

VIET NAM

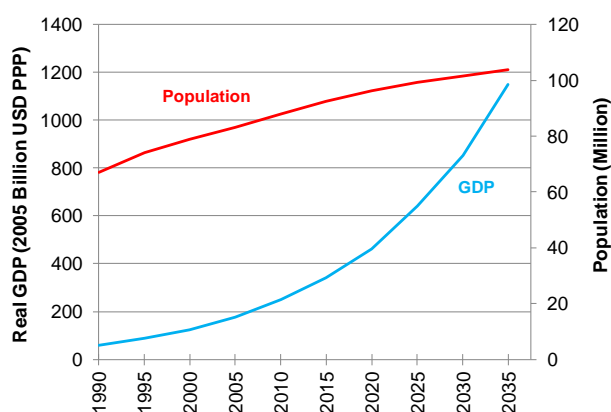
- Viet Nam's final energy demand is expected to grow at an average annual rate of 3.5% over the outlook period, from 55.6 Mtoe in 2009 to 138.7 Mtoe in 2035. The 'other' sector (consisting of the residential, commercial and agricultural subsectors) will account for the biggest share of the total demand (57%) in 2035.
- Viet Nam is expected to become a net importer of energy from 2020 and the economy's energy import dependency is projected to reach 54% by 2035.
- CO₂ emissions from fuel combustion are projected to reach 466 million tonnes of CO₂ by 2035.

ECONOMY

Viet Nam is located in South-East Asia. It shares borders with Cambodia and the Lao People's Democratic Republic (Lao PDR) to the west, and China to the north; while to the east and south it borders the Gulf of Tonkin, the Eastern Sea (also known as the South China Sea) and the Gulf of Thailand. Viet Nam's total land area is 330 958 square kilometres, spread out in an elongated 'S' shape; this also gives it an extensive marine exclusive economic zone along its 3260-kilometre coastline.

Viet Nam lies in the tropical monsoon zone. The typical features of this zone include warmth, humidity and abundant seasonal rainfall. In the north there are four seasons, while in the centre and in the south it is hot all year round with just two seasons, rainy and dry.

Figure VNI: GDP and Population



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

In 2010, Viet Nam's population was 87.9 million. Economic growth and rising household incomes mean the use of air conditioning for cooling interiors is growing in Viet Nam. In 2012 it is common in commercial buildings and also in private urban homes, and the demand for air conditioning is expected to continue to increase over the outlook period. In contrast, the use of biomass fuels for

cooking in rural areas (and for home heating in mountainous areas) will decrease.

Market-oriented reforms since 1986 and rapid economic development have transformed the economy of Viet Nam over recent decades. The economic growth rate for the period 1990–2010 was an annual average of 7.4%, with GDP increasing from USD 60 billion in 1990 to USD 250 billion in 2010 (figures in 2005 USD PPP).

In 2010, Viet Nam had an income per capita of about USD 2850 (in 2005 USD PPP). The government has set a target of GDP growth between 6.5% and 7.0% per year over the period 2010–2015 (PMVN, 2011b). The government also expects population growth to be under 1.2% over the same period. This outlook, which takes into consideration the current global economic context and Viet Nam's future economic prospects, projects an average annual GDP growth rate of 6.3% over the outlook period, and a population growth rate of 0.7% per year over the same period, with the total reaching 104 million people by 2035. The rate of urbanization growth is higher, at an average annual rate of 1.9%; this means over 50% of the population is expected to be living in urban centres by 2035. GDP per capita (in 2005 USD PPP) is expected to exceed USD 11 000 by 2035, comparable to the equivalent figure for Malaysia in 2005 (USD 11 570).

Viet Nam's economy is dependent on exports and on agriculture, including fisheries. Major export products include coal, crude oil, textiles, footwear, rice, fish and agricultural products, and electronic products (GSO, 2009, p. 459i). The sector making the highest contribution to GDP is industry, at over 35% of the total share in 2009.

The industry sector is expected to grow quickly over the outlook period, based on growth in food processing, iron and steel, and textiles and leather. Most industry is concentrated in and around Viet Nam's big cities, including Ho Chi Minh City, Dong Nai, Bien Hoa, Hai Phong, Quang Ninh and

Ha Noi. While energy use for industry will grow at a slower rate over the outlook period than it did during 2000–2009, energy-intensive industries, such as iron and steel factories and cement and chemical plants, are still expected to account for nearly 40% of the economy's total energy use in the industry in 2035.

The economy relies heavily on its road networks, which are used for 80% of passenger trips and more than half of the freight movements. Other transportation modes in use are rail and waterways.

Most public transport services in Viet Nam are privately owned and operated, using buses, taxis, and motorbike taxis. In 2009, there were 23 million motorbikes in the economy, compared to 0.8 million cars. However, car ownership is expected to increase much more rapidly than motorbike ownership over the outlook period — the share of motorbikes in the total vehicle fleet will probably be drastically reduced by 2035. Most car ownership will be private, as the Vietnamese Government is phasing out the purchase of new cars and imported second-hand cars for government use.

Traffic congestion is already an issue in urban areas, particularly in Ha Noi and Ho Chi Minh cities, where the existing road networks do not have the capacity for the growing traffic volumes. To address congestion and also to reduce CO₂ emissions, the government of Viet Nam has developed policy to promote the use of public bus systems in these cities. At the same time, mass transit systems including subways and sky trains are being constructed in stages in both Ha Noi and Ho Chi Minh. Most of the systems are expected to be operational by the end of the outlook period.

The government's long-term aim is to improve the land-based connection between Ha Noi and Ho Chi Minh cities, and in doing so to reduce the air traffic between them. A high-speed railway between the two cities has been proposed—a revised plan is to be submitted to the National Assembly after the initial proposal was rejected on cost reasons. The revised proposal will prioritise the construction of two segments: Ho Chi Minh–Nha Trang, and Ha Noi–Vinh (not the entire Ha Noi–Ho Chi Minh route proposed initially). The intent is to shift traffic to rail from road, and therefore reduce the economy's demand for petroleum fuel.

ENERGY RESOURCES AND INFRASTRUCTURE

Viet Nam has diverse fossil energy resources, including oil, gas and coal, as well as renewable energy resources such as hydro, biomass, solar and geothermal. Natural gas and crude oil are found

mainly offshore in the southern region, while coal reserves (mostly anthracite) are located in the north.

Over the period 1995–2010, oil production and exports grew at an average annual rate of 10.4%. In 2012, Viet Nam has 14 oil-producing fields: Bach Ho, Rong, Dai Hung, Rang Dong, Ruby, Emerald, Su Tu Den, Bunga Kekwa, Bunga Raya, Bunga Tulip, Ca Ngu Vang, Phuong Dong, Song Doc, and Cendor. Five of these are new fields, explored only since 2008. Most oil exploration and production activities occur off the southeast coast in the Cuu Long and Nam Con Son basins. Before 2009, Viet Nam did not have its own refinery, so all crude oil production was exported and petroleum products were imported. However, since February 2009, a refinery with a capacity of about 150 000 barrels per day has been in operation in Quang Nam province. The refinery provides around 6.5 million tonnes of petroleum products annually for domestic consumption (Petrovietnam, 2012).

Gas resources are found in many parts of Viet Nam, with the largest found in offshore basins. As well as the large gas fields discovered in the Cuu Long and Nam Con Son basins, there is the Malay–Tho Chu basin offshore of the southwest region and the Song Hong basin in the north. The Cuu Long basin is one of the developed natural gas production areas, with most of its gas produced in association with crude oil production (Petrovietnam, 2012).

Natural gas demand in Viet Nam, especially for electricity generation, has increased rapidly since 1995, and it is expected to continue to rise over the outlook period. At the same time, the current proved reserve is not very large compared with the reserves estimated in neighbouring economies, and local oil and gas experts' studies show a big gas discovery is unlikely. The reports suggest only the current annual supply of about 7–8 billion cubic metres (6.3–7.2 Mtoe) is assured from 'proven plus probable' (2P) reserves. To achieve annual production over 20 billion cubic metres (18 Mtoe) after the year 2020 will require the 'proven plus probable plus possible' (3P) reserves to move into the 'proven' category by means of further successful exploration and development (World Bank, 2010). Overall, natural gas imports are expected to be required after 2020. Unconventional gas has not been considered in Viet Nam so far.

Viet Nam has two large coalfields located in the north, in Quang Ninh province and the Red River Delta. As at the end of 2008, Viet Nam's coal reserves excluding peat were estimated at 6141 million tonnes. Of this geological reserve, 70%

is anthracite, and is deposited in Quang Ninh province. Most of the remainder is sub-bituminous coal, including deposits of 1580 million tonnes (26%) in the Khoai Chau region of the Red River Delta, and 96 million tonnes of fat coal deposits, which are used for making coke (MOIT and Vinacomin, 2008). In 2009, Viet Nam exported over 20 million tonnes of coal, a record amount, and exports made up nearly 50% of the coal industry's sales that year. Major export destinations included China, Japan, Korea, Chinese Taipei, Thailand and India.

Coal production changes expected in the outlook period include a shift from open cut mining to underground mining, as the producing coal seams in the Quang Ninh mines get deeper. In addition, the commercial development of the sub-bituminous coal of the Red River Delta is scheduled to begin after 2015. However, while the volume of coal production will keep growing, to reach 75 million tonnes by 2030 and will plateau from 2030 onwards, this will not match the increasing coal demand. Viet Nam is expected to import coal after 2020 under business-as-usual (BAU) conditions.

The rapid expansion of Viet Nam's economy between 1995 and 2009 meant electricity demand increased dramatically in the same period. The average annual rate of growth between 1995 and 2009 was 13%: the 2009 electricity demand of 83 200 GWh was nearly six times greater than the 1995 figure of 14 648 GWh. Peak demand increased more than four times during this period, rising to 13 800 MW compared to 3200 MW in 1995. The potential peak demand was even higher than reported, as power shortages led to load shedding and cuts in electricity supply during peak hours.

In 2009, power generation in Viet Nam was based on these sources: gas (43%), hydro (32%), coal (23%) and oil (2%). The construction of new electricity plants using nuclear, hydro and renewable energy sources is constrained by the availability of resources and construction sites and by high generation costs. As a result, the relatively more flexible resources of coal and natural gas make up the majority of the electricity generation mix throughout the outlook period—accounting for more than 70% of generation between them.

Some development of hydro and nuclear power plants will still take place to meet the demand growth and this will contribute to the projected five-fold increase of electricity supply by 2035. However, the limits to hydro development, and the long lead-time required to mobilize technology and funding for nuclear plant construction, mean the majority of the electricity demand increase in the outlook period will

be supplied by thermal generation, based on coal and natural gas.

ENERGY POLICIES

The key points of Viet Nam's National Energy Development Strategies include:

- Diversified and effective exploitation of domestic natural resources, in combination with a reasonable import–export balance, with the gradual reduction of primary energy exports, conserving fuels and ensuring energy security for the future.
- Development of energy in line with natural resource protection and environmental protection, ensuring sustainable development of the energy sector.
- Increasing the share of rural households using commercial energy to 80% by 2020. By 2020, 100% of rural households will have access to electricity.
- Increasing the share of renewable energy in the total commercial primary energy supply to 5% by 2025 and to 11% by 2050.
- Reducing dependence on energy imports.
- Nuclear power development plan.
- Enhancing international cooperation in the energy sector (PMVN, 2007).

To reach the targets set for increasing the share of renewable energy sources in power generation, the government of Viet Nam has, since 2008, been developing policy to support renewable energy use. Government documents in this area include the Decision by the Minister of Industry and Trade on “Regulation on avoided cost electricity tariff schedule and standard power purchase agreement” (MOIT, 2008), and the Decision by the Prime Minister on “Mechanism for supporting wind power development” (PMVN, 2011a). The key elements of the decision on wind power development are the provision of incentives for capital investment, and provisions about related land use, transmission fees and electricity tariffs.

As an agriculture economy, Viet Nam has good biomass resources, including fuel wood, waste residues from crops, and other organic wastes. However, currently these sources are mostly used as non-commercial energy for households. To better harness this potential, the government is actively encouraging the production of biomass-based electricity. A number of rice-husk power plants are under development in the Mekong River delta, with support from local authorities. The use of solar

power, however, is limited in Viet Nam by high development costs, and is restricted to a few projects supported by the government.

The development of nuclear power has been actively pursued in Viet Nam since the mid 1990s. It formed an important part of the National Energy Research Program for 1995–2000, run by a group of organizations including the Institute of Energy (IE), the Ministry of Industry and Trade (MOIT), Atomic Energy Research Institutes, and the Ministry of Science and Technology (MOST), with the assistance of foreign companies and the governments of Japan, France, Korea, Canada, and Russia. Through this program, a number of engineers, researchers and policymakers from Viet Nam have engaged in study and offshore training in various areas related to nuclear power. The research program concluded that nuclear power needed to be included as a key item in the economy's energy policy development in coming years. Since 2000, the government has been developing legal and policy frameworks, and technical and human infrastructures, to facilitate the development of nuclear power. These include the Atomic Energy Law (Government of Viet Nam, 2008), the “Strategy for utilization of atomic energy for peace in Viet Nam” (MOST, 2006), and a pre-feasibility study and a human resource development program for the first nuclear power plant (MOIT and IE, 2005 and 2009; MOST, 2006).

These preparations have laid the groundwork for the first unit of Viet Nam's first nuclear power plant, scheduled to begin operations in 2020. The share of nuclear power in the economy's energy mix is then expected to increase gradually, to reach 20–30% of the total electricity production by 2050. However, after the Fukushima Daiichi Nuclear Power Plant accident in Japan, safety issues in the development and operation of nuclear power plants, already a high priority for Viet Nam, now mean the program's timeframe is under review.

The Vietnamese Government has recognized the need to improve energy efficiency in parallel with its efforts to develop energy resources. In 2006, the Ministry of Industry and Trade (MOIT) launched the National Energy Efficiency Program (VNEEP) for the period 2006–2015. This is the most comprehensive and effective of a variety of initiatives undertaken in this area since 1995 (PMVN, 2006b). VNEEP sets targets to reduce the economy's total energy consumption by 3–5% annually from 2006 to 2010, rising to 5–8% annually during 2011–2015 (compared to BAU levels). The program includes six packages with 11 actions (projects) covering key areas of energy efficiency. These key areas include: the legal framework; education and information dissemination;

high-efficiency equipment and appliances; energy efficiency and conservation in industry; and the building code. A State Steering Committee (chaired by the MOIT) has been established, to oversee the implementation and monitoring of the program alongside the Energy Efficiency and Conservation Office, which has the role of coordinating the contribution of other governmental organizations (PMVN, 2006b).

There are no specific policies promoting the use of unconventional vehicle fuels (such as LPG, CNG, electricity and bio-fuel). In 2012, 100% of road transport fuels are oil-based, and are expected to remain so until 2035.

Viet Nam is in the process of reducing some of its fuel price regulations and subsidies. At times the government has required the **Vietnam National Coal Mineral Industries Group** (Vinacomin) to supply coal for power generation at below cost price, and oil and gas prices are also regulated by the government. While the coal subsidy has supported the development of industries using coal-based power, it also affects Vinacomin's profit and re-investment levels. The government has begun the gradual reduction of regulation of the domestic coal price, and is preparing a strategy for the gradual removal of subsidies for coal used in power generation.

The Petrovietnam Oil and Gas Group (PVN) is a government-owned company. Its functions include implementing sector management on behalf of the government, investing in gas pipelines, negotiating Product Sharing Contracts (PSCs) with exploring and producing companies, as well as monitoring those contracts. PVN is made up of four businesses, which together hold 100% of the company's assets: the Petroleum Exploration and Production Corporation, the Gas Corporation, the Electricity Production and Trading Corporation, and the Oil Refining and Petrochemical Corporation. PVN also encompasses other companies, enterprises and training organizations.

Viet Nam's gas and oil upstream sector is open to all, while the downstream functions such as transmission, distribution, and marketing are almost all within the PVN monopoly. Oil and gas production is carried out by PVN and private companies, including foreign companies and joint ventures with PVN, but all are required to sell through PVN.

The Electricity Law sets out the key principles for change in the power market (PMVN 2006a). It established the Electricity Regulatory Authority of Viet Nam (ERAV) to assist the Minister for Industry

and Trade in implementing regulatory activities in the electricity sector; to contribute to a market that is safe and stable, and provides a high-quality supply of electricity; to foster the economical and efficient consumption of electricity; and to uphold the equity and transparency of the sector in compliance with the law. Under this legislation, Viet Nam’s power market is to develop in three stages:

- Level 1 (2005–2014): a competitive generation power market will replace the current monopoly and subsidized power
- Level 2 (2015–2022): the establishment of a competitive wholesale power market
- Level 3 (after 2022): the realization of a competitive electricity retail market.

Electricity of Vietnam (EVN) is one of the important players in these changes, in its role coordinating the development, management and operation of the economy’s electric power industry assets. There are also Build-Operation-Transfer (BOT) and Independent Power Producer (IPP) schemes run in partnership with private investors. In 2009, 32% of the electricity supply system in Viet Nam was owned by companies other than EVN. In terms of electrification, 95.5% of villages in rural areas have access to electricity (GSO, 2011).

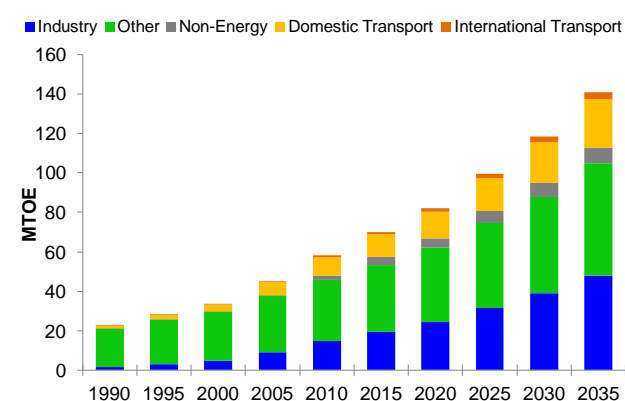
Work to enhance international cooperation in the energy field has included numerous agreements and projects that have been established and implemented within a framework of cooperation at a regional level. These include the ASEAN Power Grid, Trans-ASEAN Gas Pipeline, and Regional Power Trade in the Greater Mekong subregion. Viet Nam also has bilateral agreements on energy trade with neighbouring economies. In 2000, the governments of Viet Nam and Lao PDR signed an energy cooperation accord. Under this accord, Viet Nam will import about 2000 MW of electricity from Lao PDR (APERC, 2009). The governments of Viet Nam and Cambodia have also signed an energy cooperation agreement, under which Viet Nam has supplied 80–200 MW of electricity to Cambodia via a 220 KV transmission line since 2009 (APERC, 2009). In the future, when Cambodia builds hydro power plants and starts participating in the regional electricity market, Viet Nam will in turn buy electricity from Cambodia. In 2009, Viet Nam bought over 4.1 billion KWh of electricity from China and this annual amount will continue to increase. By 2020, a 500 KV transmission line between the two economies will be completed. Similar cooperative activities are underway in the coal, oil and gas sectors.

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

Based on our business-as-usual (BAU) assumptions under the current economic conditions, total final energy demand for Viet Nam will continue to rise at an average annual rate of about 3.6% over the outlook period. This is less than the projected GDP growth for the economy. As a result, the total final energy demand in 2035 will reach about 140 Mtoe, which is a more than two-fold increase on 2010 levels. Energy consumption will increase in every sector of the economy, including the residential and commercial sectors, which are influenced by growing modernization within Viet Nam. The strongest growth, however, is in the industry and transport sectors.

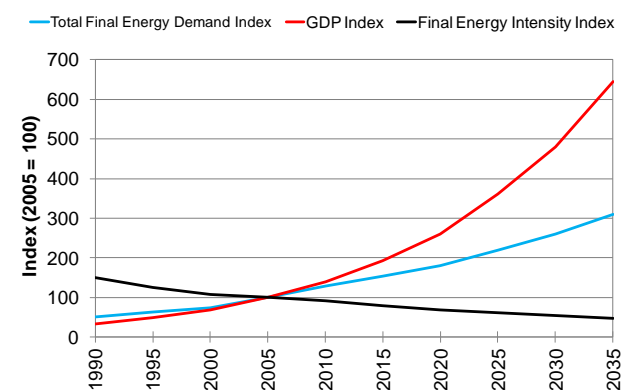
Figure VN2: BAU Final Energy Demand



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

By the end of the outlook period, oil is expected to represent the largest share of the final energy demand (34%), followed by electricity (24%) and coal (22%). Between 2010 and 2035, the consumption of gas is projected to grow the fastest, at an average annual rate of 7%. Final energy intensity is expected to decline by about 52% between 2005 and 2035.

Figure VN3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

Industry is the sector that will consume the third largest amount of energy (after the Other and Non-Energy sectors) in Viet Nam by the end of the outlook period, accounting for 35% of the total final energy consumption in 2035. This is higher than the sector's 25% share in 2010.

Energy demand in the industry sector is projected to grow at an average annual rate of 5.0% until 2035, reflecting the rapid growth of Viet Nam industry generally. Viet Nam's heavy industry is dominated by iron and steel, and non-metallic minerals. However, the growth in heavy industry's energy demand will be significantly slower than in 2000–2009. This is due to the removal of the electricity price subsidies after 2015 and to increased regulation to reduce environmental pollution. The energy demand growth rate for other industries is expected to match that in the 2000–2009 period.

The industrial use of gas is projected to increase from 0.3 Mtoe in 2010 to 1.8 Mtoe in 2035, which at 7.3% is the fastest annual growth rate for fuels.

Transport

The share of the final energy demand taken up by the transport sector (includes both international and domestic transport sectors) is expected to increase over the outlook period, from 17.8% in 2010 to 20% in 2035. It will increase at an average annual rate of 4.1% over this period.

After 2000, vehicle ownership in Viet Nam began to rapidly increase; however, the motorbike will remain the most popular means of passenger transport. Over the outlook period, the growth in motorbike ownership is expected to slow, peaking at 27 million units in 2030. In contrast, the ownership of four-wheel vehicles will grow significantly to 2035, as incomes rise and the road infrastructure improves.

Because there are no government incentives to switch to alternative fuels and vehicles, the demand for conventional fuel for transportation, such as diesel, gasoline and fuel oil, is expected to continue rising.

Other

The energy used in the 'other' sector (which includes the residential, commercial and agriculture subsectors) is expected to increase from 31 Mtoe in 2010 to 57 Mtoe in 2035, rising at an average annual rate of 2.4%. This includes a high growth in the demand for electricity (6.5%), supported by strong GDP growth, rising household incomes and high rates of urbanization during the outlook period.

PRIMARY ENERGY SUPPLY

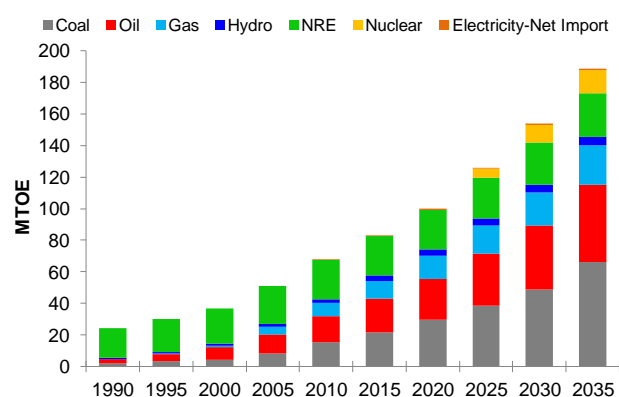
Viet Nam's primary energy supply is projected to increase almost three-fold over the outlook period, from 68 Mtoe in 2010 to about 188 Mtoe in 2035. This is based on an average annual increase of 4.2%. The proportion of non-commercial energy sources (biomass such as firewood) in the mix will decrease gradually. In 2010, non-commercial energy sources made up 37% of the primary energy supply; in 2035 they will provide just over 15%, as rising household incomes and the shift to urban centres prompts a shift to commercial energy sources.

Since 1990, Viet Nam has been a net energy exporter, with crude oil and coal as its main energy exports. However, from 2020 Viet Nam is expected to become a net importer of energy, as a result of its high energy demand growth and the limitations on available energy resources. The economy's oil import dependency is expected to start from 2014, reaching 66% in 2035.

The 2035 petroleum product demand in Viet Nam is forecast to be three times greater than the current level, and this demand will not be able to be met from domestic resources. In addition, the revenue from crude oil exports is diminishing, while the cost of energy imports is increasing. This means it is crucial for Viet Nam to use its indigenous resources as efficiently as possible and to minimize its imports.

Viet Nam is expected to reduce primary energy intensity by nearly 43% between 2005 and 2035—from 286 tonnes of oil equivalent (toe) per unit of GDP (in 2005 USD million PPP) to 164 toe per unit of GDP.

Figure VN4: BAU Primary Energy Supply



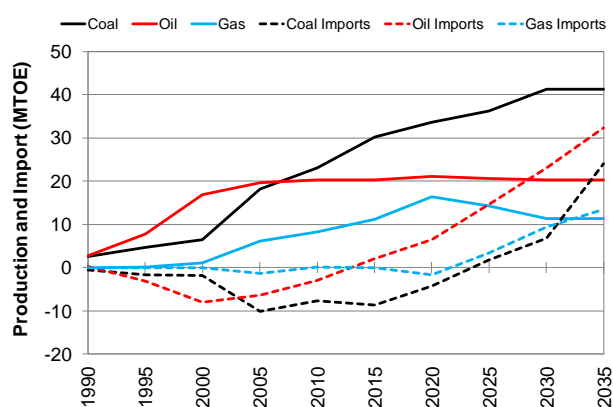
Source: APERC Analysis (2012)

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

Viet Nam's first oil refinery successfully started production in early 2009. A second refinery with the same capacity is expected to be in action by 2015. This outlook also assumes a third refinery, with a

150 000 barrel per day capacity, will start operations after 2020. In the final decade of the outlook period, 20–25 million tonnes of domestic petroleum products from the new refineries (accounting for about 50% of total supply) should be reaching the market. This will significantly contribute to the reduction of petroleum product imports to Viet Nam.

Figure VN5: BAU Energy Production and Net Imports



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

Coal will replace oil to form the largest share of the total primary energy supply. Coal demand growth will be driven mainly by the rapid development of the electricity and industry sectors, accounting for 35% of primary energy supply in 2035. After 2020, coal and natural gas demand are expected to exceed indigenous supply.

Oil will make up the second largest share of the primary energy supply, accounting for 26% in 2035. It is mainly used in the transport and industry sectors. In 2009, Viet Nam was an exporter of crude oil, but a net importer of oil products. As oil reserves decline over the outlook period, Viet Nam's oil import dependency is expected to increase to 66% in 2035.

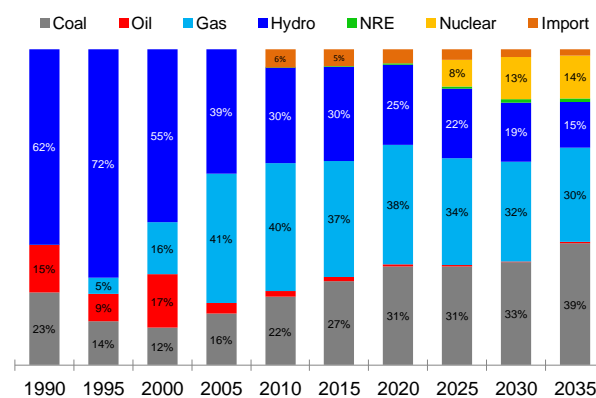
Electricity imports are expected to increase by 2020 and will account for 0.4% of the primary energy supply by 2035.

Excluding large-scale hydro, other types of renewable energy such as mini-hydro, wind, biomass, geothermal, and municipal solid waste landfill gas, will continue to be promoted. Together they will contribute 15% of the primary energy supply in 2035. Nuclear energy—based on it coming online after 2020—is expected to provide 8% of the total primary energy supply in 2035.

ELECTRICITY

The current high electricity elasticity to GDP (1.9 in the period 2005–2010) is expected to drop to 1.1 by 2035. The electricity demand forecast in the government's Master Plan on Power Development (MOIT and IE, 2011) is substantially higher than in this APERC outlook—the differences between our analysis and the Vietnamese Government's projections can be explained by our expected drop in electricity elasticity.

Figure VN6: BAU Electricity Generation Mix



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

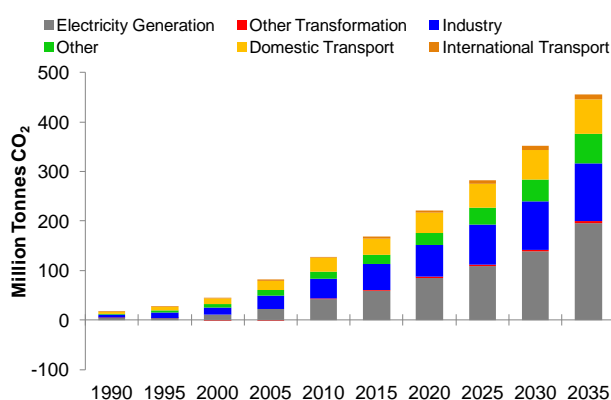
Plans for two nuclear power plants with a total capacity of 2000–4000 MW in Ninh Thuan province, in central Viet Nam, are currently at feasibility study stage. This BAU projection assumes the nuclear power plants will have started commercial operations by 2022. In 2035, the sources for electricity generation in Viet Nam are expected to be, in descending order, coal, gas, hydro, nuclear, renewable energy and fuel oil.

Electricity generation is projected to increase at an average annual rate of 6.1%, reaching 409 TWh in 2035. Over the outlook period, the hydro share of electricity production will decrease considerably, from 30% to 15%, as most potential locations for big and medium hydro plants become fully developed. By contrast, coal-fired generation will substantially increase, and will have the biggest share in 2035 (39%). The share provided by gas-fired plants is projected to decrease to 30% by 2035. Meanwhile, the nuclear share will increase from zero in 2009 to 14% in 2035. In addition, as the government continues to pursue its goal of increasing the use of domestic resources, new renewable energy sources (NRE) are expected to contribute to electricity generation, especially in remote areas where connection with the grid is not economically feasible. NRE's share will increase from zero in 2009 to 1% in 2035.

CO₂ EMISSIONS

Viet Nam is currently one of the lowest per capita CO₂ emitters in APEC; 2010 levels were 1.5 tonnes of CO₂ per person. CO₂ emissions from fuel combustion are projected to grow at an average annual rate of 5.2% over the outlook period, reaching about 466 million tonnes of CO₂ in 2035. Emissions are expected to increase to relatively high levels as Viet Nam industrializes and the economy uses more carbon-intensive energy sources. This particularly applies to coal used for power generation.

Figure VN7: BAU CO₂ Emissions by Sector



Source: APERC Analysis (2012)

The decomposition analysis shown in Table VN1 suggests the growth in Viet Nam’s CO₂ emissions from fuel combustion is driven largely by economic growth, moderated by the declining energy intensity of GDP (energy efficiency measures).

Table VN1: 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	5.5%	3.2%	1.4%	1.4%	1.0%
Change in Energy Intensity of GDP	-2.3%	-0.9%	-1.8%	-1.8%	-2.0%
Change in GDP	7.6%	7.0%	6.5%	6.4%	6.3%
Total Change	11.0%	9.4%	6.0%	5.9%	5.2%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

Under BAU, Viet Nam’s energy outlook is reasonably positive, considering the domestic and global aspects of this economy. From 2010–2035, energy security and per capita GDP will increase, while the average annual growth rate of CO₂ emissions (at 5.2%) will be less than the GDP growth rate of 6.3%. This emission growth rate is also much lower than the recorded CO₂ emission growth rate during 1990–2009 (10.4%). However, there are still significant opportunities for improved environmental sustainability; particularly in the power generation, transportation and industry sectors.

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.

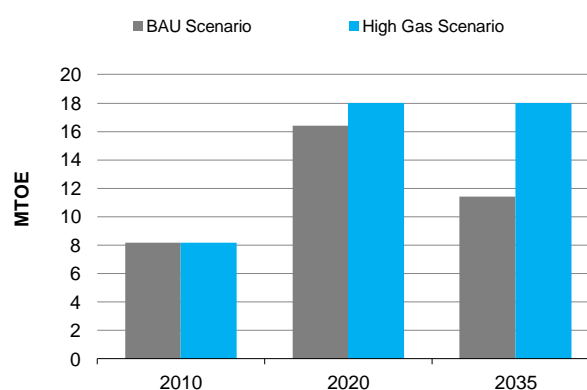
HIGH GAS SCENARIO

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.

Viet Nam has no known reserves for unconventional gas, but there is potential for offshore deep water conventional natural gas. Realizing this potential requires a significant investment in exploration, production and transportation infrastructure. The High Gas Scenario for Viet Nam assumes sufficient investment is available for additional gas extraction from these new, more challenging gas fields.

Under these assumptions, the High Gas Scenario for Viet Nam assumed the production increase shown in Figure VN8, which is 57% higher than BAU by 2035. Production is expected to increase gradually to reach its peak in 2025. Due to the retirement of old, existing gas fields, production will begin to decrease again and will plateau from 2030 onwards at the 2020 production level.

Figure VN8: High Gas Scenario – Gas Production



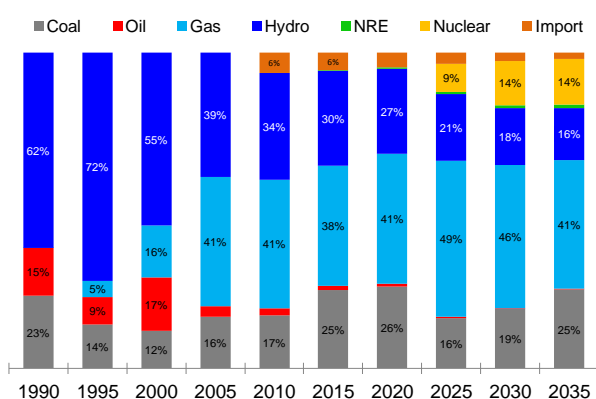
Source: APERC Analysis (2012)

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. For Viet Nam, the additional gas production provides an opportunity to reduce local air pollution and CO₂

emissions by burning less coal. Any remaining amount of gas will be exported via the Trans-ASEAN Gas Pipeline (TAGP).

Additional gas in the High Gas Scenario was assumed to replace coal in electricity generation. Figure VN9 shows the High Gas Scenario electricity generation mix. This graph may be compared with the BAU scenario graph in Figure VN6. It can be seen that the gas share has increased by 11% by 2035, while the coal share has declined by 14%.

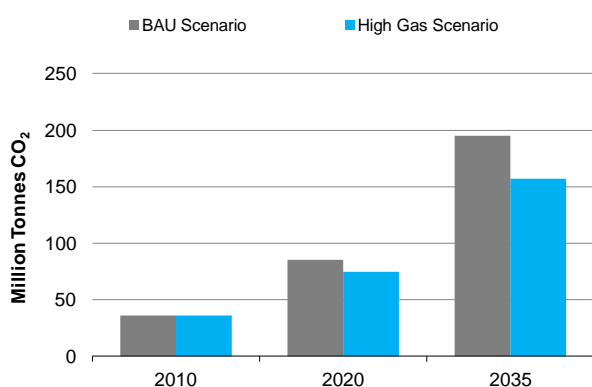
Figure VN9: High Gas Scenario – Electricity Generation Mix



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

A higher gas share in the electricity generation mix is projected to reduce the CO₂ emissions in electricity generation by 20% by 2035, since gas has roughly half the CO₂ emissions per unit of electricity generated of coal. Figure VN10 shows this CO₂ emissions reduction.

Figure VN10: High Gas Scenario – CO₂ Emissions from Electricity Generation



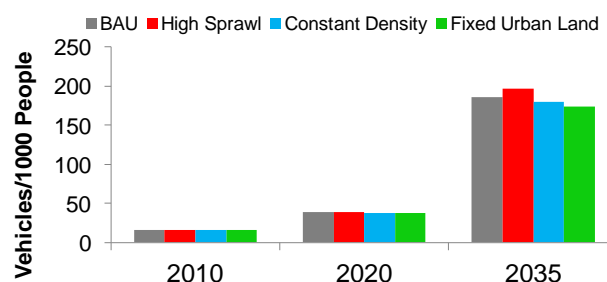
Source: APERC Analysis (2012)

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 VN11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. Since vehicle ownership is still well below saturation point in Viet Nam, the impact of urban planning on vehicle ownership is barely discernible in 2020, but by 2035 the difference between the four scenarios are more pronounced. In 2035, vehicle ownership will be about 6% higher in the High Sprawl scenario compared to the BAU scenario in 2035, and about 7% lower in the Fixed Urban Land scenario.

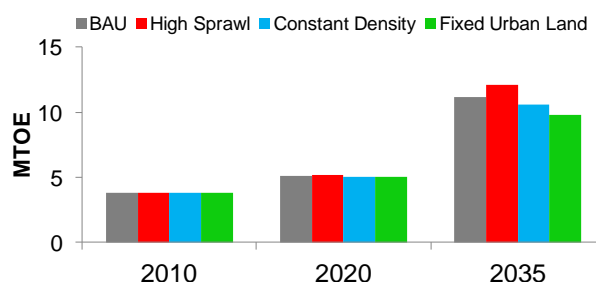
Figure VN11: Urban Development Scenarios – Vehicle Ownership



Source: APERC Analysis (2012)

Figure VN12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. The impact of urban planning on light vehicle oil consumption is relatively small and similar to that on vehicle ownership. Light vehicle oil consumption will be 8% higher in the High Sprawl scenario compared to the BAU scenario in 2035, and about 12% lower in the Fixed Urban Land scenario.

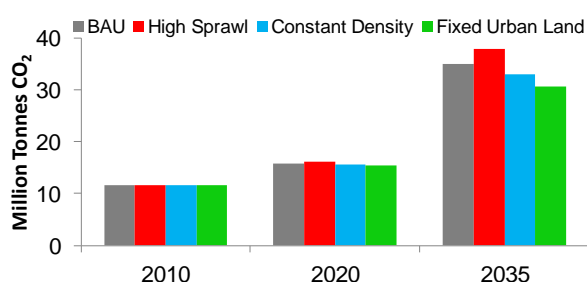
Figure VN12: Urban Development Scenarios – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure VN13 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.

Figure VN13: Urban Development Scenarios – Light Vehicle Tank-to-Wheel CO₂ Emissions



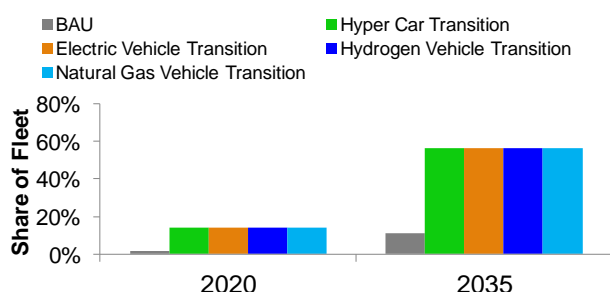
Source: APERC Analysis (2012)

VIRTUAL CLEAN CAR RACE

To understand the impacts 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 VN14 shows the evolution of the four-wheel light vehicle fleet under BAU and the four alternative ‘Virtual Clean Car Race’ scenarios. By 2035, the share of alternative vehicles in the four-wheel fleet reaches around 53% compared to about 4% in the BAU scenario. The conventional vehicles in the fleet is thus only about 47% compared to about 96% in the BAU scenario.

Figure VN14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet

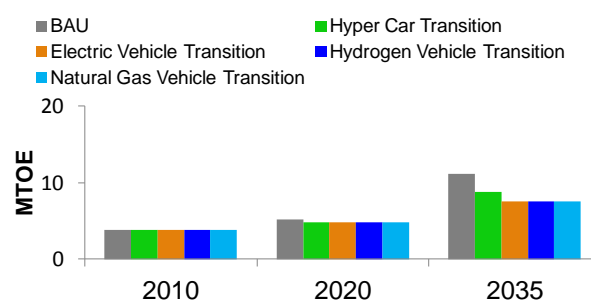


Source: APERC Analysis (2012)

Figure VN15 shows the change in all light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by 32% in the Electric Vehicle Transition, Hydrogen Vehicle

Transition, and Natural Gas Vehicle Transition scenarios compared to BAU, as these alternative vehicles do not use oil. (In this graph, motorbikes are also included in the light vehicle fleet. Viet Nam is somewhat unique in that they will account for a significant share—about 35% of light vehicle oil consumption in 2035 under BAU. Motorbike energy demand does not change in the alternative vehicle scenarios.) Oil demand in the Hyper Car Transition scenario is also significantly reduced compared to BAU—23% by 2035.

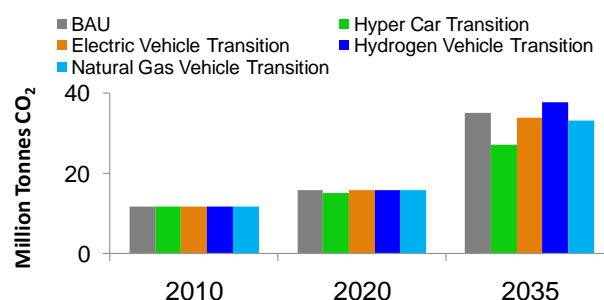
Figure VN15: Virtual Clean Car Race – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure VN16 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 impact of each scenario on emissions levels may differ significantly from its impact on oil consumption, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

Figure VN16: Virtual Clean Car Race – Light Vehicle CO₂ Emissions



Source: APERC Analysis (2012)

In Viet Nam, the Hyper Car Transition scenario is the clear winner with an emissions reduction of 22% compared to BAU in 2035. Both the Electric Vehicle Transition and Natural Gas Vehicle Transition scenarios offer less emissions reductions (3% and 5%, respectively). This is principally because

the marginal source for added electricity demand is coal-fired generation, which has an adverse impact on the emissions of electric vehicles. The Hydrogen Vehicle Transition scenario produces 8% more emissions compared to BAU in 2035. Higher emissions for this scenario can be attributed to the process of hydrogen production from steam methane reforming of natural gas.

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