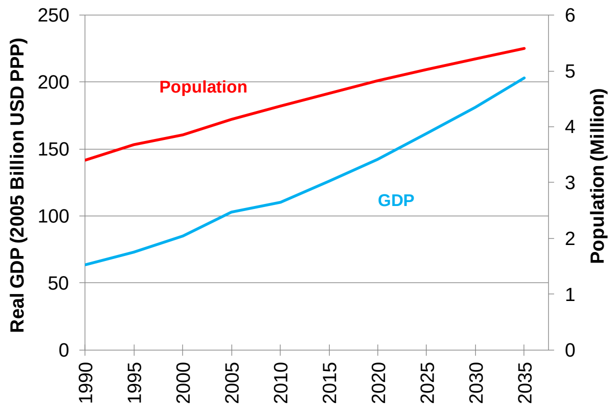
NEW ZEALAND

- *New Zealand policies aggressively promote energy efficiency; as a consequence, New Zealand's energy demand is likely to grow slowly if at all over the 2010–2035 time period.*
- *New Zealand's gas market is totally isolated, with no pipeline connections or LNG terminals; consequently, the level of future gas discoveries poses major uncertainties for New Zealand's energy outlook*
- *While annual CO_2 emissions from fuel combustion are projected to remain stable at around 35 million tonnes over the 2010–2035 time period, emissions per capita of about 8 tonnes/person in 2010 are still higher than some other wealthy economies and higher than the levels required worldwide to avoid damaging climate change.*

ECONOMY

New Zealand is an island economy in the South Pacific, consisting of two main islands—the North Island and the South Island—and a number of smaller outer islands. In land area it is a bit smaller than Japan or the Philippines, but larger than the United Kingdom. The relatively small population of about 4.3 million in 2010 is, however, comparable only to a medium-size Asian city. New Zealand's location is remote from other major economies. There are no electricity or pipeline connections to other economies.

Figure NZ1: GDP and Population



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

New Zealand is a mature economy, whose population is expected to increase only modestly to about 5.4 million by 2035. About 86% of this population is urban, with the Auckland region alone accounting for about one-third of the 2009 population (United Nations, 2009).

Economic growth will be similarly modest, with GDP increasing by an average of about 2.5% per year in real dollars between 2010 and 2035. New Zealand's per capita GDP of about USD 25 000 puts it at the low-end of the OECD economies. However, New Zealand generally rates high in most 'quality of life' surveys. New Zealanders are generally very environmentally conscious, and take pride in the 'clean and green' condition of their land, water, and air.

Most of New Zealand is hilly or mountainous. The climate is mostly cool and wet. Winters are generally not extreme, with snow and ice unusual except in the far south and at higher elevations. However, winter heating of buildings is still necessary and almost universal. Summer cooling of buildings is, however, less common, and mostly limited to large commercial structures. New Zealand is geologically prone to earthquakes, tsunamis, and volcanic eruptions; several earthquakes in 2010 and 2011 caused fatalities and major damage in the Canterbury/Christchurch area.

New Zealand's economy is heavily dependent on agriculture and associated food processing. Major agricultural activities include the raising of dairy cattle, sheep, and other grazing livestock, as well as the cultivation of orchards and vineyards. Other major export industries include tourism, fishing, coal mining, forestry, and forest products processing.

Because its climate is ideal for pastures, New Zealand is the world's largest dairy exporter, and has been described as the 'Saudi Arabia of Milk' (Wall Street Journal, 2008). The dairy processing industry is particularly energy intensive, as much of New Zealand's dairy exports must be dried or condensed.

Another energy-intensive export industry is the aluminium smelter located at Bluff, which accounts for about 12% of New Zealand's electricity consumption (Covec, et al., 2006). New Zealand has two plants that convert natural gas into methanol, mostly for export. These methanol plants are currently only partially utilized, and their future operation will depend upon the availability of gas and the spread between local gas prices and international methanol prices. There is also one integrated steel mill, one oil refinery, and one chemical plant that converts natural gas into urea (mostly for fertilizer), all of which serve mostly domestic markets.

Although Auckland and Wellington have small commuter rail systems, and all cities have local bus services, the automobile is the dominant mode of local passenger transportation. The automobile and air travel dominate the intercity passenger market, although there are some intercity bus services. Intercity rail services are limited to three routes, mostly served only once a day in each direction. New Zealand has only a few short motorways. Highways and local roads are well maintained, but often narrow and twisty. All of this is unlikely to change very much by 2035 under current policies.

Domestic freight transport is also dominated by road transport, although the railways (re-acquired by the government in 2008) have a role, especially in moving container freight, coal, and other commodities. Due to New Zealand's remote location, New Zealand is heavily dependent on overseas air and ship transport for both freight and tourism.

The majority of New Zealand's automobile fleet is imported used from Japan. There is no domestic automobile manufacturing industry.

ENERGY RESOURCES AND INFRASTRUCTURE

Although New Zealand has a modest oil and gas producing industry, New Zealand was 63% dependent on imports of oil and oil products in 2009. New Zealand also produces a significant quantity of natural gas, which is used for electricity generation, directly in homes and businesses, and in the methanol and urea plants mentioned above. However, only the North Island has a natural gas pipeline and distribution network. New Zealand's gas market is totally isolated from the rest of the world, as there are no facilities for importing natural gas on either island. All of New Zealand's gas is currently domestically produced.

New Zealand's gas and domestic oil come primarily from the Taranaki Basin, where there are several offshore fields. The largest of these fields, Maui, is in depletion, and there has been concern that New Zealand's gas supply could be inadequate in future years. Proposals have been made to build a liquefied natural gas (LNG) terminal to allow the importation of LNG. However, private investors have not been willing to finance such a major investment without government backing, and the government thus far has not been willing to provide the necessary support.

Despite the immediate concerns about gas supply, New Zealand's long-term prospects for finding more domestic gas, and oil as well, are excellent. To quote the website of New Zealand Petroleum & Minerals, the agency that manages New Zealand's oil and gas resources:

> "Taranaki Basin, covering an area of about 330,000 km^2, is currently the only producing basin in New Zealand. … The basin remains under-explored compared to many comparable rift complex basins of its size and there remains considerable potential for further discoveries.
>
> The rest of New Zealand is severely under-explored. Nevertheless, frontier basins drilled to date have all yielded discoveries confirming viable petroleum systems. Given many untested structures mapped have closures bigger than the Maui field (New Zealand's largest field), there is considerable potential for commercial hydrocarbon discoveries under New Zealand's largely untouched seabed." (NZP&M, 2012)

The last few years have indeed seen a series of small discoveries in the Taranaki Basin.

Why the lack of exploration? First, oil is the big prize that most exploration firms seek, and New Zealand's geology is widely viewed as gas-prone. Indeed, much of New Zealand's current 'oil' production is actually natural gas liquids. Second, New Zealand's gas infrastructure is underdeveloped. A modest discovery outside the Taranaki Basin would require the construction of a gas pipeline system to reach the New Zealand market. A really major gas discovery would swamp the New Zealand market and require the construction of an LNG export facility. Either way, the cost of the investment would reduce the value of the gas at the wellhead. Third, many of the best potential drilling sites are distant from shore, in deep water, and exposed to severe sea conditions, making drilling difficult and expensive (Samuelson, 2008). However, each of these barriers is likely to be overcome as technology improves and oil prices rise.

With historically abundant hydro resources, New Zealand is heavily dependent on electricity. Many homes and businesses in New Zealand have electric space heating and electric water heating. About 55% of New Zealand's electricity is generated by hydro. However, the best sites for hydro plants have been largely developed, and there is strong environmental opposition to developing the remaining sites. While some small additional hydro projects may be possible, major new hydro projects are unlikely. New Zealand's heavy dependence on hydro for electricity generation leaves its electricity supplies subject to fluctuations in precipitation. Dry years in New Zealand have historically resulted in electricity supply crises.

New Zealand has only one major coal electricity generation plant, Huntly, commissioned in 1987 (NZMED, 2012, Table G3.C). While there is only one coal plant, it operates as a baseload facility and accounted for about 8% of New Zealand's electricity production in 2009. Although New Zealand has significant domestic coal resources, there is strong opposition to new coal plants because of their greenhouse gas emissions. Although Huntly will probably continue to operate for some time, it is unlikely that a new coal plant could be built in New Zealand without carbon capture and storage.

Gas accounted for about 21% of New Zealand's electricity production in 2009. While there is environmental opposition to new gas plants on the basis of their greenhouse gas emissions, the opposition is less strong than it would be for coal. Gas has the advantages of a relatively low capital cost, a short construction and approval cycle, and an ability to avoid transmission constraints (since gas plants can be built close to major markets and existing transmission infrastructure). So gas is an attractive option for new electricity generation.

Geothermal electricity accounted for about 13% of New Zealand's electricity production in 2009, and there is significant potential for more. It is worth noting that, in accordance with New Zealand's statistical standards, we assume geothermal energy has a conversion efficiency of only 15%. This means it takes roughly seven units of primary geothermal steam energy to produce one unit of electricity. As a result, our figures for primary energy from new renewable energy (NRE) for New Zealand are quite large, perhaps deceptively so.

Wind power, which currently accounts for about 4% of New Zealand's electricity production in 2009, could also be expanded significantly. Unlike most economies, New Zealand's windy climate often allows wind farms to be developed without subsidy.

New Zealand has only one small oil-fired generation plant, which serves as a reserve resource. Due to high costs and concerns about the security of supply, oil is probably New Zealand's least-preferred option for electricity generation.

ENERGY POLICIES

New Zealand has adopted an economy-wide target for a 50% reduction in New Zealand's carbon-equivalent net emissions, compared with 1990 levels, by 2050. New Zealand is willing to commit to reducing greenhouse gas emissions by between 10% and 20% below 1990 levels by 2020, if there is a comprehensive global agreement and certain conditions are met (NZMED, 2011).

The Climate Change Response (Emissions Trading) Amendment Act 2008 established New Zealand's emissions trading scheme. The scheme places a price on greenhouse gas emissions to provide an incentive to reduce the volume of overall emissions. Six gases covered under the Kyoto Protocol are covered under the scheme—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (CCINZ, 2011).

In August 2011, the government released the *New Zealand Energy Strategy 2011–2021: Developing Our Energy Potential* (NZMED, 2011) to replace the 2007 New Zealand Energy Strategy. The new strategy focuses on four priorities: diverse resource development; environmental responsibility; the efficient use of energy; and secure and affordable energy. As part of the Energy Strategy, the New Zealand Government retains the target of 90% of electricity to be generated from renewable sources by 2025, provided security of supply is maintained.

New Zealand has a relatively long tradition of promoting energy efficiency, having passed an Energy Efficiency and Conservation Act in the year 2000, which led to the first National Energy Efficiency and Conservation Strategy, as well as the establishment of the Energy Efficiency and Conservation Authority (EECA) to spearhead the implementation of the strategy. The Energy Strategy includes a revised New Zealand Energy Efficiency and Conservation Strategy 2011–2016. The overall goal of the new strategy is for New Zealand to continue to improve its energy intensity (energy used per unit of GDP) by 1.3% per year to 2016. New Zealand has no fossil fuel subsidies that would encourage wasteful consumption.

New Zealand's oil and gas exploration and production activities are largely in private ownership and open to competition. New Zealand generally welcomes investments in oil and gas exploration by foreign firms. Electricity generation and marketing is also largely open to competition, but three of the five major generators are state-owned firms, as is the transmission grid operator. The New Zealand Electricity Authority oversees the rules of the electricity market, but does not regulate electricity prices.

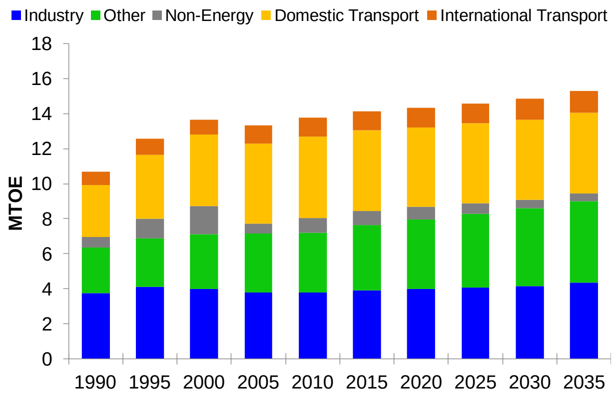
The coal mining industry in New Zealand is dominated by a large state-owned firm, although there are private operators as well.

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

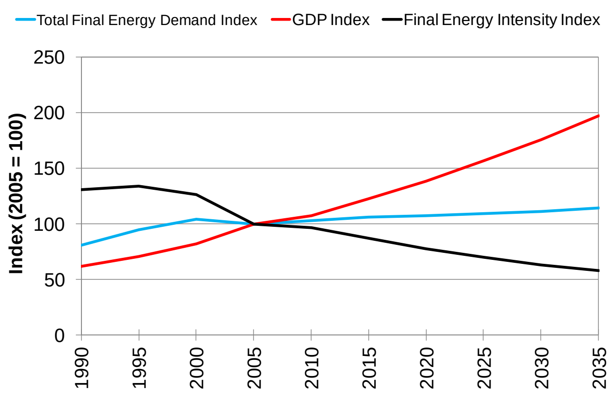
Business-as-usual (BAU) final energy demand is expected to grow at 0.4% per year over the outlook period. The 'other' sector (covering residential, commercial, and agriculture uses) will account for 91% of the growth. Demand is more or less evenly split between industry, transport and 'other'. Final energy intensity is expected to decline by about 42% between 2005 and 2035.

Figure NZ2: BAU Final Energy Demand



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

Figure NZ3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

Energy demand in the industry sector is projected to grow at an average annual rate of 0.5% until 2035, reflecting the slow growth of New Zealand industry generally. New Zealand's heavy industry is dominated by a few big firms. The aluminium and chemical industries may be viewed as a way of exporting surplus energy. Their future will depend on the availability of low-cost electricity and gas respectively. The other industries have competitive advantages in their local or export markets, so their demand is expected to be stable. Some growth in light industry is expected, but it is unlikely to be energy intensive.

Industrial electricity use is projected to increase from 1.2 Mtoe in 2010 to 1.5 Mtoe in 2035, accounting for the fastest growth, both in absolute industrial energy demand and in percentage terms, at an average annual rate of 0.8%.

Transport

Vehicle ownership in New Zealand has already reached saturation level. Over the outlook period, the domestic transportation energy demand of New Zealand is projected to remain almost unchanged. Rising vehicle kilometres travelled will be offset by increasingly efficient vehicles. Higher vehicle fuel efficiency will be stimulated by stricter fuel efficiency standards in Japan, from which the majority of New Zealand's vehicles are imported in used form, as well as by New Zealand's own vehicle efficiency labelling scheme.

Although New Zealand currently exempts electric vehicles from road user charges, almost all transport energy demand is likely to be for oil products. Conventional diesel vehicles will be increasingly common, comprising about one-quarter of the light vehicle fleet by 2035.

Other

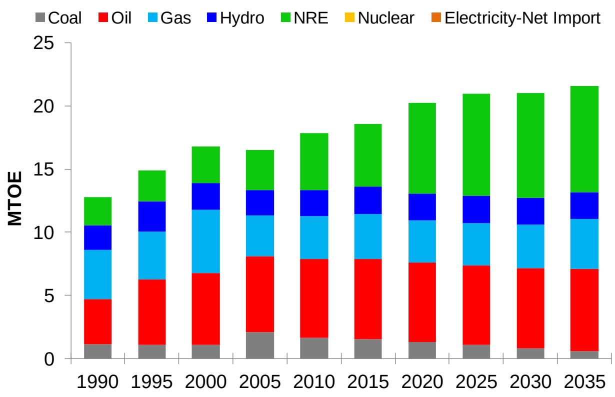
New Zealand's energy efficiency building codes, minimum efficiency performance standards for appliances, and assistance for home insulation and clean heating retrofits will help to hold down the growth of residential energy demand.

However, these efforts will be offset by a growing population, larger homes, and more appliances. Energy demand in the 'other' sector, which includes residential, commercial, agricultural and construction demand, is expected to grow at 1.3% per year over the outlook period. Electricity is expected to continue to dominate the fuel mix in this sector, accounting for 62% of 'other' energy consumption in 2035.

PRIMARY ENERGY SUPPLY

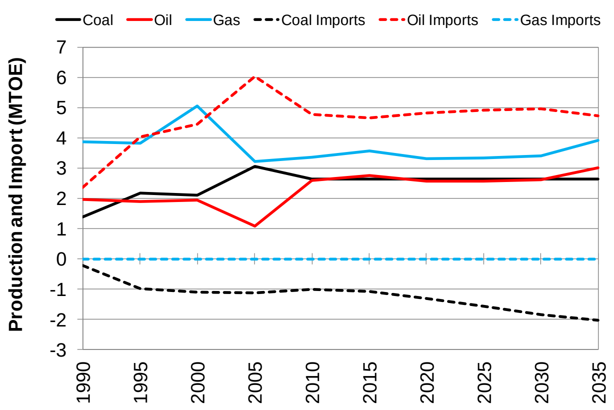
New Zealand's primary energy supply in the 2010–2035 period is projected to grow at an annual rate of 0.8%.

Figure NZ4: BAU Primary Energy Supply



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

Figure NZ5: BAU Energy Production and Net Imports



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

Given the isolated nature of New Zealand's gas market, the amount of gas that will be available is perhaps the greatest uncertainty in New Zealand's energy outlook. In APERC's view, the evidence suggests that additional gas supplies are likely to be found. As noted above, the geological prospects are good. And the market seems to be responding, with exploration and development activity continuing at historically high levels. New Zealand's Energy Data File 2012 notes that NZD 6.8 billion has been spent in the most recent five years (2007–2011) on oil and gas exploration and development. By comparison, from 2002 to 2006 a total of NZD 2.7 billion had been spent (NZMED, 2012, Table H.1).

The availability of gas is likely to allow New Zealand to continue to generate electricity from gas, and to meet any gap between electricity demand growth and new renewable energy (NRE) generation with domestic gas. It is also likely New Zealand can continue to produce methanol for export from gas.

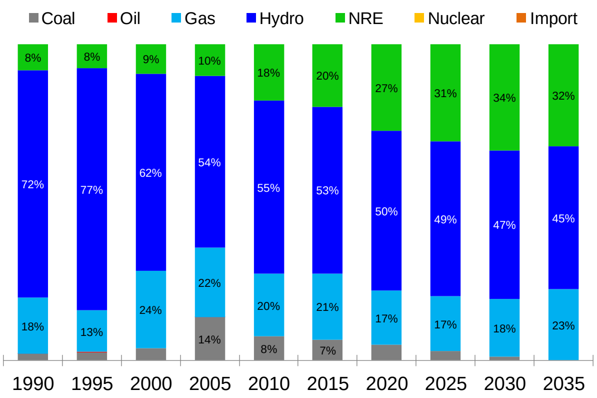
Oil production is subject to similar uncertainties and similar good prospects. Given New Zealand's very small projected increase in oil demand to 2035, any increase in oil production could reduce New Zealand's dependence on oil imports. APERC projects a very slight decline in oil imports from about 4.8 Mtoe in 2010 to about 4.7 Mtoe in 2035, but these are highly uncertain figures.

ELECTRICITY

The availability of gas and renewables should make it possible to gradually phase out New Zealand's only coal-fired generation plant, Huntly. Electricity production from hydro is likely to remain fairly constant, given the lack of attractive sites for new projects and the opposition to hydro development at the sites that are available. However, other forms of renewable generation, including wind and geothermal, are likely to more than double between 2010 and 2035, reflecting both available resources and existing supportive government policies.

Given the many uncertainties, especially regarding gas discoveries, it is difficult to say if New Zealand will reach its goal of 90% renewable electricity by 2025. Given the isolated nature of the New Zealand gas market, if significant amounts of additional gas are discovered, as APERC assumes, it will probably be priced to be competitive with renewables in the electricity generation market, since it has nowhere else to go.

Figure NZ6: BAU Electricity Generation Mix

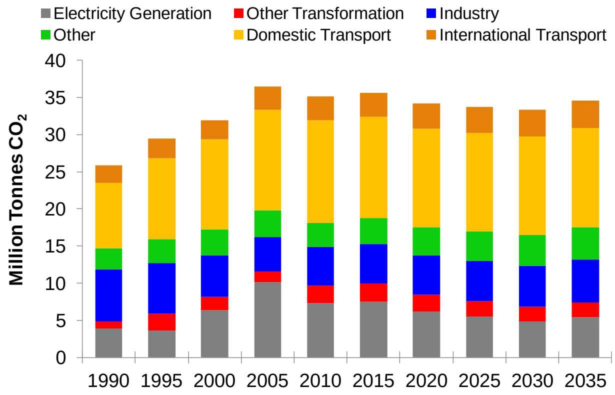


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics 2011* © OECD/IEA 2011a

CO_2 EMISSIONS

Over the outlook period New Zealand's total CO_2 emissions from fuel combustion are projected to remain approximately stable at around 35 million tonnes. This result is explained by the stable use of oil in the transport sector, the declining use of coal in electricity generation offset by a modest increase in the use of gas, the stable demand for fossil fuels in the industrial sector, and only a small increase in demand in the residential/commercial/agricultural ('other') sector.

Figure NZ7: BAU CO_2 Emissions by Sector



Source: APERC Analysis (2012)

The decomposition analysis shown in Table NZ1 below suggests the growth in New Zealand's GDP will be offset by a small reduction in the CO_2 intensity of energy (fuel switching) and a small reduction in the energy intensity of GDP (energy efficiency).

It should be noted that New Zealand is unusual among developed economies in that total greenhouse gas emissions from agriculture have historically slightly exceeded emissions from energy (NZMFE, 2011).

Table NZ1: Analysis of Reasons for Change in BAU CO_2 Emissions from Fuel Combustion

	1990-2005	2005-2010	2005-2030	2005-2035	2010-2035
Change in CO_2 Intensity of Energy	0.6%	-2.3%	-1.3%	-1.0%	-0.8%
Change in Energy Intensity of GDP	-1.5%	0.1%	-1.3%	-1.4%	-1.7%
Change in GDP	3.3%	1.4%	2.3%	2.3%	2.5%
Total Change	2.3%	-0.8%	-0.4%	-0.2%	-0.1%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

By comparison with most economies, New Zealand's business-as-usual energy outlook is reasonably good. CO_2 emissions from fossil fuels may be stable over the 2010–2035 time period, while oil imports may decline. However, at around 8 tonnes/person each year, New Zealand's CO_2 emissions per person from fossil fuel consumption remain relatively high on a world scale, higher for example than the 2009 emissions of France, Sweden, or Switzerland (IEA, 2011b, p. 97), and far above the level which must be achieved worldwide to avert damaging climate change (see Volume I, Chapter 16).

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 that 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 scenario prices or below if constraints on gas production and trade could be reduced.

New Zealand's gas market is, however, a rather exceptional case for two reasons. First, with no pipeline connections to other economies, and no LNG terminals, New Zealand's gas market is totally isolated from other economies. Second, while an increase in New Zealand's gas production beyond BAU levels is a definite possibility, it would probably cause New Zealand's CO_2 emissions to increase rather than decrease. This is because, in APERC's BAU scenario, the only major coal-fired electricity generation plant will be phased out. So rather than competing with coal, gas competes primarily with renewables including wind and geothermal.

So, unlike other APEC economies, increased gas production in New Zealand would likely have negative, rather than positive, environmental impacts. The only exception would be if the increase in New Zealand's gas production were so huge that it made the construction of an LNG export terminal economic. In this event, New Zealand could export gas to other APEC economies where it could be used to replace coal. Given the underexplored nature of much of New Zealand's territory, large future gas discoveries are a possibility. However, the currently known gas resources in New Zealand would not allow for LNG exports at the present time.

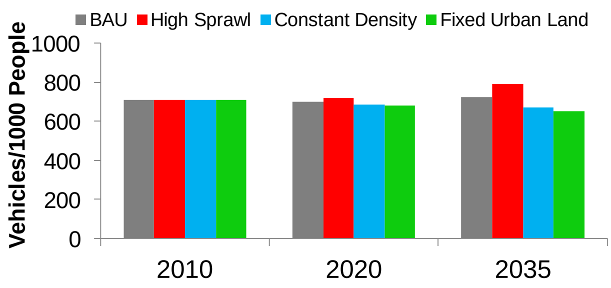
For these reasons, the High Gas Scenario was not run for New Zealand. Figures NZ8–NZ10 are, therefore, not included here.

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 NZ11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. The difference between the scenarios is significant, with vehicle ownership being about 9% higher in the High Sprawl scenario compared to the BAU scenario in 2035, and about 10% lower in the Fixed Urban Land scenario. Given that New Zealand is a relatively wealthy economy with vehicle ownership at close to saturation levels, the model results suggest better urban planning could modestly reduce the need for people to own vehicles. New Zealand's cities, especially Auckland, are currently characterized by a high level of 'sprawl'.

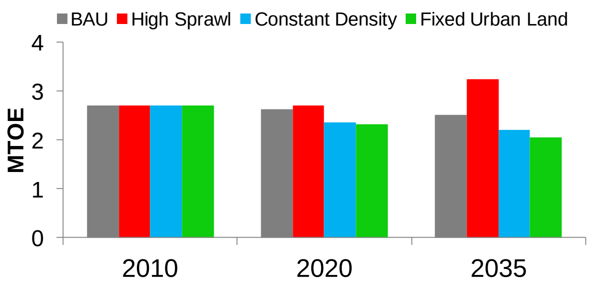
Figure NZ11: Urban Development Scenarios – Vehicle Ownership



Source: APERC Analysis (2012)

Figure NZ12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. The impact of better urban planning on light vehicle oil consumption is more pronounced than on vehicle ownership, as more compact cities reduce both the need for vehicles and the distances they must travel.

Figure NZ12: Urban Development Scenarios – Light Vehicle Oil Consumption

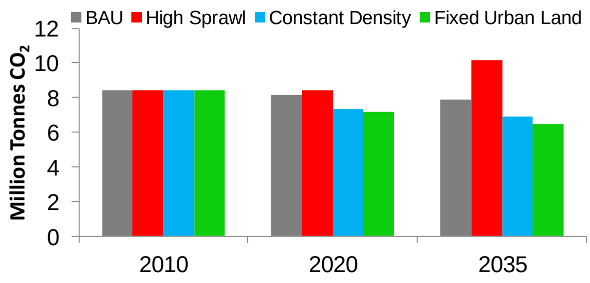


Source: APERC Analysis (2012)

Light vehicle oil consumption would be 29% higher in the High Sprawl scenario compared to the BAU scenario in 2035, and about 18% lower in the Fixed Urban Land scenario.

Figure NZ13 shows the change in light vehicle CO_2 emissions under BAU and the three alternative urban development scenarios. The impact of urban planning on CO_2 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 CO_2 emissions would be 29% higher in the High Sprawl scenario compared to the BAU scenario in 2035, and about 18% lower in the Fixed Urban Land scenario.

Figure NZ13: Urban Development Scenarios – Light Vehicle Tank-to-Wheel CO_2 Emissions



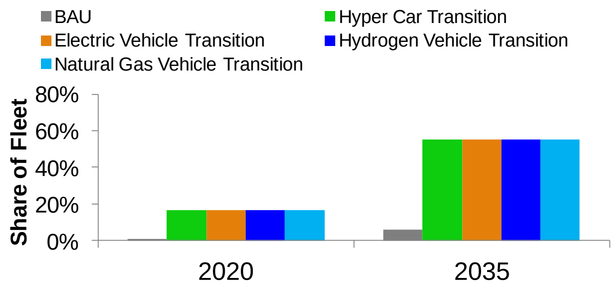
Source: APERC Analysis (2012)

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 NZ14 shows the evolution of the vehicle fleet under BAU and the four 'Virtual Clean Car Race' scenarios. By 2035, the share of the alternative vehicles in the vehicle fleet is assumed to reach about 55% compared to about 6% in the BAU scenario. The share of conventional vehicles in the fleet is thus only about 45%, compared to about 94% in the BAU scenario.

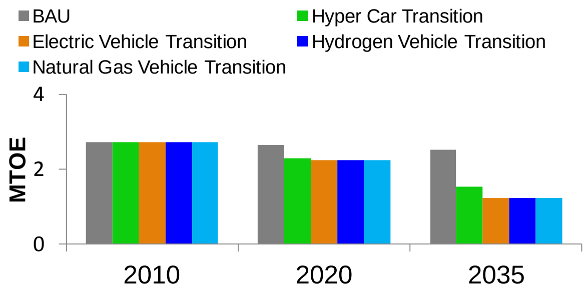
Figure NZ14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet



Source: APERC Analysis (2012)

Figure NZ15 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—40% by 2035—even though these highly-efficient vehicles still use oil.

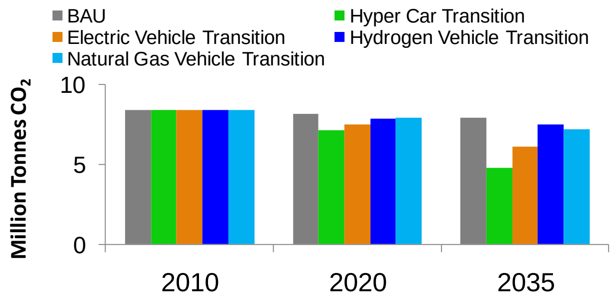
Figure NZ15: Virtual Clean Car Race – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure NZ16 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 impacts of each scenario may differ significantly from their oil consumption impacts, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

Figure NZ16: Virtual Clean Car Race – Light Vehicle CO_2 Emissions



Source: APERC Analysis (2012)

In New Zealand, the Hyper Car Transition scenario is the clear winner in terms of CO_2 emissions reductions with emissions reduced 39% compared to BAU in 2035. This figure is roughly in line with their reduction in oil demand. The Electric Vehicle Transition scenario comes in second, offering a 22% reduction. Electric vehicles offer a significant reduction because in New Zealand the additional electricity for electric vehicles would be generated with gas rather than the coal that would be used in many APEC economies (to facilitate fair comparisons, the Electric Vehicle Transition scenario assumes no additional renewable generating capacity). The Natural Gas Vehicle Transition and Hydrogen Vehicle Transition scenarios offer considerably less emissions reductions (9% and 5%, respectively).

REFERENCES

CCINZ (Climate Change Information New Zealand) (2011), *Emissions Trading Scheme Basics*, www.climatechange.govt.nz/emissions-trading-scheme/basics.html

Covec, Hale & Twomey, and Exergi Consulting (2006), *Heavy Industry Energy Demand*, www.covec.co.nz/sites/covec.tst/files/Heavy%20Industry%20Energy%20Demand_0.pdf

Global Insight (2012), *World Industry Services*, retrieved from IHS Global Insight Data Service.

IEA (International Energy Agency) (2011a), *World Energy Statistics 2011*, CD-ROM Edition.

— (2011b), *CO_2 Emissions from Fossil Fuel Consumption Highlights*, www.iea.org/media/statistics/CO2highlights.pdf f

NZMED (New Zealand Ministry of Economic Development) (2011), *New Zealand Energy Strategy 2011–2021: Developing Our Energy Potential*, www.med.govt.nz/sectors-industries/energy/strategies

— (2012), *New Zealand Energy Data File 2012*, www.med.govt.nz/sectors-industries/energy/energy-modelling/publications/energy-data-file/new-zealand-energy-data-file-2012

NZMFE (New Zealand Ministry for the Environment) (2011), *New Zealand's Greenhouse Gas Inventory 1990–2009*, www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2011-snapshot/greehouse-gas-inventory-2011-snapshot.pdf

NZP&M (New Zealand Petroleum & Minerals) (2012), 'Petroleum Basins' website page, www.nzpam.govt.nz/cms/petroleum/petroleum-basins

Samuelson, Ralph D. (2008), *Oil: An Introduction for New Zealanders*, Ministry of Economic Development, www.med.govt.nz/sectors-industries/energy/energy-modelling/publications/oil-an-introduction-for-new-zealanders

United Nations (2009), *World Urbanization Prospects: The 2009 Revision Population Database*, Department of Economic and Social Affairs, Population Division, http://esa.un.org/wup2009/unup/

Wall Street Journal (2008), "'Saudi Arabia of Milk' Hits Production Limits", 8 May 2008, http://online.wsj.com/article/SB121018928727674565.html