47156

THAILAND INFRASTRUCTURE ANNUAL REPORT

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ABBREVIATIONS

ABBREVIATIONS

ADSL	Asymmetric digital subscriber
AIS	Advance Info Services
ΑΟΤ	Airports of Thailand
BBL/day	Barrel of produced oil per day
BMA	Bangkok Metropolitan Administration
BMCL	Bangkok Metro Company Limited
ВМТА	Bangkok Mass Transit Authority
BOED	Barrels of oil equivalent per day
BOO	Build own operate
воот	Build own operate transfer
ВОТ	Build operate transfer
BRT	Bus rapid transit
вто	Build transfer operate
BTS	Bangkok transit system
BTSC	Bangkok Mass Transit System Public Company Limited
BWA	Broadband wireless access
CAT	CAT Telecom Public Company Limited
CIF	Cost insurance freight
CDM	Clean development mechanism
CMLT	Commission for the Management of Land Traffic
CNG	Compressed natural gas
CODI	Community Organization Development Institute
DEDE	Department of Alternative Energy Development and Efficiency
DGR	Department of Groundwater Resources
DLT	Department of Land Transport
DOH	Department of Highways
DMF	Department of Mineral Fuels
DPT	Department of Public Works and Town and Country Planning
DRR	Department of Rural Roads
DTAC	Total Access Communication
EE	Energy efficiency
EGCO	Electricity generating company
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office
ERB	Energy Regulatory Board

ABBREVIATIONS

ESI	Electricity supply industry
ESB	Eastern seaboard
ΕΤΑ	Expressway and Rapid Transit Authority
FAO	Food and Agriculture Organization
FEC	Final energy consumption
GDP	Gross domestic product
GWh	Gigawatt-hour
ICD	Inland container depot
IEAT	Industrial Estate Authority of Thailand
liG	International internet gateway
IPP	Independent power producers
IRF	International Road Federation
IRI	International roughness index
ISP	Internet service providers
ITU	International Telecommunications Union
JBIC	Japan Bank for International Cooperation
kW	Kilowatt
kWh	Kilowatt-hour
LAO	Local administration organization
LPG	Liquefied petroleum gas
LNG	Liquefied natural gas
LTCB	Land Transport Control Board
MEA	Metropolitan Electricity Authority
МІСТ	Ministry of Information and Communication Technology
MOE	Ministry of Energy
MOF	Ministry of Finance
MONRE	Ministry of Natural Resources and Environment
МОТ	Ministry of Transport
MRT	Mass rail transit
MRTA	Mass Rapid Transit Authority
MW	Megawatt
MWA	Metropolitan Waterworks Authority
MWe	Megawatts of electricity
NBC	National Broadcasting Commission
NBTC	National Broadcasting and Telecommunication Commission (Suggested)
NESDB	National Economic and Social Development Board
NGV	Natural gas for vehicles
NGO	Non-governmental organization

NHA	National Housing Authority
NTC	National Telecommunication Commission
ОТР	Office of Transport and Traffic Policy and Planning
ра	per annum
PAT	Port Authority of Thailand
PEA	Provincial Electricity Authority
PEC	Primary energy consumption
PDP	Power development plan
PPP	Public-private partnership
РТТ	Petroleum Authority of Thailand
PV	Photo-voltaic (solar energy)
PWA	Provincial Waterworks Authority
PWD	Public Works Department
R&D	Research and development
RE	Renewable energy
SOE	State-owned enterprise
SPP	Small power producer
SRT	State Railways of Thailand
ΤΑΟ	Tambon Administration Organization
TEU	Twenty-foot equivalent unit
ThB	Thai Baht
тот	Telephone Organization of Thailand
TRUE	True Corporation Public Company Limited
TT&T	TT&T Public Company Limited
VSPP	Very small power producer
WEF	World Economic Forum



Infrastructure plays a crucial role in economic development and enrichment of living standards. Various stages of economic development require different levels of infrastructure upgrades or enhancements to ensure infrastructure in fact facilitates economic activities. Thailand has been facing a series of infrastructure challenges, both new and well-established. To name a few: there is a need for infrastructure services to catch up with economic development and international competition, manage the growth in urban areas, respond to global energy prices, and ensure basic services for the poor.

Most of the infrastructure development in Thailand has been responsive to demand rather than forward-looking. Availability and accessibility appear to no longer be a challenge. The next step for Thailand is to put more emphasis on quality of service delivery, management, and sound regulation.

A clear policy framework is needed, and the development direction set forth by the policy makers should be based on reliable information on the current status of infrastructure development. Systematic, periodic, and internationally-standard information collection within the infrastructure sector will provide Thai policy makers with good background with which to assess the current situation, identify bottlenecks, set clear policy direction, and prioritize projects more effectively. This Report aims to contribute to this process.

The issue of sustainable infrastructure development is well-integrated into the NESDB's 10th National Development Plan. Three areas which are specifically identified in the plan are as follows: infrastructure and logistics services; energy efficiency and alternative sources of energy; and the framework for overall infrastructure development. To clearly present these issues in the plan should provide sound direction for future development of the sector.

This Annual Report covers the following subsectors of infrastructure: transport, energy, telecommunication, and water, sanitation, and low-income housing. In each subsector section, the current situation and policy and institutional framework are presented first. Next, the performance of the sector is assessed, investment prospects are provided, and lastly, key issues are identified.

Transport

Land transport in Thailand is dominated by a road network; rail plays a much less significant role both in terms of passenger and freight transport. Urban public transportation has been

gaining importance, particularly the development of Mass Rail Transit (MRT) in Bangkok and the vicinity. In terms of water transport, sea freight transport, especially the Laem Chabang deep sea port, has developed to international standards, while inland waterways' transport has been given lesser attention. Air transport has taken up a larger share of passenger transport in recent years with the emergence of low cost airlines. The bottlenecks in Don Muang Airport have eased with the opening of Suvarnabhumi Airport; however, clear policy direction is still needed with regards to future expansion and proper use of Don Muang Airport.

All three modes of the transport sector have performed relatively well by international standards, although there are several areas for improvement. With regards to land transport, reform of the rail system can contribute greatly to the national transport system. Increased use of controlled access roads and the adoption of road charges should be seriously considered for the road sector. In terms of air and freight transport, major bottlenecks in logistics are due mainly to software deficiencies, especially within customs clearance. The transport sector also experiences some institutional deficiencies, such as lack of central planning, weak coordination, and an unclear separation between operation and regulation functions. Government and state-owned enterprises (SOE) still play a large role in planning, regulation, and service provision.

In sum, important development issues in the transport sector have less to do with the accessibility or availability of infrastructure, but rather the efficiency (of provision), regulations, and appropriate institutional aspects. Multi-modal transport has become a top priority as a means to increase efficiency and improve logistics, which would eventually lead to energy savings and lower costs. Institutional, regulatory, and operational improvements are required for a successful multi-modal shift. Private investment and involvement can enhance public infrastructure projects and reduce overall risk.

Electricity and energy

The electricity subsector is based on a state-owned single buyer scheme. The single buyer, the SOE Electricity Generating Authority of Thailand (EGAT), purchases electricity from public and private power producers, and then sells it to unbundled distribution companies, which, in turn, retail to final consumers. Thailand's installed capacity is dominated by EGAT, though independent power producers (IPP) are increasing their stake. There has been increasing private sector participation in power generation through EGAT's IPP, small power producer (SPP), and very small power producer (VSPP) programs.

The main electricity indicators exceed international standards; however, sources of fuel are a major concern. The current generation relies heavily on natural gas, while EGAT's current

Power Development Plan (PDP) focuses only on offsetting its prevalence rather than reducing gross consumption. The transmission and distribution networks are developing steadily, supplying nearly the entire population.

On the demand side, the industry sector is by far the largest consumer, with business and residential consumption falling well below. Different tariff structures apply between the basic generators (IPP, SPP and VSPP), and the single buyer, EGAT, as well as among EGAT, the intermediate distributors (i.e., MEA and PEA) and the final consumers.

Policy and planning for the electricity sector is formulated in EGAT's Thailand Power Development Plan. The current PDP 2007 covers the planning period 2007 through 2021.

The institutional arrangements in the electricity subsector are fairly clear. Functions involving policy setting, regulation and monitoring, and service provision are now separate upon creation of the Energy Regulatory Board that will act as regulator in the electricity sector through its regulatory authority such as the setting of electricity tariffs and granting of licenses for new power plants.

Currently, in the energy sector, the first concern is that more than 60% of the primary supply is imported. Production and consumption has increased steadily as a result of continued expansion of the economy. The pattern of primary commercial energy production comprises 57% natural gas, 17% crude oil, 12.5% lignite, 9% condensate and 4.5% hydropower. Natural gas will remain available for the next 25-30 years, whereas other fossil fuels have little reserves left. By far, the main form of energy consumption in Thailand has been of petroleum products. In 2006, they accounted for a whopping 44% of total consumption. Natural gas had the second largest share at 37%, followed by imported coal (9%) and lignite (7%). In the same year, total energy consumption was 1,547,778 barrels per day of crude oil equivalent, and the pattern of energy consumption by sector changed slightly as manufacturing required the largest amounts of energy, albeit competing closely with transport.

Oil and natural gas infrastructures are meeting Thailand's needs: transmission, storage and refining facilities are not expected to expand substantially in the next years.

As for fuel pricing, the Thai Government intervenes through direct regulation (for natural gas) or through direct or indirect subsidies (differentiated levies for biofuel). Renewable and alternative energy development is a key policy issue in the energy sector. The development of biofuel for use in the transport sector has been supported by the government with tax incentive programs and financial assistance. As in the electricity sector, the recent Energy Act contributed to the

creation of the new independent regulatory agency, the Energy Regulatory Board, and a new regulatory framework for oil and gas industry business.

The petroleum industry is characterized by active private participation from upstream to downstream, particularly by foreign participants. However, in the natural gas industry, private participation remains limited. PTT still has significant monopoly control within the industry through its role as the sole purchaser, transporter, and distributor of natural gas.

A major investment prospect in the energy sector is the expansion of power generating capacity, either through EGAT public investments, major private sector participation (IPP bids) or through smaller scale and community-based investments, mainly in renewable energy and alternative energy projects.

The main concerns for Thailand's energy sector are the oil price hikes, the rising global concern about climate change, achieving a balanced energy portfolio, developing the renewable energy sector and establishing an enhanced regulatory framework, fair competition, and rational pricing.

Telecommunications

The performance of Thailand's telecommunications sector has come a long way in the last decade, particularly in terms of availability and use of affordable telephone service and growth of internet access. The telecommunications sector in Thailand is dominated by mobile communications. There are about 43 million mobile subscribers versus approximately 7 million fixed lines. Furthermore, growth in the mobile market remains strong compared to the fixed market, which is stagnant. Broadband network infrastructure is growing rapidly; however, it is still insignificant. The telecommunications sector is in the era of technological convergence. In this context, it is important to note that Thailand's telecommunications sector is highly concentrated in both the fixed telephony and broadband access markets with only three to four firms dominating each market. Because of concentration in the sector, it is important to take into account the potential for abuse of market power, particularly in regards to licensing and other regulatory policies. The telecommunications sector has done relatively well in providing access to telephone services through fixed and mobile services at reasonable costs. Accessibility is, however, an issue with regards to internet service. The emerging priority in the sector is the development of a broadband access strategy. The regulatory framework must also continue to be strengthened to facilitate competition and protect public interests.

Water, sanitation and low-income housing sector

Provisions of a piped water supply are mainly carried out by MWA and PWA. In rural areas, the majority of villages have access to piped water. However, supply expansion is still needed in order to achieve the goal of providing piped water to every village. Access to improved water is impressive by international standards. The private sector has played an increasing role in service provision, especially in the industrial areas of the eastern seaboard. Demands for piped water are expected to continue to grow in the future especially in the industrial and tourist areas of the country. Water shortages are a major concern and expansion of water production facilities is expected. Another key issue in the sector, which diminishes the efficiency of the piped water system, is a relatively high rate of water loss by international standards as a result of inadequate maintenance of the pipeline system. Pricing is also an issue for PWA, which operates under strong price controls.

Development of wastewater and solid waste management are lagging behind other sectors both in terms of responding to demands for service as well as performance of existing systems. The demands for wastewater and solid waste management, however, will continue to grow in response to urbanization and the increase of economic activities. Two priorities of the two subsectors will be to ensure sufficient service coverage both in urban centers as well as municipal areas, and to ensure that the systems operate up to sanitation standards and are properly maintained. Local governments deliver services in the wastewater and solid waste management subsectors, which can be quite a technical and financial challenge. Low or absent fees are another issue constraining financial resources for the operating system. With these problems, efficiency and sustainability of the systems are compromised, which, in turn, inhibits the development of the subsectors. Capacity building at the local level and systematic introduction of user fees are identified as key issues in both subsectors.

The low-income housing sector supplies housing to low-income populations through the Baan Eua-arthorn and Baan Mankong projects. The development of the low-income housing sector, however, is not well planned as policy-setting rests with the cabinet, and not with the direct responsibility of a government agency. Although providing access to low-income housing is seen as necessary by most governments, several policy shifts in budget allocations and at the project level are common in the sector. New slums and demand will continue to emerge due to rapid urbanization. The government will need to respond to recurring challenges and emerging needs under budget constraints. A lack of access to credit for low-income groups often puts project sustainability at risk. To ensure long term success of projects, capacity building and social aspects of housing and slums should be taken into account.

Looking forward, there are a number of challenges for the country in infrastructure development. The most immediate challenge in the context of the global energy situation is rising oil prices. Cross-sectoral issues such as energy security must be addressed more effectively within an integrated framework. Financing is also a challenge. Prioritization of projects is crucial to ensure that limited resources are appropriately allocated. Due to the policy emphasis on macroeconomic and fiscal stability, off-budget financing for infrastructure will be increasingly relied upon. Private participation and innovative international or national sources of financing should be tapped to provide financial flexibility. There are institutional weaknesses in the sector-such as non-integrated infrastructure planning and provision, lack of an independent regulator, negative public opinion toward privatization and new large-scale investments-to overcome in order to reduce obstacles in the delivery system. Long-awaited reform of highly indebted state enterprises provides another major challenge, which impacts heavily on overall infrastructure development. Lastly, sustainability of projects is an issue, which includes weak implementation capacity of local agencies and the lack of appropriate pricing mechanisms and user fees for several infrastructure services. How to incorporate sustainability concerns from the design through to the implementation stages will be instrumental for the long term success of every sector.



Overview of Thailand's Infrastructure Development: Past and Present





I.OVERVIEW OF THAILAND'S INFRASTRUCTURE DEVELOPMENT: PAST AND PRESENT

1. Introduction

Infrastructure plays a crucial role in economic development and enrichment of living standards. In economic development, appropriate infrastructure can improve the investment climate, facilitate trade processes, and increase efficiency in everyday business activities. Access to infrastructure services such as electricity and water can greatly enhance a society's living standards. Development of infrastructure is dynamic. Various stages of economic development require different levels of infrastructure upgrades or enhancements to properly accommodate changing types of economic and social activities.

The term "infrastructure" is rather broad and covers many activities. In this report, infrastructure is categorized into the following subsectors: transport, energy, telecommunications, and water, sanitation and low-income housing.

Transport - Transport development directly contributes to an improvement in standards of living. Roads provide access to schools and hospitals and connect communities. Urban mass transit saves time and expense. And inter-city passenger transport makes it more convenient for people to travel either for pleasure or business. In addition, transport development can help to facilitate economic development, for example, by reducing the costs of doing business.

Energy - Energy is a necessity for everyday life as well as for production. Energy issues mainly revolve around scarcity, security, and pricing. Rising oil prices reinforce the significance and at the same time encourages the need to promote energy efficiency and renewable energy. The bottom line is that every activity requires energy; the question is how one can utilize it in a sustainable way.

Telecommunications - Widespread availability of affordable broadband access infrastructure will be instrumental in developing a widespread "information economy" and facilitate e-commerce. This is a dominant theme for developed and middle income countries, and the next major area for productivity improvement after industrialization. Thailand needs to develop and implement policies for its telecommunications sector that promote timely and cost-effective deployment of new technologies while supporting adequate and fair competition.

OVERVIEW OF THAILAND'S

Water, sanitation and low-income housing - The core issues for water provision and appropriate sanitation services are basic consumption, health, and hygiene concerns. Adequate water supply is a pre-condition for poverty reduction and improved livelihoods and a basic factor of production for industrial activities. Sanitation systems, such as waste and wastewater management, are essential to protect the environment and sustain standards of living in urban and rural areas.

Infrastructure development in each of the subsectors eventually translates into the well-being of a population, either directly or indirectly through business and production. The key concern in infrastructure development is that the costs and benefits of normally large investments are distributed fairly, and the policy and its framework address the right priorities.

Infrastructure development can also enhance, or sometimes impede, economic development in a much less tractable way. As most infrastructure projects require a large amount of financial and other resources, the government often faces choices and dilemmas in prioritizing projects. A good project gone wrong or a wrong project selection leads to an inefficient use of public money; creates problems with the public and incurs losses for the public. Careful planning is required to ensure effectiveness of infrastructure development.

2. Thailand's Infrastructure Development

Thailand is facing a series of infrastructure challenges, including, for example, the need to "catch up" with economic development (within the country and with the competing economies), manage growing urban areas, and ensure sufficient basic services for the poor.

Most of the infrastructure development in Thailand has been demand responsive and focused mainly on infrastructure provision. Availability and accessibility appear to no longer be challenges. The road network coverage has reached 98.5% (paved); electricity reaches 99% of the population. The next step for Thailand is to move toward ensuring quality of service deliveries, management, and sound regulation. Because of the government's financial constraints, prioritization is also very important, given the fact that the demand for investment is always larger than the available resources.

While a clear policy framework is needed, the development direction set forth by the policy makers should be based on reliable facts and data reflecting Thailand's current status of infrastructure development. Systematic, periodic, and internationally consistent infrastructure information collection will provide Thai policy makers with good background to better assess the current situation, identify bottlenecks, set clearer policy, and prioritize projects more effectively.

OVERVIEW OF THAILAND'S

3. Infrastructure Development Strategy for NESDB's 10th National Plan

The three areas of infrastructure development identified in the 10th National Development Plan are as follows: infrastructure and logistics services, energy efficiency and alternative sources of energy, and the framework for overall infrastructure development. Below is an outline excerpt from the plan.

- (1) Development of infrastructure and logistics services to support production structural adjustment. Infrastructure development aims to support the competitiveness and enhance efficiency of the private sector both in production and services sectors.
 - (a) Develop up-to-date and efficient transport, logistics services, and telecommunication systems.
 - Develop a domestic and international logistics network through multi-modal transportation, feeder systems, and distribution centers at strategic production locations. Enhanced trade facilitation is also a key concern.
 - Enhance efficiencies in logistics management within the production sectors, particularly along the supply chain
 - Support transport modes and transport management which are energy-efficient, particularly development of rail, waterway, and delivery of energy through pipe lines. Energy-saving transport and increased use of modern technology to reduce the cost of transport is encouraged.
 - Develop an urban mass-transit network to enhance efficiency, safety, time-saving, and reduction of energy usage
 - Develop a telecommunications network that is efficient and up-to-date.
 Competition in service provision and a return on investment are emphasized, in order to serve production, private, and service sectors, and to enhance government's services.
 - (b) Transparent and efficient management of infrastructure under stakeholders' participation.
 - Create stakeholder participation in infrastructure project development
 - Emphasize careful project studies on feasibilities, environmental impacts, social impacts, and health-related impacts to ensure the project's viability with clear mitigation plans
 - Support public-private partnership in infrastructure investment through improved regulations and laws. Regulators for each sector are important for consumer protection and transparent and fair competition.
 - Support demand management initiatives, which aims to create awareness in efficient resource utilization

- (2) Improved energy efficiency and expedition of alternative energy initiatives in order to reduce energy imports, costs to both producers and consumers, and pollution.
 - (a) Find new energy sources, both domestic and international, and secure energy reserves that ensure long-term energy security for Thailand.
 - (b) Increase energy efficiency in transport, manufacturing, and household sectors through incentives and law enforcement. For example, provide investment incentives for high value-added industries with low-energy consumption and regulations for importing energy-inefficient machinery. Other strategies to enhance energy efficiency are proper city planning, transport structural reform, logistics management, development of rail and waterways as alternative modes of transportation, and industrial cluster development.
 - (c) Campaign for energy conservation and for alternative energy usage in every sector. For example, promoting NGV, gasohol, and biodiesel for vehicles. Consultation services for households, and private and public organizations, regarding alternative energy and energy efficiency to help create awareness in energy conservation.
 - (d) Research on alternative and renewable energy including new fuel and electricity generating technology. Research should encompass technical, economical, and environmental aspects of alternative and renewable energy. The programs should also include capacity building activities and public information dissemination of research results.
- (3) A framework for fair distribution of benefits of infrastructure development, particularly in favor of rural areas. This is to enhance access, ensure sufficient provision, and be responsive to the demand for infrastructure. Well-established stakeholder participation, expanded coverage on telecommunications and media, access to clean water through piped water systems in rural areas, and city planning, which will bring residents close to production bases, should lead to better distribution of infrastructure and related services around the country. This should in turn contribute to the alleviation of a rural-urban disparity.

The current situation, sector performance, policy and institutional framework, and investment prospects for each subsector are discussed in detail in Chapter 2 through 5. Chapter 6 concludes by identifying future challenges of infrastructure development in Thailand.





II.TRANSPORT SECTOR

The transport sector encompasses a wide range of infrastructure and activities. This chapter is organized along the three modes of transport as follows: land, which includes road, rail, and urban; water; and air transport. Investment prospects and key issues are addressed in the context of the whole transport sector.

1. Land Transport

1.1 Subsector overview

Land transport in Thailand is dominated by road transport. The total road network is estimated to be 390,026 kilometers (km) long, while the total length of rail network is only 4,129 km.¹

Road – Out of the total road network of 390,026 km, 51,776 km² are highway network that connect each region of the country. The major highway network is a four-lane divided highway. Major road networks are mostly reinforced concrete roads and asphalt concrete roads. In addition to major highways, there are two controlled access roads, or expressways and motorways.

In regards to motorways, Thailand started the first inter-city route in 1998 (Bangkok – Chon Buri, 81.75 km) and the second one in 1999 (Eastern Outer Ring Road, 64 km). The two motorways cover Bangkok and the surrounding industrial areas, serving as a commodities transport route from the northern part of the region to Laem Chabang Port. The expressway network is limited to Bangkok and its vicinity comprising a total distance of 150 km.

About 98.5% of the main roads and collectors road in Thailand are paved. The quality is considered moderate, with the International Roughness Index (IRI) of around 3.5-4.5. However, the average IRI has decreased over the years.

¹NESDB, National Logistics Strategy 2006-2010, May 2007 ²Department of Highway 2007



Figure 2: IRI Index in Thailand



Source: Department of Highways, February, 2004

Rail – Out of the total rail network of 4,129 km, 3,881 are single-track. There are 248 km of double- and triple-track lengths³. Recent development of the rail network has not been to provide additional coverage, but to improve facilities, particularly for freight transport. The State Railway of Thailand (SRT) developed the inland container depot (ICD) at Lad-Krabang with an original capacity of 800,000 TEU per year in order to improve efficiency of container transport to Laem Chabang Port. The rail system has been well-maintained since SRT periodically rehabilitates the track. Only 9% of the total network is severely damaged, mainly in the southern area. Some routes, however, have a problem of rail capacity (ICD route, for example).

Urban – The urban Mass Rail Transit (MRT) system deserves a separate attention. There are currently two MRT systems operating in Bangkok with a total length of 42.9 km. The first MRT line is the Bangkok Transit System (BTS) or Sky Train, also known as the Green Line. The line was opened in 1999 comprising two transit lines with a total length of 22.9 km. The BTS provides for one Park-and-Ride facility at Mochit Station. The second line is a subway line known as the MRT (Chalerm Ratchamongkol Line) or the Blue Line. The line has a total length of 20 km. Despite these lines, coverage of the MRT systems in Bangkok is still very limited. Moreover, the two systems currently operate as two separate systems and are not integrated with other public transport systems such as bus services. In addition to the BTS and MRT, which are already operational, another urban rail project, the Airport Link, is under construction. The Airport Link is designed to run in parallel with the existing railway track linking the new Suvarnabhumi Airport with the city center.

³NESDB, National Logistics Strategy 2006-2010, May 2007

Source: Department of Highways

1.2 Policy and institutional framework

Recent development in the road subsector has been limited to capacity expansion and road safety, for example, investment in the four-lane widening of the national highway. However, due to unclear regulations and weak enforcement on axle loads and vehicle loading limits for trucks, road quality has been deteriorating in recent years. A clearer regulatory framework and stronger enforcement in freight transport should be developed in order to both prevent over-utilization of roads as well as to enhance the efficiency of road transport.

Regarding rail, policies have been focused on increasing track capacity, especially for routes serving industrial areas, and on improving safety of the rail system. To increase capacity, doubling tracks in key routes such as Bangkok and the vicinity or Laem Chabang is considered the priority. Track rehabilitation is also planned in order to enhance safety and speed of the rail system. In the longer-run, a key policy issue requiring attention is SRT's reform and potential shift toward a standard gauge in the rail system.

Development of MRT to better serve the urban area is also a key priority in land transport. Policy direction is focused on route expansion of the MRT system as well as service integration (e.g., a common electronic ticketing system) of the first two lines currently operating as a stand-alone system.

Institutional arrangements in land transport are characterized by several actors including line agencies, state enterprises, and the private sector. As a result of public sector reform in 2002, policies are formulated by the Office of Transport and Traffic Policy and Planning (OTP) and the Ministry of Transport (MOT) with oversight by the Commission for the Management of Land Traffic. The Department of Land Transport is the main regulator, but its authority is limited to bus operators, vehicle safety, and road transport. Rail and the MRT are not included in its regulatory scope. There are several overlaps of regulatory and implementing functions among several agencies. Some agencies, such as the State Railway of Thailand (SRT), MRTA, and BMTA, act as both regulator-regulating service providers operating under concessions granted by them-and operator-competing in the very same service along with their concessionaires. This creates a governance issue and potential conflicts of interest. In addition, there is no single regulatory agency that can regulate all modes of transport, which creates difficulty to integrate or set well-coordinated, longer-term policies on multi-modal transport. The Department of Highways and the Department of Rural Roads are the two main implementing agencies in road provision, taking responsibility for the major highway network and rural roads, respectively. SRT is the sole operator of rail service in the country. Expressway systems are operated by the Expressway & Rapid Transit Authority (ETA) with some private sector participation. There are several agencies responsible for the implementation of urban MRT projects including, BMA, MRTA and SRT as well as private concessionaires.

Agency	Policy	Regulation and Monitoring	Implementation
Commission for the Management of Land Traffic	✓		
Ministry of Transport	✓		
Office of Transport and Traffic Policy and Planning	✓		
Department of Land Transport		✓	✓
Department of Highways		✓	✓
Department of Rural Roads			✓
Bangkok Metropolitan Authority		✓	✓
State Railway of Thailand		✓	✓
Expressway & Rapid Transit Authority of Thailand		✓	✓
Mass Rapid Transit Authority of Thailand		✓	√
Bangkok Mass Transit Authority		✓	✓
The Transport Co., Ltd.		✓	✓
Private sector			✓

1.3 Sector performance and international comparison

Land transport is the most important mode of transport in the country accounting for 99% of total domestic passenger movement and 88% of domestic freight transport in 2006. Road is the most dominant mode of transport for both passengers and freight with the modal share of 85% and 86%, respectively. Rail is not a popular mode of transport. Only 6% of total domestic passengers and 2% of total freight are carried by rail transport. MRT has become an increasingly significant mode of urban passenger transport carrying 8% of domestic passengers in 2006.



Figure 3: Modal Shares of Domestic Passengers and Freight, 2006

Given Thailand's dependence on road transport, road performance indicators convey a great deal about the overall performance of Thailand's transport sector. In terms of access, the ratio of road kilometers per arable land area (km/km2) for Thailand is 0.11. This ratio is relatively low compared to other countries in the region. However, although Thailand has less road per square kilometer than other countries in the region, most Thai roads are paved (98.5%) compared to other lower-middle income countries, or even high-income countries such as the United States (64.5%).



Figure 4: Road Kilometers per Arable Land Area

Source: IRF, World Road Statistics, 2006

Controlled access roads such as motorways can enhance efficiency of road transport by improving speed and increasing safety. However, the use of motorways in Thailand is still limited, particularly when compared to high income countries. Motorways account for only 0.1% of the total road network in the country. This suggests that there is room for motorways development that will contribute to the improved performance of the road sector.

Source: Ministry of Transport



Source: NESDB, A Study on Infrastructure Development Strategy for Enhancing Competitiveness, 2004

	EU-15	USA	JAPAN	CHINA	THAILAND	
Total Road Network (1,000 km)	4,300	6,370	1,100	1,698	160	
Motorway Network (1,000 km)	51.8	89.2	6.6	19.4	0.15	
Motorway/Road (%)	1.2	1.4	0.6	1.14	0.1	

 Table 1: International Comparison of Motorway Network

Source: NESDB, A study on Infrastructure Development Strategy for Enhancing Competitiveness, 2004

One can also measure road sector performance by looking at the rate of road utilization through the vehicle/capacity or v/c ratio. About 96% of the roads in Thailand has a v/c ratio less than 0.5, which signifies that most of the highway network has an excess capacity of about 50%. However, the road utilization rate is rather uneven. Only 1.04% of the roads has a v/c ratio greater than 0.8. These roads are located in and around Bangkok as well as the route to Laem Chabang Port. This indicates that the demand for road development is likely to be concentrated in the vicinity of Bangkok, expanding toward the eastern seaboard areas.

Passenger - During 2002-2006, the average number of passengers carried by the road and rail system was 872.65 million per year. The breakdown of total passengers in 2006 is as follows:

- Rail: 102.04 million passengers or 87%
- Road: 656.72 million passengers or 13% (mostly in Bangkok)

As shown in Figure 1-6 below, the total number of passengers has been declining in the last five years. Also, the types of passengers using road and rail indicated different trends. While the number of passengers using road has been declining, the share of passengers using rail has been growing in the last few years. However, the growing proportion of passenger rail transport was fully caused by passengers using the MRT system, which began operating in 2004. In contrast, the share of passengers using the traditional rail system has been in constant decline in the last five years. During 2004-2006, the average growth rate of passengers using MRT was approximately 58% while the rate for rail system has been declining at an average of 6%.





Source: Ministry of Transport

More than 90% of the passengers are in Bangkok and the vicinity, and most of them rely on road as a primary mean of transport. Based on this information, together with the v/c ratio of 0.8 for roads around Bangkok, one can conclude there is an increasing need for a well-structured urban mass rail transit system to serve domestic passengers. The current MRT system has performed relatively well in terms of quality and attracting patronage. However, both lines face demand much lower than the level forecasted. This resulted in poor financial performance for both line operators. The urban MRT system will certainly play a crucial part in urban transport by serving the majority of passengers, but the next two questions are: how many of the road users will shift to MRT systems and what number of passengers will be large enough to justify massive scale public investment? Careful studies and planning should be conducted to determine the optimal level of MRT systems in Bangkok.

Freight – With a structural shift in the Thai economy from resource-based merchandise exports (e.g., log and minerals) to medium/high technology products, the pattern of freight transport has also changed. Freight transport in the country has geared toward containerization as evident by rapid demand growth for an ICD. Since 2001, we have witnessed the over-utilization of the Lad Krabang ICD. Although the current capacity of Lad Krabang was upgraded to 1,000,000 TEU/year, the new capacity was already used up in 2007 with a total traffic volume of more than 1.6 million TEU.



Figure 8: Lad Krabang's ICD Utilization



Source: World Development Indicators 2007

Source: State Railway of Thailand

Due to further regional integration, freight transported from southern China to Thailand via the Mekong River and Chiangsaen Port has dramatically increased. However, Thailand's neighboring countries, such as Vietnam, have responded quickly to this growing demand by shifting international freight transport through the road and rail network that links southern China, Cambodia, and Lao PDR. Through such a network, freight can bypass Thailand. There is an urgent need for Thailand to improve and integrate into the regional network in order to maintain competitive-ness of the national logistics system and fulfill the mission of being regional gateway.

Axle load and total truck load limits are also an important factor which can determine the efficiency of the road system and competitiveness of the country's logistics system. Thailand's maximum axle load limit is 8.2 tons while the truck load limit had increased to 25 tons from 21 tons in 2006. Axle load limit is lower than in several countries including Malaysia and China while truck load limit is comparable to other countries. Truck load limit and axle load limit will have impact on Thailand's long-run freight transport cost and road maintenance cost which need to be balanced. Different load limits among Thailand and neighboring countries might also cause problems for transshipment of goods across national borders and complicate international trade negotiations.

		Countries
Countries	Axle Load (Ton)	Total Truck Load (Ton)
Thailand	8.2	25
Malaysia	9-10	24
China	10	25 - 26
Japan	10	25 - 26
Europe	10 - 13	24 - 32

Table 2: Comparison of Axle Load and Total Load among Various Countries

Source: NESDB, A study on Infrastructure Development Strategy for Enhancing Competitiveness, 2004

Railroad infrastructure in Thailand ranks 40th according to the World Economic Forum's (WEF) Global Competitiveness Report. Although the Thai railroad system receives a higher than average score, it is still ranked below most of its main competitors such as Singapore and Malaysia. The performance improves when it comes to quality of roads, where Thailand ranks 28th, scoring 5.0 out of a maximum score of 7. Both rankings re-illustrate the better performance of the road sector over rail in the country's land transport system.

	Railroad I Devel	nfrastructure lopment	Quality of Roads		
	Ranking	Score* (avg = 2.9)	Ranking	Score (avg 3.7)	
Thailand	40	3.6	28	5.0	
Singapore	9	5.7	1	6.7	
Indonesia	64	2.4	110	2.1	
Malaysia	17	5.0	15	5.7	
China	33	3.8	45	4.0	
Vietnam	70	2.2	91	2.5	

Table 3: Thailand's Railroad and Quality of Roads Ranking

*Note: 1 point – Poorly developed and inefficient, 7 points – Among the best in the world Source: WEF, the Global Competitiveness Report 2006-2007

1.4 Private-sector participation and privatization

Private participation plays a moderate role in the road transport infrastructure, mostly in the form of concessions under the umbrella of the Private Participation in State Undertaking Act, B.E. 2535 (1992). In the road sector, construction of highways and major roads were mostly funded out of the government budget and concessions were granted for road maintenance. DOH and ETA also granted concessions to private companies for some toll roads and express-way projects in the form of build transfer operate (BTO). The Don Muang Tollway is operated under a concession by DOH. Another BTO project is the Second Stage Expressway, which is operating under a concession granted by ETA.

Private participation has a larger role in urban transport where large-scale funding is required for mass rapid transit projects. Major projects such as the BTS and the MRT were financed with private participation. There are currently three agencies, namely, MRTA, SRT and the Bangkok Metropolitan Administration (BMA), which are responsible for granting concessions for the MRT projects. MRTA and SRT are both under the supervision of the Ministry of Transport. The BTS or Sky Train (Green Line), the first MRT in Bangkok, was wholly financed by a private company, the Bangkok Mass Transit System Public Company Limited (BTSC), under a concession granted by the BMA in the form of build transfer operate (BTO). BTSC not only invested in the infrastructure but also operates and maintains the system. In regards to the MRT, or the subway line, the SOE Mass Rapid Transit Authority (MRTA), invested in all civil infrastructure and granted a 25-year BTO concession for the operation and maintenance of the
system to a private company, the Bangkok Metro Company Limited (BMCL). For the Airport Link project, SRT wholly owns the line and invests in the construction and civil works. Options for operation and management of the services are still under consideration. Public private partnerships, for example, in the form of contracts with a private operator, are other options being considered.

2. Water Transport

2.1 Sector Overview

Thailand has coastline of 2,614⁴ km and 1,750 km⁵ of navigable inland waterways. Given such topographical features, water transport has a major role to play in Thailand's transport system. Water transport has a strong potential to become an important part of the country's transport system especially as an integral part in the multi-modal transport system. Water transport is mainly used for the purpose of freight transport. In 2006, both inland waterway and coastal transport account for 6% of total domestic freight transport while sea accounts for 96% of international freight transport.

Ports in Thailand comprise international and coastal ports. There are both state-owned and privately-owned ports, and Thailand has eight international deep sea ports. The two major ports are Bangkok Port (with capacity limited to 1.0 million TEU per year) and Laem Chabang Port (with current capacity at 6.9 million TEU per year). Laem Chabang port has been handling more container traffic than its capacity. The over-utilization of Laem Chabang port was caused by expansion of international trade and limited capacity of Bangkok port, which is located in the congested area of the city center. The third phase of Laem Chabang port expansion is already underway. Once completed, capacity of the port will increase to 8.55 million TEU per year.⁶

⁴According to the figures published by the Ministry of Transport ⁵The Ministry of Transport ⁶NESDB, National Logistics Strategy 2006-2010, May 2007



Figure 9: Laem Chabang Port Container Traffic, 1998-2006

Source: The Ministry of Transport

Aside from the major ports mentioned, there are other international ports developed by the private sector in the central and southern region; for example, United Shipping's and Sahaviriya's ports. These ports mainly serve transport purposes of each private owner.

		Northern	Northeastern	Central	Southern
1.	International Ports				
	1.1 Government owned	2	-	3	5
	1.2 Privately owned	-	-	9	2
2.	Coastal Ports	-	-	10	16
	Total	2	-	22	23

Table 4: Numbers of International and Coastal Ports in 2006

Source: Marine Department

For inland water transport, there are 132 privately-operated river ports in 15 provinces of the northern and central region. Mostly, they are used for primary and agricultural goods transport.

2.2 Policy and institutional framework

The main policy direction in water transport is the development and capacity expansion of Laem Chabang port which is the most important international sea port of Thailand. There has also been policy discussion on potential development of ports on the western coast (i.e. Andaman Sea) to enhance competitiveness of the logistics system. MOT also supports the development of domestic coastal and inland water transport, which has been showing potential for serving freight transport between provinces, as part of the multi-modal transport strategy.

The structure of the policy and institutional framework is relatively clear for the water transport subsector. Policy and planning comes from the Ministry of Transport and Office of Transport and Traffic Policy and Planning, while the Marine Department regulates. Operators comprise both private companies and state-owned enterprises. The Marine Department and the Port Authority of Thailand (PAT), which are the regulators of ports, are also responsible for the operation and development of some ports. PAT, which is the largest port operator, falls under the supervision of the Ministry of Transport.

Agency	Policy	Regulation and Monitoring	Implementation
Ministry of Transport	\checkmark		
Office of Transport and Traffic Policy and Planning	✓		
Marine Department		\checkmark	~
Port Authority of Thailand		\checkmark	√
Thai Maritime Navigation Co., Ltd.			√
Bangkok Dock Co., Ltd.			~
Private Sector			√

2.3 Sector performance and international comparison

Statistics indicate that Laem Chabang port can compete with ports in the region relatively well in areas of freight carrying rates and docking times. However, waiting time is relatively high. The bottleneck of deep-sea ports in serving sea freight containers is caused more by software deficiencies such as the time required for customs clearance. In 2002, customs clearance for sea freight required an average of five days, which was a little longer than that of key competitors such as Malaysia, Singapore and Hong Kong. If Thailand can shorten the customs clearance time, competitiveness of Thai ports vis-à-vis key competitors can be greatly improved.



Figure 10: Performance Indicators of Laem Chabang Port







According to the WEF's Global Competitiveness Report 2006-2007, the survey indicated that overall port quality was above average. However, key competitors such as Singapore and Malaysia attained better rankings than Thai ports. Apart from overall port quality, according to the IMD World Competitiveness Year Book, the areas that are still not satisfactory are water transport service and unofficial expenses for import/export, where the scores were below average.

Port's Quality of Service*		Water Ser	Fransport vice*	Unofficial Expense for Import/Export*		
	Ranking	Score*** (avg. = 3.7)	Ranking	Score (avg. = 6.34)	Ranking	Score (avg. = 4.7)
Thailand	37	4.7	29	4.90	59	4.3
Singapore	1	6.9	1	9.48	4	6.6
Hong Kong	3	6.6	10	8.78	9	6.3
Malaysia	13	5.8	12	7.84	49	4.6
China	55	3.7	55	5.41	43	5.0
Vietnam	89	2.7	-	-	76	3.7

 Table 5: Thailand's Port and Water Transport Service Ranking

*Note: The 1^{st} indicator is produced by WEF and the 2^{nd} and the 3^{rd} by IMD.

**Note : 1 point = Poorly developed and inefficient, 7 points = Among the best in the world

Source: WEF, Global Competitiveness Report 2006-2007 and IMD, World Competitiveness Year Book 2004

Source: World Bank, Trade and Logistics in East Asia, June 2003

In all, Thailand's ports are doing relatively well in terms of quality. The area that Thai ports can improve upon relates to custom clearance procedures and import/export regulations. In recent years, Thai Customs has been trying to streamline its lengthy process and achieve the one day clearance target, especially by introducing paperless customs and a single window customs system. Such measures are expected to contribute to better performance and greater competitiveness of the Thai ports in the future.

2.4 Private-sector participation and privatization

PAT is a state enterprise directly responsible for management of all the seven deep sea-ports, including the two main sea ports, i.e. Bangkok Port and Laem Chabang Port. Management of each port varies with different levels of control and private participation. Bangkok Port is owned and operated by PAT with PAT acting as service provider for all port-related services. At Laem Chabang port, PAT takes more of a landlord role. Operations of the port are privatized to several companies with PAT acting as supervisor of the port's operations. Private participation at Laem Chabang takes various forms. All eight berths are operated by private operators. Five of them still belong to PAT which contracted private operators to manage the port under lease contracts. Three berths belong to major shipping companies which also operate them. The investment expansion plan for the second basin is a joint venture between PAT and Hutchinson Port Holding under a BTO basis. In addition to participation in port facilities, there are a number of small private operators providing services in the inland waterway transport sector.

3. Air Transport

3.1 Subsector overview

Air transport currently accounts for a small share of total transport both in terms of freight (1% for international and 0.01% for domestic in 2006) as well as passenger transport (1% in 2006). However, the official figures might be underestimated since the statistics do not include passengers carried by low cost airlines which has been growing rapidly in the recent years. Thailand currently has 36 commercial airports around the country comprising six international airports, 27 domestic airports and three privately-owned airports. The breakdowns of airport by type and region are shown in Table 6.

	Northern	Northeastern	Central	Southern	Total
1. International Airports	2	-	2	2	6
2. Domestic Airports	9	9	1	8	27
3. Private-owned Airports	1	-	1	1	3
Total	12	9	4	11	36

Table 6: Airports in Thailand in 2007

Source: NESDB, Transport and Logistics Infrastructure, 2007

There are three main international airports, Bangkok (Suvarnabhumi), Chiang Mai, and Phuket. Passenger capacities of these main airports are as follows:

- o Bangkok Suvarnabhumi Airport (45 million passengers/year);
- o Phuket (3.62 million passengers/year); and
- o Chiang Mai (2.09 million passengers/year)

Upon the opening of Suvarnabhumi Airport, the Don Muang Airport (with capacity of 36.5 million passengers/year) temporarily suspended its operation for commercial flights in 2006. However, it was re-opened in early 2007 to provide services for non-connecting domestic commercial flights.

Most of the air traffic, both in terms of passengers and cargo volumes are concentrated in the Bangkok Airport. In 2006, the number of passengers passing through Bangkok Airport exceeded 40 million. Phuket has the second highest passenger traffic at around 4 million passengers per year, followed by Chiangmai with passengers reaching 3 million in 2006.



Figure 12: Number of Passengers at International Airports, 2005-2006

In terms of cargo volumes, as of 2006, Bangkok Airport handled approximately 1.17 million metric tons of cargo per year. Cargo volume passing through other international airports is still small and at the level significantly lower than the volume seen in Bangkok. Chiangmai handled the second highest volume of cargo in 2006 at 26,099 metric tons, followed by Phuket at 16,277 metric tons. The air freight services are operated by AOT, which has 83 planes flying to 74 destinations (13 domestic, 61 international).

Source: Ministry of Transport



Source: the Ministry of Transport

3.2 Policy and institutional framework

With the opening of Suvarnabhumi Airport in 2006, bottlenecks, traffic congestion and excessive utilization of Don Muang Airport have been alleviated. However, Suvarnabhumi has already reached 93% of its capacity just one year after opening. Total passenger movements through the airport reached 41.8 million in 2007. There is a pressing policy issue on the future plan for capacity expansion of Suvarnabhumi Airport and the appropriate use of Don Muang Airport. Since its opening, Suvarnabhumi's operation has raised complaints from nearby communities in terms of noise pollution and the problem is still unresolved. If a solution cannot be agreed upon, the original plan for the second phase expansion may be delayed. An alternative option is to have dual international airports in Bangkok by shifting some international traffic back to Don Muang. The plan is under study and consideration by AOT and the Ministry of Transport.

The division of roles among the government agencies and state-owned enterprises are clear among policy, regulatory, and implementation functions. All six international airports are run by AOT while domestic airports are owned and operated by the Department of Civil Aviation. MOT and OTP manage policy, while the Department of Civil Aviation is the sole regulator. Besides regulatory functions, the Department of Civil Aviation is also responsible for operating and managing some airports, which are mostly regional airports with low levels of air traffic.

Agency	Policy	Regulation and Monitoring	Implementation
Ministry of Transport	 ✓ 		
Office of Transport and Traffic Policy and Planning	~		
Department of Civil Aviation		✓	✓
Thai Airways International PCL			~
Airports of Thailand PCL		✓	~
Aeronautical Radio of Thailand			~
Private Sector			✓

3.3 Sector performance and international comparison

The performance of international airports has been improving, especially in terms of number of passengers and air traffic. During 2002-2006, the number of passengers passing through Bangkok International Airport (Don Muang) increased an average of 8% per year while cargo volume increased an average of 6% per year.



Figure 14: Passenger Volume of Bangkok International Airport, 2002-2006





For domestic traffic, the three airports with the highest rate of aircraft movement are Bangkok, Chiang Mai, and Phuket. With the introduction of low-cost airlines, the number of flights grew significantly since 2004. The number of flights in some airports, i.e. Udon Thani and Had Yai, grew over 100% between 2003 and 2004. During 2005-2006, Phuket and Udon Thani saw the highest growth at 22% and 20%, respectively. To accommodate the increase in passengers, Chiang Mai and Phuket International Airports are under expansion and renovation. A study regarding runway expansion in order to facilitate full load aircraft is also underway.

Alumout		% growth					
Airport	2001	2002	2003	2004	2005	2006	in 05-06
Bangkok	55,259	55,968	61,019	79,926	90,761	102,249	13%
Chiang Mai	13,589	13,739	11,564	15,829	18,012	19,211	7%
Phuket	12,842	10,920	12,669	16,765	14,115	17,207	22%
Chiang Rai	4,798	4,922	3,506	4,949	5,171	5,582	8%
Udon Thani	2,172	2,340	2,254	4,753	5,264	6,311	20%
Had Yai	4,748	4,262	3,938	8,057	9,196	9,461	3%

Table 7: Numbers of Domestic Flights through Selected Airports, 2001-2006

Source: Ministry of Transport

Source: AOT Annual Report, 2006



Figure 16: Domestic Flights through Selected Airports, 2001-2006

Although the sector has performed satisfactorily in terms of growth, performance in certain areas of airport operation still lags behind. For example, from a regional perspective, it takes a relatively long time for air freight to clear customs compared to other countries in the region. However, the overall quality of airport services is evaluated higher than average according to the survey by WEF. Thailand's ranked 31st from among 102 countries. This is similar to the evaluation of port performance, where quality is up to international standards but bottlenecks lie in lengthy and non-transparent customs processes.



Figure 17: Comparison of Average Days for Customs Clearance for Air Freight

Source: Ministry of Transport

Source: Trade and Logistics in East Asia, World Bank, June 2003

	Quality of Air Transport Infrastructur			
	Ranking	Score (avg = 4.5)		
Thailand	31	5.5		
Singapore	1	6.9		
Hong Kong	3	6.7		
Malaysia	16	6		
China	89	3.7		
Vietnam	82	3.8		

Table 8: Quality of Air Transport Infrastructure

Source: WEF, Global Competitiveness Report 2006-2007

3.4 Private-sector participation and privatization

Major airports in Thailand are owned and operated by AOT, formerly a state-owned enterprise, which became corporate and acquired a public company status in 2002. AOT is responsible for six international airports, including Bangkok, Suvarnabhumi, Chiangmai, Phuket, Hadyai and Chiangrai. Other regional airports, mainly serving domestic routes, fall under the responsibility of the Department of Civil Aviation. In addition, some domestic airports were wholly invested by private airline companies to serve their own routes. AOT mainly relies on its own fund or loans to finance projects. Suvarnabhumi Airport was funded 30% by AOT and the remaining 70% was funded from the Japan Bank for International Cooperation (JBIC) loan.

4. Investment Prospects in the Transport Sector

The development of rail mass rapid transit in Bangkok and the vicinity is the government's investment priority in the transport sector. The MRT development is expected to help alleviate traffic congestion in Bangkok and move the transport sector toward more energy-efficiency. The MRT master plan has undergone several changes with changes in government. The latest plan was approved by the Cabinet on March 12, 2008, and sets forth nine MRT lines and six priority lines with the total estimated investment of approximately ThB 770 billion. The investment is planned in two phases. The first phase of investment is estimated to cost ThB 259 billion, and the second ThB 510 billion. The six priority lines include the purple line, the blue line, two routes of the red line and two BTS green line extensions.

F1.

Line	Route	Total Length for Phase I (km.)	Phase I Investment (Million Baht)	Source of Fund
1. Purple line	Bang Sue–Bang Yai	23	55,945	Budget/JBIC loan/PPP
2. Red line (SRT) (Suburban Rail)	Dang Sua Banggit	26	50 888	Pudget/IDIC
2.2 Southern red line	Bang Sue - Taling Chan	15	8 , 971	loan/Domestic loan Budget/Domestic loan
3. Light green line (BTS Extension)3.1 Northern extension	Mor Chit - Don Muang- Lum Luk Ka	12	30,770	Budget/Domestic loan/PPP
3.2 Southeastern extension	Soi Baring – Samut Prakan - Bang Pu	13	28,639	Budget/Domestic loan/PPP
4. Blue line	Bang Sue - Tha Phra	27	75,541	Budget/JBIC/Domestic loan/PPP
Total		126	259,754	

Table 9: Planned and Approved Phase I of MRT Projects as of March 2008

Source: MOF and OTP

Figure 18: Phase I of Mass Rail Transit Development according to the Cabinet Resolution dated March 12, 2008



Funding for both phases of the MRT is expected to come from both domestic and international sources. The government plans to invest in civil infrastructure, land resettlement for all lines and system operations for SRT-owned lines. All government investment will account for approximately 77% of total investments. The government's sources of fund will come from the national budget, domestic borrowing through government-issued bonds, and foreign borrowing (e.g., JBIC loan for the first phase). The private sector is expected to participate as system operators (for all lines except the red line) for the remaining 23% of total investment. The red line will be operated by SRT possibly through SRT's to-be-established subsidiary.

Although investment in MRT is desirable from many perspectives, careful consideration is needed to lay the basis for effective and efficient MRT services and avoid ending up with a suboptimal system. The critical issue of MRT system integration must be planned from the project design and bidding stages. Other issues such as procurement methods that can facilitate an integrated system and private participation, institutional arrangements with regards to MRT that can facilitate coordination and better management, and development of a complementary urban transport system (e.g. bus services, pedestrian walkways) are also crucial to the project's long-term success.

Another important investment in urban public passenger transport is the BMA-initiated Bus Rapid Transit (BRT) system. The first line is expected to become operational by mid-2008. The comprehensive BRT master plan is also being developed.

Other investments in inter-city transport are mostly to expand capacity of the inter-regional highway network and national railway network. There is also a potential for a new deep-sea port to link sea transport from the western coast (i.e., Andaman Sea) to the eastern coast (the Gulf of Thailand) to facilitate international trade. Currently, the road connecting the two coasts from Krabi to Surathani province, part of the so-called Land Bridge project, is complete. The construction of ports on both sides will complement the land bridge and is under study (i.e. Pak Bara deep sea port in Satun province on the west coast of southern Thailand). In terms of the air transport subsector, capacity expansion for the new Suvarnabhumi Airport is a major issue. Suvarnabhumi has potential to accommodate 100 million passengers per year while the existing capacity stands at 45 million passengers. The expansion plan for Suvarnabhumi Airport will, however, depend on the government's policy direction for Don Muang Airport as well as safeguard policies to prevent negative environmental impacts on nearby communities, which might be affected from further expansion of the airport.

5. Key Issues in the Transport Sector

Issues in the transport sector must be viewed in the broader national context with its relationship with other issues such as energy efficiency, national logistics competitiveness, and trade facilitation. Development of the sector needs to be balanced with the need to achieve greater energy efficiency and supporting national competitiveness and sustainable economic development.

Modal mix - Thailand currently relies on roads much more than rail for both freight and passenger transport. However, rail transport can provide an alternative energy-efficient means of transport. Rail should be promoted to complement the road system in carrying freight and passengers. Integrated infrastructure is needed to facilitate the modal shift, which will help reduce energy costs and increase efficiency of transport. This does not imply that rail is a one-size-fits-all solution. The challenge is how to find the right mix between road and rail and achieve efficiency of the whole system.

Rail system and SRT reform – Aside from encouraging the modal shift, rail service improvement and expansion makes sense on its own. There are several problems with the existing rail network: First, the network does not cover the country's production base. Second, important routes still face severe capacity and quality problems, such as sub-standard rail widths, and different track configurations within the rail network. Third, rail tracks have been poorly maintained and efficiency is compromised. Deficiencies of the current system need to be addressed prior to moving forward with the modal mix system.

Inadequate highway maintenance - The surface quality of major highways has been deteriorating over for the past years due to inadequate budgets and maintenance, as well as frequent axle load limit violations. Inadequate highway maintenance compromises the efficiency of the road and logistics systems, as well as road safety. To ensure that resources are sufficiently allocated for road maintenance, alternative financing options, for example, the use of a fuel levy, should be considered.

Free-access highway – With free access highway, people build homes and settle down in areas along highway, which raises consequent road safety issues as well as efficiency of land utilization. A controlled access highway would help mitigate road safety risks and improve the efficiency of land use along the highway.

Regional outlook - Changing regional factors will also impact transport planning. Cargo carried from the southern part of China, transported via Chiangsaen Port, has grown significantly. There is also growing competition from Vietnam and Malaysia to become the regional gateway. With shifts in region-wide logistics patterns and deeper integration of transport networks in the region, development of a transport system in Thailand should take into account the regional perspective and implications.





III.ENERGY SECTOR

1. Electricity

1.1 Subsector overview

Infrastructure development in the electricity subsector can be categorized into the following main areas: installed capacity and generation, the transmission network, and distribution network. Additionally, the demand side is an important parameter to consider.





The Thai electricity supply industry (ESI) is based on a state-owned single buyer scheme. The single buyer, Electricity Generating Authority of Thailand (EGAT), a State-owned enterprise that was established in 1968, purchases electricity from public and private power producers, and then sells it to unbundled distribution companies and a few large direct customers.

Installed generating capacity – EGAT is not only the single buyer but also acts as an electricity generator. It accounts, along with its subsidiaries, for nearly 60% of the current installed capacity.

Thailand's total installed capacity in 2006 was 27,107 MW (up from a mere 907.7 MW in 1969).

Source: World Energy Council



Source: EGAT Annual Report 2006

Although EGAT and its subsidiaries still dominate in terms of electricity generation, the last decade saw important opportunities emerge for the private sector: since 1992, programs for IPP's and SPP's allow private operators to generate and sell electricity to EGAT. IPP's must generate an excess of 90 MW per plant. SPP's and VSPP's, those producing less than 90 MW and less than 10 MW per plant, respectively, make up the remaining. All producers have played an increasingly significant role, as their share in installed capacity approached 40% in 2006.

In addition to power generated by EGAT and private producers, Thailand relies on power from neighboring countries such as Lao and Malaysia. Electricity imports account for 2% of the total installed power of the country.

Since peak demand in 2006 reached 21,064 MW, the minimum reserve margin amounted to 22.3% of the installed capacity, considered a strong ratio.

Electricity Generation

In 2006, Thailand's overall electricity demand reached 142,948 GWh. EGAT power plants generated 67,828 GWh, accounting for 47.78% of the country's total demand. PPP's generated 74,119.26 GWh, accounting for the remaining 52.22%.

In 2006, EGAT's gross capacity factor increased 2.13% from 46.89% in 2005 to 49.02%. It is notable that EGAT's share of electricity generation stands far below its share of installed capacity. In fact, EGAT, as a Thai public utility, must also aim at securing an appropriate reserve margin, which entails capacity utilization lower than that of the private producers.



Figure 21: Installed Capacity and Generation (1986-2006)

Source: EPPO

Nevertheless, as presented in the graph below, the entire ESI, including that from private producers, managed to improve its annual load factor⁷ by nearly 10% in two decades, reaching 76.9%. This compares favorably with other neighboring countries and even some developed ones such as Japan (around 60%).⁸

⁷Annual Load Factor = (annual consumption)÷(365×24×peak annual demand) ⁸http://www.fepc.or.jp/english/library/review/2007/04.pdf



Source: EPPO

In the last decade, Thai power generation has become increasingly dependent on natural gas. The Thai Government has been trying to curb the growth of gas consumption as it has become aware of the risks of further unbalancing its energy mix.



Figure 23: Power Generation by Fuel Type

Source: EPPO

Thus, in 2006, natural gas utilization decreased slightly by 0.1%. Coal and lignite consumption are also expected to grow, since they remain the least expensive and most available fuel. In its Power Development Plan for 2007-2021, the Ministry of Energy includes an additional 2000 MW of coal-fired installed capacity in Thailand. Meanwhile, renewable energies still account for less than 2% of overall power generation. Besides, traditional biomass fuel, such as wood, still represents 2/3^{rds} of the entire so-called "renewable energy (RE) generation".

	500kV	300kV	230kV	132kV	115kV	69kV	Total
Bangkok	411.128	-	805.030	-	-	-	1,216.158
Central	1,878.782	-	3,901.571	-	2,839.268	52.069	8,671.690
Northeast	-	-	1,761.206	-	5,284.782	-	7,045.988
Southern	-	22.988	2,512.560	8.710	2,818.935	-	5,363.193
Northern	1,142.990	-	3,295.096	-	2,932.545	-	7,370.631
Total	3,432.900	22.988	12,275.463	8.710	13,875.530	52.069	29,667.660

Table 10: Length of EGAT's Transmission Line by Regions (Kilometers) in 2005

Source: EGAT

Transmission network development must accommodate the increasing demand and generating capacity. In Thailand, it is also part of EGAT's mission to operate.

The following table shows the distribution of various types of transmission network across various regions in Thailand. The 230kV and 115kV lines dominate more than 90% of the total network length. The transmission network is, to a large extent, equally distributed among the central, northeastern, and northern regions.



Figure 24: Length of Transmission (by Type)

Development of the distribution network is, for the most part, under the jurisdictions of the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). While MEA is responsible for distribution in Bangkok and the vicinity, PEA is responsible for almost the rest of the territory. EGAT sells most of the electricity it generates to MEA and PEA, which re-distribute it in their areas. However, EGAT provides direct service to a few large customers.

Source: MEA & PEA



Source: EPPO

In 2006, EGAT's sales of electricity spiked by 5.56%, reaching 134,084.35 kWh. EGAT sold 42,856.94 GWh of power to MEA while PEA purchased 88,630.33 GWh. Direct customers were provided with 1,587.27 GWh.



Figure 26: MEA Electricity Sales

Source: MEA





Source: PEA

According to data collected during 2001–2005, MEA mainly covered businesses in Bangkok and its vicinity and had fairly diverse groups of clients. PEA nearly exclusively served residents.

In 2005, PEA sold only 16.15% of the power purchased from EGAT (13,423.05 GWh out of 83,133.55 GWh).

	ME	A Power Distribu	tion	PEA Power Distribution		
Year	from EGAT	to Customers	%	from EGAT	to Customers	%
2001	35,327.39	33,842.67	95.80	60,303.38	11,549.58	19.15
2002	36,288.20	35,780.97	98.60	64,230.79	11,958.76	18.62
2003	38,587.01	37,430.64	97.00	70,107.23	12,377.48	17.66
2004	40,217.03	39,119.39	97.27	76,310.51	12,957.74	16.98
2005	41,439.84	40,099.96	96.77	83,133.55	13,423.05	16.15

Table 11: MEA & PEA Power Distribution (Million of kWh)

Source: MEA

Demand side analysis

In the last five years, peak demand for electricity has continued to rise, and in 2006, peak demand was 21,064 MW, a 2.56% increase from peak demand in 2005 at 20,537.50 MW. Power demand usually peaks during the hot season in Thailand, between March and June.





Source: EPPO

The following graph highlights a momentous and continual increase in electricity demand since the 1997 crisis. Although industry seems to be more expansive, with a six-fold growth in 20 years, in fact, residential and business demand grew at the same pace during the same period.



Figure 29: Evolution of Power Demand by Sector

Source: EPPO

As of 2006, the largest share of power demand was from industry, accounting for 45% of total demand. The second largest share was from commerce with a 25% share, followed by households and residents, accounting for 21% of total demand.

Electricity pricing

As for the upstream ESI, different tariff structures apply between the basic generators (IPP, SPP and VSPP) and their single buyer, EGAT. These structures vary according to the amount and the type of power they generate, and according to the firmness (that is, both the duration and the obligation to buy the generated power) of their contractual relationship.

Tariffs for IPP are based on the following two-part structure: the availability payment or capacity payment (payment for fixed costs, infrastructures, debt repayment) and the energy payment (the payment for the actual delivered energy).

Firm commercial energy SPP's get an unbundled base tariff, which comprises a capacity payment, an energy payment and a fuel savings payment. Firm renewable energy SPP's get the same base tariff plus two adders: a fixed one, the renewable energy promotion, and one that varies depending on the type of produced renewable energy.

Non-firm commercial energy SPP's get a special tariff based on the TOU rate, whereas nonfirm renewable energy SPP's get the EGAT wholesale tariff plus an adder that varies on the type of RE produced.

All VSPP's get a base tariff reflective of EGAT's wholesale, plus an adder that varies on the type of produced RE.

As for the downstream ESI, the current electricity tariff structure is made up of a wholesale rate and a retail rate. The wholesale rate is the rate at which EGAT sells electricity to the PEA and the MEA. The retail rate is the rate at which MEA and PEA sells electricity to final consumers. The retail rate is a uniform rate applied nationwide. The setting of electricity tariffs is based on the principle of marginal cost to fully reflect the actual economic costs of electricity generation and distribution.

EGAT sells electricity to MEA and PEA at the same wholesale rate. However, transmission costs of PEA are much higher than MEA's. Thus, in order to enable MEA and PEA to sell electricity at a uniform tariff rate to final consumers, cross subsidization between MEA and PEA is required. The subsidization is in the form of a lump sum financial transfer from MEA to PEA on an averaged monthly basis during the fiscal year.

The calculation of the retail electricity tariffs comprises two parts as follows: 1) the base tariff and 2) the tariff derived from automatic adjustment mechanism (Ft):

- **Base tariff :** The base tariff includes the costs of generation, transmission, and distribution. The tariff structure for the generation, transmission, distribution and retail is clearly unbundled. Tariff varies according to each consumer category with its own particular group's load pattern. There are currently eight categories of users. The electricity tariff structure is different in each category. For example, a time of use (TOU) rate is applied for medium and large general services, whereas a progressive rate is applied for the residential and small general services group.
- Automatic Adjustment Mechanism (Ft): The calculation of base tariff rests upon certain assumptions regarding fuel prices, inflation rates, exchange rates, operating efficiency and other factors which might not reflect actual costs at the time of consumption. The principle of Ft is to have the actual costs reflected by the tariffs. The mechanism allows for adjustment of electricity tariffs to correspond with the changing actual costs which are beyond the control of operators. Ft value will be adjusted every four months taking into account factors such as costs of fuel and energy purchased.



Figure 30: EGAT's Electricity Rates

Source: EGAT

1.2 Policy and institutional framework

Development of the electricity subsector has been focused on the expansion of generating capacity and adequate coverage of the transmission and distribution network. The objective has been to meet the growing demand for electricity and ensure security, quality and reliability of the electricity system. Policy and planning for the electricity sector is formulated in EGAT's Thailand Power Development Plan (PDP). The current PDP 2007 covers the planning period 2007-2021. Major long-term policies are:

- Continual development of the system to ensure adequate supply in response to economic growth
- Increasing participation of the private sector especially in serving industrial operators. The aim is to achieve a proportion of power generated between EGAT and private producers at a ratio of 50:50.
- · Increasing the proportion of power generation from natural gas and coal/lignite

Moreover, in EGAT's PDP for 2007-2021, a nuclear power plant is also under consideration as a long-term solution for increasing electricity demand.

The institutional arrangements in the electricity subsector are fairly clearly established. Policy setting, regulation and monitoring, and service provision functions are separated. Three state enterprises (i.e. EGAT, MEA and PEA) are responsible for service provisions. The Energy Planning and Policy Office and the Minister of Energy manage policy formulation. An interim power regulator was set up in 2005. However, with changes in policy and the repeal of EGAT's privatization plan, the interim regulator was dissolved in 2006. In December 2007, with the new Energy Act, the new permanent regulating body called the Energy Regulatory Board (ERB) was established in January 2008. The newly established ERB will act as sole regulator in the energy and electricity sectors. ERB's regulatory authority includes but is not limited to setting electricity tariffs and granting licenses for power plants. The ERB is expected to benefit the sector by integrating and coordinating regulatory functions under one body. However, it is not an independent body. The Board members are appointed by the Ministry of Energy. Nevertheless, the establishment of ERB represents an important turning point in the sector, which saw several delays in the long-awaited establishment of a proper regulatory body since its inception in the 2003 power sector restructuring plan.

Agency	Policy	Regulation & Monitoring	Implementation
National Energy Policy Council	\checkmark		
Ministry of Energy (i.e. EPPO)		\checkmark	
Energy Regulatory Board (ERB)		\checkmark	
Electricity Generating Authority of Thailand (EGAT)			\checkmark
Metropolitan Electricity Authority (MEA)			\checkmark
Provincial Electricity Authority (PEA)			\checkmark
Private Sector			✓

1.3 Sector performance and international comparison

Over 90% of the population has access to electricity in their home. The electricity network covers more than 99% of the total area of the country, according to EGAT's Annual Report.

In terms of quality, there has been continual improvement in service provision as shown by constant decline in the SAIFI (standard average interruption frequency index), and SAIDI (standard average interruption duration index) indexes for both MEA and PEA.

Figure 31: Quality of Transmission Services (SAIFI)



Source: MEA and PEA, 2006





Source: MEA and PEA, 2006

The electricity sector in Thailand performs up to international standards. Based on the WEF's Competitive Index for 2007-2008, a survey on electricity supply quality ranks Thailand 39th out of 131 countries with a score of 5.5, much higher than most Asian neighbors and above the world average (This survey rates the quality of electricity supply in terms of lack of interruption and lack of voltage fluctuation.).

	Electri	city System's Quality of Service
	Ranking	Score* (average=4.5)
Thailand	39	5.5
Singapore	11	6.6
Malaysia	33	5.8
China	79	3.9
Vietnam	88	3.5
Indonesia	90	3.5
India	97	3.1

*Note : 1 point = Worse than in most other countries, 7 points = Equal to the highest in the world Source: WEF, World Competitiveness Year Book 2006-2007

Nevertheless, a survey of Thai firms from a World Bank 2006 study on Thailand's investment climate identifies electricity supply as the second most severe obstacle to business development.

At the end of 2006, the average electricity retail tariff reached US\$ 0.09. Thailand's household and industrial tariffs were quite similar. However, a comparison of average electricity retail tariffs in middle-income and developed countries in 2004 shows that Thai industrial tariffs are relatively high, while households tariffs are more competitive.



Figure 33: Average Electricity Tariffs (Nominal US\$/kWh) in 2004

Source: Energy Information Agency, US Government

1.4 Private-sector participation and privatization

There have been ongoing privatization and liberalization efforts in the power sector. The government has been attempting to privatize EGAT and restructure its role in order to dissolve its monopoly in power generation and transmission. Hence, the sector has been gradually liberalized with increasing private sector participation in power generation through EGAT's IPP, SPP and VSPP programs.

Thai IPP's usually operate under a BOO scheme. A first round of IPP public tenders was held in 1994, which led to the set-up of seven IPPs, accounting for 5,944 MW installed capacity. In June 2007, EGAT published a request for proposals for a second round of IPPs, expecting to sign power purchasing agreements for a cumulative amount of 5,600 MW. The SPP program, launched in 1992, is designed for small plants, under 90 MW, to provide power directly to industry. Similarly, the VSPP program initiated in 2002, contains a special legal framework for very small power plants (under 10 MW) aiming to enhance power generation with renewable energy.

Finally, two EGAT subsidiaries, EGCO and Ratchaburi, were established as private stock-listed vehicles, with EGAT participation currently at 25% and 45%, respectively.

In 2003, the Cabinet approved the latest power restructuring model called the "enhanced single buyer" (ESB) model. According to this model, EGAT is to remain the country's sole electricity buyer, transmitter and wholesaler, whereas the private sector will compete with EGAT in power generation.

In addition, EGAT became partially corporate in June 2005. However, the total privatization of EGAT was repealed due to a Supreme Administrative Court ruling which ordered the suspension of the initial public offering and listing of EGAT in the stock market in 2006. The privatization of EGAT currently remains on hold.

2. Energy

2.1 Subsector overview

Thailand has moderate amounts of fossil fuel reserves, the most important of which is natural gas. Domestic consumption is partially served by domestic energy production. However, the majority of energy supply, more than 60%, is imported. Production and consumption has increased steadily as a result of continued expansion of the economy.

Currently, oil and gas companies share 38 concessions and 50 blocks, extending the exploration area to 150,000 sq km. The two major companies are PTTEP and Chevron, in both gas and oil.

Upstream and mid-stream infrastructures overview

Oil –There are two oil pipelines owned by private companies for the transmission of refined oil products from refineries to oil terminals in Bangkok vicinity. However, both pipelines are underutilized since price is not competitive with other transport systems, for example, trucking. Oil depots are located all over the country with a total storage capacity of 7,240 million liters. More than 80% of the storage capacity is located in the Bangkok area and the eastern part of Thailand. Storage capacity of existing oil depots can sufficiently serve demand and no expansion is expected in the near future.

1



Source: PTT Annual Report 2006

There are seven refineries in Thailand with a total capacity of 1,022,000 barrels per day⁹ (stream day). All major refineries are part of PTT Group, except an ESSO one, which is owned by Exxon. The total capacity of these refineries still exceeds domestic demand (705,800 barrels per day). A portion of refined products are exported. In 2006, refined products totaled nearly 869,000 million bbd, representing 85% of capacity utilization. Diesel occupies the highest share of total refined products. Given the excess, the current capacity is deemed to cover domestic needs for the next ten years.

⁹See EPPO Energy Statistics http://www.eppo.go.th/info/2petroleum_stat.htm

ENERGY SECTOR **Figure 35: Main Refineries in Thailand** THAIOIL 220 KBD COMPLEX (FCCU, HCU) SRIRACHA, CHONBURI **TPI 215 KBD** CONDENSATE SPLITTER MUANG, RAYONG ESSO 145 KBD COMPLEX (FCCU) SRIRACHA, CHONBURI RPC 17 KBD CONDENSATE SPLITTER MAP TA PHUT, RAYONG BANGCHAK 120 KBD HYDROSKIMMING **BANGCHAK, BANGKOK** SPRC 150 KBD COMPLEX (RFCCU) MAP TA PHUT, RAYONG RRC 145 KBD COMPLEX (HCU, VBU) MAP TA PHUT, RAYONG Source: Bangchak Petroleum Company

Natural Gas – Exploration and development of natural gas started in 1981 as part of the plan for the country to become less oil-dependent. The Department of Mineral Fuels (DMF) is responsible for granting concessions for exploration and development of oil and gas fields. As a result of exploration and development activities, the country was able to secure some oil and gas reserves both on- and offshore, such as gas fields in the Gulf of Thailand, and an oil field in the central plains. Major concessionaires are Chevron and PTT Exploration and Production Public Company Limited (PTTEP), which is a subsidiary of PTT Public Company Limited (PTT), Thailand's national gas company. Aside from domestic reserves, the Malaysia-Thailand Joint Development Area (MTJA) is another important supply source. Thailand and Malaysia jointly share the rights and benefits of resources in the area. The project is a joint-venture between PTT and Malaysia's national energy company, Petronas. In addition, PTT also has a natural gas purchase agreement with Myanmar.

1



Source: PTT Annual Report 2006

PTT is the sole operator of an integrated transmission and distribution pipeline system for natural gas. It procures natural gas from both indigenous (73% of the overall supply) and overseas sources (mainly Myanmar). PTT is also the largest gas separator in the country. PTT's current natural gas pipelines are approximately 2,700 kilometers in length and capable of transporting 3,170 MMcfd of gas. The network comprises 2,400 km of transmission pipelines, both on- and offshore, and 300 km of distribution pipelines. Three major off-shore pipelines are linking the Gulf's fields with Rayong and Pattaya's coasts. Their combined capacity is currently 3,350 MMcfd and is deemed to expand to 4,500 MMcfd when the Arthit pipeline in the Gulf of

Thailand will be provided with a compressor unit.¹⁰ In addition, international transmission systems include the two following pipelines: an on- and offshore pipeline linking Myanmar's gas fields in the Bengalese Gulf to Ratchaburi's power plants, and the Trans-Thailand-Malaysia Gas Pipeline in the Gulf of Thailand. PTT is planning to further expand the pipelines on both the eastern side and the western side.

In June 2007, PTT announced it would build a deep-sea port, terminal and pipeline for liquefied natural gas (LNG) in Map Ta Phut industrial zone. The LNG-receiving project, consisting of depot and terminal, is scheduled for completion in 2010, with an initial capacity to handle 5 million tons of gas a year. Capacity could later be increased to 10 million tons.

In the intermediate part of the supply chain, PTT currently owns five natural gas separation plants with a combined separating capacity of 1,710 MMcfd of natural gas. Four are in Map Ta Phut and one is in Khanom, Nakhon Si Thammarat.

Downstream infrastructure overview

According to the Energy Business Department under the Energy Ministry, there are 5,000 major oil company pumps among a total of 18,400 petrol stations nationwide. The remaining ones are all independent, buying oil from local wholesalers. The major owners of oil and gas stations are PTT (1,229 units) and Bangchak (1,100 units).

Industry overview

Fossil fuel supplies in Thailand come from both imports as well as indigenous production. In 2006, it amounted to 1,583,600 barrels of oil equivalent per day (BOED), of which 63.5% were imported and 36.5% were indigenous.

Reserves – The total amount of natural gas reserves in Thailand is approximately 30,655 billion cubic feet as of December 2006, including proved reserves, probable reserves and possible reserves. Still, according to DMF, Thailand holds 290 million barrels of proven oil reserves. Major reserves are in the Gulf of Thailand (i.e., Bongkot, Arthit, Pailin, Erawan) and the Malaysia-Thailand Joint Development Area. The amount of reserves used for planning purposes is proved reserves and probable reserves (2P). According to the 2P reserves, it is estimated that natural gas will remain available in the next 26 years. It does not include possible reserves (P3), as shown in the graph below.

Fossil fuel reserves are located in 77 on-and offshore fields, four more than in 2005.

¹⁰See Thailand country report of the US Energy Information Agency

Tuble 151 F 055h F dels reserves and Froduction in 2000 and 2000							
Energy Type	Reserves (2P)		Reserves	Droduction	Available for Use (Year)		
	P1	P1+P2	P1+P2+P3	Froduction	P1	P1+P2	P1+P2+P3
Crude Oil (million barrels)	195	312	354	47	4	7	8
Condensate (million barrels)	266	559	720	28	10	20	26
Natural Gas (Billion cubic feet)	11,697	22,335	30,655	860	14	26	36
Lignite (Million tons)	2,081	-	-	19	110	-	-

 Table 13: Fossil Fuels Reserves and Production in 2005 and 2006

Source: Department of Mineral Fuels

Coal is another important source of fuel in Thailand. As of 2006, remaining coal reserves in Thailand were estimated to be 2,081 million tons. In 2006, total domestic production of coal was 19.07 million tons, an 11% drop from production in 2005. The major producer of coal is EGAT which uses it as fuel for power generation. The main coal reserve is in Mae Moh Basin, Lampang Province, accounting for around 83% of total production.

Production-Primary Energy Production – In 2006, the production of primary commercial energy was at a rate of 764,992 barrels per day (BBL/day) of crude oil equivalent. The pattern of primary commercial energy production comprises 56% of natural gas, 17% of crude oil, 14% of lignite, 9% of condensate, and 5% of hydropower. In 2006, natural gas production was 860 billion cubic feet. Condensate and crude oil output were 28 million barrels and 47 million barrels, respectively.

Natural gas has become the most important energy source in Thailand. Production of natural gas was 422,782 BBL/day of crude oil equivalent in 2006 compared with 62,886 BBL/day of crude oil equivalent in 1986. This represents an increase of more than 500% over the last 20 years.




New and renewable energies

Regarding renewable energies, the available data include traditional biomass fuel such as wood and charcoal, which are still heavily used for household needs in the Thai countryside. In 2005, the use of biomass as a fuel accounted for 16.1% of total primary energy production.

The total production of renewable energy in 2006 totaled 17,031 kilo tons of crude oil equivalent, accounting for 31.2% of total energy production. Of this total, 60.4% was shared by fuel wood, followed by bagasse (16.8%), paddy husk (13.7%) and others.

Biomass - Apart from traditional wood, more than half of the biomass energy potential in Thailand results from agricultural waste, mainly from sugar cane, straw, paddy husk, cassava, coconut and palm empty fruit bunches.

Solar Energy - The actual generation stands at a mere 2.879 GWh per year, according to the Energy Ministry. However, the potential of solar energy in Thailand is quite important. The Department of Alternative Energy Development and Efficiency (DEDE) also estimates the potential installed capacity as high as 5000 MW. The average solar radiation varies between 18 and 19 MJ/sq m, according to DEDE. Best radiations occur in April and May, ranging from 20 to 24 MJ/day.

The Energy Ministry set a 250 MW installed capacity target to be reached by 2011, especially through renewable portfolio standards (RPS).

Currently, most solar plants are installed for households, rather than commercial and industrial zones; a trend that should be reversed if the Thai Government expects to implement the RPS. Some 30 MW PV plants were installed at the end of 2007, mostly as solar cell battery stations and water pumps. However, thermal energy is growing at a steady pace, with some 3,000 to 3,500 sq m/year of water heaters. In addition, new solar technologies are also in the pipeline such as combined hydro-PV, diesel-PV or wind-PV, used as power generators in national parks. EGAT's Klong Chong Klam in Prachinburi province, a combined hydro-PV project, or Promthep Alternative Energy Station in Phuket, a wind-PV experiment, are some examples.

Biogas – Thailand's biogas technology was introduced in the country in the early 1980's, although it has been experimental. Production, now, has begun in earnest. Used mainly for local power generation, two main sources for biogas in Thailand are farms and waste water industries. One outstanding example is Asian Palm Oil Company which uses its Krabi plant waste water in the daily production of 6,000 liters of biogas, through an anaerobic digester. This covers 93% of its power demand. Currently, two CDM-related projects are developed in pig farms in Khorat and Ratchaburi.

Bioethanol – In 2004, the Thai Government launched a plan to increase the daily capacity of production to 3,000,000 liters by 2011, through a withdrawal of gasoline 95 and fiscal incentives for fuel flexible vehicles. Last August, the excise tax on fuel flexible vehicles was lowered 5% compared to the regular car excise taxes, which range from 25% to 35%

The available commodities are cassava, sugarcane, molasses, maize, rice and even sorgo. The most usual ones are molasses and cassava.

Thailand is the world's fourth biggest sugarcane producer after Brazil, China and India. In Southeast Asia, it is by far the leader, as shown in the graph below.

The annual production of cane sugar reached 5,424,500 tons in 2006. Typically, 2/3^{rds} of the annual production is exported. The Thai Government is considering taking advantage of this huge margin to produce more bioethanol, up to 5 million additional liters daily.



Figure 38: Cane Sugar Production in South East Asia

Source: FAO

As for the second source, cassava, Thailand is the leading exporter and can produce up to 2,000,000 liters/day, according to DEDE. Following are some data on crops productivity in Thailand:¹¹

- Sugar cane juice: 1 ton produces 70 liters of ethanol
- Molasses: 1 ton produces 220 to 260 liters of ethanol (bearing in mind 22 tons of sugarcane produce 1 ton of melasse)
- · Cassava: 1 ton produces 180 liters of ethanol
- Rice and Maize: 1 ton produces 400 liters of ethanol
- Sorgo: 1 ton produces 76 liters of ethanol

¹¹Source: UNCTAD and Bangchak

There are currently eight bioethanol plants with combined capacity of around 1,000,000 liters a day. Eleven ongoing projects will raise the capacity to 3 million per day in 2008. In 2007, Thailand's bioethanol market experienced a somewhat excessive supply which forced a number of companies to stop expansion plans.¹² However, this excess might be temporary and due to sluggish internal consumption, the delay in the prohibition of gasoline 95 by the government (as there were still too many non fuel flexible vehicles) and the remote possibility of local producers to tap markets abroad.

Biodiesel – Biodiesel production in Thailand began in the early 1980's. The main raw materials are palm, rapeseed, coconut, soy, peanut, and even sesame and sunflower oils. Lately, cooking oil has also been recycled for biodiesel production. In addition, *jatropha curcas*¹³ is now offering good potential.

According to the Biodiesel Development and Promotion Committee of the Energy Ministry, palm oil is the most used raw material, owing to its high competitiveness and multipurpose. Palm tree plantation can yield up to 5,800 liters per hectare per year. That corresponds to 7.2 liters of biodiesel per hectare per day.

As for jatropha curcas, according to the Bangchak Petroleum Company data it yields up to 300 liters/rai¹⁴, or 1,800 liters/ha per year, that is to say a quarter of the palm fruit is yielding. However, the jatropha offers good potential for Thailand because of the following reasons: its implied labor costs are 90% lower than palm oil, its price level does not fluctuate widely since it is not edible, it requires far less irrigation and can be cultivated in many more places.

In mid 2007, there were six biodiesel production companies, with a combined capacity of around 1 million liters/day. They all sell their output to PTT and the Bangchak Petroleum Company. The current biodiesel production is approximately 500,000 liter/day. Actual consumption of B5 biodiesel, a blend of 95% regular diesel and 5% biodiesel is approximately 2 million liters/day, according to latest data from the Department of Energy Business.

To date, there are two CDM-related projects in biodiesel. Both are Japanese investments, accounting for approximately 350,000 liters/day.

¹²See Mitr Phol Sugar announcement on August, 14, 2007

¹³Barbados nut or Physic nut

¹⁴1 *rai* = 0.16 ha

Wind – Thailand enjoys strong winds, albeit in only 0.2% of its territory as follows: along the Andaman sea coasts and the southern shore of the Gulf of Thailand. On both shores, average wind velocity reaches 5m/s. Elsewhere, small wind turbines are required since they are more efficient in poor wind conditions. So far, wind energy has been used for power generation and water pumps as in a Phuket pilot project and for Pattaya's Koh Lan 45 mini turbines with a capacity of 200 kW.

Hydropower – Currently, hydropower installed capacity amounts to 3,764.2 MW, 14% of the overall installed capacity. Nearly all the power plants are EGAT's dams, while the mini and micro hydropower plants account for 74 MW.

Geothermal plant – In Chiang Mai province, a geothermal plant was built in 1989 with a capacity of 300 kW. It uses the energy to produce electricity and heat.

Imports

Although energy production has continually increased at an average of 8.5% per year during 1986-2006, domestic production is still not sufficient to serve the demand, which grew at an average of 8.7% per year during the same period. Thailand still relies heavily on energy imports which supplied 64% of domestic consumption. In 2006, net energy imports were 978,120 BBL/day of crude oil equivalent. The main import item is crude oil accounting for 78% of total imports. Energy imports increased at an annual average of 9.2% over the last 20 years. Although, the overall import trend has been rising, net energy imports have fallen in recent years.



Figure 39: Primary Energy Import (net) in 1996-2006

Source: Energy Policy and Planning Office

Final Energy Consumption

Primary energy is transformed into final energy to be used by consumers. Thailand still relies heavily on major commercial energy such as petroleum products, natural gas and coal, while the two sectors that consume most energy are transport and manufacturing.

Consumption by fuel type – The main primary energy consumption in Thailand has been of petroleum products. In 2006, they accounted for 44% of total consumption. Natural gas had the second largest share at 37%, followed by imported coal (9%) and lignite (7%). Total energy consumption was 1,547,778 barrels per day of crude oil equivalent in 2006. Energy consumption has increased more than 300% over the last 20 years up from a consumption level of 337,889 barrels per day of crude oil equivalent in 1986. However, the pattern of energy consumption has not changed much. Petroleum, gas and coal have remained the main types of energy consumed.



Figure 40: Primary Energy Consumption

Source: Energy Policy and Planning Office

Natural gas demand is forecasted to continue growing by 7% in 2007 due to the recent exploration of the onshore Phu Hom and offshore Thailand-Malaysia Development Area (JDA) fields, and to new Myanmar fields. Petroleum products are expected to increase more slowly, as a mechanical effect of a gas and alternative gas-derived fuel increase; for example, since PTT will be able to supply more natural gas to EGAT, automatically less fuel will be consumed.

However, lignite and imported coal are to increase markedly because of the operations of new coal-fired power plants (1,400-watt BLCP power facility).

Renewable energy consumption was 10,993 kilo tons of crude oil equivalent accounting for 17.4% of total energy consumption.

Consumption by sector - Energy consumption in every sector has been increasing in the last five years, as presented in Figure 41.



In 2006, the pattern of energy consumption changed slightly as the manufacturing industry became that which consumed the most energy, albeit in a very close margin with the transport sector. The proportion consumed by the residential, commercial and agriculture sectors was

14%, 7%, and 5%, respectively.



Figure 42: Final Energy Consumption by Economic Sector

Source: Department of Alternative Energy Development and Efficiency

Oil Pricing

In 1991, oil prices were deregulated to ensure that the domestic price reflects global oil prices. The structure of the oil price comprises the following components:

- Ex-refinery price/CIF price
- Excise and municipal taxes
- Oil fund levy/subsidy, determined by the government

- VAT
- Marketing margin, determined by the government

Although oil prices were deregulated in 1991, with an oil price hike in 2004, the Oil Fund was reinstated to stabilize domestic oil prices. Government intervention has played an important role again in oil pricing through two components: the oil fund levy/subsidy and the marketing margin. Government provides a subsidy to (when the market oil price is too high) or collects a levy from (when the oil price decreases below the base price) the fund in order to set an appropriate retail price.

Government also intervenes in the pricing of gasohol and biodiesel, by allowing them to contribute less than standard fuels to the Oil Fund. This indirect subsidy aims at spurring biofuel consumption by setting a minimum margin between the retail prices of biofuel and regular fuel.

Gas Pricing

Since PTT is the sole buyer of natural gas from gas concessionaires and the sole operator of the transmission system, the natural gas industry still relies on government intervention to ensure fair practice. The price of gas, transmission charges, and purchase agreements between PTT and concessionaires/buyers, are still regulated by the government. The LPG price is also subsidized by government using money from the oil fund.

The retail price of natural gas for vehicles (NGV) is fixed at ThB 8.50 per kg and is likely to remain fixed at this rate until 2009 according to the Ministry of Energy's plan.

2.2 Policy and institutional framework

The main policies in the energy sector are focused on energy efficiency, renewable energy development, energy security and development of Thailand into a regional energy regional hub.

As transport and industrial sectors are the largest energy consumers, the plan to achieve energy efficiency relies on a modal shift toward more use of the rail system in transport and measures to promote energy efficient practices among industrial operators. However, this will require coordinated efforts at a national level. The government also emphasized plans and measures to realize energy security, especially by reducing imports of crude oil, and having a more balanced energy portfolio. Exploration and development of new reserves in the country is promoted. The country also relied more on natural gas supplies from neighboring countries such as through a natural gas purchase agreement with Myanmar and a joint venture project in natural gas production and exploration with Malaysia in the MJDA.

Renewable and alternative energy development is also a key policy issue in the energy sector. The development of gasohol for use in transport was supported by the government with tax incentive programs and financial assistance. Clean energy such as NGV is also promoted for use in the transport sector through various tax incentives, pricing policy and industrial standard setting. The government set a goal to replace 10% of oil consumption with NGV by 2008. The government also aims to promote commercialization of biodiesel and encourage small-scale projects at the community level. In addition, attractive adders for the use of renewable energy in generating electricity are in place. The government also introduced financial measures through several funds such as the Energy Conservation Fund and the Oil Fund to boost more investments in renewable energy.

Under the recently created Ministry of Energy, four special departments are in charge of the policy making and implementation; as in the electricity sector, policy formulation, infrastructure planning and price regulation are assigned to EPPO. Oil and gas concessions are granted by the Energy Ministry's Department of Mineral Fuels. The energy trade system, which fundamentally comprises the midstream and downstream industry, is ruled by the Department of Energy Business. This department is in charge of storage, transportation and retail licenses, as well as securing fuel reserves. As for the Department of Alternative Energy Development and Efficiency, it promotes and sometimes finances the use of new and renewable energies and energy efficiency techniques implementation. However, special adders for renewable energies are still determined by EPPO.

As in the electricity sector, with the recent Energy Act 2007, the new regulatory framework for oil and gas industry and business was established. The newly established ERB will also regulate oil and gas sector. It remains to be seen how effective the new regulatory body will be in regulating the sector where state monopoly and self-regulating practice has been entrenched.

Agency	Policy	Regulation & Monitoring	Implementation
National Energy Policy Council	\checkmark		
Ministry of Energy	\checkmark	\checkmark	
Energy Regulatory Board		\checkmark	
Energy Policy and Planning Office	\checkmark	\checkmark	
Department of Mineral Fuels	\checkmark	\checkmark	
Department of Energy Business	\checkmark	\checkmark	
Dept. of Alternative Energy Development & Efficiency	\checkmark	\checkmark	
Private Sector			\checkmark

2.3 Sector performance and international comparison

One indicator to measure the performance of the energy sector is the energy intensity ratio. The energy intensity ratio is the ratio of energy consumption to GDP. The ratio reflects the amount of energy needed to produce added value in the economy. In the last 18 years, the energy intensity ratio has increased, which reflects a small decline in energy efficiency.

In comparison with other countries in the region, Thailand has a relatively low energy intensity ratio. In 2005, Thailand had an energy intensity ratio lower than China's but higher than Singapore's. Thailand's ratio is in the same range as Malaysia's. It is observed that high income countries such as Japan and the US generally have low energy intensity ratios.



Figure 43: Primary Energy Consumption per US\$ of GDP in 1996-2005

Source: The Energy Information Administration (EIA), the U.S. Department of Energy

Another important energy indicator is the energy elasticity index. Energy consumption generally follows the trend of economic growth. However, in most cases, energy consumption will grow at a higher rate than economic growth. Higher energy elasticity generally indicates lower energy efficiency. In Thailand, during 1980-2001, energy elasticity was averaging 1.565. Since 2004, however, the pattern has seemed to reverse.



Figure 44: GDP Growth, Energy Consumption Growth, and Energy Elasticity in 2002-2005

Source: Department of Alternative Energy Development and Efficiency

2.4 Private-sector participation and privatization

The petroleum industry is characterized by active private participation from upstream to downstream, especially by foreign entities. Private oil companies bid for concessions from the government to explore and develop oil and gas fields. There are many private companies in exploration activities, both Thai and foreign; in fact, both usually team up for joint venture projects. Chevron is the largest bulk oil supplier. Refining and retailing businesses in the petroleum sector are also open to private sector participation.

On the other hand, competition in the natural gas industry is still limited. PTT still has significant monopoly control through its role as the sole purchaser, transporter and distributor of natural gas, including in the downstream gas market.

Regarding privatization, the former public Petroleum Authority of Thailand was made corporate in 2001; however, the majority of its shares are still held by the Ministry of Finance (52.32%). The corporatization of PTT was implemented as a single conglomerate entity (i.e., transmission, distribution pipelines and gas trading businesses were not unbundled before it was privatized) without further liberalization in the natural gas sector. Recently, this corporatization process was at odds when the Supreme Administrative Court ruled on its legality (a rather similar judgment to the EGAT 2005 judgment). However, in December 2007, the SAC ruled out a potential de-corporatization on the grounds that it would jeopardize the Thai financial sector and stock exchange market.

3. Investment Prospects

Major investment prospects in the energy sector including expanding power generating capacity through either EGAT public investments, major private sector participation (IPP bids), or through smaller scale and community-based investments, basically in renewable energy and alternative energy projects.

Power plants – According to PDP's power demand forecast, 30,532.6 MW of new generating capacity would be required during the period 2007-2021. EGAT will supply 50% of the new generating capacity. Thus, during 2011-2021, EGAT will need to build 16 new power plants. According to EGAT's PDP, there will be eight new natural gas/LGN fueled power plants, four coal-fueled power plants and four nuclear power plants. The remaining capacity will be supplied by electricity imports and private sector investment through competitive bidding for new generation capacity under the second (current) solicitation of IPP program. On December 2007, this new generating capacity was awarded to three bidders, out of the original list of 15 proposals. The three, two foreign ventures and one Thai company, are committed to building four power plants accounting for 4,400 MW and to supply power between 2012 and 2014.

Renewable and alternative energy projects – The Board of Investment introduced new incentives to encourage private investment into these projects. Measures included the following: special adders to regular tariffs, soft loans, tax incentives, and investment promotion schemes.

The Department for Alternative Energy Development and Efficiency (DEDE) estimated a solar energy potential of an impressive 5,000 MW of installed capacity, including photovoltaic and thermal units. However, particularly in regards to PV units, Thailand still lacks a landmark investment. This is a result of many factors, including the high cost of available technologies. Thai solar cell manufacturers are very few and the industry still relies on expensive foreign technologies. Most players in the industry are assemblers which import the equipment from foreign suppliers to assemble in Thailand. However, the industry is starting to move toward indigenous production. In an attempt to offset this situation, the Thai Government allowed a much higher adder for solar energy power tariffs compared to other RET's (ThB 8/kWh).

The EPPO recently increased the adder for wind energy by ThB 1, up to ThB 3.5 /kWh, which aims to encourage private investment in the sector. Indeed, investment in wind energy is likely to emerge in Thailand with the first high-level investment: three wind farms with a combined capacity of 220 MW in the northern Isaan province of Mukdaharn were granted promotion certificates by the BOI in late 2007. Other projects could materialize in the southern provinces of Songkhla and Nakhon Si Tammarat, near the gulf coast.

After a sluggish year in 2006, biofuel consumption rose considerably in 2007, with biodiesel use skyrocketing over 1,000%, sending strong market signals. Biodiesel and bioethanol demand are expected to rise in the next five years as the fuel flexible vehicles market expands, gasoline 95 is prohibited and biofuel prices are heavily subsidized. Thailand indigenous reserves

for biodiesel such as jatropha offer strong potential in terms of productivity, lower labor intensity and environmental conservation.¹⁵

However, it is still questionable whether many of these renewable energy projects are commercially viable without heavy government subsidy. Besides, other viable types of renewable energy such as biomass, municipal wastes and waste water processing, still remain insufficiently tapped.

Additionally, DEDE announced it will pledge ThB 125 million, or nearly US\$ 4 million, during 2008-2010, to upgrade the mini and micro hydropower plants network.

Lastly, but not less important, the 4,000 MW nuclear program is on track but will require a large multi-billion dollar investment and technology transfer. Currently, the scale of the investment remains impossible to assess so far.

4. Key Issues

Globalization challenges – Thailand's energy sector is under increasingly strong pressure from the global energy situation. The key issue for the country is to find a balance between competitiveness, sustainability and supply security. Specifically, Thailand, and many other countries, face threats brought on by soaring oil and gas prices, momentous demand, rising concerns about climate change and the scarcity and reliability of suppliers.

Sustainable development of the energy sector requires a combination of innovative solutions in developing and financing renewable energy, the participation of private sector and communities, good governance and a reliable supply-side regulatory environment. Equally important is demand side management. Efficient pricing mechanisms provide sound market signals and help to adjust levels of consumption. In addition, behavior-oriented public campaigns and debates are needed in order to maximize energy savings and efficiency.

Achieving balanced energy portfolio – Thailand is facing the challenge of double dependence: it not only relies heavily on energy imports but it also on a single domestic source of energy. This entails high risks for the country to become dependent on foreign suppliers of two sources of energy, namely NG and oil. Further diversification is necessary for the country to achieve a more balanced energy mix.

¹⁵For further details see Joseph B. Gonzalves, An assessment of biofuel industry in Thailand, UNCTAD, 2006 http://www.unctad.org/en/docs/ditcted20067_en.pdf

Renewable energy sector development – Thailand's renewable energy industry is in a nascent stage. Major barriers to development are the lack of technology, trouble connecting to the supply grid, expertise, and the availability of capital and private sector participation. The financial sector should be encouraged to support growth of renewable energy projects in a sustainable manner. Government should limit involvement.

Regulatory framework, fair competition and rational pricing – Power and natural gas industries in Thailand are still characterized by a monopolistic structure. The privatization of EGAT and further liberalization of the electricity sector is delayed. EGAT, MEA and PEA still retain monopoly control over power generation and distribution businesses. EGAT can also dominate the market as the single buyer in the electricity sector. In natural gas sector, PTT still has a monopoly and considerable market control in natural gas. Similar to EGAT, PTT is also a single buyer and seller of gas production. Such structures in both industries suggest that the current electricity and natural gas industries are less than efficient.

Many attempts to liberalize and privatize the energy subsector have failed due to governance issues; for example, the lack of a clear regulatory framework to complement the privatization process, and the lack of transparency in the corporatization process. The implementation of the new Energy Act is an important requirement to clearly separate the regulatory from policy functions; thus, helping to create a level playing field for competition, proper use of monopoly control, and an environment for consumer protection.

There is strong government intervention in pricing of electricity, and for oil and gas products. In the electricity and natural gas industries, the market is not liberalized; therefore, government intervention is required to regulate prices. In the oil sector, government intervention aims to stabilize the effects of global oil price fluctuations; however, this intervention is sometimes susceptible to political meddling. Appropriate pricing policies must ensure that consumers are sent sound market signals. In this regard, there is still great need for a truly independent regulator to enforce long-term transparency in pricing mechanisms. Before, although the acting public regulator EPPO was deemed to have enforced rather rational (non-political) reviews of EGAT pricing,¹⁶ it still remained under the direct jurisdiction of the Energy Ministry, sole shareowner of EGAT. Although it remains to be seen how well the new regulatory body will fulfill its mission, its establishment provides promising signs for a better-regulated industry, and for improved transparency of major decisions in the sector.

¹⁶See Pei Yee Woo, Independent Power Producers in Thailand, Program on Energy and Sustainable Development Working Paper #51, August 2005, Stanford University, http://pesd.stanford.edu/publications/ independent_power_producers_in_thailand/





1. Sector Overview

At present the telecommunications sector in Thailand is dominated by mobile communications. There are about 43 million mobile subscribers versus approximately 7 million fixed lines. Furthermore, growth in the mobile market remains strong (3.6 million net additions during Jan-March 2007) compared to the fixed segment, which is stagnant. Broadband network infrastructure is growing rapidly, but is still insignificant.

Fixed line network – At the end of 2007, Thailand's total number of line capacity was 8.73 million. The total number of lines connected was 7.2 million, or around 82% of line capacity. In 2007, the tele-density rate was 11.47 lines per 100 residents.¹⁷ In 2001, the ratio was 9.75 lines per 100 residents. The penetration rate has been sluggish in recent years with an increase of 2.3% during the five-year period of 2001-2006. This is largely due to exponential growth in the cellular mobile service market.

There are currently three providers of fixed line telephone service: TOT Corporation Public Company Limited (TOT), True Corporation Public Company Limited (True) and TT&T Public Company Limited (TT&T). In 2007, TOT had the largest share of overall fixed line services at 57.73% of the total market. The second largest player was True with a 25.84% market share. TT&T has the lowest market share at 16.43%. In metropolitan areas, there were only two service providers, True and TOT. True holds the largest market share serving 52.73% of the metropolitan market. TOT and TT&T serve the provincial areas, the former leading the market in the provincial area with a 67.78% share. Another major player in fixed line services is CAT Telecom Public Company Limited (CAT), which is the sole international phone service provider in Thailand.

Mobile phone services – As of March 2007, the total number of mobile subscribers was 43.5 million with a penetration rate of 66%.¹⁸ The mobile communications market has enjoyed substantial growth in recent years with a compounded annual growth rate from 2001-2006 more than 80%. The ratio of mobile phone subscribers per 100 inhabitants was 40.1 in 2001. In 2007, growth in the mobile sector remains strong with 3.6 million net additions during January-March 2007.¹⁹ In addition, mobile services have greatly improved access for the rural areas, revealed by the extensive service coverage of the main mobile service provider AIS.²⁰

¹⁷The teledensity rate is calculated based on 2006 population at 62.8 millions.

¹⁸Business Monitor International Ltd., Thailand Telecommunications Report Q3 2007

¹⁹Business Monitor International Ltd., Thailand Telecommunications Report Q3 2007

²⁰AIS website (http://www.gsmworld.com/cgi-bin/ni_map.pl?cc=th&net=ad)

There are currently six mobile service operators. The three largest are Advanced Info Services (AIS), Total Access Communication (DTAC) and True. AIS is the largest player in the market, with a market share of 48.43% in March 2007. The second largest market share belongs to DTAC (30.73%) and True (18.76%). AIS has enjoyed the largest market share, although its market share has been falling in recent years.

The mobile services segment is highly concentrated: the three corporations (AIS, DTAC, and True Move) hold approximately 98% of total subscriptions. In fact, the two market leaders (AIS and DTAC) have about 79% of the subscribers, arguably creating a potential for duopolistic firm behavior. However, at this time, there is little indication of ownership concentration limiting output. The sector saw declining levels of "average revenue per unit" (ARPU) for mobile operators and strong growth in the number of subscribers: about 3.6 million net additional subscribers just in the first quarter of 2007.



Source: TOT

AIS

48.43%

Internet access - As of June 2007, there were 59 licensed internet service providers (ISP). In 2006, there were approximately 2.4 millions internet service subscribers and 8.4 millions internet users. The growth rate of internet users between 2005 and 2006 was around 13%. The ratio of internet subscribers per 100 inhabitants was 3.81. However, the ratio of internet users might reflect a better picture of the population's access to the internet. In 2006, the number of internet users per 100 inhabitants was 13.07. The internet service provider with the largest market share is True, holding approximately 1.23 million subscriptions or around 17% of the total market.

Source: Market Report, 1st Quarter, 2007, NTC

For broadband internet, the size of the sector is still small with 105,000 subscribers in 2006; however, broadband service is growing rapidly. The year-to-year growth rate was more than 700% from 2003 to 2004. The number of users should be much higher than the number of subscribers; however, official data is not available. According to True, the largest broadband internet service provider, its number of broadband internet users was 442,728 in 2006. Aside from True, there are several other broadband internet service providers. Most of the service providers are major telecommunications companies in Thailand or their subsidiaries. The main players in broadband are: True Corporation, Advanced Datanetwork Communications (a joint venture between AIS and TOT), TOT and TT&T plc. The two biggest service providers in Bangkok area are TOT and True, which have their own optical fiber cable networks in Bangkok and the vicinity. True has the largest market share of 85%. Most users are limited to the urban population and those with a high income levels. It is expected that broadband internet will continue to experience speedy growth as prices go down and demand for a system that can accommodate multimedia content continues to increase. Currently, the price of broadband service is in the range of ThB 299 – 1,000 per month. The actual and potential internet technologies are as follows: (a) asymmetric digital subscriber line (ADSL), which uses the local telephone network; (b) fiber optic cable; and (c) broadband wireless access (BWA) technologies such as mobile 3G and WiMAX.

Types	20	06	2001		Annual	Annual
	Subscribers	Per 100 inhabitants	Subscribers	Per 100 inhabitants	Growth Rate (01-06) (Total # of subscribers)	Growth Rate (01-06) Penetration Rate
Total Telephone Lines	47,888,900	73.95	-	-	-	-
Fixed Telephone Lines	7,073,400	10.92	6,049,100	9.75	3.2	2.3
Mobile Cellular	40,815,500	63.02	7,550,000	40.1	40.1	85.2
Internet Subscriber	2,403,700	3.81	-	-	-	-
Internet User	8,465,800	13.07	-	-	-	-
Broadband Internet	105,000	0.16	-	-	-	-

 Table 14: Telecommunications Sector Indicators in 2006

Source: ITU

The telecommunications subsector is drastically changing: mobile communications is a substitute for fixed, voice-over-internet is a substitute for traditional telephony, and video over the internet all create new possibilities for video distribution. Internationally, many firms are interested in becoming "triple play" businesses, providing voice, internet and television services. In this context, it is important to note the high level of concentration in Thailand's telecommunications sector in both the fixed telephony and broadband access segments with only three to four players in each market. Because of this concentration, one must take into account the potential for abuse of market control in licensing and other regulatory policies.

2. Policy and institutional framework

The government's policy is to increase service coverage in telecommunications, especially for fixed lines and internet access, and to bridge the digital divide between the urban and rural areas. Liberalization of the sector is also an important pillar of development of the sector. The development of telecommunications is guided by a Telecom Master Plan for 2005-2007. The government's strategy focuses on five facets of the telecommunications sector: (e-government, e-commerce, e-industry, e-education and e-society), which will provide a strong foundation for the development of a knowledge-based economy. A series of measures has been introduced to achieve this goal, such as the provision of affordable computers, reduction of internet fees, and expansion of basic telephone services. For example, the hourly charge for broadband internet has decreased to ThB 4 and the minimum monthly charge is ThB 299.

Historically, the telecommunications sector in Thailand was dominated by two state-owned enterprises, TOT and CAT. TOT and CAT acted both as service operators as well as regulators supervising their concessionaires. A significant transformation in the institutional landscape of the sector occurred in 2004 with the establishment of the National Telecommunications Commission (NTC) as a result of the 1997 Constitution, which provided for liberalization of the sector. In the new governing structure, policy-setting, regulatory and operational functions were clearly established. The Ministry of Information and Communication Technology (MICT) sets policies and also supervises TOT and CAT. The National Telecommunications Commission (NTC) acts as an independent regulator. NTC also has a policy-making role in formulating a master plan on telecommunications development. NTC's regulatory functions include granting licenses, spectrum management, supervising network usage and network connection, controlling the standard of networks and equipments, allocating radio frequency, consumer protection, ensuring fair competition, and enforcing the law. In the August 2007 national referendum, it was proposed that NTC merge with the National Broadcasting Commission (NBC), another independent regulatory body yet to be established. NTC and NBC shall form a single independent regulatory body called the National Broadcasting and Telecommunications Committee (NBTC), which will regulate the entire telecommunications sector including voice, content and frequency activities under one umbrella.

Since its establishment, the NTC has set criteria for the allocation of phone numbers and temporary measures for radio and frequency allocation. The NTC has issued six telecommunication licenses to TOT and CAT. The granted licenses cover the existing services provided by the two operators. NTC has also issued several more licenses to other infrastructure-based telecom service providers. As of 2007, it has issued 14 licenses for network and service providers under a type three telecommunications business license.²¹ A clearer regulatory framework for the operation of internet service providers has also been established, including licensing criteria, license fees, and interconnection charges.

Since the sector was liberalized, the market contains players from both state-owned enterprises and private organizations. TOT and CAT became corporate, in 2002 and 2003, respectively. They now have public company status, but 100% of their shares are still owned by the state and their activities are directed by policy set by MICT. It is still unclear how the privatization plan for both enterprises will proceed.

Agency	Policy	Regulation and Monitoring	Implementation
Ministry of Information and Communication Technology	✓		
National Telecommunication Commission	✓	\checkmark	
TOT Corporation Public Company Limited			~
CAT Telecom Public Company Limited			~
Private Sector			✓

²¹Type three includes telecommunications network providers and service providers with their own network for lease and whose services may have impact on general public interest.

3. Sector performance and international comparison

Access to telephone services, both fixed as well as cellular, is no longer an issue for the development of telecom infrastructure. Although access to fixed telephone lines in areas outside of Bangkok and the vicinity is still low, the high penetration rate of mobile services has largely filled the gap. As a result, the majority of the population has relatively adequate access to voice telecommunications services.

The penetration rate for fixed telephone lines per 100 residents was 10.92 in 2006. In comparison with other countries in the region, the rate is still low. Although the mobile phone market has been experiencing rapid growth, the penetration rate is somewhat lower than neighboring countries like Malaysia, or more advanced economies like Singapore, Japan. However, looking at the situation more closely, access to both fixed as well as mobile telephone services is no longer a priority concern. Mobile has become an effective and cost-effective substitute for fixed telephone service. Also, part of why the penetration rate is low for fixed lines is in fact because of limited demand rather than inadequate supply. The penetration rate of mobile services at 66% in 2007 coupled with AIS's extensive service coverage and continual strong growth in the mobile market indicate a relatively well-matured sector.





Source: ITU, 2006

Figure 48: International Comparison of Mobile Phones Penetration Rate, 2006



The digital divide is an issue for the development of telecommunications infrastructure. In 2007, the number of fixed telephone lines per 100 inhabitants was 40.76 in Bangkok and the vicinity, while the rate was 6.79 in provincial areas. The ratio between the urban and rural penetration rates, or what is referred to as the digital divide, was 6.79. With a predicted increase of connected lines in 2008, the digital divide should continue to decrease to 5.75 in 2008. However, the digital divide has less implication on telephone services given that mobile services have become an effective substitute for fixed lines. However, the unavailability of fixed telephone service in some more remote areas will have a stronger implication on the digital divide with respect to broadband access.



Figure 49: Urban and Rural Telephone Penetration Rate, 2006

Source: TOT and Department of Provincial Administration

Thailand generally has competitive and affordable prices for telephone service. A flat rate of ThB 3 is charged for local calls. There are several pricing schemes for mobile services to accommodate consumers with different usage patterns. Compared with other countries, Thailand has lower costs for mobile phone services. In 2005, the price of a three-minute local call using a cellular line on a prepaid system was US\$ 0.05, while the rates in Singapore and Japan were US\$ 0.14 and US\$ 0.52, respectively. For international calls, Thailand's tariff rate is higher than in many countries but lower than China's. However, the indicator on the cost of international phone services may not fully reflect the current situation. For example, due to recent policy direction from the government which instructed TOT and CAT to reduce fees on international phone calls, rates of international phone calls to the United States (via the 007 and 008 dial code) was reduced to ThB 5-9 per minute. An international phone call via internet network also has a much lower cost. CAT's rate for international calls made via the internet is ThB 0.91 per minute.



Source: IMD World Competitiveness Year Book, 2007



Figure 51: International Comparison of Costs of International Phone Calls

Source: IMD World Competitiveness Year Book, 2007

Access to the internet in Thailand is considered low when compared with other countries in the region. In 2006, the number of internet users per 100 people was only 13.07, while the number in Malaysia and Japan was 43.77 and 66.27, respectively. There is still a large gap to improve the country's internet access. Moreover, according to the IMD World Competitiveness Year Book 2007, Thailand ranked 49th out of 55 countries in number of internet users. Access to broadband internet is also very limited, reflecting the nascent stage of the market.

Before 2006, CAT had a monopoly on international internet gateway (IIG) services and charged relatively high prices to internet service providers. Such high costs charged on the use of international bandwidth and access to the IIG translated into high costs for internet services. The costs of internet services had been uncompetitive when compared with other countries. However, in 2006, the internet gateway fee was substantially reduced and the market on IIG services was opened to new competition. Consequently, prices for internet services in Thailand has become much more competitive (see Box 2).



Figure 52: Penetration Rates for Internet and Broadband Internet, 2006

Source: ITU, 2006

4. Private-sector participation and privatization

Thailand's telecommunications sectors was characterized by a duopolistic structure up until the 1990's, when increasing private participation took hold as state monopolies began to grant concessions to private operators. Traditionally, TOT owned a statutory monopoly in domestic telephone services while CAT had a monopoly over the provision of the IIG and internet services. In the 1990's, in response to rapid demand growth, TOT and CAT began to grant several concessions to private companies on a BTO contract basis. The concessionaires have an obligation to invest in the network and share revenue arising from their operations in exchange for the right to operate the system for a certain period of time. In fixed line services, concessions were granted to two private operators, True and TOT.

For mobile phone services, in 1990, TOT granted the concession to AIS while CAT granted the contract to UCOM (later TAC and DTAC). The two private companies have since established themselves as leaders in the mobile phone market. New competitors entered the market later in the early 2000's.

The two state-owned enterprises continue to control large shares of the market, particularly in traditional fixed-line and international long-distance services, while the private sector has been more active in emerging sectors such as mobile, internet and satellite services. In recent years, the market has also been penetrated by foreign telecommunications companies. In December 2005, the Telecommunications Business Law was amended which effectively raised the limit of allowable foreign ownership from 25 percent to 49 percent. In 2006, the two largest mobile operators, AIS and DTAC, were bought by Singapore-based Temasek and Norway's Telenor AS, respectively.

5. Investment prospects

There is large investment potential in the telecommunications sector, especially given rapid technological change and continual need to upgrade the system. As telecommunications technology converges with other media, investment is needed in new technology, such as 3G and broadband. In addition to investments in new technology and network coverage, there will be a recurring need to invest in maintenance of the system. The two state-owned enterprises, TOT and CAT, are likely to continue to play major roles in new investment, especially in the form of joint-ventures. With liberalization of the market, foreign players will become more present. To facilitate new investment and telecommunications sector development, regulatory issues have to be clarified to increase business certainty.

6. Key issues

The development of the telecommunications sector is closely linked with national competitiveness. It impacts on various facets of sustainable economic development such as energy efficiency, international trade competitiveness and human resources development. It is also instrumental in national security and the support of democracy through a free press. Despite the pivotal role of the telecommunications sector, there are several issues that need to be addressed in order for the sector to achieve its economic and social objectives.

Broadband access strategy – One of the most important emerging issues is a broadband access strategy for non-urban areas or more comprehensively, the broader broadband wireless access (BWA) strategy. The rural versus urban issue will be an important one with respect to broadband access. Wireless technologies offer the best potential for a cost effective roll-out of broadband in smaller or less dense markets. A strategy for BWA is needed.

Market structure – At a broad level, the market has been functioning fairly well given the consistent fast growth in mobile services and the decreasing prices. However, there are some distortions because of the revenue sharing arrangements and network interconnection arrangements resulting from the concessions. Looking forward, there is a potential for problems in the way the market functions because of concentration of ownership in the sector.

Regulatory framework – The NTC has brought much needed regulation to the sector and important benefits to the public. However, its effectiveness has been limited by several factors, and it still needs to address and implement actions on a larger scale. Investment is discouraged or delayed because of several factors related to uncertainty in the regulatory environment, specifically, untimely appointments of commissioners, delays in BWA authorizations, foreign ownership, and proposed legislation to establish a telecommunications and broadcasting regulator in place of the NTC.

Regulation of Thailand's telecommunications sector needs to address a challenging strategic agenda that includes:

- Regulatory processes that emphasize transparency and public consultation in order to reinforce legitimacy and minimize regulatory risk. The NTC should constantly be subject to public scrutiny. Information on policy decisions and operations should be disclosed to the public.
- Fair competition and consumer protection in the context of high concentration in the sector
- Timely deployment of new technologies
- Convergence in the sector. In the case of radio spectrum management, the convergence of different radio technologies onto the same spectrum bands, as is the case for mobile and broadband wireless access, argues for an approach to radio spectrum management that is technology neutral.
- The digital divide between rural and urban access to service. Given substantial success in providing rural access to mobile telephone services, a key emerging issue is rural access to broadband. Given the inherent advantages of radio technologies in providing telecommunications services in low density areas, a strategy for authorizing broadband wireless access will be important.
- Regulation on foreign ownership should be reviewed in order to achieve the appropriate balance between foreign and domestic investments.

TOT's future – TOT Corporation remains 100% state-owned. Its main business is the provision of fixed lines, a mostly stagnant market segment. Its overall ability to cover its operating expenses has become significantly dependent on revenues from its concessionaires. TOT's profitability is at risk. However, it also has one of the most extensive national networks that can be used to develop broadband infrastructure. How TOT positions itself will play a potentially large role on the development of the sector.

Box 2: CAT Telecom Reduces Internet Gateway Fees Source: TeleGeography, 13 December 2006

CAT Telecom will cut fees for its international internet gateway (IIG) services by up to 63%, as a reaction to an influx of new competition. The Thai state-run telco's board yesterday approved a rate reduction of between 18% and 63%, including an average 30% cut in IIG costs for ISPs. Until recently CAT had a monopoly on IIG provision, but the National Telecommunications Commission decided in January 2006 to allow private firms entry into the market. In May it announced the award of IIG licenses to Advanced Datanetwork Communication (ADC) and True Corp. ADC, which offers broadband services including multimedia content, is a joint venture of the country's mobile market leader Advanced Info Services (AIS) and state-run fixed line telco TOT Corp, while retail broadband market leader True offers a full range of fixed and mobile telecoms services. The following October the regulator awarded another IIG licenses to ISP CS Loxinfo, Thailand's largest dial-up ISP. The IIG licenses are 'type 2' concessions (for operators with or without their own networks) allowing the leasing of international bandwidth from foreign operators to provide services to local ISPs via CAT's domestic links. A group of nine Thai ISPs, including Jasmine Internet, also announced a plan to apply for a joint IIG license.





V.WATER, SANITATION & LOW-INCOME HOUSING SECTOR

This chapter covers the following four main subsectors: piped water, waste water management, solid waste management, and low-income housing.

1. Water

1.1 Subsector overview

The supply of piped water service in Thailand is the responsibility of different agencies in each service area. There are two main agencies responsible for providing piped water, the Metro-politan Waterworks Authority (MWA) and the Provincial Waterworks Authority (PWA). MWA and PWA are responsible for sourcing, production and distribution of water. In addition, the government, through local authorities, supplies non-piped water to rural populations. Some areas are also served by private water suppliers.

Bangkok and vicinity: MWA is responsible for providing water service in Bangkok and its vicinity. In 2006, MWA's production capacity reached 5.52 million cubic meters per day. Water production and distribution capacity is 1,699.7 million cubic meters for the whole year or 4.66 million cubic meters per day. MWA's water sales were 1,173 million cubic meters in 2006. The rate of water loss along the pipe and distribution line was around 30% in 2006. MWA has 1.75 million subscribers covering around 7.79 million people. Water is delivered through MWA's pipe network covering around 95% of the responsible area or 91% of the population served. Average monthly water consumption per customer is 55.69 cubic meters. The average water tariff rate is 12.0 Baht per cubic meter.

Provincial area: PWA provides water services in 73 provinces. In 2006, there were 2.48 million subscribers covering around 10.66 million people or 96.42% of the total population in responsible areas. In 2006, PWA's water production reached 981 million cubic meters per year and water sales were at 722 million cubic meters. The rate of water loss along the pipe and distribution lines was 26.31% in 2006. An average water sale is 25.146 cubic meter per customer per month.

Figure 53: Water Services by MWA



Figure 54: Water Services by PWA



Source: Metropolitan Waterworks Authority

Table 15: MWA Service Information

	2002	2003	2004	2005	2006
Water users (# of subscribers)	1.49	1.54	1.61	1.68	1.75
Population serviced (million)	7.72	7.82	7.63	7.71	7.79
% of population serviced	86.4	87.5	89.5	90.3	91.1
Production (million m ³ /day)	1,505.0	1,516.1	1,538.3	1,628.1	1,699.7
Sales (million m ³ /day)	1,013.9	1,076.0	1,121.0	1,173.0	1,013.9
Water loss (%)	35.7	33.1	30.1	30.5	30

Source: Metropolitan Waterworks Authority

Table 16: PWA Service Information

	2002	2003	2004	2005	2006
Water users (# of subscribers)	1.85	1.97	2.12	2.31	2.48
Population serviced (million)	9.27	9.84	9.56	10.38	10.66
% of population serviced	86.00	93.10	88.77	95.92	96.42
Production (million m ³ /day)	739	750	827	909	981
Sales (million m ³ /day)	515	550	606	678	722
Water loss (%)	27.52	26.62	26.63	25.26	26.31

Source: Provincial Waterworks Authority

Figure 55: Access to Water in Rural Villages in 2007



Source: Database of the National Rural Development 2 C (NRD 2C), The Community Development Department, Ministry of Interior

Rural areas: For areas that are not served by MWA and PWA, mainly rural areas, four government agencies, namely, the Department of Public Works and Town and Country Planning, the Department of Health, the Department of Mineral Resources and the Accelerated Rural Development Office are responsible. According to the latest survey by the Ministry of Interior in 2007, there were 69,763 villages in the rural area. Approximately 78% of total villages, or

54,447 villages, had access to piped water, while 15,316 villages did not. Among these villages, there were 89,244 installed piped systems, 81,828 of which (or 92%) were in use at the time of the survey. For villages without installed piped water systems, water is connected from nearby villages.

According to the survey, 7,613,674 households from a total of 7,926,620 in villages and communities countrywide have access to clean drinking water. This represents 96.66% of households. The average volume of drinking water consumed is five liters per person per day with two liters for drinking and three liters for other purposes.

Industrial areas: Water in industrial areas is supplied by the Eastern Water Resources Development and Management Public Company Limited (East Water) and the Industrial Estate Authority of Thailand (IEAT). East Water is a public company established by PWA in 1992. It provides raw water supply and a range of water services (tap water, drinking water, and piped water business) to industrial operators in the eastern region. As of 2006, East Water had 328 millions cubic meters of water distribution capacity. The total volume of water distributed in 2006 was 199.36 million cubic meters. The company has a total of 307 kilometers of water pipelines with a capacity to distribute 423 million cubic meters of water per year. East Water has two subsidiaries responsible for providing tap water to the eastern region. In 2006, the combined tap water production capacity was 98.68 million cubic meters. The total amount of tap water distributed was 39.45 million cubic meter per year. The rate of water loss was less than 20%.²² The Industrial Estate Authority of Thailand (IEAT) also provides water services in many industrial zones.

Given the current level of water allocated and the rising demand for water in the region, it is forecasted that the industrial estates along the eastern seaboard might face water shortages in the near future. The current level of piped water allocated for industrial use is 145 million cubic meters per year. However, demand was forecasted to reach 232.19 million cubic meters per year in 2013. Additional water supply will be needed to appropriately respond to potential water shortages in the area, which is the industrial center of the country.

Table 17. Tiped water Demand in the Eastern Region				
Piped water Demand (million m ³ /year)	2003	2013	2023	
For consumption	28.13	72.37	118.42	
For Industrial Use	111.67	159.82	221.40	
Total	139.80	232.19	339.82	
Allocated	145.00	145.00	145.00	
Excess (Shortage)	5.20	(87)	(195)	

Table 17: Piped water Demand in the Eastern Region

Source: Water Management Plan

²²East Water Resources Development Management Annual Report 2006

Water pricing: MWA and PWA uses a cost-plus pricing method to set the price of piped water. The price of water varies according to different categories of user, such as residents, state enterprise, commercial, and industrial. The water tariff is set progressively varying with volumes of water consumed. Water tariffs of MWA and PWA are set separately. On average, MWA's rate is slightly higher than PWA's rate. In 2006, the average water tariff for MWA and PWA was 12.00 Baht per cubic meter and 11.75 Baht per cubic meter respectively. MWA's water charge is adjusted every year to reflect the increase in the costs of production. However, PWA has not adjusted its water price since 1998 due to the government's price control policy. Since 1998, PWA's water price has been controlled and the average water tariff is ThB 11.75 per cubic meter. The controlled price has been well below actual cost per unit of water sold as shown below. In addition, there is a cross-subsidy among PWA's different groups of water users. Water sold to residential customers is priced much below cost while water sold to government agencies and small businesses is priced at commercial level. Profit made from industrials sales are used to subsidize losses incurred from residential sales.











For piped water supplied by municipal authorities in areas not covered by PWA, most municipalities collect a fixed rate of ThB 4-5 per cubic meter.²³ There is a large difference between PWA's rate and tariffs set by other service providers. This might be explained by PWA's pricing method, which sets a uniform water tariff rate in all operating areas despite differences in costs of water production in each area.

For raw water tariffs, East Water's prices vary according to costs of raw water supply in each area. Tariff ranges from ThB 0.50 to 1.00 per cubic meter.²⁴

²³NESDB, A study on Infrastructure Development Strategy for Enhancing Competitiveness, 2004
 ²⁴NESDB, A study on Infrastructure Development Strategy for Enhancing Competitiveness, 2004

1.2 Policy and institutional framework

The major policy goal in the water sector is to provide piped water for every village by 2008, to be in line with the UN Millennium Development Goals. MWA and PWA also aim to expand the service area. Other policy targets include reducing water losses and groundwater usage in Bangkok and industrial areas, promotion of efficient water usage, and expansion of clean water services in important tourist areas.

In the water sector, policies are formulated by three agencies which are responsible for different areas of the water system. The Department of Water Resource is responsible for national water policy. Groundwater policy is the responsibility of the Department of Groundwater Resources. The Royal Irrigation Department is responsible for agricultural water policy. The Water Regulatory Commission (WRC) is planned as an independent regulatory agency to regulate the water sector. As the Commission is still to be established, the regulatory functions currently lie with the policy agencies. There are several implementing agencies responsible for providing piped water, raw water and ground water supply in different areas of the country. Water service providers come from several agencies: state-owned enterprises like MWA, PWA and IEAT, line agencies such as the Department of Public Works and the Department of Mineral Resources, as well as the private sector, such as East Water. MWA and PWA supplies piped water in the urban and suburban areas. The Department of Public Works assists 117 municipalities not served by PWA to produce and distribute piped water. The Department of Mineral Resources provides services in the construction of artesian wells for rural villages. The Department of Health provides rural piped water supply for villages in remote areas.

Agency	Policy	Regulation and Monitoring	Implementation
Department of Water Resources Ministry of Natural Resources and Environment	~		
Department of Ground Water Ministry of Natural Resources and Environment	~		
Royal Irrigation Department Ministry of Agriculture and Agricultural Cooperatives	~		
National Waterworks Policy and Monitoring Commission		✓	
Metropolitan Waterworks Authority			~
Provincial Waterworks Authority			✓
Department of Public Works and Town & Country Planning, Ministry of Interior			√

Agency	Policy	Regulation and Monitoring	Implementation
Department of Mineral Resources Ministry of Natural Resources and Environment			~
Department of Health, Ministry of Public Health			√
Industrial Estate Authority of Thailand			\checkmark
Private Sector			1

1.3 Sector performance and international comparison

Selected performance indicators include average volume of water use, percentage of population with access to piped water, water loss/leakage ratio, and water tariff.

In 2004, the percentage of the population with access to improved drinking water was 99% of the total population. In terms of distribution of services, the rate of access was slightly higher in the rural area (100%) than the urban area (98%). The access rate in Thailand is considered satisfactory compared to other countries in the region, especially in terms of access for the rural areas.



Figure 58: Access to Improved Drinking Water Sources (%) in 2004

Source: Millennium Development Goals, 2007

Thailand has the highest volume of water use compared to other East Asian countries. In 2003, the average volume of water use was 8.6 cubic meters per household per week in Thailand, while the figure was 6.7 in Indonesia and 4.4 in China. The average water tariff rate for Bangkok in 2003 was US\$ 0.29 per cubic meter which is higher than the tariffs in Shanghai and Hanoi but lower than Beijing. The rate of water loss of MWA and PWA is relatively moderate compared with other major cities in Asia.





Source: Connecting East Asia, World Bank, 2005



Figure 61: Comparison of Water Tariff

Figure 60: Comparison of Water Loss



Source: Asian Development Bank, 2001

Source: Select Indicators of Infrastructure Performance, World Bank, 2006

Box 3: Water Loss/Leakage

During 2001, water loss ratios for MWA and PWA were at 37.30% and 29.69%, respectively. The reasons for the high level of water loss include budget constraints, lower quality pipes, and equipment that exceeds their lifespan.

Both MWA and PWA were able to reduce much of the water loss in order to achieve the target of 30% and 25% by 2006 and 2007, respectively. They repair broken pipes at about 4% of the total length each year and use a district metering area (DMA) system to check for leakages in order to accelerate the repairs. The DMA system can measure water pressure at designated location, where the data is sent to the control room. The rate of flow and pressure is constantly measured, which helps get repairs done in a timely manner. The SCADA and DMA system are also linked for better management of water loss.
1.4 Private sector participation and privatization

Private sector participation in the water sector takes several forms including granting concessions for the supply of water, and lease and management contracts. PWA engages the private sector to participate in the provision of water services by producing and distributing water to PWA in bulk sale specifically in the areas where the government has set targets to reduce groundwater usage. PWA grants two types of concessions: build own operate transfer (BOOT) and build own operate (BOO). As of 2006, PWA had four BOOT projects in Pathumtani-Rangsit, Chachengsao, Bangpakong and Nakornsawan and five BOO projects. PWA granted the first private sector water contract in 1995 to the Pathumthani Waterworks Co., Ltd. to supply tap water in Pathumthani province. The BOOT contract allows the company to be the sole producer and distributor of tap water in Pathumthani and Rangsit area for 25 years. The company invested in the entire construction of the production system and part of the distribution system. Under the contract, a minimum quantity of water sale is guaranteed by PWA and any shortages in the water supply less than the guaranteed amount will be compensated to the company by PWA. In addition to water supply contracts, PWA also has a lease contract with a private company to manage and operate waterworks. PWA also engages private companies under management contracts to provide technical services such as efficiency improvement and leakage control. For areas outside PWA service, concessions must be obtained from the relevant provincial authority. In addition to private participation through concessions, the private entity established by PWA, East Water, has an extensive role in the provision of the water supply. East Water was listed in the stock exchange in 1997 resulting in dilution of PWA's ownership in the company. Nevertheless, PWA is still the major shareholder of the company, holding 40% of shares in 2006.

After the crisis in 1997, both MWA and PWA were initially slated for privatization in 2003. However, the privatization plan for MWA and PWA were later abandoned due to public sentiment against privatization. Privatization of PWA and MWA is not expected in the near future.

1.5 Investment prospects

In the water sector, the investment priority is to expand water services to ensure an adequate supply of water in response to rising demand. Investment will be concentrated mainly in the area served by MWA and PWA. In metropolitan areas, demand is expected to continue to rise due to residential and commercial growth and a demand shift from groundwater supply. According to MWA's projection, existing capacity of water supply will be able to meet rising demand until the year 2011. Additional investment will be needed to prevent water shortages, especially in the eastern area of Bangkok and in Samutprakan province. According to MWA's 8th Plan (2007-2013), production will be expanded at Bang Khen and Mahasawasdi production facilities by adding 400,000 cubic meters capacity at each production site. Additional

facilities are expected to adequately serve growing demand until the year 2017. MWA also plans to invest in an additional 1,000 kilometers of pipeline to extend the service area. The total investment during 2007-2013 is estimated at ThB 7,800 million. Financing will be drawn from MWA's earnings (48.8%), while domestic and foreign loans will fund about half the total. Planned investment is expected to provide an additional 200 km² of service area, equivalent to 1.6 million people.

For PWA, investments are planned for upgrading and expansion of existing infrastructure which were transferred from local governments. Major investment projects for PWA will be on pipeline improvement, pipeline extension to increase service area coverage, and development of water sources. In addition to investment in service improvement and expansion, quality and quantity of raw water will become a major issue in piped water production. Therefore, future investment will also be channeled to construct and develop water sources to secure sufficient raw water supply. Despite growing investment needs, PWA faces certain financial constraints. Currently, more than 60% of PWA's investment budget is subsidized by the government. Whether PWA's investment will depend largely on the budget allocated by the central government in each year.

1.6 Key issues

Service expansion – The future expansion of service by MWA and PWA is inevitable. Growing demand will result from both increasing economic activities as well as the need to replace groundwater usage, especially in industrial areas. Excessive groundwater use in recent years, especially by industry, resulted in over-exploited groundwater resources. To remedy this problem, a groundwater usage charge has been raised and substitution of the tap water supply for groundwater has been promoted by the government. MWA has a goal to reduce groundwater usage by 700,000 cubic meters per day, the equivalent amount of which must be compensated with an alternative water supply. Such reduction goals will put additional pressure on piped water demand.

Reducing water loss - Water loss is also an important issue, especially in enhancing efficiency of water supply. The problem of water leakage is mainly caused by low quality and outdated pipelines. Both MWA and PWA set a goal to reduce water leakage along the pipelines and met with some success. With proper leakage control, the cost of production and unnecessary expansion/investment can be avoided, and longer-run sustainability can be achieved. Reducing water loss should be carried out in parallel with MWA's and PWA's other efficiency improvements.

Water resources – Sources of water, used for the production of piped water for consumption and industrial purposes, is also a crucial issue. In recent years, Thailand has been experiencing

a lower level of surface water and natural water resources. Securing raw water supply will become a major challenge for water service provision in the near future. Particularly in the dry season, insufficient water supply may affect consumption, industry, agriculture, and tourism. This issue, however, has to be addressed in the larger context of integrated water management at the national level.

Investment – Investment constraints are also an important issue in the water sector as in other areas of infrastructure. In PWA's case, a price control policy imposed constraint on its operations and investment capacity, forcing them to rely on government budgets. A pricing policy might need to be reconsidered to increase PWA's operational flexibility and enable them to invest in expanded service coverage and improved service quality, while still maintaining affordability of services. Private participation can play an increasing role in the water sector to complement state investments. Private investment in water utilities can be enhanced, especially to serve industrial and tourism sectors, which has special demand and supply patterns. For example, supplying water to the islands requires special techniques in water production. Demand in these sectors, which are expected to grow significantly, can be served by private operators which have better access to new technology and more flexibility in investment and operation.

Absence of regulatory body – Another obstacle for water sector development is the absence of a regulatory body. As a result, pricing decisions are politically motivated, not reflective of actual economic costs. For example, price adjustments to compensate changes in costs for PWA has not been approved by the Cabinet. As a result, PWA has been operating with persistent losses and inadequate resources for service expansion.

2. Wastewater Management

2.1 Subsector overview

Wastewater is considered wastewater discharged from households and industry. Wastewater discharged by industrial plants must be treated by a plant's own treatment facility. Public wastewater treatment facilities only treat wastewater discharged from households.

The total volume of wastewater discharged by households is approximately 14 million cubic meters per day. Household wastewater discharged from municipalities was approximately 2.5 million cubic meters per day. Bangkok and Pattaya discharges around 2.5 million cubic meters per day. The remaining 9 million cubic meters per day is discharged from areas under control of Tambon Administrative Organizations (TAOs).



Source: Wastewater Management Guidelines 2006-2009, Pollution Control Department, 2006

In 2006, there were 95 central wastewater treatment plants. Seven systems are in Bangkok and owned by BMA. Two plants are located in Pattaya and another 82 plants belong to municipalities around the country. The other three plants belong to TAOs. Capacity of existing systems in operation was 2,318,884 cubic meters per day in 2006. When all the existing wastewater treatment plants become operative, the total capacity will reach 2,969,490 cubic meters per day. The utilization rate of the total capacity currently stands at 60%. However, only 14% of total wastewater generated each day by households countrywide is treated. From the total of 80 plants already completed, only 59 plants are up and running while others are either under repair or awaiting operations to commence. For the majority of the treatment facilities, the utilization rate is less than 50% of the total capacity. Most facilities are under-utilized because network coverage of wastewater pipeline is still not sufficient and some households still have not connected their drainage system with the central system. Thus, wastewater is discharged into public waterways instead of going into the central treatment system. According to the system evaluation done by the Pollution Control Department in 2006, operations of six treatment facilities were below standard. The majority of the systems are stabilization ponds which utilize low-technology treatment systems. Other systems are aerated lagoons, activated sludge and oxidation ditches. The table below summarizes the location and status of wastewater treatment systems in Thailand.

able 16. Elocation and Status of Wastewater Treatment Systems in Thanand						
		Number & Status				pacity
Location	Number	Operating	Under repairs Await Operation	Under construction	Project Delayed	Wastewater Treatment Ca (cubic meters/day)
Bangkok Municipalities, Pattaya and Local Administrative Organizations (LAOs)	7	7	-	-	-	992,000
Central Region	21	15	5	_	1	812,100
Eastern Region	15	11	3	1	-	293,900
Northern Region	17	9	5	3	-	236,088
Northeastern Region	18	9	3	6	-	277,082
Southern Region	17	8	4	5	-	358,320
Total	95	59	20	15	1	2,969,490

Table 18: Location and Status of Wastewater Treatment Systems in Thailand

Source: Wastewater Management Guidelines 2006-2009, Pollution Control Department, 2006 Note: Data as of November 9, 2006

The seven wastewater treatment systems in Bangkok have a maximum capacity of 992,000 cubic meters per day, which accounts for 34% of total capacity in the country. The central region has the second highest treatment capacities at 27%.



Note: Data as of November 9, 2006 Source: Wastewater Management Guidelines 2006-2009, Pollution Control Department, 2006

Currently, there are only four municipalities that collect fees for wastewater treatment. Fees are collected based on types of user. The average fee collected for the four municipalities is ThB 0.6175 million per cubic meter while the average expense for the system operation is

ThB 0.895 million per cubic meter.²⁵ In three municipalities, revenue from users' fees could not cover expenses and wastewater services required subsidies. For the remaining municipalities, no fee was collected for wastewater treatment services. Every municipality is entitled to receive subsidy for operations of the facilities in the first four years at a regressive rate. This might give rise to a sustainability issue once the financial assistance runs out.

2.2 Policy and institutional framework

The role of local government in controlling, preventing, reducing and managing pollution is strongly emphasized. Local and municipal governments are tasked to provide collective wastewater treatment systems in an effective and efficient manner. The policy is based on the principle that polluters should be responsible for providing necessary treatment on pollution they emit. The policy also encourages coordinated efforts among state, private sector and community to manage wastewater.

Policy on wastewater treatment at the national level is set by the National Environment Board as part of the national environmental protection plan. The Pollution Control Committee, a subcommittee working under the Board, will then focus specifically on pollution issues and is responsible for formulating policies for pollution-related areas including wastewater treatment. There are also two line agencies under the Ministry of Natural Resources and Environment (MONRE) responsible for setting policies on wastewater treatment: the Office of Natural Resources and Environmental Policy and Planning and the Pollution Control Department. There are four agencies which regulate different activities in the wastewater treatment system. Department of Public Works and Town and Country Planning (DPT) is responsible for controlling the construction standards of wastewater treatment systems for LAOs. The Department of Industrial Works and IEAT regulate wastewater treatment of industrial plants. The Wastewater Management Authority, which is a state enterprise under MONRE, is an implementing agency and has responsibility in project design, operation and maintenance of the system. Aside from the state enterprise, DPT also carries out similar function in constructing the treatment facilities. Operations of the plants are transferred to LAOs once the construction is complete. Technical and financial support will be provided by the central agency, MONRE, to assist local authorities in running the system.

²⁵ "Solid Waste and Wastewater Management Monitoring and Evaluation Project of Local Administration Organization", Office of Natural Resources and Environmental Policy and Planning (2004)

Agency	Policy	Regulation and Monitoring	Implementation
National Environment Board	\checkmark		
Pollution Control Committee	\checkmark		
Office of Natural Resources and Environmental Policy and Planning	\checkmark		
Pollution Control Department	\checkmark	\checkmark	
Department of Public Works and Town & Country Planning		\checkmark	\checkmark
Department of Industrial Works		\checkmark	
Industrial Estate Authority of Thailand		\checkmark	
Wastewater Management Authority			\checkmark
Local Administrative Organizations			\checkmark

2.3 Sector performance and international comparison

The service coverage ratio for wastewater treatment services in urban areas is only 34%, compared to 100% in high income countries such as Japan, Canada, and Singapore.²⁶ This indicates that the wastewater treatment system in Thailand is still in beginning stages of development. The proportion of water treated to the total amount of wastewater released at 14% in 2006 also paints a similar picture. In terms of affordability, BMA does not charge any tariff for wastewater treatment service in Bangkok. In Had Yai municipality, the tariff for the wastewater treatment service as a ratio to one unit of water tariff is 0.60, much lower than rates charged in other big cities. The absence of a pricing mechanism in wastewater treatment services partly explains the deficiency in wastewater treatment facilities, as there is no financial incentive for investment in the sector.

²⁶NESDB, A Study on Infrastructure Development Strategy for Enhancing Competitiveness, 2004



Source: Wastewater Treatment Plant Rehabilitation Plan, Pollution Control Department, 2003





Source: Strengthening National Financing and Cost Recovery Policies for the Wastewater Management, ADB, PCD, 1999 cited in the Study on Infrastructure Development Strategies for Enhancing Thailand's Competitiveness, Thammasat University, 2004

2.4 Private sector participation and privatization

The private sector participates in water supply mainly as operators while constructions of facilities are fully government financed. Many wastewater treatment systems in Bangkok are operated by private parties (e.g. Chong Non-tri and Nongkhem-Phasi Charoen systems). Several local wastewater treatment systems (under LAOs), for example those in Cha-am, Pattaya, Phuket, are also operated by private sector. The government encourages increased private participation in the sector, primarily as system operators. In addition, there is private participation in joint ventures. The Ministry of Industry, IEAT, and the private sector co-founded a company called GENCO to provide industrial waste treatment services in industrial estates. Services for the project are fully provided by the private sector. The Wastewater Management Authority also has a policy to enter into joint ventures with the private sector and hold 30% or less of the total investment.

2.5 Investment prospects

Further investment in wastewater treatment facilities is expected in order to increase service coverage in the area of Bangkok. There are plans to build wastewater treatment facilities in Klongtoey (360,000 cubic meters per day) and in Thonburi (575,000 cubic meters per day).

Both projects are under feasibility studies. For provincial areas, investment will be made to utilize capacity of the existing treatment facilities. To do this, funding will be used for repair and restore facilities to make them operational. Financial support will also be provided to assist local authorities to operate and maintain the system, and building capacity of local authorities. Training, as part of future investment plans, is crucial for the long-run sustainability of the system and will ensure that the systems are properly managed and maintained.

2.6 Key issues

Financing - One of the most important issue for wastewater treatment systems is financing. Construction is government-funded; thus, the problem has more to do with how to keep the system running once it becomes operational. Often, budgets allocated at the municipal level cannot cover operational and maintenance costs. This often causes a temporary disruption in operations or sometimes permanent suspension of some facilities. Therefore, efficiency of the system is compromised since capacity of existing systems cannot be fully utilized. Closely related to this problem is the tariff issue. Tariff collection in the wastewater sector is a major bottleneck which prevents development of wastewater treatment systems. The current tariffs, where they are collected, do not reflect actual costs of wastewater management and are not based on a polluter-pay principle. Even when the tariffs are in place, tariff collection is a problem. As a result of public resistance toward wastewater treatment projects, tariffs cannot be collected without a community's willingness to pay. Without sufficient financial support, sustainability of the systems cannot be attained in the long run.

Local capacity – There is a lack of the skilled labor required to operate the wastewater treatment facilities, especially at local level. As a result, the systems cannot be operated in an efficient manner and are often operating at higher maintenance costs. How to keep the plants functioning properly and well-maintained are major challenges commonly faced by local administrators once the plants are put in place. There is a need for training and capacity building for staff who operate and maintain the wastewater treatment system.

Public acceptance – There is still lack of understanding among communities regarding the importance of wastewater treatment systems. In addition, there have been complaints and resistance from nearby communities which are environmentally affected by the construction and operation of wastewater treatment systems. Public hearings and Environmental Impact Assessments are often demanded by affected communities, although there is no legal obligation to perform them. Acceptance and understanding for the need of wastewater treatment system and measures to cushion against environmental impact are crucial factors in the sector.

Transparency and good governance – Accountability and transparency when embarking on land acquisition, selection of project locations and technology selection, are necessary to gain public acceptance. Unclear explanations for location selection or selection of outdated or inappropriate technologies reduces credibility for projects and undermines public support needed for implementation.

3. Solid Waste Management

3.1 Subsector overview

Household Waste - In 2006, households around the country generated approximately 14.63 million tons of waste or 40,082 tons per day, representing an increase of 2% from 2005. From the total amount of household waste, only 36% (14,373 ton per day) of total waste is treated according to sanitary standards. The city of Bangkok generated 8,473 tons of waste in 2006 which accounts for 21% of total waste generated. In 2006, 47% of waste was generated outside municipalities while the other 32% of waste, was generated in municipal areas and the city of Pattaya. During 2000-2006, the volumes of waste grew at a marginal rate or an average of 1%. Interestingly, the trend of waste generation for Bangkok saw some decrease in the last two years, especially in 2005.



Source: Pollution Control Department, 2006

In 2006, 3.19 million tons of waste,²⁷ or 22%, of the total waste were recovered. The majority of this amount was recycled, while organic waste was used to produce soil conditioner.

²⁷Data as of October 31, 2006



Note: Data as of 31 October 2006 Source: Pollution Control Department and Pollution Annual Report, Pollution Control Department, 2006

Non-municipal

areas

Muncipalities

and Pattaya

Bangkok

0%

20%

Figure 68: Waste Treated by Location

8.132

Percentage of Waste Treated (tons per day), 2006

1,120

100%

4 780

80%

Not Treated

Treated

17.577



60%

8.473

40%

Hazardous waste Hazardous wastes comprise industrial hazardous waste and household hazardous waste. It was estimated that in 2006, the total amount of hazardous waste was approximately 1.81 million tons.²⁸ The amount of industrial hazardous waste was around 1.41 million tons while the remaining 0.40 million tons was household waste. In terms of sources of hazardous wastes, 49% was generated in Bangkok and the vicinity. It is estimated that most of the household hazardous waste are disposed of with non-hazardous household waste.²⁹ This is partly because collection sites for hazardous wastes are not sufficient and the public is still not familiar with proper methods of disposal. Without a proper collection system and safe disposal behavior, hazardous waste may contaminate the food chain and the environment.

Industrial waste In 2006, the amount of non-hazardous industrial wastes was around 12.66 million tons. Industrial wastes are mostly treated by private waste treatment operators, which provide services to industrial operators. It is estimated that around 50% of the total amount of industrial waste in Bangkok and the vicinity are treated. Some non-hazardous industrial wastes such as packaging materials are re-used. In 2006, the amount of re-used industrial waste was around 8.24 million tons or 65% of the total amount of industrial waste.³⁰

In 2006, there were 117 sanitary solid waste management facilities but only 91 facilities were up and running.³¹ The majority of the facilities are sanitary landfills. Bangkok and the municipal areas have standardized solid waste treatment systems. BMA engages private operators to manage solid waste, including operating waste treatment and landfill facilities, and also to transport waste from the transfer sites in Bangkok to landfills. Around 70% of total waste generated in Bangkok is transferred to the landfill site in Kam Pang Saen, Nakorn Prathom Province, while

³⁰Thailand Pollution Report, Pollution Control Department, 2006

²⁸Data as of October 31, 2006

²⁹Thailand Pollution Report, Pollution Control Department, 2006

³¹Thailand Environment Report 2006, Ministry of Natural Resources and Environment

the remaining 30% is transferred to the landfill in Phanom Sarakham, Chachengsao province. In municipal areas and Pattaya, there are 96 sanitary solid waste treatment facilities which are up and running. The majority of these facilities are sanitary landfills. There are also three incinerators and three facilities that use mixed technologies. In municipal areas, 37% of waste is treated according to sanitary standards, while the remaining is treated by unsanitary means, such as open dumping and open site burning. In non-municipal areas, LAOs are responsible for solid waste management. However, waste management in these areas is usually not up to sanitary standards. Most waste is dumped or burned in open sites as in municipal areas. Only 6% of waste generated in non-municipal areas is treated in sanitary waste treatment facilities. In remote areas, each household is responsible for its own waste.

3.2 Policy & institutional framework

The government's primary aim in solid waste management is to reduce the amount of waste generated. The target set by MONRE is to reduce the rate of waste generated in Bangkok to less than 1 kilogram per person per day. The target rates for municipalities are 0.6-0.8 kilogram per person per day. The target rate at Tambon level was set at 0.4 kilogram per person per day. The government also promotes recycling and waste separation to reduce waste volume. Policy increasingly emphasizes sanitary waste management to gradually reduce unsanitary waste handling (e.g., open dumping and burning) and effective management and control of hazardous waste and substances. Waste management in Thailand is decentralized and local authorities are empowered to manage waste and control treatment facilities. Local authorities are the principal implementing agencies and they are encouraged to take ownership of the facilities. A cluster approach to waste management, which emphasizes utilizing waste benefits, such as composting and waste-to-energy approaches, is promoted by government.

There are several actors in solid waste management. The National Environment Board and the Pollution Control Department are responsible for formulating overall policies on pollution and environmental standards, including waste management. Committee on Hazardous Substances was specifically set up to control hazardous materials. The Pollution Control Department, the Ministry of Public Health and IEAT act as regulators in different areas of waste management. As community-based management of waste is emphasized, implementation functions are decentralized to local governments at local, provincial and Tambon levels.

Agency	Policy	Regulation and Monitoring	Implementation
National Environment Board	✓		
Committee on Hazardous Substances	~		
Pollution Control Department	✓	✓	
Ministry of Public Health		~	
Industrial Estate Authority of Thailand		✓	
Department of Industrial Works		~	
Local Administrative Organization			✓
Provincial Administrative Organization			✓
Tambon Administrative Organization			1

3.3 Sector performance & international comparison

The waste generation rates indicate efficiency in the system reflecting waste reduction and waste recycled. Thailand has a relatively high waste generation rate compared to other countries in the region. In 2007, Bangkok's waste generation rate was 0.88 kilograms per day. The proportion of reused waste is still small, although the indicator has shown a positive trend in recent years. There is a lot of room for improvement in solid waste management in terms of capacity expansion, collection methods, technologies used and promotion of re-use program.





Source: Asian Productivity Organization, Solid-Waste Management: Issue and Challenges in Asia, 2007



Source: Pollution Control Department, Environmental Research Institute of Tokyo ,National Environment Agency of Singapore and US. Environmental Protection Agency 2006

3.4 Private sector participation and privatization

Private participation at the local level varies from location to location and from activity to activity. In some LAOs, Lampang municipality, for example, a single private company handles the whole waste management system (including collection, treatment, and fee collection). In other LAOs, several private companies are contracted to handle different functions of waste management. For example, several private operators are contracted to handle the same collection activity in different areas of a municipality. Some LAOs contract private operators to handle only some part of waste management and operate some activities themselves. There are several forms of private participation in the sector. Some private companies are contracted as operators of the systems owned by the municipal government. Some projects receive investment and are operated by private entities under concession with municipal organizations in the form of BOO, BOT and BOOT. Private sector also participates as service providers in areas such as garbage collection, fee collection, cleaning services and waste separation. Some LAOs, which engage private sector in waste management, are Kanchanaburi, Viengsa, Dan Samrong, Bangplee Yai, Lampang, Praksa, Had Yai, Chiang Mai, and Phuket.

In Bangkok, waste treatment systems are outsourced to private companies, while BMA collects waste from households and businesses. The transportation of waste from transfer to landfill sites and the operations of the landfill sites, are the responsibility of private companies under contracts with BMA. Medical waste facilities are wholly owned and operated by a private company. In addition, BMA also contracts a private company to run its composting plant.

3.5 Investment prospects

A cluster concept of waste management is encouraged by the government. Based on the cluster concept, LAOs in nearby areas cluster to invest in and jointly use a waste treatment center. The center should utilize an integrated system for waste management, for example, by utilizing both composting and waste-to-energy approaches within the center. Investment in waste separation centers and recycling businesses is also encouraged. Private investment in

waste management businesses with sound environmental quality are welcome to complement state investment. There is also a plan to establish a waste information center to disseminate information on best practices and knowledge-sharing on waste utilization.

3.6 Key issues

Budget allocation – Similar to other issues in infrastructure services, budget allocation is a major constraint in the development of an effective waste management system. An insufficient budget results in several waste management facilities operating below sanitation standards and without proper maintenance.

Public resistance - Due to insufficient budget allocation and poor operation, some waste management facilities generate pollution and negative externalities, for example, leakages and smells, onto local communities. Public resistance thus ensues and a vicious cycle is created. Public resistance which is triggered by poor system operations discourages the community to pay for the service. Consequently, insufficient fee collection then leads to lack of funding for the services which in turn resulted in inefficiencies in facility operations.

Institutional capacity building – With decentralization of waste management, most local governments are required to manage the waste of their local communities. However, local government may lack expertise and experience in sanitary solid waste management and hazardous waste management. Insufficient expertise and manpower to operate the system reduces efficiency of the services. Some facilities, although financed and built, do not have enough qualified staffs to become operational. Capacity building at the local institutional level is needed to complement the decentralization process of waste management, especially introduction to new technologies and staff training.

4. Low-income Housing

4.1 Subsector overview

In 2005, there were 18.45 million units of housing. Approximately 3.65 million units of which were in Bangkok and its vicinity (19.78%).







Source: The Government Housing Bank

Source: The Poverty Alleviation Center, Ministry of Interior

A particular segment in the housing sector that requires government intervention is housing for low-income populations. In 2006, around 1.7 million households registered with the Poverty Alleviation Center indicating that they had housing problems. However, 58% of the registrants do not require government support. For households that need support from the government, 83,728 households have received it, while 292,399 households are expecting it. However, another 372,908 households still have not received any support from the government.

According to the Community Organization Development Institute (CODI), in 2002, Thailand had approximately 5,500 slums communities (equivalent to 1,500,000 households or 6.75 million populations) in 300 cities nationwide. Around half of these communities have been assisted by government development programs. However, there still remain around 2,950 communities or 680,000 households which need development assistance.

4.2 Policy & institutional framework

The government aims to accomplish a goal of 'Cities without Slum' by 2008. To achieve this, the government has initiated two major low-income housing projects, Baan Eua-arthon and Baan Mankong, to provide housing for low-income households and to upgrade living environments of slum communities.

The National Housing Authority (NHA) and CODI are the two main government agencies responsible for the provision of low-income housing. NHA is a state enterprise under the Ministry of Social Development and Human Security, and is assigned to implement the Baan Eua-arthorn project to provide housing to low-income households. Under the project, 601,727 units will be built during 2003-2009. CODI is a public organization responsible for Baan-Mankong project, which aims to improve the slum areas by building houses in state-owned land for household with income below ThB 10,000/month. The project will cover 1,826 communities and is expected to improve living conditions for 285,000 households or 1,425,000 beneficiaries. For the Baan Eua-arthorn project, the government provides subsidy of around 17% of the overall

costs of house constructions. For Baan-Mankong project, the government subsidy is around 33% of total costs.

Institutionally, there is currently no government agency directly responsible to set policy on low-income housing; rather, they are set on an ad hoc basis by the cabinet. The Department of Land and DPT regulate the housing sector in general. NHA and CODI are implementing agencies, responsible for providing housing services, upgrading slum communities, and for assisting low-income groups to achieve tenure security. In addition, two state-owned banks play an important role providing credit to low-income groups for housing.

Agency	Policy	Regulation and Monitoring	Implementation
Department of Land		\checkmark	
Department of Public Works and Town & Country Planning		✓	
National Housing Authority			~
Government Housing Bank			~
Government Saving Bank			~
Community Organization Development Institute			~

4.3 Sector performance & international comparison

Information on the low-income housing segment is relatively scarce. One indicator which provides insight into sector performance is the number of demand served. As discussed, 50% of registrants which sought government support in housing have been assisted. However, there are still more than 372,908 registrants seeking government support for housing that have not yet been assisted by government. In 2002, there were also around 2,950 slum communities or 680,000 households, which represents existing demand for low-income housing.

According to NHA, during January 2004 to June 2007, NHA provided assistance in upgrading slums and providing loans for housing for 980 communities in 220 cities/districts.

Table 19: NHA's Project Progress during January 2004 – June 2007			
Project Progress	Number		
Projects Approved	495 Projects		
Cities/Districts	220 Cities/Districts		
Number of Communities	980 Communities		
Total Budget Approved			
Grant for Upgrading	16,000 million Baht		
Loans for Housing	1,850 million Baht		
Sources NHA			

Source: NHA

However, by international comparison, the number of slums in Thailand as a percentage of urban population is relatively small.





Source: Select Indicators of Infrastructure Performance, World Bank, 2006

4.4 Private sector participation and privatization

The private sector plays a large role in the government's Baan Eua-arthorn project. NHA allows private companies to participate in turn key projects under which they procure land, obtain funding and undertake construction. NHA also has a plan to purchase 5,160 units of developed properties from the private sector partly to relieve the burden of non-performing loans for financial institutions. However, as most of these properties do not pass NHA's quality tests, only 200 units have been purchased from the private sector to date.

4.5 Investment prospects

Government will continue to invest in low-cost housing to promote home ownership among lowincome groups, including civil servants. Additional investment will also be channeled to upgrade slum communities and improve living standards of slum populations. However, investment in the low-income housing sector is being reprioritized because of government policy shifts. According to the original Baan Eua-arthon plan, NHA will continue to invest in the next phase in 2007. However, the December 2007 Cabinet resolution³² gave new direction to the development of Baan Eua-arthorn, effectively downsizing the project from the planned 600,000 units to only 300,504 units (including 78,000 units already completed).

³²The Cabinet Resolution on December 18, 2007.

4.6 Key issues

Budget allocation - To provide low-income housing, a large amount of investment is required. Partial, or sometimes full, subsidy is required to support home ownership among low income groups; giving rise to sustainability issues as government budgets are depleted. New slums also emerge due to rapid urbanization. The government, thus, faces recurring urbanization challenges and emerging housing needs under constant budget constraints.

Low-income group credit and project sustainability – A low-income group's ability to pay back loan is very limited since they have uncertain income streams while credit terms are fixed. Often, NHA buys back loans from households and shoulders the debt with the banks. As for upgrading slums, relocation is sometimes not successful as social and economics aspects are not taken into account along with the provision of physical housing. For example, sometimes individuals cannot find income earning opportunities in the new environment. The problem of slums is not only economic, but also social, such as in the case of drug addiction. Education and career building for low-income people are concerns which are closely related to the challenges in the new housing development and upgrading of slums communities. Hence, the challenge is how to tie in the aid with a capacity building component to help individuals support themselves for the longer term.



FUTURE CHALLENGES



VI.FUTURE CHALLENGES

It is a challenging time for infrastructure development in Thailand. Investments in major infrastructure projects stagnated after the 1997 financial crisis as demand for infrastructure services sharply decreased. Today with the economy back on track, demand is growing rapidly. Capacity shortages and bottlenecks are emerging in all subsectors, constraining economic upgrading as well as impeding public well-being. The need for large-scale investment to upgrade and introduce new infrastructure systems are fully recognized by the government, the private sector and the general public. There is common understanding among different parties involved on strategic directions and benefits of infrastructure projects such as urban mass transit, renewable energy, rail transport and water supply. The more critical question is how these projects should be realized to make the best use of limited resources of the country. Although challenges vary within each subsector, some common themes and cross-sectoral issues can be identified.

1. External Challenges

Global Energy Context

The future challenges in infrastructure development are greatly compounded by changes in the global environment. An external factor which is one of the most serious concerns for the Thai economy is international oil prices. Thai economy is deeply vulnerable to oil price volatility, and energy security is one of the highest priorities for the government. Separate sectoral responses may prove insufficient in dealing with cross-cutting issue such as energy security, and the rising issue of climate change. An integrated framework will be needed to address the issues more effectively. An integrated framework will require the energy and transport sectors to address issues not only from the supply side, that is, promotion of renewable energy and diversification of the supply sources, but also the demand side. The underlying question in formulating integrated responses is how to find the right balance among the notions of competitiveness, sustainability and supply security.

Competitiveness in the Global Economy

Another external factor which poses a challenge for infrastructure development is national competitiveness in the global economy. With globalization, which induces a free flow of people, commodities, and capital along with trade liberalization through various bilateral and multilateral trade agreements, how to maintain the competitiveness of the country vis-à-vis other countries is a major concern of every government. There is a challenge of how to develop an efficient infrastructure that can facilitate free movement of people, goods and services, attract quality FDI, and contribute to the country's economic competitiveness.

FUTURE CHALLENGES

2. Internal Challenges

Policy Framework

In the past years, several infrastructure investments were expected to resume. However, with uncertainty in the political situation, only a few projects materialized. Without a sound policy framework, there is no continuity in policy and projects are unnecessarily delayed. A strong policy framework, both in terms of sector strategy and project implementation, can bring commitment and consistency critical to the success of infrastructure projects.

• Prioritization

With various demands competing for government budgets, financing remains challenging at the policy level. Challenges are twofold: how to prioritize projects and make the best use of available resources and how to best utilize off-budget financing? Prioritization of projects is crucial to ensure that limited resources are appropriately allocated, the most needed groups are served, and benefits are accrued to the most people. The challenge facing the government is to increase efficiency of the infrastructure service delivery system—but how to weigh benefits and costs, how to select the good projects, how to finance and implement the projects quickly and appropriately?

• Private participation and new sources of funding

As stronger emphasis is placed on maintaining macroeconomic and fiscal stability, off-budget financing for infrastructure will be increasingly relied upon. Private sector participation in infrastructure financing and service provision will be increasingly important as public resources will be insufficient to meet large and growing demands for infrastructure services in the coming years. Since the financial crisis, private sector investment in infrastructure has diminished. The readiness of the private sector to reenter the market will be another challenge for infrastructure investment. A survey undertaken for the East Asia infrastructure study³³ shows that private sector sentiment is contingent upon policy improvements and reduced risks.

Moreover, other innovative international or national sources of funding can be tapped to finance infrastructures and renewable energy projects. Sources can be found in national funds, such as the Energy Conservation Fund or the Oil Fund that has been recently cleared of indebtedness. Other alternatives include the growing Thai Bonds Markets through government-issued, long-term bonds.

³³Connecting East Asia—A New Framework for Infrastructure, ADB, JBIC, and World Bank (2005)

Institutional Framework

Historically, major weaknesses in Thailand's infrastructure service delivery system have been the un-integrated infrastructure planning and provision, and lengthy approval and delivery processes. Institutional weaknesses in the sector are also characterized by the lack of an independent regulator, public sentiment against privatization, and public protests against new large-scale investment in hydro power, waste incineration plants, coal-fired power plants and new roads. To reduce obstacles in the delivery system, a number of institutional hurdles need to be overcome.

• Legal Framework

The first institutional arrangement that needs strengthening is the legal framework. To transform policy into practice, a strong legal framework is required that creates an enabling environment. A major problem in infrastructure sector in Thailand is the lack of a clear regulatory environment and specific subsector guidelines at national and local levels. Recently, some reforms of the legal framework, particularly the definition of clear guidelines in private public partnerships (PPP), have been undertaken. Other areas, which require a clear legal framework, such as the evaluation of projects and guidelines for the feasibility studies, are also under much-needed reform.

• Public Participation Framework

The second area which needs institutional strengthening is a sound public participation framework. A big challenge has resulted as public acceptance increasingly comes to determine feasibility of projects. In addition, according to the Article 57 and 67 of the Constitution of the Kingdom of Thailand B.E. 2550, the implementation of infrastructure projects, particularly mega projects, must be done with public consultation. The implementation agency must consult with stake-holders who will be impacted by the project, and public consensus must be sought prior to commencing construction. The implementing agency and relevant parties face the challenge of devising a framework and best practices, which will give the public confidence that environmental, social and community impact are carefully managed. The involvement of key stakeholders and project-affected people early in the project design process needs to be increased. In addition, institutional strengthening that results in greater transparency and independence of regulators is important to improve the institutional environment and increase public acceptance.

• Difficult Reforms of State-Owned Enterprises

Long-awaited reform of highly indebted state enterprises such as SRT and BMTA is another major challenge. These reforms are strategic to the overall infrastructure development as both organizations play central roles in passenger and freight transport and have considerable impact on the competitiveness of the economy and well-being of the population. At the same time,

FUTURE CHALLENGES

their current operations have consumed a large portion of government resources. Reforms of SRT and BMTA are in any case a sensitive issue with a wide range of repercussions. Several efforts have been put in by previous governments to push a reform agenda but without clear success. Challenges must be addressed such as: reducing the massive outstanding debt, introducing organizational reform, finding new sources of finance and appropriately compensating groups that will lose out from the reform programs to minimize loss for all stakeholders.

3. Sustainability

Once projects are implemented, there is a remaining challenge of how the projects can be sustained; for example, concerning local infrastructure service delivery. A common problem is where responsibilities are delegated much further down the decentralization chain. Under fiscal decentralization, local governments, especially those at the Tambon level, increasingly assume responsibility for the delivery and management of local infrastructure services. Local agencies sometimes have weak implementation capacity and do not have sufficient experience or the technical skills required in running a project. Another obstacle to sustainable infrastructure provision is the lack of user fees or lower-than-desirable level of user fees. Although it could be politically sensitive, the government should determine how to break the political impasse in order to put the sector on a long term, financially-sustainable track. One good example would be a decision to gradually increase petroleum prices during the interim government in 2006-2008, where the pressure from rising oil prices is cushioned by demand adjustment.

Future challenges are how to make projects sustainable in the long-run, how to incorporate sustainability concerns into the project selection and design stages, how to build up local capacity, and how to institute user fees to reasonably reflect costs of operating and maintaining the facilities.

ANNEX

ANNEX

The Linkage of Manufacturing Subsector and Energy Requirement (From Thailand Economic Monitor, November 2006)

Structural energy requirement of some manufacturing subsectors can explain sectoral impacts from the rising energy cost. The continuous rise in the world price of crude oil over the last few years has put more pressure to the rising domestic prices and to the slow down growth in output. Manufacturing sector can also have repercussion impact on capital investment. However, among the manufacturing subsectors, some rely more on energy input than others. The different degree of energy reliance can help identifying these vulnerable subsectors and, consequently, a clearer picture of energy price impact on manufacturing.

The oil price has increased sharply over the last three years (2002-2005). Historical data has shown that the average annual crude oil price has surged from around \$20/barrel (which has been more-or-less steady since 1960s) to around \$50/barrel in 2005, and it has hit the \$60/barrel level in early 2006. Although the oil price in "real" term (adjusted to base-year 2000 price) has not reach the level of 1980's surge, the magnitude is not negligible. Thailand's domestic price of diesel and ULG has also surged for about three folds, similar to the world price.



Figure 74: Average Annual Crude Oil Prices (1960 – 2005)



Figure 75: Diesel, ULG, and LPG Prices (monthly)

Figure 76: Relationship between manufacturing PPI and crude oil price (January 1995 – June 2006)



ANNEX



Figure 77: Manufacturing subsectors price changes over the period 2002 – 2005

While the oil-price impact is economy-wide, some sectors are affected more than others. Particularly in manufacturing, energy is inevitably a necessary part of production. A time-series plot shows that, historically, there is a relatively strong positive relationship between the crude oil price and the manufacturing producer's price index (PPI) over the period of January 1995 – June 2006.

Manufacturing subsectors are affected at different magnitudes as they have different degree of energy dependency. The increase in manufacturing PPI for each of the subsectors somewhat reflects the impact of the oil price surge, but at different degrees. Metals, chemicals, rubber, and plastic related products show relatively larger price surges than others. The different degrees of impact can be explained partly through the difference in structural dependency on energy inputs for each subsector. According to the Input-Output data in 2000, the energy cost share for each manufacturing subsector can be summarized and ranked in Table 14. For example, Cement and Concrete Products are expected to be structurally more vulnerable to the oil price surge than Leather Products.

		Energy Cost Share (of Total Cost)			
Rank	Manufacturing Subsectors	Petroleum Products	Electricity & Gas	Total	
1	Cement and Concrete Products	11.8%	8.3%	20.1%	
2	Basic Chemical Products	4.8%	6.6%	11.5%	
3	Other Non-metallic Products	4.9%	5.4%	10.3%	
4	Spinning, Weaving and Bleaching	1.4%	6.6%	8.0%	
5	Non-ferrous Metal	5.3%	2.6%	7.9%	
6	Iron and Steel	2.6%	5.1%	7.7%	
7	Other Chemical Products	4.4%	1.7%	6.0%	
8	Plastic Wares	0.7%	4.6%	5.3%	
9	Other Foods	1.5%	3.4%	4.8%	
10	Industrial Machinery	2.3%	1.3%	3.6%	
11	Rubber Products	1.4%	2.0%	3.4%	
12	Textile Products	0.5%	2.0%	2.5%	
13	Saw Mills and Wood Products	0.5%	1.8%	2.3%	
14	Paper and Paper Products	1.0%	1.3%	2.2%	
15	Fabricated Metal Products	1.1%	1.0%	2.1%	
16	Processing and Preserving of Foods	0.9%	0.8%	1.7%	
17	Sugar Refineries	0.9%	0.8%	1.7%	
18	Other Transportation Equipment	0.9%	0.7%	1.7%	
19	Motor Vehicles and Repairing	0.6%	1.0%	1.6%	
20	Beverages	1.0%	0.5%	1.5%	
21	Rice and Other Grain Milling	0.4%	1.0%	1.4%	
22	Fertilizer and Pesticides	0.2%	1.1%	1.3%	
23	Other Manufacturing Products	0.4%	0.8%	1.2%	
24	Printing and Publishing	0.3%	0.8%	1.2%	
25	Animal Food	0.3%	0.8%	1.1%	
26	Slaughtering	0.6%	0.5%	1.1%	
27	Electrical Machinery and Apparatus	0.3%	0.7%	1.0%	
28	Leather Products	0.5%	0.5%	0.9%	
29	Tobacco Processing and Products	0.4%	0.3%	0.6%	

 Table 20: Manufacturing subsectors and their energy cost share

For manufacturing subsectors with higher the degree of energy dependency, larger impact from oil price is likely the case. There is some evidence of positive correlation between the total energy cost shares and the producer's price of corresponding manufacturing subsectors. This implies that higher energy cost share will lead to a larger price response. It should also be noted that the analysis looks at the production structure from the supply side – how a sector would react to higher energy cost through a supply shift – while assuming the demand and everything else doesn't change. Although the analysis is partial, the linkage of interest appears to be significant enough.

ANNEX



Figure 78: Fitted plot for PPI & Energy Cost Share (excluding Cement and Concrete Products)

The hardest-hit sectors relate to Basic Chemicals, Iron & Steel, and Rubber & Plastics. These sectors show relatively high degree of energy dependency and high price impact. The un-absorbable energy cost burden is reflected in increasing prices through supply-side contraction. Cement and Concrete Products also have high level of energy dependency, in fact, the highest among the subsectors. But, the price of Cement and Concrete Products hasn't increased as much. This is due to other factors, which include the fact that Cement and Concrete Products is in the price-control list. Therefore, the market has limited influence on price.

	PPI Change (2002-5)	MPI Growth Comparison (2000/2 – 2003/5)
Basic Chemical Products	39.5%	-5.4%
Rubber Products	11.6%	-12.7%
Cement and Concrete Products	7.9%	-1.8%
Iron & Steel Products	53.6%	-15.6%
Manufacturing subsector Avg.	14.0%	-0.8%

 Table 21: Producer Price and Output Dynamics over the period of interest for selected, vulnerable manufacturing subsectors

Output impact corresponds to the price impact. While output almost always rises, output growth were explored and compared. Some output growths accelerate; some decelerate. The vulner-able sectors mentioned shows above-average output growth deceleration rate – a contraction along the demand. This, with prior analysis from the supply-side, confirms the identification of manufacturing subsectors that are vulnerable to the rise in energy price.

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In sum, the rising cost of energy likely has a higher impact on those (manufacturing subsectors) who are less flexible in their production's energy requirement. Although there are many factors affecting manufacturing prices, higher share of energy requirement often translates into higher impact from oil price rise. Other factors may involve abilities to pass on or steer away from higher cost, such as high market power or elasticity of substituting energy inputs. One can take time to explore these factors in details for each individual subsector in order to see how exactly energy cost affects them. However, the simple analysis mentioned can give a sense of where things are in manufacturing subsectors regarding the issue of energy price.

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