030 (Not specified)	Partly on-going
	Urban Road	・ Upgrade and new construction of urban trunk roads (260 kms)	By 2020	Partly on-going
		・ Upgrade and new construction of urban trunk roads (138 kms)	By 2030	Not yet
Static Transport Plan	Terminals and Parking Facilities	・ Northern bus terminal	By 2030	Not yet
		・ Truck terminals ・ Urban bus terminals and parking spaces ・ Parking system	By 2020/2030 (Not specified)	Not yet
Intersections and Bridges Plan	Intersections	・ 9 grade-separated interchanges ・ 38 access-controlled signalized intersections	By 2020/2030 (Not specified)	Partly on-going
	Bridges	・ New Han River Bridges (6) ・ New Cam Le River Bridges (3) ・ Tuy Loan River Bridges (5) ・ Co Co River Bridge (4) ・ Lo Giang River Bridge (1) ・ Vinh Dien Bridge (2) ・ Yen River Bridge (3) ・ Cu De River Bridge (2)	By 2020/2030 (Not specified)	Partly on-going
Urban Traffic Management and Operation	Traffic Control System	・ Traffic signal system, CCTV system, software, ITS, etc.	By 2020/2030 (Not specified)	Partly on-going
Non-motorized Transport (NMT) and Pedestrian Promotion	NMT and Pedestrian	・ Improvement of Nguyen Van Troi Bridge for pedestrian bridge ・ Promotion of NMT/pedestrian street in the CBD and tourist site	By 2020/2030 (Not specified)	Not yet

Source: Da Nang City Government, 2014, Da Nang Transport Development Master Plan up to 2020 and Vision to 2030.

Table 3.2: Da Nang Status of Transport Development Plans or Projects (continued)

Subsector	Category	Project	Schedule	Status as of May 2017
Public Transport Network Plan	Urban Rail	・ Metro Lines ・ Tramways	By 2030	Not yet
	Urban Bus	・ BRT and BRT standard routes ・ Urban bus routes	By 2020/2030	Partly on-going
National Railway Network Plan	National Railway	・ New Da Nang Station ・ New Kim Lien Station ・ Study of New Hai Van Tunnel	By 2020	Partly on-going
		・ Re-route of 20-km railway section ・ Upgrade of Le Trach Station	By 2030	Not yet
Waterway Transport Plan	Da Nang Port	・ Upgrade of Tien Sa and Lien Chieu ports (general cargo and container) ・ Relocation of Han River Port ・ Upgrade of Son Tra Port (general cargo and oil)	By 2020/2030 (Not specified)	Partly on-going
	Inland Waterway	・ New construction material berths ・ New tourist boat berths ・ Upgrading of waterway routes (cargo and tourist)	By 2020/2030 (Not specified)	Partly on-going
Air Transport Plan	Da Nang International Airport	・ New International Passenger Terminal	By 2020	On-going (to be completed in 2017)
		・ Improvement of related facilities	By 2030	Partly ongoing
		・ Expansion of civil aviation land	By 2020	Partly ongoing

Note: Status was indicated by the Study Team.
Source: Da Nang City Government, 2014, Da Nang Transport Development Master Plan up to 2020 and Vision to 2030.

Consistent with the Transport Master Plan, Da Nang City prepared Master Plan for Passenger Transport by Bus for 2013–2020 and Vision to 2030, which was approved on 19 November 2013 (No. 8087/QD-UBND). From this decision, the phased development plan of the urban bus routes is summarized in Table 3.3.

Table 3.3: Status of Urban Bus Route Development Plan

Year Period	Planned No. of Routes			Status (as of May 2017)
	BRT	BRT Standard	Urban Bus	
2013–2015	-	-	11	6 existing routes only
2016–2020	2	3	15	New 5 bus routes started in 2016.
2021–2025	4	3	19	N.A.
2025–2030	4	3	21	N.A.

Note: Status was indicated by the Study Team. BRT = bus rapid transit, N.A. = not applicable.
Source: Da Nang City Government, 2014, Da Nang Master Plan for Public Passenger Transport by Bus for 2013–2020 and Vision to 2030.

(3) Consideration for the Master Plan Implementation

As a result of review of current implementation status of the transport plans and projects, we identified the following considerations for effective implementation of the master plan:

- Urban road network development is progressing relatively smoothly, but improvement of traffic management system, terminal and parking system development, and promotion for non-motorized transport and pedestrians are somewhat falling behind.
- The expected modal shift to public transportation is relatively delayed as BRT development by the World Bank and the expansion of the urban bus route network by the Department of Transport (DOT) are delayed.
- Due to the delay in the development of Lien Chieu Port, port cargoes are concentrated in Tien Sa Port which increases truck traffic and has a negative impact on urban road traffic.
- Da Nang–Quang Ngai Expressway opens soon, but the northern section connecting to Hue is still underdeveloped. As a result, the impact on Da Nang urban transport due to regional traffic moving in the neighbouring areas remains significant.

3.2. Modelling Analysis

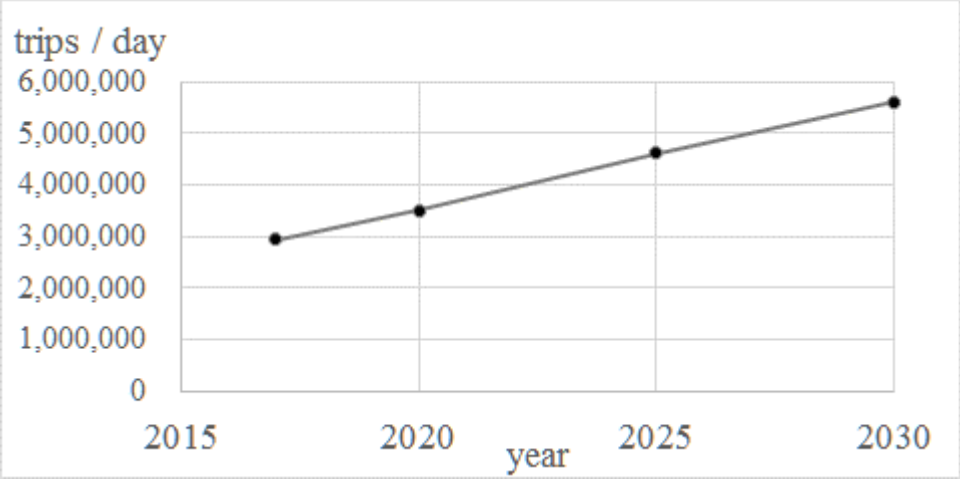
3.2.1. Transport Development and Energy Efficiency in Da Nang City

The first step in handling an energy policy and a traffic policy in an integrated manner is to understand the relation between traffic and fuel consumption. Since traffic congestion is becoming a significant social issue in developing countries in EAS region, the road network and public transportation systems have been designed as the Transport Master Plan by the concerned authority of each country corresponding to the development stage of cities for achieving their sustainable development.

From a transport economy's standpoint, traffic congestion represents a state in which transport demand for roads exceeds the transport supply. Since Da Nang City, like other Asian cities, has been

From a transport economy's standpoint, traffic congestion represents a state in which transport demand for roads exceeds the transport supply. Since Da Nang City, like other Asian cities, has been developing rapidly, transportation demand is expected to grow significantly. The traffic volume in the entire city (trips between zones) is estimated at about 2.9 million trips per day in 2017, which figure is expected to almost double to about 5.6 million trips per day in 2030[5] (Figure 3.3). Therefore, the city intends to cope with the expected sharp increase in traffic volume.

Figure 3.3: Da Nang Transition of Trip Number by Year



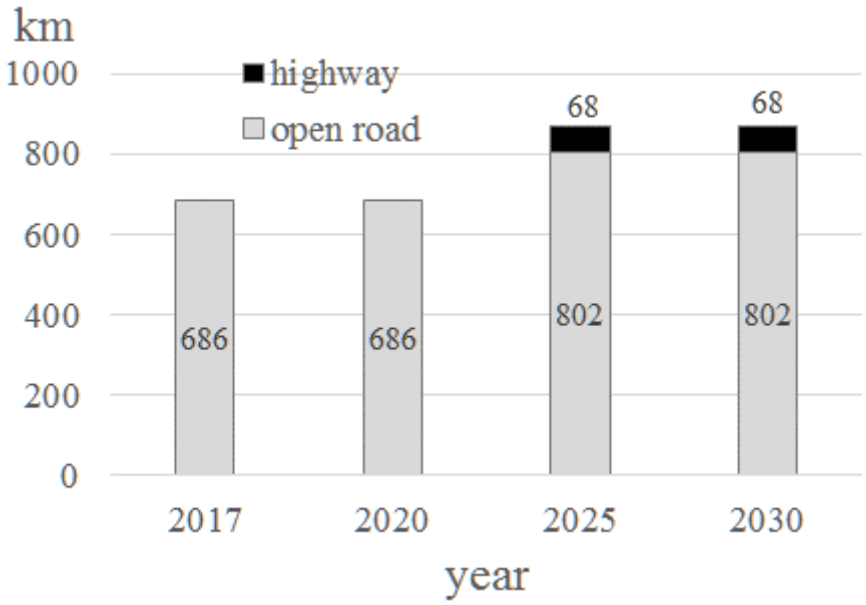
Source: Create from the "Study on the Integrated Development Strategy for Danang City and Its Neighboring Areas in the Socialist Republic of Vietnam"

When congestion occurs in a city, it is usually caused by an increase in transport demand; a significant and sudden fluctuation in supply is unlikely in the case of road-based transport. Methods for improving supply capability to improve traffic flows can be categorized into (i) methods that directly increase supply, such as increasing road capacity or rationalizing road structure (like highway construction) and (ii) methods that improve the supply efficiency by introducing a large-sized road public transport system, such as bus, BRT, or mass rail transit (MRT) system.

For method (i), it is not easy to double the road capacity in accordance with demand increments within such a short period, although the city is planning to expand and improve road transport. According to Transport Master Plan, as shown in Figure 3.4, the 686-km length of open road in 2017 is planned to extend only to 802-km length (an increase of 17% from 2017) in 2030 and 68-km length of highway in 2030.

[5] The numbers in the DaCRISS (Study on the Integrated Development Strategy for Danang City and Its Neighboring Areas in the Socialist Republic of Vietnam) Scenario 3 of 2025 multiplied by the rate of population change are used.

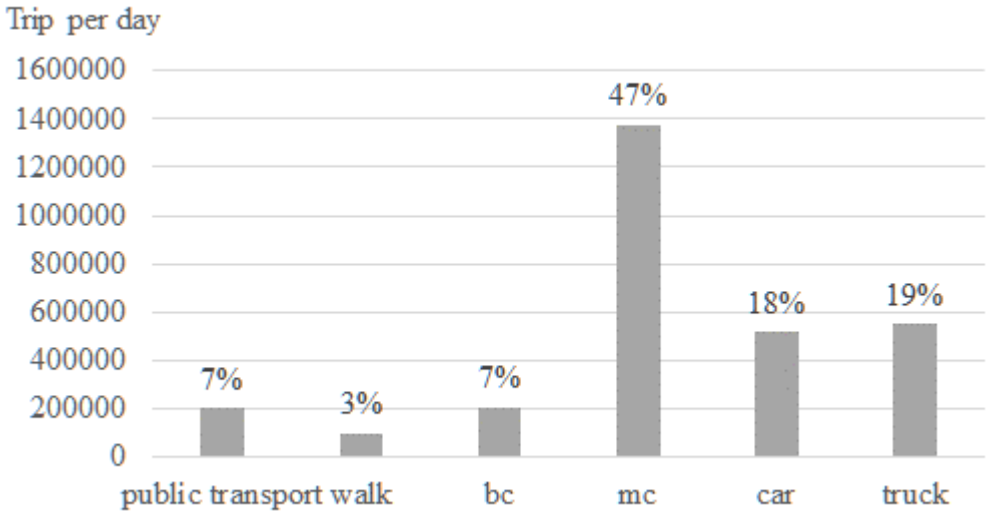
Figure 3.4: Road Lengths Extension (Planned) by Year



km = kilometre.
Source: Create from the "Da Nang Master Plan for Public Passenger Transport by Bus for 2013–2020 and Vision to 2030"

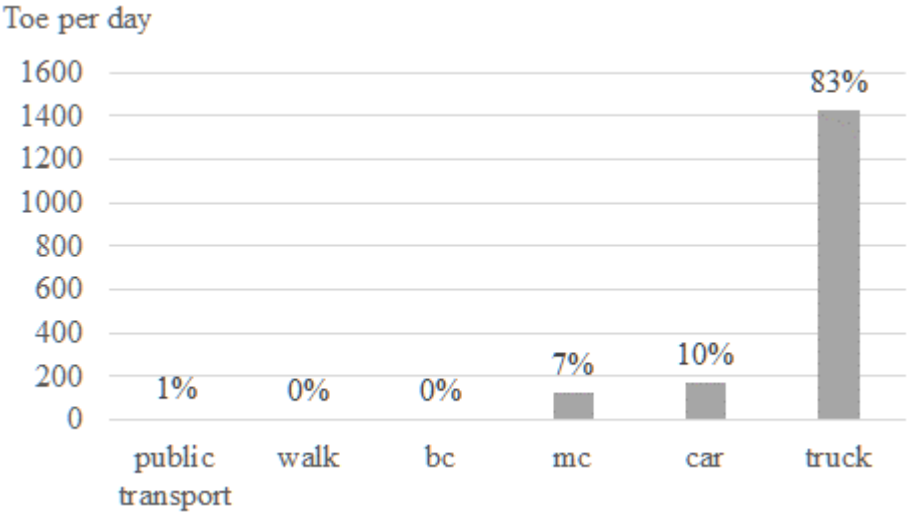
The estimated modal share and fuel consumption volume in 2017 in Da Nang City are summarized in Figures 3.5 and 3.6. The number of truck trips takes only 19% of trip share (548,813 trips per day) in Da Nang City, and the fuel consumption shares 83% of total volume (1,424 tonnes of oil equivalent [toe] per day). On the other hand, the number of car trips takes 18% of trip share (516,074 trips per day), and the fuel consumption shares 10% of total volume (169 toe per day); subsequently, for motorcycles 47% (1,375,669 trips per day) and 7% (124 toe per day), and for other mode 13% and 1%. Thus, the truck trips in Da Nang City is important from the viewpoint of fuel consumption volume since an increase of this trip will have an environmental impact on the society. While truck move in and outside Da Nang City, the other mode trips move mainly inside the city. Thus, we will first examine the effect of the highway construction in the next section.

Figure 3.5: Modal Split Using DaCRISS Model (2017)



bc = bicycle, mc = motorcycle, DaCRISS = Study on the Integrated Development Strategy for Danang City and Its Neighboring Areas in the Socialist Republic of Vietnam.
Source: Study team. (The same 'User preference model' as the FY 2016's report is applied.)

Figure 3.6: Fuel Consumption Volume by Mode (2017)



bc = bicycle, mc = motorcycle. toe = tonne of oil equivalent.
Source: Study team.

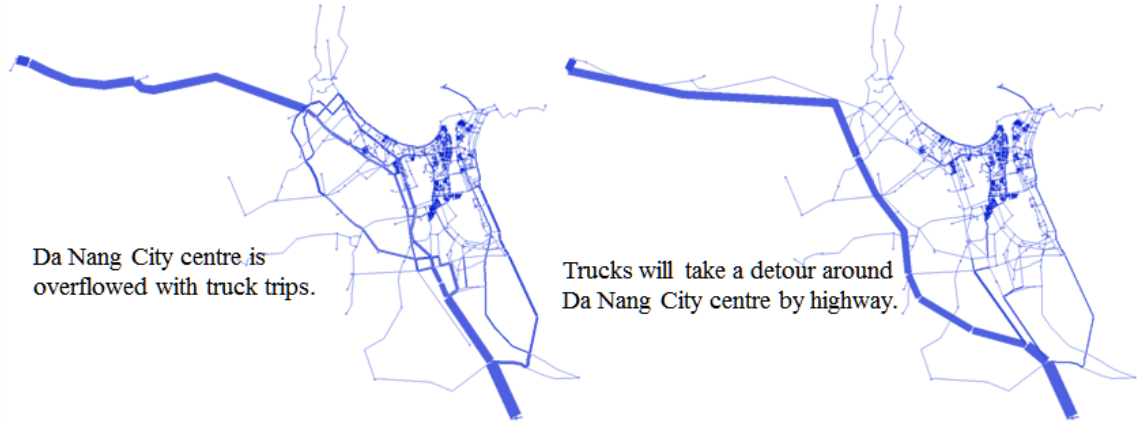
3.2.2. Highway Installation and Energy Efficiency in Da Nang City

The planned highway construction that bypasses Da Nang City centre may achieve not only reducing fuel consumption but also alleviating the traffic congestion in the city, since the currently overflowed truck trips passing through Da Nang City may be taking a detour around the city centre and quite effectively reduce fuel consumption as well.

In fact, according to the website news[6] the Da Nang–Quang Ngai Expressway Project (DQEP), as part of the North–South Expressway, will connect Da Nang and Quang Ngai provinces. Construction started in May 2013 and is expected to complete by 2017 almost as scheduled. This new expressway is expected to shorten the distance and travel time between the provinces of Da Nang (outside Da Nang City), Quang Nam, and Quang Ngai. It is also expected to reduce traffic congestion and increase economic development opportunities in the region.

With this background, we conducted a traffic simulation on how effectively the planned bypass highway construction in the Transport Master Plan around Da Nang City centre will alleviate traffic congestion and reduce fuel consumption volume (Figure 3.7).

Figure 3.7: Traffic Flow with or without Highway (2017)



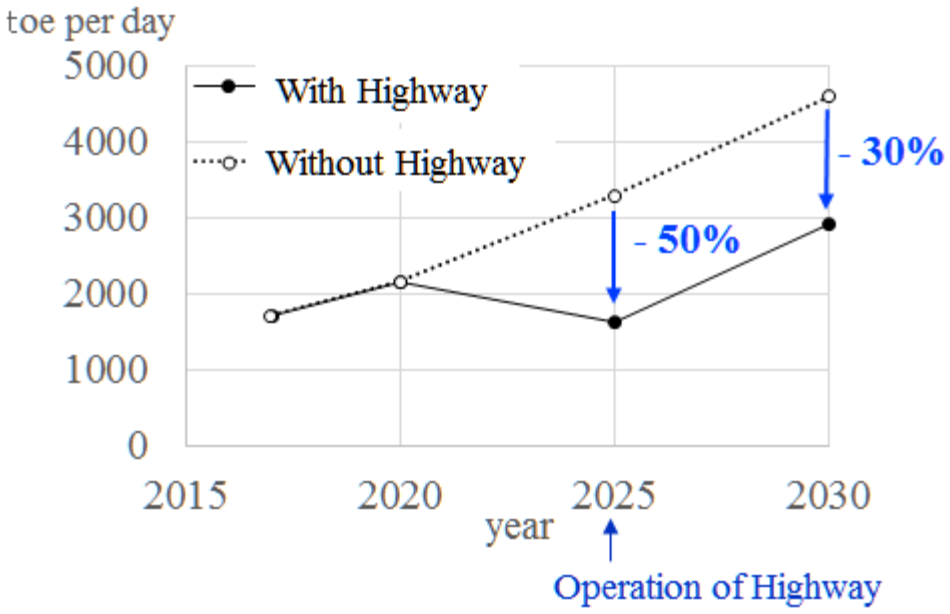
Note: Volume in passenger car unit (PCU).
Source: JICA (2010), Study on Integrated Development Strategy for Danang City and Its Neighboring Areas in the Socialist Republic of Vietnam (DaCRISS).

The results of effect on the fuel consumption with and without highway are shown in Figure 3.8 and Figure 3.9. The highway installation will reduce 50% of the fuel consumption volume in 2025 (equivalent magnitude of the effect of replacing all existing trucks in Da Nang City to fuel-efficient vehicles) and 30% in 2030. If we compare the reduction volume by mode, the truck trips is the largest (39% reduction of fuel consumption from the 'without highway' case), followed by 28% reduction in the car trips, and 12% reduction in motorcycle trips.

This happens because of the traffic flow improvement with highway operation from an average speed of 20 kms/hour (h) in 2020 to 26 kms/h in 2025 (decline to 17kms/h in 2025 without highway). Therefore, the highway operation is a great measure of improving fuel economy and, as a result, curbing oil demand. We could prove that a highway installation is quite effective to reduce not only direct fuel consumption volume caused by traffic flow improvement of trips in and outside Da Nang City but also fuel consumption volume caused by alleviating inside trips congestion in the city centre.

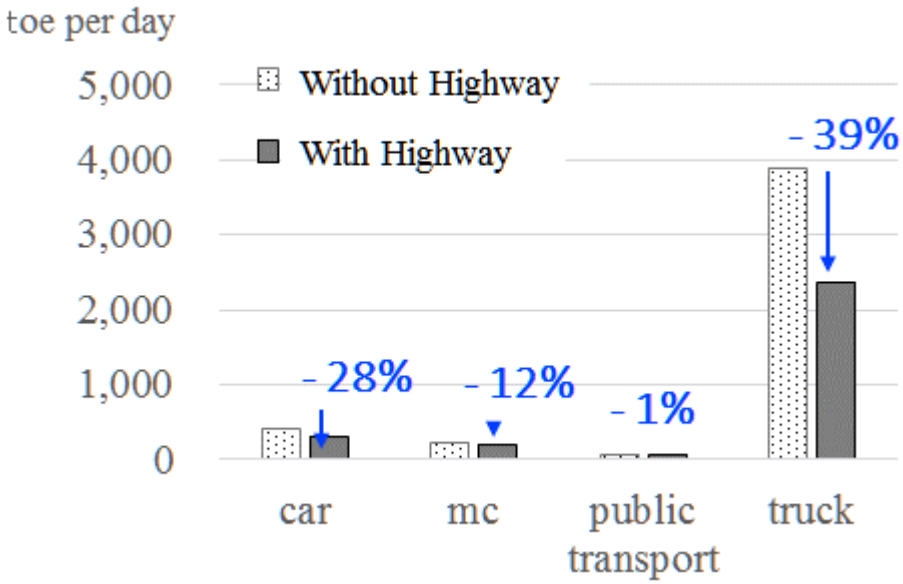
[6] http://www.roadtraffic-technology.com/projects/-da-nang-quang-ngai-expressway-vietnam/

Figure 3.8: Comparison of the Fuel Consumption Effect with or without Highway



toe = tonne of oil equivalent.
Source: Study Team.

Figure 3.9: Comparison of the Fuel Consumption Effect by Mode with or without Highway (2030)



mc = motorcycle, toe = tonne of oil equivalent.
Source: Study Team.

3.2.3. Public Transport and Energy Efficiency in Da Nang City

Besides the trips moving on the highway, the other mode trips, except truck trips, move mainly inside the city using the open road. On method (ii) described in Section 3.2.1, the lengths of open road are planned to extend only an increase of 17% from 2017 in 2030. Thus, those trips must shift to a larger-sized public transport system through the provision of optimum combination of public transport systems to reduce the fuel consumption.

As shown in Table 3.4, it is clear that bus[7] is the most efficient mode of road-based transportation. Cars require four to nine times bigger road space compared with bus for transporting the same number of passengers. This means that the traffic volume could be alleviated by shifting to the bus mode from cars and motorcycles. Thus, the introduction of a BRT system is one of the key features of public transport system development in Da Nang City.

Table 3.4: Utilization Efficiency of Road Space by Transportation Mode

	Car	Motorcycle	Bus
Average Occupancy (pax/vehicle)	2.0	1.3	15–36
PCU (Passenger Car Unit)	1.0	0.4	2
Ave. No. of Passengers per PCU	2.0	3.0	8–16

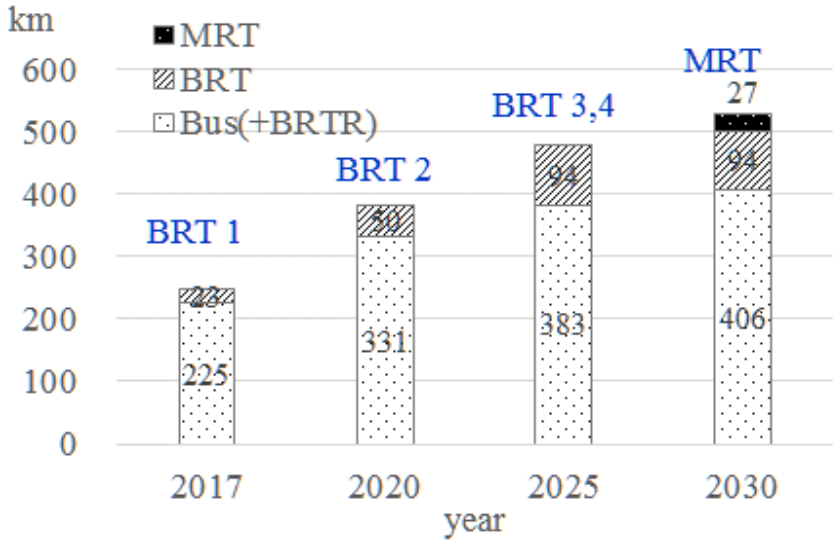
PCU = passenger car unit.
Note: PCU is a vehicle unit used for expressing highway capacity. One car is considered as a single unit, motorcycle is considered as 0.4 car unit. Bus causes a lot of inconvenience because of its large size and is considered equivalent to two cars or two PCUs.
Source: DaCRISS (2009), The Study on the Integrated Development Strategy for Danang City and Its Neighboring Areas in the Socialist Republic of Vietnam.

According to the Transport Master Plan, four types of public transport are scheduled to be introduced: BRT, BRT standard bus (BRTR[8]), MRT, and bus in the 4 target years, namely 2017, 2020, 2025, and 2030. The first BRT line is planned to be introduced in 2017, and four more in 2025. In addition, the MRT is scheduled to be introduced in 2030. MRT is a track vehicle that is expected to have 10 times the capacity of BRT. MRT, BRT, and BRTR are considered to play the role as the main public transport mode. Table 3.10 shows that the 225 kms route lengths of bus and 23 kms of BRT in 2017 are planned to extend to 406 kms route lengths of bus (an increase of 80% from 2017), 94 kms of BRT (an increase of 400% from 2017), and 27 kms of MRT in 2030.

[7] Average occupancy of bus is 15 passengers at present. It is assumed that it will increase if urban bus service is significantly improved.

[8] BRTR is a type of bus that is specific to Da Nang City. Although it is positioned as a special kind of bus, it is little different from a normal bus given that it does not have dedicated lanes. It is treated here as the main public transport (not the target of optimization) considering its special positioning.

Figure 3.10: Route Length of Public Transport by Year



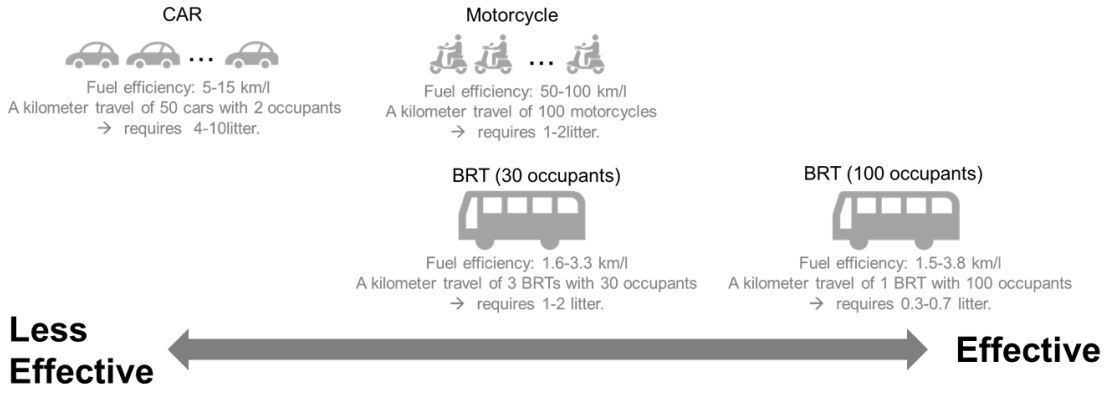
BRT = bus rapid transit, BRTR = bus rapid transit standard bus, MRT = mass rail transit.
Source: Da Nang City Government, 2013, Master Plan for Public Passenger Transport by Bus in Da Nang City for 2013–2020 and Vision to 2030.

In a BRT system, dedicated BRT lanes give the bus system priority over private transport mode, allowing the system to carry a larger number of passengers faster. If used effectively, it could contribute to reducing energy consumption in the transport sector. Alleviating traffic congestion would have a much greater effect on improving fuel efficiency in a shorter period than technological improvements and actual deployments by automobile manufacturers.

As a rough illustration of the energy consumption reduction effect by introducing the BRT system, suppose 100 people travel 1 km along the same road as shown in Figure 3.11. If one person rides on one motorcycle, as is typical in Da Nang City, 100 motorcycles are needed to transport 100 people. Whereas when using the BRT, we can expect a reduction in fuel consumption of about 60% since a bus can accommodate 100 people. Additionally, the BRT, as compared with cars, is expected to reduce fuel consumption by about 90%. Moreover, when the number of passengers per vehicle increases, the BRT system is capable of sudden fluctuation in demand even during doubling trips in a short period, and the energy consumption is reduced.

According to the current transport development situation in Da Nang City described in Section 3.1, the road and highway construction is proceeding almost as scheduled, but the implementation of BRT deployment has been delayed for almost 3 years in its service commencement (from 2016 to 2019). Although some metropolitan areas in the developing world have urban public transit services, such as MRT and BRT, implementation of these projects often tends to take a longer time because of complicated planning and design process, land acquisition procedures, political disputes, and preparation of funding. Therefore, the study examined whether this implementation delay would lead to worsening traffic congestion and, consequently, increase fuel consumption volume due to the increasing trip shares of car and motorcycles modes, to identify the importance of timely deployment of MRT and BRT systems.

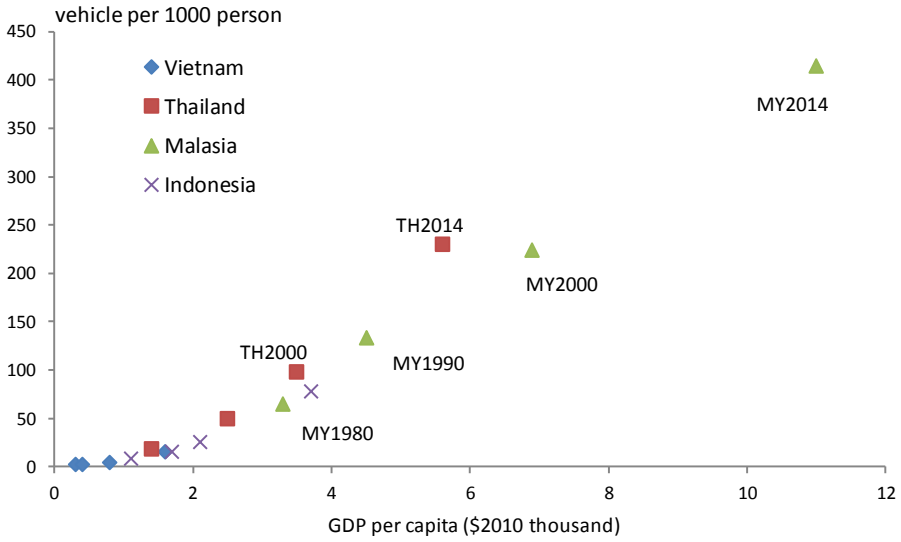
Figure 3.11: Illustration of Fuel Consumption Volume by Transport Mode



BRT = bus rapid transit, km = kilometre, l = litre.
Source: Study team.

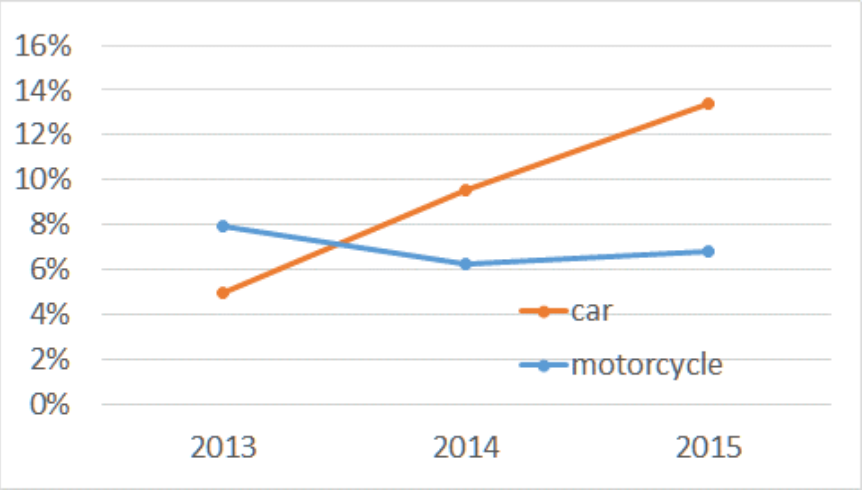
In addition to project delay effect, the study examined the effect of more-than-expected increase of car ownership. History tells an existence of strong correlation between income level of people and number of car ownership. This relationship can be observed in ASEAN countries, such as Indonesia, Malaysia, and Thailand (Figure 3.12). As gross domestic product (GDP) per capita increases, the number of can ownership also increases. Viet Nam seems tracing the same pattern. The balance of GDP per capita and car ownership in Viet Nam in 2014 is similar to that of Indonesia in 1990 and Thailand in 1980. Although there remains a possibility of its going other way, it can be said that car ownership in Viet Nam will increase with high probability. In fact, motorcycles still share the majority of transportation mode in Da Nang City, but, currently, the increment rate of car sales volume is larger than that of motorcycles from 2013 to 2015 (Figure 3.13).

Figure 3.12: Correlation between per Capita Income and Car Ownership in Selected ASEAN Countries



GDP = gross domestic product, TH = Thailand, MY = Malaysia.
Source: The Institute of Energy Economics, Japan (IEEJ) (2016*), Asia/World Energy Outlook 2016*.

Figure 3.13: Recent Growth Rates of Sales Volume for Car and Motorcycle



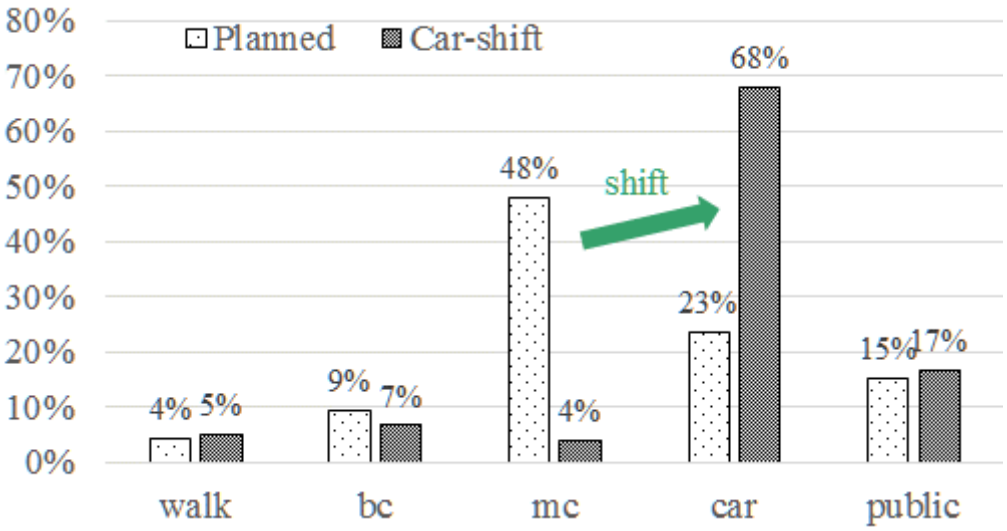
Source: Da Nang Police Department.

Further, in 2018, custom duty on car import and export within the ASEAN region is scheduled to be eliminated, according to the ASEAN Economic Community Blueprint 2025, that may result in an inflow of cheap imported cars to Viet Nam. We expect the worst case of more people shifting from motorcycle to car use than to the planned shares in the Transport Master Plan, which will worsen traffic congestion and increase fuel consumption volume.

As for the passenger car in Viet Nam, the domestic market is immature unlike on the two-wheeled vehicle (motorcycle), and the expansion potential of the market is much larger. The ownership ratio of passenger car in Viet Nam in 2013 was 20 per 1,000 people[9], which is the lowest level among the ASEAN nations. However, the domestic market is in the trend of expansion because of rise in income levels. Global competitiveness of domestic automotive products is remarkably inferior compared with that of other ASEAN nations due to reliance on the import goods for production. Thus, import, for example, from Thailand may increase the import volume if the present high custom duty of 50% is eliminated in 2018. Although the increasing import volume of cars depends on government's future policies of a domestic tax system on cars, we can foresee that a car-dominant society, like in developed cities, is coming to Viet Nam, if the current situation continues. Thus, we have a hypothetical situation where most of motorcycle trips will shift to car trips first (the car-shift scenario, Figure 3.14), and then car trips will shift to public transport trips as Tokyo had experienced (Figure 3.15). This path is different from that of the Transport Master Plan where motorcycle trip will shift directly to public transportation.

[9] ASEAN Automotive Federation, OICA, World Bank.

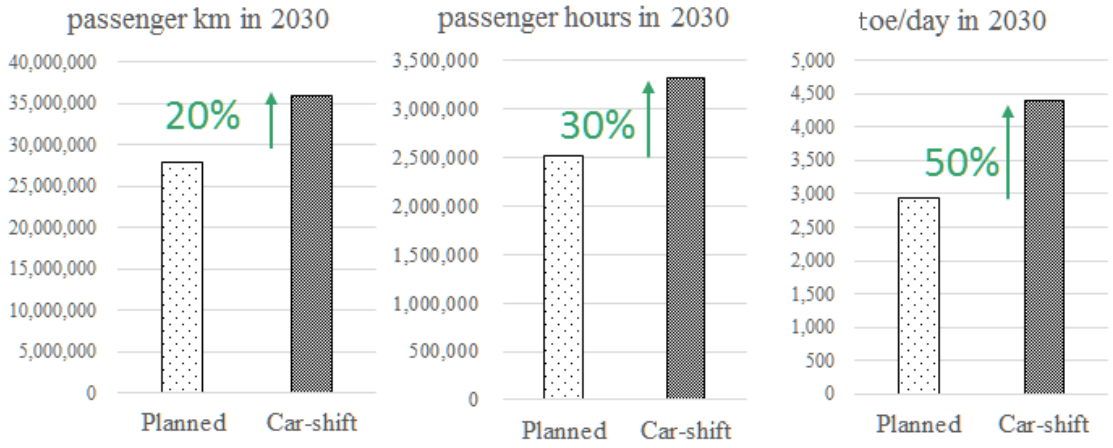
Figure 3.14: Comparison of Modal Share between the Planned Scenario and the Car-shift Scenario in 2030



bc = bicycle, mc = motorcycle, public = public transportation.
Source: Study Team.

We examined whether this car-shift scenario may lead to worsening traffic congestion and increasing fuel consumption volume due to the increasing trip shares of car, with the condition that the number of trips does not change from the Transport Master Plan. The car-shift scenario is compared with the Transport Master Plan (Figure 3.15). The total travelling distance in kilometre will increase by approximately 20% due to the increasing detour traffic in a certain part of roads caused by the larger-sized car influencing other traffic critical than that of a motorcycle. Then, this leads to a 30% increase of passenger hours and a decline in an average speed from 22 kms/h to 20 kms/h in 2030. As a result, the fuel consumption volume for the car-shift scenario increases by 50% than that for the planned scenario. This happens not only because of traffic congestion but also because of the greater fuel consumption rate of cars than motorcycles. The modal shift from motorcycle to car has a significant effect on the increasing fuel consumption volume. Therefore, we need to prepare for this scenario with certain measures in advance before we face an age of 'car-affluent society' on the road.

Figure 3.15: Comparison of the Fuel Consumption Effect between the Planned Scenario and the Car-shift Scenario in 2030



toe = tonne of oil equivalent.
Source: Study Team.

From the above arguments, we examined the following scenarios, i.e. comparison of scenarios with and without the influence of 10 years' implementation delay from the Transport Master Plan, and comparison of scenarios with and without the influence of 10 years' implementation delay from the car-shift scenario, to grasp an effective traffic flow improvement policy.

The following are the four scenarios:

(i) The implementation of the public transport development plan in the Transport Master Plan will proceed as planned (the planned scenario).

(ii) The implementation of the public transport development plan will be behind 10 years as scheduled (the 10 years' delay scenario).

(iii) As more motorization will proceed due to higher economic development with the scheduled implementation of road construction, and the government is adopting a favourable custom duty on car import policy, most motorcycle trips will shift to car trips using the current available trip data (the car-shift scenario).

(iv) The implementation of the public transport development plan in the Transport Master Plan for the car-shift scenario society will be behind 10 years as scheduled (the 10 years' delay car-shift scenario).

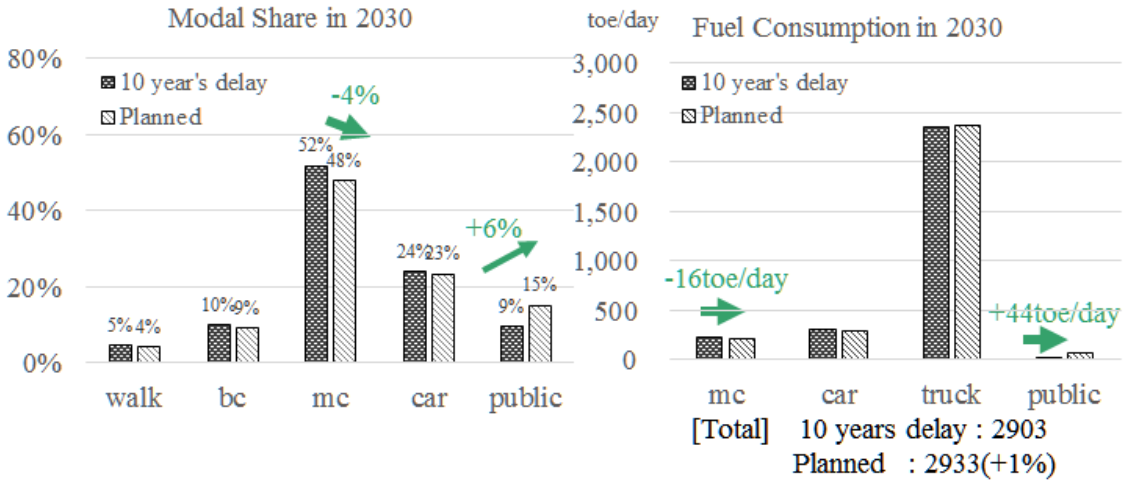
Table 3.5: Scenario Setting

	Name of the Scenario	Progress of the Transport Master Plan	More Car/ Less motorcycle
i	Planned scenario	as scheduled	
ii	10 years' delay scenario	delayed	
iii	Car-shift scenario	as scheduled	✓
iv	10 years' delay car-shift scenario	delayed	✓

Source: Study team.

The results of comparison between the planned scenario and its 10 years' delay scenario are shown in Figure 3.16. The differences are the 6% increase of modal share in the public transportation, and the 4% decrease of modal share in the motorcycle, if there is no delay. These differences do not lead to reduction of the fuel consumption as a whole (in fact, an increase of 1%, i.e. 2,903 toe in the delayed scenario against 2,933 toe in the planned scenario). This happens because motorcycle is very small to alleviate the traffic congestion with the planned public transportation system deployment, and its fuel consumption rate per trip is not that big compared with that of the public transportation use. Thus, we may conclude that this modal-shifting scenario (shift from motorcycle to public transportation) is not effective in terms of fuel consumption reduction.

Figure 3.16: Comparison of the Modal-Shift Effect on the Fuel Consumption between the Planned Scenario and the 10-Year Delay Scenario

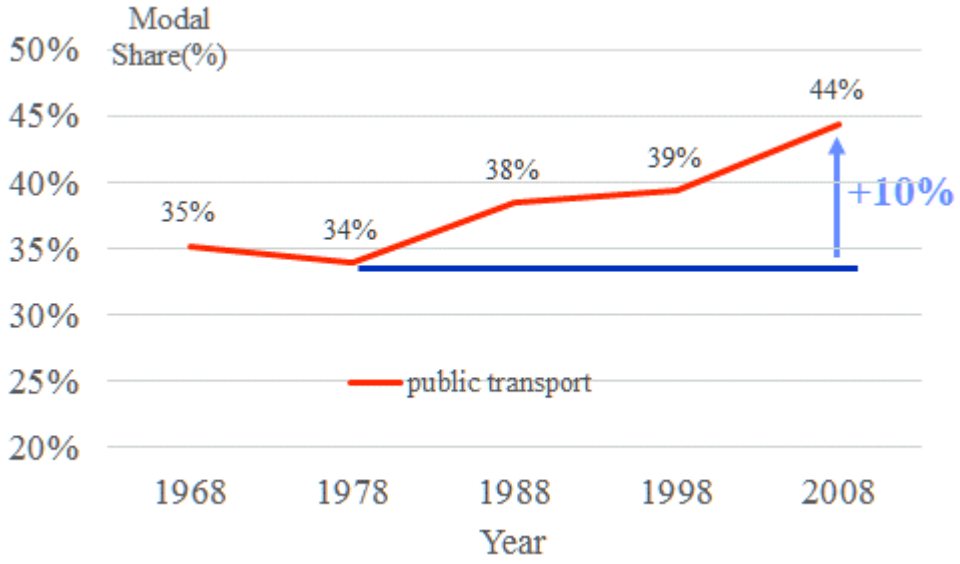


bc = bicycle, mc = motorcycle, public = public transportation, toe = tonne of oil equivalent.
Source: Study Team.

The results of the comparison between the car-shift scenario and its 10 years' delay scenario are shown in Figure 3.18. The differences are the 7% increase of modal share in the public transportation and the 5% decrease of modal share in the car. Tokyo, Japan achieved a 10% increase of modal shift from 1978 to 2008 (Figure 3.17).

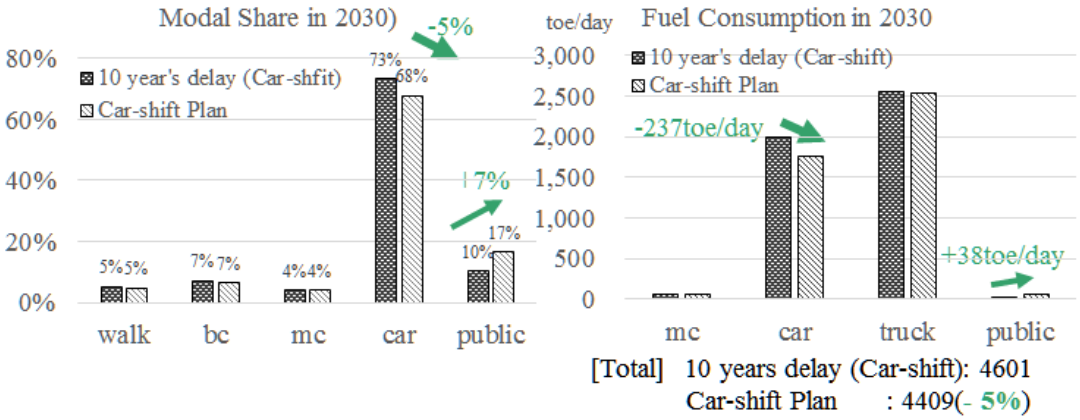
These differences will lead to fuel consumption reduction (a decrease of 5% from 4,601 toe per day in the 10-year delay scenario against 4,409 toe). Thus, if we require reducing a larger amount of fuel consumption as an energy policy (more than 5%), we need to adopt such a traffic policy to decrease the car trip share (more than 5%) and increase the public transportation trip share (more than 7%). This happens because the size of car is large enough to induce traffic congestion compared with that of public transportation, and its fuel consumption rate per trip is a big enough compared with that of public transportation use. Thus, we may conclude that this modal-shifting scenario (shift from car to public transportation) is very much effective in terms of fuel consumption reduction. Therefore, we need to prevent delay in implementation of the public transport development plan with certain measures in advance, before we face an age of 'car-affluent society' on the road.

Figure 3.17: Change of Modal Share of Public Transport in Tokyo, Japan



Source:Tokyo Metropolitan Transport Planning Council (www.tokyo-pt.jp/about/index.html) under Ministry of Land, Infrastructure and Transport of Japan, Tokyo PT Survey in 1968, 1978, 1988, 1998, 2008.

Figure 3.18: Comparison of the Modal-Shift Effect on the Fuel Consumption between the Car-shift Plan and the 10-Year Delay (Car-shift Plan)



bc = bicycle, mc = motorcycle, public = public transportation, toe = tonne of oil equivalent.
Source: Study Team.

3.3. Conclusion

To understand the relation between traffic and fuel consumption, it is noteworthy that the estimated modal share and fuel consumption volume in 2017 in Da Nang City revealed that the number of truck trips shares only 19% (next to 47% of motorcycles), but the fuel consumption volume shares 83% of total volume. Since trucks move mainly in and outside Da Nang City, we examined the effect of the highway installation. The simulation results show that the highway operation will reduce 50% of the total fuel consumption volume (in toe) in 2025 and 30% in 2030. By comparison of various modes, the truck trips shares the largest part of energy consumption of transport sector, i.e. 39%, the car trips shares 28%, and motorcycle trips shares 12%. Therefore, we could prove that a highway installation is quite effective in reducing not only direct fuel

consumption volume caused by traffic flow improvement of trips in and outside Da Nang City but also fuel consumption volume caused by alleviating inside trips congestion in the city centre.

Besides trips moving on the highway, the other mode trips, except trucks, move mainly inside the city on the open road. These trips must shift to a larger-sized public transport system through the provision of the optimum combination of transport mode such as bus, BRT, and MRT, to reduce fuel consumption. However, implementations have often been delayed and, hence, an increase in fuel consumption volume due to the increasing trip share of car mode under the car-favourable custom duty policy starting 2018 is expected. Thus, we examined the following scenarios in the traffic congestion and the fuel consumption volume. The scenarios are (i) the planned scenario in the Transport Master Plan, (ii) its implementation delay (10 years) scenario, (iii) the car-shift scenario (car shares the most society) than the planned scenario (motorcycle shares the most society), and (iv) the implementation delay (10 years) of the public transport development plan in the car-shift society.

The modelling analysis indicates that the car-shift scenario will result in a 50% increase of fuel consumption compared with the planned scenario. Further, according to the current transport development situation in Da Nang City described in Section 3.1, the implementation of BRT deployment has been delayed almost 3 years in its service commencement (from 2016 to 2019). In addition to the car-shift scenario analysis, we examined the effect of delay in implementing planned public transportation systems to traffic and fuel consumption volume.

From the above arguments, the four scenarios are set up: (i) the planned scenario in the Transport Master Plan, (ii) its implementation delay (10 years) scenario, (iii) the car-shift scenario, and (iv) the implementation (10 years) delay of the public transport development in the Transport Master Plan scenario.

As a result of comparison between the planned scenario and its 10 years' delay scenario, the increase of modal share in the public transportation, in turn the decrease of modal share in the motorcycle, is not effective in terms of fuel consumption reduction. However, as a result of the comparison between the car-shift scenario and its 10 years' delay scenario, the increase of modal share in the public transportation and the decrease of modal share in the car lead to a meaningful reduction of fuel consumption. Thus, if the policy aims to reduce fuel consumption, government need to adopt such traffic policy to decrease car trips share and increase public transportation trip share. This is because the size of car is large enough to induce traffic congestion and its fuel consumption rate per trip is big enough compared with that of the public transportation.

Thus, we conclude that in the planned scenario, shifting from motorcycle to public transportation, the fuel consumption reduction effect is limited, but shifting from car to public transportation trips in a car-dominated society will directly lead to traffic congestion alleviation and fuel consumption reduction. We therefore need to prepare for this car-shift path process with the necessary measures and prevent implementation delay, before we face an age of 'car-affluent society' on the road.

Chapter 4

Policy Recommendation

The policy study in Chapter 2 indicates that Viet Nam has gradually been developing its policy to address energy efficiency in the transport sector. Although there may remain some room for improvement, Viet Nam seems doing well in terms of policy development. What then is the challenge and recommended action for Viet Nam?

The second working group meeting held on 17 May 2017 in Hanoi was concluded to identify several challenges which the policy should address to enhance energy efficiency in the transport sector in Viet Nam. The identified challenges (Table 4.1) can be divided into two groups, primary challenges and secondary challenges. The primary challenges represent fundamental problems that will affect another challenge listed in the secondary challenge. The secondary challenges are more specific issues directly relative to energy efficiency in the transport sector.

Table 4.1: Challenges for Viet Nam in Transport Energy Efficiency Improvement

Primary	1. Coordination among stakeholders or government agencies 1.1 Consistency or harmonization between economic planning and transport system planning 2. Analysis of big data about the traffic 3. Education for enhancing human resources 4. Enhancement of financial resources 4.1 Use of public–private partnership (PPP) to support investment in transport infrastructure
Secondary	1. Increase of public transportation 1.1 Issues of business model, government incentive mechanism, and supportive policy framework for public transportation 1.2 Compact city 1.3 Transport demand management, including electric road pricing (ERP) 2. Improvement of fuel economy of vehicle 2.1 Implementation of fuel economy standards 2.2 Fuel quality 2.3 Education for eco-driving 3. Fuel switch or alternative fuel: compressed natural gas (CNG) or biofuel

Source: Study team.

4.1. Primary challenges

The fundamental challenges indicated include: (i) coordination among stakeholders or government agencies, (ii) analysis of big data about the traffic, (iii) education for enhancing human resources, and (iv) enhancement of financial resources. All of these are important challenges for Viet Nam to pursue its energy-saving policy in the transportation sector. The following is the explanation on these points:

1) Coordination among stakeholders or government agencies

Needless to say, coordination among stakeholders is critical. If we are to reduce energy use in the transportation sector, we will be required to take measures in a wide range of fields, including the desirable vision of cities, selection among transportation modes, improvement of energy efficiency in each transportation mode, and individual lifestyle, etc. To achieve this purpose, a variety of stakeholders – those from government offices; operators of public transportation; manufacturers of transportation equipment and systems, including automobiles; energy suppliers, and citizens – should be involved. An optimal transportation system for each city will be established if these various entities work together to address the transportation issues of cities. Unless sufficient coordination is in place in a partially optimal situation[10], although, for example, a transportation means sufficient to meet transportation demand is provided, side effects, such as waste of energy or deterioration of the living environment, could take place. The importance of deeper coordination can be easily understood but actually doing it is different. Even in a developed country like Japan, sectionalism of bureaucrats is always criticized, hampering the delivery of integrated solution.

Economic planning and transport system planning were indicated as examples of fields especially requiring enhanced coordination. Economic planning may be regarded as a higher-level plan specifying the guidelines for national economic development and national land development. The transportation plan of each city is naturally required to be consistent with the higher-level plans. The process of formulating an economic plan will be important for enhanced coordination. If, in the process of formulating an economic plan, sufficient exchange of ideas and coordination with experts and government officials in charge of transport system plan are made, subsequent formulation of a transport system plan will naturally be in line with the economic plan, and a facilitated implementation of the plan by diverse stakeholders can be expected. It can be surmised from the fact that coordination between economic planning and transport system planning was indicated as a challenge that this process is currently inadequate, and there is a large gap between them. To reduce this gap, we recommend that exchange of ideas and coordination with subordinate plans be enhanced in the process of formulating an economic plan. Enhancement of these will include, for example, addition of persons in charge of a transport system plan as members of the team formulating the economic plan.

2) Analysis of big data about the traffic

It is the premise of a good measure for transportation to have the correct perception of the current situation. In addition, correct data are indispensable for the correct perception of the current situation. Information and communication technology (ICT) has developed remarkably, and at

[10] For instance, construction of wide load can satisfy increasing traffic demand which is a partially optimized state as it increases oil consumption and air emission along the load. Coordinated approach to this issue could include development of train system and re-design of residential or office location.

present a huge amount of transportation data can be collected and analyzed in a comparatively easy manner. Development of ICT will bring a latecomer advantage to Viet Nam. In Japan, for instance, while transportation demand significantly increased until the 1970s after World War II, ICT technology could not be used at the time, and collection of data as the basis for formulating plans was not easy. On the other hand, it is possible that Viet Nam will be able to collect various data utilizing advanced ICT. For example, the smartphones that many people possess now can be a tool to explore individual location and route to a destination. In addition, with the cooperation of companies operating many vehicles, such as taxis, it will be possible to grasp the characteristics of the service routes using ICT. It will also be possible to clarify the transportation characteristics, such as moving paths of automobile and pedestrians, by analyzing the big data obtained, and to take more appropriate measures. With respect to analysis of collected big data, various precedents exist in the world, and Viet Nam will be able to obtain the cooperation of companies having related technologies and know-how. In a sense, this may be the very field where inter-governmental cooperation is suitable, and cooperative projects, technology transfer, and human capacity building, for example, will be realized by utilizing existing frameworks such as the East Asia Summit.

3) Education for enhancing human resources

Human resources are sources of all sorts of activities. With respect to policies, various human abilities are required, including the ability to analyze information and grasp the current situation, to formulate appropriate policies, and to carry out defined policies, etc. As mentioned in Chapter 2, Viet Nam has achieved a certain degree of success in the formulation of policies. The country is expected to continue to make efforts in this field and enhance human abilities in a variety of fields, such as information gathering and analysis mentioned in Section 4.1 (2), as well as ensuring the execution of policies, etc.

In addition, public acceptance for the policy and particular development project is another critical part. We can learn its importance from the fact that public protest sometimes stops project proceeding. So what should be done to gain acceptance from the public? Although there is no single immediate answer to this question, continuous education of the public and their 'involvement' are the keys. Education through open conference and various forms of media, such as TV program and free papers, are examples. Involvement of the public, dense communication between the policy maker and the project owner and mechanism of reflecting public voices to policy or project, is the more difficult part. From this point of view, it is suggested that government should set up public comment or hearing process when formulating new policy or plan. The transparent process will give the public a sense of involvement in developing the new policy or plan, hence government can anticipate to gain better acceptance from them.

International cooperation is an effective means to shorten capacity building period. By inviting experts from other countries and providing educational courses to promising human resources in foreign educational institutions, a high-level education can be given in a comparatively short time. In addition, if a clear challenge exists, it is possible to cultivate human resources that will address such challenge in a selective manner. While some specific issues will be listed in Section 4.1 (4), where the scheme and fund raising for establishing any kind of transport infrastructure, e.g. roads, ICT for traffic data, are pressing issues, it is worth considering to promptly convey the practical know-how required to build the PPP.

Related efforts are already being made in Viet Nam, but we recommend that these continue for the next decade or so.

4) Enhancement of financial resources

Fund raising is always a critical issue for a developing country where investment requirement expands to too broad a field. Several measures can be taken in such a situation. As a precondition, a country is required to identify priority areas and to distribute limited funds efficiently. Before haphazardly procuring funds, it should aim for the efficient use of these resources. From such viewpoint, government can use, for example, proceeds from 'special-purpose tax' and private funds to finance its projects.

A special-purpose tax is a tax collected for special use. Example includes taxation on automobile gasoline and gas oil for the purpose of using the revenue for constructing roads. In this case, as the users of roads are automobiles, the relationship between the beneficiary and the tax burden is clarified. However, government should exercise discipline in using collected tax revenues. Since this method makes it possible to secure financial resources in a stable manner for a long time, it functions effectively at times when there is a high demand for investment in infrastructure. But then, if financial discipline is loose, like if funds are used for a purpose different from the initially intended one, or if it is a wasteful investment, it could cause a problem. Therefore, it is required to consider in advance the requirement to strictly manage the funds and the method for abolishing the system or exit strategy, when the intended purpose has been achieved.

Utilization of private funds has various facades. In all of those facades, the point is whether each project is attractive to a private company. Since the subject is public infrastructure, it would be difficult to provide high profitability supported by a high-usage fee. For this reason, low-risk nature of business is a benefit of the public infrastructure project that may possibly attract private investor, but private companies should be able to derive a stable profit therefrom. Therefore, in the case of infrastructure project which is important from the viewpoint of policy but cannot be economically feasible, utilization of private funds is difficult. Therefore, such infrastructure will need constant compensation from tax revenues[11]. In this sense, public transportation infrastructure of cities with a concentrated population and industries will likely attract private finance initiative[12].

4.2. Secondary challenges

1) Increasing public transportation

In general, public transportation is superior to automobiles as regards energy efficiency. If the proportion of public transportation in modal split is increased, the efficiency of the entire transport sector will improve. What we should be careful of, in the case of Viet Nam, is the current overwhelming proportion of motorbike users. Motorcycles have comparatively high energy efficiency, and the energy consumption reducing effect is limited if only motorbike users are converted to bus users, for example. However, many precedent cases indicate that increased

[11] It is possible to pursue efficiency in projects by utilizing private operational know-how and innovations.
[12] Private finance initiative is one of the cases among the public–private partnership where the private sector contributes its funds.

income leads to an increase in automobile owners, and Viet Nam is not likely to be an exception. Additionally, if a conversion is made not to buses but to railways, a certain level of efficiency improvement effect will be expected. Therefore, while we need to pay attention to a change in bike use in middle- or larger-scale cities with a population sufficient to support public transportation, we recommend a generally wider use of public transportation.

Issues of business model, government incentive mechanism, and supportive policy framework for public transportation

First, the capacity of private companies should be actively utilized in this field. Under certain conditions, public transportation will be a profitable business. Moreover, it will also be possible to reduce the operational cost by utilizing the know-how of the private sector. However, prudent determination on the use of the private sector is recommended. For example, when a route with a low profitability needs to be maintained, measures for maintaining transportation service, including cross-subsidization, can be more easily carried out if such route is operated by the public sector together with profitable routes.

A frequently indicated issue in relation to public transportation is its operation. Public transportation assumes a certain number of users for its operation. Since transportation fees sometimes are set at low by considering affordability of the public, there are cases where collection of initial investment and operation cost is difficult. For this reason, in operating public transportation, it is important to increase the number of users by enhancing its appeal. Specifically, it is recommended to employ strategy to improve image targeted for users through the enhancement of convenience, such as by increasing the operation frequency and the travel speed, while maintaining a favourable environment inside the vehicles (temperature, security, and appearance).

In terms of funds, on the assumption that public transportation itself is generally a low-profitability project, it is recommended to balance the entire financial state by nurturing other pillars of profit. Examples include development and sale of residential areas featuring the convenience of railway lines, and operation of commercial facilities united with railway stations, etc. Many successful cases of public transportation can be found where public transportation is sustained through a synergy effect realized by such ‘side business’.

Compact city

From another point of view, it will be possible to build a city itself in a manner where public transportation can easily be used. It is the so-called ‘compact city’, where dwelling houses, workplaces, and other facilities required for life are geographically concentrated in a narrow area, and movements are planned mainly thru walking, bicycle, and public transportation. As density of population and transport demand naturally become high in such a city, users of public transportation will also increase, making public transportation more likely to be sustained as a business.

In the process of economic growth, the city area usually widens. Unless properly managed, the city will expand in a disorderly fashion, and the demand for constructing various infrastructures, such

as electricity, waterworks, and telecommunication, to say nothing of roads, will soar in an unregulated manner. The concept of 'compact city' is based on the intention to apply an order to the expansion of the city, and to make investments in urban infrastructures, including transportation, more efficient. This may be the very concept required for Viet Nam, which is in the middle of rapid economic growth.

Transport demand management, including electric road pricing

Another conceivable measure is to urge the use of public transportation by dispersing and controlling the demand for automobile traffic. Specific examples include shifting and making working hours flexible, park and ride, and electric road pricing (ERP), etc. Shifting and making working hours flexible reduces traffic concentration at certain times by changing the work start and end time. Park and ride restricts automobiles being driven into the central area of business districts, and urges commuters to transfer from automobiles to buses, etc. at the perimeter of controlled areas.

A representative example of introducing ERP can be found in Singapore. This is a system of charging automobiles entering the central area, and has an effect of limiting the non-essential and non-urgent inflow of automobiles. In addition, it is also possible to allocate the fees collected through ERP to the preparation of public transportation means in controlled areas. What we need to be careful of is the order of development in introducing ERP. If ERP is introduced while public transportation is still lacking, the cost burden is simply brought to automobile users, and neither the reduction in automobile inflow nor the improvement of energy efficiency will take place. It is the usual policy to first build a public transportation system with sufficient capacity in the controlled area and thereafter introduce ERP.

Further, another means to control automobile traffic is through 'sharing', which has been seen recently. It is also called 'ride share' or 'car share', etc., and is basically meant to urge two or more persons to use one automobile in a shared manner. Shared use of automobiles leads to reduction of the number of automobiles running and of energy consumption. Proposals for various services combining 'sharing' with ICT have been devised and are being disseminated. By incorporating these schemes in a pioneering manner, a transportation system with high energy efficiency is likely to be established through an unprecedented approach.

2) Improvement of fuel economy of vehicle

Implementation of fuel economy standards

Considering the extreme convenience provided by automobiles of traveling freely and comfortably to any destination, it does not make sense to completely eliminate the use of automobiles. For this reason, improving the fuel efficiency of automobiles is important. Viet Nam indicates the degree of fuel efficiency of automobiles using a labelling system, thus allowing consumers to refer to it when making choices. Coupled with the effect of school education and public relations pursued simultaneously with the labelling system, the energy-saving consciousness of the nation will gradually improve, and these efforts will result in further effects.

Another conceivable measure, which is rather complicated, is to impose tax on the possession of

automobiles, etc., and then change the rate according to the respective fuel efficiency. This measure aims to persuade people to choose more fuel-efficient vehicles. However, it is desirable to introduce an induction scheme through labelling or a new tax system in stages in consideration of the current situation of Viet Nam, such as per capita national income. Since high fuel-efficiency automobiles are not necessarily low-cost, just haphazardly pursuing a highly set goal will only make it difficult for the nation in general to purchase automobiles. There may be other various affairs specific to Viet Nam, thus prudent consideration is required.

Fuel quality

Fuel quality influences the fuel efficiency of automobiles. Automobiles are designed and manufactured to use fuels of a certain quality. When non-standard fuel is used, automobiles cannot deliver their specified performance. Therefore, it is a basic principle to produce and import fuels of a specified quality. However, quality of gasoline and gas oil is strictly regulated, and, except in cases of intentional violation of laws, non-standard fuels are unlikely to be generally distributed.

In contrast, it will be an issue whether refining and supplying low-sulphur fuels as a prerequisite to meet automobile exhaust gas regulations under Euro 4, etc. is allowed. In Viet Nam, operation of the Euro 4 standard began in January 2017, and automobiles registered after 1 January need to meet this standard. The use of cleaner fuels is essential for reducing GHG emission of automobile, to say nothing of the improvement on the vehicle side, such as introduction of higher-efficiency engines and more sophisticated exhaust gas treatment methods, etc. Since exhaust gas regulations are expected to be stricter in the future, gasoline and gas oil that are domestically refined or imported will need to be cleaner in line with the tightening of regulations. Specifically, Viet Nam will need more investment to make the treatment equipment of refineries more upgraded to produce cleaner fuel, and we will have to pursue this strategy in a systematic manner.

Education for eco-driving

Automobiles consume a lot of fuel at the time of start-up and rapid acceleration. Additionally, stepping on the brake causes energy loss[13]. Moreover, fuel consumption efficiency changes according to driving speed. Driving manner influences the efficiency of energy utilization in this way, but there may be many drivers who do not know this fact. For this reason, a certain degree of efficiency improvement can be expected by providing education on driving manner.

Two methods are conceivable as means to convey such information to drivers. One of them is to directly deliver public notification to drivers. This method includes the use of mass media, such as television and newspapers, or through a campaign for a certain period. The other is to provide educational information and materials to businesses dealing with loans and insurance for car drivers, as well as to car dealers and auto-repair shops, and get them to convey information to drivers as agents. Either of the two methods has no immediate effect as in the case of human capacity building; thus, continuous efforts are required.

[13] This is because the kinetic energy obtained by combustion of oil is converted by the brake into thermal energy and emitted into the atmosphere.

3) Fuel switch or alternative fuel: compressed natural gas (CNG) or biofuel

From the viewpoint of oil saving, wider use of automobiles driven by alternative fuels, such as CNG and biofuels, is also effective. In urging the wider use of automobiles using alternative fuels, several measures are required. Firstly, strengthen the price competitiveness of automobiles using alternative fuels. Automobiles using alternative fuels are manufactured by partially remodelling ordinary diesel vehicles and so on, but the number of vehicles produced inevitably tends to be small, thus the price will generally be higher. If CNG and biofuels used for such vehicles were sufficiently cheaper than gas oil, an economic advantage could be acquired in the life cycle especially in the case of freight cars and commercial vehicles with longer distance covered. Since economic advantage is an important factor in choosing each vehicle in the case of freight cars and commercial vehicles, subsidy for the purchase cost of vehicles, for example, will be an effective incentive.

Secondly, it will be a challenge to establish infrastructure for supplying alternative fuels. Since expansion of the town gas pipeline network is limited to larger cities in the case of CNG, use of CNG vehicles will generally be limited to larger cities and surrounding areas. In addition, while CNG feeding stations will need to be newly constructed, there will be a high risk of not being able to recover the construction or operational costs because the number of users will be limited, particularly during initial introduction. In this respect, the initiative of the government will be critical. On the other hand, biofuels have fewer challenges in terms of back-end supply infrastructure because biofuels can be used by mixing them in gas oil and gasoline. However, there still remains a challenge to build a system for producing biofuels in a stable manner. Suppose plant material is used for biofuels, their growth, i.e. their yield and production period, is significantly influenced by weather conditions. It will not be easy to prepare a system for producing sufficient quantity of biofuels for automobile fuels in a stable manner.

Thirdly, wider use of alternative fuels for passenger cars will face difficulty because most passenger cars travel only a short distance, and prospects are poor for recovering the increased vehicle cost from reduced fuel expense. In addition, shortage in the number of fuelling stations will limit the travel range expected. Thus, prospects will inevitably be poor especially for a wider use of CNG in passenger vehicles. Moreover, consumers will not choose this fuel unless the automobiles themselves have appeal, meaning the car has ‘cool’ outward appearance and interior, as well as good traveling performance, etc. which will stir up customer’s desire to own one. Further, provision of diverse choices (models and grades) is also important. In the case of automobiles using alternative fuels that are not expected to be very commercially successful, there is a risk of falling into a vicious cycle where car manufacturers cannot focus on development, and the resulting unattractive vehicles do not sell well. On the basis of these issues facing the sales of passenger cars, it will be realistic to focus on freight cars and commercial vehicles if we aim for a wider use of automobiles using alternative fuels.

4.3. Conclusion

In our study of this fiscal year, it was confirmed that Viet Nam was beginning to produce results in terms of policy development (Chapter 2), and we showed that, referring to the example of Da Nang City, timely introduction of public transportation and road construction plans would be indispensable for energy saving (Chapter 3). In addition, we made proposals to address various

remaining issues (Chapter 4).

Finally, the study would like to present another proposal made from a geographically larger viewpoint beyond the boundary of cities. Demand for transportation is not limited to cities but spreads widely across the country. In the case of Viet Nam, since its land area is long from north to south, the traveling distance of passengers and freight inevitably gets longer in the north–south direction. As the traveling distance becomes longer, just a slight improvement will result in reduction of a large amount of energy consumption.

The following are some choices to improve efficiency of freight transportation using trucks:

1) Use more-efficient trucks for transportation (including the use of new technologies, such as platooning vehicles).

2) Change the transportation means to railroads.

3) Change the transportation means to domestic vessels.

In terms of efficiency, changing the transportation means to domestic vessels is probably the most effective, followed by railroad transportation. Since Viet Nam is narrow in the east–west direction and major cities are located at a comparatively short distance from the coastal line, it will function well to connect major bases with domestic vessels and use railroads or trucks for local distribution. Enhancement of the transportation capacity of railroads running in the north–south direction will also be effective. As for travel from Hanoi City or Ho Chi Minh City to cities in the central region, in particular, a high-speed rail will be more advantageous than airplanes in terms of traveling time. In the case of freight transportation, although disadvantageous in terms of efficiency when compared with domestic vessels, railroads can transport freight in a shorter time.

Activation of the local economy may result as a secondary effect of developing a traffic network across the entire area. Shortening the travel time is expected to activate the movement of objects and people, and give rise to new centre of development in local areas. However, since there are cases where districts without railroad stations are left behind from development when we look at the situation of Japan as an example, prudent planning is required when a national traffic network is to be developed.

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