CHAPTER 2

AUSTRALIA COUNTRY REPORT

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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 around 7.7 million square kilometres, and is diverse in geography and climate. It has six states and two territories. Over the past 25 years, Australia's population grew at an average annual rate of 1.3%, from 17.1 million in 1990 to 23.8 million in 2015.

Australia's gross domestic product (GDP) increased at an average annual rate of 3.1%, from US$636 billion in 1990 to US$1.36 trillion in 2015 (constant 2010 US$ values), which translates the increase of Australia's per capita income from around US$37,300 in 1990 to US$56,950 in 2015. Economic activities are focused on the eastern and southeastern seaboard, where most of the population lives. For example, in 2016, only three states – New South Wales, Victoria, and Queensland – generated 73% of Australia's GDP, while these states represent 32%, 25%, and 20% of the national population, respectively (Carr et al., 2017).

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 1.27 million tons of economic demonstrated resources of uranium, which is equivalent to 16,984 million tons of oil equivalent (Mtoe) or 711,076 petajoules (Geoscience Australia, 2018). This amount is more than one-third of the world's uranium resources. Australia also has a major share of the world's thorium resources, and thorium could be an alternative to uranium as a nuclear fuel in the future.

The country has 70,927 million tons of recoverable black coal resources, which is 10% of the world's black coal resources. It has a further 76,508 million tons of brown coal resources, about 24% of the world's brown coal reserves (Geoscience Australia, 2017). Australia's substantial conventional and unconventional gas resources account for almost 2% of the world's gas resources, and it has a relatively small share (0.2%) of crude oil resources (BP, 2017). 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 also has large, widely distributed wind, solar, geothermal, hydroelectricity, ocean energy, and bioenergy resources. Wind energy technology is relatively mature, and its uptake is growing faster in the country. Generation capacity of solar electricity is also increasing rapidly due to the rapid reductions of 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 examined at existing hydro installations and new sites.

Australia's 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 2015, Australia was the world's eighth-largest energy producer (381.3 Mtoe), accounting for 2.8% of global primary energy supply. It was the world's 21st-largest energy consumer, accounting for 0.9% (125.3 Mtoe) of world primary energy supply (IEA, 2017).

Primary energy supply is largely based on fossil fuels. In 2015, coal contributed about 34% of primary energy supply; oil, 33%; and natural gas, 26%. Renewables contributed the remaining 7%, consisting of hydro (1%), solar and wind (2%), and biofuel and waste (4%) (IEA, 2017).

Australia plays a prominent role in meeting the increasing energy demand of the Asia-Pacific region and the world. In 2015, Australia was the world's fourth-largest energy exporter; it exported 78% of its energy production, consisting largely of coal and liquefied natural gas. It is the world's largest exporter of metallurgical coal and the second-largest exporter of thermal coal (IEA, 2017). It is also 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 imports for its transport fuels.

Over the past 25 years, Australia's gross electricity generation has increased at an average annual rate of 2% from 154 terawatt-hours (TWh) in 1990 to 252 TWh in 2015. In 2015, coal accounted for almost two-thirds (63%) of total electricity generation; followed by natural gas, 21%; hydro, 5%; oil, 3%; and others (non-hydro renewables), 8%. Coal still dominates Australia's electricity generation mix, though its share has fallen from 79% in 1990 to 63% in 2015. The share of natural gas and non-hydro renewables in the generation mix has increased significantly over this period.

2. Modelling Assumptions

Australia's GDP is assumed to grow at an average annual rate of 2.5% between 2015 to 2040, compared with the average annual growth rate of 3.1% between 1990 and 2015. The Australian economy will gradually shift from energy-intensive industries towards less energy-intensive ones. Its GDP growth will gradually decrease towards the end of the projection period. Australia's population is assumed to grow at an average annual rate of 1% between 2015 to 2040, which is marginally slower than the average annual growth rate of about 1.3% from 1990 to 2015.

Fossil fuels will remain the dominant energy source in Australia's primary energy mix due to their relative abundance and costs. In electricity generation, no new coal plants will be installed, and the share of coal-fired electricity generation will decrease due to the scheduled closure and/or retirement of a few coal-fired electricity plants. Gas-fired electricity and non-hydro renewable electricity generation is assumed to rise to meet the increasing demand over the projection period.

The Alternative Policy Scenario (APS) assumes the implementation of improved efficiency of final energy consumption in the end-use sectors. The APS will see more efficient thermal power generation, and a higher contribution of renewable energy to the total supply. Combined effects of these measures are assumed to provide maximum energy savings over the projection period. Energy savings in the industry sector are 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 away from energy-intensive industries. In the residential and commercial sectors, efficient end-use technologies and energy management systems are assumed to further achieve energy savings. The transport sector is assumed to be more energy efficient through 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.

This study further attempts to develop a Nationally Determined Contributions (NDC) scenario to analyse Australia's emissions reduction target for 2030. This scenario in this study is designed to meet Australia's emissions reduction target of 26%–28% below the 2005 level by 2030.

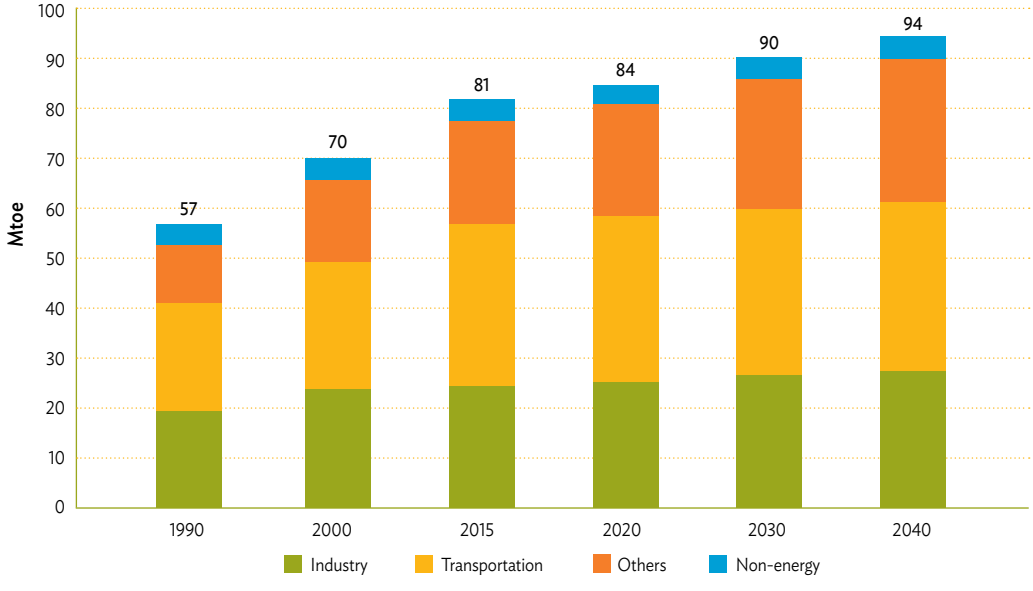
3. Outlook Results

3.1. Business-As-Usual Scenario

3.1.1. Final energy consumption

Under the BAU scenario, total final energy consumption in Australia is projected to increase from 81.3 Mtoe in 2015 to 94.1 Mtoe in 2040, a rise of about 15.7% over the projection period and an average annual rate of increase at 0.6% (Figure 2.1). The strongest growth is projected to occur in the 'others' sector (e.g. residential and services sectors), increasing at 1.3% per year between 2015 and 2040. The growth of energy consumption in the transport sector is projected to remain slow (0.1% per year) over the projection period, though it saw relatively strong growth (1.7% per year) in the past 25 years.

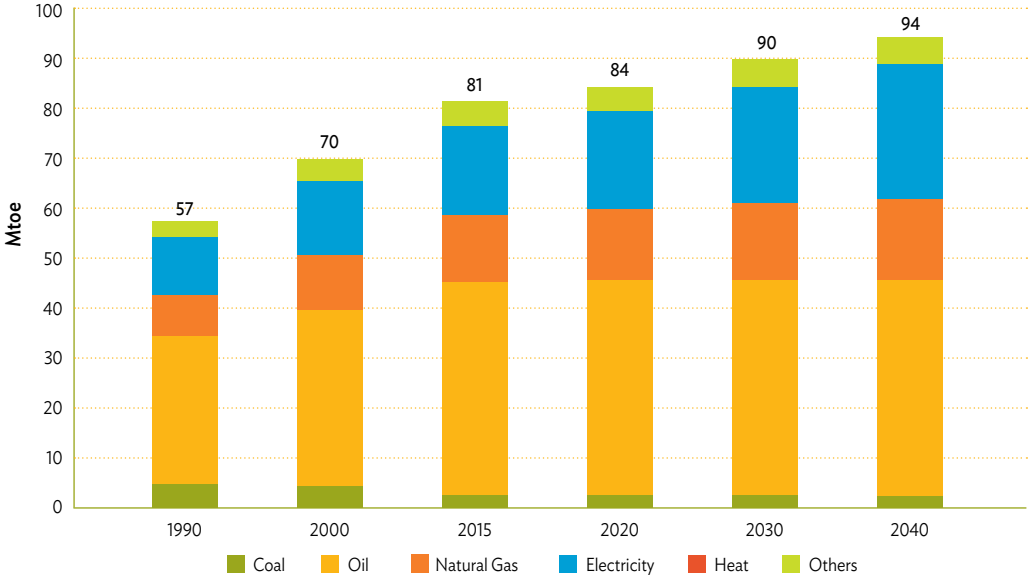
Figure 2.1: Final Energy Consumption by Sector, BAU Scenario



BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Authors' calculation.

Figure 2.2: Final Energy Consumption by Fuel Type, BAU



BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

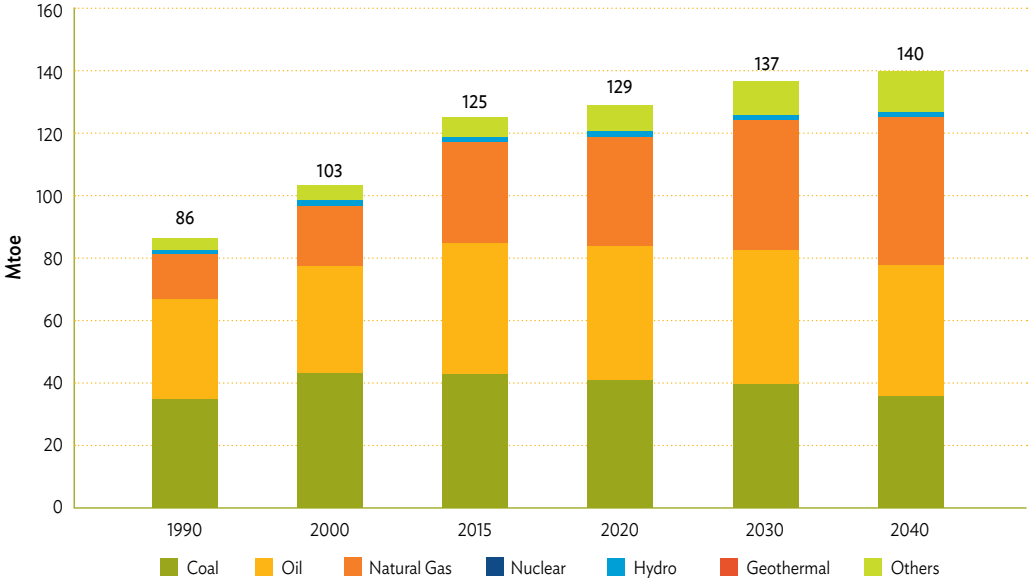
Source: Authors' calculation.

Electricity consumption is projected to have the fastest growth at an average annual rate of 1.7% per year between 2015 and 2040 (Figure 2.2). Natural gas is projected to increase at the second highest rate of 0.7% per year. Petroleum products are projected to see a slower growth rate, with an average rate of 0.1% per year. Coal consumption is expected to decline at an average rate of 0.9% per year.

3.1.2. Primary energy supply

Under the BAU scenario, Australia's primary energy supply is projected to increase from 125.3 Mtoe in 2015 to 140.1 Mtoe in 2040 at an average annual rate of 0.4% (Figure 2.3). Coal consumption is expected to decline at an annual average rate of 0.8% during this period, and growth in oil consumption is projected to remain flat. Natural gas will increase at 1.5% per year between 2015 and 2040, where its share in the primary energy mix is expected to increase from about 26% in 2015 to 34% in 2040. The overall share of fossil fuel in Australia's primary energy supply will decline from 94% in 2015 to 89% in 2040.

Figure 2.3: Primary Energy Supply by Fuel Type



Mtoe = million tons of oil equivalent.

Source: Authors' calculation.

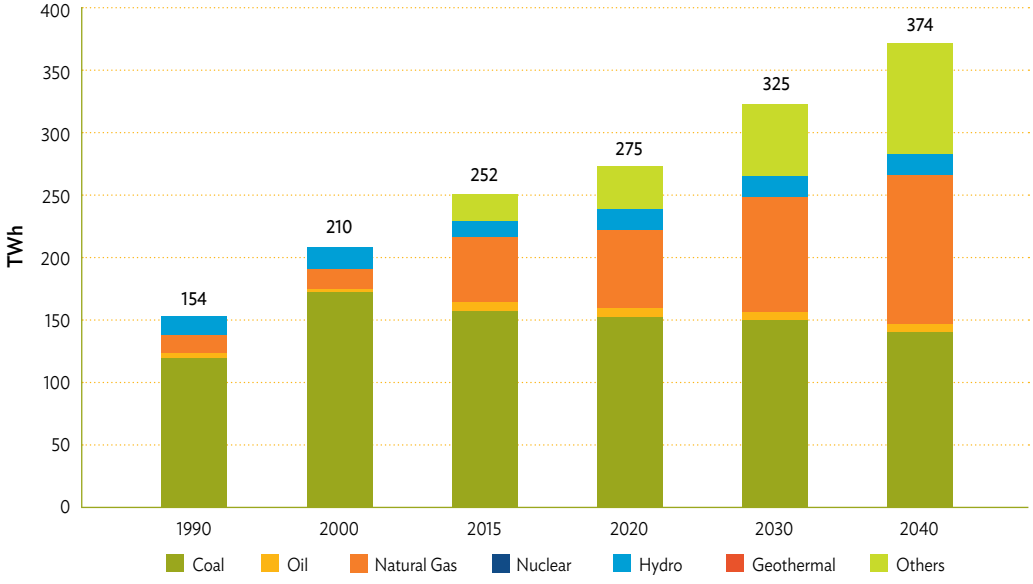
'Others' (including non-hydro renewables) is projected to increase by 2.7% a year over the projection period. The share of 'others' is expected to increase from 5.7% in 2015 to about 10% in 2040, where the major contribution to this increase would come from solar and wind followed by biofuels and biomass. Solar, wind, and ocean energy together are expected to grow at an average annual rate of 5.9% between 2015 and 2040.

3.1.3. Power generation

Electricity generation in Australia, under the BAU scenario, is projected to increase from 252.3 TWh in 2015 to 373.7 TWh in 2040 at an average rate of 1.6% per year (Figure 2-4). The share of coal in Australia's power generation mix is projected to fall from 63% in 2015 to 38% in 2040, which will still maintain its largest share in the generation mix under the BAU scenario. Coal share will decline due to the scheduled closure and retirement of some old coal-fired generation plants. Generation from oil is also projected to decline at an average rate of 0.1% per year, and the share of oil in the generation mix will decline from 2.7% in 2015 to 1.8% in 2040. In contrast, the share of natural gas–fired generation will increase from 21% in 2015 to 32% in 2040, and natural gas use in electricity generation is projected to grow at an average rate of 3.3% per year over the period.

Hydro's share in Australia's power generation mix is expected to decline slightly from 5.3% in 2015 to 4.7% by 2040. Electricity generation from 'others' (non-hydro renewables) is expected to grow faster at an average rate of 6% per year between 2015 and 2040. Declining costs of wind and solar technology would partly contribute to the faster growth of electricity generation from 'others' (including wind and solar) in Australia.

Figure 2.4: Power Generation under BAU



BAU = Business-As-Usual, TWh = terawatt-hour.

Source: Authors' calculation.

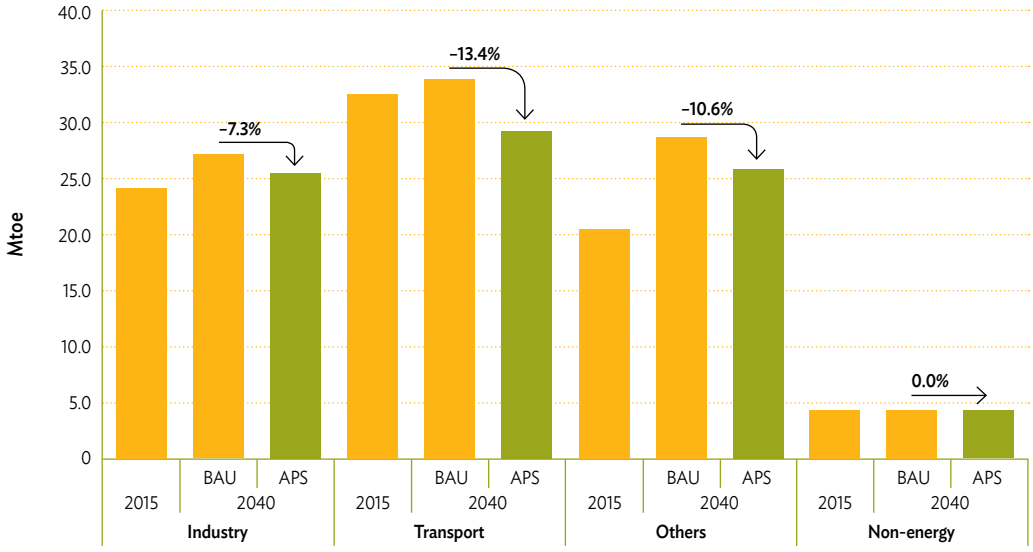
3.2. Energy Saving and CO_2 Reduction Potential

3.2.1. Final energy consumption

Under the APS, final energy consumption is projected to increase at a slower rate of 0.2% per year from 81.3 Mtoe in 2015 to 84.5 Mtoe in 2040 (Figure 2.5). This shows energy savings of 9.6 Mtoe, or 10.2%, under the APS in 2040, compared to that of the BAU scenario in 2040. The slower growth in demand is expected to occur across all end-use sectors, excluding the non-energy sector. The transport sector is projected to see the highest energy savings followed by the 'others' (residential and commercial) sector. These reflect the improvements in vehicle fuel efficiency and end-use technologies.

In 2040, under the APS, estimated savings are 2.0 Mtoe (7.3%) in the industry sector, 4.5 Mtoe (13.4%) in the transport sector, and 3.0 Mtoe (10.6%) in the 'others' sector (Figure 2.5).

Figure 2.5: Final Energy Consumption by Sector, BAU and APS



BAU = Business-As-Usual, APS = Alternative Policy Scenario, Mtoe = million tons of oil equivalent.

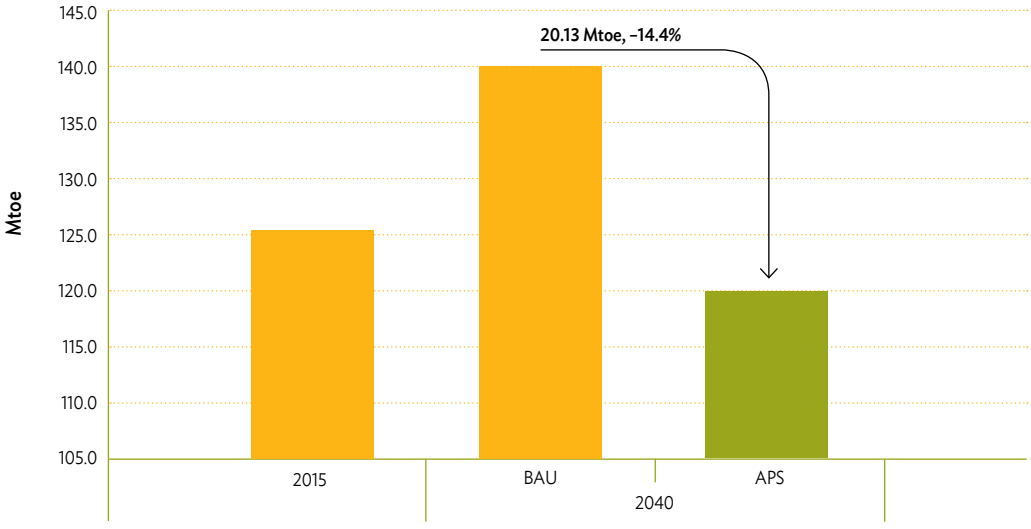
Source: Authors' calculation.

Under the NDC scenario, final energy consumption is forecast to decrease at a rate of 0.6% per year from 81.3 Mtoe in 2015 to 70.5 Mtoe in 2040. Therefore, the NDC scenario shows further savings of 14 Mtoe final energy compared to the savings under the APS. The highest contribution to final energy savings would come from the transport sector, followed by 'others' (i.e. residential and services) in this scenario.

3.2.2. Primary energy supply

Under the APS, Australia's primary energy supply is projected to decrease at a rate of 0.2% per year from 125.3 Mtoe in 2015 to 119.9 Mtoe in 2040. This implies that in 2040, under the APS, savings of primary energy supply will be around 20.1 Mtoe or 14.4% compared to BAU (Figure 2.6).

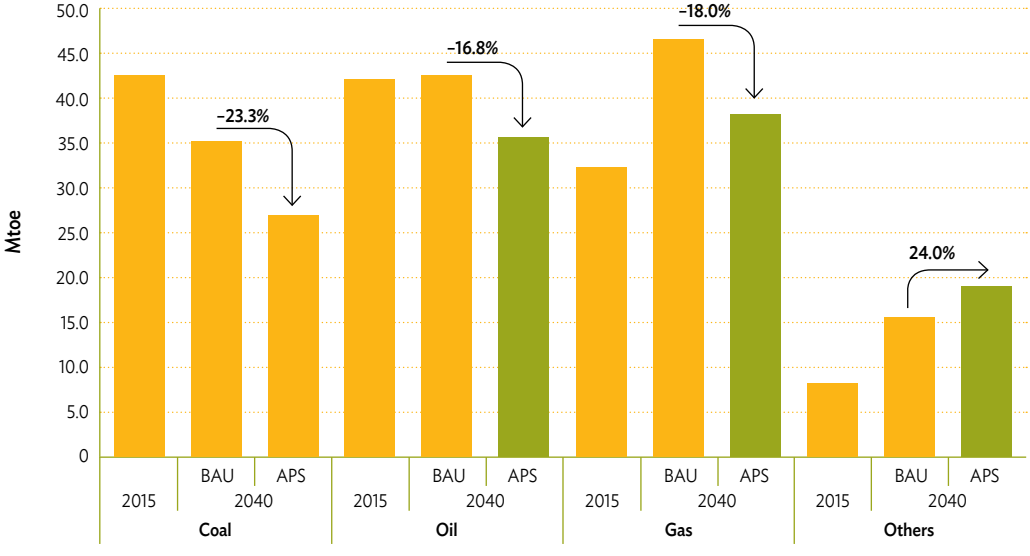
Figure 2.6: Total Primary Energy Supply, BAU and APS



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Authors' calculation.

Figure 2.7: Primary Energy Supply by Fuel Type, BAU and APS



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Authors' calculation.

Primary energy supply in the APS is expected to decline for coal at 1.8% per year (compared to a decline of 0.8% per year in the BAU scenario) over the projection period. This will result in a saving of coal consumption by about 8.3 Mtoe in 2040 compared to the BAU scenario. Similarly, the negative growth of oil demand (0.7% per year) will save oil consumption of about 7.1 Mtoe in 2040. With an average annual growth of 0.7%, savings on natural gas consumption will be about 8.4 Mtoe compared to the BAU scenario. However, the demand for 'others' (renewables) is expected to increase by about 3.7 Mtoe, or 24%, compared to the BAU scenario in 2040 (Figure 2.7).

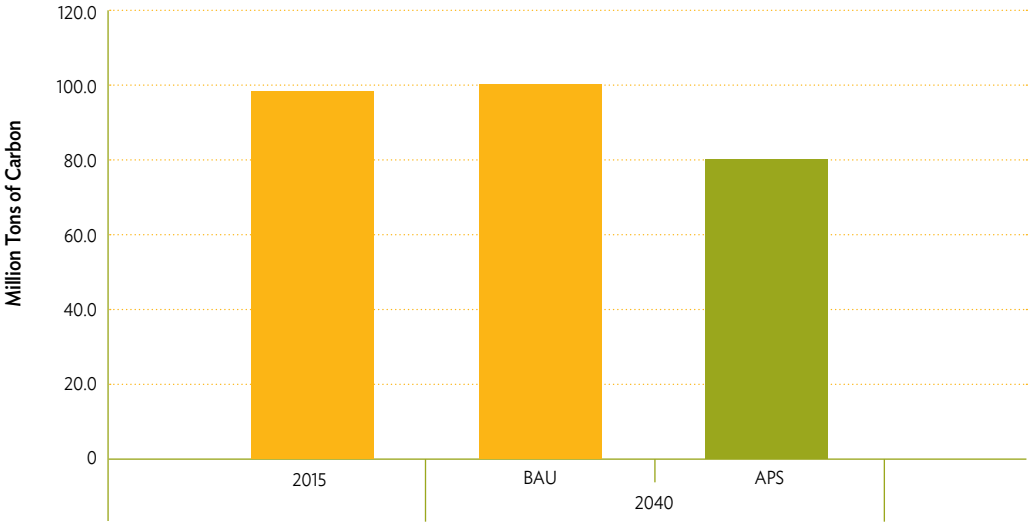
Primary energy supply under the NDC scenario is projected to decline at a rate of 1.3% per year, from 125.3 Mtoe in 2015 to 89.3 Mtoe in 2040. Therefore, this scenario provides additional savings of 31 Mtoe of primary energy compared to the APS in 2040. The share of renewables in the primary energy mix needs to increase from 11% in 2015 to about 27% in 2040 under the NDC scenario.

3.3. CO_2 Emissions

CO_2 emissions from energy consumption under the BAU scenario are projected to increase by 0.1% per year from 98.8 million tons of carbon (Mt-C) in 2015 to 100.3 Mt-C in 2040 (Figure 2.8). The growth in emissions appears to be less than the projected growth in primary energy supply, reflecting increased use of fewer carbon-intensive energy sources over the period.

In the APS, CO_2 emissions are projected to decrease at an average annual rate of 0.8% from 98.8 Mt-C in 2015 to 80.0 Mt-C in 2040. Emissions savings in the APS will be about 20% compared to the BAU scenario in 2040. The lower growth rate for the APS indicates that the energy-saving options are effective in reducing CO_2 emissions in Australia. Reduced demand for coal in power generation and in final demand, including reduced oil consumption in the transport sector, will contribute the most to the expected reduction of CO_2 emissions in the APS.

Figure 2.8: CO_2 Emissions from Energy Combustion, BAU and APS



APS = Alternative Policy Scenario, BAU = Business-As-Usual.

Source: Authors' calculation.

CO_2 emissions under the NDC scenario will decline at an average annual rate of 2.6% from 100.3 Mt-C to 50.5 Mt-C in 2040. This is about 50% reduction of CO_2 emissions compared to the BAU scenario in 2040.

In 2005, energy-related CO_2 emissions in Australia were 94.1 Mt-C. In 2030, such emissions are projected to be 101.9 Mt-C in the BAU scenario, 88.8 Mt-C in the APS, and 69.5 Mt-C in the NDC scenario. It appears that the energy-related emissions reduction target of 26%–28% below the 2005 level by 2030 will not be achieved under the APS. The NDC scenario in this study is designed to meet Australia's emissions reduction target of 26% below the 2005 level by 2030, by further enhancing the assumptions of energy efficiency and renewable energy.

4. Implications

- Fossil fuels – namely, coal, oil, and gas – will continue to dominate the energy mix in both the BAU scenario and the APS.
- Coal will continue to dominate Australia's electricity generation mix over the period up to 2040; however, the share of coal in the power mix is projected to decline. Advance technologies for power generation would be necessary to enhance efficiency, energy savings, and emissions reduction.
- Australia has substantial reserves and a secure supply of coal. Coal prices are expected to remain much lower over the long term. Coal-fired generation is likely to remain cheaper than other energy sources. However, global attempts to curb emissions would put pressure on Australia to adopt low-emission technologies for power generation. The use of efficient and clean coal technologies will be necessary. Research, development, and deployment of clean energy technologies will play a key role.
- Substantial expansion of traditional hydropower will likely not occur due to the dry climate and low water runoff in much of Australia. While wind and solar technology costs are going to fall more quickly over the next 25 years, the growth of renewable energy will likely come from large-scale adoption of wind and solar energy supported by energy storage. Better integration of variable renewable energy sources into Australia's energy systems will be necessary.
- Energy efficiency and demand-side management are important. The implementation of improved and efficient end-use technologies will reduce final energy consumption in the end-use sectors. Energy savings in the industry sector will come from the improved efficiency of large energy-intensive industries.
- Oil will continue to supply Australia's transport fuel needs. Improved vehicle fuel efficiency and uptake of electric vehicles would reduce oil demand in the transport sector. Investment in new petroleum refinery plants may be necessary to reduce import dependence of transport fuel.

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