PAPUA NEW GUINEA

- *Papua New Guinea will become a major LNG exporter with the start-up of LNG export projects after 2014.*
- *Papua New Guinea's total primary energy supply is projected to increase from 2.2 Mtoe in 2010 to 6.7 Mtoe in 2035; fuel gas for LNG liquefaction accounts for a significant portion of this increase.*
- *Papua New Guinea may shift from a net oil exporter to a net oil importer after 2020 unless new reserves of oil are found.*
- *Papua New Guinea has a significant hydroelectric and geothermal potential. The government plans to either build or upgrade 800 MW of hydro electricity and over 500 MW of geothermal generating capacity within the next 10–15 years to provide a reliable and affordable electricity supply.*

ECONOMY

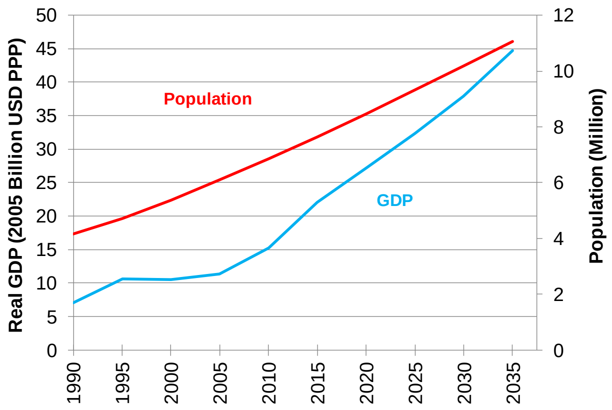
Papua New Guinea is located in the south-western Pacific Ocean, just south of the equator. It is made up of over 600 islands, including the eastern half of New Guinea—the world's second-largest island—as well as the Bismarck Archipelago, the D'Entrecasteaux island group, and the three islands of the Lousiade Archipelago. New Guinea and the larger islands are mountainous and rugged, with a string of active volcanoes dotting the north part of the mainland and continuing to the island of New Britain.

Papua New Guinea's population was 6.7 million in 2009, with more than 80% living in rural areas. Most of the rural population are dependent on subsistence farming. Only 13% of households have access to electricity (DNPM, 2010a).

The population is expected to grow at an average annual rate of 1.9% over the outlook period. The population in Papua New Guinea's major cities and towns is expected to double by 2035, to reach 2 million people as a result of the high rural-urban migration to the National Capital District and other major towns like Madang, Mt Hagen, Lae, Kimbe and Rubail. Rural provinces such as Chimbu, East Sepik, Milne Bay, Oro, Gulf and Munus are expected to experience an out-migration of people as a result of a lack of services and income opportunities.

Papua New Guinea has achieved moderate economic growth and government surpluses since 2003. Economic growth has primarily been aided by high commodity prices. The real GDP growth rate between 2005 and 2010 was 6%. GDP is expected to continue to expand at an average annual rate of 4.4% over the outlook period.

Figure PNG1: GDP and Population



Sources: USDA ERS (2012) and APERC Analysis (2012)

The economy of Papua New Guinea can be separated into subsistence non-market and market sectors. The market economy is dominated by large-scale resource projects, particularly mining, oil and gas. Agriculture currently accounts for 13% of GDP and supports more than 75% of the population (DNPM, 2010a). The economy's primary cash crops are coffee, palm oil, cocoa, copra, tea, rubber and sugar. Some of the rural population are involved in smallholder cash cropping of coffee, cocoa and copra. Operations in Papua New Guinea's mining, timber, and fishing sectors are largely foreign owned.

Papua New Guinea is endowed with substantial mineral resources, including gold, copper and natural gas. Government revenue depends heavily on minerals exports and after 2014 it will benefit from the start of liquefied natural gas (LNG) exports. The remainder of Papua New Guinea's industry sector is made up of light industries and agricultural processing industries.

Papua New Guinea's economic development will require considerable growth in the coverage and quality of its state transport network. Currently, Papua New Guinea has one of the lowest road densities in the world. The total road network is

30 000 kilometres (km), of which 8460 km are state roads. Only 28% of the 8460 km of state roads were in a good condition in 2010. A comprehensive program of rehabilitating existing roads and constructing new roads would expand the state road network to 25 000 km by 2035 (DNPM, 2010a, p. 66). Congestion on roads in the urban areas will be a growing issue as the number of passenger vehicles is expected to increase rapidly with rising income levels.

About 60% of Papua New Guinea's population depends on water transportation including for the delivery of goods and services. The water transport system's services and infrastructure will also require upgrading. Port Moresby, Lae and Kimbe are the economy's busiest seaports, accounting for more than 80% of its cargo. Between 2010 and 2035 it is projected the cargo throughput at all Papua New Guinea's ports will increase five-fold under rapid development (DNPM, 2010a).

The aviation industry will continue to play a vital role. For many remote parts of Papua New Guinea, air transport is their only possible link with the main centres. However, the economy's regional airports do not meet international standards and need to be developed to handle larger planes and increased passenger numbers.

ENERGY RESOURCES AND INFRASTRUCTURE

The Papuan Basin in the south-eastern part of Papua New Guinea is the most explored and developed oil and gas region in the economy—particularly the Papuan Fold Belt and Papuan Foreland areas. There has also been exploration in the North New Guinea basin, and the Cape Vogel, New Ireland and Bougainville basins.

Papua New Guinea's proven hydrocarbon reserves consist primarily of natural gas (440 billion cubic metres (bcm)), followed by oil (0.660 billion barrels) and gas condensates (0.262 billion barrels). The inclusion of inferred, mean-risk reserves would increase oil reserves by an additional 1 billion barrels, and natural gas by more than 283 bcm (PNG CMP, 2012).

Oil development started in 1991 with crude oil production at the Kutubu fields. Production at the Kutubu fields peaked in 1993, but has been declining. The fields are projected to be depleted by 2026 (DNPM, 2010a).

In 2005, Papua New Guinea's first oil refinery started production, sourcing crude oil from both local oil fields and imports. In 2008, 5.8 million barrels of crude oil were processed (DNPM, 2010a). The capacity of the existing refinery, with expansion, could reach 9 million barrels by 2035.

Papua New Guinea's ExxonMobil-led LNG export project is expected to start up in 2014, with a capacity of 6.6 million tonnes per year. Consideration is being given to adding a third train (ExxonMobil, 2010). InterOil has obtained government approval for its plans to develop another LNG project at Elk-Antelope with construction starting after 2014. Its project would be similar in size to the ExxonMobil-led LNG export project (Platts, 2012). The project's final investment decision should be reached in 2013. These projects can greatly stimulate Papua New Guinea's economy. In general, Papua New Guinea is considered to be underexplored for gas.

Papua New Guinea has a significant hydroelectric potential. Its land area includes nine large hydrological drainage divisions (basins). The largest river basins are the Sepik (catchment area of 78 000 square kilometres (sq km)), the Fly (61 000 sq km), the Purari (33 670 sq km), and the Markham (12 000 sq km). There are other catchments of less than 5000 sq km, in areas that are very steep. On the mainland, the mean annual rainfall ranges from less than 2000 mm to 8000 mm in some mountainous areas, while the island groups receive a mean annual rainfall of 3000–7000 mm. The gross theoretical hydropower potential for Papua New Guinea is 175 terawatt-hours (TWh) per year (Encyclopedia of Earth, 2008). By 2035, 800 MW of hydro electricity generating capacity is planned to be either built or upgraded (DNPM, 2010a).

The Geothermal Energy Association estimates Papua New Guinea's geothermal potential at 21.92 TWh. The association also categorizes Papua New Guinea as an economy that could, in theory, meet all its power needs from geothermal sources alone, well into the future (GEA, 2010).

The government in partnership with the private sector will pursue the development of renewable sources, including geothermal. By 2035, about 500 MW of new geothermal electricity generating capacity could be put into operation in the economy (DNPM, 2010a).

Papua New Guinea has three large regional electricity power grids. The Port Moresby system serves the National Capital District and surrounding areas in the Central Province. The main source of generation is the Rouna system consisting of four hydro stations on the Laloki River, controlled water storage in the Sirinumu Reservoir, and a small generator at the toe of the Sirinumu dam. The total generation capacity from the Rouna power stations is

62.2 MW. A thermal power station at Moitaka, outside Port Moresby, has a generation capacity of 30 MW based on diesel and gas turbines. A privately-owned diesel power station at Kanudi has a capacity of 24 MW (JOGMEC, 2011).

The Ramu system serves the load centres of Lae, Madang and Gusap in the Momase Region and the Highlands centres of Wabag, Mendi, Mt Hagen, Kundiawa, Goroka, Kainantu and Yonki. The main source of generation is the Ramu Hydro Power Station with an installed capacity of 75 MW, comprising five units of 15 MW each. Additional hydro energy is supplied by Pauanda, a 12 MW run-of-river station in the Western Highlands Province. Power is also purchased when required from the privately owned Baiune Hydro Power Station at Bulolo in the Morobe Province, and varies between 1 MW to 2 MW depending on availability. There are diesel plants at Madang, Lae, Mendi and Wabag. These plants serve as stand-by units.

The Gazelle Peninsula system serves the townships of Rabaul, Kokopo and Keravat and the system is powered by the 10 MW Warangoi hydro plant, the 8.4 MW Ulagunan diesel plant, and the 0.5 MW Kerevat diesel plant (PPL, 2012).

In addition to these three grids there are also oil-based power stations serving various isolated communities.

ENERGY POLICIES

The Papua New Guinea Government has jurisdiction over energy matters. The Papua New Guinea National Energy Policy and the Rural Electrification Policy are under review by the Government Task Force on Policy. The exploration and development of petroleum resources are authorised and administered by the Department of Petroleum and Energy.

The Papua New Guinea Government has initiated the Papua New Guinea Vision 2050 (NSPT, 2010) which has seven 'pillars'; natural resources, climate change and environmental sustainability are among the areas of focus. In the Vision 2050, the Papua New Guinea Government notes the economy can make a significant contribution to reducing global greenhouse gas (GHG) emissions with good forest management and through the development of its hydroelectric and geothermal potential.

In its Copenhagen Accord response of 2 February 2010, Papua New Guinea stated it was seeking to "decrease GHG emissions at least 50% before 2030 while becoming carbon neutral before 2050", subject to certain conditions (UNFCCC, 2010).

In March 2010, the Papua New Guinea Government announced the Development Strategic Plan 2010–2030 (DNPM, 2010a), which has five pillars—one of which is 'natural resources and environment'.

In October 2010, the Papua New Guinea Government announced its Medium Term Development Plan (MTDP) 2011–2015 (DNPM, 2010b). The MTDP 2011–2015 will focus on increasing access to electricity for all households in the economy. A comprehensive analysis of the cost effectiveness of various alternative sources of power will be required.

Petromin PNG Holdings Limited (Petromin), a state-controlled company, holds the economy's oil and gas assets and seeks to maximise indigenious ownership and revenue in the petroleum and gas sectors. It will do this through proactive investment strategies either alone or in partnership with resource developers (PNG CMP, 2012).

The state-owned PNG Power Ltd (PPL) is a fully integrated power authority responsible for the generation, transmission, distribution and retailing of electricity throughout Papua New Guinea and for servicing individual electricity consumers.

PPL services customers in almost all urban centres throughout the economy, encompassing the industrial, commercial, government and domestic sectors. The company also has a regulatory role in approving licences for electrical contractors, providing certification for electrical equipment and appliances to be sold in Papua New Guinea, and providing safety advisory services and checks for major installations.

PPL is regulated under a price control mechanism known as the maximum average price (MAP). Under MAP, for each of the tariffs PNG Power Ltd charges to the different classes of its consumers (Industrial, General Supply, Domestic Customers and Public Lighting) the average price of those tariffs must not exceed the MAP determined by the Papua New Guinea Government (PPL, 2012).

The Papua New Guinea Government has been successful in attracting major international oil and gas companies to the economy with its very open oil and gas industry structure.

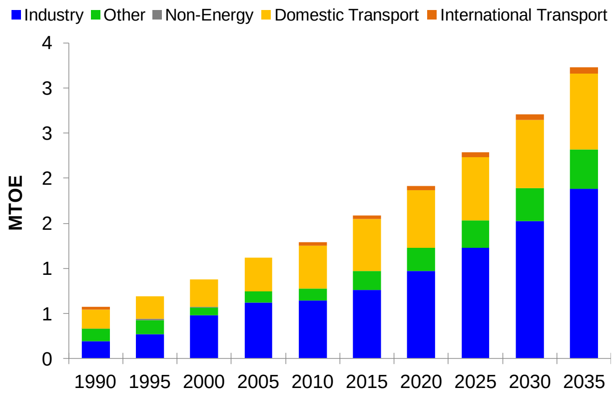
A key strategic objective for the Papua New Guinea Government's energy policy is to provide access to electricity to at least 70% of households by 2030 (DNPM, 2010a).

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

Business-as-usual (BAU) final energy demand is expected to grow at 3.8% per year over the outlook period. The industry sector will account for 59% of final demand in 2035, driven by the development of LNG projects.

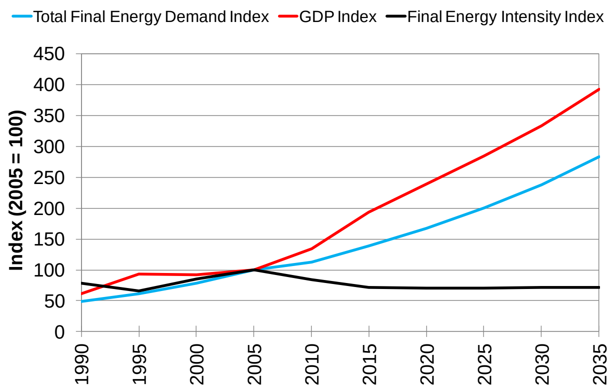
Figure PNG1: BAU Final Energy Demand



Source: APERC Analysis (2012)
Historical Data: APEC (2011)

Final energy intensity is expected to decline by about 28% between 2005 and 2035, with the industry, transport and services sectors projected to see a substantial improvement in their energy intensity.

Figure PNG3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

This outlook assumes Papua New Guinea's industry sector will retain its current structure, which consists mainly of mining, light manufacturing and agricultural processing. However, the scale of production of these industries is expected to grow.

Final industry energy demand is projected to increase at an average annual rate of 4.4%, from 0.6 Mtoe in 2010 to 1.9 Mtoe in 2035.

Transport

Final energy demand in the transport sector is expected to increase at an average annual rate of 2.3% over the outlook period. This demand will be met almost entirely by oil-derived fuels.

Other

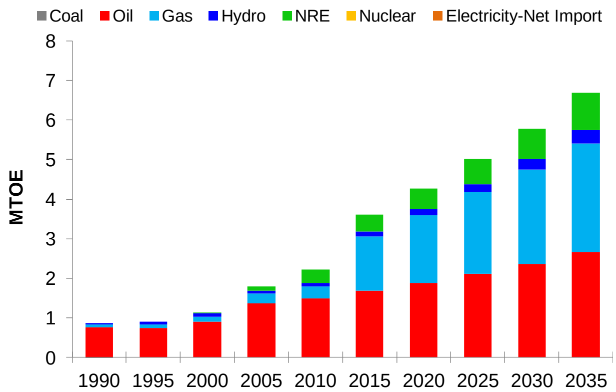
The final energy demand in the 'other' sector, which includes residential, commercial and agricultural users, is projected to increase at an average annual rate of 4.8% over the outlook period. In the 'other' sector, commercial energy demand will be primarily for electricity, kerosene and LPG (liquefied petroleum gas). There are currently no plans for the construction of a gas distribution network for residential and commercial customers.

The projection for the 'other' sector includes only the final demand for commercial energy, due to inadequate information about non-commercial energy use in Papua New Guinea. The economy's consumption of non-commercial biomass is projected to remain significant over the outlook period.

PRIMARY ENERGY SUPPLY

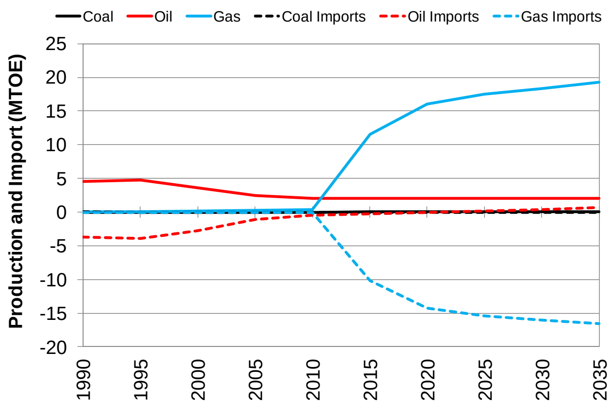
Papua New Guinea's primary energy supply in the 2010–2035 period is projected to grow at an annual rate of 4.5%. Oil, which was the predominant form of energy before 2010, will be increasingly supplemented with natural gas and new renewable energy (NRE) (mainly geothermal). Papua New Guinea has historically been a modest oil exporter, but could become an oil importer after 2020.

Figure PNG4: BAU Primary Energy Supply



Source: APERC Analysis (2012)
Historical Data: APEC (2011)

Figure PNG5: BAU Energy Production and Net Imports



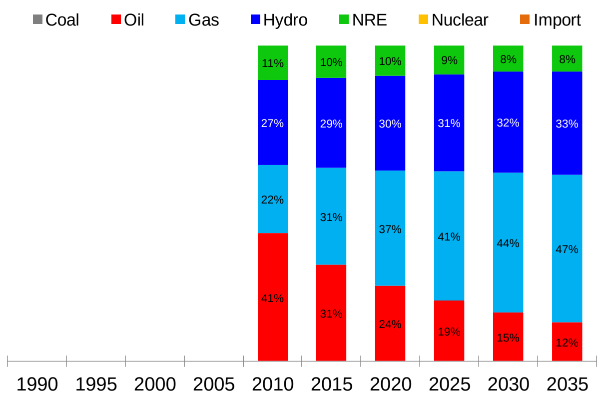
Source: APERC Analysis (2012)
Historical Data: APEC (2011)

Although not part of final energy demand, about 25% of Papua New Guinea's primary energy supply in 2035 will be used to produce and liquefy natural gas for export. And, although not part of either primary energy supply or final energy demand, about 86% of Papua New Guinea's natural gas production will be exported.

ELECTRICITY

Electricity generation is projected to grow by 4.9% annually over the outlook period and to reach 12.2 TWh in 2035.

Figure PNG6: BAU Electricity Generation Mix



Source: APERC Analysis (2012)
Historical data is not available for Papua New Guinea.

Natural gas electricity generation is expected to increase over 700% between 2010 and 2035 as a result of a natural gas supply becoming available in the Port Moresby area.

Diesel and heavy oil generated electricity have been the main contributors to the high cost structure in the economy's electricity sector. After 2015, diesel and heavy oil generators will be phased out and retained mainly for back-up purposes.

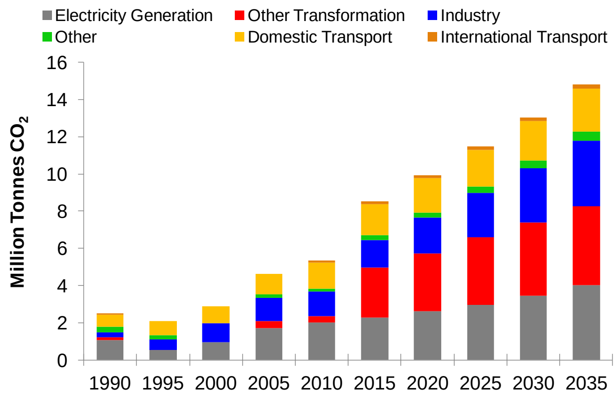
Papua New Guinea has no plans to use coal for power generation.

CO_2 EMISSIONS

Papua New Guinea's CO_2 emissions from the combustion of fuels are projected to reach 14.8 million tonnes in 2035, which is almost a 2.8 times increase from the 2010 level of 5.5 million tonnes.

In 2035, electricity generation and other transformation (primarily own-use in LNG liquefaction plants) are projected to contribute the largest shares of CO_2 emissions (4.0 million and 4.2 million tonnes, respectively), followed by industry (3.6 million tonnes) and transport (2.5 million tonnes).

Figure PNG7: BAU CO_2 Emissions by Sector



Source: APERC Analysis (2012)

From the decomposition analysis shown in Table PNG1, it can be seen that economic growth at an annual rate of 4.4% through the outlook period drives the growth in Papua New Guinea's CO_2 emissions. This will be offset by modest reductions in energy intensity and carbon intensity (in particular, the shift away from oil).

Table PNG1: Analysis of Reasons for Change in BAU CO_2 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	-0.8%	-1.1%	-0.7%	-0.6%	-0.5%
Change in Energy Intensity of GDP	1.7%	-1.1%	-0.4%	-0.5%	-0.3%
Change in GDP	3.3%	6.0%	4.9%	4.7%	4.4%
Total Change	4.2%	3.6%	3.9%	3.5%	3.5%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

Given the success of Papua New Guinea's efforts to attract investment in gas exploration and development, the economy should be able to achieve the significant growth in natural gas production we project throughout the outlook period. Our business-as-usual projection, however, shows Papua New Guinea will become a net oil importer before 2035 unless significant new oil reserves are found.

There is a great potential to replace oil in electricity generation. Papua New Guinea is fortunate to have a diversity of lower-carbon options, including the greater use of geothermal and hydropower resources. The development of these resources will have high upfront investment costs. However, they may well be more economic in the long run, compared to the more readily available option of gas-fired electricity generation.

The needs for specialised expertise and considerable financial resources mean Papua New Guinea's development will depend on a transparent, stable, and fair incentive regime for foreign investors.

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, although only two could be developed for Papua New Guinea.

HIGH GAS SCENARIO

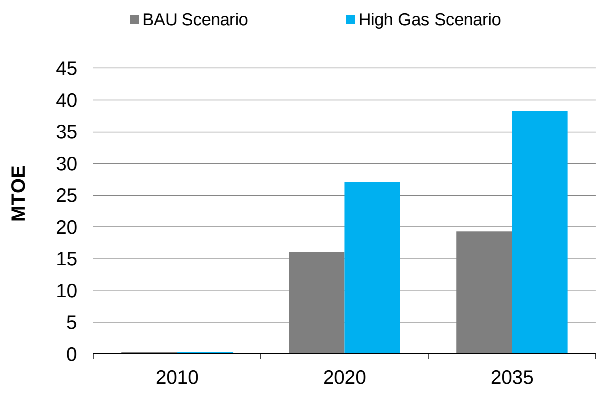
To understand the impacts higher gas production might have on the energy sector, an alternative 'High Gas Scenario' was developed. The assumptions behind this scenario are discussed in more detail in Volume 1, Chapter 12. The scenario was built around estimates of gas production that might be available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

The High Gas Scenario production for Papua New Guinea assumed a production increase almost double the BAU levels, as shown in Figure PNG8. Papua Guinea has the potential for increasing production based on resources which are believed to exist, but this will require significant investment in both production and LNG infrastructure. The High Gas Scenario assumes a continuing transparent, stable, and fair incentive regime for foreign investors, which will enable greater investment in gas production for LNG exports to international markets.

The major impact of this scenario would be to enable Papua New Guinea to increase its LNG exports to other APEC economies, thereby enabling them to replace more coal with natural gas in electricity generation. Papua New Guinea itself uses no coal in electricity generation, even in the BAU scenario, so we assume no change in the generation mix. Hence Figures PNG9 and PNG10 are not shown.

There may be an additional potential for Papua New Guinea to replace some of the remaining oil used in electricity generation with natural gas. However, oil generation may be needed to serve remote communities where natural gas would not be available. Due to data limitations, this option was not examined.

Figure PNG8: High Gas Scenario – Gas Production



Source: APERC Analysis (2012)

ALTERNATIVE URBAN DEVELOPMENT SCENARIOS

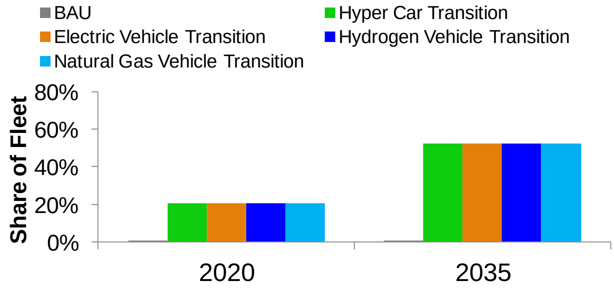
The three alternative urban development scenarios were not examined for Papua New Guinea due to a lack of adequate data. Hence Figures PNG11 to PNG13 are not shown.

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 PNG14 shows the evolution of the vehicle fleet under BAU and the four 'Virtual Clean Car Race' scenarios. By 2035, the share of alternative vehicles in the fleet reaches around 51% compared to about 1% in the BAU scenario. The share of conventional vehicles in the fleet is thus only about 48%, compared to about 99% in the BAU scenario.

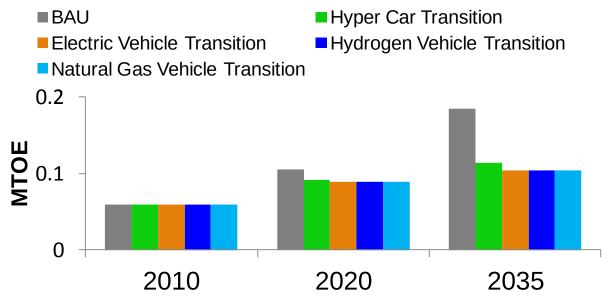
Figure PNG14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet



Source: APERC Analysis (2012)

Figure PNG15 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by 52% 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 38% by 2035—even though these highly-efficient vehicles still use oil.

Figure PNG15: Virtual Clean Car Race – Light Vehicle Oil Consumption

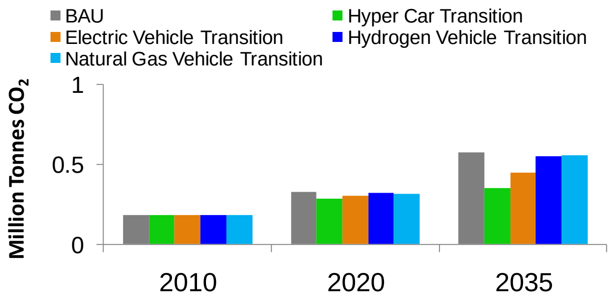


Source: APERC Analysis (2012)

Figure PNG16 shows the change in light vehicle CO_2 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 CO_2 emissions is defined as the change in emissions from electricity and hydrogen generation. The emissions impact of each scenario may differ significantly from its oil consumption impact, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

In Papua New Guinea, the Hyper Car Transition scenario is the winner in terms of CO_2 emissions savings, with an emissions reduction of 38% compared to BAU in 2035. The Electric Vehicle Transition scenario would offer a reduction of 22% in emissions in 2035, larger than in many other economies due to the assumption none of the additional electricity would be generated from coal. The Hydrogen Vehicle Transition scenario would reduce emissions by 4% and the Natural Gas Vehicle Transition scenario would decrease emissions by 3% compared to BAU in 2035.

Figure PNG16: Virtual Clean Car Race – Light Vehicle CO_2 Emissions



Source: APERC Analysis (2012)

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