AUSTRALIA

- *Australia's new Clean Energy Future package, which includes a carbon trading mechanism, is likely to see an increase in energy efficiency and decrease in overall CO_2 emissions in the long term.*
- *Due to its considerable coal seam gas reserves, Australia is likely to become a strategic producer of unconventional gas within the outlook period.*
- *Annual CO_2 emissions from fuel combustion are projected to decrease by 1.4% over the outlook period; this can largely be attributed to Australia's commitment to increasing the use of renewable energy, particularly in electricity generation as well as the switch from coal to gas.*

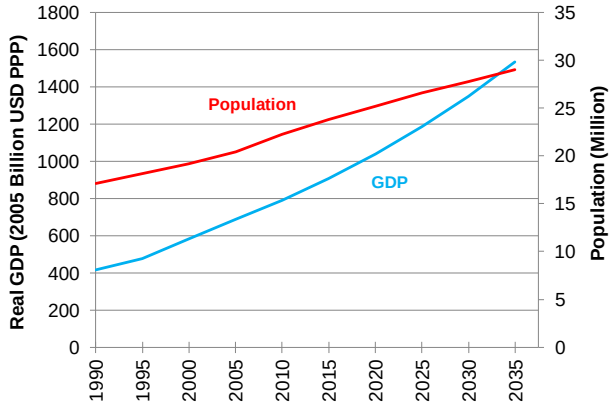
ECONOMY

Australia is the world's largest island economy, and the sixth largest economy (in land area) in the world. It lies in the southern hemisphere, between the Indian and Pacific Oceans. Its total land area of nearly 7.7 million square kilometres is made up of the mainland, the major island of Tasmania, and other small islands. Australia has no land boundaries with other economies; its ocean neighbours include Indonesia, East Timor, Papua New Guinea, the Solomon Islands, Vanuatu, New Caledonia, and New Zealand.

The Australian mainland is largely desert or semi-arid land. A temperate climate and moderately fertile soils are found in the southeast and southwest corners, while the far north is characterized by a tropical climate (warm all year) and a mix of rainforests, grasslands and desert.

As of June 2011, Australia's population was 22.6 million people, mostly concentrated along the eastern and south eastern coast, and some on the west coast. Across the total landmass the population density (three people per square kilometre) is one of the lowest in the world. Nearly 92% of the population live in urban areas; the average household is a family of no more than four.

Figure AUS1: GDP and Population



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

Australia is rich in mineral resources and is a major world producer of bauxite, coal, gold, copper, nickel, zinc and iron ore—some concentrated in a particular region, others dispersed across its six states and two territories. The minerals sector is a substantial contributor to the Australian economy, with minerals production increasing over the past decade. Historically, mineral discoveries in Australia have been characterized by high-grade deposits and surface mineralization (Hogan, 2003); most of the surface mineralization has been developed and future mining activities are expected to be more energy intensive. The majority of Australia's resource production is exported, accounting for significant export earnings.

Australia has developed a world-class minerals processing industry to complement its mining industry; the three major areas are alumina refining, aluminium smelting, and iron-and steel-making.

Australia is one of the world's largest alumina producers with production estimated at 19.3 million tonnes in 2011–12 (BREE, 2012e).

Australia is also a significant exporter of iron ore, with the majority of exports going to China. Future iron ore production and exports are supported by a number of significant iron ore projects expected to be completed in the foreseeable future (BREE, 2012c). Other energy-intensive industries of note in the Australian economy include other non-ferrous metals processing (aluminium), non-metallic mineral production, and chemical and associated production.

Agriculture in Australia is a highly commercialized, technology-based, export-orientated industry, with exports such as dairy products, grain and live cattle going mostly to Southeast Asia and the Middle East. Agriculture and the associated industries of food, beverages and tobacco, wood, and pulp and paper are important contributors to the economy.

Australia's harsh and wide-flung geography makes road transport a crucial element in the

economy; Australia has three to four times more road per capita than Europe, and seven to nine times more than Asia. The rail network is slighter than the road system, although train networks are established within cities and between states.

Air travel, domestic and international, has grown rapidly since the early 1990s, particularly with the emergence of budget airlines. Generally, while cars are the usual mode of travel between rural centres, and cars or train the mode between rural centres and state capitals, air transport is the most economic form of travel between state capitals.

ENERGY RESOURCES AND INFRASTRUCTURE

Australia has abundant coal reserves and is one of the world's leading coal producers and exporters. At the end of 2011, Australia's recoverable coal reserves stood around 86 billion tonnes (Geoscience Australia, 2011b), with estimated production in 2011–12 of 219.2 million tonnes (BREE, 2012e). Australia's economic reserves are sufficient to sustain current black coal production rates for nearly 100 years. Brown coal economic reserves are estimated to be able to sustain current production for over 500 years (BREE, 2012a). Coal is the dominant primary energy source in Australia; in 2008–09, it accounted for 39% of primary energy consumption in the economy (BREE, 2011, p. 30). Coal use is heavy in the power generation sector, where it currently accounts for more than 70% of the generation mix (BREE, 2011, p. 30). Over 80% of coal produced in Australia is exported.

Environmental issues, in particular climate change, are expected to have a strong influence on the future of Australian coal exports and domestic consumption. The industry is focused on the development and deployment of 'clean and green' coal conversion and storage technologies. In addition, the Australian Government's efforts in promoting coal-to-liquids technology and carbon sequestration could play an important role in shaping future domestic coal consumption, especially in meeting the rising domestic demand for transport fuels.

Natural gas has become the fastest growing fossil fuel in terms of production and consumption in Australia. According to the CIA's World Factbook, at the end of 2010 Australia had an estimated 3.115 trillion cubic metres of proven natural gas reserves, which places it within the top 15 of economies with proven natural gas reserves (USCIA, 2011).The majority of Australia's conventional gas resources are located off the northwest coast of Western Australia, which makes this the largest gas-producing region in Australia. However, the rise of non-conventional gas resources in the eastern region, such as coal seam gas reserves, means gas production is forecast to increase significantly in the east in the outlook period.

On average between 2010–11 and 2011–12 Australia's production of natural gas (including natural gas from coal seam methane projects) is estimated to be about 52.7 billion cubic metres (BREE, 2012e). About 35% of this production is exported as liquefied natural gas (LNG), mostly within the Asia–Pacific region (ABARES, 2011). Environmental concerns about energy use have provided a boost to natural gas use in Australia. Federal and state policy initiatives have encouraged the use of cleaner energy resources, including natural gas, which has a lower CO_2 emissions factor than coal or oil. Combined with its security of supply, natural gas will be the preferred choice for many Australian energy consumers. The power generation, manufacturing and mining sectors are all expected to significantly increase the share of natural gas in their energy mix in the medium and long term.

Australia has significant reserves of coal seam gas (CSG). As at the end of 2010, Australia had economic demonstrated resources of 35 055 petajoules (PJ), but only produced 175 PJ (0.5% of the economic demonstrated resources) in that year (Geoscience Australia, 2011a). Due to environmental risks associated with the extraction of CSG, such projects need to undergo a comprehensive and sometimes lengthy approvals process overseen by the respective state government. There are three LNG–CSG projects under construction currently, with environmental impact studies being conducted on two other CSG projects (BREE, 2012b). In 2011, CSG was produced only in Queensland and New South Wales, where it accounted for the majority of each state's total gas production. Production of CSG is expected to strengthen in the future with LNG plant plans already in place based on production and export from Queensland (BREE, 2012d).

As of the end of 2010, Australia's total oil economic demonstrated resources were estimated at 22 161 PJ—made up of 12 413 PJ of condensate, 5685 PJ of crude oil and 4063 PJ of liquefied petroleum gas (LPG) (BREE, 2012a). Australia's proven oil reserves are not as impressive as that of its coal, accounting for about 2% of the world's proven reserves. Most of Australia's oil reserves are located in the Carnarvon Basin, Gippsland Basin, Bonaparte Basin, Cooper–Eromanga Basin, and Bass Basin; these areas cover the north, west, southeast and southern regions of Australia. Australia is a net oil importer, in 2011 Australia's crude oil and

condensate production was 425 614 barrels per day, with imports in the year around 554 270 barrels per day (BREE, 2012e). Australia's oil production has been declining since 2003—this is due to natural depletion (especially in the Cooper–Eromanga Basin and Gippsland Basin), lack of new exploration fields coming online, and higher exploration costs for unexplored resources located offshore (in deep water). There is some export of crude oil, particularly heavy crude from wells in the northwest.

Petroleum products are the main energy source for the transport and mining sectors in Australia. In 2008–09, they accounted for 35% of primary energy consumption in the economy, second only to coal. Within the transport sector there are a range of alternative low-carbon fuels that have the potential to complement or replace conventional oil, but they need further research, development and demonstration before they can be adopted (BREE, 2011). While hybrid and electric vehicles are available in Australia the price competitiveness of conventional vehicles generally beats out these forms of automobile transportation.

Australia has enormous potential renewable energy resources, especially wind, solar, geothermal and hydro. While in 2009–10 only 2% of total energy produced in Australia was from renewable sources (predominantly bio-energy), Australia's Clean Energy Future plan and its Renewable Energy Target (both discussed under 'Energy Policies') emphasize Australia's commitment to renewable energy and should therefore see its further development (BREE, 2012a). The National Electricity Market (NEM) was established in 1998 to allow the inter-jurisdictional flow of electricity between the Australian Capital Territory, New South Wales, Queensland, South Australia and Victoria (Tasmania joined the NEM in 2005). Western Australia and the Northern Territory are not connected to the NEM because of their distance from the rest of the market. The NEM comprises a wholesale sector and a competitive retail sector. All electricity dispatched must be traded through the central pool, where output from generators is aggregated and scheduled to meet demand.

ENERGY POLICIES

Australia enjoys a high level of energy security characterized by low-priced, reliable energy supplies and a significant natural endowment of energy resources, including coal, natural gas, crude oil and considerable potential for renewable energy. Underpinning Australia's natural resources are extensive infrastructure and well-functioning domestic and international energy markets.

The Australian Government released a draft Energy White Paper (EWP) on 13 December 2011. The consultation process included public forums in each state capital across Australia and 285 written submissions were received. The final Energy White Paper is due to be released at the end of 2012.

The EWP promotes well-functioning markets supported by efficient and effective regulatory frameworks to deliver competitively priced energy. The core objective is to build a secure, resilient and efficient energy system that provides accessible, reliable and competitively priced energy for all Australians; to enhance Australia's domestic and export growth potential; and to deliver clean and sustainable energy. The four key priority areas outlined in the draft EWP are strengthening the resilience of Australia's energy policy framework; delivering better energy market outcomes for consumers; developing Australia's critical energy resources—particularly gas resources; and accelerating clean energy outcomes.

An update to the 2009 National Energy Security Assessment (NESA) was released in December 2011. The 2011 NESA found that Australia's overall energy security situation is expected to remain adequate and reliable, but it will increasingly be shaped by the strength of new investment going forward and the price of energy, which are both materially influenced by global trends (DRET, 2011c). The 2011 NESA was a key input into the development of the draft Energy White Paper.

On 10 July 2011, the Australian Government announced the Clean Energy Future plan, which makes the move from the previous Clean Energy Initiative and other government programs to a comprehensive plan to reduce Australia's greenhouse gas emissions. The Clean Energy Future includes:

- the introduction of a carbon price
- the promotion of innovation and investment in renewable energy
- encouragement for energy efficiency
- the creation of opportunities in the land sector to cut pollution.

The carbon pricing mechanism establishes a fixed carbon price of AUD 23 (USD 24) per tonne (rising at 2.5% per year in real terms) for the period 1 July 2012 to 30 June 2015. The carbon price will apply to around 500 of Australia's largest greenhouse gas emitters. Around 60% of Australia's emissions will be directly covered by the carbon pricing mechanism, and around two-thirds will be covered by a combination of the mechanism and equivalent carbon pricing arrangements. From 1 July 2015, the

carbon price will become flexible under a 'cap and trade' emissions trading scheme, with the price largely determined by the market. Emissions units will be able to be traded from 1 July 2015, and a lower and upper limit of emissions unit prices will apply for the first three years beyond 1 July 2015 (DCCEE, 2011a).

The Australian Government does not undertake or finance energy resource exploration or development. In the petroleum sector, the government relies on an annual acreage release to create opportunities for investment. The release, distributed worldwide, is a comprehensive package that includes details of the acreage, bidding requirements and permit conditions. All foreign investment proposals in Australia are subject to assessment and subsequent government approval through the Foreign Investment Review Board.

The approvals process for unconventional gas exploration is overseen by each responsible state government, under the Environment Protection and Biodiversity Conservation Act 1999. In this process each state assesses applications from each company looking to explore in their area, and then declines or grants access; this can be quite a lengthy process. Similarly, the assessment of safety requirements and environmental regulation for the coal industry is carried out by the state in which each project is based.

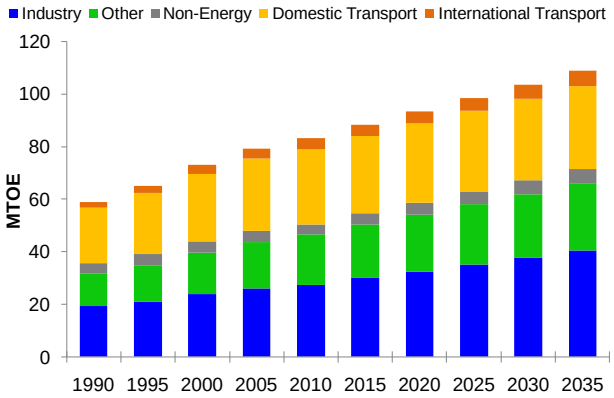
The Australian Government has a number of policies and programs in place to capitalize on the potential economic growth and emissions reduction resulting from improved energy efficiency within the industrial, transport, and residential and commercial sectors. There is also a suite of policies and initiatives introduced over the last few years to increase the role of renewable energy. This includes the Renewable Energy Target, which requires 45 000 GWh of electricity generation to be sourced from renewable energy by 2020. The Renewable Energy Target has been separated into a Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES), to provide greater certainty for households, for large-scale renewable energy projects and for installers of small-scale renewable energy systems. Combined, the new LRET and SRES are expected to deliver more renewable energy than the overall Renewable Energy Target (DCCEE, 2011b). Other measures promote low-carbon energy research, development, demonstration and deployment including the Global Carbon Capture and Storage Institute.

BUSINESS-AS-USUAL OUTLOOK

FINAL ENERGY DEMAND

Final energy demand under business-as-usual (BAU) assumptions is expected to grow at an annual average rate of 1% over the outlook period. Most of this growth can be attributed to increases in energy consumption across all sectors, especially in the industrial and 'other' (residential, commercial and agricultural) sectors.

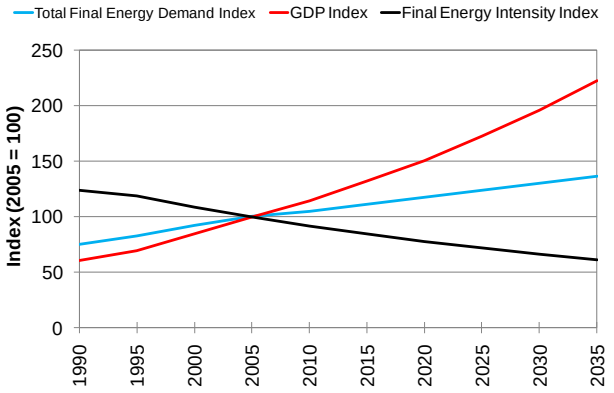
Figure AUS2: BAU Final Energy Demand



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics2011* © OECD/IEA 2011

Despite this increase in final energy demand, final energy intensity (as shown in Figure AUS3) is expected to decline by 39% between 2005 and 2035.

Figure AUS3: BAU Final Energy Intensity



Source: APERC Analysis (2012)

Industry

Energy demand in the industrial sector is projected to grow at an average annual rate of 1.6% between 2010 and 2035. This reflects the steady but relatively slow growth of Australia's industrial sector in general, along with Australia's focus on the services sector. However, given that Australia is experiencing a mining boom, energy consumption in this sector is expected to increase (on average 2.2% a

year over the outlook period) in tandem with the rapidly growing industry.

Combustible fuels are expected to account for the majority of industrial energy demand, with consumption increasing by more than 45% over the outlook period.

Transport

Vehicle ownership in Australia has very nearly reached saturation level. The transportation energy demand of Australia is projected to grow by 10% over the outlook period.

Given the lack of incentives for consumers to shift to vehicles using alternative fuels, virtually all transport-based energy consumption will be of oil products. Conventional gasoline vehicles will account for a greater proportion of vehicles, comprising more than half of the light vehicle fleet by 2035. Conventional diesel vehicles will make up the second highest share of the light vehicle fleet (17%), while vehicles using alternative fuels will account for only a small share.

Other

Australia has many policies promoting energy efficiency within the residential and commercial sectors. Through building codes and standards Australia promotes energy efficiency within commercial buildings. In the residential space the government has retrofit programs promoting initiatives such as installation of energy-efficient lighting.

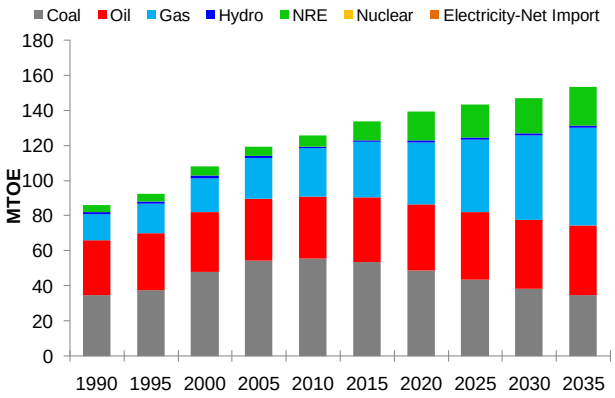
However, such efforts will be offset by a growing population and an increasingly consumer-driven society, which is likely to result in the use of more electrical gadgets and home appliances. Energy demand in the 'other' sector, which includes residential, commercial, and agricultural demand, is expected to grow at an average annual rate of 1.1% over the outlook period. Electricity is expected to continue to dominate the fuel mix in this sector, accounting for 55% of 'other' energy consumption in 2035.

PRIMARY ENERGY SUPPLY

Australia's primary energy supply between 2010 and 2035 is projected to grow at an average annual rate of 0.8%.

Given the potential for significant production of natural gas from unconventional sources, Australia is expected to increase its production of gas in the outlook period. Primary supply of gas is projected to nearly double between 2010 and 2035.

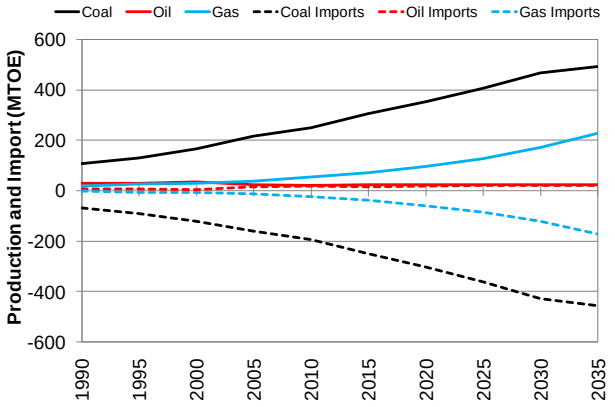
Figure AUS4: BAU Primary Energy Supply



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics2011* © OECD/IEA 2011

Coal will dominate energy supply in most of the first part of the outlook period (2010–2027), with an average share of 37% over those years. Although much of the gas produced will be exported as LNG, predominantly to economies in the Asian region, gas is expected to overtake coal in domestic energy supply in the latter half of the outlook period, accounting for 36% of primary energy supply in 2035.

Figure AUS5: BAU Energy Production and Net Imports

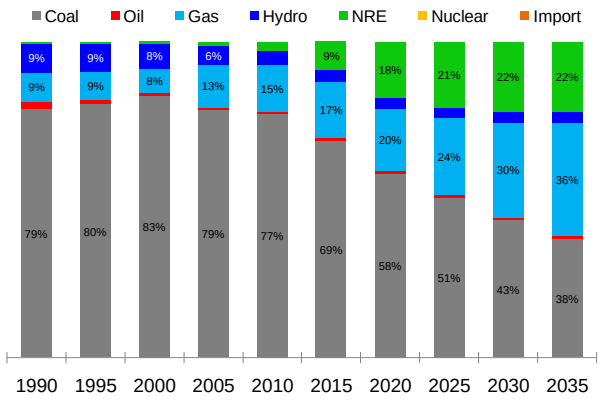


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics2011* © OECD/IEA 2011

ELECTRICITY

Australia's coal reserves mean this fuel will dominate the electricity generation mix in the outlook period. However, the Australian Government's commitment to energy efficiency and the promotion of renewable energy makes it highly likely that the economy will at least very nearly achieve its goal of 20% electricity sourced from renewable energy by 2020. This will bring about a reduction in the role of coal in the electricity generation mix over the outlook period, as with increased contribution from natural gas and NRE (predominantly wind).

Figure AUS6: BAU Electricity Generation Mix

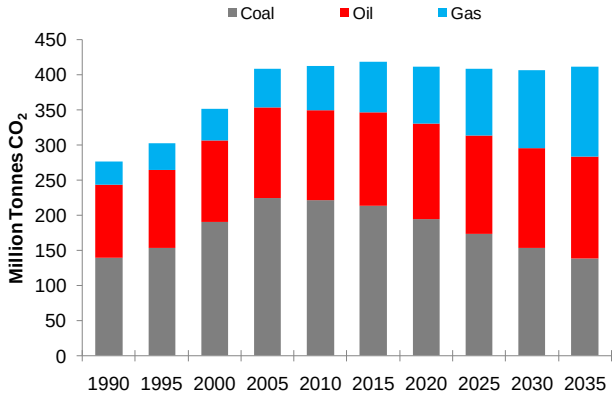


Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics2011* © OECD/IEA 2011

CO_2 EMISSIONS

Over the outlook period Australia's total CO_2 emissions from fuel combustion are projected to decrease by 0.3 million tonnes from 2010 to 2035, to 412.3 million tonnes. This decrease in emissions can be attributable to Australia's policies promoting renewable energy in the household and commercial sectors. Most notable, however, is Australia's push to increase use of renewable energy sources in electricity generation; in particular wind power capacity is expected to increase by 30–35% over the outlook period. This structural change will be a key factor in emissions reduction.

Figure AUS7: BAU CO_2 Emissions by Sector



Source: APERC Analysis (2012)

Table AUS1 indicates that emission increases due to GDP growth will be offset by a reduction in both the CO_2 intensity of energy (contributed by fuel switching from coal to gas and NRE) and energy intensity of GDP from effective energy efficiency measures, which will lead to a modest reduction in total CO_2 emissions over the outlook period.

Table AUS1: 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	0.4%	-1.7%	-0.8%	-0.7%	-0.5%
Change in Energy Intensity of GDP	-1.2%	-0.9%	-1.9%	-1.9%	-2.2%
Change in GDP	3.4%	2.7%	2.7%	2.7%	2.7%
Total Change	2.6%	0.2%	0.0%	0.0%	0.0%

Source: APERC Analysis (2012)

CHALLENGES AND IMPLICATIONS OF BAU

Under business-as-usual, the Australian energy outlook is steady. However, as demand for cleaner sources of fuel such as natural gas increases globally over the outlook period, Australia may wish to expedite regulation and exploration processes in order to maximize its sizeable natural gas resources.

ALTERNATIVE SCENARIOS

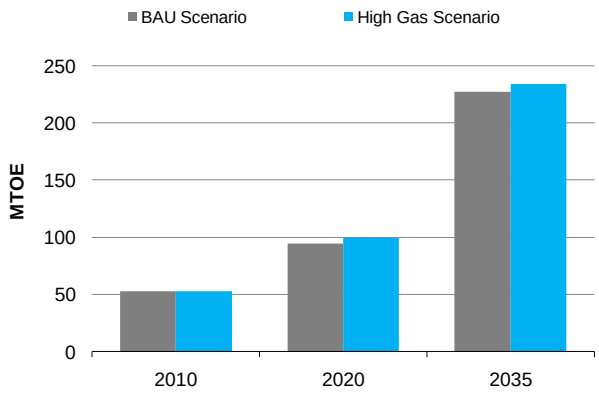
To address the energy security, economic development, and environmental sustainability challenges posed by the business-as-usual (BAU) outcomes, three sets of alternative scenarios were developed for most APEC economies.

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.

The High Gas Scenario for Australia assumed the production increase shown in Figure AUS8, which equals 3% by 2035. This was based on expanding Australia's current unconventional and conventional gas development given its strong customer base in the Asia–Pacific region.

Figure AUS8: High Gas Scenario – Gas Production



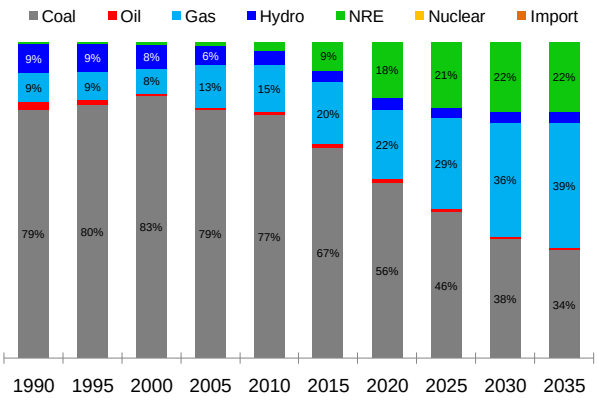
Source: APERC Analysis (2012)

Even under BAU assumptions, Australia's gas production is expected to increase significantly over the outlook period. The slight additional increase in gas production under the alternative scenario can be attributed to the assumption that the sometimes cumbersome and lengthy approvals processes will be improved and expedited to allow more gas projects to become operational.

Additional gas consumption in each economy in the High Gas Scenario depends not only on the economy's own additional gas production, but also on the gas market situation in the APEC region. Given the perceived environmental benefits of gas over coal, a portion of the gas produced will be consumed locally. However, given Australia's modest population in terms of its gas reserves, the majority of the additional gas is expected to be exported.

Figure AUS9 shows the High Gas Scenario electricity generation mix for Australia. This graph may be compared with the BAU scenario graph in Figure AUS6. It can be seen the gas share has increased by 3% by 2035, while the coal share has declined by 4%. It is interesting to note that under the alternative scenario gas has a greater share than coal in the electricity generation mix by 2035. However, even under the BAU case, gas would only be 2% shy of the share of coal in the generation mix by 2035, a substantial change from 2010.

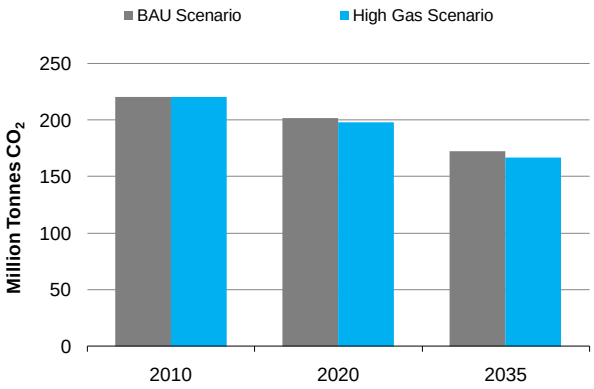
Figure AUS9: High Gas Scenario – Electricity Generation Mix



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

The additional domestically-consumed gas in the High Gas Scenario was assumed to replace coal in electricity generation. Since gas has roughly half the CO_2 emissions of coal per unit of electricity generated, this had the impact of reducing CO_2 emissions in electricity generation by nearly 5% in 2035. Figure AUS10 shows this CO_2 emission reduction which is significant given Australia's GDP growth.

Figure AUS10: High Gas Scenario – CO_2 Emissions from Electricity Generation



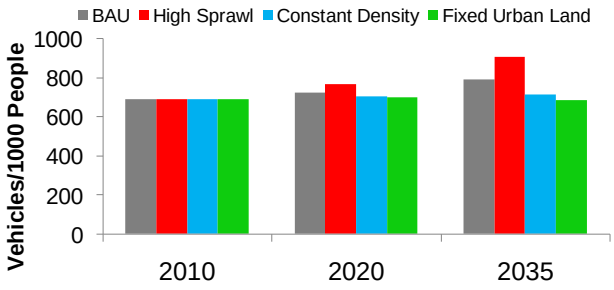
Source: APERC Analysis (2012)

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 AUS11 shows the change in vehicle ownership under BAU and the three alternative urban development scenarios. If Australia's cities were to stay at a constant population density it is expected that there will be a decrease in vehicle ownership of 10% in 2035 compared to the BAU case. The High Sprawl case would result in an expected 15% increase in vehicle ownership by 2035 compared to BAU.

Figure AUS11: Urban Development Scenarios – Vehicle Ownership

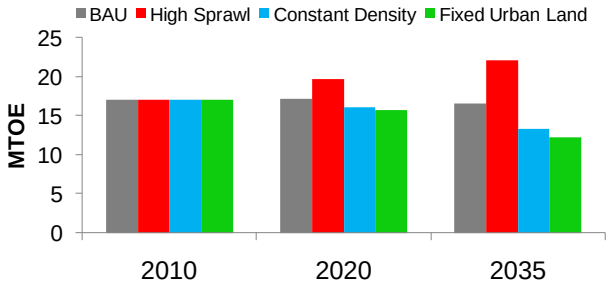


Source: APERC Analysis (2012)

Figure AUS12 shows the change in light vehicle oil consumption under BAU and the three alternative urban development scenarios. The High Sprawl scenario is likely to see 33% more light vehicle oil consumption in 2035 compared to BAU. Under the Constant Density and Fixed Urban Land scenarios, there were reductions in light vehicle oil consumption

of 19% and 26% respectively in 2035 compared to BAU. This demonstrates the benefits of better urban planning.

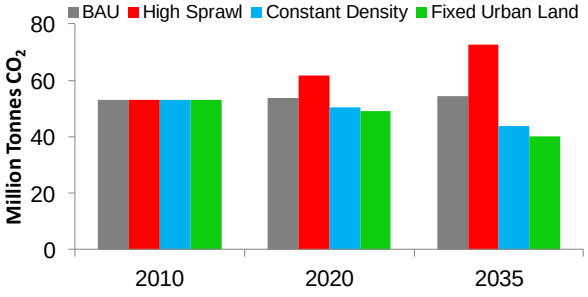
Figure AUS12: Urban Development Scenarios – Light Vehicle Oil Consumption



Source: APERC Analysis (2012)

Figure AUS13 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.

Figure AUS13: Urban Development Scenarios – Light Vehicle Tank-to-Wheel CO_2 Emissions



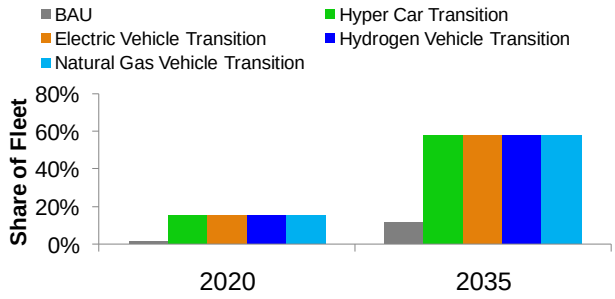
Source: APERC Analysis (2012)

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 AUS14 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 fleet reaches around 58% compared to about 11% in the BAU scenario. The share of conventional vehicles in the fleet is thus only about 42%, compared to about 89% in the BAU scenario.

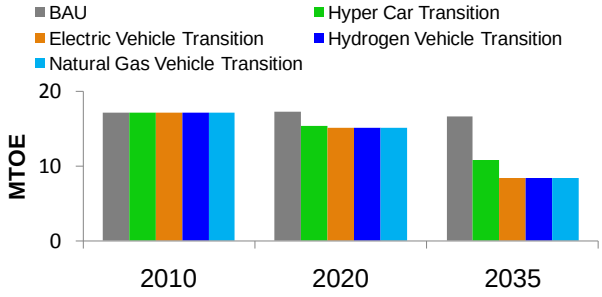
Figure AUS14: Virtual Clean Car Race – Share of Alternative Vehicles in the Light Vehicle Fleet



Source: APERC Analysis (2012)

Figure AUS15 shows the change in light vehicle oil consumption under BAU and the four alternative vehicle scenarios. Oil consumption drops by 50% in the Electric Vehicle Transition, Hydrogen Vehicle Transition, and Natural Gas Vehicle Transition scenarios compared to BAU by 2035. The drop is large as these alternative vehicles use no oil. Oil demand in the Hyper Car Transition scenario is also significantly reduced compared to BAU—down 35% by 2035—even though these highly efficient vehicles still use oil.

Figure AUS15: Virtual Clean Car Race – Light Vehicle Oil Consumption



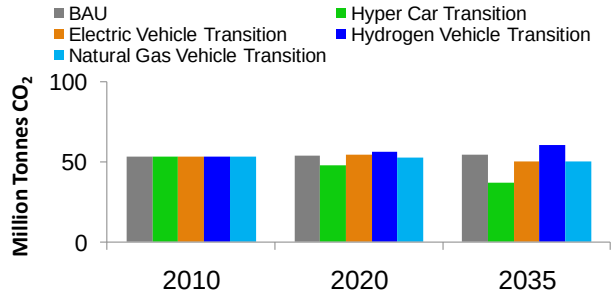
Source: APERC Analysis (2012)

Figure AUS16 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 impact, since each alternative vehicle type uses a different fuel with a different level of emissions per unit of energy.

In Australia, the Hyper Car Transition scenario is the clear winner in terms of CO_2 emission reduction, with an emission reduction of 33% compared to BAU in 2035. This is probably because hyper cars do better in economies like Australia where coal is more likely to be the marginal source of electricity generation. To facilitate fair comparisons, the Electric

Vehicle Transition scenario assumes no additional non-fossil electricity. The Electric Vehicle Transition scenario would rate second, offering a reduction of 9% compared to BAU in 2035. The Natural Gas Vehicle Transition scenario offers emission reductions of 8%, while in the Hydrogen Vehicle Transition scenario, emissions increase by 11% compared to BAU. This is likely due to the emissions associated with converting natural gas to hydrogen to fuel these vehicles.

Figure AUS16: Virtual Clean Car Race – Light Vehicle CO_2 Emissions



Source: APERC Analysis (2012)

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