CHAPTER 2

Australia Country Report

Shamim Ahmad and Seiya Endo

March 2021

This chapter should be cited as:
Ahmad, S. and S. Endo (2021), 'Australia Country Report', in Han, P. and S. Kimura (eds.), *Energy Outlook and Energy Saving Potential in East Asia 2020*, Jakarta: ERIA, pp.33-44.

CHAPTER 2
Australia Country Report

Shamim Ahmad and Seiya Endo

1. Introduction

Australia is the largest country in Oceania and the sixth-largest country in the world by total area. It has a land area of about 7.7 million square kilometres and is diverse in geography and climate. It has six states and two territories. Over the past 27 years, Australia's population has grown at an average annual rate of 1.4%, from 17.1 million in 1990 to 24.6 million in 2017. [31]

Australia's gross domestic product (GDP) increased at an average annual rate of 3.0%, from US$638 billion in 1990 to US$1.43 trillion in 2017 (constant 2010 US dollar values), i.e. an increase of per capita income from about US$37,300 in 1990 to US$58,200 in 2017. Economic activities are concentrated in the eastern and south-eastern seaboards, where most of the population lives. In 2017, only three states – New South Wales, Victoria, and Queensland – generated 75% of Australia's GDP, whilst they represent 33%, 26%, and 20% of the national population, respectively (ABS, 2019).

1.1. Energy Situation

Australia has abundant, high-quality, and diverse non-renewable and renewable energy resources. Its non-renewable energy resources include fossil fuels (coal, gas, and oil) and nuclear energy fuels (uranium and, potentially, thorium). Australia has 1.33 million tons of economically demonstrated resources of uranium, equivalent to 17,727 million tons of oil equivalent (Mtoe) or 742,179 petajoules (Geoscience Australia, 2019), more than one-third of the world's uranium resources. Australia has a major share of the world's thorium, which could be an alternative to uranium as a nuclear fuel.

[31] All data in this chapter, unless otherwise cited, can be referenced to the 2020 energy outlook modelling results of the Institute of Energy Economics, Japan.

The country has 73,719 million tons or 10% of the world's recoverable black coal and 76,951 million tons or 24% of the world's brown coal (Geoscience Australia, 2019). The substantial conventional and unconventional gas resources of Australia account for almost 1.2% of the world's gas resources, and it has a small share (0.1%) of the world's crude oil resources (BP, 2020). The amount of recoverable resources is expected to grow with further exploration, and these resources are expected to last for many more decades even if production increases.

Australia has large, widely distributed wind, solar, geothermal, hydroelectricity, ocean energy, and bioenergy resources. Wind energy technology is mature and its uptake is growing fast. Generation capacity of solar electricity is increasing rapidly due to fast-decreasing solar technology costs. Australia has the highest solar radiation per square metre in the world. No substantial expansion of traditional hydropower will likely occur due to the dry climate and low water runoff over most of Australia. Pumped hydro for electricity storage is being considered for existing hydro installations and new sites.

Energy resources play a significant role in the country's economic prosperity. Coal and gas resources support not only domestic consumption but also significant export earnings. In 2017, Australia was the world's ninth-largest energy producer (405.6 Mtoe), accounting for 2.9% of global primary energy supply. The country was the world's 21st-largest energy consumer, accounting for 0.9% (127.6 Mtoe) of world primary energy supply (IEA, 2019).

Primary energy supply is largely based on fossil fuel. In 2017, coal contributed about 35% of primary energy supply; oil, 34%; and natural gas, 24%. Renewables contributed the remaining 7%, consisting of hydro (1%), solar and wind (2%), and biofuel and waste (4%) (IEA, 2019).

Australia plays a prominent role in meeting increasing energy demand not only in Asia and the Pacific but also in the rest of the world. In 2017, Australia was the world's fourth-largest energy exporter; it exported 79% of its energy production, consisting largely of coal and liquefied natural gas. The country is the world's largest exporter of metallurgical coal, the second-largest exporter of thermal coal (IEA, 2019), and a large exporter of uranium. With limited crude oil resources, Australia is a net importer of crude oil and petroleum products; it is increasingly reliant on imported transport fuels.

Over the past 27 years, Australia's gross electricity generation has increased at an average annual rate of 1.9%, from 154 terawatt-hours (TWh) in 1990 to 258 TWh in 2017. In 2017, coal accounted for almost two-thirds (63%) of total electricity generation, followed by natural

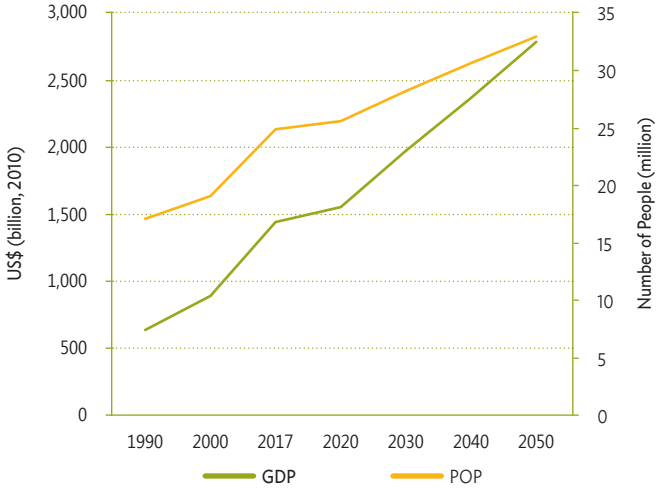
gas, 20%; hydro, 6%; oil, 2%; and others (non-hydro renewables), 9%. Coal still dominates the electricity generation mix although its share fell from 79% in 1990 to 63% in 2017. The share of natural gas and non-hydro renewables in the generation mix increased significantly over this period.

2. Modelling Assumptions

The business as usual (BAU) scenario reflects Australia's current trends of energy demand and supply and existing goals, action plans, and policy commitments. Australia's GDP is assumed to grow at an average annual rate of 2.0% from 2017 to 2050, compared with average annual growth of 3.0% from 1990 to 2017.[32] The economy will gradually shift from energy-intensive industries towards less energy-intensive ones. GDP growth will gradually decrease towards the end of the projection period. The population is assumed to grow at an average annual rate of 0.9% from 2017 to 2050, which is marginally slower than the average annual growth rate of about 1.4% from 1990 to 2017 (Figure 2.1).

Fossil fuels will remain dominant in the primary energy mix because they are abundant and cheap. New coal plants will not be installed to generate electricity, and the share of coal-fired

Figure 2.1. Gross National Product and Population (1990–2050)



GDP = gross domestic product, POP = population.
Source: Authors.

[32] The global coronavirus disease (COVID-19) pandemic has a negative impact on GDP and energy consumption, and when the economy will return to normal is highly uncertain. The data and analysis for this report were completed before the pandemic. Its impact, therefore, has not been accounted for in modelling the two scenarios.

electricity will decrease due to the scheduled closure and/or retirement of a few coal-fired electricity plants. No nuclear power plants will be installed. Gas-fired electricity and non-hydro renewable electricity generation are assumed to rise to meet increasing demand over the projection period.

The alternative policy scenario (APS) applies the same GDP and population assumptions as BAU. APS assumes improved efficiency of final energy consumption in end-use sectors. APS will see more efficient thermal power generation and higher contribution of renewable energy to total supply with no nuclear power plants. These measures' combined effects are assumed to provide maximum energy saving over the projection period. Energy saving in industry is assumed to be achieved from improvements in large energy-intensive industries and closure of inefficient small plants. Structural changes are assumed to gradually shift the economy from energy-intensive industries. In the residential and commercial sectors, efficient end-use technologies and energy management systems are assumed to further achieve energy saving. The transportation sector is assumed to be more energy-efficient because of improved vehicle standards and fuel economy. Rapid uptake of energy-efficient electric vehicles for private and public transport is assumed to occur during the second half of the projection period.

By comparing APS and BAU results, this study provides a basis for determining the impacts of promoting energy efficiency and increasing the use of renewable energy on energy saving and carbon dioxide (CO2) emission reduction in Australia.

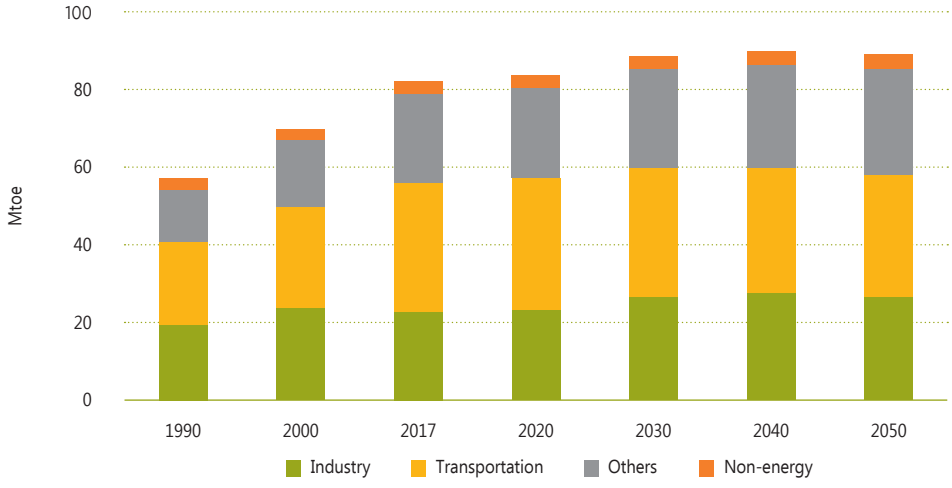
3.Outlook Results

3.1.Business as Usual

3.1.1.Final Energy Consumption

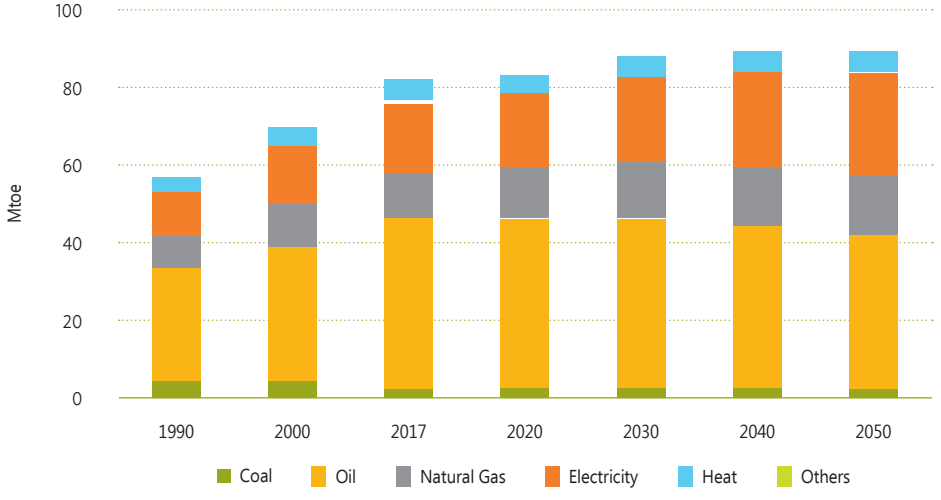
Under BAU, total final energy consumption is projected to increase by about 8.7%, from 81.8 Mtoe in 2017 to 89.0 Mtoe in 2050, or an average annual rate of 0.3% (Figure 2.2). The strongest growth is projected to occur in the 'others' sector (e.g. residential and service), increasing by 0.5% a year from 2017 to 2050. Transport energy consumption is projected to decline (0.2% a year) over the projection period, although it has seen strong growth (1.7% a year) in the past 27 years.

Figure 2.2. Final Energy Consumption by Sector, Business as Usual



Mtoe = million tons of oil equivalent.
Source: Authors.

Figure 2.3. Final Energy Consumption by Fuel Type, Business as Usual



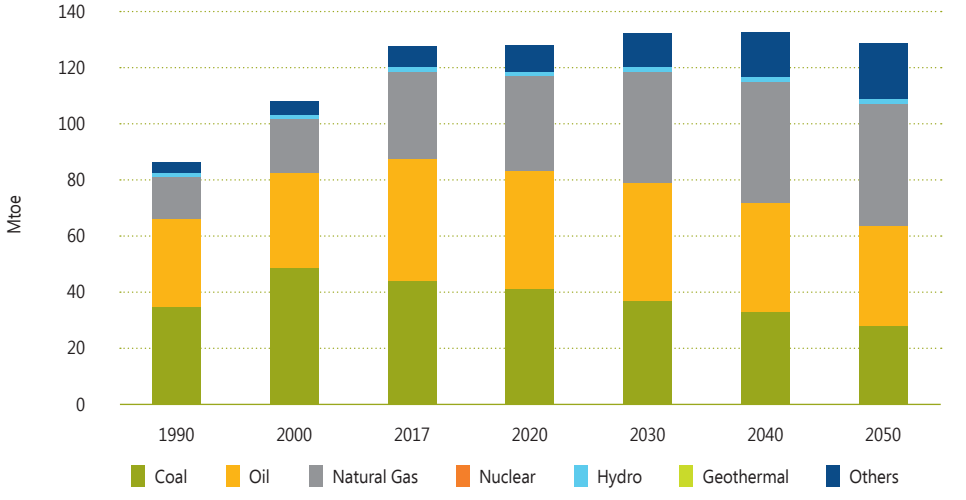
Mtoe = million tons of oil equivalent.
Source: Authors.

Electricity consumption is projected to have the fastest growth at an average annual rate of 1.2% per year from 2017 to 2050 (Figure 2.3). Natural gas is projected to increase at the second-highest rate of 0.5% per year. Growth in petroleum products is projected to decline by 0.3% per year. Coal consumption is expected to decline at an average rate of 0.2% per year.

3.1.2. Primary Energy Supply

Under BAU, primary energy supply is projected to remain flat, slightly increasing from 127.1 Mtoe in 2017 to 127.9 Mtoe in 2050 (Figure 2.4). Coal consumption is expected to decline at an annual average rate of 1.4% as is oil consumption (0.6% per year) from 2017 to 2050. Consumption of natural gas will increase by 1.0% per year from 2017 to 2050, with its share in the primary energy mix expected to increase from about 24.6% in 2017 to 33.9% in 2050. The overall share of fossil fuel in primary energy supply will decline from 92.9% in 2017 to 83.5% in 2050.

Figure 2.4. Primary Energy Supply by Fuel Type, Business as Usual



Mtoe = million tons of oil equivalent.

Source: Authors.

Others' (including non-hydro renewables) are projected to increase by 2.9% a year over the projection period. The share of 'others' is expected to increase from 6.0% in 2017 to about 15.3% in 2050; the increase will come mainly from solar and wind, followed by biomass. Solar, wind, biomass, and ocean energy together are expected to grow at an average annual rate of 5.5% from 2017 to 2050.

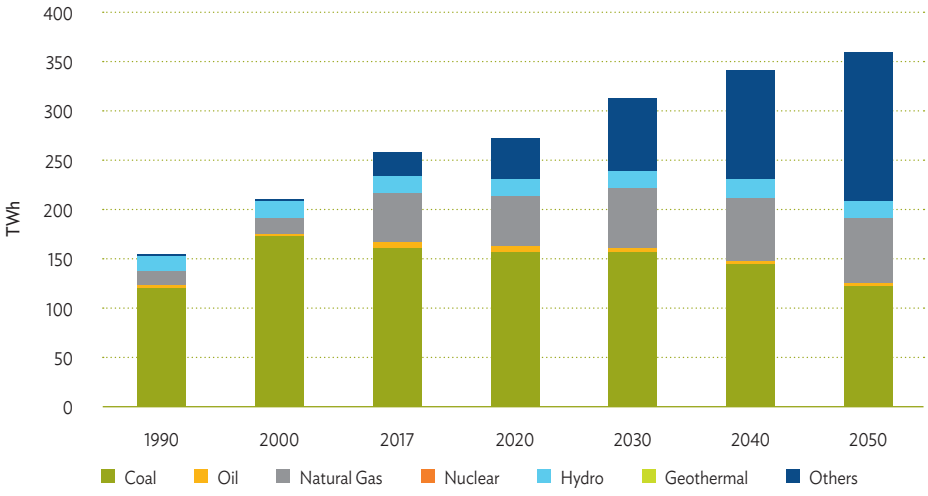
3.1.3. Power Generation

Electricity generation under BAU is projected to increase at an average rate of 1.0% per year, from 257.8 TWh in 2017 to 360.2 TWh in 2050 (Figure 2.5). The share of coal in the power

generation mix is projected to fall from 62.8% in 2017 to 34.5% in 2050, but coal will still maintain the largest share under BAU. Coal share will decline due to the scheduled closure and retirement of some old coal-fired generation plants. Generation from oil is projected to decline at an average rate of 2.8% per year, and the share of oil in the generation mix will decline from 2.0% in 2017 to 0.6% in 2050. The share of natural gas–fired generation will fall from 19.6% in 2017 to 18.3% in 2050, and natural gas use in electricity generation is projected to grow at an average rate of 0.8% per year over the period.

Hydro's share in the power generation mix is expected to decline from 6.2% in 2017 to 4.8% by 2050. The share of 'others' (non-hydro renewables), however, is expected to increase from 9.4% in 2017 to 41.8% in 2050. Electricity generation from 'others' (non-hydro renewables) is expected to grow at an average rate of 5.7% per year from 2017 to 2050. Declining costs of wind and solar technology will partly contribute to the faster growth in electricity generation from 'others' (including wind and solar).

Figure 2.5. Power Generation, Business as Usual



TWh = terawatt-hour.

Source: Authors.

3.2.Energy Saving and Carbon Dioxide Reduction Potential

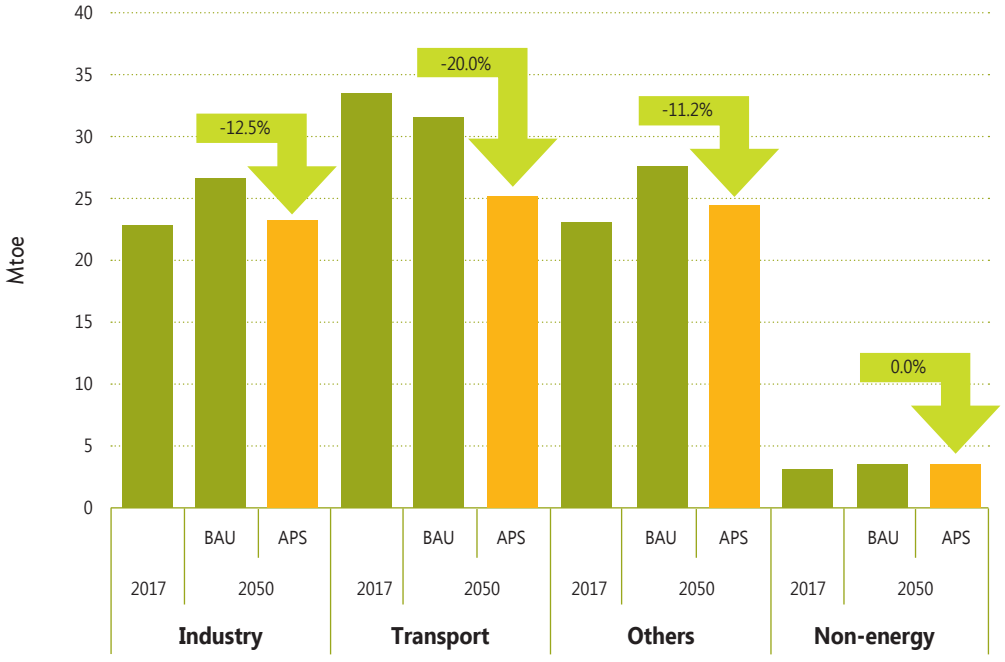
3.2.1.Final Energy Consumption

Under APS, final energy consumption is projected to decline by 0.2% per year from 81.8 Mtoe in 2017 to 76.2 Mtoe in 2050 (Figure 2.6), representing energy saving of 12.7 Mtoe or 14.3%

under APS in 2050 compared with BAU. Demand is expected to grow more slowly across all end-use sectors, excluding the non-energy sector. Transport is projected to see the highest energy saving, followed by industry and 'others' (residential and commercial sectors), reflecting improvements in vehicle fuel efficiency and end-use technologies.

In 2050, under APS, estimated savings are 3.3 Mtoe (12.5%) in industry, 6.3 Mtoe (20.0%) in transport, and 3.1 Mtoe (11.2%) in 'others' (Figure 2.6).

Figure 2.6. Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario



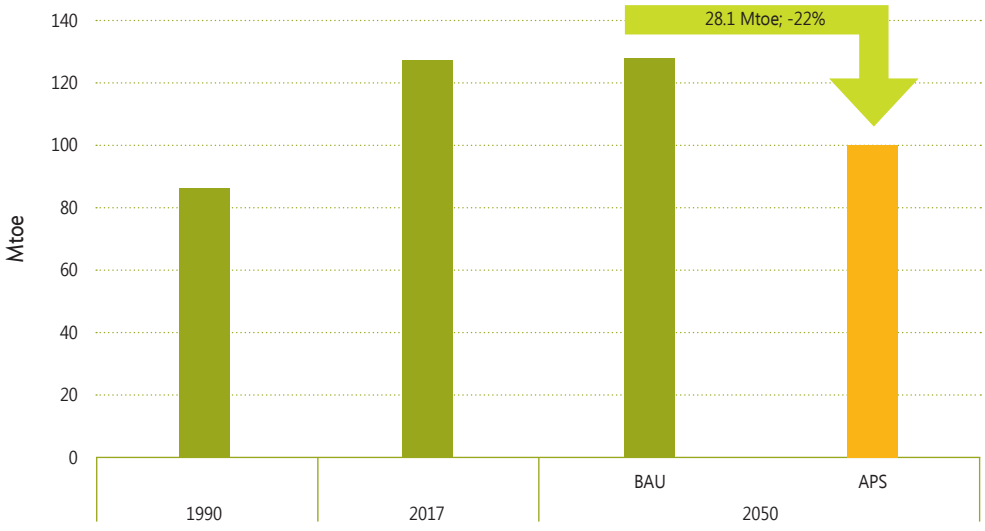
APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.
Source: Authors.

3.2.2. Primary Energy Supply

Under APS, primary energy supply is projected to decrease by 0.7% per year from 127.1 Mtoe in 2017 to 99.8 Mtoe in 2050, implying that in 2050, under APS, saving in primary energy supply will be about 28.1 Mtoe or 22.0% compared with BAU (Figure 2.7).

Coal is expected to decline by 3.7% per year under APS (compared with 1.4% under BAU) over the projection period, resulting in saving in coal consumption of about 15.1 Mtoe in

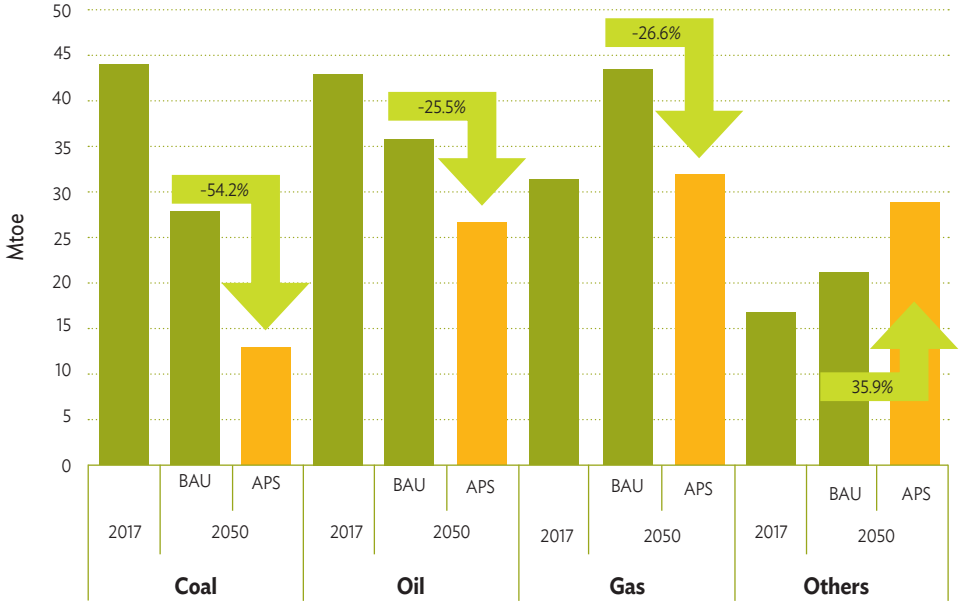
Figure 2.7. Total Primary Energy Supply, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe =million tons of oil equivalent.

Source: Authors.

Figure 2.8. Primary Energy Supply by Fuel, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.

Source: Authors.

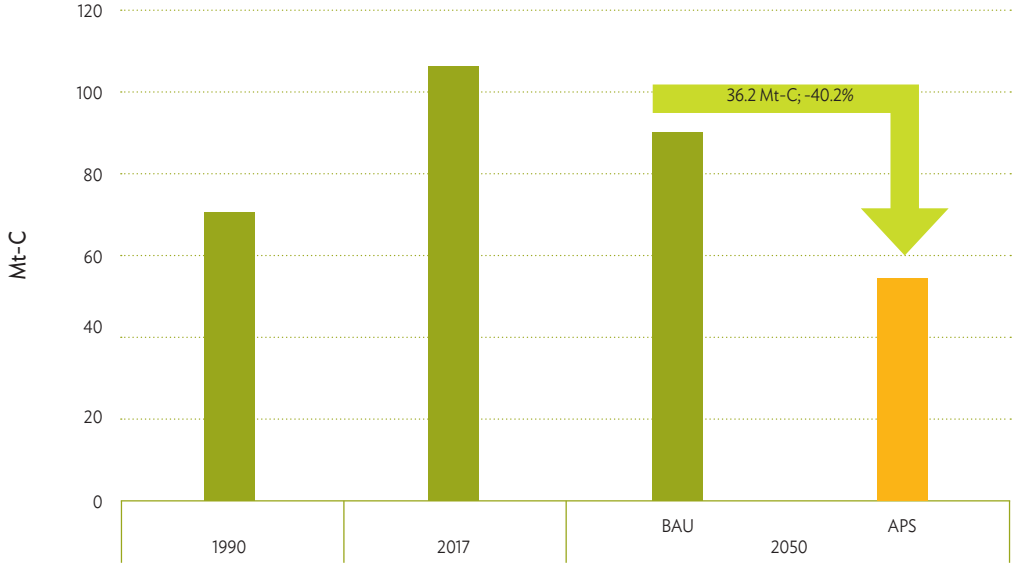
2050 compared with BAU. Similarly, negative growth in oil demand (–1.4% per year) will save oil consumption of about 9.1 Mtoe in 2050. With average annual growth of nearly 0% under APS, saving in natural gas consumption will be about 11.6 Mtoe compared with BAU. However, demand for 'others' (renewables) is expected to increase by about 7.6 Mtoe or 38.7% compared with BAU in 2050 (Figure 2.8).

3.3.Carbon Dioxide Emissions

CO2 emissions from energy consumption under BAU are projected to decline by 0.5% per year from 106.1 million tons of carbon (Mt-C) in 2017 to 89.9 Mt-C in 2050 (Figure 2.9). Growth in emissions appears to be less than projected growth in primary energy supply, reflecting increased use of energy sources that are less carbon-intensive.

Under APS, CO2 emissions are projected to decrease at an average annual rate of 2.0%, from 106.1 Mt-C in 2017 to 53.7 Mt-C in 2050. Emission saving under APS will be about 40.2% compared with BAU in 2050. The lower emission growth rate under APS indicates that energy-saving options are effective in reducing CO2 emissions. Reduced demand for coal in power generation and in final demand and reduced oil consumption in transport will contribute the most to expected reduction of CO2 emissions under APS.

Figure 2.9. Carbon Dioxide Emissions from Energy Combustion, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mt-C = million tons of carbon.

Source: Authors.

4. Implications

(i) Energy-saving options are effective in reducing CO2 emissions. Under APS, however, Australia will not achieve its intended nationally determined contribution target: reduce energy-related emissions of 26% to 28% below the 2005 level by 2030.

(ii) Energy efficiency and demand-side management are important. Using improved and efficient end-use technologies will reduce final energy consumption in end-use sectors. Transport has more opportunities for energy saving. Energy saving in industry will come from improved efficiency in large energy-intensive industries.

(iii) Fossil fuel – coal, oil, and gas – will continue to dominate the energy mix under both BAU and APS.

(iv) Coal will continue to dominate the electricity generation mix up to 2050, but its share in the power mix is projected to decline. Advanced technologies for power generation are necessary to enhance efficiency, energy saving, and emission reduction.

(v) Coal-fired generation is likely to remain cheaper than other energy sources. However, global attempts to curb emissions will put pressure on Australia to adopt low-emission technologies for power generation. The use of efficient and clean coal technologies is necessary. Research, development, and deployment of clean energy technologies will play a key role.

(vi) Oil will continue to supply transport fuel needs. Improved vehicle fuel efficiency and uptake of electric vehicles will reduce oil demand in transport. Investment in new petroleum refinery plants might be necessary to reduce dependence on imported transport fuel.

(vii) Substantial expansion of traditional hydropower is not likely due to the dry climate and low water runoff over much of Australia.

(viii) Wind and solar technology costs will fall more quickly over the projection period. Growth in renewable energy will likely come from large-scale adoption of wind and solar energy supported by energy storage.

References

Australian Bureau of Statistics (ABS) (2019), *Australian National Accounts: State Accounts, 2018-19, Table A. Australian Demographic Statistics,* Table 4. Canberra: ABS.

BP (2020), *BP Statistical Review of World Energy – all data (1965-2019),* June 2020. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html (accessed 27 November 2020).

Geoscience Australia (2019), *Australia's Identified Mineral Resources 2019.* Canberra: Geoscience Australia. https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/132457 https://d28rz98at9flks.cloudfront.net/132457/132457_00_0.pdf (accessed 21 August 2020).

Geoscience Australia (2019), '*Table 5. World Ranking for Australia's Mineral Resources (EDR) and Production as at December 2018'.* https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/aimr/world-rankings (accessed 10 August 2020).

International Energy Agency (IEA) (2019), *World Energy Balances*. Paris: IEA.

The Institute of Energy Economics, Japan (IEEJ) (2020), E*nergy Outlook Modelling for Australia*. Tokyo: IEEJ.