

THAILAND

- Thailand's final energy demand is expected to grow at an average annual rate of 2.6% over the outlook period. This is driven mainly by increased demand in the 'other' sector (which covers residential, commercial and agricultural use) and in the non-energy sector.
- Energy imports are expected to keep growing through to 2035; oil, gas and electricity will all be imported to meet demand.
- Thailand's known domestic oil and gas resources are limited; diversification of supply through the use of renewable and/or alternative energy resources may provide an effective option for improving energy security.

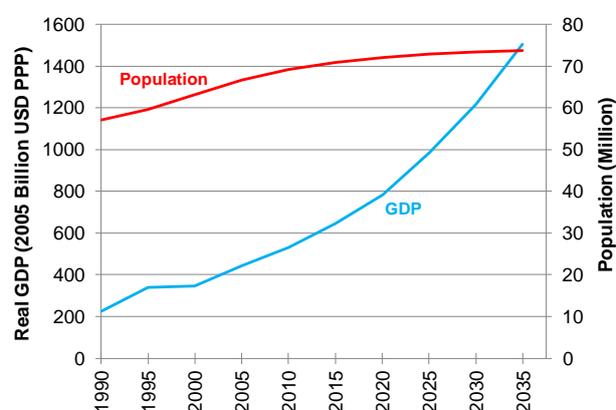
ECONOMY

Thailand is located in South-East Asia. It is bounded to the west by Myanmar, to the north by Myanmar and Lao People's Democratic Republic (Lao PDR), to the east by Lao PDR and Cambodia, and to the south by Malaysia. It has an area of 513 115 square kilometres and had a population of about 69 million at the end of 2010. The climate is generally hot and humid.

Thailand is the second largest economy in the Association of South East Asian Nations (ASEAN). It is a newly industrialized economy, and heavily export dependent. Its total GDP in 2010 was USD 530 billion (in 2005 USD PPP) or about USD 7675 per person.

Thailand's population is expected to increase at the slow annual average rate of 0.3%, to about 73.8 million by 2035. About half will be living in Bangkok, which is both the capital and the most populous city. Thailand's economy is expected to grow moderately at an annual average growth rate of 4.3% to about USD 1500 billion (in 2005 USD PPP), or about USD 20 390 per person by 2035.

Figure THA1: GDP and Population



Sources: Global Insight (2012) and APERC Analysis (2012)

The World Bank ranks Thailand the fourth easiest place in Asia to do business and seventeenth in the world (The World Bank, 2012). Thailand is a

diversified economy dominated by agriculture and international trade. It is the world's leading exporter of rice and a major exporter of shrimp. Other crops include coconuts, corn, rubber, soybeans, sugarcane and tapioca. The economy is also an automotive and electronics goods exporter.

In 2010 the major energy consumers were the manufacturing and transportation sectors, at 36% and 35% respectively. For the manufacturing sector, most of the demand was for coal (32.6%), followed by renewable energy (27.5%) and petroleum products (10.3%) (DEDE, 2010b, pp. 16–17).

Thailand's transport sector energy consumption is dominated by road transport, which uses 89.4% of transport energy consumption in 2009 (MOT, 2009, p. 14). Thailand's road network is 204 425 kilometres (km) long, of which 30% is classified as national highways. The motorway network is quite small, 226 km at present (NESDB, 2012). The railway network covers a total distance of 4119 km; of this 94% is single-track and 6% (234 km) is double-track (NEDSB, 2012). In 2009, 11 million tonnes of freight and 47 million passengers were transported by the rail network (MOT, 2009, p. 15).

Mass rapid transit (MRT) has become an increasingly significant mode of urban passenger transport, carrying 10% of domestic passengers. In 2011, there were two MRT lines in operation in Bangkok: BTS–Sky Train and MRT–Blue Line, which transport about 600 000 and 190 000 daily passengers respectively (BTS, 2012, p. 31; MRTA, 2012, p. 81). The current total length for these two MRT lines is about 58 km. A bus rapid transit (BRT) system complements the MRT system. The BRT was opened in May 2010 and consists of five bus routes covering 110 km; it can accommodate 50 000 passengers a day (Link Technologies, 2011).

Water transportation plays an important role in Thailand and can be categorized into either inland waterway transportation or coastal transportation. The Mekong River flows through Thailand, allowing international cargo delivery with China, Burma and

Lao PDR. Main domestic inland water routes include the Chaopraya River, Pasak River, Bangpakong River, Mae Klong River and Tha Chin River. Within Bangkok, canals provide an alternative service to the capital's traffic-congested roads.

There are a total of 57 airports in Thailand, of which nine are international airports. In 2010 there were an average 84 450 person-trips per day and 303 ton per day of air cargo delivery (OTP, 2011).

Thailand has formulated an ambitious and comprehensive Transport and Traffic Development Master Plan (2011–2020) with six goals emphasizing sustainability and connectivity. Indicators have been developed to ensure that plans are on track. A total of THB 1862 trillion (USD 60 trillion) has been budgeted for the master plan and will cover all modes of transport.

One key project under this master plan is to develop four routes for high-speed trains that will originate from Bangkok's main terminal: to Chiang Mai in the north, to Nong Khai in the north-east, to Rayong in the east and to Huahin in the south. The plan is to complete the 1915-km high-speed train network by 2032 (NESDB, 2012). A second key project is the metropolitan mass rail transit development project that will consist of 12 routes covering a distance of 495 km and 308 stations. Other measures listed under the Transport and Traffic Development Master Plan are to upgrade the Laem Chabang Port to a world class green port, improve accessibility to public boat transport, and to expand the capacity and upgrade domestic and international airports to be able to handle more customers in a more efficient and sustainable manner (OTP, 2011).

At the end of 2010, Thailand had a total registered gasoline vehicle fleet of 20.5 million units, and diesel fleet of 7.0 million. Motorcycles accounted for 84% of registered gasoline vehicles. Pick-up trucks accounted for 66% of registered diesel vehicles while public buses and trucks accounted for another 11% of the diesel fleet (DLT, 2011). About 90% of all vehicles are domestically produced; the remaining 10% are imported from many economies, mostly from the European Union or United States (DLT, 2011). The consumption of diesel is 2.5 times higher than gasoline due to the significant number of diesel light vehicles in the economy.

In 2010, 98.4% of villages and 86.8% of households in Thailand had access to the electricity network (DEDE, 2010a, p. 5). The use of residential biomass (in the form of charcoal and fuel wood) accounted for 59% of total residential final energy demand in 2010 (DEDE, 2010b, p. xi). It is expected

that this use of biomass for cooking in rural areas will decline as the population increasingly becomes more urbanized.

ENERGY RESOURCES AND INFRASTRUCTURE

Thailand is highly dependent on energy imports, which accounted for 46% of the total primary energy supply in 2009. Imports accounted for 72% of oil demand and 28% of gas demand the same year (IEA, 2011). Oil was mainly imported from the Middle East via tanker, while gas was imported from Myanmar via pipeline.

At end of 2011, the Department of Mineral Fuel reported proven reserves of petroleum both onshore and offshore at 215 million barrels of crude oil, 239 million barrels of condensate, and 284 billion cubic metres (10.06 trillion cubic feet) of natural gas (DMF, 2011, p. 79). Based on 2011 production rates, crude oil reserves will last another four years, condensate reserves another seven years, and natural gas reserves will be depleted in less than 15 years. Although Thailand's coal reserves are large, most of the proven coal reserves are lignite coal of low calorific value. There has been to date no significant assessment of Thailand's unconventional oil and gas resources.

Conservative assumptions suggest that Thailand will need to continue to increase imports of oil and gas from neighboring economies. Thailand has had gas pipeline interconnections with Myanmar since 1999 and Malaysia since 2005; these were constructed as a part of the on-going Trans-ASEAN Gas Pipeline (TAGP) project (ASCOPE, 2010). Within Thailand, the total natural gas network covers 4056 km and natural gas is distributed to power generators, including the Electricity Authority of Thailand (EGAT), independent power producers (IPP) and small power producers (SPP), as well as to 272 industrial users (PTT, 2011a).

Because of the economy's faster than expected growth in demand for natural gas, and the limited scope of its reserves, Thailand is actively seeking new gas resources. It is also seeking to improve security of energy supply by diversifying its power generation fuel mix, through increased use of renewable resources, particularly solar, wind, hydro and biomass.

Liquefied natural gas (LNG) has also been used as a fuel for electricity generation since 2011. The Map Ta Phut LNG Terminal, Thailand's first LNG re-gasification terminal, was inaugurated in Rayong province in September 2011. The terminal has an initial capacity of 5 million tons per annum,

extendable to 10 million tons a year (PTT, 2011b). The anticipated growth in demand for natural gas has led the government to consider building a second LNG terminal, possibly in the south of Thailand to avoid the current freight traffic congestion around Rayong.

Thailand has good potential for generating electricity from renewable energy. Assessments from Thailand's Ministry of Energy estimated that about 57.3 GW of renewable energy capacity may be available, mostly from solar, biomass and wind energy. As of 2010, only 1750 MW of renewable energy capacity had been installed in Thailand, of which 92% was fuelled by biomass (EGAT, 2010, p. 99).

ENERGY POLICIES

Thailand's energy policy aims for sustainable energy management so the economy has sufficient energy to meet its needs. Currently, it is based on these five strategies:

1. Energy security.
2. Promoting the use of indigenous energy resources including renewable and alternative energy.
3. Monitoring energy prices and ensuring prices are at competitive levels and appropriate for the wider economic and investment situation.
4. Effectively promoting energy conservation and efficiency.
5. Supporting energy development domestically and internationally while simultaneously protecting the environment.

Thailand's energy policy also seeks to build an energy self-sufficient society; achieve a balance between food and energy security; build a knowledge-based society; promote Thailand's role in the international arena; and enhance economic links with other economies in the region to facilitate harmonious cooperation in energy and other sectors.

To improve energy security, Thailand's government has adopted a range of comprehensive measures covering the oil, gas and electricity sectors. The policy development includes comprehensive and careful study of nuclear energy as another option for increasing the stability of the economy's future electricity supply. According to the original Power Development Plan 2010 (PDP 2010), the Electricity Generating Authority of Thailand (EGAT) has estimated that nuclear power could contribute up to 10% of the economy's total electricity generation from 2023 (EGAT, 2010). However, public acceptance of nuclear energy is a major challenge in

Thailand, and an effective communication strategy will be needed to reduce the public's fear of nuclear power and increase recognition of the benefits it would offer to the community. The latest version of the PDP 2010 released in June 2012 reflects this sentiment, and limits the share of nuclear to less than 5% of total generation capacity.

The same revision of PDP 2010 stipulates that Thailand's reserve margin should not be less than 15% of peak power demand and reduces the allowable share for foreign power purchase from neighboring countries from 25% to 15% of total generating capacity.

The Renewable and Alternative Energy Development Plan (2012–2021) sets a framework for Thailand to increase the share of renewable and alternative energy to 25% of total energy consumption by 2021 (DEDE, 2011). The plan states the Thai government will encourage the use of indigenous resources including renewable and alternative energy (particularly for power and heat generation), and supports the use of transport biofuels such as ethanol-blended gasoline (gasohol) and biodiesel. The plan also strongly promotes community-scale alternative energy use, by encouraging the production and use of renewable energy at a local level, through appropriate incentives for farmers. It also rigorously and continuously promotes research and development of all forms of renewable energy.

Thailand has adopted a 20-year Energy Efficiency Development Plan 2011–2030 (EEDP) (EPPO, 2011). This plan sets a target of 25% reduction in the economy's energy intensity by 2030, compared to 2005 levels. In 2011, the EEDP targets were revised to meet the new target declared by APEC Leaders at the APEC Summit 2011. Thailand now aims to achieve a 25% reduction of energy intensity by 2030, compared with 2010 levels (APEREC, 2012). The focus for energy efficiency measures is on transport and industry sectors. If the energy conservation measures can be successfully implemented, energy elasticity (the percentage change in energy consumption to achieve a 1% change in the economy's GDP) will be reduced from an average of 0.98 in the past 20 years to 0.7 in the next 20 years. Implementation of the EEDP will result in cumulative final energy savings of about 289 000 ktoe by 2030 (or an average of 14 500 ktoe per year), and avoided CO₂ emission of 976 million tons (EPPO, 2011). The EEDP employs these strategies:

1. *Mandatory Requirements via Rules, Regulations and Standards.* This includes the enforcement of Minimum Energy Performance Standards

(MEPS), mandatory energy efficiency labelling and enforcement of the Energy Conservation Promotion Act.

2. *Energy Conservation Promotion and Support.* This includes measures for incentives to encourage voluntary energy efficiency labelling, promotion for travelling by mass transit systems, and financial support for Energy Services Companies (ESCO).
3. *Public Awareness Creation and Behavioural Change.* This includes public relations and provision of knowledge about energy conservation to the general public, promoting activities related to the development of a low carbon society and low carbon economy, and the determination of energy prices as a tool to foster public awareness and change energy consumption behaviour.
4. *Promotion of Technology Development and Innovation.* This includes measures to promote research and development to improve energy efficiency and reduce the technological costs, promote demonstrations of technically proven energy efficiency technologies and support for wide commercial deployment of viable technologies.
5. *Human Resources and Institutional Capability Development.* This includes support measures to build professional and institutional capabilities for planning, supervising and implementing energy efficiency conservation measures.

Liquid petroleum gas (LPG) and natural gas vehicle (NGV) fuel prices have been subsidized at below cost levels in Thailand since the 1980s. The price subsidy for LPG and NGV is now being removed, through a gradual increase in price that began in January 2012. The subsidy for transport LPG and NGV will be gone by the end of 2012; the removal of the subsidy for LPG and natural gas for residential, industrial and other sectors will follow more slowly. There will be some government assistance in the residential sector, to offset the increase in the cost of living, before the residential LPG subsidy is completely removed.

Foreign investment in the energy sector is covered by the Foreign Business Act 1999. There is no restriction on foreign investment in businesses involved in energy (oil, gas, electricity) exploration and production. However foreign equity is limited to minority shares of transmission and distribution service businesses. This means foreign companies seeking to operate transmission, trading or distribution services in Thailand require a local joint venture partner. For natural gas transmission and distribution, third parties are able to gain direct access

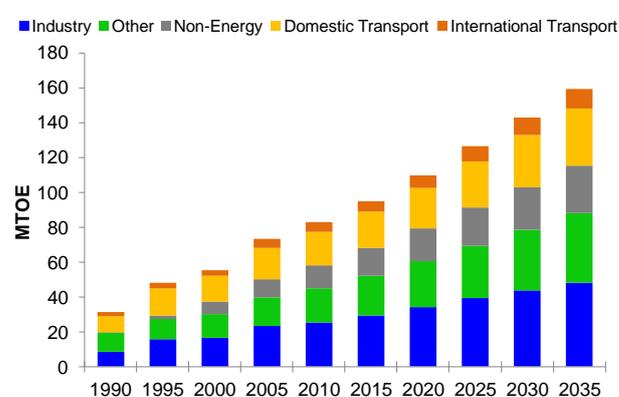
to the network, but there are currently no third party companies doing this (APEC, 2011, p. 392).

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

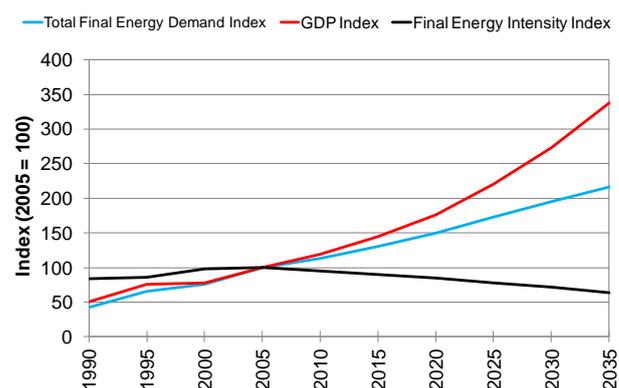
The final energy demand is expected to grow under business-as-usual (BAU) assumptions at an average annual rate of 2.6% over the outlook period (a 92% growth in total). In 2035, industry and non-energy use together will account for 48% of the total final energy demand, while transport will account for 27% and 'other' sector demand for 25%, as shown in Figure THA2. More than half of the final energy demand will be for oil. Natural gas demand will be the most rapidly growing energy source, at an annual average rate of 4.4% per year from 2010 to 2035.

Figure THA2: BAU Final Energy Demand



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics* 2011 © OECD/IEA 2011

Figure THA3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Thailand's final energy intensity is expected to decrease by over 25% between 2010 and 2030, and over 35% between 2005 and 2035, as shown in Figure THA3. This should meet the economy's own target of 25% energy intensity reduction by 2030, compared to 2010 levels, as set in the Energy Efficiency Development Plan (EEDP).

Industry

Industry's energy demand is expected to grow by 2.6% per year over the outlook period. This is due to growth in the manufacturing subsector, particularly in food and beverages, chemicals and non-metallic minerals. Coal and electricity are expected to be the largest industrial energy sources. The fastest growing, however, will be oil, which is expected to grow at an average annual rate of 5%, from 2.7 Mtoe in 2009 to 10 Mtoe in 2035.

Transport

Domestic transport demand is expected to grow by 2.1% per year over the outlook period, due to increasing vehicle numbers (which are still far below saturation level) and the increase in vehicle kilometres travelled. Demand will be moderated by the gradual shift in transport modes in urban centres (to rapid transit systems) and a modest increase in the use of biofuels and alternative vehicles.

The light vehicle fleet in Thailand will be more diverse by 2035. Hybrids and plug-in hybrid vehicles will account for 4% of the fleet, while vehicles running on LPG and CNG will account for 7%.

Other

Energy demand in the 'other' sector, which includes the residential, commercial and agricultural subsectors, is expected to increase at an annual average of 3.0% over the outlook period, to 40 Mtoe in 2035. A large percentage of 'other' sector demand will be for electricity in the commercial subsector and for oil in the agricultural subsector.

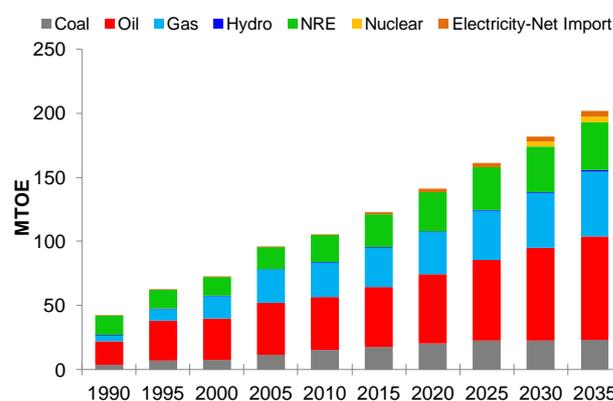
The likely increase in home appliance ownership, and its impact on residential demand, varies between types of home appliance. In 2010, air conditioners were owned by only 15.6% of the households, which is a long way below saturation level. In comparison television and fan ownership levels are much higher: 96% of households own a television and 97% own fans (NSO, 2011). Thailand is promoting energy conservation and efficiency through various measures, including building codes and minimum efficiency performance standards for appliances, and this is expected to moderate electricity demand in this sector.

PRIMARY ENERGY SUPPLY

Thailand's total primary energy supply is projected to grow at an annual average of 2.6% over the outlook period. Figure THA4 shows oil and gas will dominate the mix, and in 2035 will account for over 65% of total primary energy supply. New renewable energy sources (NRE) are expected to

grow by 77% over the period, and will account for 19% of the 2035 total. In this BAU projection, Thailand will likely introduce nuclear energy into the primary energy fuel mix from 2027 onwards. However, as noted in the 'Energy Policies' section above, there is still much uncertainty about the future of nuclear in Thailand.

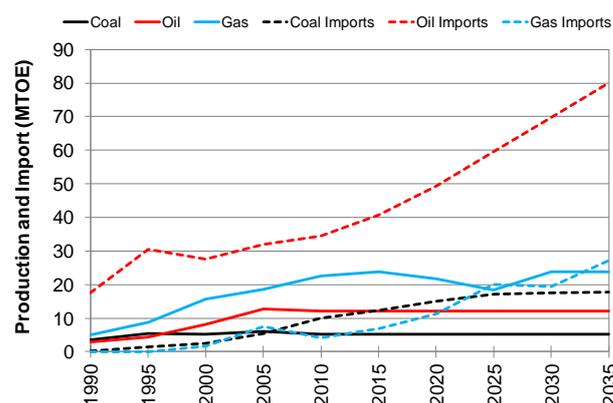
Figure THA4: BAU Primary Energy Supply



Source: APERC Analysis (2012)

Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Figure THA5: BAU Energy Production and Net Imports



Source: APERC Analysis (2012)

Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011

Over the outlook period Thailand is expected to remain highly dependent on energy imports, particularly for oil, as seen in Figure THA5. Oil imports are expected to grow at an average annual rate of 3.4%, to 80 Mtoe in 2035. This is to meet the projected demand for oil, especially in the domestic transport and non-energy sectors over the outlook period.

Increasing demand for natural gas, especially for electricity generation, and Thailand's limited gas production will require the economy to increase its gas imports almost four-fold from 7.5 Mtoe in 2009 to 27 Mtoe in 2035. Coal imports are expected to grow at an annual average of 2.3% from 2010 to 2035, mostly serving the industrial sector and electricity generation.

ELECTRICITY

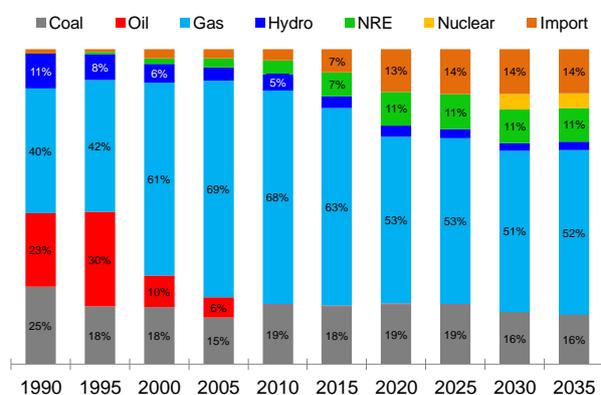
Figure THA6 shows Thailand’s electricity generation fuel mix will remain heavily dependent on natural gas throughout the outlook period. By 2010, oil-fuelled power plants had mostly been removed from use; as a result, the oil share in the total generation mix is almost negligible throughout the outlook period. During the same time, the coal share will be maintained at about 16–19%.

After the Fukushima Nuclear Accident, the Ministry of Energy postponed construction of a proposed nuclear power project and reduced the plant’s final capacity from four 1000 MW units to two: one unit to commence operation in 2026 and the next unit in 2027 (EGAT, 2012). With this latest proposal incorporated, our BAU scenario projects that nuclear energy will contribute about 5% of the electricity generation mix from 2027 onwards. This may still change depending on Cabinet endorsement and public acceptance, as well as the results of feasibility and safety review assessments of Thailand’s nuclear readiness.

The share of electricity generation based on hydro and NRE sources will increase from 9.5% in 2010 to 13.4% in 2035. As a tropical economy with strong agricultural sector, most of Thailand’s NRE will be in the form of biomass, biogas and solar energy.

Thailand has signed a number of Memoranda of Understanding (MOU) with Lao PDR, Myanmar and China to develop power generation projects over the next 20 years to enable Thailand to import electricity from these economies (EGAT, 2010, p. 22). Most are hydroelectric and renewable energy projects. The associated transmission systems are already under construction. As these power purchase projects come online, Thailand’s electricity imports will increase and account for at least 14% of the total electricity generation mix from 2025 onwards.

Figure THA6: BAU Electricity Generation Mix

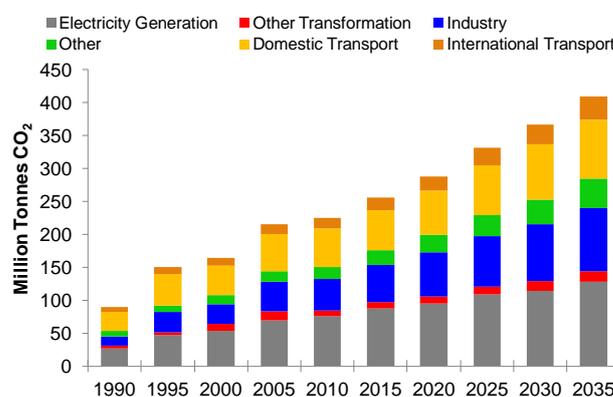


Source: APERC Analysis (2012)
Historical Data: World Energy Statistics 2011 © OECD/IEA 2011

CO₂ EMISSIONS

Thailand’s level of CO₂ emissions is expected to increase throughout the outlook period, across all sectors, as shown in Figure THA7. The average annual rate of increase for the whole economy is 2.4%. Electricity generation, industry and domestic transport will be the main contributors.

Figure THA7: BAU CO₂ Emissions by Sector



Source: APERC Analysis (2012)

The decomposition analysis in Table THA7 shows Thailand’s growth in GDP drives the total change in CO₂ emissions, offset by reductions in CO₂ intensity of energy (fuel switching) and energy intensity of GDP (energy efficiency and industry structure).

Table THA1: Analysis of Reasons for Change in BAU CO₂ Emissions from Fuel Combustion

	(Average Annual Percent Change)				
	1990-2005	2005-2010	2005-2030	2005-2035	2010-2035
Change in CO ₂ Intensity of Energy	0.4%	-1.0%	-0.4%	-0.4%	-0.2%
Change in Energy Intensity of GDP	0.9%	-1.6%	-1.5%	-1.6%	-1.5%
Change in GDP	4.7%	3.6%	4.1%	4.1%	4.3%
Total Change	6.1%	0.9%	2.1%	2.2%	2.4%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

Under business-as-usual assumptions, Thailand’s final energy demand will double within the next 25 years, and with its limited resources, the economy will likely remain a net energy importer to meet its increasing energy demands. The BAU scenario also indicates Thailand’s high dependency on fossil fuels will likely result in the further increase of CO₂ emissions and environmental pollution.

To improve energy security and alleviate the climate change problem, the economy is actively pursuing initiatives in biofuels and natural gas for vehicles, and nuclear and renewable energy in the power sector, as well as diversifying its imported energy resources. The economy already has a 20-year Energy Efficiency Development Plan 2011–2030 in place—this should accelerate energy efficiency and

conservation measures in the economy, with the result of reducing energy intensity by 25% from 2010 to 2030.

ALTERNATIVE SCENARIOS

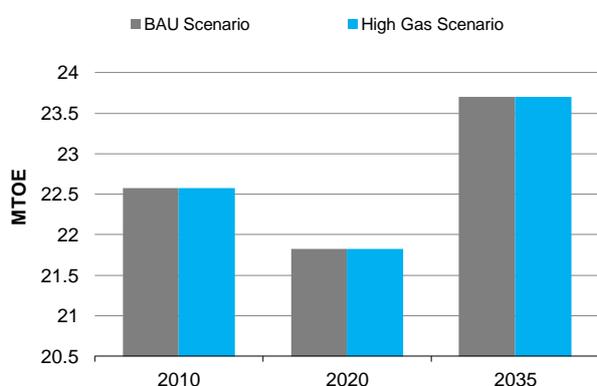
To address the energy security, economic development, and environmental sustainability challenges posed by the business-as-usual (BAU) outcomes, three sets of alternative scenarios were developed for most APEC economies.

HIGH GAS SCENARIO

To understand the impacts higher gas production might have on the energy sector, an alternative ‘High Gas Scenario’ was developed. The assumptions behind this scenario are discussed in more detail in Volume 1, Chapter 12. The scenario was built around estimates of gas production that might be available at BAU prices or below, if constraints on gas production and trade could be reduced.

Due to natural gas resource depletion (DMF, 2010), gas production under the High Gas Scenario for Thailand is likely to be the same as for BAU, as shown in Figure THA8.

Figure THA8: High Gas Scenario – Gas Production



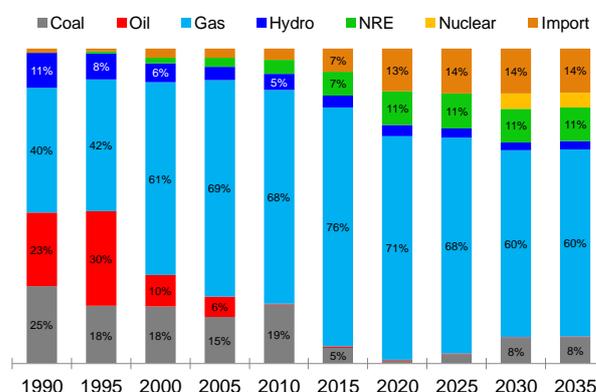
Source: APERC Analysis (2012)

Additional gas consumption in each economy in the High Gas Scenario will depend not only on the economy’s own additional gas production, but also on the gas market situation in the APEC region. In Thailand, natural gas demand for electricity production is projected to increase over the outlook period; therefore, in a situation of high gas availability, Thailand can be expected to import more gas via pipeline and as LNG to meet the growing demand. The proportion of imported gas will depend on the market situation.

Additional imported gas in the High Gas Scenario was assumed to replace coal in electricity generation. Figure THA9 shows the High Gas

Scenario electricity generation mix. This graph may be compared with the BAU scenario shown in Figure THA6. It can be seen that the gas share has increased by 8% by 2035, while the coal share has declined by an equal amount.

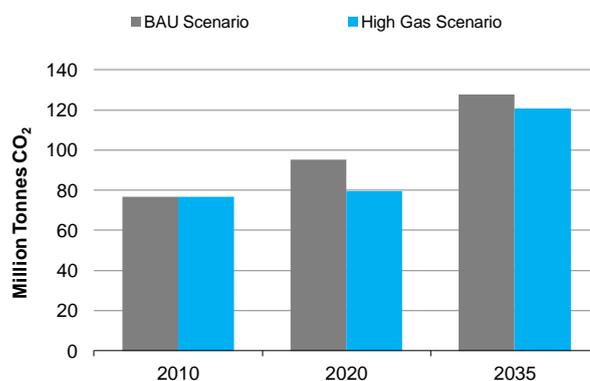
Figure THA9: High Gas Scenario – Electricity Generation Mix



Source: APERC Analysis (2012)
Historical Data: World Energy Statistics 2011 © OECD/IEA 2011

Since gas has roughly half the CO₂ emissions per unit of electricity generated than coal, this had the impact of reducing CO₂ emissions in electricity generation by 6% by 2035 as shown in Figure THA10.

Figure THA10: High Gas Scenario – CO₂ Emissions from Electricity Generation



Source: APERC Analysis (2012)

The CO₂ emissions reduction in the High Gas Scenario could contribute towards Thailand’s Energy Efficiency Development Plan (EEDP) target to achieve cumulative avoided CO₂ emissions of 976 million tons from 2010 to 2030 (EPPO, 2011, p. 8)

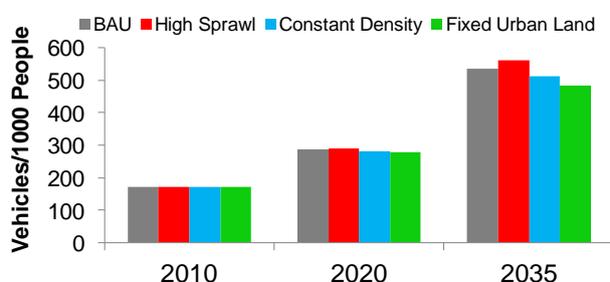
ALTERNATIVE URBAN DEVELOPMENT SCENARIOS

To understand the impacts of future urban development on the energy sector, three alternative

urban development scenarios were developed: ‘High Sprawl’, ‘Constant Density’, and ‘Fixed Urban Land’. The assumptions behind these scenarios are discussed in Volume 1, Chapter 5.

Figure THA11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. The difference between the High Sprawl scenario and BAU is moderate: vehicle ownership is 5% higher in the High Sprawl scenario. However, there is a significant shift in the Fixed Urban Land scenario, where vehicle ownership is 9% lower than BAU. The impacts of improved urban planning are likely to be more significant in the years after 2035, as vehicle ownership approaches saturation levels typical of wealthy economies.

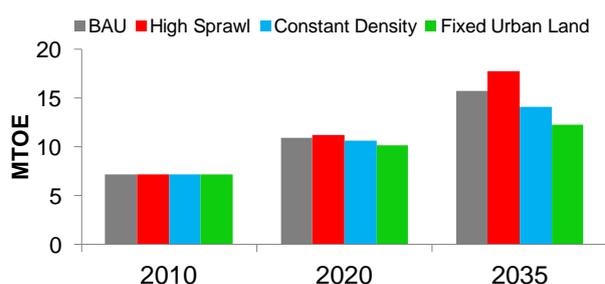
Figure THA11: Urban Development Scenarios – Vehicle Ownership



Source: APERC Analysis (2012)

Figure THA12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. The different urban development scenarios have greater impact on light vehicle oil consumption than they did on vehicle ownership figures. In addition to reducing vehicle ownership, denser urban development also reduces the length of vehicle trips. Light vehicle oil consumption in the High Sprawl scenario is 13% higher than BAU, while in the Constant Density and Fixed Urban Land scenarios, it is 10% and 22% lower, respectively.

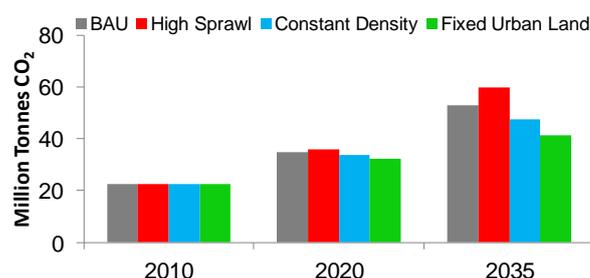
Figure THA12: Urban Development Scenarios – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure THA13 shows the change in light vehicle CO₂ emissions under BAU and the three alternative urban development scenarios. The impact of urban planning on CO₂ emissions is similar to the impact of urban planning on energy use, since there is no significant change in the mix of fuels used under any of these scenarios. Light vehicle CO₂ emissions would be 13% higher in the High Sprawl scenario compared to BAU in 2035, and about 10% and 22% lower in the Constant Density and Fixed Urban Land scenarios, respectively.

Figure THA13: Urban Development Scenarios – Light Vehicle Tank-to-Wheel CO₂ Emissions



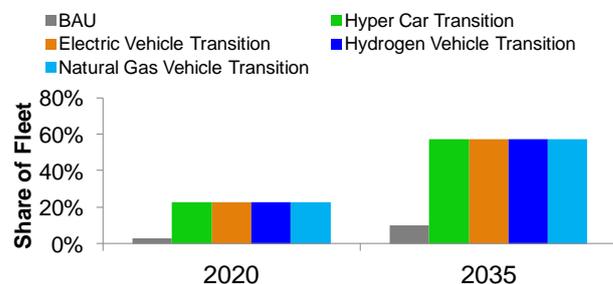
Source: APERC Analysis (2012)

VIRTUAL CLEAN CAR RACE

To understand the impact of vehicle technology on the energy sector, four alternative vehicle scenarios were developed: ‘Hyper Car Transition’ (ultra-light conventionally powered vehicles), ‘Electric Vehicle Transition’, ‘Hydrogen Vehicle Transition’, and ‘Natural Gas Vehicle Transition’. The assumptions behind these scenarios are discussed in Volume 1, Chapter 5.

Figure THA14 shows the evolution of the vehicle fleet under BAU and the four ‘Virtual Clean Car Race’ scenarios.

Figure THA14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet

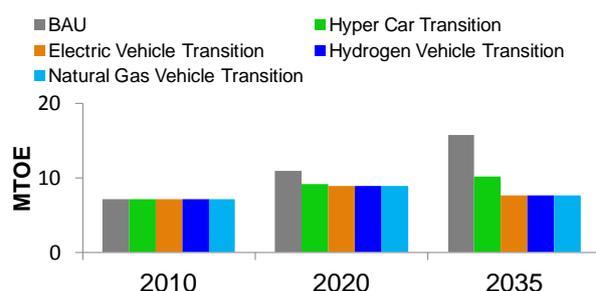


Source: APERC Analysis (2012)

By 2035 the share of the alternative vehicles in the fleet reaches around 57% compared to about 9% in the BAU scenario. The share of conventional vehicles in the fleet is thus only about 43%, compared to about 91% in the BAU scenario.

Figure THA15 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by 51% in the Electric Vehicle Transition, Hydrogen Vehicle Transition, and Natural Gas Vehicle Transition scenarios compared to BAU by 2035. The drop is large as these alternative vehicles use no oil. Oil demand in the Hyper Car Transition scenario is also significantly reduced compared to BAU: down 35% by 2035, even though these highly efficient vehicles still use oil.

Figure THA15: Virtual Clean Car Race – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

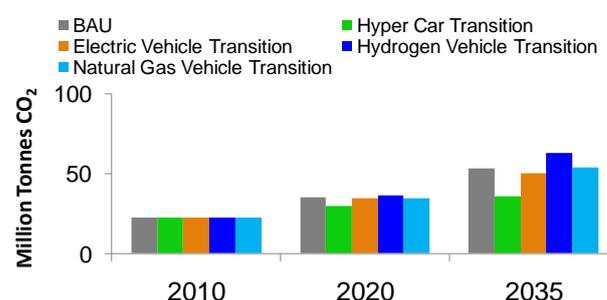
Figure THA16 shows the change in light vehicle CO₂ emissions under BAU and the four alternative vehicle scenarios. To allow for consistent comparisons, in the Electric Vehicle Transition and Hydrogen Vehicle Transition scenarios, the change in CO₂ emissions is defined as the change in emissions from electricity and hydrogen generation. The emissions impacts of each scenario may differ significantly from their impact on oil consumption, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

In Thailand, the Hyper Car Transition scenario is the clear winner in terms of CO₂ emission reduction, with an emission reduction of 32% compared to BAU in 2035. This is because of the higher fuel efficiency in hyper cars reduces the oil consumption per kilometre travelled. The Electric Vehicles Transition scenario would be second, offering a reduction of 6% compared to BAU in 2035. While electric vehicles and the power plants that supply them use energy more efficiently than conventional vehicles, this scenario assumes they still rely on fossil-fuel generated electricity, which in Thailand is mainly from natural gas.

In contrast, the Natural Gas Vehicle Transition and Hydrogen Vehicle Transition scenarios would actually increase emissions level, by 2% and 18% respectively, compared to BAU in 2035. Thailand has a large proportion of diesel and LPG light vehicles,

which are more efficient than light vehicles using regular petrol or natural gas as fuel. This means there is actually a drop in efficiency when switching to natural gas vehicles, which causes a small increase in emissions for the Natural Gas Vehicle Transition scenario. The large increase in emissions for the Hydrogen Vehicle Transition scenario reflects the conversion losses in producing hydrogen from gas which involves significant CO₂ emissions. The results would be more favourable if hydrogen could be produced from a renewable or low carbon energy source.

Figure THA16: Virtual Clean Car Race – Light Vehicle CO₂ Emissions



Source: APERC Analysis (2012)

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