Final Report for the APEC Energy Working Group

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Follow-up Peer Review on Energy Efficiency in Thailand

Final Report

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CONTENTS

PREFACE

The APEC Peer Review on Energy Efficiency (PREE) objectives, as endorsed by APEC Leaders at the 2007 meeting were to:

- Share information on energy efficiency performance as well as on policies and measures for improving energy efficiency;
- Provide opportunities for learning from the experiences of other economies and for broadening the network among energy efficiency policy experts;
- Explore how energy efficiency goals on an overall and/or sectorial basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstance of each economy;
- Monitor progress attaining energy efficiency goals on an overall and/or sectorial basis and implementing action plans, if such goal and action plans have been already formulated at the time of the review; and
- Provide recommendation for voluntary implementation on how implementation of action plans could be improved with a view to achieving energy efficiency goals.

Two activities form the PREE:

a) **Peer Review** of volunteer member economies; and

b) The **Compendium of Energy Efficiency Policies** of APEC member economies based on either the APEC voluntary PREE or energy efficiency aspects of the IEA Energy Policy Review.

Follow-up PREEs are a secondary phase of the first activity. Follow-up PREEs form part of the monitoring process. It helps previous PREE-hosting economies implement recommendations from a previous report, or provides a more detailed analysis with recommendations for a particular sector or sectors.

Thailand volunteered to undertake a Follow-up Peer Review on Energy Efficiency, following the fourth PREE in Thailand held in 2009. This is the third Follow-up PREE exercise for an APEC economy. Viet Nam hosted the first Follow-up PREE in February 2012. It was a workshop on assisting Viet Nam to implement the energy data collecting and monitoring recommendations from the Viet Nam PREE Report in 2009. The second was hosted by Philippines in September 2014 which focused on the industrial sub-sectors of sugar, cement and glass, and the commercial buildings sector in the Philippines.

This report presents the results from the peer review of energy efficiency conducted by the Follow-up PREE Review Team, which consisted of 10 experts (see Appendix A). The team visited Bangkok, Thailand from 3-7 August 2015. The host economy and the Review Team share accountability for each APEC peer review. During the visit, the Follow-up PREE Review Team held comprehensive discussions through the presentations on energy efficiency with representatives and experts from Government ministries and agencies, local government, companies, NGOs and research institutions (see Appendix B). The Follow-up PREE Review Team also participated in site visits related to each subject matter. The Review Team wishes to thank all the presenters, site visit organisations and those who participated in the discussions, and special thanks to the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy for arranging such a very faithful workshop.

EXECUTIVE SUMMARY

Like many economies, Thailand is having difficulties in promoting energy efficiency in its transport sector. This is especially the case in developing economies, where the sector's authorities focus on their core function, to move passengers and freight smoothly, over improving energy use.

With its large population and high oil import dependency, the Thai Ministry of Energy notes that energy is a crucial commodity factor for economic growth necessitating both energy stability and energy conservation. As a fast growing economy, its transportation sector is one of the fastest growing sectors. This means managing existing and increased energy demand through energy efficiency is crucial for the sustainable growth of the sector.

The Peer Review on Energy Efficiency Report from 2010 ('the 2010 PREE Report') made 34 recommendations on the following topics: the institutional context; energy efficiency goals, targets and strategy; energy data collection and monitoring; the industry sector; the electricity sector; the commercial and residential sector; the transport sector; appliances and equipment; and energy efficiency related R&D. The Government has made progress on many of the recommendations, however, this report ('the Follow-up PREE Report' or 'the Report') focuses exclusively on energy efficiency in the transport sector. This is because the transport sectors is the fast growing and highest energy intensity sector in Thailand. Please refer to the 2010 PREE Report for analysis and recommendations on other sectors. It is available on APERC's website: http://aperc.ieej.or.jp/publications/reports/pree.php.

The Follow-up PREE Review Team found that the Thai Government and related organisations had a positive attitude towards energy efficiency. It has made excellent groundwork towards establishing the economy as an energy efficient economy. This Report highlights 32 Achievements, which shows the progress that the Thai Government has made towards energy efficiency in the transport sector Thailand since the 2010 PREE Report.

The Report makes 48 recommendations to the Thai Government covering overarching recommendations and recommendations for 6 specific issues including: transport financing and investment; urban land use and transport integration; low carbon transport systems; travel demand management; vehicle fuel economy labelling and standards; and high efficient vehicle technology. The Review Team tailored the recommendations made in this Report towards aligning policy options under a unified framework, and sharing best practices and innovative approaches from around the world. The Review Team hopes that the recommendations will help the economy to realise its energy efficiency potential and achieve its energy efficiency goals, especially within the transport sector.

The recommendations are listed below.

RECOMMENDATIONS

OVERARCHING

Recommendation 1 The Thai Government should develop a Memorandum of Understanding between transport agencies and organisations to share data to improve evidence-based decision-making in the transport sector.

Recommendation 2 The Ministry of Energy should organise a regular meeting with the Ministry of Transport and other relevant ministries to ensure policy coordination and achieve necessary energy saving in transport sector.

Recommendation 3 The Thai Government should support local governments to implement preventive measures to develop efficient public transport systems in medium and small cities in the regions of Thailand to avoid car dependency like in Bangkok.

Recommendation 4 Reducing fossil fuel subsidies by the Ministry of Energy was a remarkable success and will make energy efficiency measures through price mechanisms (incentives, taxes, etc.) more workable. The Thai Government should continue to employ those measures, while monitoring and evaluating their policy effects.

Recommendation 5 The Thai Government should continue to raise public awareness in transport energy efficiency through various events and media.

Recommendation 6 Policymakers in the relevant ministries (including the Ministry of Energy and the Ministry of Transport) should continue to listen to the opinions/concerns of policy implementing bodies, the business sector and the public.

TRANSPORT FINANCING AND INVESTMENT

Recommendation 7 Expanded and more flexible use of the ENCON fund (for policy support, infrastructure development, local government investments, subsidies) should be promoted in the transport sectors and regional governments agencies.

Recommendation 8 Better energy pricing to reflect cost of supply, and gradually the public costs (safety, local pollution and greenhouse gases).

Recommendation 9 Moving from an input-based to output-based taxation regime, and creating a fiscal space for transport investment.

Recommendation 10 More structured local government finance for improving first/last mile infrastructure including pedestrian and cycling facilities, and encouraging the use of public transport.

Recommendation 11 Prudent policies on internationally funded projects, and consolidation of three railway systems (narrow gauge, standard gauge and high speed system) into the regional/international rail networks.

Recommendation 12 Increasing the capacity to manage PPP scheme by gradual introduction of private sector partnership (management contract, extended turnkey, availability payment, VGF/partial construction support and guarantee scheme, BOT/BTO).

Recommendation 13 Expanded role of the MRTA to manage and finance TOD projects and negotiate in a B2B (Business to Business) arrangement with property owners around stations.

URBAN LAND USE AND TRANSPORT INTEGRATION

Recommendation 14 Implement car restrictions and congestion controls.

Recommendation 15 Design the area around rail stations 'precincts' carefully to include a number of features including walkability, greening, mixed-use development and bicycle access.

Recommendation 16 Carefully assess railway precinct areas before making planning decisions.

Recommendation 17 Fund the costs of new public transport lines from the profits of land development.

Recommendation 18 Continually improve public transit amenity, including access, information systems, shelters, timetables, and consistent colour-coding.

Recommendation 19 Make all railway stations multi-modal interchanges.

Recommendation 20 Create circumferential MRT services to connect sub-centres away from the CBD.

LOW CARBON TRANSPORT SYSTEMS

Recommendation 21 Improve data collection on passenger and cargo movement, and traffic data such as VKT and emissions factor.

Recommendation 22 Improve the Bangkok's Transport Master Plan to include the role of *feeder transport*.

Recommendation 23 Reform the bus system in Bangkok to improve its overall system strategic planning, network planning and operations.

Recommendation 24 Develop a plan to improve MRT capacity.

Recommendation 25 Develop more strategic plans for freight transport within of the 'Lean Logistics' program's framework.

TRAVEL DEMAND MANAGEMENT

Recommendation 26 Include TDM strategies to meet energy savings targets in the 20-year Energy Efficiency Development Plan.

Recommendation 27 Set key performance indicators (KPIs) for mode share, bus and rail ridership, and VKT, and collect data to track trends.

Recommendation 28 Conduct a detailed road pricing study, considering several design options.

Recommendation 29 Educate the public about road pricing policy.

Recommendation 30 Conduct a study on the measures to increase the cost of vehicle acquisition and ownership, along with adopting alternatives such as city-owned car sharing services and extending the efficient operation of public mass transport system.

Recommendation 31 Increase the cost of vehicle ownership by raising economy-wide vehicle excise tax and car registration fees based on carbon emissions emitted.

Recommendation 32 Unify the ticketing system across all modes of transit.

Recommendation 33 Introduce employer subsidised transit passes.

Recommendation 34 Implement road pricing and create an office for Mobility Management.

Recommendation 35 Supporting the use of IT in the transport/logistics industries (on demand service, virtual marketplace).

VEHICLE FUEL ECONOMY LABELLING AND STANDARDS

Recommendation 36 Institutionalise an annual review of the taxation scheme and establish 'a committee' to check whether the intended outcome is being achieved.

Recommendation 37 Policies and incentives for vehicle manufacturers under Eco Car Phase II should include other vehicle types, e.g. 2-wheelers.

Recommendation 38 Explore the adoption of a feebate system that provides fees for less efficient vehicles and rebates to more efficient vehicles.

Recommendation 39 Explore the adoption of Minimum Energy Performance Standards (MEPS) as mandatory standards for LDVs.

Recommendation 40 Include a comparison reference point in the Eco-Sticker labelling.

Recommendation 41 Analyse how the Eco-Sticker can apply to second-hand vehicles.

Recommendation 42 Establish a database of the sales of new vehicles, including detailed information, e.g. engine size, fuel, etc through the Excise Department, for example.

HIGH EFFICIENT VEHICLE TECHNOLOGY

Recommendation 43 Develop policies for encouraging the adoption of more efficient electric 2-wheelers, particularly for urban traffic.

Recommendation 44 Remove speed limit requirements for electric 2-wheelers, adding optional safety measures (banning them from highways for example), to allow the market to develop.

Recommendation 45 Analyse the potential for using of LNG for trucks along suitable corridors.

Recommendation 46 Address the emissions efficiency of the passenger and freight maritime sector and develop appropriate policies.

Recommendation 47 More analysis should be done on hybrid cars and buses in Bangkok's start-stop traffic, as their efficiency is currently greatly underestimated.

Recommendation 48 Supporting the replacement of old vehicles and old vehicle technologies with more energy efficient vehicles/vehicles technologies (e.g. electric vehicles) for the domestic market, i.e. using tax incentives and promoting public awareness of this issue.

PART I: BACKGROUND INFORMATION

The Thai Government has contributed the background information contained in this report. This information provides some context to the recommendations made by the Follow-Up PREE Review Team. More detailed background information is contained in the 2010 Thailand PREE Report

INTRODUCTION

THAILAND'S ENERGY SITUATION

The Office of the National Economic and Social Development Board (NESDB) reported 0.7% economic growth with deflation in the first quarter of 2014. It was a lower than usual growth due to political unrest in the economy. As the political unrest settled, economic growth in the second quarter improved. The stabilised political situation returned consumer confidence, and renewed energy consumption growth. Followed by increasing private investment and the tourism industry in the third quarter of 2014. The economic recovery suggests a trend for increased energy consumption in the economy.

PRIMARY COMMERCIAL ENERGY CONSUMPTION

In 2014, energy production was 79 314 ktoe and increase of 1.6% from the previous year. Classified by commercial energy production contributed 66.7% of the total energy production, renewable energy 13.4%, traditional renewable energy 17.3%, biofuel 2.3% and other energy contributed 0.3%.

Total commercial energy production was 52 888 ktoe, an increase of 0.3% from the previous year. Of this amount, the production of crude oil was 6 906 ktoe, decreased 6.2%, lignite production was 4 622 ktoe, increased 3.7%, natural gas 37 035, increased 1.7%, condensate 4 325 ktoe, decreased 4.1%. In part of total production of renewable energy (solar, fuel wood, charcoal, paddy husk, bagasse, agricultural waste, MSW and biogas) was 10 619 ktoe, increased 9.4%, traditional renewable energy (fuel wood, charcoal, paddy husk and agricultural waste) was 13 740 ktoe, increased 0.01%, as well as biofuel was 1 799 ktoe, increased 11.8% and other (black liquor & residual gas) was 268 ktoe, decreased 5.6%.

Table 1.1: Total Primary Energy Supply, 2014 (ktoe)

Total	**136 832**
Production	79 314
Imports	69 248
Exports	10 716
Stock	(1 014)

Source: DEDE, 2015.

FINAL COMMERCIAL ENERGY CONSUMPTION

In 2014, Thailand consumed 75 804 ktoe of final commercial energy. The consumption of final commercial energy grew at 0.8% from 2013 levels. By fuel type, demand for petroleum products increased by 1.7% from 2013, but imported coal/lignite utilisation decreased considerably by 22.2%. Natural gas demand also increased by 8% because of higher demand in the industrial and the transport sectors. Electricity consumption increased by 2.6% from 2013.

FINAL ENERGY CONSUMPTION EXPENDITURE

While the volume of commercial energy consumption decreased, the expenditure on petroleum products still increased by 46% because of service maintenance to several oil refineries in the economy. The expenditure, on the whole, decreased by 1.2% compared with that of 2013.

ENERGY IMPORTS

Total energy imported in 2014 was 69 248 ktoe, a decrease of 1.4% from the previous year, almost energy imported was commercial energy shared 99.8% of the total energy imported and the rest 0.2% was traditional renewable energy. Total value of energy imports was THB 1 309 billion, or about USD 39 666 million (at 33 THB/USD). Of this, the value of crude oil imports were THB 980 billion (US$ 29 700 million), or 74.8% of the total value of energy imports, a decrease of 8.6 % from 2013. The value of natural gas accounted for the second largest share at 8.0% with an increment of 6.2%. The share of petroleum products grew by 36.1% to a7.5% share, while coal imports held a share of 3.7%, and grew by almost 20%.

Table 1.2: Value of energy imported

Value of Imports (billion THB)	2013	2014	2014 Change (%)	2014 Share (%)
Crude oil	1 072	980	-8.6	74.8
Petroleum products	139	98	-29.5	7.4
Natural gas	112	105	-6.2	8
Imported coal	40	48	20.0	3.5
Electricity	16	19	18.7	1.4
Liquefied natural gas (LNG)	35	33	-4.4	2.5
Condensate	32	25	-2.2	1.9
Renewable Energy	0	1		0.7
Total	1,379	1 309	-5.07	100

Source: DEDE, 2015.

Table 1.3: Final energy consumption by fuel types

Final energy consumption by fuel	Amount (ktoe)			Percentage (%)	
	2012	2013	2014	2013 Growth	2014 Growth
Total final energy consumption	73 316	75 214	75 804	2.6	0.8
Consumption energy	60 340	61 236	61 061	1.5	(0.3)
Petroleum products	34 881	35 948	36 570	3.1	1.7
Electricity	13 783	14 002	14 371	1.6	2.6
Imported coal/lignite	6 582	5 947	4 629	(9.6)	(22.2)
Natural gas	5 094	5 339	5 505	4.8	3.1
Renewable energy	5 635	5 902	6 408	4.7	8.6
Traditional renewable energy	7 341	8 076	8 321	10.0	3.0

Source: DEDE, 2015.

Table 1.4: Imported energy by fuel types

Imported energy	Amount (ktoe)			Change (%)	
	2012	2013	2014	2013	2014
Total imported energy	69 963	70 232	69 248	0.4	(1.4)
Commercial energy	69 868	70 107	69 144	0.3	(1.4)
Crude oil	43 048	43 322	40 171	0.6	(7.3)
Condensate	1 466	1 206	1 216	(17.7)	0.8
Imported coal	11 642	10 852	13 188	(6.8)	21.5
Petroleum products	2 881	3 186	3 732	10.6	17.1
Natural gas	9 951	10 470	9 792	5.2	(6.5)
Electricity	880	1 071	1 045	21.7	(2.4)
Renewable energy	0	0	0	-	-
Traditional renewable energy	95	125	104	31.6	(16.8)

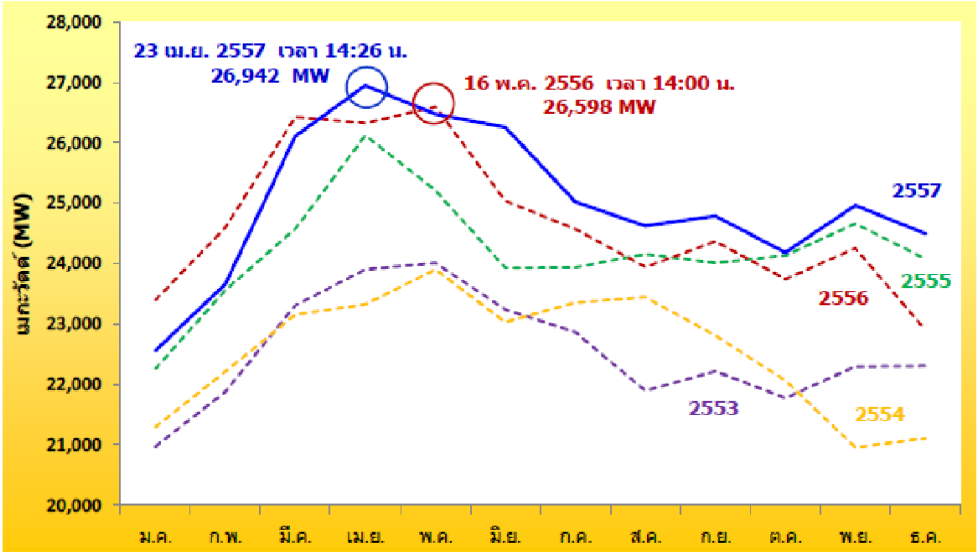
Source: DEDE, 2015.

THE ELECTRICITY SECTOR

In 2014**,** Thailand's total installed electricity generation capacity was 34 668 MW, comprising the generation by Electricity Generating Authority of Thailand (EGAT), 15 482 MW (45%); Independent Power Producers (IPP), 13 167 MW (38%); Small Power Producers (SPP), 3 614 MW (10%); and imports from Lao PDR and exchange with Malaysia, 2 405 MW (7%). By source, natural gas remained the major fuel used in power generation, accounting for a share of 66%; followed by imported coal/lignite, at a share of 23%; renewable energy and others accounting for a share of 10%; and bunker oil and diesel oil, 1.1%. In 2014, Thailand's peak demand was 26 942 MW at 2.26PM on 23 April 2014, which was 1.3% higher than the 2013 peak demand occurring at 2.00 PM on 16 May 2013 at 344 MW. Total electricity generation in 2013 was 180 945 GWh, an average increase of 2.0%. The average load factor was 75% and the minimum reserved margin was 17% (EGAT, 2015).

The total electricity demand of the economy in 2014 was 168 620 GWh, an average increase of 2.6% from 2013 due to economic recovery, which is considered rather low when compared with the growth rate of 4% to 5%, under normal economic conditions, in recent years. By sector, industry is the largest electricity user in the economy with a share of 44% of total electricity demand. On average in 2014, electricity demand by the industry sector increased by 1.7% from the previous year. Demand in the household sector increased by 3.5%, in the commercial building sector 3.1% and small-scale enterprise sectors 2.4%. The overall demand increased by 2.6%, compared with that in 2013.

Figure 1.1: Peak demand, 2014



Remark: Demand on maximum net power demand of the Electricity Generating Authority excluded the electric used in the Station Service.

Source: EPPO, 2015.

Table 1.5: Peak Demand and Load Factor, 2010-14

Year (Buddhist Era Year)	Peak demand (EGAT*) (MW)	Load factor (%)
2010 (2553)	24 010	75.9
2011 (2554)	23 900	75.6
2012 (2555)	26 121	75.2
2013 (2556)	26 598	74.5
2014 (2557)	26 942	75.2

Source: EPPO, 2015. Note: * excludes power station use.

In 2014, natural gas shared the highest proportion of electricity generation in Thailand with the ratio of 64% (120 314 GWh), an increment of 0.9% from the year 2013. Imported coal/lignite shared 21% (37 572 GWh) with an increment of 6.3%. However, the electricity generated from renewable energy increased significantly with a share of 2% (3 993 GWh), an increment of 17%.

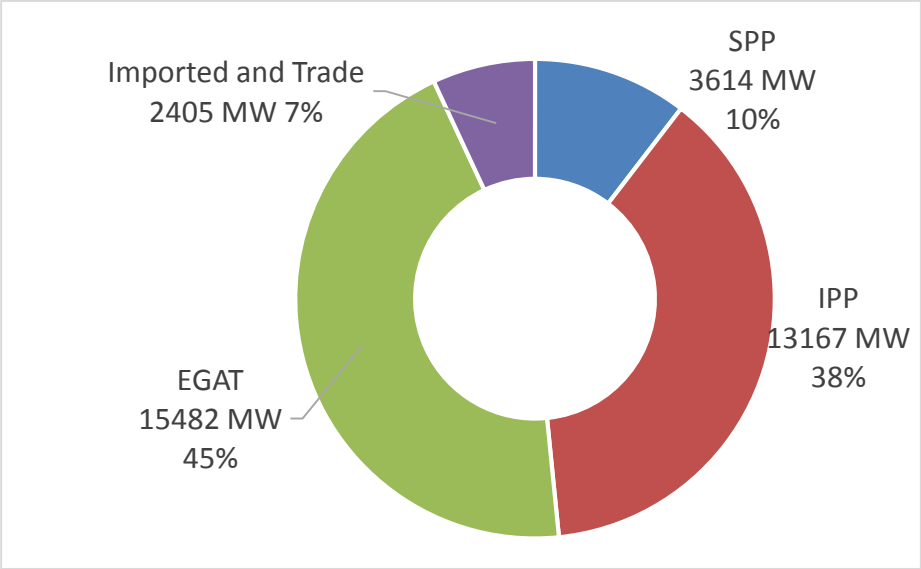
Table 1.6: Thailand's Electricity Demand by Sectors, 2012-14 (GWh)

Sectors	2012	2013	2014	Change %	Share %
Household	36 447	37 657	38 993	3.5	23
Small Scale Enterprise	17 013	18 374	18 807	2.4	11
Commercial Building	27 088	30 413	31 362	3.1	19
Industry	72 336	72 536	73 782	1.7	44
Government offices and NFPs	3 799	149	152	2.0	0.1

Agriculture	377	354	414	17.2	0.2
Free of Charge	2 191	2 379	2 517	5.8	1
Others	2 527	2 479	2 592	4.6	2
Total	161 779	164 341	168 620	2.6	100.0

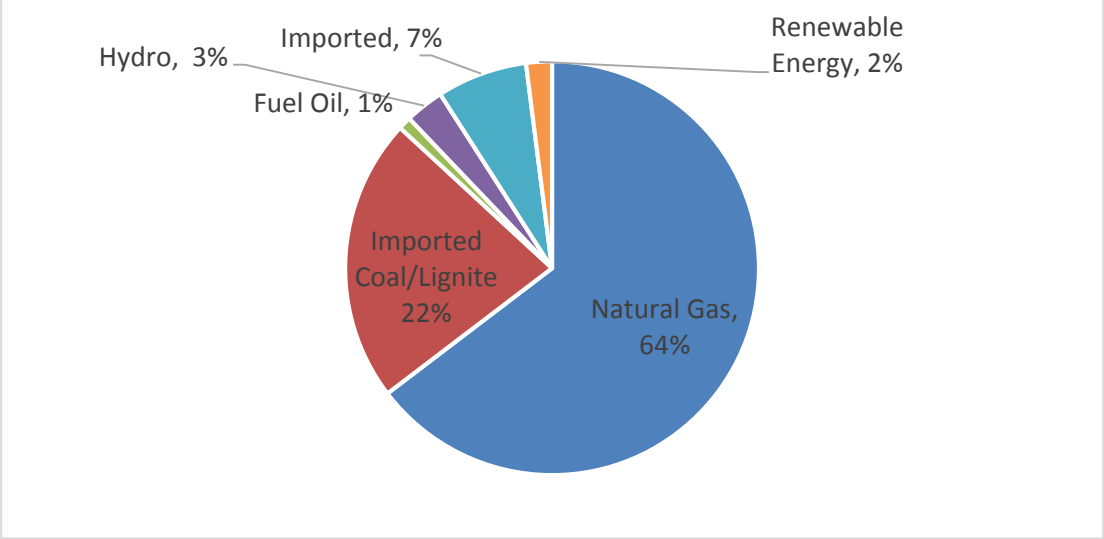
Source: EPPO, 2015.

Figure 1.2: Total installed capacity by utility, 2014, 34 668 MW



Source: EPPO, 2015.

Figure 1.3: Electricity generation by fuel mix, 2014, 180 945 GWh



Source: EPPO, 2015.

ENERGY IN THE TRANSPORT SECTOR

Thailand's transport heavily depends on road-based modes. As a result, the majority of total transport energy consumption (of which liquid fuels account for 76%), about 76% is in road transport. If international air and international water transport were excluded from the total, the share for road transport would reach 98%. In 2014, energy consumption in this sector (excluding jet and fuel oil) was 17 996 ktoe, which decreases by 0.7 % from 2007 because of high oil prices, while the use of alternative transport energy, LPG and CNG (or natural gas for vehicles: NGV), increased. By fuel, diesel held the largest share accounted for 62% in 2008, followed by gasoline at 29%, LPG at 5% and NGV at 4%. In comparison, the consumption of diesel and gasoline decreased by 5.7% and 2.9% respectively in 2008. However, LPG consumption increased by 36% from 667 ktoe to 905 ktoe, and NGV increased significantly by 223%, from 212 ktoe to 684 ktoe.

Table 1.7: Registered vehicles stock as of 31 December 2012

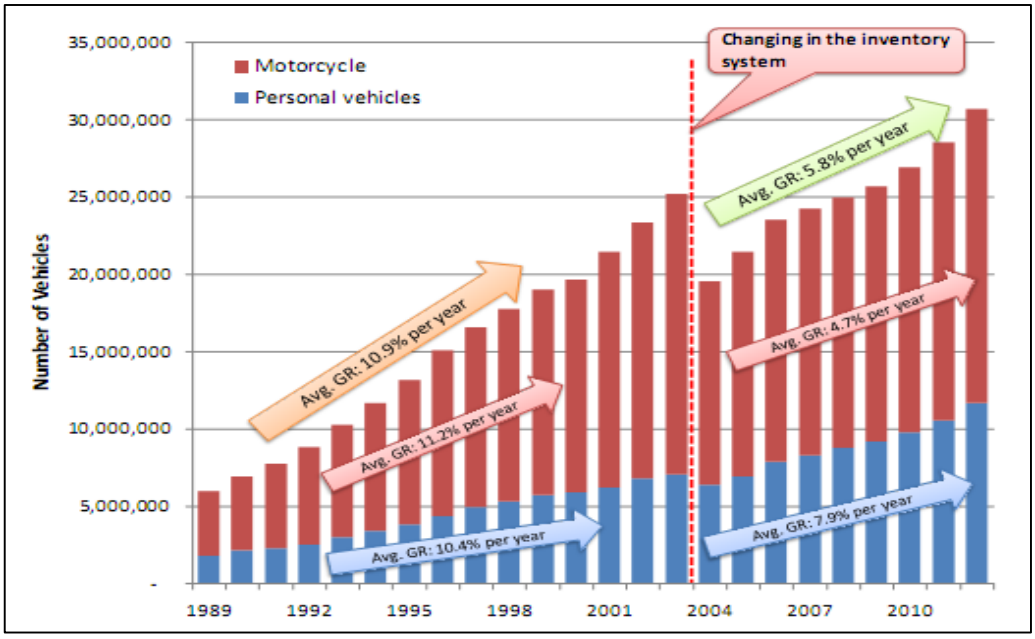
Type of Vehicle	**Number of Vehicles**	**%**
Grand Total	**32 476 977**	**100**
A. Total Vehicle under Motor Vehicle Act	**31 439 643**	**96.8**
A.1) Sedan (not more than 7 pass.)	5 856 454	18.6
A.2) Microbus & Passenger Van	417 529	1.3
A.3) Van & Pick Up	5 437 988	17.3
A.4) Motor-tricycle	1 477	0.0
A.5) Interprovincial Taxi	3	0.0
A.6) Urban Taxi	109 281	0.3
A.7) Fixed Route Taxi	3 293	0.0
A.8) Motor-tricycle Taxi (Tuk-Tuk)	20 716	0.1
A.9) Hotel Taxi	1 975	0.0
A.10) Tour Taxi	1 099	0.0
A.11) Car For Hire	88	0.0
A.12) Motorcycle	19 023 751	60.5
A.13) Tractor	334 292	1.1
A.14) Road Roller	10 872	0.0
A.15) Farm Vehicle	94 551	0.3
A.16) Automobile Trailer	2 800	0.0
A.17) Public Motorcycle	123 474	0.4
B. Total Vehicle under Land Transport Act	**1 037 334**	**3.2**
B.2) Truck	898 214	86.6
B.2.1) Non Fixed Route Truck	201 389	22.4
B.2.2) Private Truck	696 825	77.6
B.3) Small Rural Bus	1 511	0.1

Source: Department of Land Transport, 2013.

Figure 1.4 shows trend for vehicle growth over the last 20 years based on vehicle registration data from the Department of Land Transport (DLT). It should be noted that there was a big drop in vehicle registration numbers in 2003 to 2004 as the DLT modified the inventory system of vehicle stocks by cutting very old vehicles that had not

renewed annual registration after several years. During 1989-2003, personal cars (including sedans, vans, and pick-ups) and motorcycles had a similar growth rate, about 10% per year. For the last decade, average motorcycle growth rate significantly decreased, by about 5% per year, while personal car growth rate grew by about 8% per year. The registration data improved reliability as it is an online registration system within every provincial office of DLT. With the current growth rates, it is possible to project that the number of personal cars could be equal to the number of motorcycles someday in future. As the growth of overall private vehicle ownership is driven by per capita GDP growth, the car ownership in Thailand is expected to equal motorcycle ownership when per capita GDP of Thailand is about 15 600 USD before the year 2050.

Figure 1.4: Motorcycles and passenger cars trend over the last 20 years



Source: Pongthanaisawan and Sorapipatana, 2012.

Table 1.8: Thailand's Land Transport Energy Consumption by Fuel

Fuel type	2012 (ktoe)	2013 (ktoe)	2014 (ktoe)	Share (%)	Growth Rate (%)		
					2012	2013	2014
Gasoline	5 741	6 106	6 338	28.4	5.1	6.4	3.8
Diesel	11 906	10 712	10 803	48.5	2.3	-10.0	0.8
LPG	1 238	2 071	2 304	10.3	15.3	67.3	11.3
NGV	2 498	2 753	2 839	12.7	20.8	10.2	3.1
Total	21 382	21 641	22 284	100	5.6	1.2	3.0

Source: EPPO, 2015.

Table 1.9: Use of diesel and gasoline, 2014

Million litres/day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Share	Change (%)
1 Diesel	59.2	60.6	60.4	60.5	61.0	56.8	55.0	53.2	53.7	53.8	57.2	61.5	100	0.8
2 Gasoline	21.8	22.4	22.8	23.3	22.9	22.5	23.3	23.7	23.6	23.5	24.0	25.8	100	3.7
Gasoline 95	1.4	1.4	1.5	1.4	1.4	1.3	1.4	1.3	1.3	1.2	1.3	1.4	6.0	(19.1)
Gasohol													94.0	7.2
91 E 10	9.2	9.5	9.6	9.8	9.6	9.5	9.8	10.0	10.0	9.9	10.2	11.0	42.0	7.7
95 E 10	7.4	7.5	7.5	7.5	7.4	7.2	7.5	7.5	7.5	7.4	7.5	8.1	32.0	(9.7)
95 E 20	3.1	3.3	3.4	3.8	3.6	3.6	3.7	3.9	3.8	3.8	3.8	4.2	16.0	39.6
95 E 85	0.6	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.0	1.1	1.2	1.1	4.0	137.6

Source: EPPO, 2015.

ENERGY EFFICIENCY POLICY AND INSTITUTIONS

Thailand has an energy saving mentality in its culture and encourages energy conservation in all sectors -- household, industrial, services & commerce and transport -- through campaigns aiming to build an energy-saving conscience. The economy also promotes efficient use of energy by providing incentives to attract the private sector to opt for energy-saving appliances. Incentives have also been set to reduce electricity use during the peak period. The government launched four major energy saving initiatives to stimulate decision-making of entrepreneurs to implement energy efficiency improvements. For example, the Revolving Fund (in progress but only for EE Projects), the ESCO venture capital fund, tax incentives for energy saving and DSM Bidding. The government also conducts research, develops and sets standards for electrical appliances and energy conservation buildings, and encourages the development of mass public transport and railway systems to promote efficient energy use. All of which reduces the economy's investment in energy procurement.

ENERGY EFFICIENCY POLICY

POLICY DIRECTIVE

The present government's, under General Prayut Chan-o-cha's administration, energy efficiency policy that 'encourag[es] energy conservation and efficiency in [the] household, industrial, service and transportation sectors through campaigns fostering energy-saving discipline and conscience and promoting effective energy use; providing incentives to induce private sector investment in opting for energy-saving appliances; setting incentive measures for the household sector to reduce electricity consumption during the peak period; supporting research and development and standard setting for electrical appliances and energy-saving buildings; and supporting the development of mass public transportation and railway system to improve energy efficiency which will help defer the economy's investment in energy procurement.'

STRATEGY/TARGET/IMPLEMENTATION METHODOLOGY

In pursuance of the mentioned policy directive, the Ministry of Energy has developed an energy conservation and efficiency strategy together with targets and implementation methodology as follows:

1. Economy-wide energy development and energy conservation.
   - To increase the energy conservation target stipulated in the Energy Conservation Program, focusing on increasing energy-saving achievement in the industrial and transport sectors.
2. Organise campaigns to create energy-saving conscience and provide knowledge about energy conservation, for example, to:
   - Forge ahead with implementing the '11 Energy-Saving Measures for the People' to rapidly attain practical achievement by placing emphasis on pilot provinces at three scales (SML), and by pushing forwards energy-saving measures emphasising a participation process, mainly through the 'Community Energy Volunteers' mechanism, prior to expansion to other provinces in 2011.
   - Enhance Local Administration Organisations (LAOs) as focal agencies in creating and disseminating 'energy-saving culture' via such target groups as children and juveniles, housewives and senior citizens under the 'Community Energy Volunteers' mechanism.
   - Assign the Energy Mobile Units, via the Provincial Energy Offices, to carry out their field work in energy conservation awareness economy-wide.
3. Devise incentives and provide privileges to induce investment in energy saving.
   - To set a target to reduce 'Energy Intensity,' or energy consumption per production unit, in the industrial and commercial sectors, for example:
     - Joint ventures via the use of ESCO Fund;
     - Subsidy in advance technologies.
     - Partly subsidy in high efficiency technology in factories and buildings.
4. R&D on energy-saving systems and technologies.
   - To have in place an Integrated Resources Planning with regard to energy conservation R&D.
   - Gather information about energy-saving innovations in each locality and encourage further development.
5. Set standards, rules and regulations for energy-saving equipment, materials as well as energy management.
   - To announce the Minimum Energy Performance Standards (MEPS) of 18 appliances.
   - Expedite the issuance of Ministerial Orders, particularly on the Building Energy Code and ISO - Energy.
6. Promote the creation of prototype networking, e.g. SMEs with distinguishing features or with interest in energy-saving.
   - To make 'Thailand Energy Awards' recognised by general target groups.
     - *Intensify the implementation via the 'Thailand Energy Awards' project.*

THE ENERGY CONSERVATION PROMOTION ACT & ENERGY CONSERVATION PROMOTION FUND

The Energy Conservation Promotion Act, B.E. 2535 (1992) came into effect in 3 April 1992, with the objective of promoting energy conservation 'discipline' and energy conservation investment in factories and buildings. Under this Act, the Energy Conservation Promotion Fund (ENCON Fund) has been established to provide financial support to government agencies, state enterprises, non-government organisations, individuals, and businesses that wish to implement measures to increase efficiency in energy utilisation. At the same time, a punishment clause is stipulated in the Act for owners of any designated factory or building who fails to comply with the standards, criteria and procedures as provided by related ministerial regulations issued under the Act. The role of the public sector is to establish and utilise government mechanisms to encourage and promote energy conservation implementation by consumers, including development and utilisation of renewable energy which is environmentally friendly.

The Ministry of Energy has established ESCO Fund to promote private investments in RE/EE projects, with initial capitals from the ENCON Fund. In the early stage of energy efficiency promotion, Ministry of Energy established, with the support from ENCON Fund, EE Revolving Fund with several phases of implementations. The structure of ESCO Fund is shown in the Figure 1.5 below:

Figure 1.5 - Schematic Diagram of the ESCO Fund under the Energy Conservation Promotion Fund

ENERGY CONSERVATION PROGRAM

Financial assistance from the ENCON Fund to materialise the above-mentioned objectives is monitored under the framework of the Energy Conservation Program. The first three phases of the ENCON Program covered the periods 1995-1999, 2000-2004 and 2005-2011 respectively. Presently, the implementation is under Phase 4 (2012-2016). Under the 'rolling plan,' the programs/projects under the Energy Conservation Program and the expenditure estimation will be reviewed and adjusted each year because changes in influential factors may occur, for example, new policies/strategies determined by the government, economic and social conditions and the implementation outcome.

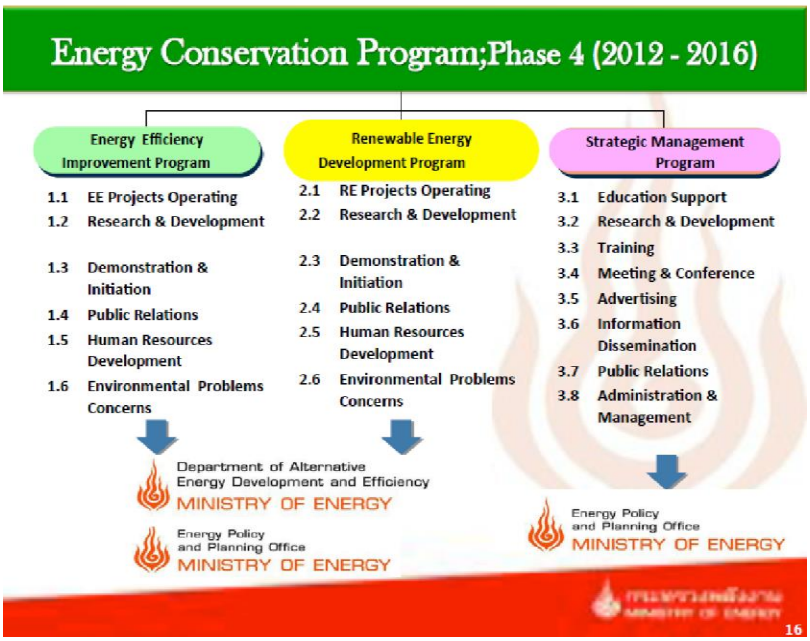
ENERGY CONSERVATION PROGRAM, PHASE 4 (2012-2016)

The Energy Conservation Program, Phase 4 (2012-2016) aims to increase energy efficiency by reducing commercial energy use in the year 2016 from 80 331 ktoe to 72 511 ktoe, i.e. to reduce non-productive energy use by 11% or 7 820 ktoe. Concurrently, alternative/renewable energy development will be encouraged, with a target to increase its share to 16% of the total final energy consumption, being able to replace about 10 961 ktoe of commercial energy demand. Please note that, this Program is currently under revised by the Fund.

The Energy Conservation Program, Phase 4, comprises the following three main sub-programs:

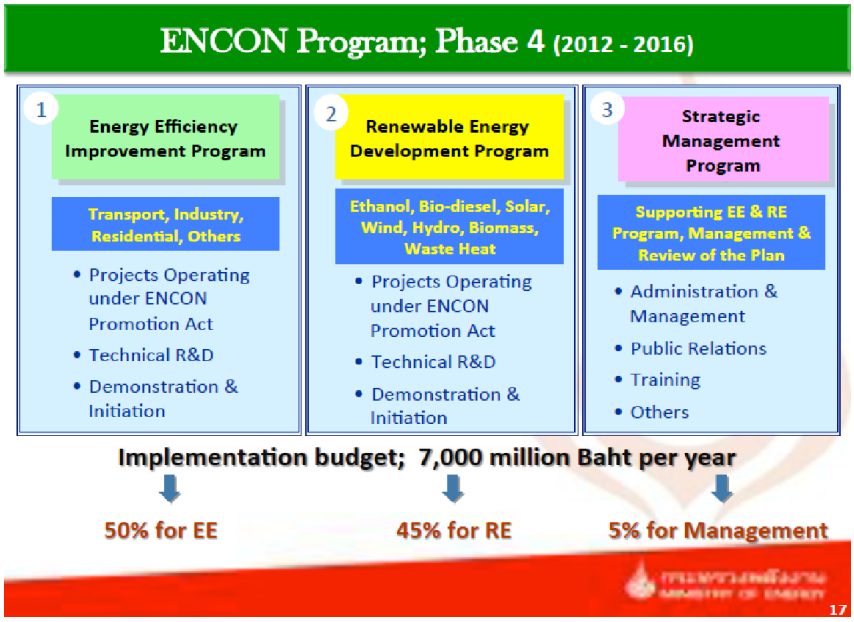
1. Energy Efficiency Improvement Program;
2. Renewable Energy Development Program; and
3. Strategic Management Program.

Figure 1.6: ENCON Program, Phase 4, 2012-16



Source: EPPO, 2014.

Figure 1.7: ENCON Program, Phase 4, 2012-16



Source: EPPO, 2014.

1. Energy Efficiency Improvement Program

The program involves R&D and support to bring about the efficient use of energy in the transport, industrial, residential and commercial, and others sectors. The target is to increase energy efficiency and hence reduce

commercial energy consumption. The program implementation is expected to support Thailand 20-year Energy Efficiency Development Plan (2010 – 2030). The implementation will include six areas, i.e.:

- Energy efficiency projects operating;
- Research and development;
- Demonstration and initiation;
- Public relation;
- Human Resources Development; and
- Environmental problems concerns.

2. Renewable Energy Development Program

The objective is to increase the use of renewable energy and other alternative energy. It is expected that in the year 2021 the share of renewable/alternative energy utilisation will increase to 25% of the final energy demand, accounting for the replacement of commercial energy use of about 24 638 ktoe. The implementation will focus on six areas, namely:

- Renewable energy projects operating;
- Research and development;
- Demonstration and initiation;
- Public relations;
- Human resources development; and
- Environmental problems concerns.

3. Strategic Management Program

The implementation will include:

- Education support;
- Research and development;
- Training;
- Meeting and conference;
- Advertising;
- Information dissemination;
- Public relations; and
- Administration and management.

SECTORAL ENERGY EFFICIENCY IMPROVEMENT GOALS

The target of the Energy Efficiency Improvement Program at the end of ENCON Program Phase 4 (under revision), is to reduce energy demand of the economy by 5,041 % in 2015 (refer to Thailand 20-year Energy Efficiency Development Plan (2011-2030)), focusing on three energy-intensive sectors with an individual goal for each sector. The sectors and goals are as in Table 1.10.

Table 1.10: Annual Targets of Final Energy Saving

Economic Sector	Energy Type	Annual Target			
		2012	2013	2014	2015
Industry	Electricity (GWh)	1 777	2 670	3 597	4 612
	Heat (ktoe)	580	872	1 175	1 506
	Total (ktoe)	**731**	**1 100**	**1 482**	**1 899**
Large Commercial Building	Electricity (GWh)	1 424	2 140	2 884	3 697
	Heat (ktoe)	21	32	43	55
	Total (ktoe)	**142**	**214**	**289**	**370**
Small Commercial Building & Residential	Electricity (GWh)	1 237	1 859	2 505	3 212
	Heat (ktoe)	102	153	206	264
	Total (ktoe)	**207**	**311**	**419**	**538**
Transportation	Electricity (GWh)	-	-	-	-
	Heat (ktoe)	861	1 293	1 743	2 235
	Total (ktoe)	**861**	**1 293**	**1 743**	**2 235**
Grand Total (ktoe)		**1 942**	**2 913**	**3 932**	**5 041**

Source: Thailand 20-year Energy Efficiency Development Plan (2011-2030), Ministry of Energy, 2011.

The measures for energy efficiency improvement in the industrial, transport and household/business/government sectors may vary from year to year depending on the proposal submitted to and approvals received from the fund. In general, these measures can be summarised as follows:

Industrial sector

Various measures have been introduced, e.g. revolving funds (soft loans), tax incentives, and investment promotion, via the Board of Investment (BOI), to encourage energy efficiency improvement in the industrial sector. The details of the measures are:

ESCO Fund (monitored by DEDE).

The ESCO Fund was established as a source of venture capital for ESCOs to jointly invest with private operators in energy efficiency and renewable energy projects, through various channels – venture capital, equity investment, equipment leasing, carbon market, technical assistance and credit guarantee facility.

The Fund was launched in October 2008, with an initial capital of THB 500 million (about USD 14.7 million) targeted for SMEs; and as a pilot venture capital initiative to address the issue of lack of equity capital for small developers. The Fund provides equity capital up to 50% of total equity; and in the case of very small projects, provides its support through equipment leasing. The Fund has outsourced the identification and appraisal of projects to two entities (THB 250 million each for Energy Conservation Foundation of Thailand (ECFT) and Energy for Environment Foundation (E for E).

Tax incentives (monitored by DEDE)

- Cost-based: Allow 1.25 times of actual investment capital for tax calculation, which will lessen the tax burden by phasing the tax deduction in over a period of 5 years;
- Performance-based: Return 30% of saving value to the project owners through income tax reduction, but not exceeding THB 2 million; and
- BOI: Waive income tax for 8 years and also waive the import tax for ESCO or renewable energy projects.

Other Supportive Measures for SMEs (monitored by various organisations)

Provision of grants for factories for the replacement of existing production processes and technologies by advance high-efficiency ones. Examples are energy efficiency improvement of pulp and paper, plastic industry, as well as the high energy efficiency machines for SMEs such as tobacco curing process, ceramic shuttle kilns, and Chinese sausage dryers, etc.

Transport sector

According to the 20-year Energy Efficiency Development Plan (2011-2030) energy conservation in the transport sector can be divided into three major approaches, i.e. 1) improvement of energy efficiency of motor vehicles, 2) energy efficiency improvement by shifting the modes of travel or goods transport, and 3) energy efficiency improvement by travel demand management (TDM). Energy saving potential of each approach can be analysed as follows.

Table 1.11: Share of Energy Saving by Economic Sector in 2030

Economic Sector	Technical Potential			Specified Target (ktoe)	Share (%)
	Heat (ktoe)	Electricity (GWh)	Total (ktoe)		
Transport	16 250	-	16 250	13 400	44.7
Industry	10 950	33 500	13 790	11300	37.7
Commercial Building & Residential					
Large Commercial Building	410	27 420	2 740	2 300	7.6
Small Commercial Building & Residential	1 690	23 220	3 670	3 000	10.0
Total	**29300**	**84140**	**36450**	**30000**	**100.0**

Source: Thailand 20-year Energy Efficiency Development Plan (2011-2030), Ministry of Energy, 2011.

Table 1.12: Energy Conservation Potential in Transport Sector

Approach to Energy Efficiency Improvement	Energy Conservation Potential in 2030 (ktoe)	Share (%)
Use of higher energy-efficient vehicles and efficient use of vehicles	12 470	77
Travel and goods transport mode shift	2 770	17
Application of Travel Demand Management (TDM)	1 010	6
Total	**16 250**	**100**

Source: Thailand 20-year Energy Efficiency Development Plan (2011-2030), Ministry of Energy, 2011.

Table 1.13 - Energy Conservation Potential as a Result of Goods Transport Modal Shift

Transport Mode	Energy per Transport Unit (MJ/ton-km)	Share of Transport Mode Current	Share of Transport Mode In 2030 (Base Case)	Share of Transport Mode In 2030 (Target)	Energy Saving Potential (ktoe)
Land	2.5	87.5%	85.0%	73.2%	2 422
Rail	0.75	2.6%	5.2%	17.0%	
Waterway	0.25	9.8%	9.8%	9.8%	

Source: Thailand 20-year Energy Efficiency Development Plan (2011-2030), Ministry of Energy, 2011.

Table 1.14: Energy Conservation Potential as a Result of Travel Demand Management (TDM)

Travel Mode	Energy per Travel Unit (MJ/man-km)	Share of Travel Mode Current	Share of Travel Mode In 2030 (Base Case)	Share of Travel Mode In 2030 (Target)	Energy Saving Potential (ktoe)
Private car	2.2	39.6%	48.0%	35.3%	1 010
Private motorcycle	0.9	15.0%	12.8%	9.7%	
Public transport systems - Land	0.8	41.6%	32.9%	28.2%	
Public transport systems - Rail	0.25	3.7%	6.2%	26.8%	

Source: Thailand 20-year Energy Efficiency Development Plan (2011-2030), Ministry of Energy, 2011.

Demand Side Management (Household/Business/Government Sectors)

Promoting high-efficiency equipment:

- Minimum Energy Performance Standards (MEPS): air-conditioners, refrigerators, self-ballasted lamps, single capped fluorescent lamps, double-capped fluorescent lamps, 3-phase motors, LPG stoves, insulator (fibre glass), diesel engines, rice cookers, microwave ovens, electric ovens, electric kettles, electric pumps, motorcycles, electric irons, magnetic ballasts and electronic ballasts.
- Energy efficiency labelling (Energy label NO. 5) by EGAT: refrigerators, air-conditioners, self-ballasted lamps, electromagnetic ballasts, electric fans, rice cookers, luminaires (T8), oscillator electric fans, fluorescent T5 lamps, standby power (TV), standby power (computer monitor), electric pots, luminaires (T5), water heater, irons, ventilation fans, washing machines, LED lamps, microwave ovens, induction cookers, television (on mode) and electric kettles.
- Energy efficiency labelling by DEDE: low pressure LPG stoves, high pressure LPG stoves, fiberglass insulator, window glass, VSD, diesel engines, gasoline engines and 3-phase induction motors.
- Promotion of high-efficiency charcoal cooking stoves;
- Establishment of building codes & building material standards; and
- Public awareness campaigns such as TV spots, booklets, youth activities, etc.

TRANSPORT INFRASTRUCTURE

Thailand's infrastructure, particularly its transport network, is set to undergo a long-awaited transformation over the next eight years, following the approval of a USD 75 billion (THB 2.4 trillion) master plan by the economy's ruling military regime. The National Council for Peace and Order (NCPO) agreed in principle to implement a set of projects known as the 'Strategies on Thailand's Infrastructure Development in Transportation (2014 - 2022)', as proposed by the Ministry of Transport. Concerned public agencies are to lay out their long-term plans based on the Strategies. The NCPO also approved the need to initiate immediately certain critical phases of the Strategies in 2014 and 2015. For instance, transportation connectivity between commercial/primary cities and Bangkok (plus environs), and upgrading railway transportation through the construction of dual-gauge rail infrastructure for transport logistics purposes and for capacity enhancement of local trains.

The primary goal of the government in this regard is to restructure the Thai transportation system by accelerating the expansion and improvement of Thai railway network to correct the economy's lopsided dependence on road transportation. Thus, 78% of the THB 2.4 trillion budgeted for investment in the transport infrastructure of Thailand over the next seven years would be devoted to railway development. Among other aims, the government seeks to reduce Thailand's logistics costs from 15% to 13% of GDP, create 1.6 million jobs; and raise annual GDP growth by 1%. The real benefit to be derived is the enhanced competitiveness of the economy after Thailand's transport and logistics have been restructured.

ROADS

Thailand's transport infrastructure is road-oriented. There are 462 133 km of roads in the economy but less than 4 000 km of railroad track. Water transportation also is under-utilised as waterways comprise only 5 000 km. Thailand ranks 48th overall for infrastructure under the basic requirements rankings (WEF Global Competitive Report 2014-2015). Comparing the different modes of transport, freight transport by road is the most expensive, estimated at THB 2.12 per ton per km (t/km), followed by rail at THB 0.95/t/ km and water transport 0.65/t/km. The issue is that 88% of Thailand's freight is transported by road and only 1.4% by rail which causes from uncomplete *networking system* on the surface transport. As a result, the transport sector consumes as much as 31% of Thailand's energy use (industrial production by comparison accounts for 41%). Typically, the transport sector accounts for about 15% of total energy use in advanced economies and countries.

Thailand's road system is already well-developed and gets the continuously from the annual budget to build and maintain roads is already sufficient. Therefore, investment in roads as part of the THB 2.4 trillion infrastructure plan is more modest. In particular, it is meant to complement the Asia Development Bank's Greater Mekong Sub-region project (started in 1990) aimed at linking by road countries such as China, Myanmar, Thailand, Cambodia, Laos and Vietnam.

On the Thailand side, the proposed road projects include: the Southern Economic Corridor, which aims to connect Bangkok Metropolitan area (BMA) to major cities in Cambodia and Ho Chi Minh City in Vietnam; the East-West Economic Corridor, which links Myanmar, North/Northeast Thailand, Laos, Da Nang port in Vietnam; and the North-South Economic Corridor, which links northern Thailand through Laos and Myanmar to Kunming which locates in southern China. All in all, there are 27 projects involving the three countries, which share their borders with Thailand.

There are eleven projects involving Laos, three projects involving Cambodia, five projects involving Malaysia, and eight projects involving Myanmar.

Overall, the rationale of the government's transport investment program is to engineer a modal shift from road to rail. Furthermore, the new infrastructure projects are likely to tap the fiscal budget, borrowing and public-private partnerships (PPPs). In other words, the construction of four-lane roads, ports, motorways and the sky-train extension should be paid for by the fiscal budget, while mass-transit routes and some dual track railways could rely on domestic (Public-Private Partnership: PPP investment) and foreign loans.

Apart from the railway infrastructure, State funds will be tapped for airport and seaport improvements. For instance, Thailand's newest scheme to boost air transport capacity calls for raising efficiency standards at Suvarnabhumi International Airport, promoting the economy's regional airports, advancing domestic aviation industries, and improving the use of Thai air space. The government also intends to improve water infrastructure to prevent devastating floods like the ones that inundated Bangkok and surrounding areas in 2011.

Setting dual track rail lines, building four-lane highways to nine key border points, and even adding more truck terminals would do more to boost trade with neighbouring economies and countries, and improve transport logistics. Planned construction is likely to boost Thailand's GDP and - as a knock-on effect - lead to significant private investment. Industrial and real estate firms will step up their own investments in private projects as a result of the Thai government's plans. Similarly, it is expected there would be more business opportunities in the service sector, such as hotels and logistics.

RAILWAYS

By 2020, the plan is to spend USD 67 billion, equivalent to approximately 20% of current GDP. Of this, 83% would be invested in rail transport, 15% for road transport, and other 2% on marine transport and the construction of customs houses. Total estimated cost is approximately THB 2.2 trillion approximately USD 67 billion by 2020.

Thailand has an excellent rail system with the total length of 4 429kms that constitute a vital link in the transport network. At the beginning, the office of the Royal State Railways of Thailand (SRT) was first established under the control of the Ministry of Public Works in October 1890.

The State Railway of Thailand (SRT) has transferred from the Ministry of Public Works to be under the Ministry of Transport in 1912. It is responsible for building, operating, and maintaining Thailand's railway tracks.

According to the master plan for rail and high-speed train development-proposed by the Office of Transport and Traffic Policy and Planning, 3 145 km of rail will be laid by 2025.

Phase I (2010-2014) covers 873 km of tracks for 120 kph. This phase of construction is scheduled to be completed by the end of 2017. In 2012, the first phase of the Chachoengsao to Kaeng Khoi line (Chachoengsao – Siracha - Laem Chabang) already started operating while Phase II of the route was already approved by the Cabinet to support the Eastern Seaboard area with a total distance of 184 km.

Table 1.15: Dual track railways initiative (Phase I)

From	To	Distance (km)	Cost (USD million)
Chachoengsao	**Kaeng Khoi**	106	360
Lop Buri	**Nakhon Sawan**	118	420
Map Kabao	**ThanonChira Junction**	132	370
ThanonChira Junction	**KhonKaen**	185	410
Nakhon Pathom	**Hua Hin**	165	530
Prachuap Khiri Khan	**Chumphon**	167	500
Total		**873**	**2 590**

Source: Office of Transport and Traffic Policy and Planning (OTP), 2015.

Phase II (2015-2020) the total railway of 1 025 km will be built on longer routes for high-speed trains travelling at 120-250 kilometres per hour.

Phase III (2020-2025) the total railway length of 1 247 km. of tracks will be added.

It is expected that when the third phases are completed, the speed of trains will be raised up from 60-80 kilometres per hour to 100-120 kilometres per hour.

Table 1.16: Thailand's rail statistics

	2010	2011	2012 (planned)
No. of locomotives ready for operation	272	265	263
No. of passenger coaches	1 238	1 238	1 260
No. of freight wagons	6 069	6 069	5 637
Total passengers (m)	45	44	41
Passenger-km (m)	8 083	7 504	7 566
Freight (x1,000 tonnes)	11 399	10 864	11 849
Freight-km (m tonne/km)	2 582	2 455	2 586
Total domestic freight volume (x1000 tonnes)	11 399	10 864	11 849
Total domestic freight movement (m tonne/km)	2 582	2 455	2 586
Total import cargo (x1,000 tonnes)	14	13	6
Total export cargo (x1,000 tonnes)	158	133	95

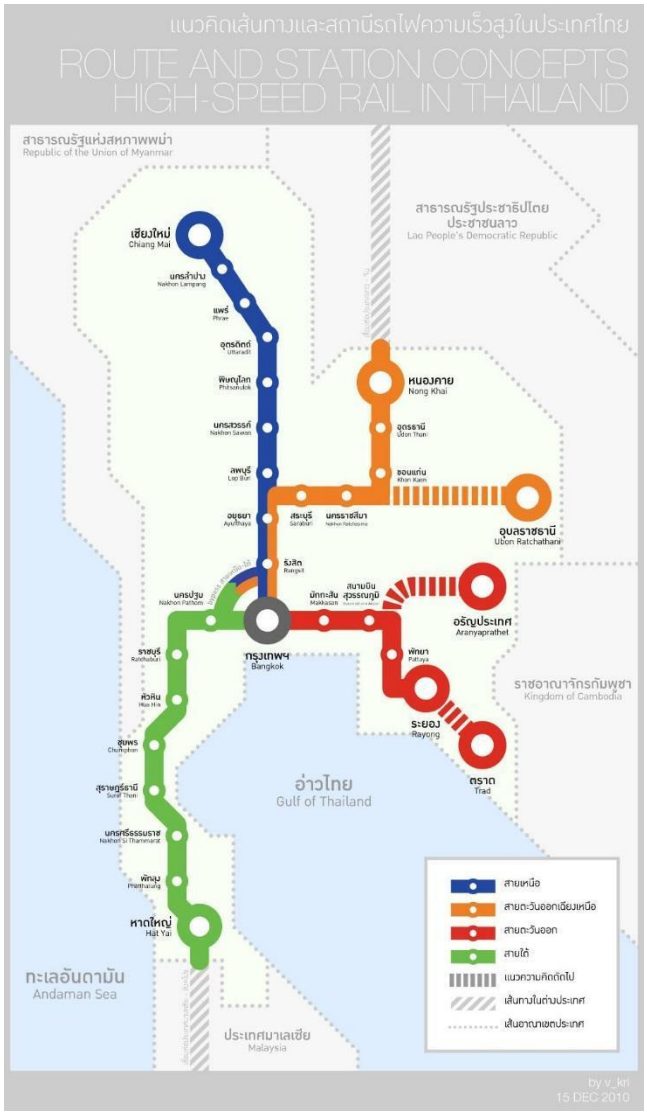
Source: ASEAN-Japan Transport Partnership, 2012.

Thai-China High-Speed-Rail Project

SRT is also preparing for high-speed trains to link tourism destinations and reduce travel time in satellite cities by 2020. Thai and China authorities are planning to construct a high speed line stretching from the north-eastern province of NongKhai to Bangkok and southern Thailand within seven years.

This high-speed train project consists of four main lines: 1) Bangkok - Chiang Mai 745 km; 2) Bangkok - NongKhai 615 km; 3) Bangkok – Rayong 221 km; and 4) Bangkok - Padang Besar 982 km.

Figure 1.8 - Four main lines high-speed train project

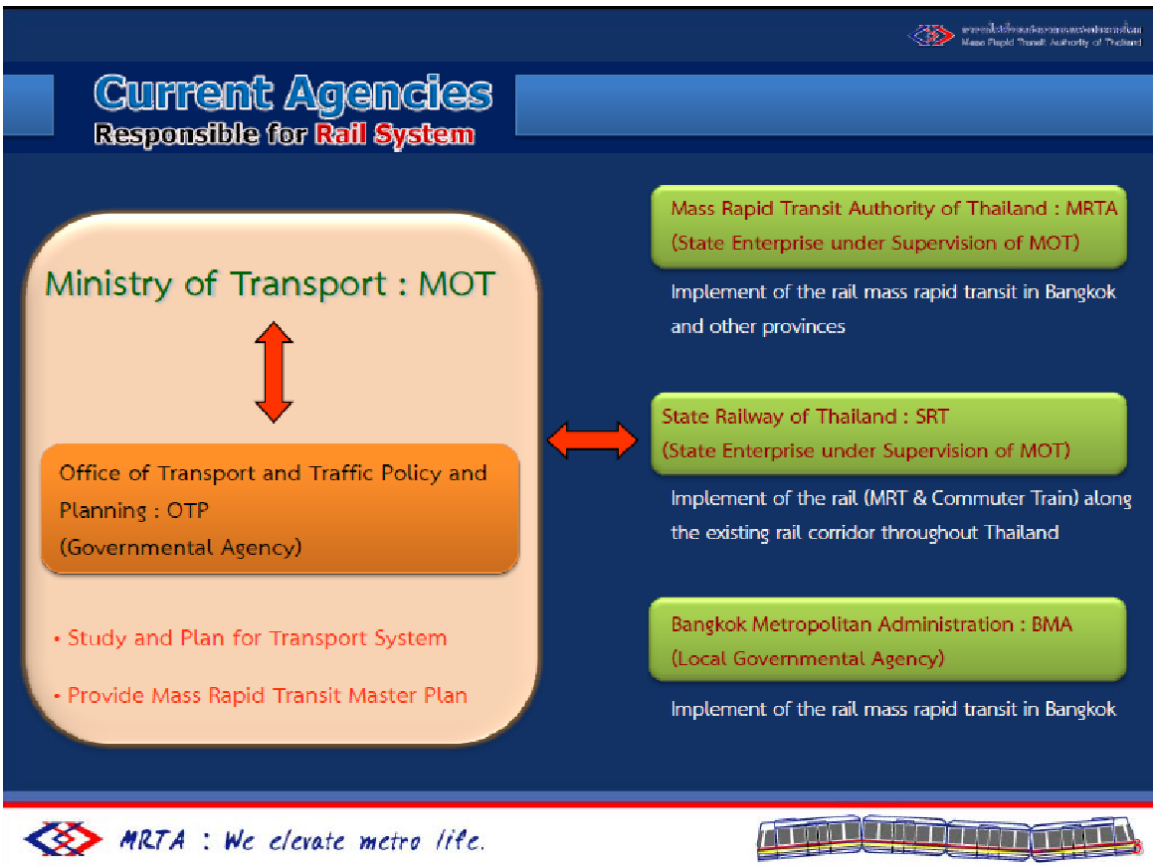


Source: OTP, 2015.

In early 2012, the Cabinet agreed with the committee's proposals to construct 774 km of rail for high-speed trains (Bangkok - Chiang Mai) for an investment of THB 380 billion, including other infrastructure development in the north as well. In 2014, the first project is now under conducting the EIA study and design process.

The project is divided into 2 phases: Phase I (Bangkok - Phitsanulok) has expected to be completed by the end of 2018, and Phase II (Phitsanulok - Chiang Mai), has scheduled to be completed by 2020.

Figure 1.9 - Agencies responsible for the rail system



Source: Mass Rapid Transit Authority of Thailand, 2015.

The Bangkok Metropolitan Region (BMR) covers an area of 7 785 km^2 with a population of 17.5 million. The BMR has a significant impact on the GDP of the economy with the value of 68% of the economy's GDP.

The most popular mode of transport in the BMR is private car as shown in Table 1.17.

Table 1.17: Mode of transport in Bangkok Metropolitan Region

Mode	No. of Trips (million trips/day)	Percentage of Trips (%)
Private Car	12.5	57
Bus	8.0	36
Bus + MRT + ARL	1.0	5
Others	0.5	2
Total	22.0	100

Source: OTP, 2015.

There is Rapid Transportation Master Plan for the BMR and peripheral areas as shown in the Figure 1.10. The main features of the plan (underground and elevated MRT) can be summarised as the following;

Eight Primary Lines

- Dark Red Line (Thammasat – Mahachai)
- Light Red Line (Salaya – Huamark)
- Airport Rail Link (Don Mueang – Bangsue – Phayathai – Suvarnabhumi)
- Dark Green Line (Lumlukka – Mochit – Bearing – SamutPrakarn)
- Light Green Line (Yotse – Bangwa)
- Blue Line (Bangsue – Hualamphong – Thaphra – Phutthamonthon 4)
- Purple Line (Bangyai – Ratburana)
- Orange Line (Talingchan – Minburi)

Two Feeder Lines

- Pink Line (Khaerai – Minburi)
- Yellow Line (Ladphrao – Samrong)

Figure 1.10 - Bangkok Mass Transit Master Plan (BMT)

Source: Mass Rapid Transit Authority of Thailand, 2015.

Figure 1.11 - Implementation Plan for Mass Rapid Transit

	Project	FS Design	Cabinet Approval	Tender	Construction	Operate
2	North Purple Line (Bangyai – Bangsue)	√	√	√	√★	Aug 2016
3	West Blue Line (Hualamphong-Bangkae) (Bangsue-Thaphra)	√	√	√	√★	Apr 2019
4	South Green Line (Bearing – Samutprakarn)	√	√	√	√★	Feb 2020
5	North Green Line (Mochit – Saphanmai – Khukot)	√	√	Dec 2013	★Jun 2015	Feb 2020
6	East Orange Line (Thailand Cultural Centre – Minburi)	√	★Sep 2015	Feb 2016	Jan 2017	Dec 2020
7	Pink Line (Khaerai – Minburi)	√	★Nov 2015	Apr 2016	Mar 2017	Jun 2020
8	Yellow Line (Ladprao – Samrong)	√	★Nov 2015	Apr 2016	Mar 2017	Jun 2020
9	South Purple Line (Taopoon – Ratburana)	√	★Sep 2015	Feb 2016	Jan 2017	Dec 2020
10	West Orange Line (Talingchan -Thailand Cultural center)	★	Dec 2015	May 2016	Apr 2017	Apr 2021
11	West Blue Line 2 (Bangkae - Phutthamonthon Sai 4)	★	Nov 2015	Apr 2016	Mar 2017	Mar 2021
12	South Green Line 2 (Samut Prakan (Bang Ping) – Bang Pu)	√	Aug 2016	Jan 2018	Dec 2018	Dec 2022
13	North Green Line 2 (Khukot – Lamlukka)	√	Aug 2016	Jan 2018	Dec 2018	Dec 2022

Source: Mass Rapid Transit Authority of Thailand, 2015.

AIRPORT LINK

The Suvarnabhumi Airport Rail Link or SARL, is a rapid transit line in Bangkok. The line functions as an airport rail link from Suvarnabhumi Airport, via Makkasan city air terminal, to Phaya Thai station in central Bangkok. Most of the line is on a viaduct over the main eastern railway. It is owned by State Railway of Thailand (SRT) and operated by SRT subsidiary SRT Electrified Train (SRTET). Services consist of the Express Line, a 15-minute non-stop service between the Makkasan city air terminal and the airport, and the City Line, a commuter rail service with eight stations.

HIGH EFFICIENT VEHICLE PROMOTIONS

MINIMUM ENERGY PERFORMANCE STANDARD (MEPS)

The Department of Alternative Energy Development and Efficiency (DEDE) within the Ministry of Energy has set up a draft standard for Minimum Energy Performance Standard (MEPS) and High Energy Performance Standard (HEPS) for personal passenger cars and pickups with loading capacity less than 1 tonne since 2013. The current status of these draft standards are in consideration of Energy Efficiency Working Committee. After passing the consideration, these standards will be submitted to Thai Industrial Standards Institute (TISI), Ministry of Industry for enforcement.

The energy performance standards for cars determines the fuel consumption rate by dividing into gasoline and diesel engines and expresses the standard in term of kilometres per litre.

DISCLOSURE OF AUTOMOBILE INFORMATION

The Ministry of Industry and the Ministry of Finance have worked together to develop the 'ECO Sticker' system, which disclose automobile information to consumers. The information attached on the ECO Sticker can be divided into four main parts of 1) Manufacturer/importer detail and website; 2) Car specification such as model, type, chassis engine, transmission gear, tire size, number of seats, weight, usable fuel; 3) List of installations from factory, e.g. energy saving system, safety system, and others; and 4) Testing results and testing standard of fuel consumption (unit of litre per 100 kilometres) under urban and extra-urban conditions. The ECO Sticker also shows the fuel consumption at the combined testing condition and a QR Code for more details on the car's energy efficiency performance on a website. Since 1 October 2015, every manufacturer of new automobiles will put ECO Sticker on new automobiles' windshields or side windows, prior to delivering the car to any dealer.

Figure 1.12 - Eco Sticker for energy and environment concerns

Source: Office of Industrial Economics, 2015.

NEW EXCISE TAX

From 1 January 2016, Thailand will have a new excise tax for cars, which is determined by the engine size, along with CO_2 emission. Whereby the larger the engine and the higher the emissions, the higher the excise taxes incurred. The new excise tax and current tax schemes are shown in the following figure.

Table 1.18: New excise tax scheme for cars compares to current tax scheme

Categories Of Vehicle	Tax Structure in Present				Tax Structure in Future			
	Engine Capacity (Horse Power)	Tax Rate (%)			CO_2	Tax Rate (%)		
		E10	E20	E85		E10/E20	E85/NGV	Hybrid
Passenger Vehicles								
- Passenger Vehicles and, Vans less than 10 seats	≤2,000 CC	30	25	22*	≤100 g/km	} 30*	} 25	10
	2,001-2,500 CC	35	30	27	101-150g/km			20
	2,501-3,000 CC	40	35	32	151-200 g/km	35	30	25
					>200 g/km	40	35	30
	>3,000 CC (เกิน 220 HP)	50	50	50	>3,000 CC	50	50	50
PPV / DC /Space Cab/Pick Up	≤3,250 CC	20/12/ - /3,18			≤200 g/km	25*/12/5/3,18		
					>200 g/km	30/15/7/5,18		
	>3,250 CC	50			>3,250 CC	50		
Eco Car (Benzine/Diesel) / E85	1,300/1,400 CC	17			≤100 g/km	14*/12		
					101-120 g/km	17/17		
Electric Vehicle /Fuel Cell/ Hybrid	≤3,000 CC	10				10		
		10				**		
	>3,000 CC	50			>3,000 CC	50		
NGV-OEM	≤3,000 CC	20				**		
	>3,000 CC	50			>3,000 CC	50		

Remarks * : Assign safety standard for Active Safety (ABS+ESC) for Passenger Vehicles and, Vans less than 10 seats must obtain CO_2 ≤150 g/km / PPV must obtain CO_2 ≤200 g/km / Eco Car must obtain CO_2 ≤100 g/km

4

** Depend on CO_2 emission

* less than 1,780 CC but not over 2,000 CC

Source: Excise Department, 2015.

PART II: FOLLOW-UP PEER REVIEW TEAM REPORT

This part of the report presents the Follow-up PREE Review Team's conclusions and recommendation about energy efficiency in the transport sector in Thailand.

1. OVERARCHING FINDINGS

1.1 ACHIVEMENTS AND CHALLENGES

The Thai Government has made considerable progress with its energy efficiency policies and measures. Thailand has revised its energy intensity (EI) reduction target under the new Energy Efficiency Plan (EEP) in 2015, to reducing 30% of EI by 2036 compared to 2010 levels.

Achievement 1. *Progress with the Energy Efficiency Plan and its energy saving targets in sectoral and measure levels.*

On 13 August 2015, the National Energy Policy Council (NEPC) has approved the Thailand`s Energy Efficiency Plan (EEP2015) which has updated the EI reduction target of 51700 ktoe by 2036. Transport sector is expected to contribute in energy saving 30 213, equal to 58% of total reduction. The target is further allocated into three groups of measures as follow:

- Group 1: Promoting high efficient standard vehicles and EE labelling (e.g., CO_2 taxation and car labelling), with the expected reduction of 14 200 ktoe.
- Group 2: Developing infrastructure (e.g., modal shift, double track railway, electric vehicles), with the expected reduction of 11 324 ktoe.
- Group 3: Increasing energy efficiency in trucks and buses by using management system and financial incentives (e.g., logistics and transport management, eco-driving, financial incentives), with the expected reduction of 5 139 ktoe.

Achievement 2. *Involvement of Ministry of Transport and other relevant ministries in energy efficiency policy implementation.*

The Ministry of Transport and other departments had not participated in the original PREE in 2010. After the original PREE was released, more cooperation occurred between relevant Ministries, especially Ministry of Energy, Ministry of Transport to enable energy efficiency improvements in transport sector. The Follow-up PREE trip to Bangkok demonstrated that many Ministries and other relevant organisations, not only government agencies but also private and public agencies, are now involved in energy efficiency matters in Thailand.

Achievement 3. *Progress on reducing motor vehicle dependency in the greater Bangkok area.*

The mass rapid transit (MRT) system's developments in Bangkok provide an alternative option for travellers. However, feeder systems to MRT, for example, land transport (bus) and water transport (Chaophraya River and related canal express boat) system should improve their reliabilities, safety, and comfort to attract more private car users.

Achievement 4. *Reductions of unnecessary fuel subsidies.*

Thailand is implementing a fuel prices structural reform policy, which will be compliant with costs and create a reasonable tax between different oil types and consumers, in order to enhance the economy's energy efficiency and conservation awareness.

Achievement 5. *Voluntary target to reduce GHG emissions in the transport sector.*

Thailand has voluntarily submitted its Nationally Appropriate Mitigation Actions (NAMAs) to lower greenhouse gas emissions (GHGs) below business as usual by 2020. Thailand's NAMA proposes action in the energy and transport sectors to reduce emissions between 7% and 20% below the projection for 2020. The named measures include renewable and alternative energy sources, energy efficiency improvements, bio-fuels in transportation, and a sustainable transit system. Following submission of its NAMA, Thailand will design specific actions aimed at local, regional, and sectorial greenhouse gas mitigation as noted in its NAMA, partly pending on global support for their efficient preparations and implementations.

1.2 RECOMMENDATIONS

Recommendation 1. *The Thai Government should develop a Memorandum of Understanding between transport agencies and organisations to share data to improve evidence-based decision-making in the transport sector.*

The Government has already set targets in the sub-sector and measure levels, however, the clear/keen assumptions and methodologies to monitor and evaluate the impact of implementing policies and measures. To track energy efficiency progress, Thailand should develop a Measuring, Reporting and Verification (MRV) system for each policy and measure. To do this, close cooperation among relevant agencies to share data is necessary.

Recommendation 2. *The Ministry of Energy should organise a regular meeting with the Ministry of Transport and other relevant ministries to ensure policy coordination and achieve necessary energy savings in the transport sector.*

Transport is a multidisciplinary issue that needs cooperation between many agencies. To maintain the momentum for collaboration among ministries, the Ministry of Energy should take this opportunity to set a regular Steering Committee which chairs by EPPO Director General to conduct the regular meeting to follow up all related matters in order to share data, report and follow-up on progress on energy efficiency improvements in the transport sector.

Recommendation 3. *The Thai Government should support local governments to implement preventive measures to develop efficient public transport systems in medium and small cities in the regions of Thailand to avoid car dependency like in Bangkok.*

Vehicle ownership in medium and small cities in Thailand is still low. However, it will increase rapidly as people's incomes increase, especially if there are no efficient public transport systems are provided. Therefore, local governments need to develop reliable public transport systems connected with non-motorised modes, such as, bicycles and walking. This needs to occur early before traffic is congested, otherwise, the regional cities will be like Bangkok. The comprehensive sustainable transport master plan for medium and small cities should be developed and implemented effectively.

Recommendation 4. *Reducing fossil fuel subsidies by the Ministry of Energy was a remarkable success and will support the policy on energy efficiency measures through price mechanisms (incentives, taxes, etc.) more workable. The Thai Government should continue to employ those measures, while close up on monitoring and evaluating their policy effects.*

Recommendation 5. *The Thai Government should continue to raise up more public awareness in transport energy efficiency through various continuously events and media.*

Recommendation 6. *Policymakers in the relevant ministries (including the Ministry of Energy and the Ministry of Transport) should continue to listen to the opinions/concerns of policy implementing bodies, the business sector and the public.*

2. TRANSPORT FINANCING AND INVESTMENT

The year 2015 was a difficult time for every economy. The weaker currency against USD, European (i.e. Greece) financial crisis, China's economic slowdown and Yuan devaluation, lower fuel prices and demand for commodities are all impacting the economic condition of all economies and countries and tightening of fiscal space for governments. Despite the positive outlook the World Bank gave to Thailand[1] in 2015 after the slower 0.9% growth in 2014, the GFC caused Thailand to re-think and re-strategise its economic development, including its investment strategy in its transport and infrastructure sectors. The slowdown of exports, the automotive industry' s stagnant growth, as well as the tourism sector's struggle to increase its visitors and revenue due to political instability, domestic safety and security issues, means that the economy has to develop cost efficient policies and programs to maintain its resilience toward recovering from the economic crisis.

The automotive industry however, remains Thailand's important economic driver at around 10% of its GDP and employing more than 500 000 workers. Its strategic importance is also significant because more than 50% of the industry outputs are exported to neighbouring South-East Asian economies – enjoying the ASEAN trade agreement, and other countries as well. Exporting to developed economies and countries such as EU has created a demand for investment in cleaner cars. In 2015, the 2nd Phase Eco Car program attracted 138 billion BHT of Foreign Direct Investment. The downside of this situation are the difficulties in implementing energy efficiency. Therefore policies that restrain private ownership vehicles are necessary. In fact, the Thai government had a policy to support the purchase of people's first car, a similar policy exists in Malaysia. In effect, the 'pull' policies rationalise the use of vehicles and the use of better and cleaner fuels and engines.

The cost for logistics cost is currently 16.8% of the GDP[2], which is relatively good for developing economies. Out of the top middle-income developing economies and countries, Thailand's LPI (logistics performance index) is at the above average. It shows that both physical connectivity and data processing is well established in moving goods in Thailand. The Thai Government plans to continue to reduce it. The need to lower logistics costs is even more important now, since economic vulnerability is real and present in Thai's econospace, and to maintain export competitiveness. Ensuring an economic backbone by promoting the use of rail is an option that the Thai government is trying to pursue.

[1] The World Bank, 2015, http://www.worldbank.org/en/news/press-release/2015/06/03/thailand-economy-expected-to-grow-up-to-3-5-percent-in-2015-world-bank.

[2] GIZ, 2015, http://transportandclimatechange.org/wp-content/uploads/2014/10/GIZ-TCC_Thailand-Stocktaking-Report-September-2014.pdf.

The policies in the energy sector also reflect the government's concerns about ensuring future economic sustainability. Developing a better energy mix and reducing energy use are central to the Thai government's policy in dealing with a growing demand for mobility of goods and services. The statistics of energy demand, especially for fuels and the GDP growth in Thailand has shown an initial sign of decoupling[3]. The government was consistently addressing the plan to reduce energy intensity by 25% between 2010 and 2030[4] through combining demand side management and the availability of transport modes with high energy-efficiency.

The budget commitment in transport sector was increased to 3.3 trillion BHT (2015-2022), from 2.4 trillion BHT (published by NCPO) and 2 trillion BHT of the previous government (Bangkok Post Articles, 2015). The investment will rely heavily on rail projects, focusing on regional rail development (narrow gauge, standard gauge, high speed system) and improvements in urban rail systems. This plan however, as described in the EEDP 2011-2030, is addressing a mode shift from bus to rail, rather than motorcycle/car to public transport.

2.1 ACHIEVEMENTS AND CHALLENGES

Overall, the Thai Government has been on the right track in managing their financial resources and government budget to respond to its policies to reduce energy consumption. The issues in investment and financing are relatively new policy items, which are not discussed in the original PREE. Therefore discussing achievements in this area is based on the understanding that the government designed their investment and financing policies according to the programs stipulated in the original PREE Report.

Achievement 6. *Pricing policy in the energy sector reflects the cost of supply, which will enable both government and consumers to be more aware of the cost of fuels. Transport users, operators and the users of private vehicles are more educated in the selecting the choice of fuel types, vehicles and their means of transport.*

The policy will establish a firm foundation for the government to go one step forward by incorporating the cost of environment damage, including mitigating and adapting to climate change, into the energy price. While the relationship between the pricing policy and the introduction of the ENCON (EERF and ESCO) fund has not been fully established, the message to the public is clear that the government is committed to gradually rationalising the cost of energy, and at the same time promoting domestic innovations (through capital investment, and business leveraging) to reduce energy consumption.

Achievement 7. *Thailand's taxation policy incentive is proven to be effective for both attracting investment, mainly in the energy efficient vehicles project, and changing vehicle users' behaviour.*

[3] It means that energy demand growth pattern does not always correspond with the economic growth. For further reading concerning early discussion on the topic, please refer to Mulder and de Groot, 2004, Decoupling Economic Growth and Energy Use, Tinbergen Institute Discussion Paper, Amsterdam.

[4] Ministry of Energy, 2011, Thailand 20-Year Energy Efficiency Development Plan (2011-2030), http://www.enconfund.go.th/pdf/index/EEDP_Eng.pdf/.

The discussion with both government officials and the private sector players revealed that incentives, instead of enforcement of gradually tightening regulations on environment, are powerful tools to draw interest from private sector to invest in energy efficiency projects. Consumers are also given incentives to purchase 'green' products. The 'green labelling' program is underway and expected to be tested in the car market, which is also an example of how consumers are educated to select the technologies that are cheaper to own in the long term through fuel efficiency. An initial exercise by the tax office to move from an input-based to an output-based tax for vehicle ownership and use can be seen as a reflection of a policy concern for the environment and energy.

Achievement 8. *The government is introducing a gradual tightening of standards for fuel consumption, emission and safety for cars.*

This policy creates opportunities for investments and persuading consumers' choices. Despite car manufacturers' concerns that the short period for introducing standards will affect the economy of scale for production, the reality was that the new standards attracted new financing for the industry and contributed to economic growth.

Achievement 9. *Public transport operation, especially in urban areas is considered important for the economic growth.*

There is a general consensus among stakeholders that public transport is within the government's jurisdiction, and hence should be supported by the government. The Thai Government and regional governments provide subsidies to public transport services, and fares reflect the OM costs, not infrastructure costs.

Achievement 10. *The Government has a clear direction to utilise the private sector's potential through the public-private partnership (PPP) projects.*

In 2013, Thai government enacted a renewed PPP Act, focusing on projects that have a value more than 1 billion BHT. The Act replaces the 1992 Act on Private Participation in State Undertakings (PPSU)[5]. While the 1992 Act was a response to the issues in project governance prior PPSU, the 1992 PPSU Act has been criticised by the private sector, particularly foreign investors, for its lack of clarity on scope, definitions, project valuation methodologies, and for its lack of contract amendment procedures. More importantly, the PPSU Act has no procedural time limits, which often leads to considerable delays. In addition, the absence of clear arbitration provisions has aggravated uncertainty in the event of disputes[6]. The new Act is expected to provide: (1) a Value for Money (VfM) guideline for the GCA Government Contracting Agencies; (2) PPP arrangement for different project types; (3) establishing PPP Central Unit; (4) Master plan for strategic projects, including treatments for unsolicited projects; (5) availability of PDF project development fund; and (6) a more streamlined PPP process.

Achievement 11. *Energy efficiency is considered in transport project investments.*

[5] Example of projects using PPSU Act 1992 is mass rapid transit projects (such as the BTS sky train and thee underground mass rapid transit MRT), express highways, elevated roads, and telecommunication systems (such as AIS mobile, Telecom Asia, and TT&T).

[6] See Kokkaew et.al. 2013, Thailand's New Public Private Partnership Law: A Cure to the Problem?, www.researchgate.net/publication/239948923_Thailands_New_Public_Private_Partnership_Law_A_Cure_to_the_Problem, accessed 01 September 2015

The Peer Review Team observed that there is a convergence in energy and transport policies. Transport policy makers are aware that not only the efficiency of transport services is important, but also the reduction of energy use is an essential consideration. Many transport policies are linked with land use configuration, which is managed by regional governments, and only to a limited extent is this relationship is well designed. The Peer Review Team was not exposed to the integration of transport and ICT policies, although IT applications in transport have been put into practice, in both facilitating passenger and freight movement. The IT application in transport is overlooked despite its potential to improve resource efficiency (space, time, and energy).

Achievement 12. *Institutional coordination among relevant organisations in energy efficiency policy implementation.*

As mentioned in recommendations 1 and 2, it was apparent during the review process, that the Thai Government has made significant progress in their efforts on energy efficiency. Better institutional coordination enables a smoother and faster implementation. Land acquisition with the example of rail projects, despite its operational on-ground difficulties, is relatively fast (compared with other developed and developing economies), attracting private investments. This achievement is perhaps the most significant observation of the study team in managing a comprehensive policy package involving technical agencies from the Thai Government and regional agencies, and fiscal authorities.

However, several challenges in financing and investment should be addressed to ensure sustainable transport infrastructure development in Thailand.

Challenge 1: *To ensure complimentary investments to all levels of government and the transport sector.*

The current policy in the transport sector is quite ambitious, with heavy investment required to achieve its target. Investment in long haul traffic for rail freight and logistics centres is the priority of the current government and requires huge public finance support. International agencies and partner governments, i.e. Japan and China, are supporting the Thai government to finance its strategic projects. What needs to be realised is that complimentary investments are often neglected or not provided. Local government finance for example, needs to reflect the first/last mile components of the mobility and a capacity to manage local traffic and parking

Challenge 2: *To allow more flexible use of the ENCON fund.*

The ENCON fund is currently used for technology/private sector related investment, and kept mostly within the energy sector. It would be much better if the use of the fund can be made available for the transport sector for energy efficiency processes, allowing a more flexible use of capital, especially for innovative local government projects.

Challenge 3: *To continue the taxation reform process.*

In the fiscal management sector, the creation of a new fiscal window for transport infrastructure investment using a better and more rational taxation system is necessary to convey clear government policy messages in the energy and transport sectors. The Thai Government has started to reform process, and the concept for moving an input-based tax into output-based tax should be supported by the stakeholders.

Challenge 4: *To replace government funding with private sector investment.*

Replacing investments for infrastructure currently funded by the government with private investment will take some time since in the past the Thai Government has not experienced a good result with PPP projects. The new PPP Act will require government capability in delivering PPP projects.

Challenge 5: *To review and possibly enlarge the MRTA's mandate to better integrate stations with other land uses.*

MRTA is singularly important authority for delivering transport services in Bangkok. MRTA is doing well in undertaking its project and manage transport services, but its mandates need to be reviewed and possibly enlarged, especially to integrate stations with development around stations. Incorporating Transit Oriented Development (TOD) and implementing a good business model to ensure the government to maximise the benefit of expensive mass transport investment. The example of doubling income from connecting the Sky Train (BTS) with nearby shopping malls has shown that integrating rail connections with private property development is mutually beneficial.

2.2 RECOMMENDATIONS

The recommendations provided in this section based on the Peer Review Team's understanding of the economic and fiscal context of Thailand and the Thai Government. The documents and information presented during the workshop gave the Review Team limited knowledge to draft detailed and comprehensive recommendations on investment and financing for reducing energy consumption in the transport sector. Taking an example of the level of decoupling between (transport) energy consumption and economic growth. This macroeconomic indicator will be a powerful tool to develop an economy-wide strategy for investment and budget allocation of the government.

The share of energy consumption reduction from transport sector is estimated to reach 60%. The Review Team had limited information on the breakdown of 60% contribution of transport sector to the reduction of energy consumption (by project, by mode, by region, demand side vs. supply side). Demand elasticity to own vehicles, with respect to the change of car price and energy (fuel price), including spatial distribution of demand (Bangkok and non-Bangkok) is also not yet fully understood. Another important indicator to indicate investment effectiveness is the cost-curve to relate investment cost and energy reduction, relative to the types of investment.

The success of transport investment often lies in the availability of first/last mile infrastructure, and the capacity for local government to provide public transport subsidies. Local government financing structure, which impacts the capacity for local governments to build infrastructure and to provide subsidies will need to be addressed properly by the Thai Government. The level of risks exposed to private sector to invest in infrastructure, and the interest of local banks to give loans for transport operators need to be understood better if the government wants to promote the PPP scheme for transport infrastructure project.

The recommendations for the Thai Government will focus on improving investment and financing capacity to both manage demand for motorised travel, fuel efficiency of vehicles, and increase capacity/availability of public transport and NMT. The recommendations will enable a direct and explicit link between project investments and their impacts on energy efficiency.

PUBLIC SECTOR FINANCE

Recommendation 7. *Expanded and more flexible use of the ENCON fund (for policy support, infrastructure development, local government investments, subsidies) should be promoted in the transport sectors and regional governments agencies.*

A successful example of the ENCON fund for both energy efficiency revolving fund and supporting energy service companies (ESCO) should be replicated in the transport sector focusing on energy reduction projects. Regional governments and local transport service companies should be eligible to receive such funding. Transport agencies might use the fund to finance a pilot project, which, if successful, can be mainstreamed using the regular budget.

Recommendation 8. *Better energy pricing to reflect cost of supply, and gradually the public costs (safety, local pollution and greenhouse gases).*

Better energy, especially fuel pricing helps policy makers to better design the revenue and expenditure plan, and transport users to rationally adjust their trip-making behaviour. The Thai Government has started to reform their energy price and it is expected that the inclusion of externalities, i.e. safety, local pollution for example CO, PM10 and noise, and GHGs, enable them to implement market mechanisms in the supply and demand of transport infrastructure and services. At the same time, the pricing policy will create a new fiscal space for the government to invest in transport projects.

Recommendation 9. *Moving from an input-based to output-based taxation regime, and creating a fiscal space for transport investment.*

The new excise tax structure for cars initiated by Tax Office will start from 2016, and will focus on reclassifying cars based on CO_2 emission produced, thus eliminating the impact of size of engines and engine technologies. This classification is complimented by the change in tax level for hybrid vehicles. The scheme will help the government to focus on output of the available technology and encourage the private sector to make innovations to reduce the energy consumption. The government can directly link revenues generated by this tax policy with the energy efficiency impacts.

Recommendation 10. *More structured local government finance for improving first/last mile infrastructure including pedestrian and cycling facilities, and encouraging the use of public transport.*

First and last mile infrastructure consists of among others, the provision of pedestrian and cycling facilities, the designation of taxi ranks and the access to 'tuk-tuk' services. This small-scale infrastructure is critical to ensuring the successful implementation of public transport programs/projects. Often, large projects do not economically, socially and financially succeed because the government neglected to put such infrastructures on the ground. Several CSR projects in the private sector illustrated by the Ministry of Transportation during the Follow-up PREE trip to Bangkok were good examples of how Bangkok's government could mobilise local resources for pedestrian facilities. This approach should be systematically developed to allow other regional governments to learn and utilise the knowledge and mechanism.

Recommendation 11. *Prudent policies on internationally funded projects, and consolidation of three railway systems (narrow gauge, standard gauge and high speed system) into the regional/international rail networks.*

Large investment for rail is often financed by donor economies. Not only because the scale of funds that are required to undertake the projects, but low interest rates, technological advancement that are needed, complication in the inter-agency coordination, and political ties between the recipient and donor economies, are factors determining a donor economy's involvement in infrastructure projects. The Thai Government's current plan is to have three systems of railway operating at the same time, i.e. narrow gauge, standard gauge connecting east and west corridor funded by the Japanese Government and standard gauge for high speed rail system, potentially funded by the Chinese Government. While it might be complicated to run different systems using different technologies, this plan is not impossible to operate. The Thai Government has to make sure that the capacity of its regulatory authority is sufficient to manage the planning and operation of those services. This will require a reform in the State Railway of Thailand and ensuring that new rail operators have a robust coordination protocol with the existing operator. The railway plan should have a robust economic, social, and environmental analysis, including an acceptable passenger/freight forecast and risk mitigation strategies to avoid future operational failure.

PRIVATE SECTOR FINANCE AND PPP SCHEME

Recommendation 12. *Increasing the capacity to manage PPP scheme by gradually introducing private sector partnership (management contract, extended turnkey, availability payment, VGF/partial construction support and guarantee scheme, BOT/BTO).*

Past experiences with Thai PPP projects in transport infrastructure have been an expensive exercise. The new PPP Act established in 2013 is expected to address issues that arose from past governance practices. Often, economies implementing PPP projects are moving too fast to introduce very large, complex projects incorporating many agencies, horizontally and vertically. These projects are often bearing significant risks that the government cannot mitigate easily. It is always advisable that private sector partnerships are gradually introduced. Introducing a proper management contract for the existing infrastructure assets will be an initial stage towards a more complicated PPP process. This contract is a wholly or partially transferable asset to the private sector. An example of this project is a transfer of a government-managed truck terminal infrastructure to the private sector with a performance-based contract.

Another key element of PPP scheme is the knowledge creation and management of the partnership with the private sector. PPP projects are unique in nature and they should be documented and learning incorporated in future projects. The Thai's Government experience with establishing the Thailand Automotive Institute (TAI) is a good example how a knowledge-based institute can be utilised to promote a certain type of industry. Establishing the '*Thailand Institute for Infrastructure Development*' focusing on PPP will be a good program to be exercised by the Thai government.

Recommendation 13. *Expanded role of the MRTA to manage and finance TOD projects and negotiate in a B2B (Business to Business) arrangement with property owners around stations.*

The success of transport and land use integration will depend on the commercial structure of the agreement between transport operator and the property owners/developers. When there is a mutual benefit from the business arrangement, both parties will agree to co-invest in the TOD infrastructure. At the moment, the MRTA has a limited mandate to negotiate and finance TOD projects. An expansion of the mandates for the MRTA will allow more flexible arrangements and business processes for future investment in the TOD projects. The

Government can then establish a service standard for transport interchange and intermodal transport facilities that should be provided through the business deals, i.e. pedestrian, cycling, tuk-tuk or taxi facilities.

3. URBAN LAND USE AND TRANSPORT INTEGRATION

The importance of urban land use patterns and urban form and the way they interact with the supply of transport infrastructure to create demand for travel has been known for many years (Mitchell and Rapkin, 1954). Urban form or structure, as characterised by factors such as population and job densities and particularly the pattern of centres within metropolitan areas (the CBD and sub-centres), is now widely accepted as critical to the mobility characteristics in cities (Garreau, 1991; Kunstler, 1993; Thomson, 1977; Cervero, 1998). In particular, the density, number, type, location and size of centres within cities and the type of transport infrastructure connecting and servicing them (e.g. freeways or mass transit) are paramount in determining levels of car use and transport energy use in cities (Cervero, 1986, 1995, 1998; Cervero and Landis, 1992; Kenworthy and Laube, 1999; Newman and Kenworthy, 1989, 1996, 1999, 2006, 2015; Naess, 1993a, b, 1995).

The higher the urban density of a metropolitan region, the lower is the per capita car use and transport energy use. This produces a very strong negative correlation between urban density and per capita private passenger transport energy use, which has been shown to be robust over decades (Newman and Kenworthy, 1989, 1999, 2015). Figure 3.1 demonstrates this relationship.

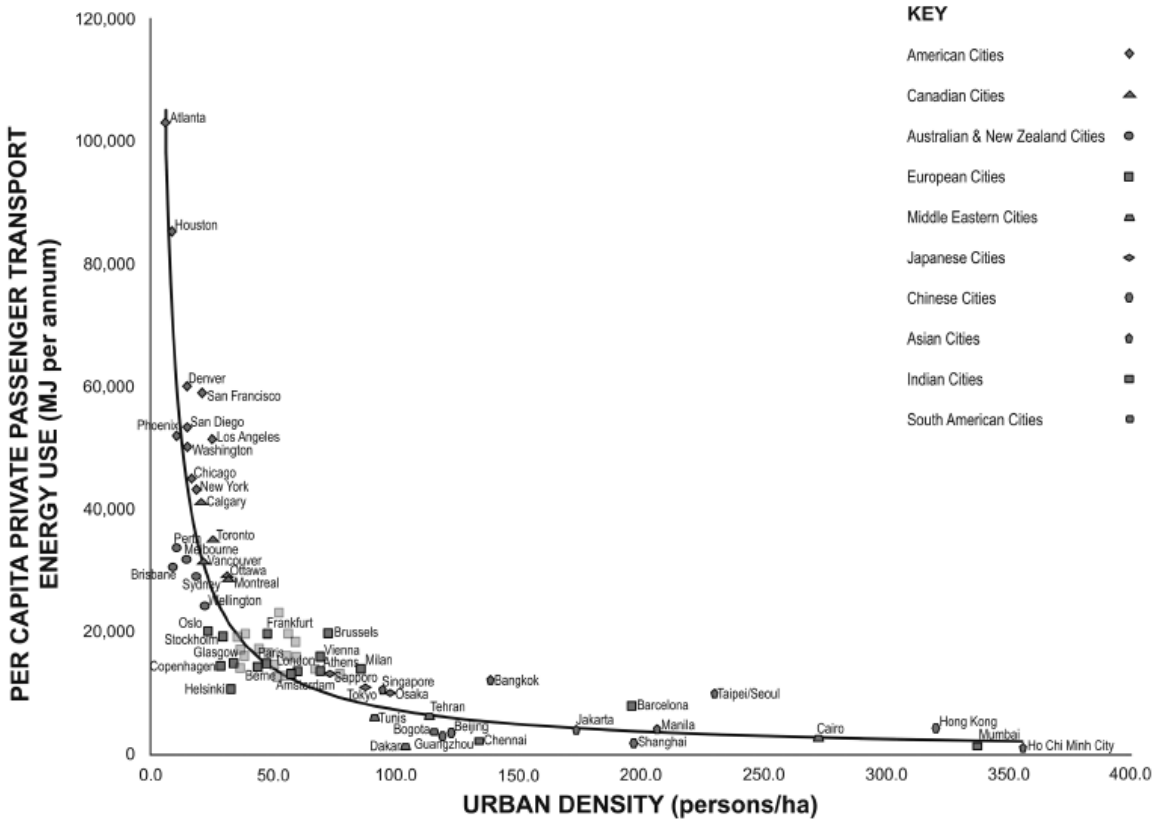
Selectively raising urban densities, especially in centres linked to quality mass transit, in particular urban rail with good provision for walking and cycling, i.e. TOD, can help to reshape cities for reduced car use and lower transport energy use by improving the viability of transit and the possibilities for walking and cycling (Thomson, 1977; Newman and Kenworthy, 1996; 2006; Schiller, Bruun and Kenworthy, 2010; McIntosh et al, 2014; Newman et al, 2013). Decentralised concentration of jobs outside the CBDs of cities in transit-oriented sub-centres is important in creating more polycentric metropolitan areas that are better served by non-auto modes. There are many studies that have shown how 'salt and pepper' dispersal of jobs, which can only be serviced by cars (e.g. relocation of enterprises from the CBD to car-based suburban locations) has led to radical drops in transit use by employees (Cervero and Landis, 1992; Baillieu Knight Frank, 1991), as well large increases in transport energy use and increased car trip lengths (Alexander, 1980, 1981).

Figure 3.1shows how Bangkok is a dense urban area with modest per capita energy use in private passenger transport when compared to other global cities (11 750 megajoules (MJ) per capita in contrast, for example, to the highly automobile dependent regions in Australia, Canada and the USA, with figures ranging from about 30 000 up to 100 000 MJ per capita). However, the statistical relationship in the graph shows that with an urban density of 139 persons per hectare, Bangkok's transport energy use per capita is something of an outlier (i.e. higher than the statistical relationship suggests), and should sit closer to the curve at about 6000 MJ per capita, if all the advantages of dense, mixed land uses are being exploited.

The reasons why Bangkok's transport energy use per capita is significantly higher relative to its density are complex. However, they principally relate to the priorities afforded to high capacity freeways and highways, unrestrained growth in car ownership and use (and motorcycles) for decades, an historically poor public transport system (though now significantly improving), rather low rates of walking and cycling related to the difficult conditions for pedestrians

and cyclists caused majorly by high levels of air pollution and noise, poor infrastructure and hostile public environments for people on foot and bike (e.g. pedestrians are required to use pedestrian bridges throughout the region), and high levels of congestion helping to create high vehicular fuel consumption rates. The higher than expected per capita transport energy use can also be linked to a land use dichotomy in the region; despite high densities in central and inner areas of Bangkok, which primarily account for the region's high overall density, there are some rather scattered, sprawling and more car-dependent land uses that have developed in peripheral areas, adding more car use to an already overburdened road system (Kenworthy, 1997; Kenworthy et al, 1995).

Figure 3.1 Per capita private passenger transport energy use versus urban density in global cities, 1995



Source**:** Newman and Kenworthy, 2015.

It can be said that Bangkok is not an automobile dependent urban region, but rather an automobile saturated one. This has occurred because there is a fundamental mismatch between Bangkok's dense, mixed land uses and its transport infrastructure, in common with numerous other highly congested and very dense metropolitan areas in the South-East Asian region (e.g. Jakarta, Kuala Lumpur, Ho Chi Minh City). This critical issue, which was initially highlighted by Thomson (1977) in his archetypal global city types, underlies many of these cities' most difficult mobility problems (e.g. chronic traffic congestion and growing transport energy use and pollution). It has been explored by Dimitriou (2013) for cities in the Asian region and analysed in great detail for Bangkok by Poboon (1997). In an even more extensive review, Barter (1998) made an in-depth exploration of this 'land use-transport infrastructure mismatch problem' for numerous dense Asian cities. He found a consistent pattern: those cities that

apply early restraints on car ownership and use and best integrate and support their dense, mixed use urban forms with the provision of mass rapid transit and good conditions for walking and cycling, rather than building high capacity freeway systems for private individual transport, perform better on all aspects of urban mobility, transport energy use and livability. All these authors found that the problematic transport issues that exist in these dense Asian cities can be traced primarily to the fact that they have extremely limited road space due to their traditional high density, mixed land use character, which simply cannot accommodate even modest levels of car ownership without quite severe traffic problems. Furthermore, they highlight the fact that no amount of new urban road construction can fundamentally change that, as evidenced by the still chronic congestion to be found in the majority of these cities.

On the positive side, unlike the utterly car-dependent, low density cities in North America and Australia, which struggle to provide alternatives to the car because of their spread out nature, the high density, mixed land uses in Asian cities are ideally suited to mass transit, walking and cycling. Contrariwise, these Asian cities are not at all amenable to high levels of car ownership and use. However, at early stages in their industrialisation (since the 1970s), many of these Asian cities (e.g. Bangkok and Jakarta), have adopted the car (and motorcycle) much more than they have focussed on the transit systems and non-motorised mode (NMM) facilities most suitable to their land use and urban form. In doing so, they have built a huge amount of high capacity freeway/tollway infrastructure in an attempt to increase road space and to accommodate higher levels of car use, instead of early adoption of restraints on car ownership and use, early construction of mass transit systems and support of walking and cycling, as has been done in Singapore. Singapore as a result has evolved a more sustainable urban transport system with high levels of public transport use and greater livability. It has kept car ownership at about 100 cars per 1000 persons with minimal congestion and low transport energy use per capita, compared to other cities with similar or even lower levels of metropolitan gross domestic product (GDP) per capita (Newman and Kenworthy, 2015).

The very dense cities in China, which had traditionally relied heavily on walking and especially bikes, even up to the mid-1990s (Kenworthy and Laube, 2001; Kenworthy and Hu, 2002), also followed the motorisation path with identical consequences of unsustainable levels of traffic congestion, growing transport energy demand, severe air pollution and the decimation of non-motorised modes. More recently, many Chinese cities have been adopting Singapore-style economic restraints on their growth in car ownership and use (Gao et al, 2015). All these cities are now also building extensive urban rail and bus rapid transit systems in order to improve their mobility options, reduce congestion and transport energy use and to create more liveable cities. Beijing and Shanghai now have amongst the longest urban rail systems in the world, mostly built in the last 20 to 25 years. This trend and process is explained in detail in Newman et al (2013), Newman and Kenworthy (2015) and Gao et al (2015).

The above overview and critique provides an essential context and background to the issue of urban land use and transport integration and its relationship to transport energy consumption and efficiency in the Thai context. In the light of this background and critique, achievements, challenges and recommendations for Thai cities in relation to urban land use and transport integration to reduce transport energy consumption are now considered.

3.1 ACHIEVEMENTS AND CHALLENGES

The 2010 Peer Review on Energy Efficiency in Thailand, made a number of recommendations about transport energy efficiency, which relate directly and indirectly to urban land use and transport integration. These recommendations

(22-26) are provided below and are referred to where appropriate in the achievements, challenges and recommendations for urban land use and transport integration.

Box 3.1: Extract of transport relevant recommendations from the 2010 Peer Review on Energy Efficiency, Thailand.

Recommendation 22. *It is recommended that the Thai Government should develop a comprehensive transport development plan that covers all modes (roads, car, motorcycle, truck, bus, rail, etc.) for passenger and freight transport. In this plan, it should*

- *set major policy directions (e.g. rail-based development) that will address the long-term trend of increasing transport energy consumption; and*
- *link energy efficiency sub-targets with transport measures.*

Recommendation 23. *It is recommended that the Thai Government should study and introduce many demand management measures to meet the needs of different types of commuters in order for them not to drive.*

Recommendation 24. *It is recommended that the Thai Government and the Bangkok Metropolitan Administration should work together to*

- *Develop the Bangkok MRT system as planned. At the same time, the transport system should be well integrated, for example, between MRT lines, with SkyTrain, buses, taxi, cars and two- or three-wheelers ; and*
- *Develop bus priority schemes, including Bus Rapid Transit (BRT).*

Recommendation 25. *It is recommended that the Thai Government and the Bangkok Metropolitan Administration should work together to*

- *Increase car driving cost in comparison with the public transit fare*

Recommendation 26. *It is recommended that the Thai Government should*

- *Develop rail (MRT & railways) as the backbone of a national transport system. Rail is the most efficient transport mode for passenger and freight transport. For Bangkok, commuter rail at suburb areas should be developed which are less costly to build and operate; and*
- *Adopt the rail-based development strategy to maximise transit usage and to finance infrastructure. Rail systems, including MRT, suburb commuter rail and inter-city railways, require large capital to build the infrastructure. Rail-based development has been successful in Japan, followed by Hong Kong. Many other countries encouraged development around rail stations and captured the value through tax, transport development charge, selling state land at a premium, etc.*

Source: APERC, 2012.

Since the above 2010 PREE study, there have been considerable achievements in line with the above recommendations. The following list of achievements explains this progress towards fulfilment of these recommendations:

Achievement 13. *Significant development of new rail transit lines in Bangkok with major plans for further expansion of the network in the Bangkok region.*

Likewise, there are also extensive plans for new long distance lines, double and triple-tracking projects and high-speed rail throughout the economy. These projects offer major opportunities for land use integration and densification around existing and new stations, leading to reduced car use and lower transport energy use.

Achievement 14. *MRT systems are creating a sense of pride and identity for Bangkok residents and easier orientation around the city.*

The systems are well staffed and friendly and they offer a way to beat the congestion, heat and stress for many trips. Residents, businesses and visitors are increasingly orientating themselves around these rail systems and are giving directions to destinations according to the rail lines and stations. The city is becoming more legible and understandable and easier to move around. Moving forward, this can have a major positive effect on transport energy efficiency, as more and more people opt for rail travel over cars or motorcycles.

Achievement 15. *Significant recognition within Bangkok's planning and transport agencies of the critical nature of mass transit station precincts within a 500 to 1000 metre radius of the station, as places for dense, mixed use Transit-Oriented Development (TOD).*

Through both market forces and government efforts, these sites are gradually becoming preferred locations for more urban development due to the improved accessibility and ease of travel that they afford. Already, many stations on Bangkok's mass transit system are rich in amenities such as food outlets and other businesses and services. Furthermore, many of the stations themselves are directly connected via walkways to large shopping centres and other land uses.

There is also a rapidly growing understanding by many Thai planners and decision-makers of the need for a high level of amenities, walkability, livability, greening, superior urban design and integration between modes at stations (bikes, bike and car sharing systems, feeder buses, taxis, water modes, tuk-tuks and others). At rail interchange stations where different rail lines and operators intersect, there is also recognition of the need to make transfers as seamless as possible between these rail lines.

The BMA has introduced a series of density bonuses (increased Floor Area Ratios or FAR) of up to 20% for developments within 500 metres of stations which provide for public open space, greening and water-permeable space (Biotope Floor Area Ratio), on-site rainwater retention/storage, green building (energy saving) standards and extra public parking.

MRT corridors are now cited as locations for greater restriction on cars in the future. If this can be achieved it will also enhance bus travel times and conditions for NMM, leading to possible modal shifts towards these more energy-efficient modes.

There is more emphasis on walking and cycling modes, which greatly suit the land use arrangements in Bangkok and other Thai cities. Many trips in Bangkok and other Thai cities are short due to compact and mixed land uses. More cycleways (bikeways) are being introduced across the economy and there is a strong civil society bike lobby campaigning for greater attention to these modes on health, equity, liveability, environmental and other grounds.

In summary, there is a developing recognition within government and the broader community that mass transit can shape Bangkok and other Thai urban settlements into a new corridor-based and multi-centred (polycentric) urban form, if land use within 500 to 1000 metres of stations can be more effectively integrated, including a high level of amenities, excellent street environments and superior urban design, with priority access to bus feeder systems and NMM.

Land use-transit integration, higher transit use and more NMM use can create multiplicative reductions in car use through the 'transit-leverage effect' where 1 pass-km on transit replaces 5 to 10 car passenger kilometres due to

the trip chaining habits of public transport users (Neff, 1996; Newman and Kenworthy, 1999; 2015). This effect changes the emphasis from more fuel-efficient vehicles alone (with fuel efficiency expressed in terms of MJ/passenger km), to more fuel-efficient cities (with fuel efficiency expressed in terms of MJ/person), which is the more comprehensive and effective measure of fuel-efficiency. The reason for this is that improvements in vehicle efficiency can be negated by rebound effects due to increases in car use. In other words, individual vehicles operating in the traffic stream can experience lower rates of fuel use per kilometre due to technological improvements or less congestion, which helps to create more fuel-efficient traffic. However, if car travel is growing to the extent that these gains are negated or reversed, actual energy use per person can still rise, which creates a less fuel-efficient urban system as a whole (transport energy use overall rises). This problem has been thoroughly documented in Newman and Kenworthy (1984; 1988).

Although achievements so far in Bangkok in meeting the recommendations in the original 2010 PREE report have been significant, numerous challenges still remain. The following challenges in relation to better urban land use and transport integration stand out as being the most significant.

Challenge 6: *Financing new MRT lines, extensions and other rail projections.*

The ability to finance all the planned multi-billion Baht new MRT lines and extensions, plus other rail projects throughout the economy may present a challenge, as such worthwhile projects are likely to do in any economy. Further transit-land use integration could be threatened if these projects cannot be realised. There will likely be a need to explore all possible avenues for funding such projects, including through the capture of land value uplift brought about by such rail projects. Challenge 5 in Section 2 also highlights this problem, while Recommendation 13 above, specifically addresses how an expanded role for the MRTA can help in achieving co-investment in TOD infrastructure around rail stations.

Challenge 7: *Finding more funding and ensuring more attention to bicycle and pedestrian facilities.*

The cost of bicycle and pedestrian facilities (footpaths, cycleways, bike racks etc) are modest when compared to the investment required in new roads or public transport systems. Although some funding has been found for these infrastructure projects and there are better cycleways now being developed throughout Thailand, greater funding and attention would accelerate this process. Recommendation 10 is designed to partially address this problem.

Challenge 8: *To not see building higher capacity roads as a solution to reduce transport energy use.*

In the face of chronic road traffic congestion, the obvious policy response is to build more high capacity roads and this has certainly been attempted in Bangkok. However, experience in other economies shows that it is not possible to ever build one's way out of congestion, since traffic behaves more like a gas than a liquid and expands to fill all the road space that is provided (Newman and Kenworthy, 2015; Schiller et al, 2010, Kenworthy, 2012). Building more high capacity roads, which encourages more car use, is not a way to reduce transport energy use. If building more road capacity were a way to save energy, cities such as Atlanta and Houston would not have the world's highest per capita use of energy in transport (see Figure 1 and Kenworthy and Laube, 2001).

Challenge 9: *To ensure many agencies and government bodies are involved in decision-making.*

Fragmentation of decision-making in land use planning and transport was cited by Poboon (1997) as a key problem in achieving a more sustainable and lower energy transport system in Bangkok. It is clear that decision-making in

transport still involves many agencies. These agencies are working together more and more, however, greater integration needs to be achieved, especially if Recommendations 22 to 26 cited above from the 2010 PREE report and those outlined in this report are to be further advanced. In this regard, Recommendations 1, 2 and 6 are aimed at achieving better coordination between agencies.

Challenge 10: *To not treat mass transit systems as just a civil engineering problem, but a multi-disciplinary problem requiring a multifaceted analytical approach.*

In virtually all economies throughout the world, constructing mass transit systems is often treated primarily as a civil engineering exercise, but it is not. Such projects are integrated and complex engineering, urban planning and urban design tasks, which require a lot of understanding of human needs and how to achieve best practice in every aspect from operations, ticketing, access to stations, information, integration of amenities, land use planning, urban design and other factors. This understanding is growing throughout planning and transport agencies in Thailand, but there is scope for further improvement.

Challenge 11: *To look into the cost-benefit of using Park and Ride systems at train stations before adopting the program more widely.*

Park and Ride (P&R) is often favoured as a way of delivering transit riders to stations, especially in car-dependent areas and Thailand appears to be no exception. However, Schiller and Kenworthy (2011) have shown that P&R is a poor use of valuable land near stations and that P&R in all transit systems worldwide is expensive, but contributes generally less than 3% of the total annual transit ridership of any city. P&R generally works against the human attractiveness and livability of station areas and can thwart land use integration, thus working against Recommendation 26 from the 2010 PREE report.

Challenge 12: *To improve accessibility in the MRT system, which will improve ridership.*

The elevated MRT systems in Bangkok provide better views and an overall better experience for users within the train. However, the stations present a real access challenge to children, the elderly, people with bikes and luggage and those with disabilities if there are no escalators or elevators. This presents a challenge to fully implementing Recommendation 24 in the PREE 2010 report.

Challenge 13: *To integrate different public transport modes and operators with one another to create one ticketing system.*

Transit systems work most effectively when treated as a genuine integrated network with the ability to seamlessly change modes, both physically and in terms of tickets. The experience of cities such as London after the introduction of a unified ticketing system has been very good, with radically increased ridership. The MRT system in Bangkok has been developed initially as a number of separate projects with different operators. Despite careful and on-going efforts to better connect and integrate the systems, there are still physical interchange challenges, as well as a lack of ticket integration, which works against greater fulfilment of Recommendations 22 and 26.

Challenge 14: *To create strong sub-regional centres as focal points for circumferential MRT/BRT transit options.*

The Bangkok MRT system is limited at present to radial, monocentric lines. Strong sub-regional centres, which could create the focal points for circumferential MRT/BRT transit options, relieve pressure on central Bangkok and provide

a much more comprehensive and effective mass transit system, at present do not exist. Fulfilment of Recommendations 22 and 26 will be further enhanced as this challenge is more closely addressed.

Challenge 15: *To improve investment in and prioritisation of buses.*

Buses are a critical part of the transit system of Bangkok but appear in many cases to suffer from lack of investment (e.g. very old, un-air-conditioned buses) and are mostly stuck in traffic with no priority (few bus lanes and no traffic light priority). They still cannot compete in speed with cars or motorcycles, as suggested by Recommendation 24 from 2010. Section 2 on Transport Finance and Investment provides a number of recommendations that might provide additional means of funding such investment in bus systems.

Challenge 16: *To introduce controls on car ownership registration, to limit increased vehicle numbers.*

MRT, improved buses and NMM cannot alone solve congestion. As already mentioned, traffic behaves more like a gas than a liquid. It expands to fill available road space if there are no direct controls exercised over both car ownership and use, as in Singapore and now also in some Chinese cities. At present there appears to be little being done to exercise control over car ownership and use, as suggested by Recommendations 23 and 25 from the 2010 PREE report. In Section 5 a series of specific recommendations are provided on how such controls on cars might be implemented, specifically, Recommendations 30, 31 and 34.

Challenge 17: *To improve bike and pedestrian crossings.*

Non-motorised modes are critical for better integration between land use and transport and reducing transport energy use, especially in cities. At present in both central and outer areas of Bangkok pedestrians are mostly required to cross roads using pedestrian bridges. This presents a physically demanding challenge to many people and generally places both a physical and psychological obstacle to the use of walking. Most cities allow pedestrians to comfortably cross at walk signals on traffic lights. Cyclists in most cities rely on the same surface crossings as pedestrians, so this approach of overpasses for NMM also works against greater use of cycling in Thai cities, especially Bangkok. Recommendation 10 in Section 2 also highlights this major issue, in particular the problems it presents for people in getting to transit stops and it provides a way to finance improvements in pedestrian and bicycle facilities.

3.2 RECOMMENDATIONS

The following recommendations are designed to help Thai cities, especially Bangkok, to achieve greater integration of urban land use with transport systems so as to reduce transport energy use by decreasing the use of cars and increasing the use of public transport and NMM. These recommendations reflect many of the concerns addressed in Recommendations 22 to 26 in the 2010 PREE report, giving due consideration to both the achievements since then and the current challenges, as outlined above.

Recommendation 14. *Implement car restrictions and congestion controls.*

It is recommended that in order to minimise further motorisation in Bangkok and other Thai cities and to avoid further increases in transport energy use, all government agencies concerned with transport in Thailand should work together to curtail further investment in expensive high capacity urban road construction and rather shift funding

to continue prioritising investment in improved public transit (both MRT and buses) and to significantly improve pedestrian and cycling facilities. MRT corridors especially, should be subject to car restrictions/congestion controls. In order to achieve this recommendation, critical attention will need to be paid to Recommendations 1 and 2 aimed at achieving greater institutional and inter-agency communication and coordination.

The dense and mixed use urban fabric of Bangkok and other Thai cities is inherently non-motorised and transit-based and is plainly struggling to accommodate more traffic. The construction of new roads has not been found to change the overall congestion situation anywhere in the world, but it has been found to encourage greater use of cars, exacerbate car-related problems such as air pollution and noise, and to increase rather than decrease transport energy use.

Recommendation 15. *Design the area around rail stations 'precincts' carefully to include a number of features including walkability, greening, mixed-use development and bicycle access.*

Rail stations and their immediate environs are the key to producing transit-oriented regions. They need to be understood and developed in ways that fully recognise this and allow them to perform their city reshaping role. Accordingly, it is recommended that rail station precincts of between 500 metres and 1000 metres radius around stations should:

- be priority areas for densification and mixed land use including use of air rights development where feasible;
- have walkable, green, attractive streets leading to stations;
- use biophilic architecture to green all buildings;
- have first class bicycle access, bike parking and bike sharing stations;
- have limited, if any, park and ride facilities;
- have maximum not minimum parking requirements;
- contain car-free housing projects and
- have apartment offerings which decouple the cost of the dwelling from the parking space.

Recommendation 10 also highlights the above matters and provides funding recommendations.

Recommendation 16. *Carefully assess railway precinct areas before making planning decisions.*

A detailed understanding is needed around each rail station of the existing development situation and the potential this holds for further development or redevelopment that is consistent with and supportive of the investment in mass rapid transit. Hence, it is recommended that both existing and prospective new rail station precincts (500 to 1000 metre radius) should be studied in detail to assess:

- the existing land ownership situation;
- the extent of vacant or re-development land potential for higher density, mixed uses and
- needed urban design improvements (footpaths, cycleways, greening etc as in Recommendation 17 above and also in Recommendation 10 in regard to funding these changes).

It is further recommended that a visionary re-development and urban design plan should be created for each precinct, along with appropriate existing or new planning and regulatory mechanisms to achieve this. In order to

respond to the above recommendation, attention would also need to be paid to Recommendation 35, which addresses the legal and policy barriers that may exist in implementing TOD.

Recommendation 17. *Fund the costs of new public transport lines from the profits of land development.*

Investment in world-class public transport systems is expensive. Governments worldwide are increasingly finding it hard to afford such systems solely from their own revenues or from large scale borrowings (though redirecting funds away from highway construction to public transport makes this easier). It is therefore worthwhile to also seriously consider past eras when the construction costs of new tram and train lines were funded privately from the profits of the land development that such new infrastructure opened up. It is also useful to consider more recent examples of land value capture and joint development between government and the private sector being used to fund or partly fund the construction of new rail lines in particular. This has been happening in various US cities to different extents, in Hong Kong's mass transit rail system, which was fully funded from integrated land development, and most recently in Copenhagen with its new metro line built into previously vacant land, and which was also fully funded from the new housing, office and other development now closely linked to each station on the line (McIntosh et al, 2015, Newman and Kenworthy, 2015).

It is recommended that all existing and prospective new station precincts be studied for land value uplift effects of the new rail infrastructure. It is further recommended that mechanisms used worldwide for capturing such land value improvements (e.g. as in Hong Kong and Copenhagen) should be studied and assessed and those suitable to Thailand should be used to help fund the capital costs of new MRT/BRT projects and even some of their operating costs (see for example McIntosh et al 2015 and Marinaki, 2015). This recommendation should be seen in the light of Recommendations 12 and 13 and any results evolving from Recommendations 12 and 13 should be integrated with this recommendation.

Recommendation 18. *Continually improve public transit amenity, including access, information systems, shelters, timetables, and consistent colour-coding.*

Public transport users should always feel that they are using a unified, understandable and integrated public transport system that provides them with excellent waiting environments. It is recommended that all rail stations (and bus stops) should strive for best practice in the following factors:

- access for all (e.g. overcome the station stairs problems in accessing elevated systems);
- superior information systems and signage for users;
- good quality shelters, system maps and timetables; and
- a clear and consistent colour, design and livery for vehicles and stops.

Recommendation 19. *Make all railway stations multi-modal interchanges.*

It is critical for public transport users that they see stations as more than just places to wait for and enter or exit a train. Station environments should provide users with a sense of place that they can identify with and which provide them with many of their daily needs. They should also be in places that allow rail users to accomplish the 'last mile' of their trip by integrating other modes to take them quickly and conveniently to their final destination. It is recommended that all rail stations should aim to become multi-modal interchanges involving the following factors:

- integrated feeder buses (and long distance buses where relevant), water transport modes, bikes, taxis, car and bike sharing systems and other supplementary modes;
- rich and diverse amenities (in effect stations should become 'mini-cities'); and
- small freight/parcel pick up points to minimise local truck delivery traffic.

This recommendation also suggests a study of the legal and policy barriers that may exist surrounding the implementation of TOD.

Recommendation 20. *Create circumferential MRT services to connect sub-centres away from the CBD.*

Cross-city transit mobility, not just radial travel, is needed in every city. Many cities worldwide have found the need to develop public transport options that allow travel across and around the city, rather than just into the main centre. London developed its circular tube line early in the 20th century. Singapore has used modern elevated and driverless advanced light rail transit (ALRT) systems to create connections between sub-centres on its radial mass transit rail lines. Paris has developed a series of LRT lines, which join to create a circular system around the Ville de Paris. Perth in Western Australia has a large Circle Route provided by buses, which join together significant shopping centres, universities, hospitals and other large trip generators and it is the single most utilised bus service in the region. Vancouver has developed a Skytrain system that provides both radial and circumferential movement around the region with intensive development around many stations.

It is recommended that Bangkok should develop circumferential MRT services to create circle lines joining together substantial new sub-centres away from the CBD, adding to the already expanding MRT system and helping to create and strengthen a genuine 'network effect', which can yield quantum jumps in transit patronage.

People need to be attracted to and be proud of their public transport systems. They need to be able to understand the systems, identify exactly how they work and be sure that they can be relied upon to get them to their destination on time and with a reasonable degree of comfort. This is happening to a greater degree with Bangkok's MRT system than it is with its buses

4. LOW CARBON TRANSPORT SYSTEMS

As proposed by Asia Low Carbon Society Project, low carbon transport systems might be realised by a comprehensive approach including not only technological innovation such development of low emission vehicle, usage of renewable energy, construction of highway network, etc. but also changes in lifestyle such as modal sift to public transport, usage of non-motorised transport, relocation of our settlement. Even the original 2010 PREE Report didn't state low carbon transport system directly, it is no doubt that low carbon transport systems might be realised by achieving all recommendations in the original 2010 PREE report.

Since policies or countermeasures regarding technological aspects on fuel/vehicles and behavioural change relating to land-used and traffic demand management (TDM) are evaluated by other experts. Thus, in this section, policies and countermeasures regarding public transport and NMT were mainly reviewed.

4.1 ACHIEVEMENTS AND CHALLENGES

The recommendations regarding public transport and NMT in the original 2010 PREE report were achieved as follows:

Achievement 16. *Developing and forming the idea of a low carbon transport system based on public transportation and NMT.*

The Thai Government has:

- Established a green growth policy by order of the Prime Minister in 2013;
- Proposed green transport under the 11th National Economic and Social Development Plan (2012-2017), which included: 1) changing to alternative energy, green energy and efficiency use in energy; 2) integrating the road and railway integrated around the economy and neighbouring economies; 3) improving multi-modal transportation; 4) improving transport system, efficiency, effectiveness, accessibility, safety, transport for all (Aging people and Handicap), and 5) more public private partnership (PPP) investment; and
- Adopting the Bangkok 2020 Declaration for sustainable transport goals 2010-2020 which was adapted on the fifth regional EST forum in Bangkok, Thailand in 2010.

Achievement 17. *Including this idea of a low carbon transport system into the Office of Transport and Traffic Policy and Planning (OTP) developed Transport and Traffic Development Master Plan 2011-2020 (here after TDMP), in 2011.*

In this plan, five strategies were proposed as follows;

- Strategy 1: Upgrade capability of agencies and personnel for the development of an environmentally sustainable transport system.
- Strategy 2: Establish appropriate plans and mechanisms for interfacing and monitoring of transport and traffic work plans/measures/projects; and to move them forward to implementation.
- Strategy 3: Establish comprehensive and inter-connected transport infrastructure.
- Strategy 4: Efficient transport management for sustainability and greenhouse gas reduction.
- Strategy 5: Promote transport R&D and adoption of environment-friendly innovations and technologies.

Achievement 18. *In 2015, the OTP developed Long Term Development Plan on Thailand Transport Infrastructure Development (8 years; 2015-2022) (here after LTDP) which included:*

- The development of rail network between cities,
- The development of the public transport network to solve traffic problems in Bangkok and its vicinity,
- The empowerment highway linking the economy's major production base with the neighbouring countries,
- Integrated development of water transport and,
- The increment in the provision of air transport services.

According to the LTDP, which followed the TDMP, the Thailand rail network development including constructing a double track, three new lines, a new rail truck with standard gauge and a high speed rail (HSR) was proposed as a major policy direction.

Based on this plan, it is proposed that 2529 km of single truck on 14 routes will be converted to double trucks and 1060 km of 3 new routes and 1060 km of three routes with standard gauge will be constructed by 2022. Also, under feasibility of some new routes are studied by State Railway of Thailand (Here after, SRT).

To shift freight transport from heavy-duty trucks to railway, there have been suggestions to construct ICDs/container yards. Model share of freight by railway is expected to increase from 2% to 5%. The locations of ICDs/container yards are studies by SRT now.

Table 4.1: National Railway Development Plan in Thailand by 2022

Gauge	Track	Existing	Proposed	Total
Meter gauge	Single	3 569	-	1 156
	Double	367	2 529	2 780
	Triple	107	-	107
Standard gauge	Double	-	1 060	1 060
Total		4 043	3 589	5 103

Source: Long Term Development Plan on Thailand Transport Infrastructure Development (8 years; 2015-2022).

The development plan of public transport network in Bangkok and its vicinity to the LTDP basically followed Mass Rapid Transit Master Plan in Bangkok Metropolitan Region (here after M-Map), which was developed by OTP in 2010, and the TDMP. On the M-Map, 11 lines with total length of 391 km by 2019 and 15 lines with total length of 509 km by 2029 were proposed.

According to the M-Map and the TDMP, two sections of BTS between On Nut and Bearing in 2011 and between Wongwian Yai and Bang Wa were already constructed in 2013, and the section between Bearing and Keen Samutprakan is under construction. Also, the Purple line which is a new line of MRT and the two sections of the Blue line between of Bang Sue and Tha Phra, and Hua Lamphong and Lak Song are under construction. Construction of the two sections of SRT between Rangsit and Maeklong, and Hua Mak and Salaya also started from 2015.

Additions to the M-Map, the LRTs and the Monorails were planned on four routes between Siam and Chulalonkorn University (2 km), Bangkok City Hall 2 and Yothee Rd. (5 km), Ramkhamhaeng University and Thoblor (11.1 km), and Bangna and Suwannabhumi (18.3 km).

Also, 220 km of BRT on 10 routes including exiting route between Chong Nonsi and TalatPhluwere proposed by Bangkok Metropolitan Administration.

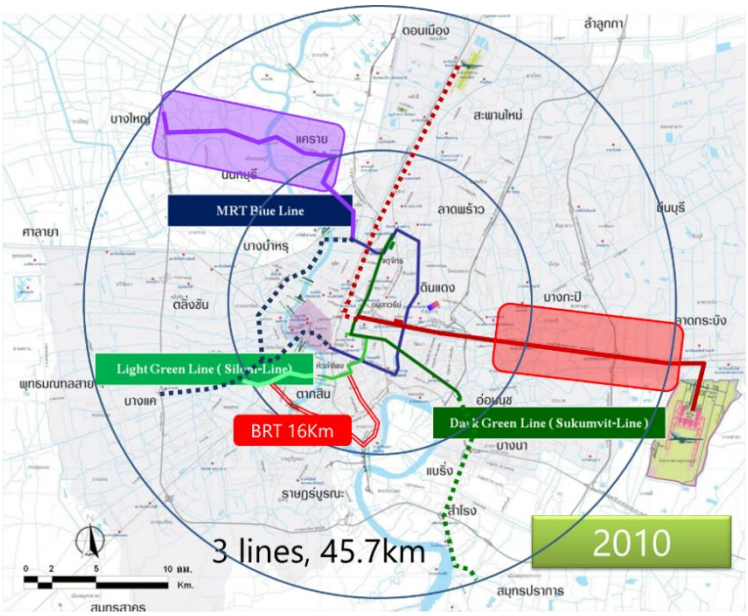
The Monorail was proposed on three routes, between Siam and Chulalongkorn University, Bangkok City Hall 2 to Yothee Rd., and Ramkhamhaeng University and Thonglor and Light Rail Transit on one route between Bangna to Suwannabhumi Airport to provide feeder access of MRT network.

Bicycle ways were proposed by MOT and BMA to provide access to the public transport including BTS, MRT, Express Boat in Chao Phraya River and Canals in BMR. In 2011, total length of 185 km of bicycle ways (sometime on side works) on 23 routes were already existed and 39 new routes were proposed under the TDMP.

Figure 4.1 National Railway Network Development Plan

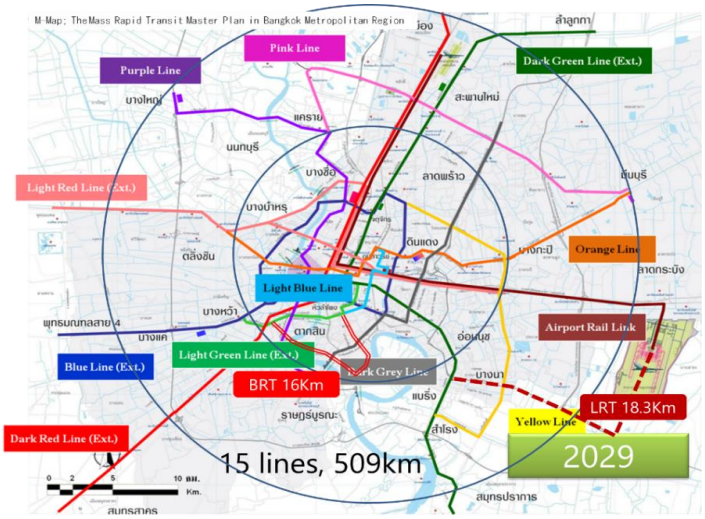
Source: State Railway of Thailand, 2015.

Figure 4.2 Current Situation of Mass Transit Development by 2015



Source: MRT, 2015.

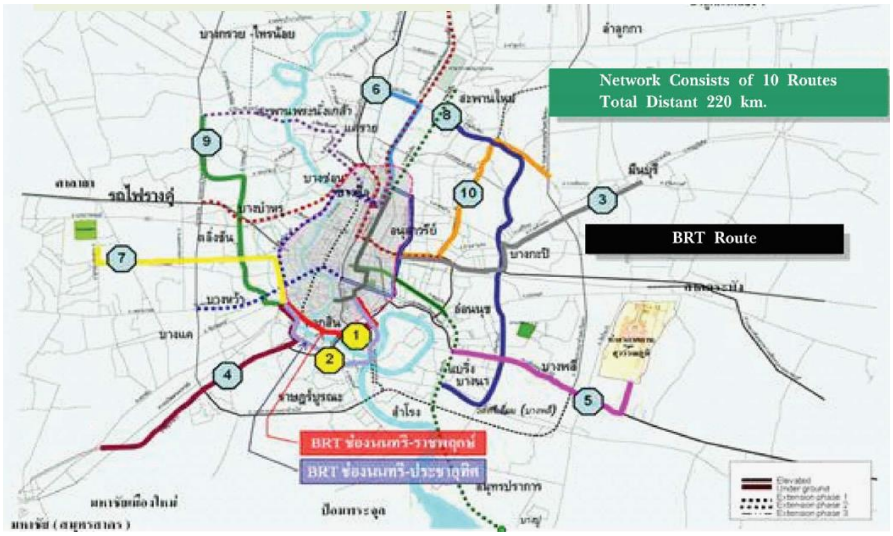
Figure 4.3 Future Plan of Mass Transit Development in Bangkok in 2029



Source: MRT, 2015.

The BRT masterplan, which includes 220 Km of 10 routes a well as the exiting route between Chong Nonsi and Talat was originally developed by Bangkok Metropolitan Administration (here after BMA). This plan is considered under TDMP by OTP.

Figure 4.4 Proposed Bus Rapid Transit Network



Source: Bangkok Metropolitan Administration, 2010.

Figure 4.5 Plan of Bicycle Lanes in Bangkok

Source: Bangkok Metropolitan Administration, 2010.

The economy set 1000 bicycle lanes as the target for the LTDP. The OTP estimated CO2 emission reduction through above mentioned public transportation and NMT policies.

However, several challenges still exist as follows.

Challenge 18: *Improve demand forecasting for railway projects.*

The existing process for forecasting demand for railway projects is not clear, especially for determining inter-provincial volume for both passenger trips and cargo transport, parameters for modal share between rail, road and air, and economy-wide development influences. Future demand for proposed new railway projects seems to be overestimated and hence feasibility studies could assist to clarify projections.

Challenge 19: *Determine feasibility of the rail redevelopments.*

The proposed route of rail redevelopment, especially double track development, standard gauge development and high speed rail (HSR) development are planned on many sections and overlap in many areas. Accordingly, the feasibility of master plan of economy-wide rail development is unclear.

Challenge 20: *Clarify the Master Plans by include other important transportation modes and policy measures.*

Some of important transportation modes, which provide access to the public transport such as Songthaew, Silorek, and Soi-bike, etc., were not included in the Master Plans. Additionally the city's approach to analysing intermodal in Bangkok was not explained on any of the master plans. For example, there are many of obstructions on bicycle ways which are set as side works in the BMA. Some of them are not feasible.

4.2 RECOMMENDATIONS

Recommendation 21. *Improve data collection on passenger and cargo movement, and traffic data such as VKT and emissions factor.*

The Thai Government should collect necessary data such as passenger and cargo movement between provinces, etc. to estimate transport demand and confirm feasibility of many proposed projects for both passengers and commodities continuously. This includes collecting fundamental transportation and traffic data such as VKT, emission factor, etc. For example, DLT should record odometer reading of each car on renewal of registration to estimate annual average VKT. The data can then be used to determine targets in Master Plans.

Recommendation 22. *Improve the Bangkok's Transport Master Plan to include the role of feeder transport.*

The Thai Government should improve the transport Master Plan to include feeder transport. This plan should include re-routing of BMTA's bus, improvement of para-transit route and operation, improvement of bicycle ways and side work, etc.

Recommendation 23. *Reform the bus system in Bangkok to improve its overall system strategic planning, network planning and operations.*

It is recommended that the relevant authorities improve system performance, amenity and comfort within the bus system. The bus system in Bangkok should receive much greater investment and attention. Specific improvements be examined, namely:

- New air-conditioned buses to replace old stock;
- Improved bus waiting areas (e.g. proper information systems and shelter, air-conditioned waiting facilities as in Dubai).
- Bus-only lanes and traffic signal priority to improve speed competitiveness with cars and motorcycles.
- A consistent identity and presence on the streets by using a strong, unified corporate logo, colour and design for all bus livery and stops.
- A smartcard based fare collection system.

This recommendation also suggests to form a regional transport agency for Bangkok with powers to operate the bus and rail services as a comprehensive system.

Recommendation 24. *Develop a plan to improve MRT capacity.*

Bangkok's MRT system is already well-used, demonstrating how attractive it has become, even with the challenges outlined previously. As a result, the capacity of the existing MRT services in Bangkok is not sufficient. This is causing overcrowding, discomfort at times, and probably limiting ridership growth. Even though 509 km of MRT network plan will be built, the transportation capacity of each of the lines is quite limited. For example, the size of MRT/BTS car is compact and only three to four cars for one train. It is recommended that the Thai government and BMA develop a plan addressing how to increase the transportation capacity of each of the MRT/BTS (e.g. longer trains, larger stations, more frequent services, larger vehicles). For new planned lines, it is recommended that higher capacity vehicles, trains and stations (with elevators and escalators) be designed in from the beginning in order to cope with big jumps in new demand as a 'system effect' develops.

Recommendation 25. *Develop more strategic plans for freight transport within the 'Lean Logistics' program's framework.*

The Thai Government should develop more strategic plans for freight transport by rail, including developing ICDs/Container Yards, Rest Area, coastal shipping and waterways.

5. TRAVEL DEMAND MANAGEMENT

5.1 ACHIEVEMENTS AND CHALLENGES

As opposed to supply-side measures, Travel Demand Management (TDM) measures aim to reduce demand for driving by to influencing the behaviour of travellers. The most effective measures are paired measures, that work together to increase the cost of driving (both in terms of price and time) and reduce the cost of transit (both in terms of price and time). Typically this means measures that make it more expensive to drive, paired with measures that make transit travel times faster. Alternatives to driving, that is, an effective public transport system that offers a similar travel time to driving, must be in place in order to accomplish a behaviour change where drivers shift their mode of travel to transit. Thailand's efforts to introduce TDM policies recognise this and to date efforts have been focused on building out the rail transit system as a precursor to pricing or other measures to curb driving, which are planned for the longer term.

The original 2010 PREE report recommended TDM measures as one of a three main strategies for improving energy efficiency in the transport sector. The report recommended for the Thai Government to 'study and introduce many TDM measures to meet the needs of different types of commuters in order for them not to drive' (Recommendation 23), and to 'work together with the Bangkok Metropolitan Administration to increase car driving cost in comparison with the public transit fare' (Recommendation 25). Specific TDM measures were not recommended, but a list of recommended measures suitable for short, medium and long-term implementation was provided (Section 4.4.2.4). This list is shown in Table 5.1.

Table 5.1: List of recommended TDM measures

Term	Measure	Precedents
Short-term (1-2 years)	Special bus for working professionals	Red minibus in Hong Kong, premium bus in Singapore
	High Occupancy Vehicle lanes	USA
	Promoting carpools	USA
	Limiting odd-even plate number to enter city centre	Manila, Beijing
	Off-peak car scheme	Singapore
	Weekly no driving day	Seoul
	Tax on parking spaces	New York city, San Francisco
Medium-term (3-5 years)	Electronic Road Pricing	Singapore, London
	Increase fuel tax, possibly in the form of BRT or rail infrastructure fund	
	Limiting new car registration	COE bidding in Singapore, auction of new car plate number in Shanghai
	Energy efficiency or CO_2-based tax	United Kingdom
Long-term (beyond 5 years)	Reduce the provision of parking in new buildings through building regulatory measures	Hong Kong, London

Source: APERC, 2010.

In general, information on the status of TDM policies or planning, or whether the TDM measures on the list in Table 5.1 had been studied or undertaken, was lacking during the Follow-Up Peer Review mission trip to Thailand. Therefore it was not possible to make a thorough assessment of progress on most of these TDM recommendations during the Follow-up PREE. Yet several other measures that have been taken represent progress toward energy demand management in the transport sector.

Achievement 19. *Setting goals for shifting freight to less energy-intensive modes.*

The Ministry of Energy's Energy Efficiency Development Plan projects energy usage by all economic sectors over 20 years and sets energy savings goals for each sector. The plan for 2011 to 2030 proposed to achieve almost half of the overall energy savings from the transport sector, 13400 ktoe, or 45% of the total annual energy saving goal for all sectors. (APERC, 2015) The most recent plan, up to 2036, has increased the reliance on the transport sector, proposing to achieve 30213 ktoe energy savings, or 58% of the total goal. (MOE, 2015) Annual targets for transport energy savings have increased from 1942 ktoe in 2012 to 5041 ktoe in 2015. (APERC, 2015) This means that the energy efficiency plan must achieve a 46% energy savings over business as usual, that is, cut transport energy use nearly in half compared to current levels. This is an ambitious goal, which will require significant changes to infrastructure, vehicles, and traveller behaviour.

In the EEDP2010 plan, there were three main approaches for energy savings in the transport sector: vehicle efficiency (12470 ktoe, 77%), mode shift (2770 ktoe, 17%), and TDM (1010 ktoe, 6%). The 2036 plan also has three main approaches: vehicle efficiency (14,200 ktoe, 47%), developing infrastructure (11324 ktoe, 37%), and logistics management/financial incentives (5139 ktoe, 16%). The TDM approach appears to have changed from including

measures targeting personal travel, to be entirely focused on freight. The TDM approach explicitly aimed to shrink the share of car travel by growing rail transit share, as shown in Table 1.14 in the background information part. The plan projected car travel to grow to 48% of all trips by 2030, and set a target to limit it to 35%, mainly by shifting driving trips to rail transit. The new EEP2015 plan contains no major strategies for energy savings for personal travel. This is an unfortunate change of focus, as the personal travel sector represents significant transport energy use. A challenge will be to re-integrate transport energy use by personal vehicles into energy efficiency planning.

Achievement 20. *Alternatives to driving in Bangkok are being provided via expanding the rail services and bus rapid transit.*

There has been strong progress on rail transit supply in Bangkok. The network is well established and rail capacity is growing via Mass Rapid Transit (MRT) and Sky Train extensions. Cabinet approval is expected on four new MRT lines in late 2015, which will be an important step in growing the system. (APERC, 2015) These services are starting to generate network effects and grow demand for rail transit. Bus capacity is also growing, with the first Bus Rapid Transit (BRT) line completed. There is a strong focus on infrastructure development and significant funding has been committed.

Yet a challenge remains to improve integration and convenience of the transit system as a whole. In order to grow mode share for rail transit, rail services must be well linked with bus services and operate as a seamless system. Only then will it be possible to offer travel times competitive with driving. The greatest challenge in this regard is with the bus network. Buses that are trapped in traffic congestion cannot offer a faster travel time than cars. As Bangkok's rail network grows, the time is coming to experiment with bus-only lanes during peak times, to feed the rail network and to fill in areas with low rail coverage. Buses are a neglected mode, as evidenced by the lack of mention of bus services as having a role in energy savings during the Follow-up PREE mission trip.

Achievement 21. *Beginning to invest in bicycle infrastructure to provide more alternatives to driving.*

Thailand has taken steps to embrace and promote bicycle travel, which is an important step in providing alternatives to driving. The National Health Assembly and worked with the Thailand Cycling Club (TCC) to pass a resolution on 'Systems and structures for promotion of walking and cycling in daily life.' The Government Cabinet assigned various Ministries to take actions promoting cycling and walking. (TCC 2015) TCC is also working with many local leaders to improve conditions for cycling and become 'bicycle friendly communities.'

An achievement by the BMA is the creation of some 50 bike sharing stations and 200 kilometres of blue bicycle lanes. (KSL, 2013) However these bike lanes directly adjacent to traffic area easily blocked by parked cars and less safe than segregated cycle ways. A challenge remains to build a comprehensive bike network, complete with adequate public parking.

Improving safety is another key challenge to growing the share of travel by walking and cycling, the most energy efficient modes. To improve safety, many cities have enacted 30 kph speed limits for vehicle traffic. Improving the design of sidewalks and crossings, and planting more trees for shade, would greatly improve walkability.

Achievement 22. *Ending the fossil fuel tax subsidy for LPG is an important move toward 'getting the prices right'.*

Letting drivers pay the full market cost of LPG fuel is an important step toward increasing the cost of driving. Giving drivers an accurate price signal about the cost of fuel helps manage demand for travel. A challenge remains further using taxes and fees as a way to further suppress demand.

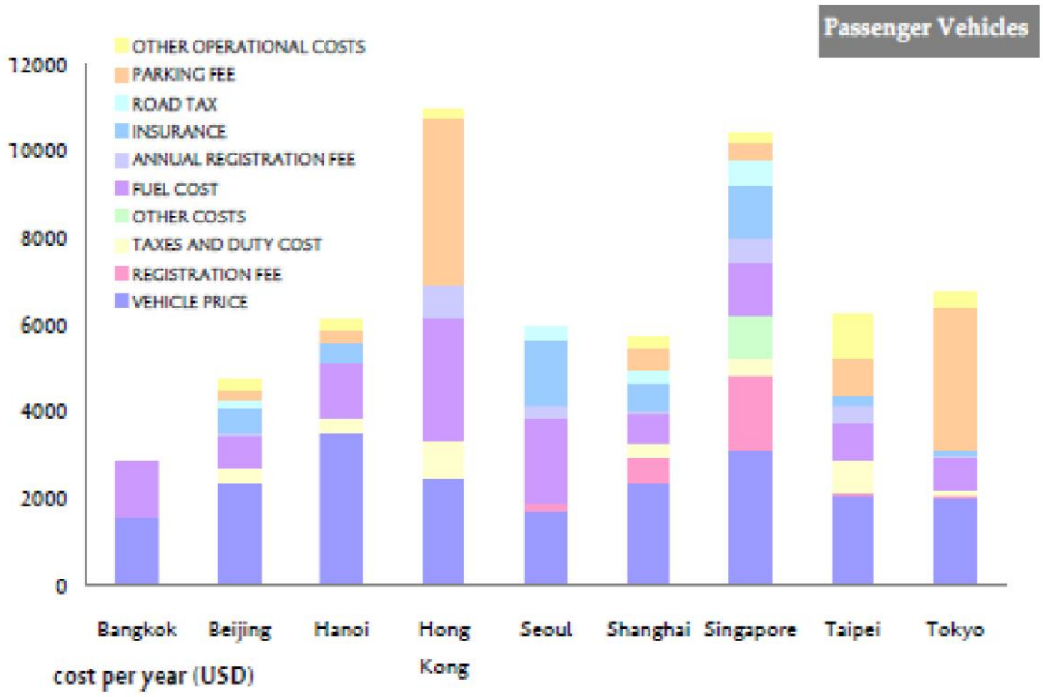
Achievement 23. *Excise tax reform has linked CO_2 emissions to vehicle cost.*

Thailand's excise tax reform is an admirable achievement, as it links CO_2 emissions to vehicle cost. The new tax structure linking the excise tax rate to engine size and CO_2 emissions will make the most polluting vehicles the most expensive. Lower tax rates for fuel-efficient and low emission cars will encourage the purchase of these cars and lead to a more energy efficient fleet over time.

However, while the excise tax will influence car purchase decisions toward more fuel-efficient cars, it will have little impact on car use decisions. Once a vehicle is purchased, the owner has an economic incentive to use it and is far less likely to use public transport. In Thailand, where the vehicle fleet is growing rapidly, net energy usage will still increase as growth in energy use by new vehicles outpaces energy savings from vehicle efficiency. Fleet growth remains a challenge.

In the longer term, managing demand for travel means suppressing the rate of fleet growth. Pricing is an effective strategy used by many peer economies. As shown in Figure 5.1, the cost of vehicle ownership in Bangkok is lower than in peer cities in APEC economies. In Bangkok, the annual cost of vehicle ownership is estimated as USD 2500, but over USD 10000 in Hong Kong and Singapore. Excise tax and duty cost (shown in yellow) hardly counts as a factor as a component of ownership cost in Bangkok, yet forms a significant component of the cost in peer cities in the region, particularly Hong Kong and Taipei. Thailand's cost of vehicle acquisition and ownership are lower than other countries with strong and growing car manufacturing industries such as Japan, Korea, and China.

Figure 5.1 Bangkok has a lower cost of vehicle ownership than peer cities in APEC economies



Source: APERC, 2008.

Many cities experiencing rapid car fleet growth use taxes and fees as a way of managing vehicle fleet growth. For example, Singapore and Shanghai both limit the number of new car registrations allowed in a year. Both cities let the market of would-be car owners set the price of car registration by holding an auction. Other cities use an annual registration fee to discourage car ownership, for example Hong Kong and Seoul.

A challenge is managing the balance between supporting a high-wage industry like car manufacturing and managing demand for cars. In Thailand, the government is committed to growing auto manufacturing capacity. Although much of this production is for export, efforts are to be made to support this industry during times of economic downturn. For example, car sales were encouraged by policies like tax rebates for first time car purchase after the tsunami in Japan. Such polices that increase car sales can work against and undermine efforts to reduce energy use in the transport sector. A city-owned car sharing system can be a way to deter car purchase decisions. A system could be developed in partnership with car manufacturers that would promote energy efficient Thai cars without personal ownership required.

Achievement 24. *An initial study of road pricing has been undertaken which identifies barriers and next steps toward implementing a road-pricing scheme.*

An initial study of road pricing noted that road pricing has been recommended as a TDM strategy for Bangkok for over three decades, with little action due to a lack of alternatives to driving and lack of public acceptability. (ATRANS, 2008) The Thai government appears committed to road pricing and has included it as a strategy in long-term

transport plans. However, Thailand has yet to establish the legal basis to enact a road-pricing scheme, an important first step. Enabling legislation is needed at the economy level that would grant the Bangkok Metropolitan Authority powers to introduce road pricing and authority to utilise the revenue. The question of which level of government will control the revenues, must be settled before the Mayor of Bangkok can credibly claim that road pricing revenues will benefit the city.

The road pricing study noted that one reason road pricing has not been pursued to date was that developing competitive transit alternatives to driving was seen as a necessary precursor. It was considered unfair to increase the cost of driving without first providing viable alternatives. At the current time, transit system development is well on track, and it would make sense to begin studying road pricing scenarios in greater detail.

A challenge identified by the road pricing study was that demand-side policies get less attention in the media, and so public understanding of the impacts and benefits of these measures is low. (ATRANS, 2008) When political leaders have tried to pursue pricing, they have faced pushback from the public and the business community. Increasing the cost of driving is politically unpopular, and so support must be built over time by detailed study and public education. When educating the public about pricing, it should not be presented as an isolated measure, but as part of an overall transport strategy linked with public transit. In particular, questions about winners and losers must be resolved, that is, which groups of drivers will pay the charge, how revenues will be used, and which groups of people will benefit from the revenues. Ideally the revenues will be reinvested in transit services to ensure widespread benefits. For example, revenues from the London congestion charge are dedicated to increased public transit services, meaning that winners greatly outnumber losers.

Achievement 25. *Double-tracking the economy's rail network will help manage demand for shipping goods by truck, and potentially shift some inter-city travel from cars and buses to rail.*

Thailand is in the midst of a historic rail investment, with plans to double-track most of the economy's rail network. This should be done in step with demand, meaning that high demand corridors should be done first, and double-tracking may not be needed in low demand corridors. Investment in rail infrastructure could considerably boost freight intermodal capacity, if further investments are made to support it. Intermodal port terminals for maritime-rail-truck transfers may be needed, and additional intermodal terminals like the Inland Container Depot may be needed, in the longer term. The double-tracking, by modernising the rail network and allowing for higher speed travel, makes new inter-city passenger rail services possible. But much depends upon the types and quality of land development around rail station areas where passenger flows are expected to increase.

Achievement 26. *Beginning to link land use around major rail transit stations to transit-supportive uses.*

Some steps toward linking land use around major rail transit stations to transit-supportive uses are evident, for instance, encouraging transit oriented development (TOD). Some rail transit stations, such as the one at the hotel where the Follow-up PREE was held, are very well integrated with commercial development. There are other local examples, like the retail centre at Chatuchak Park, and plans for a new mixed commercial and residential development on the Pink Line. (MRTA, 2015) Challenges identified during the review was the lack of a clear TOD policy in Bangkok's land use plan, and legal and financing barriers that need to be solved. The connectivity of TOD projects to the pedestrian network was another challenge, that is, ensuring that the design of new TODs is walkable

and facilitates easy access to rail or bus stations. For more attention needs to devoted to improving the quality of the walking experience in Bangkok.

An interesting challenge that emerged during the Follow-up PREE was the balance between maximising land near rail transit stations for parking cars or for residential use, such that the supply of housing within easy walking distance of the rail system is expanding. Zoning policy to encourage the development of park and rides has been accomplished, and a new park-and-ride facility built at Lad Phrao. (BMA, 2015) Park-and-ride facilities are best located on the fringes of the metropolitan area, at the outermost terminal stations. More central stations are better suited for housing.

Achievement 27. *Requiring major employers to monitor and reduce energy use.*

Thailand's Energy Conservation Program and Promotion Act was revised in 2007 to require large energy users to monitor their energy use and take steps to reduce it. These defined buildings and factories are required to meet the latest energy code and standards for efficient office equipment and machinery. They monitor their progress by designating a person responsible for energy and conducting energy management audits. These are important steps toward raising awareness and promoting energy reduction measures.

Challenge 21: *Including energy use for transport in monitoring energy use under the Energy Conservation Program and Promotion Act.*

Energy use for transport is not currently included in the Act. Many occupants of large buildings and factories are large energy users requiring inputs arriving by truck and rail, which is part of their energy footprint. Further, many occupants are large employers and energy used for commuting is also part of their energy footprint. Including energy use for transport would create an incentive for monitoring and reducing transport energy use. A precedent is the US Clean Air Act amendment of 1990's Employee Commute Options Program, which required companies with more than 100 employees in areas with poor air quality to take measures to reduce workplace-related transport emissions and boost carpooling and transit among employees' commutes (Cusumano, 1993). There are several successful regional examples in engaging with employers to reduce energy use and improve transport system efficiency. Australia's Travel Smart program required employers to create access plans and provided toolkits to help. Singapore launched a Travel Smart program and worked with employers to promote flexible working arrangements and transit use.

Challenge 22: *Decouple income growth from car ownership.*

Motorisation, or increasing car ownership is leading to mode shift away from public transport and motorcycle to private cars, the most energy intensive mode. The vehicle population is growing at a much faster rate than the population of people. From 2004 to 2012, the average annual growth rate for personal car ownership was 7.9% per year. (APERC 2015) As shown in Table 5.2, in 2004 there were .09 cars per capita in Thailand, but by 2012 this had nearly doubled, to .17. Table 5.3 shows the same calculation for Bangkok, where incomes are highest and motorisation is proceeding most rapidly. There were approximately .38 personal vehicles

Table 5.2: Growth of car ownership in Thailand (millions)

Year	Personal vehicles (Cars, vans and pickups)	Population	Personal vehicles per capita
2003	6.0	65	0.09
2012	11.2	67	0.17

Source: APERC, 2015.

Table 5.3: Personal vehicles growth in Bangkok (millions)

Year	Cars	Motorcycles	Total personal vehicles	Population	Personal vehicles per capita
2003	1.23	0.86	2.09	5.5	0.38
2010	3.47	2.45	5.92	6.3	0.93

Source: APERC 2010, UN Habitat 2013, BMA 2015.

Historically, growth in car ownership has been coupled with per capita income growth. A challenge is for Thailand to de-couple growing prosperity from car ownership and associated energy use. Some leading world cities have been able to achieve this by developing excellent public transport systems that offer more convenient and faster services than cars. For instance, car ownership in the Greater London Area declined from .85 cars per household to .81 from 2001 to 2011. (TfL, 2013).

Challenge 23: *Reduce impact of urban decentralisation on energy consumption.*

Urban decentralisation, or the increasing distance between origins and destinations in the Bangkok metropolitan area (BMA) is increasing energy demand in Thailand's transport sector for personal travel. As shown in Table 5.4, the population of the inner city has been in a long-term decline while outer areas have grown. This trend is driving up energy expenditure. As people choose homes located further away from workplaces, and in low-density developments lacking walkable access to shops, more frequent and longer car trips are necessary.

Table 5.4: Decentralising population trend (persons per km^2)

Year	Population density, Inner Bangkok	Population density, Outer Bangkok
1978	15 270	770
2000	11 090	1 280

Source: Nitivattananon and Noonin, 2008.

The key metric to track is vehicle kilometres travelled (VKT), which is a rough proxy for energy use. Thailand's population is increasingly concentrated in the BMA, and as the most densely populated area it has the greatest potential for transport energy savings. Setting targets for VKT reduction in the BMA is an important step towards slowing decentralisation.

Challenge 24: *Coordinate transport systems with urban land use planning.*

Historically, the transport system and urban land use have been developed independently. A challenge is for Thailand to begin coordinated transport and land use planning, both at the national and metropolitan level. Demand

management in the longer term depends a compact urban development where a high share of trips can be made by walking and biking. Urban design and connectivity are also important factors to supporting these most energy efficient modes.

5.2 RECOMMENDATIONS

A TDM programme should be developed by targeting strategies to influence different types of trips: commute trips, other metro non-work trips, and intercity trips. Work trips are the most readily switched to public transport, as the origin and destination are always the same. It helps to engage employers in supporting TDM strategies by such measures as removing free parking and offering a subsidised transit pass. Non-work trips can be reduced by concentrating commercial activities for one-stop shopping. Creating a transit oriented development policy to link transit access to commercial activities will help to reduce demand for non-work car trips in the longer term. The growing rail system offers great opportunity to influence intercity travel. Rail stations should be well served by local transit, ticket prices competitive with cost of driving, and schedules convenient.

The list below summarises TDM measures recommended for short, medium, and long term implementation. The below measures include increasing the cost of driving and low political impact that can be undertaken while studying more controversial measures.

Recommendation 26. *Include TDM strategies to meet energy savings targets in the 20-year Energy Efficiency Development Plan.*

Develop a clear set of TDM strategies to meet the energy savings targets set out in Thailand's 20-year Energy Efficiency Development Plan. For each strategy, a performance measure should be defined and data collected to track it. Also need a clear set of strategies and regional sub-strategies to achieve the goal of growing the share of travel by rail transit. For example, most of the potential to shift travel to rail transit is in Bangkok, and so strategies should be developed together with the BMA.

Recommendation 27. *Set key performance indicators (KPIs) for mode share, bus and rail ridership, and VKT, and collect data to track trends.*

Transport investments and land development strategies should be linked to key performance indicators (KPIs), in order to clearly communicate goals and measure progress toward them. While the Ministry of Energy has done great work setting targets and breaking them down into sectoral and annual targets, KPIs would help identify the 'vital statistics' to monitor and track annual progress in the transport sector. A key performance indicator simply identifies a key metric reflecting the government's or agency's goals, which is easily quantified and tracked. Once goals are set and KPIs identified, it becomes clear which data should be collected to monitor progress. Some KPIs are set numerically, for instance, 'reducing pedestrian fatalities by 50% by 2030.' They may also be set to indicate the desired direction of progress, for instance, 'increasing annual rail transit ridership.' Sensible and oft-used transport KPIs include annual VKT, mode share for cars vs public transit, travel delay due to congestion, bus reliability, and serious injuries and fatalities.

Recommendation 28. *Conduct a detailed road pricing study, considering several design options.*

Conduct a detailed road pricing study, considering several design options, i.e. congestion charge by area or time of day, per km charge, and addressing the question of revenue allocation.

Recommendation 29. *Educate the public about road pricing policies.*

The government should begin educating the public the public about pricing, presenting it as part of an overall transport strategy linked with public transit. Form a committee or commission for engaging and educating key stakeholders, particularly the business community and the media, about the impacts and benefits of road pricing.

Recommendation 30. *Conduct a study on the measures to increase the cost of vehicle acquisition and ownership, along with adopting alternatives such as city-owned car sharing services and extending the efficient operation of public mass transport system.*

Conduct a study on the impacts of measures to increase cost of vehicle acquisition and ownership, e.g. raising the excise tax, instituting a car registration fee and annual renewal fee in Bangkok. It should also estimate the impacts of a 30 km/h speed limit, including energy savings, reduced injuries and fatalities and look into the feasibility of a city-owned car sharing service.

Recommendation 31. *Increase the cost of vehicle ownership by raising economy-wide vehicle excise tax and car registration fees based on carbon emissions emitted.*

Make Bangkok the most expensive place to own a car by instituting an annual fee for Bangkok addresses. This would include adopting enabling legislation for road pricing and developing partnerships between land use and transport planning agencies at the economy and BMA levels.

Recommendation 32. *Unify the ticketing system across all modes of transit.*

The aim in any public transport system should be to have a high proportion of committed transit users using mostly pre-sold tickets (e.g. monthly or annual passes), the users of which benefit from large fare discounts compared to single fare purchases. Transferability to other family members of such pre-purchased passes should be considered (as for example in Zurich, Switzerland, generally a model of sound transit practices).

It is recommended that all transit systems in Bangkok (and other Thai cities) should have their own single unified ticketing/fare system to create a seamless and hassle-free travel experience for passengers and which rewards such committed users with large discounts over travel using single fares. This has been shown to rapidly build mass transit use (e.g. in London). It is further recommended that such a system could be administered and modelled on the German or Swiss Verkehrsverbund (Pucher and Kurth, 1996).

Although, it notes that it is already the intention to introduce a common ticketing system in 2016 amongst the MRT, BTS and MRTA's bus system in Bangkok.

Recommendation 33. *Introduce employer subsidised transit passes.*

Extend the Energy Conservation and Promotion Act to include energy monitoring and reduction for transport. Provide assistance or a tax incentive for employer-subsidised transit passes. This could be funded by a tax on commercial parking, to discourage new supply.

Recommendation 34. *Implement road pricing and create an office for Mobility Management.*

In the longer-term, road pricing will be the most effective measure for reducing Bangkok traffic congestion. The revenues from pricing should be used to cross-subsidise transport demand measures. One potential use would be to create an office of Mobility Management for the BMA, charged with monitoring travel trends, working with employers to implement commute-reduction strategies, and conduct public outreach about bike sharing, car sharing, living near transit, and other ways to reduce energy use for personal travel.

Recommendation 35. *Supporting the use of IT in the transport/logistics industries (on demand service, virtual marketplace).*

There is an apparent and a growing demand for the IT of application in transport. Either for personal or freight mobility, applying IT using handheld and mobile device is attracting private sector investment. With the availability of adequate bandwidth and IT infrastructure for wireless communication, efficiency in the transport industry can be enhanced. Empty running taxis and trucks can be reduced and travellers can use their time more productively. The Government can support the IT industry by creating incentives for IT innovation, use ENCON fund to encourage start-up companies willing to invest in transport IT application and establish a technology-oriented regulation to allow future development of IT incorporated in the existing system.

6. VEHICLE FUEL ECONOMY LABELLING AND STANDARDS

6.1 ACHIEVEMENTS AND CHALLENGES

Achievement 28. *Established robust automotive industry and research institutes*

Thailand has a robust automotive industry. The Government has put in place consistent policies to support the industry since the late 90s. As a result, the production, domestic sales, and export of motor vehicles increased more than eight-times from about 320000 units in 2000 to 1.8 million units in 2014. Thailand has become the twelfth largest producer of motor vehicles in the world and fifth largest producer of motorcycles in the world. Most, if not all, of the big international car manufacturers have set up manufacturing shops in Thailand.

Together with relevant government agencies and the private sector, a semi-government entity, the Thai Automotive Institute, was established in 1998 to further support the development of the automotive industry and to act as a 'broker' between government and the industry. The institute has since become a fully-equipped institute that is able to support the technical testing required by vehicle manufacturers and other related industries. A succession of Thai Automotive Industry Development Master Plan was also started since 2002 and has paved the way for the economy to become a vehicle manufacturing hub in South-East Asia. Thailand has also become the leader in South-East Asia in terms of adopting a roadmap for cleaner fuels and vehicles. Vehicle emission standards and fuel quality is currently at Euro 4 equivalent and 50ppm sulphur in gasoline and diesel. There are plans to move to Euro 5 and 10ppm sulphur in fuels by 2021.

Achievement 29. *Policies and incentives adopted to support vehicle manufacturers and encourage production and sales of more efficient vehicles through the Eco Car Phase 1*

In 2007, Thailand has started developing its Eco-Car program that aimed to provide incentives for manufacturers to develop more efficient cars, in particular, cars that have an engine size of 1100cc and 1300cc. Policies on improving energy efficiency of motor vehicles have also been discussed by various government agencies. In fact, in the original Peer Review on Energy Efficiency in 2010, the report already included recommendations for various sectors, including the transport sector such as, the adoption of eco-stickers to inform the public of cleaner and efficient vehicles and putting in place fiscal measures to encourage adoption of more efficient vehicles.

In 2013, the government launched a program called Eco-Car Phase II, which put more emphasis on the production and use of more efficient vehicles. The program provides exemption on import duty on machinery, up to 90% import duty reduction on raw materials, exemption on corporate income tax of 6 years, not exceeding the project investment amount, and one or two additional year if there is investment or expenditure in developing Thai auto part suppliers. In addition, the Thai government has also announced adoption of Eco-Stickers to be put on new vehicles, and this will be accompanied by a new tax structure by January 2016, that provides lower excise taxes for more efficient vehicles based on CO2 ratings (see Table 1.14 in Part 1).

However, there are still some challenges with respect to improving energy efficiency and providing cleaner and more efficient vehicles in Thailand. One is how to further encourage the local market to prefer more efficient cars particularly for city driving. The most popular vehicle in the market is the 1 Tonne Pickup truck, for example total sales amount to about 47% of the total from January to March 2015. Perhaps more people prefer this type of vehicle because it is used for business purposes as well. It is important to note that big SUVs are also included in this category, and as such could be indicative of the propensity of people even in urban areas to use this type of vehicle for short distance city driving. The eco-sticker program and the revised vehicle taxation scheme are expected to address this challenge. Needless to say, traffic and transport challenges in urban areas could further be improved by having integrated solutions that prioritise public transport and non-motorised transport over personal motorised transport.

In terms of monitoring the impact of fiscal policies promoting more energy efficient vehicles, another challenge is to make sure that there is a consolidated database that will pull together information on the sales of new vehicles, and to some extent characteristics of vehicle use. This information will be vital for evaluating existing policies and for formulating better and more appropriate policies encouraging adoption of more efficient vehicles. Another challenge is on how to ensure a stronger cooperation among all stakeholders involved in the implementation and monitoring of the eco-sticker program and revised taxation scheme, including but not limited to, DEDE, EPPO, OIE, TISI, TAI, etc.

6.2 RECOMMENDATIONS

In order to strengthen and support the implementation of the energy efficiency policies to be implemented by Thailand, the following are recommended.

Recommendation 36. *Institutionalise an annual review of the taxation scheme and establish 'a committee' to check whether the intended outcome is being achieved.*

It will be important to make sure that there is a mandated review of the policies, i.e. Eco-Car Phase II, the Eco-Sticker Program, and the revised taxation scheme, during the half-year or end of 2016. Establishing a 'committee to put in

place a mechanism to assess the impacts of these policies will also benefit relevant stakeholders, including the public, and verify whether the intended objectives are being met.

Recommendation 37. *Policies and incentives for vehicle manufacturers under Eco Car Phase II should include other vehicle types, e.g. 2-wheelers.*

The incentives provided for vehicle manufacturers under the Eco Car Phase II program are notably focused for manufacturers of cars (4-wheelers). It may be prudent to expand the scope of this scheme or in future schemes to include 2-wheelers, particularly electric bicycles, scooters, and motorcycles. It is apparent that there is very high share of motorised 2-wheelers in urban areas, as also reflected in the high percentage of motorcycle shares compared to cars in Thailand. While motorcycles are inherently efficient, the potential of electric 2-wheelers to improve over-all energy efficiency in the transport sector in Thailand is still high. Integration of electric cars into the program or in succeeding programs should also be explored.

Recommendation 38. *Explore the adoption of a feebate system that provides fees for less efficient vehicles and rebates to more efficient vehicles.*

A feebate system combines a fee with a rebate. For example, from a pivot point of 150 g CO_2/km, all vehicles more than this point will pay a fee and all vehicles below this point will get a rebate. It is relatively easy to introduce and can be cost neutral – i.e. the overall tax income can remain the same, as this is often a demand from the Ministry of Finance. This system may be effective to encourage people to buy more efficient cars as they can get some rebates (or discount in the total cost) and in the longer term, more efficient cars will be in urban traffic. In France and Singapore, such a system worked well in getting more efficient and smaller cars on the road in urban areas (see Box 6.1 for more information).

Box 6.1: Feebates

Feebates are essentially a fee on inefficient technology and a rebate on efficient vehicles. The International Council on Clean Transportation published a report on best practices in designing and implementing feebate programmes. According to David L. Greene, Professor of Economics at the University of Tennessee, feebates are a fiscal policy for encouraging car buyers to prefer more efficient, lower emission vehicles and manufacturers to design them.

FEEs on inefficient vehicles; and ReBATEs on efficient vehicles need to set a 'benchmark' (also known as a pivot point) which defines who pays and who receives benefits by setting a level of fuel economy or emissions (e.g. in gCO_2/km). A 'rate' determines the marginal costs and benefits (usually priced in cost per g/CO2). Depending on the choice of benchmark, feebates can produce revenue, be revenue neutral or be a net subsidy to cleaner, fuel efficient car purchases.

Recommendation 39. *Explore the adoption of Minimum Energy Performance Standards (MEPS) as mandatory standards for LDVs.*

The Minimum Energy Performance Standards for light-duty vehicles are currently voluntary. If these MEPS can become mandatory, it can push the market into selling only efficient vehicles and will complement the revised tax scheme that provides incentives for other types of vehicles, e.g. hybrid and alternative fuel vehicles.

Recommendation 40. *Include a comparison reference point in the Eco-Sticker labelling.*

The Eco-Sticker has a reference point on where is the fuel consumption from 0 to 10 L/100km (see Figure below). However it would be more informative if there is a comparison on how the vehicle compares to other types of vehicles in the market, e.g. whether it is more fuel efficient than 90% of the cars, or only 30% of the cars.

Figure 6.1 Eco-Sticker

Source: Office of Industrial Economics, 2015.

Recommendation 41. *Analyse how the Eco-Sticker can apply to second-hand vehicles.*

Thailand has high vehicle ownership compared to other ASEAN countries and vehicle turnover is also relatively faster. As such, more and more second-hand vehicles will enter the market. At present, it is not clear how these second-hand vehicles will be integrated into the Eco-Sticker program and also affected by the revised taxation scheme. The adoption of a feebate system can also potentially increase the number of second hand vehicles into the market as more people will be incentivised to replace their older vehicles. It will be important to analyse how second-hand vehicles will be integrated into the program.

Recommendation 42. *Establish a database of the sales of new vehicles, including detailed information, e.g. engine size, fuel, etc. through the Excise Department, for example.*

A central database or repository of information related to the implementation of the Eco-Sticker including the collation of detailed information on engine size, fuel type, footprint of vehicle, etc. will be important in evaluating the policy. A single government agency should be held responsible for keeping the data for practical purposes. But mechanisms should also be in place to make sure that other relevant agencies can access this database, and use the information for policy-making.

7. HIGH EFFICIENT VEHICLE TECHNOLOGY

7.1 ACHIEVEMENTS AND CHALLENGES

Thailand has made significant progress in the last years with increased infrastructure for public transit in Bangkok, but is lagging in overall energy efficiency for the transport sector. There is currently a 30% energy efficiency target by 2036, with transport accounting for 58% of those savings (a 46% decrease compared to BAU). Yet, in 2010 61% of new cars achieved only 157 grams of CO_2 per km, which is far behind international standards. Furthermore, sales of new vehicles is growing, with half of all sales being pick-up trucks weighing more than one tonne, taking up relatively more space and being very energy inefficient.

Considering other vehicles for energy efficiency, the road freight sector is overlooked despite accounting for 88% of freight activity. Similarly, the motorised two-wheeler sector is also not sufficiently considered, despite being a significant vehicle mode in Thailand (60% of vehicles) and in the region, with around two million two-wheelers produced each year in Thailand – number three in ASEAN.

For other fuels, 6.8% of CNG consumed in Thailand in 2014 was for transport, and Thailand has approximately 10 years left of natural gas resources, which is leading the government to consider more coal for power generation and LNG imports for other uses.

Achievement 30. *Restructuring fuel price.*

Fuel price restructuring has levelled the playing field for all fuels, especially LPG and CNG, which increased overall energy efficiency, adjusted refining capacity, and has led to better technology/fuel neutrality. A pragmatic approach to CNG has been implemented, focusing on fleets (taxis and buses); and Thailand has almost eliminated all oil and fossil fuel subsidies. These are substantial achievements.

Achievement 31. *Increasing the diesel tax.*

Diesel tax has gone up 3.5-times so as to align refining capacity, and LPG is now at a pooled price, but used to be heavily subsidised, and LPG imports have already gone down by half last year (2014) as a result. CNG is still subsidised, but its subsidy has been reduced recently, and the government is planning for a move to a floating price. Supply and distribution problems in the last seven years have lead NGVs to not take off (passenger car segment), and pricing is now the only incentive for NGVs, which might keep things interesting enough for taxis and buses as CNG is half the price of diesel.

Achievement 32. *Excise taxes and an oil fund levy on fuels are both being used as instruments to further energy efficiency in the transport sector, with the oil fund only to be used for short-term measures, including the promotion of biofuels.*

The excise tax structure will change January 1, 2016, which will use grams of CO_2 per km as a measure instead of only the size of the engine, which is a welcome move. Hybrid excise tax benefits include all types of hybrids, including 'simpler/mild' hybrids, which will lead to preferential treatment towards start-stop hybrids. This is welcome given the underestimated benefits of hybrids in Bangkok's start-stop traffic (please see Figure 7.1 below).

Figure 7.1 Comparison of average fuel consumption between weekdays and weekends

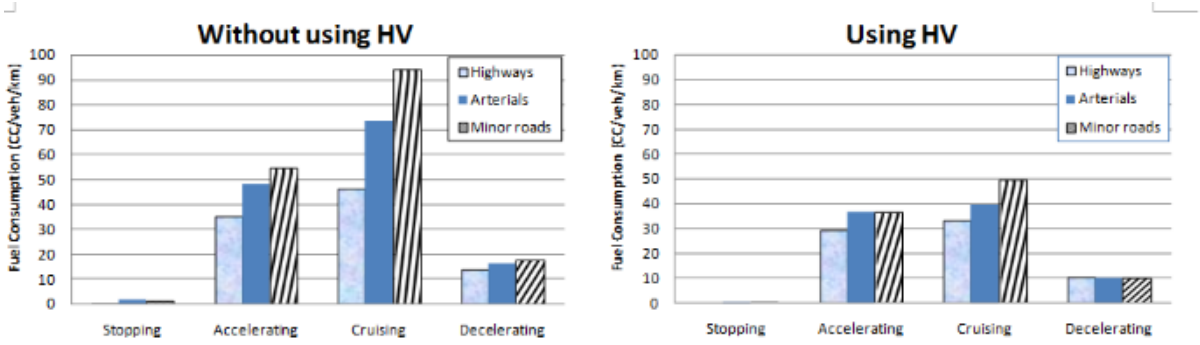
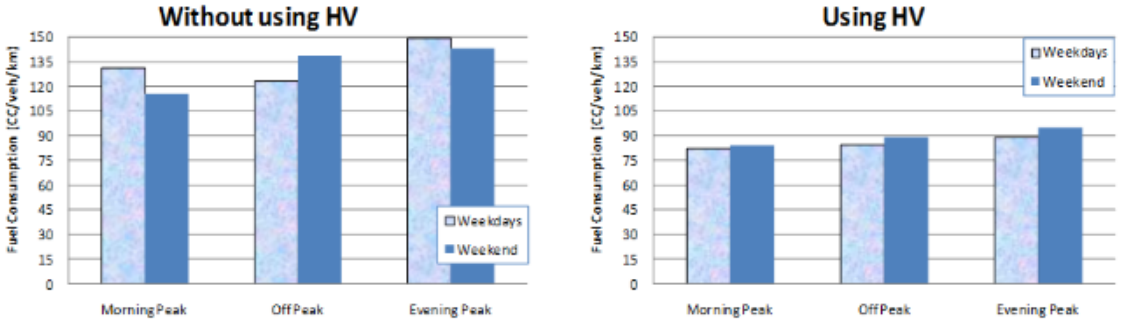


Figure 6. Monthly average fuel consumption in each mode on weekdays in cases of without using and using hybrid system



Source: Srisakda et al, 2015.

Challenge 25: *Include biofuel into Phase II of the Eco-Car Initiative.*

25% of cars produced in the Phase I of the Eco-Car initiative were sold in the domestic market; Phase II is meant to increase the competitiveness of the Thai auto manufacturing sector with 90% aimed for export; Phase II might include some AFVs (ethanol, B20, etc.) Currently, the share of biofuel is increasing, already standing at 92% of current market share (share of petrol that includes some share of biofuel, so-called 'gasohol').

Challenge 26: *Developing a strategy on freight.*

According to TDRI, an independent research institute on freight, there is a no clear strategy on freight in Thailand, and few if any price signals to help improve its energy efficiency, not counting a ban on trucks in Bangkok for certain hours, a regulation that came from the Prime Minister's office. A sustainable freight master plan is called for to ensure freight meets energy efficiency targets. MOT is planning on REST AREA construction in Nakhon Ratchasima to support trucks' operator to reduce the single trip transport by fulfil all trucks full loading without/less empty space by fulfil/sharing the loading to reduce one trip carrying like in the USA and European implementing.

Challenge 27: *Developing an energy efficiency strategy for 2W vehicles.*

Thailand has the world's fifth largest production of two wheelers, is situated in the biggest 2W market in the world (ASEAN), and with 58% of vehicles being motorcycles, there is nevertheless no clear strategy for increasing their

energy efficiency. Moving towards electric two-wheelers (e2W) (pedelecs, e-bikes, and e-scooters)[7] would achieve this goal (they are up to 92% more efficient), help capture the lead for the e2W market, and would have substantial air and noise pollution co-benefits.

Several perceived and real barriers exist, including the DLT banning all e2Ws with maximum speed limits below 45 kph / 5 kW. While mid-range e-bikes can 'only' go as fast as 50-60 kph (not the case for more powerful e-scooters), the average speed in Bangkok is just 20 kph, and around 10 kph at peak traffic. Given Thailand having the second most dangerous roads in the world, more moderate speeds would not be a bad consideration for its cities. Also, while driving range might be limited for e-bikes to around 60 km, the average daily travel by all modes in Bangkok is only 35 km per day. Finally, the annualised cost of a lead-acid e2W is one-third less compared to a conventional 2W, even taking battery replacement into account.

For other electric vehicles, an electric bus trial took place in 2015 in Bangkok, aiming for 3 000 buses on the road.

Challenge 28: *Moving to second generation biofuels.*

As for biofuels, they have reached an enviable share of gasoline or 'gasohol', but need to move to second generation biofuels to not compete with food, and 2021 targets are in place but will be challenging to meet as little to no production is up-and-running.

Challenge 29: *Shifting CNG prices to floating prices.*

CNG prices still need to go floating like LPG prices, and the Eco-car Phase II (Eco-car Phase II is Euro V and <100gCO_2/km) should include alternative fuel vehicles, e.g., electric and fuel cell vehicles.

Challenge 30: *Addressing energy efficiency in the maritime transport subs-sector.*

Little attention is paid to maritime transport as a tool to increase energy efficiency, reduce pollution, and shift freight from trucks on roads to ships on inland waterways and along coasts, but this is untapped potential.

7.2 RECOMMENDATIONS

Recommendation 43. *Develop policies for encouraging the adoption of more efficient electric 2-wheelers, particularly for urban traffic.*

With 60% of vehicles on the road being motorised 2-wheelers, there is great potential to increase their efficiency, including through electrification, which is around 90% more efficient than the reference vehicle on the road. Motorised 2-wheelers account for a substantial share of local air and noise pollution, and their improved efficiency is 'low-hanging fruit' that Thailand should consider as a priority.

Recommendation 44. *Remove speed limit requirements for electric 2-wheelers, adding optional safety measures (banning them from highways for example), to allow the market to develop.*

[7] Pedelecs are electric two-wheelers that have a maximum speed of 25 kph; electric bikes or 'e-bikes' up to 50 kph; and electric scooters or 'e-scooters' going above 50 kph.

While e-bikes might be slower, there is pent-up demand as seen by China's 200+ million market, and Thai cities stand to benefit hugely from air and noise pollution co-benefits, and decreased maintenance and fuel costs for drivers. More analysis is needed to address real issues with research, and perceived issues with education.

Recommendation 45. *Analyse the potential for using of LNG for trucks along suitable corridors.*

LNG corridors are known to be worthwhile where multi-modal access is possible. Analysis should be conducted to assess the potential of LNG being used for the heavy-duty truck sector along suitable corridors, including river-, rail-, and pipeline-corridors.

Recommendation 46. *Address the emissions efficiency of the passenger and freight maritime sector and develop appropriate policies.*

Thailand has tremendous opportunity for modal shift towards inland waterways and coastal shipping, as well as passenger maritime possibilities. However, this neglected sector (only 5% of freight traffic in Thailand is moved by water) should be assessed according to appropriate metrics of energy efficiency, pollution (local and global pollutants), as well as fuel options, including options for action through policies and measures.

Recommendation 47. *More analysis should be done on hybrid cars and buses in Bangkok's start-stop traffic, as their efficiency is currently greatly underestimated.*

While hybrid cars are thought to get 20-25% better fuel economy than a conventional vehicle, research shows that in Bangkok's start-stop traffic, this might be closer to the 50%. This should be further analysed and considered, as Bangkok might be able to tap into huge energy efficiency savings by using hybrid cars and buses, including for example business (e.g. taxis) and government fleets to more quickly recoup upfront costs through higher mileage.

Recommendation 48. *Supporting the replacement of old vehicles and old vehicle technologies with more energy efficient vehicles/vehicles technologies (e.g. electric vehicles) for the domestic market, i.e. using tax incentives and promoting public awareness of this issue.*

With a stagnant domestic consumption of cars, the Thai Government has to ensure that the automotive industry remains a strong contributor to economic growth and at the same time reducing the fuel use for transport activities. The policy for vehicle replacement and replacement of vehicles with older technologies will serve both automotive and transport sectors. Older vehicles can be scrapped or exported to economies where environment standards are less stringent. The importing economies will still benefit from the higher standards from Thai vehicles. The use of tax incentive to vehicle/engine replacement and retrofit has been successful in other countries and can be an example to be implemented in Thailand.

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APPENDIX B: CONSULTATION AND DISCUSSION PRESENTATIONS

Overview of Thailand Energy Outlook, Energy Efficiency Policy and Energy Efficiency Improvement Potentials in Transport Sector, Mr.AsawinAsawutmangkul, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy.

Thailand's Policy and Trend on Promoting Energy-Efficient Vehicle, by Mr Vichai Jirathiyut, Thailand Automotive Institute (TAI).

Development Plan on Thailand Transport Infrastructure Development 2015-2022 and Action Plan on Urgent Implementation Stage 2015 (Action Plan), Dr Malee Uabharadorn, Office of Transport and Traffic Policy and Planning (OTP), Ministry of Transport.

Cycling and Walking Promotion in Thailand, Mr Gawin Chutima, Thailand Cycling Club.

Bangkok Land Use Policy and Planning, Dr Orapim Pimcharoen, Bangkok Metropolitan Administration (BMA).

Thailand's Oil Price Subsidy Policy for Transport Sector and the Master Plan for Promotion Fuel Efficiency for Vehicles ,Dr Twarath Sutabutr, Energy Policy and Planning Office (EPPO), Ministry of Energy.

Eco car Promotion in Thailand, Mr Chokedee Kaewsang, The Board of Investment of Thailand (BOI).

The Regulation of Emission Standards for Vehicles in Thailand, Mr PanyaWorapet hcharayut, Pollution Control Department (PCD), Ministry of Natural Resources and Environment.

Fuel Choices for Transport Sector in Thailand, Dr Nuwong Chollacoop, National Metal and Materials Technology Center (MTEC), Ministry of Science and Technology.

The ECO Sticker Promotion Scheme in Thailand Dr Nattapol Rangsitpol, Office of Industrial Economics, Ministry of Industry.

The Master Plan for Railway Development, Mr Boonlert Tantiwinyupong, The State Railway of Thailand (SRT), Ministry of Transport.

PTT Natural Gas Pipeline Overview and Energy Management, Mr Chatchai Subin, Petroleum Authority of Thailand (PTT).

Oil Pipeline System in Thailand, Mr Chalat Boonlai, Thai Petroleum Pipeline Co., Ltd.

New Carbon Tax Measure for Excise Tax Structure on Automobile, Mr Nutthakorn Utensute, The Excise Department, Ministry of Finance.

Domestic and International Airport Management and Cargo Freight, Mr Khata Vinin, Airports of Thailand (AOT), Ministry of Transport.

Energy Efficiency in Freight Transportation of Thailand, Dr Sumet Ongkitikul, Thailand Development Research Institute (TDRI).

Challenges of Transit Oriented Development (TOD) in Thailand, Dr Somprasong Sattayamully, Mass Rapid Transit Authority of Thailand (MRTA), Ministry of Transport.

APPENDIX C: REFERENCES

Alexander, I. (1980) Office dispersal in metropolitan areas II. Case study results and conclusions. Geoforum 11, 249-275.

Alexander, I. (1981) Employment dispersal in metropolitan areas: Equitable and energy saving? Proceedings of 51st ANZAAS Conference, Architecture and Planning Section, May.

APERC, Asia Pacific Energy Research Centre, (2010). 'Peer Review on Energy Efficiency in Thailand,' Tokyo: Asia Pacific Economic Cooperation.

ATRANS, (2008). 'A Road Map for Road Pricing Implementation in Thailand: Decision Making Context,' Bangkok: Asian Transportation Research Society.

Baillieu Knight Frank (1991). The wasting of the CBD: A paper on infrastructure use and employment in Melbourne, BKF Research, June.

Barter, P.A. (1998). An international comparative perspective on urban transport and urban form in Pacific Asia: Responses to the challenge of motorisation in dense cities. PhD Thesis, Murdoch University.

BMA, (2015). 'Bangkok Land Use and Planning,' Presentation by O. Pimcharoen, Bangkok Metropolitan Authority. APEC PREE Policy Review, Bangkok, August 3, 2015.

Cervero, R. (1995) Sustainable new towns: Stockholm's rail served satellites. Cities, 12 (1), 41-51.

Cervero, R. (1986). Suburban Gridlock. New Brunswick, NJ: Center for Urban Policy Research, Rutgers University.

Cervero, R. and Landis, J. (1992). Suburbanisation of jobs and the journey to work: A submarket analysis of commuting in the San Francisco Bay Area. Journal of Advanced Transportation 26 (3), p. 275–97.

Cervero, R. (1998). The Transit Metropolis: A Global Inquiry. Washington, DC: Island Press.

Cusumano, (1993). 'Analysis of the 1990 Clean Air Act's Employee Commute Options Program – A Trip Down the Right Road,' William & Mary Law and Policy Review, Vol. 18, No. 1, Article 5, pp. 175-218.

Dimitriou, H. (2013) Urban transport planning: A developmental approach. Routledge Revivals, London (originally published 1992)

Gao, Y., Kenworthy, J. and Newman, P. (2015) Growth of a Giant: A Historical and Current Perspective on the Chinese Automobile Industry. World Transport Policy and Practice 21 (2) 40-55.

Garreau, J. (1991) Edge City: Life on the New Frontier Doubleday, New York.

Kenworthy, J. (2012) Don't shoot me I'm only the transport planner (apologies to Sir Elton John). World Transport Policy and Practice 18 (4) 6-26.

Kenworthy, J. and Laube, F. (1999) A global review of energy use in urban transport systems and its implications for urban transport and land use policy. Transportation Quarterly 53 (4), 23-48

Kenworthy, J. and Laube, F. (2001) The Millennium Cities Database for Sustainable Transport. (CDROM Database) International Union (Association) of Public Transport, (UITP), Brussels and Institute for Sustainability and Technology Policy (ISTP), Perth.

Kenworthy, J.R. (1997) Automobile Dependence in Bangkok: An International Comparison With Implications for Planning Policies and Air Pollution. In: Fletcher, T. and McMichael, A.J. (editors) Health at the Crossroads: Transport Policy and Urban Health, John Wiley and Sons, Chichester, England (Chapter 19, pp 215-233).

Kenworthy, J.R., and Hu, G. (2002) Transport and urban form in Chinese cities: An international and comparative policy perspective with implications for sustainable urban transport in China. DISP 151, 4-14.

Kenworthy, J.R., Newman, P.W.G., Barter, P. and Poboon, C. (1995) Is increasing automobile dependence inevitable in booming economies?: Asian cities in an international context. IATSS Research 19 (2), 58-67.

KSL, (2013). 'For Bangkok bikers, gridlock intimidates, inspires,' KSL.com, October 10, 2013. Bangkok: Associated Press. Accessed August 28, 2015. http://www.ksl.com/index.php?sid=27187711&nid=481

Kunstler, J. H. (1993). The geography of nowhere. Touchstone, New York.

Marinaki, E. (2015) .Capturing Land Value Increases Generated by Public Transport Improvements. Master of Science in Urban Agglomerations Thesis. Frankfurt University of Applied Sciences, Germany.

McIntosh, J., Newman, P., Trubka, R. and Kenworthy, J. (2015) Framework for Land Value Capture from the Investment in Transit in Car Dependent Cities. Accepted into Journal of Tranport Land Use (publication 2015).

McIntosh, J., Trubka, R., Kenworthy, J. and Newman, P. (2014) The role of urban form and transit in city car dependence: analysis of 26 global cities from 1960 – 2000. Transportation Research D, 33: 95-110.

Mitchell, R. B. and Rapkin, C. (1954). Urban Traffic: A Function of Land Use. New York: Columbia University Press.

MOE, (2015). 'Thailand's Oil Price Subsidy Policy for Transport Sector and the Master Plan for Promotion Fuel Efficiency for Vehicles,' Presentation by Twarath Sutabutr, Ministry of Energy. APEC PREE Policy Review, Bangkok, August 3, 2015.

MRTA, (2015). 'Challenges of Transit Oriented Development (TOD) in Thailand,' Presentation by S. Suttayamully, Mass Rapid Transit Authority of Thailand. APEC PREE Policy Review, Bangkok, August 3, 2015.

Naess, P. (1993a). Energy use for transport in 22 Nordic towns. NIBR Report No 2, Norwegian Institute for Urban and Regional Research, Oslo.

Naess, P. (1993b). Transportation energy in Swedish towns and regions. Scandinavian Housing and Planning Research 10: 187–206.

Naess, P. (1995). Urban form and energy use for transport: A Nordic experience. Ph.D. thesis, Norwegian Institute of Technology.

Neff, J. W. (1996). Substitution Rates between Transit and Car Travel. Paper presented at the 1996 Annual Meeting of the Association of American Geographers (AAG). North Carolina.

Newman, P. and Kenworthy, J. (2006). Urban design to reduce automobile dependence. Opolis 2 (1), 35-52.

Newman, P. and Kenworthy, J. (2015). The End of Automobile Dependence: How Cities are Moving Away from Car-Based Planning. Island Press, Washington DC.

Newman, P. Kenworthy, J. and Glazebrook, G. (2013). Peak Car and the Rise and Rise of Global Rail: Why this is happening and what it means for large and small cities. Journal of Transportation Technologies 3, 272-287.

Newman, P.W.G. and Kenworthy, J.R. (1984). The use and abuse of driving cycle research: Clarifying the relationship between traffic congestion, energy and emissions. Transportation Quarterly 38 (4) 615-635.

Newman, P.W.G. and Kenworthy, J.R. (1988). The transport energy trade - off: Fuel - efficient traffic versus fuel - efficient cities. Transportation Research 22A (3) 163-174.

Newman, P.W.G. and Kenworthy, J.R. (1996). The land use-transport connection: An overview. Land Use Policy 13 (1) 1-22

Newman, P.W.G. and Kenworthy, J.R., (1989). Cities and Automobile Dependence: An International Sourcebook. Gower, Aldershot.

Newman, P.W.G. and Kenworthy, J.R., (1999). Sustainability and Cities: Overcoming Automobile Dependence. Island Press, Washington DC.

Nitivattananon, V. and C. Noonin (2008). 'Thailand urban environmental management: Case of environmental infrastructure and housing provision in Bangkok Metropolitan Region', In: T. Kidokoro, J. Okata, S. Matsumura and N. Shima (eds), Vulnerable Cities: Realities, innovations and Strategies, Springer, Heidelberg, pp. 187–208.

Poboon, C. (1997). Anatomy of a traffic disaster: Towards a sustainable solution to Bangkok's transport problems. PhD Dissertation, Murdoch University, Murdoch, Western Australia.

Pucher, J. and S. Kurth, (1996). 'Verkehrsverbund: The success of the regional public transport in Germany, Austria and Switzerland,' Transport Policy, Vol. 2, No. 4, pp. 279-291.

Schiller, P. and Kenworthy, J. (2011). Walk to transit or drive to transit? Walk 21 Conference, Vancouver BC.

Schiller, P.L. Bruun, E.C. and Kenworthy, J.R. (2010). An Introduction to Sustainable Transportation: Policy, Planning and Implementation. Earthscan, London.

Srisakda, N., Ishizaka, T., Fukuda, A., and Malaitham, S. (2015). Study on Fuel Consumption Estimation Considering the Impacts of Hybrid Vehicle Promotion Based on Time Sharing of Driving Regimes from Probe Data in Bangkok,

Proceeding of the 11th International Conference of Eastern Asia Society for Transportation Studies", 11-14 September, 2015, in Cebu City, Philippines.

TfL, (2013). 'Travel in London: Report 6,' London: Transport for London.

Thomson, J.M. (1977). Great cities and their traffic. Penguin Books, Middlesex, England.

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