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Thailand: Green Transport Policy Directions

for improved freight and passenger travel outcomes, with lower energy use and emissions

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THE WORLD BANK

The World Bank Office, Bangkok
Siam Tower,30th Floor, 989 Rama 1 Road, Pathumwan, Bangkok 10330
Tel.: +66 (0) 26868300 Fax: +66 (0) 26868301
www.worldbank.org/th

NESDB

Office of National Economic and Social Development Board
962 Krung Ka-sem Road, Promprab, Bangkok 10100
Tel.: +66 (0) 22828454 Fax: +66 (0) 2628-2871
www.nesdb.go.th

Table of Contents

List of Tables

List of Figures

Abbreviations

ADB	Asian Development Bank
B	Billion
BMA	Bangkok Metropolitan Administration
BMCL	Bangkok Metro Company Limited
BMR	Bangkok Metropolitan Region
BMTA	Bangkok Mass Transit Authority
BRT	Bus Rapid Transit
BTS	Bangkok Transit System
CDM	Clean Development Mechanism
CDP-SD	Country Development Partnership in Sustainable Development
CLTCB	Central Land Transport Control Board
CMLT	Commission for the Management of Land Traffic
CNG	Compressed natural gas
CH4	Methane
DEDE	Department of Alternative Energy Development and Efficiency
ETA	Expressway and Rapid Transit Authority
EURO	European emission standard
EPPO	Energy Policy and Planning Office
GHG	Greenhouse gas
GIZ	German International Cooperation
HST	High Speed Train
IEA	International Energy Agency
IFC	International Finance Corporation
ITS	Intelligent transportation systems
IFIs	International financial institutions
JICA	Japan International Cooperation Agency
Ktoe	kilo tonne of energy equivalent
LTCB	Land Transport Control Board
M	Million
MONRE	Ministry of Natural Resources and Environment
MRT	Mass rapid transit (rail)
MRTA	Mass Rapid Transit Authority
NCCC	National Climate Change Policy Committee
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Five Year Plan
NGOs	Non-governmental organizations
NMT	Non-motorized transport
NPV	Net Present Value
OECD	Organization for Economic Co-operation and Development
ONEP	Office of Natural Resources and Environmental Policy and Planning
ORR	Outer ring road
OTP	Office of Transport and Traffic Policy and Planning
pa	per annum
pax	passengers
PLTCB	Provincial Land Transport Control Board
PM10	Particulate matter (<10 microns)
PPP	Public-Private Partnership
PWD	Public Works Department
SEPO	State Enterprise Policy Office, Ministry of Finance
SRT	State Railways of Thailand
TA	Technical assistance
TGO	Thailand Greenhouse Gas Management Organization (Public Organization)
THB	Thai Baht
TOR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change

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The study team was led by Chanin Manopiniwes (Infrastructure Economist), and consisted of Philip Sayeg (Transport Consultant), Pajnapa Peamsilpakulchorn (Infrastructure Consultant), Photchara Vichalai (Research Assistant), and Chutima Lowattanakarn (Team Assistant).

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The study was conducted under the general guidance of Annette Dixon (Country Director of the World Bank, Thailand), Arkhom Termpittayapaisith (Secretary General, NESDB), Julia Fraser (Sector Manager, South-east Asia Sustainable Development Unit, World Bank), and Danucha Pichayanan (Director of Infrastructure Development Unit, NESDB).

Currency Equivalent

Currency unit = Baht (THB)

Exchange rate at March 31, 2012:

US$1.00 = THB31.6229

THB1.00 = US$0.03162

Government Fiscal Year

October 1- September 30

Weights and Measures

Metric units

1 meter (m) = 3.2 feet (ft)

1 kilometer (km) = 0.62 miles (mi)

Price Units

Prices in this report are expressed in approximately early 2012 prices unless otherwise noted

Key Messages

The aim of this Policy Note is to describe in plain language what 'green transport' is, why it is important, and how it can be effectively adopted by Thai policy makers. The primary focus is on green transport options that improve welfare, mitigate excessive energy use, reduce global emissions and air pollution. While recognizing that the issue of adaptation is another key aspect of green transport, the Note does not consider measures that might be taken in the transport sector to better adapt to climate change. The key messages arising from the analytical work undertaken are:

- **Energy intensity in Thailand across the board is not improving.** Transport's share of national energy use equals that of manufacturing with each representing over a third of the national total. Transport like, manufacturing and other sectors, is an inefficient user of energy compared to selected comparator nations. Further, Thailand's transport sector has not demonstrated a significant improvement in energy use per unit of economic output (i.e. energy intensity) over the past three decades.

- **Addressing transport's energy use and associated greenhouse gas emissions is therefore critical for realizing Thailand's 'green growth' vision** where economic growth is sustained without compromising the environment and natural resources.

- **Transport impacts individual consumers, firms and the public directly and indirectly and in several dimensions.** Although transportation services facilitate individuals and firms to access goods and services and to conduct their business, the production of transportation services consumes energy, generates greenhouse gas emissions, and creates air pollution affecting users and the community at large. Moreover, public resources are used to finance transport infrastructure which is expensive and costly to operate and maintain.

- **Consequently, achievement of 'green transport' to support the vision of 'green growth' requires consideration of transport's impacts across all relevant dimensions: (i) economic efficiency; (ii) environmental sustainability; and (iii) social sustainability.**

- **The characteristics of transport infrastructure and services should exhibit the following important characteristics to be considered 'green' or 'sustainable': (i) efficiency of use of resources; (ii) resilience to climate risk; (iii) financial sustainability; and (iv) institutional sustainability.**

- **A narrow focus for example on only reducing energy consumption or greenhouse gas emissions may be counterproductive.** For example, very expensive measures may yield significant green benefits (i.e. reduction in energy and emissions). But the same resources applied elsewhere in the transport sector, or elsewhere in the economy, might be able to achieve even more significant benefits. Prioritizing transport policy or infrastructure initiatives for implementation therefore needs to quantify and monetize all impacts as far as possible and compare them to implementation and operations costs on a whole-of-life basis.

- **Left unchecked transport's energy use will continue to rise at a faster rate or closely follow economic growth.** Increased motorization and growth in demand for national and cross border transport services are contributing to this trend.

- **The efficiency of Bangkok and other cities is critical to reducing the energy intensity of the nation's transport sector.** The Bangkok Metropolitan Region (BMR) is continuing to grow and is currently estimated to represent 25% - 30% of national transportation energy use and an increasing share of national economic output. Accompanying the growth in urban motorization, a steady decline in use of public transport and increase in dispersion of urban land use is increased commuting distances and travel times. Significant adverse welfare and environmental impacts are also being incurred as a consequence. The path taken by cities like Seoul and Tokyo offers a greener alternative for Bangkok. Getting on this path calls for a significant reduction of energy intensity of economic activities (energy use per GDP) and improvements in energy efficiency overall.

- **Carefully considered and prompt action could unlock a 25% saving in energy use and emissions** in the period 2020-2030 compared to the 'business as usual' across national and urban transport systems as has been confirmed by several recent studies by DEDE (2011) and World Bank (2009a and 2009c).

- **Transitioning to effective implementation requires comprehensive and timely implementation** of the full suite of potential measures including (i) pricing and policy; (ii) technology improvement/ fuel economy/ alternative fuels; and (iii) rapid transport infrastructure and improved public transport. Fuel economy standards that alone can achieve half of the estimated energy saving (by 2030) are currently being formulated but will take at least two years to bring into force. However, they will affect only new vehicles and so their potential impact will require 20 years to flow through the vehicle fleet. Transport infrastructure and improved public transport should be designed to effectively support a desirable land use arrangement (location and density of activities) and to operate efficiently to maximize benefits in all dimensions. The lead time for provision of transport infrastructure is of the order of 5 to 10 years and even longer to facilitate favorable land use change. Consequently, implementation of appropriate infrastructure and services for vehicles and non motorized modes should also be implemented without delay.

- **While a range of potential measures to achieve the potential reduction is known the challenge lies in bringing plans and policy to action.** Comprehensive and effective implementation requires a holistic plan of action with cross-sectoral leadership that incentivizes and coordinates each responsible agency's contribution to the common goal.

- **Improved pricing of fuels and vehicle access and user charges are critical for underpinning the veracity of any plan for green transport.** Pricing measures avoid the need for detailed project management of many individual measures since appropriate pricing signals would be expected to induce favorable behavior of firms and individuals. But pricing measures present complex political and social challenges that only high level leadership can overcome.

1 The Challenge of Greening Transport

1.1 Context

Thailand's policy makers are seeking to strengthen the foundations for sustainable economic and social development. Responding to the threat of climate change, the aim includes reducing energy intensity and greenhouse gas emissions throughout the economy. The underlying vision advocates a 'low-carbon society' and 'green growth' that implies a development path without compromising the environment and the integrity of the nation's natural resources.

Representing 35% of final energy use in 2010 transportation's share is slowly growing and now equals that of manufacturing (DEDE 2012). Almost totally reliant on fossil fuels, transportation is a major source of greenhouse gas emissions that contribute to climate change. The efficiency of passenger and freight transportation systems throughout the nation is critical. Although transport is a major consumer of energy, it provides a vital role in the economy by connecting homes to jobs, education and community services and links hinterlands to economic zones and producers to markets.

Traffic congestion in Bangkok and the major regional cities and on inter urban highways has a major daily impact on all transport users. With fewer opportunities to optimize home and job locations, or the timing of their trips, the poor are disproportionately disadvantaged by congestion. Air pollution from transport is a major source of damage to human health. Road trauma through loss of life and injury is a serious public health and social issue.

Transportation infrastructure and services plays a vital role in times of natural disaster aiding evacuation and also emergency response. During the 2011 flooding in Bangkok, rail transit systems operated virtually unimpeded and assisted many parts of the city to function as normally as possible.

Policy makers are faced with the task of addressing the day to day challenges posed by transport while positioning transport to effectively contribute to 'green growth' over the long term. The 'greening' of transport requires a comprehensive approach that considers all the potential positive and negative impacts that transport may have. It requires action spanning the energy, environment and urban sectors rather than each sector acting independently and without overall coordination.

1.2 Objective and Scope

The objectives of this Policy Note are to:

- Examine green transport's development challenges;
- Provide a conceptual and policy framework for green transport;
- Indicate the potential impacts of measures to achieve green transport; and
- Prioritize green transport interventions.

The scope is limited to land passenger and freight transport that represents almost 80% of total transport energy use in Thailand. Most of the balance of transport-related energy use is represented by aviation.

Further, the focus is on green transport options that improve welfare, and mitigate excessive energy use, global emissions and air pollution. Transport may have other 'green' attributes. For example, the appropriate design of transport facilities may enable it to function better during extreme weather events, or long term changes in weather patterns, that may or may not be due to climate change. Such attributes are briefly described in Section 2 but are not dealt with in detail in this Note.

The contents of this Note are consistent with the World Bank's broader global and regional efforts in particular the 'East Asia Pacific: Sustainable Urban Energy and Emissions Planning[1]' that commenced with support of AusAID in January 2011.

1.3 Analytical Framework

The Note first reexamines the role of the transport sector in the economy and the contributions of 'green transport' to 'green growth' in a broad context. This is important to recall the role and functions of transport in the economy and to better understand the relevance of green transport. Key trends in energy use, greenhouse gas emissions, and land transport performance are then reviewed to provide the rationale for the required shift towards greener transport.

The spatial pattern of economic activities is a key determinant of the demand for transport and its impacts. Transport enables communication of people and goods throughout the nation and within urban areas. Through transport services people can participate in activities at their destination and goods can be shipped from production zones to markets and international gateways. Transport is therefore often called a 'derived demand' where the real demand is for the activities and services available at different locations in a nation or urban area. Consequently, transport infrastructure and services are needed to support economic activities and the spatial distribution of population centers, economic hubs and ports through the underlying accessibility it confers. In some circumstances, transport can strongly influence where these activities occur and is therefore of value as a policy instrument to support broader goals.

Transport interventions may therefore be aimed at one or more of three distinct levels[2] at the national or metropolitan scales:

- **System level (travel demand)** – supporting economic structural change (e.g. shift to service sector) or influencing settlement patterns (e.g. support development of major regional centers) and therefore give rise to potentially 'favorable' changes in travel demand such as avoiding the need for travel with potentially strong positive impacts on economic welfare, social sustainability and environmental sustainability. At a national level, transport is an important

1 Refer Vietnam Urban Briefs – SUEEP Program: Overview and Application" Accessed on October 18 <www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/07/16/000333038_20120716020848/Rendered/PDF/710100BRI0VN0U00Box369258B00PUBLIC0.pdf].

input to achieving system level outcomes but the success of the policies tends to rely on factors outside of the transport sector.

- **Modal level (travel alternatives)** – here the availability, quality and quantity of modes is important with the main beneficial impacts being on efficiency with lesser impacts on 'social sustainability' and 'environmental sustainability'.

- **Vehicular level (or trip)** – the performance of vehicles and trips (such as by non-motorized means) is important. Here the main impacts are usually environmental and possibly social through choice of vehicle types, fuel types, fuel efficiency and load factors.

The analysis upon which this Note is based addresses more than 80% of energy use and emissions generated by land transport in Thailand. In analyzing the transport system and types of interventions, the framework is applied to the inter-urban corridors in Thailand and the BMR, the major contributors to energy use and emissions from land transport.

Qualitative assessments of performance or transport outcomes are provided in this report in three dimensions: (i) economic efficiency; (ii) environmental sustainability; and (iii) social sustainability. The analytical framework of the study is shown in Figure 1.1.

The potential impacts of interventions are quantified in respect of energy use (and associated greenhouse gas emissions). To do this, the Note relies on the analysis of two recent studies carried out by the World Bank for the Bangkok Metropolitan Region (BMR) and Thailand as a whole. For the national level analysis, the Note summarizes and extends the effect of interventions to improve energy efficiency in Thailand's inter-urban and urban freight and passenger transport sub-sectors analyzed by a recent policy study entitled "Thailand: Making Transport More Energy Efficient" (World Bank 2009a).

Fuel sales data indicates the BMR and adjoining urbanizing areas represent a significant share of Thailand's total transport-related energy use.[3] Consequently, for urban transport, a more detailed simulation of Bangkok's urban transport performance is especially important. A more

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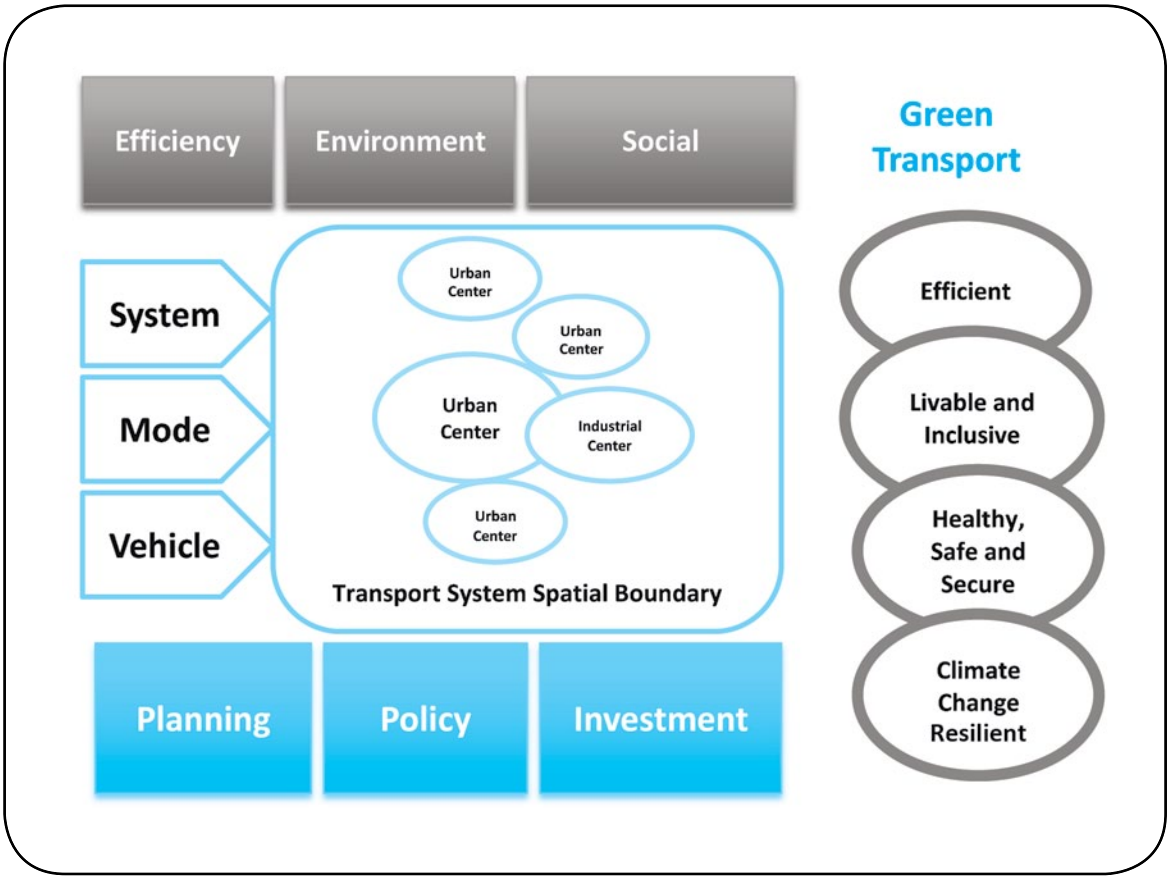
2 Shipper et al. (1999) described this Framework as "Activity, Share, Intensity, Fuel Mix." GIZ (2007) described it as the "Avoid-Shift-Improve" Framework although the concepts were articulated earlier, for example, by Thomson (1974), (pages 159-170). For this report, an identical but simpler form of the same framework (System-Mode-Vehicle) has been proposed as also articulated by GIZ (2007). 'Intensity' and 'Fuel Mix' used in ASIF is encompassed in the term 'Vehicle' where both the load factor and type of fuel used are prime concerns. The 'System-Mode-Vehicle' framework also seems more appropriate when discussing national transport systems in the context of associated settlement patterns where optimization of land use and minimization of trips (as implied in the term 'Avoid') are but one consideration for locating cities and towns, in contrast to the allocation of activities within urban areas, as described in Section 4.2.

3 Fuel sales data indicates that about half of Thailand's land transport energy use is represented by the BMR. But this would overstate the actual energy use since some four million persons live outside, but close by, the BMR and statistics on fuel sales in the BMR may be for fuel shipped and used up-country. In Section 5, it is estimated using a 'bottom up' approach that 20% of Thailand's total transport-related energy use is consumed in the BMR but this appears to be an underestimate. It is likely the actual figure is somewhere in the range 25% to 30%.

detailed analysis using more comprehensive analysis methods especially for the BMR[4] is thus beneficial. Such detailed analysis would necessarily require the use of a comprehensive computerized transport model for the region to simulate the effect of planned interventions and other policy options on transport demand, energy use, emissions (greenhouse gases and vehicle exhausts), and transport user effects (e.g. travel time). The World Bank's 2010 Flagship Report entitled "Winds of Change: East Asia's Sustainable Energy Future"[5] provided strategic but detailed modeling of several alternative scenarios for provision of infrastructure and implementation of other policies in Bangkok. The results of the BMR transport analysis were not reported separately in "Winds of Change" but are reported in this Note extended by the addition of two scenarios.

Figure 1.1: Analytical Framework



Source: Study Team

4 Due to 'network' effects and interaction of transport supply, land use and travel demand.

5 The "Winds of Change" report analyzed alterative energy scenarios for East Asia including Thailand and proposed a strategic direction for the region to meets its energy needs on a sustainable basis. In support of the study detailed transport analyses were undertaken of 10 cities in Asia including the BMR.

2

What is Green Transport?

- *How does 'green transport' differ from 'environmentally sustainable transport' or just 'transport'?*

Transport has impacts in the economic, environmental and social dimensions. Economic efficiency, as often measured by travel time reductions to users, is the principal objective of improved transport. However, transport affects the environment in terms of energy use, greenhouse gas emissions and air pollution. Transport also impacts on the social dimension by promoting (or reducing) social inclusion and generating other co-benefits such as safety. The three dimensions of transport impacts are summarized in Table 2.1.

A growing concern for environmental sustainability directs more attention to 'sustainable transport' and 'green transport'. In simple terms, the majority of transport except for walking and other non-motorized modes is not green or sustainable. Most transport uses some form of fossil fuel and is likely to do so for the foreseeable future. Modern urban rail systems such as those that operate in Bangkok at present use electricity as their motive source that is almost entirely produced by the combustion of fossil fuels[6].

Although virtually all motorized transport systems are fossil-fuel based some systems are greener than others. Conceptually, the 'green' element of a transport system can be measured in three ways: energy-efficiency, carbon-intensity and extent to which it produces local pollutants that are harmful to human health. Rail and bus mass transport may achieve 'green' credentials by attracting significant volumes of drivers from cars. Alternatively, the 'green' effect may arise from the inherent and direct energy efficiency of the mode's motive power such as a use of a hybrid (gasoline/ electric) engine compared to, for example, a conventional gasoline engine. Transport used in an effective way and operated efficiently with high load factors can therefore achieve strong economic benefits, reduce energy consumption and emissions.

A focus on the 'green' components of transport expands the scope of sustainable transport to comprehensively consider environmental and energy impacts. But for transport to be truly sustainable it needs to fully consider green concerns. For the purposes of this Note 'sustainable transport' and 'green transport' are therefore considered identical concepts.

Achieving green transport requires comprehensive analysis of costs and impacts (i.e. benefits and disbenefits) across the three dimensions to achieve an optimal outcome. Viewing transport from the perspective of 'green transport' or 'low-carbon transport' or 'environmentally sustainable transport' or any other point of view does not mean the other dimensions would not be important. The approach advocated is to always think about transport in all its dimensions even when focusing

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6 92% in 2005 according to "World Bank Development Indicators."

on ‘green transport.’ The dimensions are closely related and the opportunity cost of implementation needs to be considered. For example, very expensive measures may yield significant green benefits (i.e. reduction in energy and emissions). But the same resources applied elsewhere in the transport sector, or elsewhere in the economy, might be able to achieve even more significant benefits. Prioritizing transport policy or infrastructure initiatives for implementation therefore needs to quantify and monetize all impacts as far as possible and compare them to implementation and operations costs on a whole-of-life basis.

Economic, social and environmental benefits often go hand in hand. For many transport projects, maximization of ‘green’ impacts requires projects to deliver strong user benefits (i.e. economic efficiency) through faster and more reliable travel times to induce travel behavior changes such as mode shift that may deliver the desired ‘green’ benefits. The optimal choice of transportation initiatives needs to be those that achieve the highest economic return where ‘impacts’ in all dimensions are comprehensively quantified and monetized.

Table 2.1: Consider Transport’s Impacts in Three Dimensions

Dimension	Perspective – Impact
Economic efficiency	• Benefits to transport users (i.e. welfare) as the main purpose of transport improvements is to provide improvements in mobility, accessibility to jobs and services, and support economic growth.
Environmental sustainability	• Reduced energy intensity. • Reduced greenhouse gas emissions per unit of output (GHG as typically represented by Carbon Dioxide or CO_2 equivalent emissions) that impact on climate change. • Reduced tailpipe emissions that affect human health (e.g. particulate matter or PM).
Social sustainability	• Enhanced access to basic services – covering the transport services enabling access, affordability of these services and physical accessibility to vehicles and facilities. • Protection from harm – e.g. from safety and security risk, traffic accidents and poor quality air.

Source: Study Team

Green transport infrastructure and services should also have the following desirable characteristics:

- Efficiency of resources use – such as energy and water during implementation and operation;
- Resilience to climate risk – the design of both the transport infrastructure and consideration of the way it will operate needs to consider changing requirements such as due to shifts in

weather and climate patterns (e.g. flood frequency and severity) and the role of transport in aiding communities to function during, and recover after, major floods and other natural disasters;

- **Financial sustainability** to ensure well selected infrastructure and services continue to operate as planned;

- **Institutional sustainability** to support desirable planning, implementation and operations.

Irrespective of the importance of these subjects they are not dealt with further in this Note with instead the main focus being on economic, social and environmental impacts. The focus of this Note is on green transport initiatives to **mitigate energy use and emissions** but at the same time to **maximize user economic benefits and promote social inclusion** without compromising safety.

3

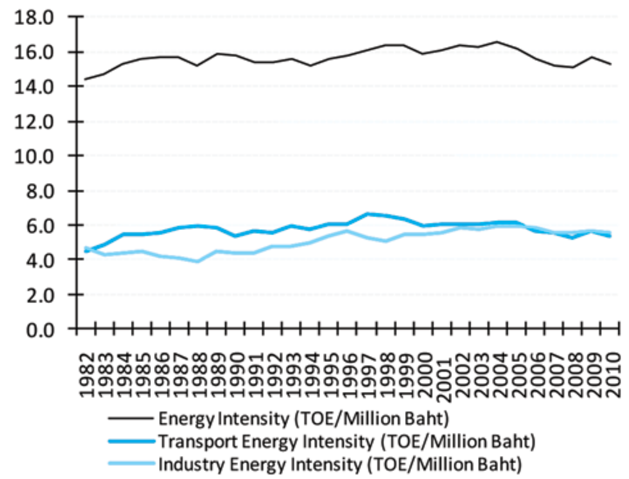
Why Green Transport?

- *Why green transport is important for green growth?*
- *What are the emerging challenges?*

3.1 Current Situation and Future Trends

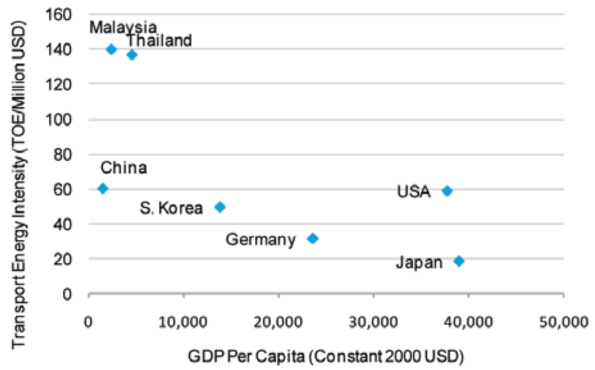
Transport and industry consume over 70% of the country's energy, however, energy intensity in both sectors has not improved much. Final energy consumption in Thailand reaches 70,247 ktoe in 2010 and the share of the transport sector is 35% following only the manufacturing and mining sector with a 36% share. Together and individually the efficiency of these two sectors has a major influence on the nation's total energy use. Transport energy consumption has been growing at a faster rate than GDP growth and transport's energy intensity, similar to industry energy intensity, has not improved significantly since 1982 (Figure 3.1). In contrast, other countries have been able to reduce transport energy intensity as their GDP per capita grows. Thailand's transport energy intensity thus compares poorly with either comparable (except the net oil-exporter Malaysia) or well-performing nations (Figure 3.2).

Figure 3.1: Thailand's Total, Transport and Industry Energy Intensity



Source: Calculated by the Study Team with data from Ministry of Energy and Bank of Thailand.

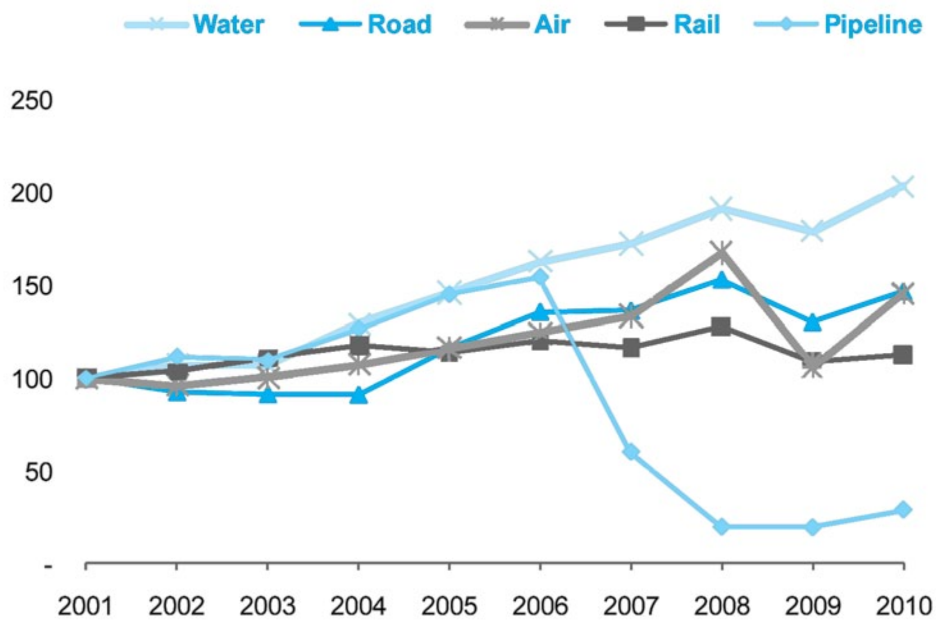
Figure 3.2: Transport Energy Intensity and GDP Per Capita in 2005, Various Countries



Source: Calculated based on transport energy consumption data from IEA available at http://data.iea.org/ieastore/default.asp, and GDP data from World Bank's Data Development Platform/World Development Indicators Database.

Rising oil prices impact the energy-intensive transport sector. In the long-term real global oil prices will continue to increase despite short-term fluctuations. According to the International Energy Agency (2011), the oil price is projected to reach 118 USD per barrel in year 2020 and 140 USD per barrel in year 2035 (in 2010 prices) in IEA's Current Policies Scenario. This oil price increase will affect the transport sector, particularly on logistics costs [7], but the extent of the impact will depend on the flexibility of the transport system to adjust and consumer behavior in response to any price increases that are passed on to them. Real transportation costs that represent 47% of total logistics costs have risen by over 46% during 2001-2010 for road transport (Figure 3.3).

Figure 3.3: Growth Index of Thailand Logistics Costs, 2001-2010 (2001=100)



Source: National Economic and Social Development Board.

Key trends in transport sector will be characterized by continued growth in demand for travel for both freight and passengers. Vehicle-kilometers have grown steadily since 1995 with passenger vehicle-kilometers growing by 74% to 2009 roughly equivalent to GDP growth with freight vehicle-kilometers growing by 30% over the same period [8]. Freight and passenger travel demand (measured in vehicle-kilometers, passenger-kilometers and tonne-kilometers) will continue to grow with higher GDP. With an already extensive road network nation-wide, road will continue to carry the majority of freight and passengers. The share of the transport task as measured by aggregate vehicle-kilometers performed by motorcycles, passenger cars and trucks (freight vehicles) from 1995 to 1999 indicates relatively stable shares. Similarly, in terms of freight tonne-kilometers of travel in 2010 the role of road (85%), rail (2%), air (less than 1%) and coast shipping (5%) have not changed much from 2001 – 2010 as shown in Figure 3.4. However, inland water transport had significantly increased its share of freight carried from 5% in 2001 to about 7% in 2010 at the expense of road. Despite this road continues to dominate the freight task and passenger task. Due to this dominance, the structure of national modal shares in the next 10 years or more is not

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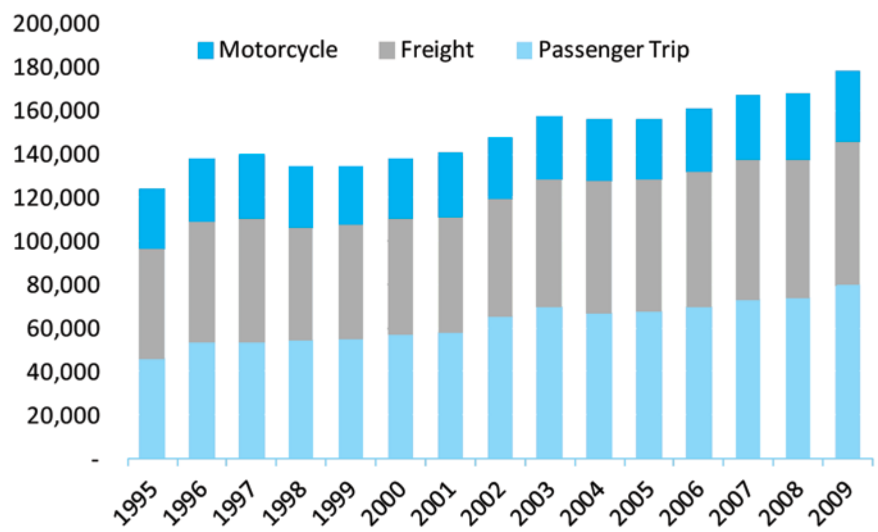
7 According to NESDB, logistics costs comprise of transportation cost (47%), inventory holding cost (44%) and logistic administration cost (9%).

8 These data only represent traffic volumes on roads which belong to Department of Highways and not on other roads which belong to the Department of Rural Roads and local municipalities.

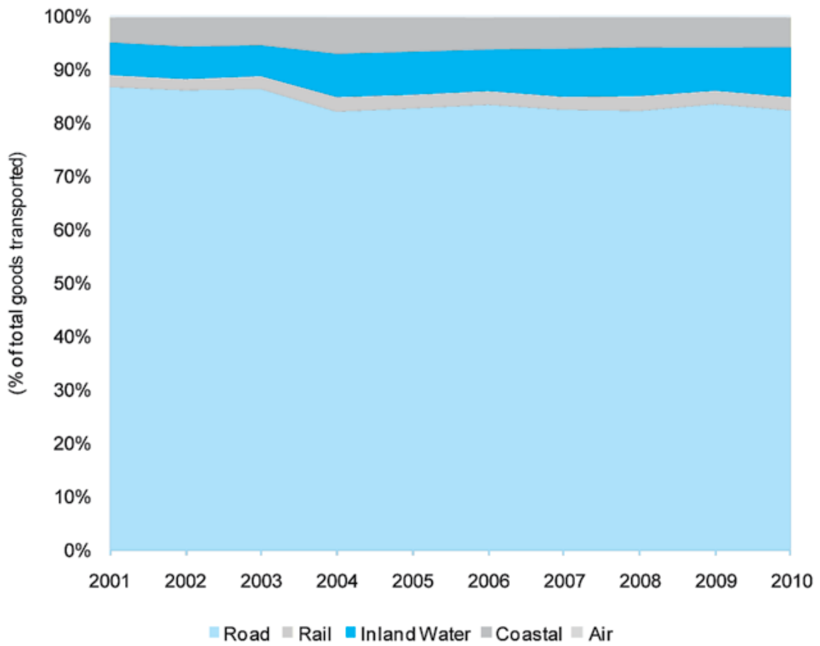
expected to change much. However, there is potential for rail to play a more significant freight transport role as a result of government's planned major investments in rail infrastructure (e.g. dual-track expansion) in selected corridors.

Figure 3.4: Road Travel Demand (vehicle-km), 1995-2009



Source: Department of Highways

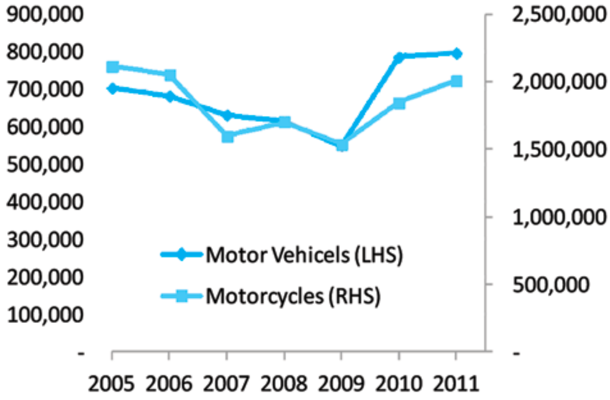
Figure 3.5: Modal Shares of Goods Transported, 2001-2010



Source: Ministry of Transport

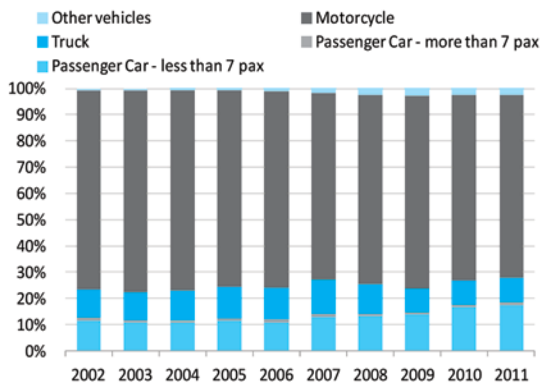
Growth in motorization rate is expected to moderate while vehicles technology is likely to improve resulting in some improvement in fuel efficiency. Domestic sales for motor vehicles and motorcycles have been growing at a slower pace since 2005 (Figure 3.6) while the trend in new vehicle registration shows that the share of small passenger cars has been increasing in recent years (Figure 3.7). Vehicle availability is increasing with currently fewer than 25% of households having no car or motorcycle available compared to over 50% in the early 1990s (World Bank 2007). New vehicles being introduced to the fleet are expected to be more fuel-efficient as well as safer as a result of global market development and consumer preferences. However, a conscious effort to introduce fuel economy and enhanced fuel quality standards could play a vital role in re-shaping the vehicle market and improving fuel efficiency.

Figure 3.6: Domestic Sales of Automotives, 2005-2011



Source: Thailand Automotive Institute

Figure 3.7: New Vehicle Registration, 2002-2011



Source: Department of Land Transport.

Bio-fuels have been penetrating the fuel market. Responding to higher oil prices, Thailand has developed a strong bio-fuel policy with B5, E10, E20, and E85 already available in the market[9]. The major motive for bio-fuel promotion in Thailand is energy security. E10 is well-penetrated in the gasoline market while E20 and E85 sales are still very limited. In 2011, total bio-fuels consumption reached 3,734 ktoe accounting for 57% of total gasoline consumption and 4% of total diesel consumption. The government has set a target to further promote bio-fuel for both diesel and gasoline in the future with a target to replace 44% of imported oil with bio-fuels by the year 2021[10]. However, with a close relationship and complex interaction between food and bio-fuels production, economic and environmental sustainability concerns need to be considered more carefully and comprehensively. Since bio-fuels are blends with gasoline and diesel subsidizing bio-fuels may not necessarily yield green transport outcomes if lower prices encourage excessive energy use.

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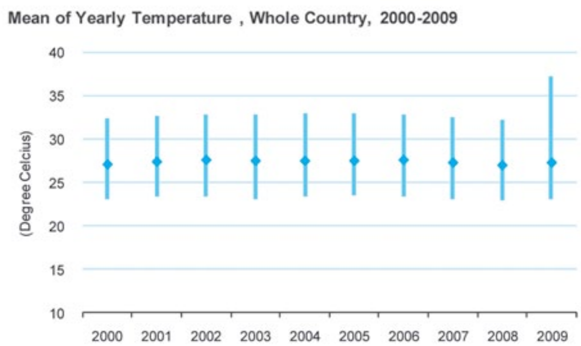
9 B5 and B10 are bio-diesel mixes with 5% and 10% bio-diesel with 95% and 90% conventional diesel respectively. E10, E20, and E85 mixes are ethanol mixes with 10%, 20% and 85% ethanol and 90%, 80% and 15% conventional gasoline respectively.

10 According to the government's Ten-Year Alternative Energy Development Plan, it aims to increase ethanol consumption to 9 million liters per day, biodiesel to 5.97 million liters per day and diesel substitutes with new technologies to 25 million liters per day. The government also plans to phase out ULG 91 by 2021.

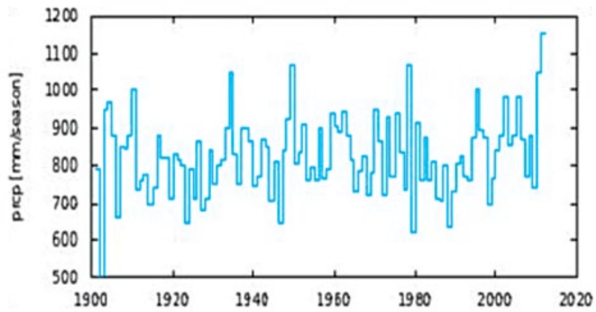
Higher variations in global weather patterns are projected resulting in more occurrence of extreme events. The impact of global warming on long term changes in climate is still surrounded by some uncertainty due to limits in the duration of temperature and weather records and understanding of climate processes. Nevertheless, some significant variations in weather patterns are being observed. The highest maximum temperate recorded in the last 10 years was recorded in 2009 (Figure 3.8) although the mean temperature did not vary much from year to year. In 2011, the quantity of rain during the rainy season was the highest recorded since 1900 (Figure 3.9) with rainfall exhibiting a slow increasing trend over the past 100 years. Thailand's Second National Communication to UNFCCC anticipates that rainfall across all the regions in the country has a potential to increase by about 10-20% and the weather will tend to be warmer due to an increase in maximum and minimum temperatures by 2 degrees Celsius.

Figure 3.8: Mean of Yearly Temperature, Whole Country, 2000-2009



Source: National Statistical Office.

Figure 3.9: The Observed Quantity of Rain in July, August and September in Northern Thailand



Source: GPCC v5 analysis 1901–2009, monitoring/first guess analysis 2010–2011. From: [knmi.nl] accessed November 2011 quoted in World Bank (2011b).

Droughts and flooding are projected to become more common with increasingly severe impacts. Global warming is expected to aggravate flooding, droughts and other natural disasters. Statistics indicate that although the occurrence and severity of flooding vary from year to year the magnitude of impact and associated damages have tended to be higher in recent years. In 2009, more than 30,000 villages were affected by flood which is the highest number of villages affected since 2000 (Figure 3.10). In the same year, 4.5 million people were affected by drought which is the highest on record since 2002 (Figure 3.11). In 2011, Thailand endured a very severe flood event caused by heavy rain combined with multiple tropical storms throughout the extended rainy season resulting in unprecedented damage in terms of life and costs[11]. There is thus a growing awareness of the

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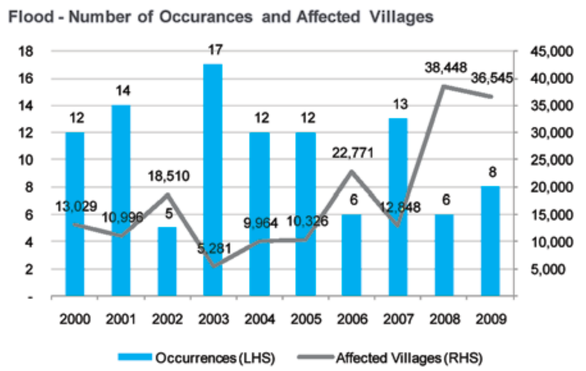
[11] Flash floods were reported in several areas in the north in May, and tropical depression Haima arrived in June followed by Nock-Ten in July, the combination of which caused widespread flooding. The southwest monsoon in August-September and the northeast monsoon in October added to the flooding, which was making its way into the central plains, filling many major dams to capacity and causing breaches in 10 major flood control structures. Some 66 provinces were

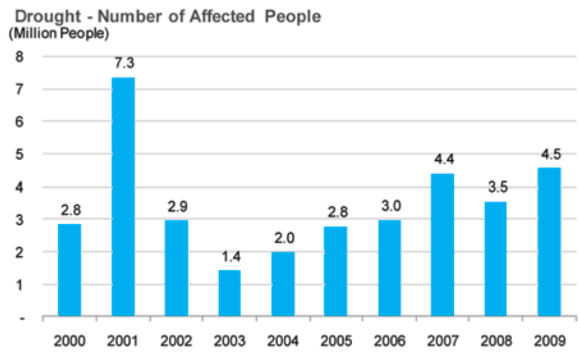
need for: (i) comprehensive disaster risk management incorporating climate factors; and (ii) the design of more resilient transport and other infrastructure in terms of their ability to continue to operate during, or quickly recover, after natural disaster events.

Figure 3.10: Flood – Number of Occurrences and Affected Villages



Source: National Statistical Office.

Figure 3.11: Drought – Number of Occurrences and Affected Villages



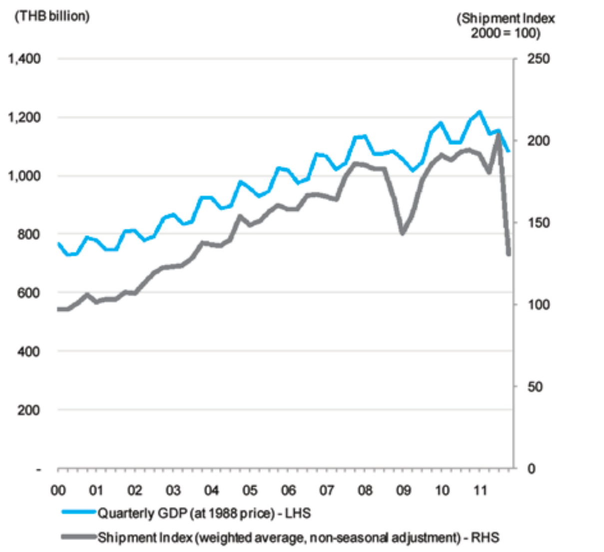
Source: National Statistical Office.

3.2 Key Issues

Continued GDP growth, gradual restructuring of the economy, improving regional connectivity all imply continued growth of demand for transport services. Passenger and freight transport growth is closely related to GDP growth (Figure 3.12). It is expected the economy will continue to adjust and restructure to increase the significance of the services sector while reducing that of industry. While this trend will lower the demand for transport service inputs since the services sector is less transport intensive than industry, it is expected that this shift will occur gradually. The role of the service sector has actually slowly reduced since 1970 as a proportion of GDP but the future growth in services is expected to be in more productive activities than the past with emphasis on financial and commercial services. Over the past decade the significance of manufacturing was maintained (at 39%-40% of GDP) while the agricultural sector increased its contribution to GDP from 11% in 2000 to 17% in 2011 (Figure 3.13). In addition, improving regional physical connectivity in the context of wider and deeper regional economic integration and growing trade volume will impose additional demand for freight and passenger transport.

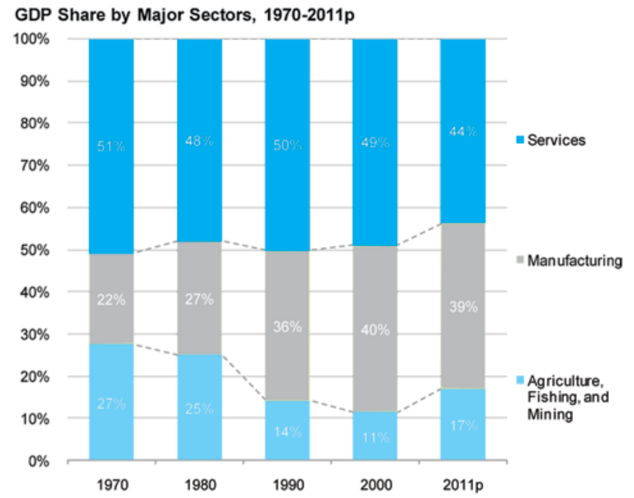
affected by severe, record-high flooding, including the Bangkok metropolitan area and its surrounding areas. By November more than 5.5% of total landmass in the country had been inundated, and at the time of writing, approximately 11.2 million rai (18,000 km2) of farmland remained under water. Overall, the floods affected more than 13 million people and resulted in more than 680 deaths.

Figure 3.12: Shipment Index and GDP



Source: Office of Industrial Economics and National Economic and Social Development Board.

Figure 3.13: GDP and Share by Major Sectors



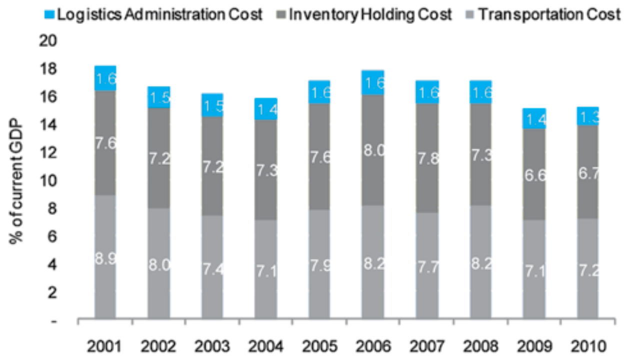
Source: National Economic and Social Development Board.

Traffic congestion in the BMR has a significant effect on quality of life, undue economic losses, externalities and excessive fuel use due to the BMR's high share of national transport energy use. Bangkok has not seen recent major declines in peak hour traffic speeds in the central area despite the continuing growth of population and vehicle ownership. Congestion was likely more severe in the 1980s and early 1990s, when the road and expressway network was less comprehensive and modern Mass Rapid Transit system did not exist. Today's average peak hour speed of 20 kilometers per hour observed on major roads is typical of that experienced in many large cities. But congestion has spread outwards geographically and to the off-peak periods. With more dispersed land use and congestion, commuting times for many trip makers remain time consuming and unreliable. With some 40% of daily person trips still made by road-based bus services and limited use of bus priority measures, large numbers of bus passengers must endure slow, unreliable travel on a daily basis. With continued economic growth, congestion will continue to deepen and spread geographically and temporally. There are significant opportunities for addressing traffic congestion through: (i) modern traffic control systems to manage traffic more efficiently that ought to be able to achieve, perhaps on average, a 3% reduction in delay and excessive fuel use; (ii) supporting traffic management to allocate road space to buses and other priority users; and (iii) improved pricing to moderate demand (e.g. removal of diesel fuel subsidies) or more comprehensive forms of road user charging.

Transport cost is one of the factors contributing to the competitiveness of the overall economy. There is a close linkage between transport system performance, as reflected in efficiency and transport costs, and the economy. Efficient transport has a direct impact on national competitiveness and national welfare. The cost of logistics is one of the key factors which determine industry competitiveness. Although the proportion of Thailand's logistics cost to GDP has declined from 18%

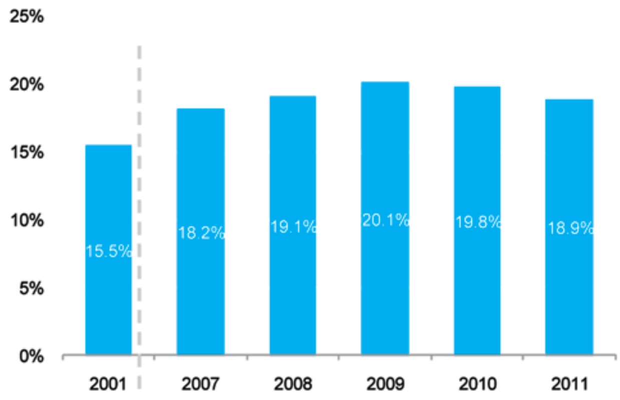
in 2001 to 15% in 2010 (Figure 3.14) the transportation component of logistics cost is declining slowly. Compared to inventory, storage and administration components of total logistics costs in Thailand, transportation represents the highest share at 47% of the total cost compared to 49% in 2001. Transport's expenses also account for a significant share of households expenses at 18.9% in 2011 representing an increase of 17% from 2001 (Figure 3.15).

Figure 3.14: Thailand's Logistics Costs to GDP



Source: National Economic and Social Development Board.

Figure 3.15: Share of Transport Expenses to Household Expenses



Source: National Statistical Office.

Given that fuel price is a key factor in determining transportation costs the manner in which the transport sector can respond to future oil price increases will have significant implications for the economy. The long-term fuel price elasticity in Thailand is estimated to be -0.31 for the period during 1986-2007 (World Bank 2009a). In Europe which relies more heavily on rail, barge transport, bus and non-motorized transport, the short-term gasoline price elasticity of road traffic is estimated at -0.27 with the long-term elasticity lying between -0.6 to -1.0[12]. Thailand's relatively low long-term fuel price elasticity compared to Europe's, together with high fuel intensity for diesel and gasoline, suggests that Thailand's transport system is less able to adjust fuel consumption in response to fuel price increases over the long term.

Transport is recognized both as a major energy consumer and source of GHG emissions. Transportation is a major source of greenhouse gas emissions that contribute to climate change. Transport sector's emission in 2008 accounts for around 18% of total emissions. The share of the transport sector's emission is projected to increase to 22% in the year 2050 (Figure 3.16)[13].

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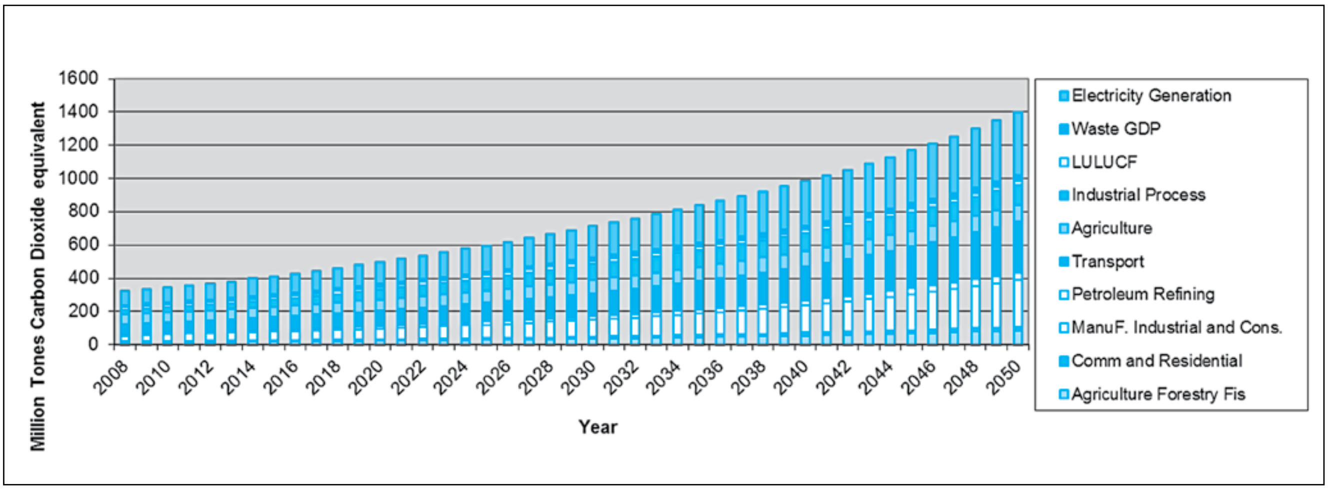
12 Goodwin and others (2004); Graham and Glaister (2004)

13 Joint Graduate School for Energy and Management (2010) quoted in ADBI (2011).

Figure 3.16: GHG Emission Projections Under the Business as Usual Scenario



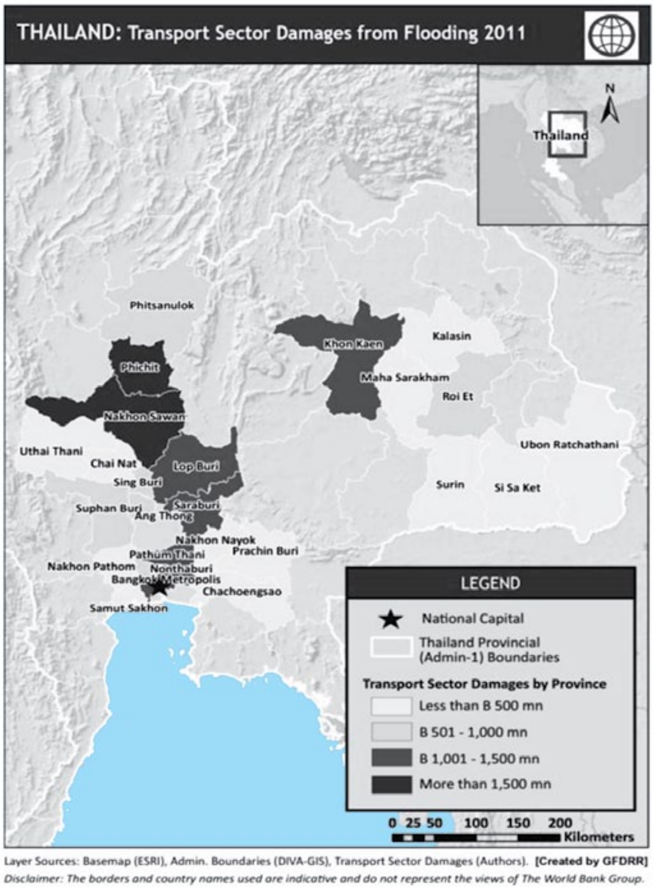
Source: Joint Graduate School for Energy and Management (2010) quoted in ADBI (2011).

At the same time, transport activities generate external costs to the society which should be minimized. In addition to imposing externalities by emitting greenhouse gas emission from vehicle fuel combustion, transport is also a major source of damage to public health by contributing to air pollution and road trauma through loss of life and injury. Congestion imposes external costs on the economy by decreasing productivity and lowering quality of life[14].

Transport needs to adapt to cushion the impacts of weather variations and natural disaster in order to provide reliable and undisrupted services to the economy. The impact of an extreme weather event on the transport sector was demonstrated by the major flooding in Thailand in 2011. Damages and losses to the transport sector (Figure 3.17) are estimated to have been THB 23 billion. The damage is almost entirely to the road sector with some damages to rail infrastructure and airport which was inundated (Figure 3.18). Losses were incurred in the form of increased costs of transport across the road network post-flood compared with pre-flood as well as losses in tolls revenues (World Bank 2011b). As an example of how transport contributed to continuous community functioning during times of natural disaster is provided by Bangkok's new urban rail systems. Although they service less than 10% of all daily person trips in the BMR continued, these rail systems continued to operate virtually unimpeded during most of the extended period of flooding in 2011.

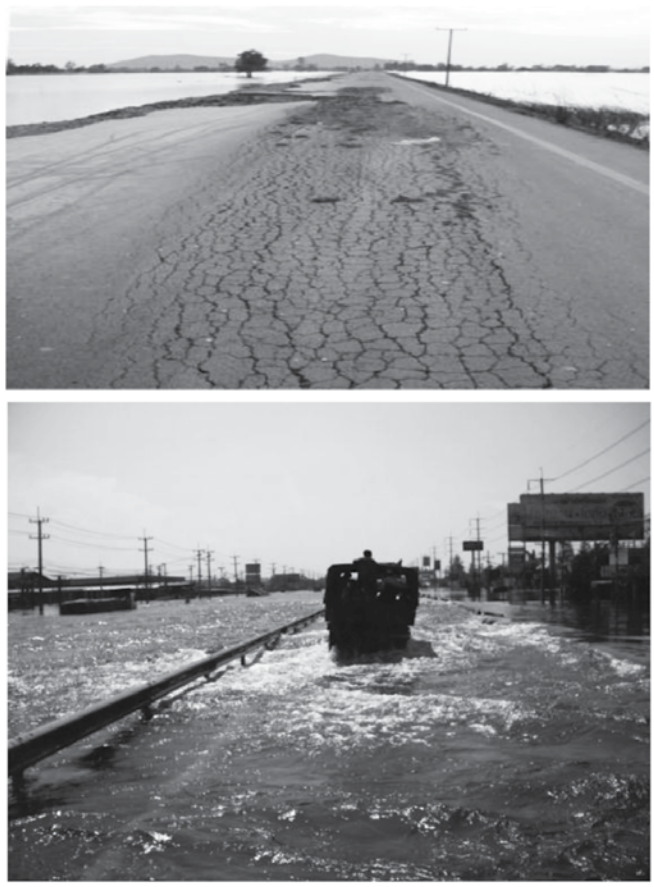
[14] For example, estimates of external costs in the USA show that congestion, accidents and local air pollution have the highest costs on the economy at 105 cents per gallon, 63 cents per gallon, and 42 cents per gallon, respectively.

Figure 3.17: Areas Affected by Flood in Land Transport



Source: World Bank (2011b).

Figure 3.18: Damages from Flood on Road Infrastructure



Source: World Bank (2011b).

3.3 Meeting Transport Challenges

Serving growing demand with quality services under resource constraints in the environment of higher risk and uncertainty. The transport sector is facing several challenges from both the demand and supply side. To fulfill its function in the economy, the transport system must strive to deliver safe, efficient and cost-effective services at zero or minimal environmental and social costs in an environment of higher risk from climate change impacts. Besides meeting typical constraints such as funding availability, transport must also deal with growing energy supply constraints and an increased obligation to climate change mitigation efforts. At the same time, lessons learnt from the recent major floods suggest that the concept of disaster resilience must be more comprehensively integrated into transport infrastructure planning.

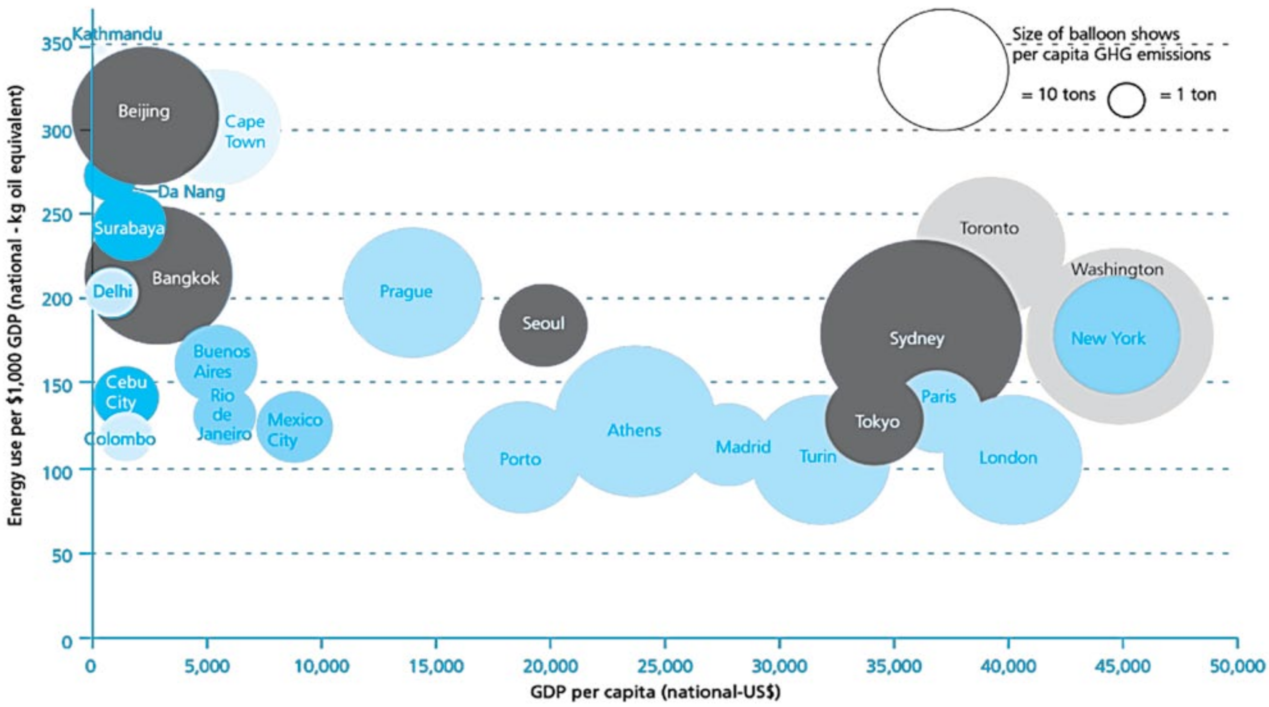
Effectively responding to future trends in global oil prices. With a relatively high transport energy intensity that has remained static for the last two decades, the transport sector will need to improve its efficiency to better cushion the impact of long term oil price increases. A more efficient and diversified transportation system together with appropriate pricing will allow consumers and the economy to have more flexibility (e.g. in making choices of location, travel mode, and vehicle type) to adjust their behavior to respond to price increases. Improved efficiency will also have a direct impact on the nation's transportation costs, economic competitiveness, balance of payments and energy security.

Realizing large untapped potential in the transport sector for energy savings and GHG emission reductions. The country's national energy efficiency plan highlights transport as the key sector to achieve energy savings and contribute to the target of reducing Thailand's final energy consumption. The recently announced Twenty-Year National Energy Efficiency Development Plan (NEEDP) 2011-2030 sets the target to reduce the country's energy intensity by 25% in year 2030 from the base year in 2005, or from 16.2 ktoe per THB billion of GDP in 2005 to 12.1 ktoe per THB billion of GDP in 2030. This target is equivalent to reducing energy consumption by 20% or 30,000 KTOE from the BAU scenario in 2030. The sectoral targets for energy reduction are: (i) transport (44.3%); (ii) industry (37.7%); (iii) medium and small commercial buildings and residential buildings (10.7%); and (iv) large commercial buildings (7.3%). The most important policy measure is improved fuel efficiency in vehicles that is expected to contribute 77% of the estimated total energy savings in transport (i.e. of 12,470 ktoe). The second highest potential is modal shift for both passenger and freight transport which has the potential to achieve 17% of the target, followed by travel demand management measures which could achieve 6% of the remaining potential saving. In addition, as transport is a major emitter of greenhouse gas enhanced transport energy efficiency will contribute to reducing emissions and meeting Thailand's relevant international obligations.

Translating the 'green growth' and 'green transport' vision into reality. While it is recognized that green transport can make a major contribution to the green growth vision, 'Green Growth' and 'Low-carbon Society' are ambitious concepts. In order for these concepts to be meaningfully integrated into transport policy and planning efforts several actions are required including: (i) definition of a clear planning and policy framework; (ii) choice of appropriate policy instruments and well prioritized investments; (iii) efficient and accountable implementation; and (iv) establishment of a robust monitoring and evaluation framework.

Choosing the right path for future growth of Bangkok and secondary cities. In addition to efforts at the national level, cities are the most important operating units where to take action on initiating greener transport and economic policies. Figure 3.19 illustrates that most developing cities in Southeast Asia currently have relatively low GHG emissions (and energy use) per capita, although their energy intensity (energy use per $1,000 GDP) may be higher, when compared to many cities around the world. However, as GDP per capita increases, urban GHG emissions and energy use may take different paths as illustrated by various cities in the region. Seoul and Tokyo have higher GDP per capita than Bangkok, yet their energy intensity per $1,000 of GDP is lower, and their GHG emissions per capita are less than half of Bangkok. These cities appear to offer an alternative greener growth path that could be pursued by Bangkok in the long term. This greener alternative calls for a significant reduction of energy intensity of economic activities and improvements in energy efficiency across all sectors not only transport.

Figure 3.19: Energy Use Per $1,000 GDP Vs GDP Per Capita In 25 Cities



Note: (tGHG per capita – circa 2006, except Da Nang, Surabaya and Cebu – 2010)
Source: World Bank (2012)

4

How to Facilitate Green Transport?

- *What specific initiatives might be considered for inter-urban and urban areas?*

4.1 Applying the System-Mode-Vehicle Framework

Transport interventions at different level have different economic, social and environmental outcomes. Table 4.1 sets out in general terms how transport interventions aimed at the three levels (described in Section 1.3) may influence outcomes in the economic, social and environmental dimensions. Because they are designed to be comprehensive, System level interventions have the potential for strong beneficial impacts in the economic, social and environmental dimensions. Modal interventions (e.g. urban rail) are primarily aimed at improving the efficiency of travel for a given land use and economic structure. They can therefore be expected to have strong economic impacts, a lesser impact on social aspects (e.g. inclusion, equity etc.) and a weak association with the environment that would be strongest where significant modal switch from less efficient modes (e.g. single occupancy cars) is likely. Vehicle level interventions aimed at reducing emissions or improving fuel efficiency are unlikely to improve the speed or quality of travel. Consequently, the impact is potentially strongest for the environment and to a lesser extent for the social dimension as reduced vehicle emissions would reduce damage to human health.

Table 4.1: Potential Impacts of System, Mode and Vehicle Interventions

<table>
<tr><th colspan="3">System</th><th colspan="3">Mode</th><th colspan="3">Vehicle</th></tr>
<tr><td colspan="9">Impacts</td></tr>
<tr><td>Eco-nomic</td><td>Social</td><td>Envi-ronment</td><td>Eco-nomic</td><td>Social</td><td>Envi-ronment</td><td>Eco-nomic</td><td>Social</td><td>Envi-ronment</td></tr>
<tr><td>OOO</td><td>OOO</td><td>OOO</td><td>OOO</td><td>OO</td><td>O</td><td>O</td><td>OO</td><td>OOO</td></tr>
<tr><td colspan="9">Potential indicators</td></tr>
<tr><td colspan="9">• Travel time for freight per tonne-km or passengers per pax-km (economic)
• Travel time for low income passengers per pax-km (social)
• Energy use, CO2 emissions or PM emissions per freight tonne-km or pax-km (environment)</td></tr>
<tr><td colspan="9">Determinants</td></tr>
<tr><td colspan="3">• Ability to influence land use, arrangement and structure of economic activities:
o Policy on decentralization of industry, administration and higher education facilities
o Investment incentives
o Policies on infrastructure provision incl. transport</td><td colspan="3">• Ability to plan, deliver and operate effective and efficient transport infrastructure and services:
o Transport investment – modes, location, level of service
o Integration and efficiency of transport modes on origin – destination basis</td><td colspan="3">• Ability to influence new and in-use fleet fuel efficiency and emissions:
o Number/ type/age of vehicles
o Fuel efficiency & fuel type
o Emission rates
o Vehicle operating regime (e.g. how they are driven)</td></tr>
</table>

Note: OOO = strong impact; OO – moderate impact; O – low impact.
Source: Study Team.

4.2 Inter-city Transport Including Logistics and High Speed Passenger Train

At a national level transport is not usually the decisive factor that determines where people live, urban centers flourish or where economic investment occurs. But the historical proximity of agricultural and mineral resources to suitable sites for river ports and seaports, and the abundance of water for urban and agricultural use, has had a major influence on the nation's settlement pattern. Combined with the influence of government policies[15] on, for example, investment and infrastructure development the present day spatial arrangement of population centers and economic hubs has arisen. Where regional centers do not have a substantial economic base improved inter-city transport may facilitate access away from these centers to others with greater advantages.

Agglomeration forces are still dominating with a continuing concentration of economic activities and population density in Bangkok and surrounding areas. Thailand's regional cities[16] are much smaller in size than the BMR that has a current population of around 11 million people. While there has been a long held desire to 'deconcentrate' Bangkok in fact urbanization is continuing with the largest share of growth in urban population represented by the BMR and urbanization of the adjacent peri-urban area[17]. Projections indicate that while 43% of Thailand's population lived in urban areas in 2005 with the share expected to grow to 50% by 2015. An increasing share of the nation's economic output is being produced in the BMR region as shown in Figure 4.1. The ongoing improvements in regional highways, bus services and air services all of which center on Bangkok have likely contributed to enhancing its primacy more than promoting decentralization.

Nevertheless, the regional cities are growing and obtaining greater critical mass. Policies outside of the transport sector are likely to have been more influential in enhancing the relative attractiveness of regional centers. Such policies including development of major universities in principal regional cities, investment in infrastructure, and the relatively recent phenomenon of enhancing the autonomy of provincial and local governments. Regional cities also increasingly require transport infrastructure and services to support their own internal needs.

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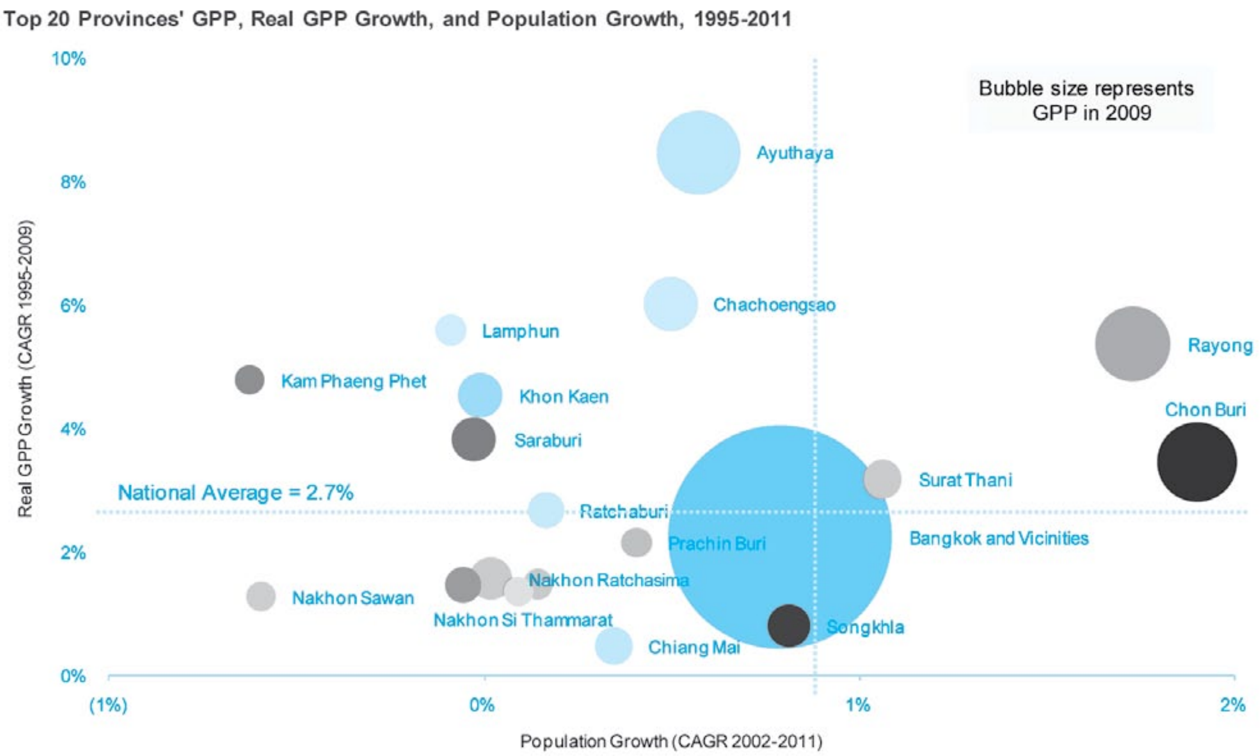
15 That may not always have achieved their goals.

16 The metropolitan populations of the second and third major cities in Thailand after Bangkok in 2005 were: Chiang Mai (500,000) and Nakhon Ratchasima (340,000).

17 Kmonwatananisa, N. (2008) – data contained in Table 3 plus other data from ADB (2006).

Figure 4.1: Top 20 Provinces' Real GPP and Population Growth, 1995-2011



Source: National Statistical Office and National Economic and Social Development Board.

At a national level, system-level interventions would primarily be driven by an economic rationale which would influence the pattern of travel demand. In this case the question for green transport is what is the best way to serve growing travel demand and improve efficiency in key freight and passenger corridors? The potential policies and investments for improving inter-city transport need to be assessed comprehensively. To inform appropriate decisions on the range of potential interventions shown in Table 4.2, the full range of economic, social and environmental impacts need to be assessed and balanced against the whole-of-life costs of implementation and operation[18]. The results of this assessment are summarized in Section 5 of this Policy Note.

[18] It is not within the scope of this Policy Note to undertake a comprehensive assessment of any of the interventions listed in Table 4.2. Several of the interventions (Inter-city passenger rail, Inter-city freight rail and multi-modal logistics, Interurban bus, truck and bus retrofits to reduce emissions and energy use, the adoption of fuel economy standards to reduce vehicle-related energy use and emissions) were assessed from an energy efficiency perspective by World Bank (2009).

Table 4.2: Potential Range of Inter-City Transport Interventions

System Economic structure/ settlement arrangement giving rise to travel demand intensity	Mode Travel alternatives and their characteristics influencing modal choices and load factors	Vehicle Policies influencing the energy efficiency and emission rates of vehicles and how they are used
Planning and policy		
• National settlement and industrial development policy • Location of government services (e.g. education, administration) • Regional economic integration, cross-border trade development policies	• Policies to promote bus, rail and logistics industry development • Logistics facilitation (cross border, other) • Pricing of transport services • Sustainable funding mechanisms/ tools	• Enhanced traffic and land transport code/ laws/ regulations • Standards for accessible, fuel efficient fleet with advanced emission controls • Fleet operation and eco-driving to reduce fuel consumption
Investment		
• Government owned/ facilitated industrial estates/ universities/ airports/ seaports etc. to promote regional development	• Arterial road and expressway capacity expansion • Passenger and freight rail upgrading • Bus industry upgrading • Waterway enhancement • Black spot and other road safety programs	• Train and bus fleet acquisition and renewal • Supporting investment in fueling stations for transit fleets • Supporting investment in terminals and access ways

Source: Study Team

Two particular issues are of concern to the government at the time of writing this report: (i) improvements to Thailand's logistics system to make it more efficient and greener; and (ii) the potential for high speed train (HST) to contribute to economic and sustainability goals. These topics are discussed below.

4.2.1 Efficient Logistics

A shift in the economy to emphasize knowledge-based industries requires deepening of economic clusters and geographic clustering to realize agglomeration economies. These industries form vital links in global and domestic supply chains and require fast, reliable and secure access to airports, seaports, and good quality national transport systems, to meet the requirements of downstream production processes. To achieve this goal, logistics systems, including freight transport, which could provide efficient services that meet the price, on-time attributes and other quality attributes desired by customers will be required.

Thailand's freight transport services appear to exhibit several major inefficiencies due to aged fleets, with low load limits and low fuel efficiency, a low penetration of multi-modal logistics providers, limited capital for new investment by small firms and limited use of Electronic Data Interchange for facilitating shipment and delivery and supply chain management (NESDB and World Bank, 2008; JETRO, 2003; ADB et. al. 2005). There is substantial room for efficiency gains and associated energy savings. While transport infrastructure investment is needed to address capacity shortages, the key challenges will be in achieving more efficient services through appropriate management of both road and rail modes.

The extensive national highway network is of good quality and has benefited the logistics industry greatly. Outside the BMR, vehicles are generally able to travel without excessive delays. Within the BMR, there is no overwhelming evidence that truck transport is greatly inefficient due to traffic congestion. Truck transport benefits from the presence of strategic road infrastructure around and within Bangkok that supports the bypass function, and the plentiful supply of industrial land within the region permitting industrial firms to locate conveniently near their supply chains. Moreover, distribution of goods within the central city of Bangkok is provided by a large fleet of small trucks operated by thousands of private firms in a competitive market that has adapted to the operating environment over many years.

Operational inefficiencies may exist because the sector relies heavily on third party truck operations, but these are of varying quality and fragmented. It also appears that there is inadequate use of Electronic Data Interchange in supply chain management for the production and distribution of high-value goods (e.g. electronics and automobile). However, given the dominant role of the private sector and market in this sector, public policy might have a limited role in addressing these issues.

The truck fleet is old and inefficient, consisting of many energy-inefficient and polluting 6 and 10 wheel diesel-fueled trucks which are cheap to purchase and maintain. Current medium and heavy truck taxes or charges are not differentiated by age, emissions, and energy performance, thus providing no incentive for the use of less polluting and more energy efficient vehicles. A review of vehicle taxation and charges is needed as a basis to formulate differentiated taxation and charges. This could help minimize the distortions between old and new trucks, between heavy and light trucks, and among rail, water and truck transport. In addition, Thailand's heavy truck and bus industries rely on the practice of rebuilding vehicles on an old chassis to lower the perceived costs of ownership. Rebuilding on the scale that has existed allowed vehicle owners to avoid investing in new trucks and buses with advanced technologies, and consequently lose the opportunity for progressive improvements in emissions, fuel economy and safety performance

The government can facilitate continued reduction in freight transport costs by: (i) enhancing land use-transport links such as better access to industrial and warehouse areas; (ii) ensuring adequate road capacity to meet freight transport needs; (iii) improving the standard and appropriateness of trucks through regulatory changes, e.g. limiting the extent to which old trucks are continually recycled, allowing the introduction of larger trucks that reduce freight transport costs and which have axle distributions and suspension that cause less damage to roads than current trucks, and strict enforcement of truck standards; (iv) facilitating truck operations (including periodic re-examination of constraints on the movement of trucks in Bangkok to ensure that the balance meets the ongoing needs of the city); and (v) improving the standard of safety in the truck industry, covering drivers, vehicle loading and vehicles. This requires sufficient motivation and capacity in government to pursue such change over the medium term in conjunction with the private sector, seeking to maximize the level of self-enforcement with sound auditing and enforcement arrangements.

4.2.2 The Potential for High Speed Train

High Speed Train (HST) lines to connect Bangkok to principal regional centers would represent a generational step in technology and potential benefits, but also present high costs and risks. The Thai Government is considering HST for several reasons including a desire to reduce energy consumption used in Thailand's long distance passenger transport. It is also recognized that the main benefits would be welfare benefits to travelers due to fast and convenient travel and possible favorable effects on regional development.

HST systems are extremely capital-intensive, and require new dedicated rail corridors. Viability therefore depends on achieving good load factors and high use of the available infrastructure by HST services. According to a study initiated by the World Bank in 2010[19] the criteria for HST to be economically and financially viable are:

- **Congested rail and transport corridors** characterized by extensive urbanization.
- **Two very large cities located 250-500 km apart** (e.g. Seoul-Busan, 420km; Brussels-Paris, 275km; Rome-Milan, 514km: London-Paris, 495km).
- **Longer corridor that has several very large urban centers located every 150-300km** (e.g. Tokyo-Osaka, 700km; Beijing-Shanghai, 1,300km; and Beijing-Guangzhou, 2,100km) with maximum speeds of 300kph to maintain competiveness with air transport.
- **Annual passenger demand of 20 million to 30 million and more** – 20 million passengers per year is the minimum required to cover the working expenses and interest costs of HST assuming they are paying commercial fares.

None of these criteria are currently or likely to be met in the next several decades in Thailand. With a population of 11 million, metropolitan Bangkok (i.e. the BMR) is large but Thai regional cities are quite small and located at distances from Bangkok that are either too far apart for HST to be competitive with aviation or possibly too close to be competitive with car or bus for large segments of the population. Large population hubs at each end of a HST line and a large proportion of the urban hub populations able to access HST line stations conveniently are both

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[19] Figure 5 in P. Amos, R. Bullock and J. Sondhi (2010) "High-Speed Rail the Fast Track to Economic Development". Prepared by World Bank, July.

needed to ensure high demand. But current circumstances are not favorable. For example, Chiang Mai (745 km from Bangkok) and Nakhon Ratchasima (256 km from Bangkok), the second and third largest cities respectively, have urban populations of 513,000 and 250,000[20] which combined represent only 7% of the BMR's population.

The recent pre-feasibility study for long term railway development found that of 16 routes studied three were worthy of implementation by 2014 as rapid trains operating initially at 120 kph: (i) Bangkok – Nakhon Sawan (240 km); (ii) Bangkok – Khon Khaen (443 km); and Bangkok – Hua Hin (225 km). In the long term, it was recommended that the Khon – Khaen Line be extended to Nong Khai and a line to Hat Yai be developed. Although proposed to be implemented as rapid train the aim was to develop to HST standard over time as double tracking and electrification are progressively implemented.

Closely ranked was the Chiang Mai line which is the current government priority. The results of the pre-feasibility showed very little difference between the implementation cost of rapid train (160 kph) and HST (250 kph) but higher benefits for the latter with the result: (i) that 160 kph rapid train was generally ranked higher than 120 kph rapid train; and (ii) 250 kph HST was ranked higher than 160 kph rapid train. The results of this or any pre-feasibility study should be used with caution. A more detailed analysis of options, potential designs, initial investment and whole of life operation costs and risks is required prior to making a large financial commitment to developing a HST line at a cost of several billion dollars with likely high recurrent financial commitments to bridge the gap between revenues from passengers and operating and maintenance cost. Such a detailed study is proposed for the Chiang Mai line.

The case for rapid inter-city passenger train could be better than that for HST. Modern rapid train services using specially acquired rollingstock can travel at service speeds of up to 160 kph on well constructed narrow gauge[21] dedicated railway track. Where double tracking is already planned then modern rapid trains might be considered to be added for a moderate incremental cost (trains, control systems, appropriate engineered corridor, higher strength ballasted track etc). Although slower than HST, modern inter-city passenger train services could greatly improve the quality and speed of long distance passenger travel in Thailand.

Modern inter-city passenger train services providing in-service speeds of 160 kph consume less than half the energy of HST operating at 300kph as shown in Figure 4.2. As CO_2 emissions are closely related to energy consumption[22] in Thailand they would be expected to rise similarly with speed also.

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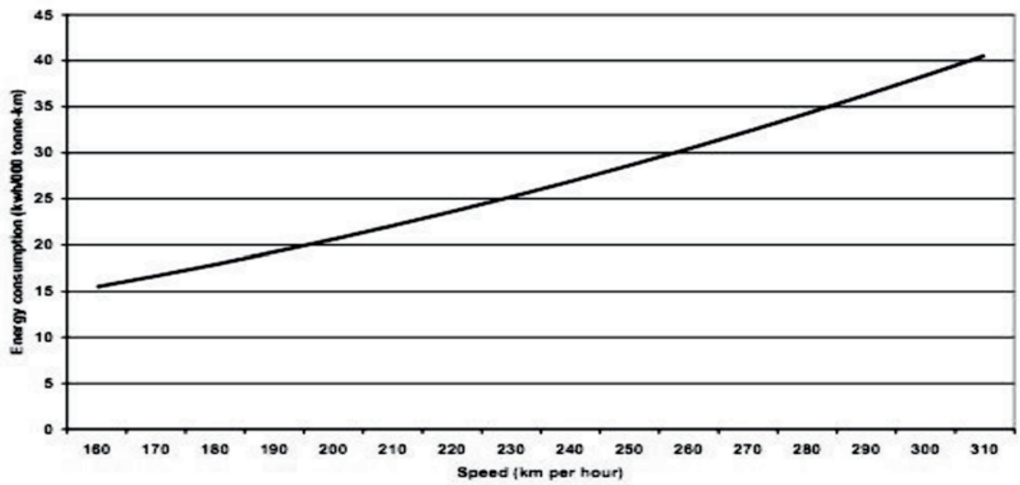
[20] The population of the Chiang Mai Urban Plan Area in 2005 was 513,000 persons. Greater Nakhon Ratchasima which is defined as the region covered by the City Plan had a population of 340,000 persons in 2008.

[21] 1,067 mm as used in Thailand.

[22] According to Power Development Plan 2010 (2010-2030) 69% of Thailand's future power generation (i.e. in 2030) will be generated by fossil fuels.

In Europe it was found that intercity trains generates significantly fewer CO_2 emissions per capita than HST but are unlikely to generate lower emissions than long distance bus. As shown in Figure 4.3, a recent European study found that intercity trains generates significantly fewer CO_2 emissions per capita than HST and dependent on the precise characteristics of the rail corridors (and demand) may sometimes generate as few emissions as inter-city bus. The latter have low CO_2 emissions per passenger because they normally operate with high load factors as in Thailand. Intercity train was found to be usually more efficient than car from a CO_2 perspective under European conditions[23].

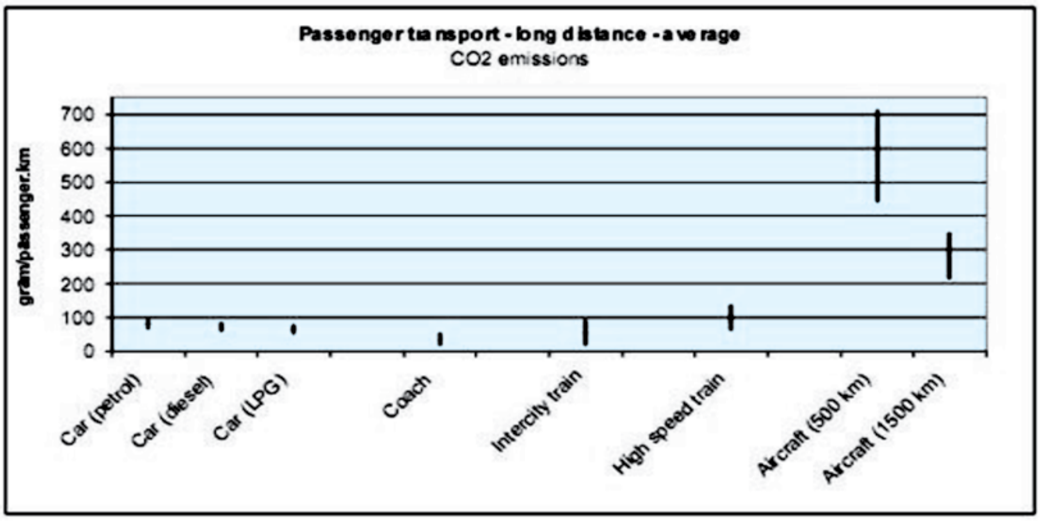
Figure 4.2: Energy Consumption versus Speed for HST



Source: Figure 5 in P. Amos, R. Bullock and J. Sondhi (2010) "High-Speed Rail the Fast Track to Economic Development". Prepared by World Bank, July.

[23] This European study based its comparative analyses of modes on CO_2 emissions per passenger but European intercity transport experiences carries much higher volumes of passengers than Thailand. Consequently, Thai decision makers should be aware that the European results give an overly optimistic view of the potential effect of HST and Intercity train on CO_2 emissions.

Figure 4.3: Average CO_2 Emissions per Passenger-km for Long Distance Passenger Transport (in Europe)



Source: Figure 8 in Van Essen H, Olivier B, Dings J and Van Den Brink R (2003). “The environmental performance of the principal modes of freight and passenger transport in the policy-making context”. Prepared by CE, Delft, Netherlands.

4.3 Urban Areas: Opportunity for Integrated Transport/ Land use Planning

Continuing urbanization and motorization have aggravated Bangkok’s well known transport problems. Due to poor land use planning and management, land use has dispersed increasing commuting distances and time spent traveling to jobs, educational establishments, shops and community facilities. Within BMR, urban densities are high with affordable housing not always conveniently located with respect to job locations or schools. This process of land use dispersion has also been driven by a growing demand for modern, spacious housing and offices away from the traditional city center and at the fringes of the urban boundary (that is expanding outwards). As a result public transport’s role is declining, further encouraging the switch to private vehicles, and exacerbating traffic congestion. Air and noise pollution are rising with harmful effects on human health and a general deterioration of the amenity of urban life. Increased energy use and greenhouse gas emissions are accompanying this growth in motorized travel with impacts on climate change.

There is a complex interaction between city structure and relative accessibility. The geography of a city, its history and the ability (or inability) of government to plan and manage land use, have influenced the current land use arrangement of the BMR and the region’s current transport performance in the economic, social and environmental dimensions.

Transport can be used to structure urban land use and contribute to favorable transport and system level outcomes. How might the array of urban transport interventions set out in Table 4.3 best be used to support the desirable development of cities? Due to the strong nexus between transport (modal level) and land use (system level), the range of actual impacts in urban areas, the impacts of typical interventions (e.g. as shown in Table 4.3) at the urban scale may vary considerably depending on the precise nature of the intervention (e.g. its capacity and extent of integration with other modes) and what areas they serve.

Table 4.3: Potential Range of Urban Transport Interventions

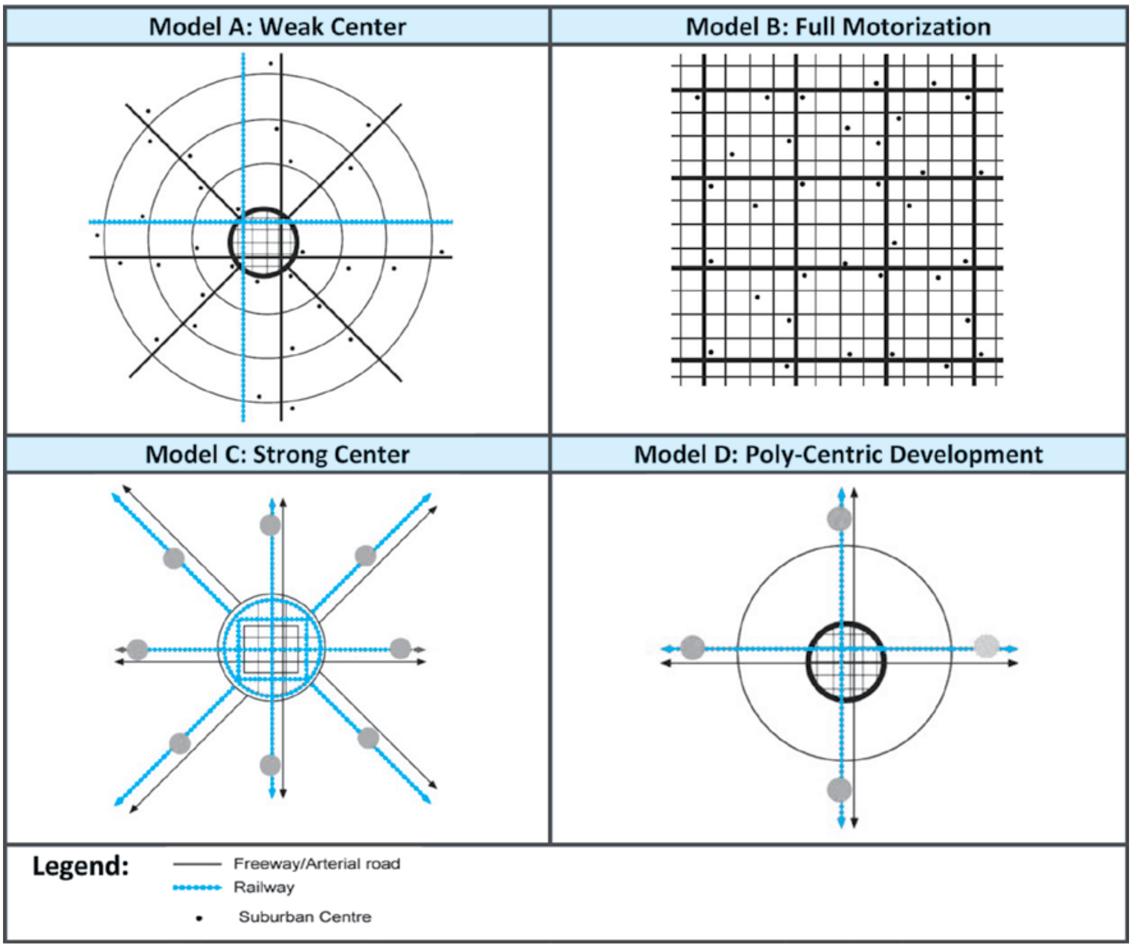
System ⇩ Economic structure/ settlement arrangement giving rise to travel demand intensity	Mode ⇩ Travel alternatives and their characteristics influencing modal choices and load factors	Vehicle ⇩ Policies influencing the energy efficiency and emission rates of vehicles and how they are used
Planning and policy		
• Strategic land use planning and management • Selective densification around rapid transit stations and infill between 'superblocks' • Policy to promote development (e.g. incentives for investment in industrial areas etc.) • Location of government service centers • Demand management and pricing policies	• Policy on development of transport as an integrated system of infrastructure and services • Integrated and 'layered' public transport system development, appropriate regulation • Policies to give priority to buses, pedestrians and non-motorized transport • Policies to promote efficient freight transport • Hierarchical road networks – a balance of large and small roads	• As for national scale
Investment		
• Initial 'seed' investment in activity centers to support land use policies • Coordination of transport and other infrastructure to support desirable land use development sequencing and densification	• Rapid transit systems – rail and bus • Road system development • Pedestrian and non motorized vehicle network improvements • Integrated ticketing systems, tolling systems, information systems	• As for national scale • Urban traffic management • Targeted retrofit/ buy-back programs

Source: Study Team

Four conceptual city models are described below to provide some guidance on how transport and land use may be mutually reinforcing to provide favorable transport and broader outcomes. These models are summarized in Figure 4.4 and are based on three city archetypes described by (Thomson 1977, pages 99-223). The fourth model is that proposed for the BMR by PCI (2005). The starting assumption is that the level of population, jobs and other demographic characteristics are the same in each city model.

While some models are likely to produce better transport outcomes than others they are not necessarily achievable or ideal. The models are described in terms of various key characteristics such as the proportion of jobs in the key activity centers and public transport mode share but these numbers are only indicative. The articulation of the city models is aimed at assisting national and local government policy makers to visualize the current transport challenges facing their cities and how they would like the cities to develop in the future.

Figure 4.4: Four City Models



Source: Thomson (1977) pages 99-223 and PCI (2005) and others.

4.3.1 Model A - Weak Center

This first model 'Weak Center' characterizes present day Bangkok, Chiang Mai and Nakhon Rachasima (refer Table 4.4 for a summary of attributes). Here the city has grown beyond the traditional city center as per capita incomes and motorization have increased. Public transport's mode share is less than that for car and motorcycle (at between 10% and 40% of total trips) and public transport, dominated by bus and song-taew,[24] is primarily radial in orientation since it is focused on the city center (or Central Business District, CBD) which despite pressure to disperse still contains

[24] Fixed route open light vans usually registered as a fixed route public transport vehicle.

a high percentage of the metropolitan region's jobs. The strong radial focus of public transport, including new urban rail systems in Bangkok, have reinforced the high level of accessibility of the city center but despite this the city is continuing to decentralize assisted by expressways and new bridges across the Chao Praya River that have been completed in the last 30 years.

Table 4.4: Model A – Weak Center

City Characteristics:	Transport System Attributes:

• Traditional CBD is expanding but role weakening as suburban centers grow
• up to 30% of jobs in CBD
• Small scale suburban centers providing some higher order urban services
 	
Examples:
• Bangkok
• Chiang Mai
• Nakhon Rachasima
	• Policy characterization: Pro-public transport but not at the expense of the car
	• **Consists of:**
	  ◦ Radial arterial roads with bus priority
	  ◦ Some radial rail/ BRT
	  ◦ Ring arterials/ expressways
	  ◦ Poor walk/cycling facilities
	  ◦ Extensive off street parking in activity centers
	  ◦ Motor vehicle use facilitated by favorable pricing and policies

Outcome:	**Sample Indicators:**[25]
• Moderate commuting times/ average trip • Moderate transport energy use/ GHG use per capita • Moderate social exclusion due to transport	• Travel time/day/capita — Bangkok 40 minutes[26]. • VKT per day per capita – Bangkok 33 VKT per day per capita[27]. • Fuel use per capita –n/a. • PT mode share: [city-wide <25%; CBD <50%]

Source: Study Team

The transport outcome is mixed with public transport playing an important but declining role with a heavy reliance on cars. While public transport carries a significant quantity of trips to the central area that reinforces its accessibility, private cars and motorcycles are the primary means of travel in outer suburban areas. Over time, public transport's share of total trips is declining as motorization increases and the city suburbanizes. Commuting distances and commuting times are tending to increase under this model as is transport energy use per trip.

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25 The indicators cited are broad measures of welfare (first and fourth bullet) and fuel use/ energy use (second and third bullets). Other indicators could be considered for other purposes e.g. (i) kilometers of high capacity transit per 1,000 people that is a crude but easily measured surrogate indicator for welfare and other things; (ii) fatal accidents per 1M people as a measure of safety; (iii) carbon emissions for capita or per unit of transport system output as a measure of carbon intensity; (iv) transport energy intensity (e.g. MJ/ passenger-km); and (v) measures of air quality (e..g. particulate matter emissions per VKT)

26 Burapatana and Ross (2011).

27 Ibid.

The trend is for further motorization as characterized by Model B. However, given Bangkok's historical development path, and its density, the almost total reliance on private vehicles represented by Model B is unlikely to ever be reached. For Chiang Mai and Nakhon Rachasima, there is a greater risk that they will dramatically increase their reliance on private vehicles in the future since public transport already represents less than 15% of all trips in these cities respectively and this share is declining.

4.3.2 Model B – Full Motorization

The second model 'Full Motorization' represents an extreme reliance on cars (refer Table 4.5 for a summary of attributes). Under this model, the land use and jobs are dispersed and private vehicle is the principal means of movement. In order to support the high use of cars, large tracts of land are devoted to both at-grade car parking or in denser areas, car parking buildings. Due to the reliance on private vehicles, but also the physical design of roadways and the buildings nearby, walking and other non motorized travel are inconvenient and unsafe. Further, since access to buildings relies on private vehicles pedestrian access may be indirect with limited legibility. While there is a distribution of centers most serve as sub-centers with perhaps some higher order functions. There is a historical central area but the concentration of jobs in that center is likely less than 20% of the region's total.

Table 4.5: Model B – Full Motorization

City Characteristics:	**Transport System Attributes:**

• Traditional CBD's role greatly diminished
• Higher order urban services scattered through the urban area in small centers
• <20% of jobs in any center
 	
Examples:
• No Thailand example
• Los Angeles, Detroit in USA
	• **Policy characterization:** Aggressive pro-car policy, minimal public transport, walking/ cycling discouraged
	• **Consists of**:
	  • Arterial roads and expressways
	  • Public transport – basic services for those w/o access to cars
	  • Walking/ cycling – minimal facilities and difficult given city scale and difficulties in crossing roads
	  • Large tracts of land in activity centers devoted to parking, extensive parking on street, parking is free or cheap
	  • Motor vehicle use facilitated by favorable pricing and policies

Outcome:	**Sample Indicators:**
• Long commuting times/ average trip • High transport energy use/ GHG use per capita • High social exclusion due to transport	• Travel time/day/capita – n/a. • VKT per day/capita – n/a. • Fuel use per capita– n/a. • PT mode share: [city-wide < 5%; CBD < 10%]

Source: Study Team

Transport energy use is high due to the role of cars and limited use of public transport and the resultant dispersed pattern of land use. Road development is actively pursued to create new suburbs and new outlying industrial and sub-regional shopping complexes to support wide scale private vehicle use. Public transport has been largely provided at a very basic level for those that do not have access to a private vehicle. Commuting distances, commuting times and transport energy use per trip are already quite high and likely increasing slowly.

4.3.3 Model C – Strong Center

The third model 'Strong Center' represents a dense urban form that is exhibited by megacities around the world (refer Table 4.6 for a summary of attributes). Cities such as London (14M metro population), Paris (12M), New York (20M), and Tokyo (32M) exhibit the characteristics of a strong center. A major proportion of the region's jobs are contained in a very extended and dense central area. These cities tend to have developed over a long time and were already established centers prior to the commencement of the motorization age. Urban rail services and other public transport support the high order functions and services provided by the center and facilitate growth in employment and agglomeration economies. Due to high urban densities, car ownership is discouraged with, for example, only around 50% of households in London and New York owning a car[28].

Transport benefits from a dense land use with high share of public transport and non-motorized modes and low transport energy use. The net result is that travel by public transport and by non-motorized modes dominate travel within London in 2007, only one third of daily trips were made by car, and one third each by public transport and non motorized modes. In New York, for trips to work, 40% was made by rail, 15% by bus, 8% by walking and 37% by car. With extensive arterial streets well used by pedestrians, non motorized transport, buses and private vehicles, frontage shops and developments take advantage of the street level activity. Major expressways exist but at a lesser level than in cities are more motorized. These expressways are used to facilitate external traffic to bypass the city or to access airports, sea ports and other regional economic hubs. Commuting distances and commuting times are moderate for these highly populated cities and transport energy use per trip likely to be low to moderate.

[28] In 2007, 50% of households did not own a car in 2007 (Office for National Statistics UK) while in 2003 in New York 54% of households did not own a car in 2007 (Texas Transportation Institute: Urban Mobility Report 2003).

Table 4.6: Model C - Strong Center

<table>
<tr><th>City Characteristics:</th><th>Transport System Attributes:</th></tr>
<tr><td>

- CBD primacy maintained by strong radial transport, density constraints that limit car use, and the concentration of specialized services to achieve high agglomeration economies
- >50% of region's jobs in extended CDB

Examples:

- No Thailand example
- London, Paris, New York
- Traditional CBD's role greatly diminished
- Higher order urban services scattered through the urban area in small centers
- <20% of jobs in any center

</td><td>

- Policy characterization: Pro-public transport, car use not encouraged due to high urban density
- **Consists of:**
  - Radial arterial roads with bus priority
  - Extensive radial and circumferential rail and suburban commuter train
  - Arterial ring around CBD
  - Possible middle or outer ring arterial road or expressway
  - City-scale facilitates walk/cycling as car use is low
  - Parking in CBD and at residential end limited by shortage of land
  - Motor vehicle use discouraged by shortage of density of development, parking pricing and policies

</td></tr>
<tr><th>Outcome:</th><th>Sample Indicators:</th></tr>
<tr><td>

- Moderate commuting times/ average trip
- Low transport energy use/ GHG use per capita
- Low-moderate social exclusion due to transport

</td><td>

- Travel time per day per capita – New York 34 minutes[29].
- VKT per day per capita – Paris 19-20 km[30].
- Fuel use per capita - Paris 15,500 MJ/Capita, London 14,500 MJ/capita[31].
- PT mode share: [city-wide >50%; CBD >70%]

</td></tr>
</table>

Source: Study Team

4.3.4 Model D – Poly-Centric Development

The fourth model 'Poly-Centric Development' represents a structure where the aim is to guide and manage the dispersion of land use (refer Table 4.7 for a summary of attributes). The CBD is linked by rapid transit to surrounding satellite centers each with their own employment and population base but are still reliant on the CBD for many higher order services.

Poly-centric development has been proposed for 'structuring' land use in the expanding Bangkok region (PCI et al. 2005). Under this model, transport investment and urban development are synchronized and transport is used to enhance accessibility to desired areas. Areas to be protected from urban development are also identified and planning measures plus the withholding of key infrastructure is used to accomplish this measure. In principle, high quality rail and bus

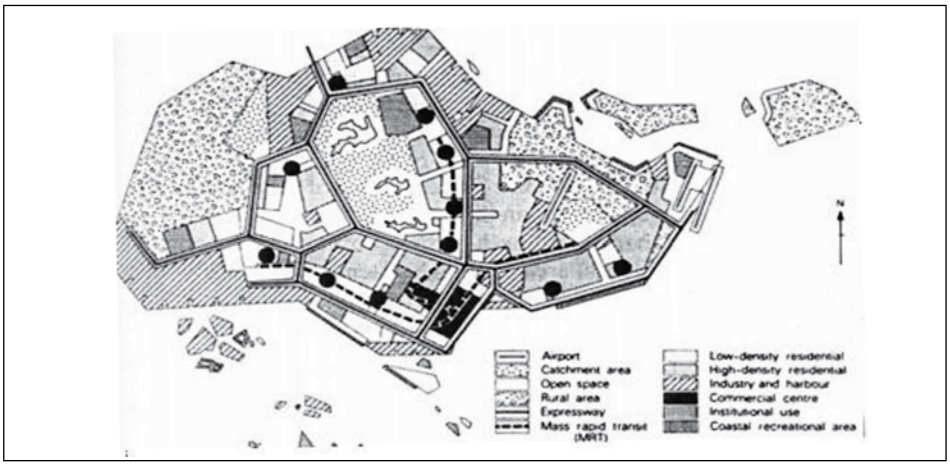
[29] Burapatana and Ross (2011).
[30] Rat (2001).
[31] Rat (2001).

transit is used to link the satellite centers surrounding the urban area and the central city, and high efficiency is obtained by achieving balanced flows in each direction which increases load factors, energy efficiency, and economic and financial performance of these transit systems. Accordingly, commuting distances and commuting times are likely to be very similar to that for the Weak Center model until such time as the restructuring effect becomes significant.

Early integrated transport and land use planning in urbanizing areas at the fringes and outside of the BMR could achieve a better transport outcome. For the BMR that has already decentralized to a great extent, the possibility of reversing the forces of disperson and aiming to become a strong center city are remote. However, it seems feasible to intervene in developing areas to guide where subsequent new urban development and infill occurs through appropriate provision of transport and other major infrastructure supported by suitable urban management policies. Since urban development in the region is already well advanced, achieving a sigificant change in travel and energy efficiency is unlikely in the short to medium term. And to achieve this change requires considerable and sustained effort to strengthen land use policies and coordinate land development with infrastructure provision.

For other cities, the poly-centric model can achieve significant long term benefits if implemented in a formative stage of city development. For cities like Chiang Mai and Nakhon Ratchasima, there is a strategic opportunity to integrate land use and urban transport planning to achieve more efficient and greener transport outcome as demonstrated in the poly-centric model. A good example is Singapore which since the 1960s pursued an "…orderly path for decentralization while maintaining a strong centered development pattern" in its "Ring Plan" (refer Figure 4.5). A key aim was to achieve efficient commuting patterns (i.e. balanced flows) through the coordination of development of new towns and transit systems. Singapore's one party rule over several decades has been the reason the plan has been followed closely (Cervero 1998).

Figure 4.5: Singapore's Ring Plan



Source: Cerveo (1998) reproduced from original source L. Wang, "Residential New Town Development in Singapore, Background, Planning and Design. *New Towns in East and South East Asia: Planning and Development.*" D. Phillips and A. Yeh (eds.) (Hong Kong; Oxford University Press, 1987).

Table 4.7: Model D – Poly-Centric Development

City Characteristics:	Transport System Attributes:

• CBD role may be significant with up to 30% of region's jobs
• Higher order urban services distributed to activity centers each with 10-15% of all region's jobs
 	
Examples:
• Proposed for BMR by PCI (2005)
• Singapore
	• **Policy characterization:** Coordinated transport-land use development. Opportunity to achieve balance between residential and job location minimizing travel.
	• **Consists of:**
	  • Radial arterial roads / outer ring
	  • Some radial rail/ ring rail
	  • Bus on radial arterials
	  • Extensive on and off street parking
	  • Activity centers walkable and cycle friendly but urban scale not conducive to long walk/cycle trips
	  • Strong land use policies
	  Motor vehicle use discouraged by shortage of density of development, parking pricing and policies

Outcome:	**Sample Indicators:**
• Low-moderate commuting times/ average trip • Low-moderate transport energy use/ GHG use per capita • Low-moderate social exclusion due to transport	• Travel time/day/capita – n/a. • VKT per day/capita – Singapore 21 km[32]. • Fuel use per capita– n/a. • PT mode share: [city-wide 10-25%; CBD 20-50%].

Source: Study Team

4.4 Conclusion on Facilitating Green Transport

There are several broad conclusions that can be drawn from the foregoing:

- Transport is important to support the implementation of regional development policies but alone is insufficient to guarantee the success of those policies.

- Efficient inter-city transport options would enhance economic, social and environmental outcomes in inter-urban corridors. Where justifiable, improved inter-city train and freight rail services and other public transport could play an important role.

- At the urban scale, rapid transit, public transport and, where appropriate, roads should be used to structure land use and support the accessibility of activity centers with desirable economic, social and environmental outcomes. Coordination of provision of transit and road systems along with appropriate land use regulations in urbanizing areas is feasible but demanding.

32 Rat (2011).

- Policies to support energy efficient and low emission vehicles are vitally important in the short term while the longer term modal and system level interventions are planned, implemented and take effect.

For urban areas, the analysis of the city models provides some insights on the relative advantages and disadvantages of modes under various circumstances:

- Urban roads are not unambiguously good or bad. Secondary and distributor roads that relieve primary roads and provide access to land-locked development in the urban area may promote a more efficient and compact land use form. Further, buses may use such roads to provide enhanced access to residential areas.

- Expressways that promote efficient access across urban areas for long distance freight traffic from hinterlands to sea ports may be quite beneficial compared to the alternative of heavy trucks having to negotiate congested arterial roads with increased congestion and emissions for all.

- Urban expressways that promote access to already congested activity centers such as the downtown area are likely to have poor economic, social and environmental outcomes compared to rail or bus rapid transit systems that are best suited to serve such centers. Expressways and other major roads are more likely than rapid transit to disperse land use with unfavorable impacts.

- Rapid transit systems permit the growth of activity centers without the same level of disruption and emissions that may result from trying to expand road infrastructure in a dense downtown area. Further, the knock-on effects of enhanced accessibility and growth of activity centers are likely to be positive from a transport and broader perspective.

- An urban land use arrangement that is suited to high public transport use is also likely to encourage walking and cycling for its own sake but also to access rapid transit stations and other public transport with considerable economic, social and environmental benefits.

5

What Scenarios for Green Transport

- *What is the potential impact of green transport interventions and their priority?*

Given the right policy interventions, the transport sector could be made much more efficient and greener than the business-as-usual case. There are several studies which have quantified the impacts of policy interventions on energy savings and carbon emissions. All confirmed that with appropriate mix of various policy and investment interventions, the transport sector could achieve significant improvement across the board.

This Note summarizes the results reported by two recent World Bank studies that analyzed the potential transport-related energy reduction potential for Thailand (including BMR) and the BMR alone[33]. The impacts are principally expressed in terms of the impacts on energy which is correlated with CO_2 and to a lesser extent local emissions[34]. The Bangkok study also quantified welfare impacts as represented by per capita travel times. To enable a comparison of the two studies a common horizon year of 2020 was adopted. This is only eight years away. In reality the policies and investment measures discussed in this section will take several years to implement even with a prompt decision to 'go ahead'. Consequently, the 2020 horizon should be viewed not as rigid deadline but representative of feasible reductions in energy and emissions in the period 2020 to 2030 dependent on the speed of implementation.

5.1 National Scale

Without any interventions, transport energy use is projected to increase by 70% over 2006 to 2020. Energy use associated with transport activity in Thailand[35] was estimated at 16,700 ktoe/year in 2006. In the BAU scenario at 2020, without particular interventions to reduce energy use, energy use was projected to grow by 70% to 28,100 ktoe/year. About one quarter of the total transport-related energy use that was modeled is consumed in the BMR, i.e. around 4,000 ktoe/year.

The impacts of several scenarios or policy options aimed at enhancing energy efficiency for land transport for the whole country were examined by World Bank (2009a). These scenarios combined the effects of 16 individual interventions into logical and mutually supportive packages. The policy options cover those at the modal level (rail investment and reform, better urban bus services), and trip level (better vehicle and fuel) as well as pricing measures. Refer Box 5.1.

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[33] For Thailand, the "Making Transport More Energy Efficient" by World Bank (2009a) and, for Bangkok, background analysis for the World Bank's 2010 Flagship report "Winds of Change: East Asia Sustainable Energy Future" (World Bank 2009c).

[34] Such as particulate matter that is damaging to human health.

[35] Modeled for Bangkok, intercity roads and railways which together represent almost 75% of Thailand's transport sector-related energy consumption.

The results show that all scenarios for Thailand as a whole are expected to achieve a maximum potential reduction in energy usage in the land transport sector of 27% at 2020 (compared to the BAU). This is equivalent to a saving of 7,500 ktoe in energy at 2020 which is more than the estimated energy usage projected for the BMR at 2020. Refer Figure 5.1 for the results of the respective scenarios.

Measures with the highest impacts are better vehicle standards (i.e. fuel economy) and policy and pricing measures. The results show that better vehicle standards (i.e. fuel economy measures) and policy and pricing measures each are expected to contribute almost equally to 70% of the total estimated energy reduction. As a result, both of these scenarios were shown to demonstrate high cost effectiveness (World Bank 2009a).

Box 5.1: Transport Scenarios for Thailand

Fuel efficiency and fuel switching: upgrade engine technologies for buses and trucks, and use natural gas and other alternative fuels selectively in vehicle fleets, especially commercial vehicles.

Better vehicle standards: establish and (progressively) tighten fuel economy standards of passenger vehicles to match European standards, and improve logistics practices in the road-based freight transport sector to better match truck sizes to the task and operating environment.

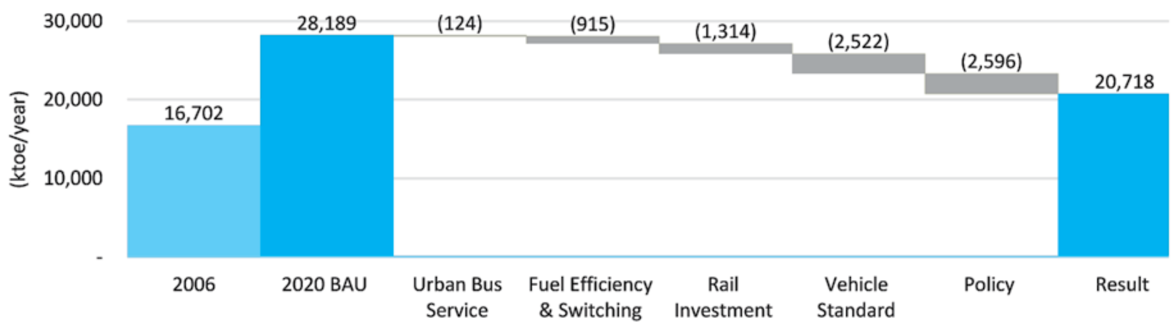
Rail investment and reform: reform and modernize the rail sector, expand the role of rail in freight transport and long-distance passenger services; and in the BMR, expand mass rail transit and improve its integration with bus services, and improve accessibility and walkability to bus stops and mass rapid transit stations.

Better urban bus services: increase the speed and quality of bus services through expansion of BRT and investment in new fleet which will bring improved passenger comfort, better fuel efficiency and lower emissions.

Policy and pricing measures: upgrade the vehicle registration system and associated charges that reflect actual vehicle use; improve traffic management; and promote more efficient bus services through reforms that encourage competition and new investment.

Source: World Bank (2009a).

Figure 5.1: Estimated Energy Impacts of Thailand-specific Scenarios (ktoe/year)



Source: Adapted from World Bank (2009a).

5.2 Bangkok Metropolitan Region

Various scenarios for 2020 were modeled starting from a do-minimal to a most comprehensive scenario for BMR. The various scenarios shown in Box 5.2 build on the minimal intervention case which includes completion of urban rail construction as committed in 2009[36] (Scenario 1) to the completion of the urban rail master plan for Bangkok (Scenario 2) to adoption of measures to develop an integrated, high quality public transport system (Scenario 3). The comprehensive scenario (Scenario 4) includes measures to discourage car use. A fifth scenario was modeled that represented a case of no capital investment but only the effect of demand management measures.

For the purposes of the analysis to support this Note two minor scenarios were added to: (i) examine the impact of operational improvements to Bangkok's bus services to improve passenger loadings per bus trip through creation of more direct and efficient routes and services and **(ii) technology measures to improve the fuel economy** and reduce emissions for diesel buses (and trucks). The key characteristics of the scenarios are shown in Table 5.1.

Table 5.1: Characteristics of Scenarios for BMR

Scenarios	Population	Urban Rail-Km	Bus-km/ year (M)	Daily-pax trips (mechanized, unlinked)(1)	Public Transport Mode Share (%) (2)	Avg speed (kph)	Average travel time per unlinked trip (hours)+
Circa 2005-2007 Ref. year	11,160,000	46	661.6	24,101,191	22.4	26.4	0.54
Scenario 1: 2020	12,900,000	75	720.9	33,715,227	20.2	12.6	1.24
Scenario 2: 2020	12,900,000	225	515.7	34,248,295	20.8	19.3	0.82
Scenario 3: 2020	12,900,000	225	648.2	33,844,370	25.1	20.7	0.77
Scenario 4: 2020	12,900,000	225	684.6	33,741,353	27.4	22.3	0.68
Scenario 5: 2020	12,900,000	75	866.6	33,611,923	27.3	22.1	0.69

Notes: (1) Linked trips are the trips between origin and destination. Unlinked trips are for individual stages of a journey between origin and destination. Hence, data on ticket sales for each mode are also the equivalent of unlinked trips. A mechanized trip is one which has one or more legs using a mechanical mode of transport as opposed to one which has all legs using non mechanized modes such as walk or bicycle. Walk and cycle modes not simulated here except for access to mechanized modes. (2) On the basis of linked mechanized trips mode share is normally reported to be around 35-40% of all trips for BMR in 2005. It is not clear why these numbers are low but they are considered useful in a relative sense. (3) Average travel time per linked trip would be higher – at least 25% more on average in line with the ratio of unlinked to linked trips.

Source: Data contained in "Transport Analysis" spreadsheet supporting World Bank (2009c).

[36] The year in which the study was being undertaken.

In the 2020 with 'business-as-usual', the BMR's energy use is expected to rise by 85% with a continuing decline in public transport mode share and average traffic speeds. In 2007, total energy use in BMR's land transport sub-sector was estimated to be 4,300 ktoe. In the BAU at 2020, as represented by Scenario 1, total energy use in BMR's land transport sub-sector is estimated to rise to 7,900 ktoe representing a growth of 4.8% per year.[37] The baseline forecast at 2020 (i.e. Scenario 1 compared to 2007 Reference) shows that the population would grow by 15.6% to 12.9 million up from 11.16 million in 2007. Public transport mode share would decline from 22.4% to 20.2% of all mechanized trips. Average car speeds would decline dramatically although this effect may be exaggerated due to limitations of the transport model to simulate the feedback between land use and transport on a comprehensive basis.

Scenario 4 with the most comprehensive series of measures to improve public transport and limit car use indicates potential energy savings of 26% compared to the 2020 BAU level. Public mode share increases to 27.4% representing a 36% increase compared to the BAU at 2020 and car speeds would improve dramatically compared to the BAU but still be slightly lower than in 2005. Scenario 4 as modeled here includes two additional sub-scenarios or measures applying to Bangkok's bus services (refer Box 5.2) shows the 26% reduction in energy use compared to the 2020 BAU represents 2,000 ktoe of energy at 2020 for BMR.

But this improved scenario at 2020 still represents an increase of 38% in BMR's annual energy use compared to the 2007 reference year. On a per capita basis the growth would be just under 20% between 2007 and 2020. The results of all these original scenarios as modeled by World Bank (2009c) and the two additional sub-scenarios applying to Bangkok buses are shown in Figure 5.2.

Box 5.2: Transport Scenarios for Bangkok

Scenario 1: Do-minimal: complete current urban rail construction (as committed in 2009) and do not make any improvements to the quality of public transport. With the analysis for the reference year of around 2007, Scenario 1 represents the BAU for the Bangkok transport analysis.

Scenario 2: Implementation of the urban rail masterplan: all major projects as part of the urban rail masterplan published in 2007 are implemented by 2020 but no significant efforts are made to integrate bus services with urban rail or improve the quality of bus transport.

Scenario 3: Scenario 2 plus complementary measures to create a high quality public transport system including timed 'transfers' between modes, high quality transfer facilities and integrated fares. Additionally, bus services were assumed to have increased coverage and be given on-street priority possibly at the expense of private vehicles.

Scenario 4. Scenario 3 plus additional measures to discourage car use (comprehensive scenario). These measures included higher vehicle and fuel taxes, and higher parking costs and longer distances to between final destination and car parks.

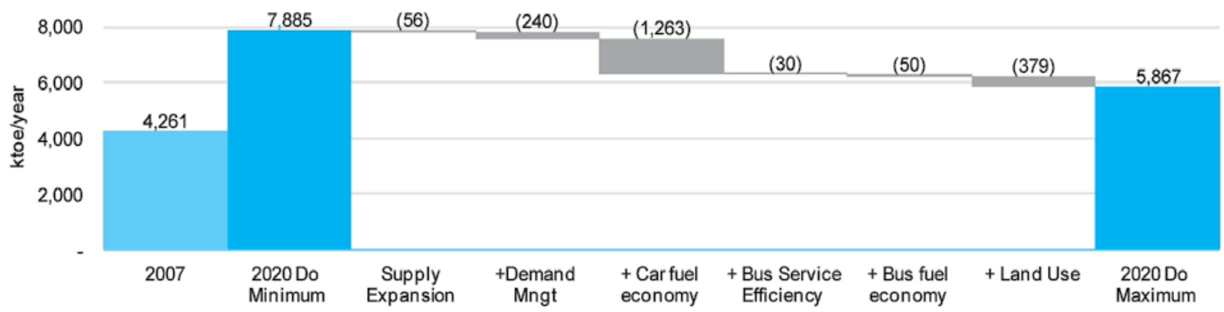
[37] Which is slightly faster than estimated by World Bank (2009a) for the "Thailand: Making Transport More Energy Efficient" report.

Scenario 5: No capital investment. That is, only the demand management measures are included.

The two minor scenarios were developed as follows (i) a 10% reduction in unproductive bus kilometers – the bus improvements considered in the scenarios were oriented to improving coverage and quality and not specifically directed to improving bus productivity and so an additional scenario was added; (ii) diesel bus fuel economy and emissions improvements of 17%, the same as that for gasoline powered vehicles. This technological effect is achievable and was omitted by World Bank (200c) and was therefore added in this current study.

Source: World Bank (2009c).

Figure 5.2: Estimated Energy Impacts of BMR-specific Scenarios (ktoe/year)



Source: World Bank (2009c) plus supplementary analysis

Fuel economy standards for private vehicles are the single most important measure but pricing and other measures combined are likely to be more important in the long term. The results of individual measures (including demand management, land use densification on a scale likely to be achievable by 2020, technological measures to improve fuel economy and reduce emissions for private vehicles and buses) show that fuel economy standards for private vehicles could achieve 60% of the total projected reduction in energy use by 2020. This analysis is confirmed by World Bank (2009a) and the recent analysis by the Ministry of Energy (2010) for their Energy Conservation Plan 2011-2030. But the other measures combined deliver the balance of BMR's energy savings at 2020 of 756 ktoe (i.e. another 40%). Pricing and land use measures would be expected to influence the structure, level and location of transport demand and associated transport effects in the long term and so would likely come into prominence with the passage of time.

The energy savings in the BMR represents a major part of the total potential energy savings nation-wide but other secondary cities also offer potential. As reported in Section 5.1 measures to reduce transport-related energy consumption in Bangkok are estimated to represent about one quarter or more of the total transport-related energy savings projected for Thailand. The energy saving projected for all urban areas would be around 2,500 ktoe in 2020 with most of this attributable to the BMR. Besides the BMR, Chiang Mai and other secondary cities also offer significant potential for energy savings and GHG emission reductions (refer Box 5.3).

Box 5.3: Sustainable Urban Transport in Chiang Mai

Chiang Mai, the major city in northern Thailand, is facing pressing challenges as urban sprawl continues horizontally and the city is gradually losing its compact character. Common urban transport problems such as congestion, air pollution, unavailability of high quality public transport, are starting to emerge as the city and suburban areas grow. It is estimated that if the city could shift away from the business-as-usual scenario (without proper and forward-looking urban transport planning and investment) towards a sustainable urban transport planning and implementation scenario (where Chiang Mai could move on the sustainable urban transport path and fully implement urban transport plan and policies, i.e. adopt integrated land use and transport planning seriously, improve the role of non-motorized transport in the old town to serve short-trips, invest in efficient and modernized public transport, etc.) the city could reduce GHG emissions by 77,036 tonnes of CO_2 equivalent emissions annually by transforming the modal shares with greater role of public and non-motorized transport. Sustained efforts and comprehensive implementation of a mix of policies and investment in a long-run will be critical to achieve this desirable outcome.

Source: Study Team based on the Global Environment Facility's document for the Chiang Mai Sustainable Urban Transport Project.

All the measures proposed for the national scale and BMR are technically feasible, however, the challenge is to implement them comprehensively and without excessive rebound. The reported estimates for energy reductions are realistic estimates of the potential through implementation of policies on a comprehensive basis. They are challenging to implement in their entirety but are all quite technically feasible. However, these estimates do not take into account the effect of 'rebound[38]' that would tend to erode the benefits of improvements. World Bank (2009a; 2009c) specifically called for improved pricing measures, as well as other demand management, to minimize rebound.

5.3 How to Prioritize Measures ?

Cost effectiveness and ease of implementation criteria could be used to derive a simple index of priority in conjunction with quantified benefits. Simplified cost-effectiveness of interventions from an energy or greenhouse gas perspective can be carried out by comparing the expected cumulative reduction in energy and emissions to the cost of implementation to prioritize these measures. However, the ease of implementation also has to be considered and a practical opportunistic approach may be required in practice.

Only fuel economy standard measures exhibited high cost-effectiveness and low implementation difficulty while other measures were considered very important but face serious implementation challenges or were of high cost. This simple analytical approach was used by World Bank (2009a) to prioritize measures to improve energy efficiency in Thailand's land transport sector. It was found that fuel economy measures exhibited high cost-effectiveness and low implementation

[38] 'Rebound' occurs as additional travel is induced in response to transport supply improvements and give rise to additional energy use and emissions (that are called 'leakage')

difficulty. Other measures which are also important but have high implementation barriers or exhibit low cost-effectiveness are: (i) improved traffic management in Bangkok; (ii) enhanced bus industry efficiency and integration with urban rail in Bangkok; (iii) improved pricing of fuels and of transport generally; (iv) upgraded long distance freight rail in corridors where it can be competitive; and (v) enhanced land use planning and densification of land use in key activity centers starting with areas around urban rail stations.

A more detailed analysis might look at the incremental cost and benefits of each measure or package of measures to determine an optimal mitigation strategy. However, as pointed out in Section 2, most transport interventions tends to have impacts in the economic, social and environmental dimensions and an analysis from solely an energy or greenhouse gas perspective would be insufficient to determine overall priority e.g. in the case of the current High Speed Train proposal.

5.4 Summary of Key Indicators for BMR and Thailand

Significant improvement in selected key indicators is possible and they provide a useful means of high level monitoring of implementation progress. Based on the indicators proposed in Section 4, the potential performance of the Thailand and BMR scenarios are shown in Table 5.2 for 2020 (and subsequent decade). For Thailand the measure of transport energy intensity indicates a reduction of 26% in energy use per capita that is consistent with the findings on absolute energy reduction reported above. For the BMR, a wider range of indicators were calculated by World Bank (2009c). Energy intensity was calculated but also public transport mode share (an indirect measure of transport efficiency) and the average time spent commuting per passenger trip. The indicators showed that for BMR the potential reduction in energy intensity was also 26%; public transport mode share could be improved by almost a quarter; and average commuting time per passenger trip (across all modes) could be reduced on average by one fifth.

Table 5.2: Key Indicators for Land Transport Energy Use

Indicator	Population (x 1000)	Transport Energy Use/ 1000 people p.a.	Public Transport Mode Share (%)	Average travel time (hours)/ pax. Trip
Thailand as a whole including BMR (World Bank 2009a)				
BAU 2020	76,000	0.38 ktoe	N.A.	N.A.
All Scenarios (2020)	76,000	0.28 ktoe	N.A.	N.A.
BMR only (World Bank 2009c)				
BAU 2020	12,900	0.61 ktoe	22.4	0.68
Scenario 4 + bus efficiency improvements (2020)	12,900	0.45 ktoe	27.4	0.54

Source: Data from Figure 5.1, Figure 5.2 and Table 5.1.

6

How to Action Green Transport?

6.1 Overcoming the Barriers

While the range of potential measures to achieve the potential reduction is known the challenge lies in bringing plans and policy to action. Transitioning to effective and purposeful implementation requires overcoming stakeholder concerns and then comprehensive and timely implementation of the full suite of potential measures: (i) pricing and policy; (ii) technology improvement/ fuel economy/ alternative fuels; and (iii) rapid transport infrastructure and improved public transport.

Several barriers exist for implementing improvements to transport whether considered 'green' or 'conventional'. These barriers would need to be considered when engaging relevant agencies to progress a green transport agenda:

- **Legal and institutional:** National and regional governments are always critical for transportation policies and regulation, and the role of city governments in setting policies and regulations is currently limited although developing. The divisions of responsibilities between different agencies are generally subject to poor coordination, co-operation and integration. The barrier can be experienced within the transport sector (with institutions both horizontally and vertically) but also in its relationship with other agencies since demand for transport is intrinsically linked with decisions made in other sectors.

- **Methodological:** Given energy and GHG emissions' cross-sectoral nature, governments need to evaluate options holistically. Within urban and regional planning frameworks, transport options must be assessed across sectors as well as across time because sustainability initiatives do not always have immediate impacts. This barrier tends to be characterized by a lack of appropriate performance indicators and targets and the absence of full cost accounting methods for transport impacts. Evaluation methods need therefore to include indirect costs in terms of energy security, environmental (local pollution), congestion and safety costs. Co-benefits from interventions in the transport sector are often much larger than climate benefits (if both are monetized), which considerably enhance the cost effectiveness of activities in the transport sector.

- **Capacity:** Another major barrier is the lack of skills to develop and implement appropriate technologies and methods in a wide variety of fields such as integrated transport planning; vehicle, fuel and infrastructure standards; assessment, evaluation and accounting of transport impacts. Given the complexity and emerging knowledge in the field it would appear that government agencies at different levels require support to promote solutions that would help delink high levels of carbon-intensive energy use from urban growth and to define a governance system for its implementation. Without such support it would be quite difficult to see how a large metropolitan region like BMR or other fast growing cities like Chiang Mai can achieve and measure the progress towards making their cities less carbon intensive, more environmental-friendly and socially inclusive.

- **Market and Commercial:** Technology is a necessary condition to pave the way towards low-carbon growth. But emerging low-carbon technologies in the transport sector vary as to their technical readiness and commercial attractiveness. In many developing countries the market for low-carbon alternatives is not fully developed. The implication is that significant and accelerated efforts toward technological innovation and diffusion of low-carbon transport technologies are needed.

6.2 Holistic Approach

Comprehensive and effective implementation requires a holistic plan of action with cross-sectoral leadership that incentivizes and coordinates each responsible agency's contribution to the common goal. Implementing the priority policies will require concerted action and appropriate technical support. Consistent with the 'cross-sectoral' nature of making improvements in transport energy efficiency, there are several agencies which are responsible in various aspects of green transport ranging from climate change policy, energy policy, transport policy and industrial policy. Several agencies and units in government agencies have been recently established to directly deal with climate change issues that are closely related with energy efficiency. The current institutional responsibilities for policy making cover transport, energy and environment including Climate Change are as displayed at Table 6.1.

Table 6.1: Institutional Responsibilities

Sector/ area	Responsible Agencies
National	
Transport	MOT via OTP, Line Agencies MRTA, SRT, BMTA
Energy	MOE/ EPPO, DEDE
Environment	MONRE/ PCD
Climate Change	ONEP, TGO
Urban or town administration	Local governments
Cross-cutting/ coordination/ finance	Commission for the Management of Land Traffic, NCCC, NESDB, MOF

Source: Study Team.

Improved pricing of fuels and vehicle access and use charges is critical for underpinning the veracity of any plan for green transport. Pricing measures avoid the need for detailed project by project implementation since appropriate pricing signals would be expected to induce favorable behavior by firms and individuals. But pricing measures present complex political and social challenges that only high level leadership can overcome.

The identification of practical steps and clear responsibilities is the key to making progress. Table 6.2 regroups the proposed options set out in World Bank (2009a) and based on the updated assessment of priority (refer Section 5), sets out a desirable future policy direction and identifies possible next steps to enable implementation during the period of the 12th Plan.

Timing matters greatly, as transport policy, measures and infrastructure investment need long lead time (5-20 years) to materialize and achieve their intended outcome. Fuel economy standards that alone can achieve approximately an estimated one quarter of the estimated energy saving[39] by 2020-2030 are currently being formulated but will take at least two years to bring into force. However, they will affect only new vehicles and so their potential impact will require 20 years to flow through the vehicle fleet. Transport infrastructure and improved public transport should be designed to effectively support a desirable land use arrangement (location and density of activities) and to operate efficiently to maximize benefits in all dimensions. The lead time for provision of transport infrastructure is of the order of 5 to 10 years and even longer to facilitate favorable land use change. Consequently, implementation of appropriate infrastructure and services for vehicles and non-motorized modes should also be implemented without delay.

[39] As shown in Figure 5.1 for ''better vehicle standards' that represents an estimated 2,500 ktoe/year energy saving or 22% of the estimated total of 11,500 ktoe.

Table 6.2: Simplified Priority, Future Direction & Next Steps

Note: XXX – First priority; XX – second priority; X - third priority

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
All Vehicles			
Fuel economy improvements in private sector's vehicles	XXX	**Introduce fuel economy standards for new gasoline and diesel vehicles** **Government role:** (i) set standards in consultation with industry, (ii) set time-table for implementation; (iii) implement. **Key agencies:** DEDI/ MOE, MOI-TISI, industry etc	• DEDE acting as lead agency – using energy efficiency and labeling mandate • Cabinet to ratify and implement by 2014
Freight Transport			
Non-fixed Route Truck use CNG	XX	**Maintain 'status quo'** **Market-determined:** operators will switch dependent on prices & quality of CNG distribution network **Government role:** to regulate standards of equipment operation **Key agencies:** MOT/ DLT	• DLT to review and upgrade standards for CNG installations in new and in-use vehicles and monitor compliance
More efficient freight rail	XX	**Fostering a commercial freight logistics culture** apart from only a focus on rail infrastructure.	• NESDB to continue to implement their logistics strategy • MOT/ OTP with SRT to undertake

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
		Government role: (i) prioritize key lines based on fuel consideration of all benefits and costs; (ii) **undertake selective industry modernization;** and (iii) adopt active policies to **promote multi-modal logistics** **Key agencies:** MOT/OTP, SRT, NESDB	a demand-oriented study of potential opportunities for enhanced freight rail and supporting policies leading to selective prioritization of rail lines (Budget US$500,000) • NESDB/MOT implement priority line upgrading and supporting actions under 12th Plan
Fuel efficiency improvement in diesel vehicles due to engine and technology upgrades	XX	**Facilitate the truck industry to upgrade the level of technology.** Can include retrofits but regulatory approach needs to 'make trucks' meet higher standards in terms of emissions and energy efficiency. A key step forward would be achieved by removing regulations that favor maintaining aged, inefficient and polluting trucks on the road. **Government role:** set and enforce standards, industry facilitation **Key agencies:** DLT	• DLT to limit use of aged chassis that permit constant truck rebuilding and perpetuation of outdated vehicles • Draft new regulation on prohibiting use of old chassis for implementation by DLT under 12th Plan.
More efficient and higher payload trucks	XX	**Foster a commercial freight logistics culture** **Government role:** (i) set and maintain performance standards; (ii) revise heavy	• MOT/ DLT to rationalize vehicle registration charges to make trucks 'pay their way' • Draft new regulation on vehicle taxation for implementation by DLT

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
		vehicle taxation; and (ii) provide key infrastructure Key agencies: MOT/ DLT	under 12th Plan • NESDB/ MOT to identify strategic infrastructure barriers to efficient logistics (budget: US$200,000) with key infrastructure to be implemented under the 12th Plan • Identify scope for more stringent operator performance standards in return for being permitted to transport higher loads to raise operator quality and efficiency (budget: US$ 50,000)
Inter-city Passenger Transport			
Improving passenger train (inter-urban)	X	Focus on developing services that correspond to rail's competitive strengths i.e. travel 300-700km. Government role: (i) prioritize key lines based on fuel consider-ation of all benefits and costs; and (ii) facilitate appropriate integrated bus services Key agencies: MOT/ OTP/ SRT	• MOT/ OTP with SRT to review 2010's High Speed Train study. • Based on potential demand and economic potential, prioritize passenger rail lines/ services and identify supporting policies (Budget US$ 100,000) • Complete detailed feasibility study for Bangkok-Chiang Mai examining rail system needs including potential for rapid transit and HST.
Urban Passenger Transport			
Improve traffic management	XX	Modernize and professionalize traffic management in Bangkok – a symptom of current challenges is BMA's Area	• OTP to review performance of Area Traffic Control system in Bangkok (US$100,000) & determine barriers to improved performance

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
		Traffic Control (computer-controlled traffic lights) system has not been permitted to work unimpeded **Government role:** (i) clearly allocate the responsibilities for traffic management between BMA and the Police; and (ii) provide systems and services to support and upgraded and more professional approach **Key agencies:** MOT/ Ministry of Interior, BMA and Police	• OTP to make recommendations for improvement including the roles and responsibilities of BMA/ local governments and the Police to the Commission for the Management of Land Traffic • Identify in consultation with stakeholders cooperative actions for implementing new arrangements under the 12th Plan • Identify changes to relevant laws and regulations for later implementation
Improve road user pricing	X	**Understand the available options and costs and benefits** **Government role:** (i) monitor latest developments; and (ii) study the advantages of 'average cost' pricing using variable vehicle registration charging and/or vehicle insurance; and (iii) encourage early introduction of variable insurance pricing ie pay dependent on distance. **Key agencies: MOT/ OTP**	• OTP to keep a 'watching brief' on new developments in approaches to road user pricing globally • OTP to specifically identify practical measures to make pricing more efficient by 12th Plan (US$100,000)

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
Improve bus industry efficiency	XX	**Improve efficiency and market-orientation of bus routes and services** in Bangkok Metropolitan Region including enhanced integration with new urban rail **Government role:** (i) plan and implement revised routes and services; and (ii) enhance bus management and operational capacity. **Key agencies:** MOT/ OTP, MOF-SEPO	• MOT/OTP/ DLT to develop a Bangkok Metropolitan Region Bus Route and Services plan that meets market demand & is integrated with rail • OTP/ DLT to set up a 'task force' to plan the phased implementation of new routes & services starting in existing and new rail corridors • Prepare one 'concrete' implementation plan for new bus services in the Purple Line MRT corridor by the start of the 12th Plan to coincide with the opening of the Purple Line during the Plan period.
Introduce BRT	XX	**Identify potential role of bus rapid transport** in serving moderate demand corridors in Bangkok & potential for integration with urban rail and other bus **Government role:** (i) develop a single Rapid Transit Infrastructure and Services Plan covering rail, BRT, monorail & LRT modes irrespective of agency ownership; (ii) identify key priorities based on a full assessment of all costs and benefits; and (iii) implement according to priorities and affordability. **Key agencies:** MOT/ OTP & BMA	• MOT/OTP in consultation with BMA consolidate current BRT, LRT and monorail lines into a single plan and map the degree of integration with each other, other bus and MRT • MOT/OTP to prioritize lines based on likely demand, cost and economic benefits and review the type of technology proposed for continued relevance • MOT/ OTP to prepare more detailed feasibility studies including business case to be performed of priority lines under the 12th Plan (US$ 500,000)

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
Integrate MRT/Bus/ Walking	XX	**Improve accessibility to urban rail stations and terminals** for pedestrians and other modes **Government role:** (i) plan and implement revised pedestrian and bus access at existing MRT; and (ii) develop station accessibility plans with investment budgets for urban rail under construction. **Key agencies:** MOT/ OTP, SRT, MRTA and BMA	• MOT/OTP with BMA to identify priority stations and terminals for walk-in and bus feeder access. And develop plans to improve walk-in and bus access and associated urban design by start of 12th Plan • BMA & rail operators MRTA, SRT and BTS to oversee implementation under the12th Plan to coincide with commencement of operations of the new rail lines.
Use CNG in bus fleet	XX	**Maintain 'status quo'** **Market-determined:** Permit BMTA and private operators to choose CNG motive option based on a proper assessment of all costs and benefits. **Government role:** to regulate standards of operation **Key agencies:** EPPO, MOT/ DLT, BMTA	• DLT to review and upgrade standards for CNG installations in new and in - use vehicles and monitor compliance

Options	Priority	Future Direction	Next Steps by 12th National Development Plan
Fuel efficiency improvement in diesel buses due to engine and technology upgrades	XX	**Introduce new urban buses with good fuel economy** and meeting Euro IV emission standards **Government role:** (i) set standards; and (ii) arrange appropriate bus route contracting and procurement arrangements. **Key agencies:** MOT/OTP, MOF/SEPO, BMTA, private firms	• MOF/SEPO with OTP to update the current phased bus procurement plan for Bangkok linked to policies to modernize the bus regulatory system and the performance of BMTA by start of 12th Plan (budget $200,000) • New bus contracting & potential bus investment arrangements to be prepared and implemented under 12th Plan as part of implementation of Improve bus industry efficiency (refer to page 54).

Source: World Bank (2009a).

7

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The World Bank

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org
E-mail: feedback@worldbank.org

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Thailand: Green Transport Policy Directions

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The World Bank Office, Bangkok
Siam Tower,30th Floor, 989 Rama 1 Road, Pathumwan, Bangkok 10330
Tel.: +66 (0) 26868300 Fax: +66 (0) 26868301
www.worldbank.org/th

Office of National Economic and Social Development Board
962 Krung Ka-sem Road, Promprab, Bangkok 10100
Tel.: +66 (0) 22828454 Fax: +66 (0) 2628-2871
www.nesdb.go.th