Chapter 2

Australia Country Report

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Chapter 2

Australia Country Report

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Executive Summary

Australian energy projections were derived using the *E4cast* model, a dynamic partial equilibrium model of the Australian energy sector. The *E4cast* modelling framework incorporates domestic as well as international trade in energy sources. It provides a complete treatment of the Australian energy sector, representing energy production, trade, and consumption at a detailed level. As a result, the model can be used to produce a full range of results, including Australian energy balance tables.

Key results in the latest Australian energy projections worth highlighting and reported in this paper are in terms of energy supply and demand. In the policy scenario, electricity generation is projected to grow by 30 percent over the period (0.08 percent per year) to total 332 terawatt-hours (TWh) in 2050. Coal's share of this production is projected to remain at 64 percent in 2050, whereas the share of gas declines to 14 percent, from the current 19 percent, due to the assumed rising gas prices over the projection period. About one-fifth of Australia's electricity is projected to be generated from renewable sources by 2049–2050.

Primary energy supply is projected to grow by 42 percent, at an annual average rate of growth of 1 percent. This compares with average annual growth in primary energy supply in Australia of 1.5 percent per year recorded from 2001–2002 to 2011–2012.

The projections include existing government policies, including the Renewable Energy Target (RET) and the repeal of carbon pricing ('no carbon pricing' has been included). They also incorporate the latest estimates of electricity generation technology costs from the Australian Energy Technology Assessment (Syed, 2013).

The Business-as-Usual scenario (BAU) has not been included, since the projections represent the Australian Government's official estimates of energy consumption and production to 2050 in light of present and known future energy policies.

1. Introduction

1.1. Historical Australian Energy Context

1.1.1. Energy resources

Australia is endowed with abundant, high-quality and diverse energy resources (Map 2-1). Australia has around 34 percent of the world's uranium resources, 14 percent of the world's black coal resources, and almost 2 percent of world gas resources. It has only a small proportion of the world's crude oil resources. Australia also has large, widely distributed wind, solar, geothermal, hydroelectricity, ocean energy, and bioenergy resources.

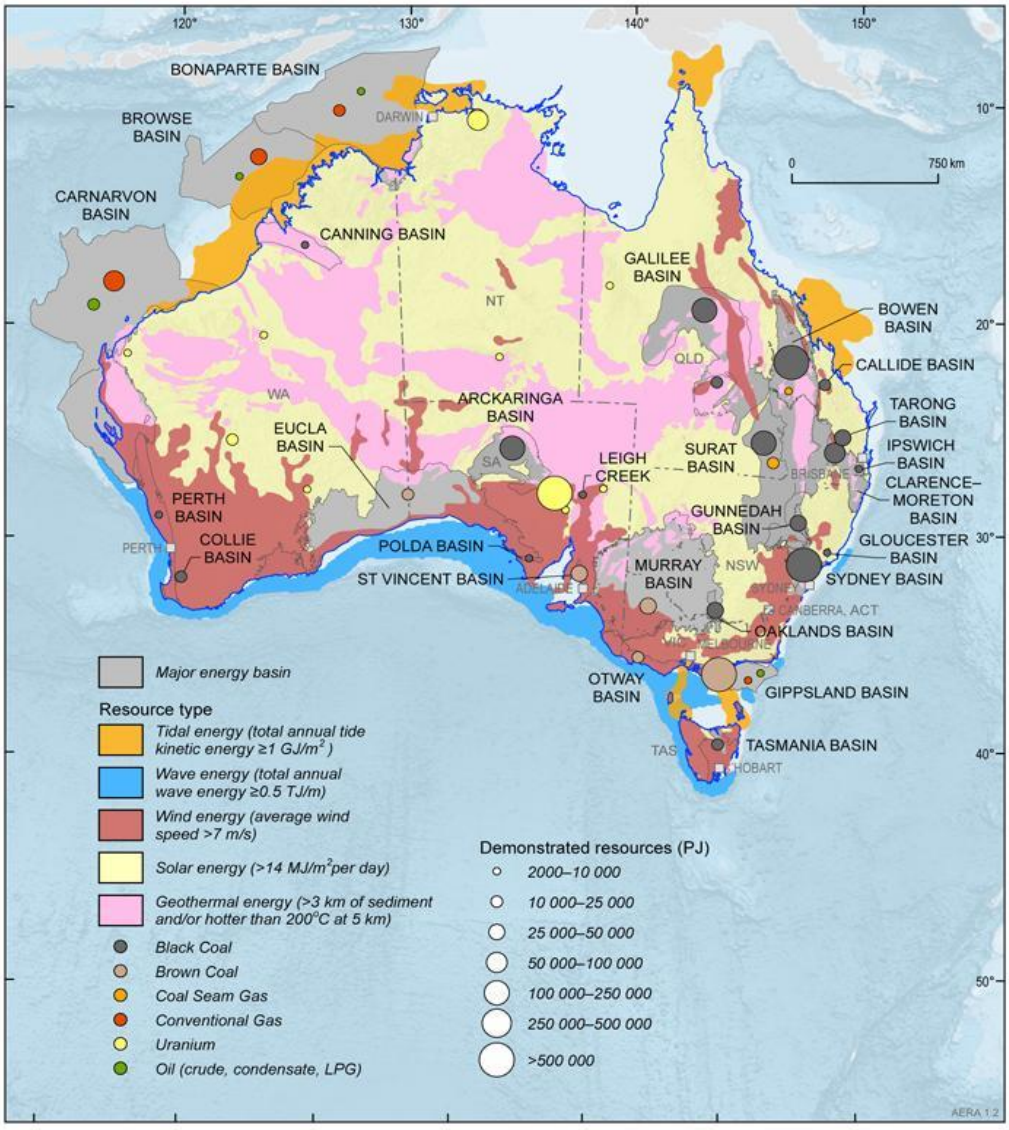
Geoscience Australia and the Bureau of Resources and Energy Economics (BREE) published the *Australian Energy Resource Assessment* (AERA) in June 2014 (Geoscience Australia and BREE, 2014), which has informed the present section of this report. Australia's energy resources are a key contributor to Australia's economic prosperity. It is estimated that total demonstrated non-renewable energy resources, except oil, have increased since 2010.

Australia's diverse energy resource base includes substantial coal resources that support domestic consumption and sizeable energy exports around the world.

Australia is endowed with renewable energy resources (wind, solar, geothermal, ocean, and bioenergy). Wind and solar energy resources are being increasingly exploited, whereas geothermal and ocean energy remain largely undeveloped.

Since uranium is not consumed domestically, it is not included in the energy balance projections presented in the following text. In this section, uranium is included in production and exports to provide a historical description of Australian energy. Therefore, the numbers in this section are not strictly comparable to the numbers in the following sections that exclude uranium.

Map 2-1. Distribution of Australia's Energy Resources

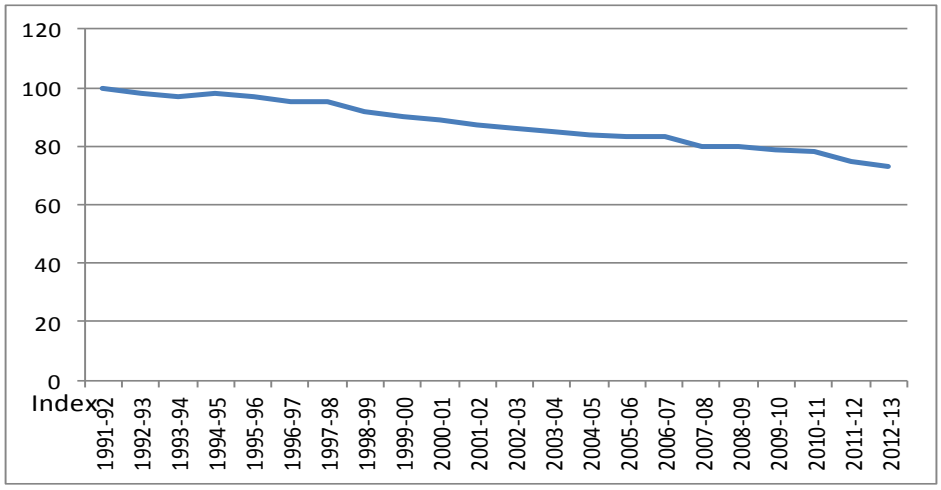


Source: Geoscience Australia and BREE (2014).

1.1.2. Energy consumption

Primary energy supply measures the total amount of energy used within the Australian economy. It is the total of the consumption of each fuel in both the conversion and end-use sectors. Over the past 3 decades, growth in energy consumption has generally remained below the rate of economic growth. This indicates a longer-term decline in the ratio of primary energy use to gross domestic product (GDP), or energy intensity (Figure 2-1) in the Australian economy. This can be attributed to two key factors: improvements in energy efficiency associated with technological advancement; and a shift in industry structure towards less energy-intensive sectors such as the commercial and services sectors.

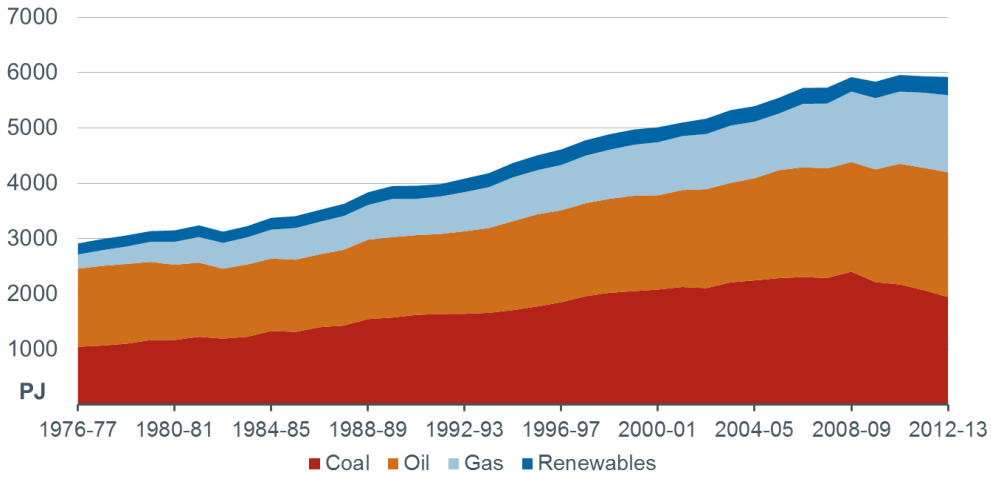
Figure 2-1. Australian Energy Intensity



Source: BREE (2014a), Table B.

In 2012–2013, black and brown coal together accounted for 33 percent of total energy consumption, its lowest share since the early 1970s. Coal consumption fell by 6 percent in 2012–2013, underpinned by falling coal use in the electricity generation and iron and steel sectors.

Figure 2-2. Australian Energy Consumption by Fuel Type



PJ = petajoules.
Source: BREE (2014a), Table C.

The share of natural gas in Australia's energy mix has increased in recent years, supported by greater uptake in the electricity generation sector and growth in industrial use, particularly in the non-ferrous metals sector. Gas consumption rose by 2 percent in 2012–2013, supported by an expansion in alumina output and additional gas-fired electricity generation capacity.

Hydro energy has been another significant contributor to energy consumption in Australia, with other renewables (solar, wind, and bioenergy) representing a much lower proportion of the total primary energy supply.

1.1.3. Energy production

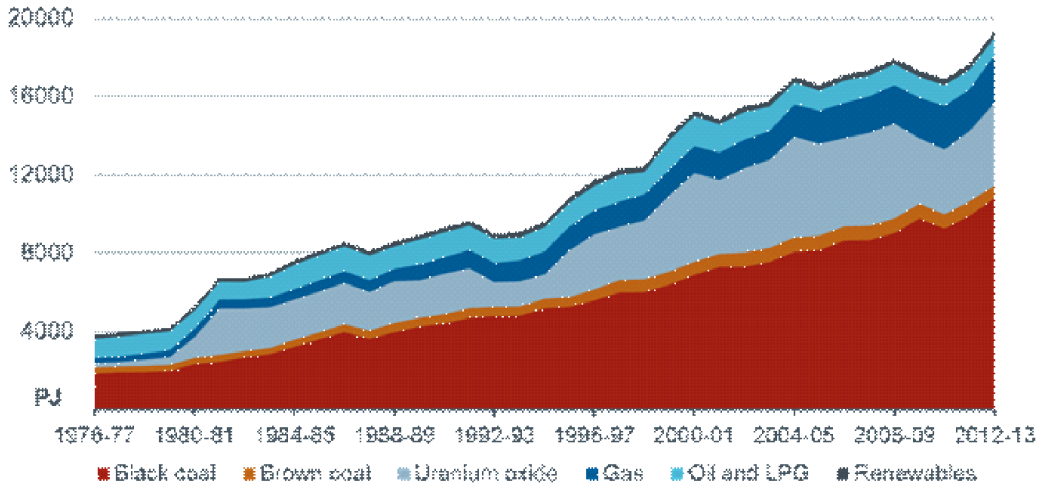
Energy production is defined as the total amount of primary energy produced in the Australian economy, as measured before consumption or transformation. Australia is the world's ninth largest energy producer, accounting for around 2.4 percent of the world's energy production (IEA, 2012). The main fuels produced in Australia are coal, uranium, and gas (Figure 2-3).

Although Australia produces uranium, it is not consumed domestically and all output is exported. Coal accounted for around 59.3 percent of total energy

production in energy content terms in 2012–2013, followed by uranium (22 percent) and gas (12.7 percent). Crude oil, condensate, and naturally occurring liquefied petroleum gas (LPG) represented 4.6 percent of total energy production in that year, and renewable energy the remaining 1.7 percent.

Australian production of renewable energy is dominated by bagasse, wood and wood waste, and hydroelectricity, which together accounted for around 80 percent of renewable energy production in 2012–2013. Wind and solar energy accounted for the remainder of Australia's renewable energy production, and their production has been increasing strongly.

Figure 2-3. Australian Energy Production, by Fuel Type



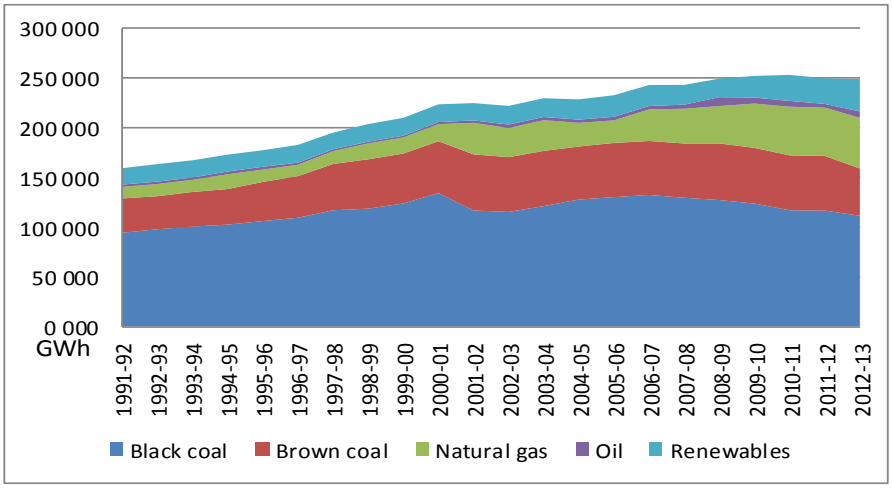
PJ = petajoules; LPG = liquefied petroleum gas.
Source: BREE (2014a), Table J.

1.1.4. Electricity generation

Electricity generation grew at an average annual rate of 3.5 percent per year from 1991–1992 to 2001–2002. However, there has been a gradual decline in generation over the past few years (Figure 2-4). It decreased from 253 TWh (around 911 petajoules) in 2010–2011 to 249 TWh (897 petajoules) in 2012–2013. Electricity generation grew at an average rate of 1.2 percent from 2002–2003 to 2012–2013 (Figure 2-4).

Coal continues to be the major fuel source for electricity generation, although its share in total production fell from 77 percent in 2003–2004 to around 66 percent in 2012–2013. In contrast, natural gas-fired generation continued to rise in 2012–2013, supported by new capacity coming on line in Victoria.

Figure 2-4. Australian Electricity Generation by Fuel Type



GWh = gigawatt-hour.
Source: BREE (2014a), Table O.

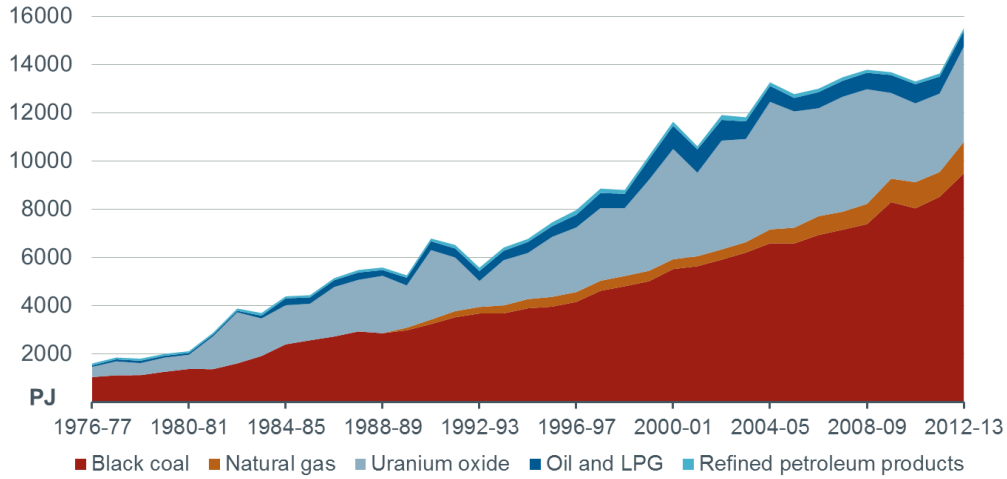
The share of renewables in Australian electricity generation rose from approximately 8 percent in 2003–2004 to about 13 percent in 2012–2013.

1.1.5. Energy trade

Australia's energy exports grew by 14 percent in 2012–2013 in energy content terms, to reach 15,504 petajoules, which is equal to around 80 percent of total energy production. This strong growth was led by Australia's three largest energy exports: black coal, uranium oxide, and liquefied natural gas (LNG) (Figure 2-5).

Total export earnings for mineral and energy commodities for 2013–2014 are forecast to be around US$196 billion, supported by robust growth in both mineral and energy commodity export volumes. These predictions are in spite of tighter international commodity market conditions and lower margins for domestic producers.

Figure 2-5. Australian Energy Exports by Fuel Type



PJ = petajoules; LPG = liquefied petroleum gas.
Source: BREE (2014a), Table J.

In 2013–2014, LNG exports reached 1,303 petajoules (around 23.9 million tons). Over the past decade, two new LNG trains built at NWS (in 2004 and 2008), and the start-up of Darwin LNG in 2006 and Pluto in 2012 have been responsible for sustained LNG export growth of 13 percent per year (BREE, 2014b). Australia is a net importer of liquid hydrocarbons, including crude oil and most petroleum products.

1.1.6. Energy policy

Energy related policy responsibilities are shared across the different levels of government in Australia. Much of Australia's energy policy is developed and implemented through cooperative action between the Australian and state and territory governments.

The government has prioritised a new Energy White Paper to address the challenges facing Australia's energy sector and to provide industry and consumers with certainty in government policy.

The Energy White Paper articulates a coherent and integrated national energy policy, addressing the issues of reliable and competitively priced energy supply,

streamlining regulation, and driving a commercially driven energy market that provides transparent prices and investment signals across all sources of energy and proven energy technologies.

Further information is available on the Energy White Paper website: www.ewp.industry.gov.au

1.1.7. Renewable energy target

The RET aims to advance the development and employment of renewable energy resources over the medium term and to assist in moving Australia to a lower-carbon economy. The RET legislation requires that the scheme is reviewed every 2 years.

From 1 January 2011, the RET has operated as two parts:

1. Large-scale Renewable Energy Target (LRET), and
2. Small-scale Renewable Energy Scheme (SRES).

The LRET encourages the deployment of large-scale renewable energy projects such as wind farms, whereas the SRES supports the installation of small-scale systems, including rooftop solar panels and solar water heaters. The LRET is set in annual gigawatt hour targets, rising to 41,000 GWh in 2020. The LRET target remains at 41,000 GWh from 2021 to 2030.

Small businesses and households are anticipated to provide more than the additional 4,000 gigawatt hours through the SRES. The Clean Energy Regulator (CER) oversees the RET. The LRET targets are presented in Table 2-1 (CER, 2014).

In *E4cast*, the RET is modelled as a constraint on electricity generation – renewable energy must be greater than or equal to the interim target in any given year.

Table 2-1. LRET Renewable Electricity Generation Target (excluding existing renewable generation)

Year ending	TWh
2014	16.9
2015	18.8
2016	21.4
2017	26.1
2018	30.6
2019	35.3
2020 and onwards	41.0

TWh = terawatt-hour.
Source: CER (2014).

In the model, the large-scale grid renewable generation is modelled by a subsidy to renewables that is funded by a charge on non-renewable generators. This is endogenously modelled so that total renewable generation meets the target.

The RET includes compulsory targets, such as 41 TWh LRET by 2020 that is maintained to 2030, and 15 TWh existing renewable generation below baseline. Thus, the compulsory RET target equates to a total of 56 TWh renewable electricity generation from large grid-based plants.

In *E4cast*, only grid generation is modelled (excluding rooftop solar, or non-grid small generation plants).

1.1.8. Energy efficiency

Over the last 2 decades there has been a significant coordinated effort between Australian Commonwealth and state and territory governments to ensure that energy efficiency opportunities are recognised and realised. In particular, governments have sought to act where market failures have limited the take up of cost-effective energy efficiency activities. In 2009, Australian governments entered into a partnership agreement and developed a National Strategy on Energy Efficiency to accelerate energy efficiency efforts.

These activities – in particular, improved efficiency of refrigeration, air conditioning and electronics, minimum performance standards for a range of common household appliances, and energy efficiency requirements in the Building Code – are beginning to show up in Australia's energy use trends. Together with the growth in rooftop solar PV and a decline in some energy intensive industries, improved energy efficiency has reduced demand in the national electricity market, although this trend may be reversing since the repeal of the carbon price (Sadler, 2014). Moreover, energy efficiency measures can also reduce the need for costly upgrades to electricity infrastructure, if they are targeted at reducing peak demand.

2. Key Assumptions

A number of economic drivers will shape the Australian energy sector over the next 2 decades. These include

- Population growth,
- Economic growth,
- Energy prices,
- Electricity generation technologies,
- End-use energy technologies, and
- Government policies.

The assumptions relating to these key drivers are presented below.

2.1. Population Growth

Population growth affects the size and pattern of energy demand. Projections for the Australian population are taken from the Australian Bureau of Statistics publication (ABS, 2013) and are presented in Table 2-2.

2.2. Economic Growth

Sector-level energy demand within *E4cast* is primarily determined by the value of the 'activity' variable used in each sector's fuel demand equation, along with fuel

prices; that is, direct and cross price, and income elasticities, as well as energy efficiency improvements.

Table 2-2. Australian Population Assumptions

Year	Population Millions
2015	23.94
2020	26.03
2030	30.11
2040	33.92
2050	37.59

Source: ABS (2013).

Since *E4cast* is a bottom-up model, the activity variable used for all non-energy-intensive sectors is gross state product (GSP), which represents income or business activity at the state level. However, for energy-intensive industries (aluminium, other basic nonferrous metals, and iron and steel manufacturing) projected industry output is considered as a more relevant indicator of activity than GSP because of the lumpy nature of investment.

The long-term projections of the GDP and GSP assumptions (Table 2-3) are provided by the Australian Treasury.

Table 2-3. Australian Economic Growth, by Region

Annual Growth Rate 2014–15 to 2049–50	%
New South Wales	2.6
Victoria	2.5
Queensland	3.2
South Australia	1.5
Western Australia	3.3
Tasmania	1.8
Northern Territory	2.6
Australia	**2.7**

Source: Australian Treasury provided assumptions on GSP and gross domestic product (GDP).

2.3. Real Energy Prices

Domestic fuel costs, such as gas, black and brown coal, biomass, and biogas, are based on the fuel price projections to 2050 used in Syed (2013).

2.4. Electricity Generation Technologies

The *Australian Energy Technology Assessment* (AETA) provides insights on 40 market-ready and prospective electricity generation technologies in Australia (Syed, 2013). AETA provides latest levelised cost of energy (LCOE) estimates and projections to 2050. Although other similar cost estimates have been conducted internationally, these studies are not directly applicable to Australian conditions due to differences in domestic costs (e.g. labour), differences in the quality of domestic energy resources, technology performance, and other local conditions. The LCOE estimates provided in Syed 2012, and 2013 were used in the present projections.

2.5. Government Policies

The key policies that have been modelled explicitly in *E4cast* included the repeal of carbon tax and the Minerals Resource Rent. Noting that government policy is to introduce the direct action plan to mitigate carbon emissions, there is no direct or indirect pricing of carbon emissions in the projections. The existing RET has been retained. Direct action plan was not modelled directly given the capacity of the model.

3. Energy Projection Results in Alternative Policy Scenarios

Australian energy projections in the Alternative Policy Scenarios (APS) for 2015–2050 on energy consumption, electricity generation, and production are provided in Tables 2-4 to 2-8 below.

3.1. Energy Consumption

Total primary energy supply is projected to grow by nearly 42 percent (or 1 percent per year) over the projection period (Table 4). This compares with average annual growth in primary energy supply in Australia of 1.5 percent per year from 2001–2002 to 2011–2012.

Coal and gas will continue to supply Australia's energy needs, although their share in the energy mix is expected to decline. The use of gas (conventional and unconventional natural gas) in industries is expected to grow over the outlook period, with projected falls in gas-fired electricity generation offset by growth in the consumption of gas in LNG production.

Renewable energy consumption is projected to increase moderately at a rate of 0.9 percent per year over the projection period. The growth in renewable energy is mainly driven by strong growth in wind and solar energy, at 2 and 1.7 percent, respectively.

The higher growth rates in energy consumption projected for Queensland, Northern Territory, and Western Australia, compared with other states, are underpinned by higher gross state product assumptions, combined with the high share of mining in economic output and the significant projected expansion of the gas sector, in particular LNG.

The electricity generation sector and the transport sector are expected to remain the two main users of primary energy over the outlook period.

The mining sector accounts for 8.7 percent of primary energy supply in 2014–2015 and is projected to have the highest energy consumption growth rate over the outlook period. This reflects the expected ongoing moderate global demand for energy and mineral commodities and the large number of mineral and energy projects (including LNG and coal seam gas) assumed to come on stream over the next few years.

Oil consumption in the transport sector is expected to grow steadily over the projection period at an average rate of 1.3 percent per year, driven largely by economic growth. Within the transport sector, road transport is the largest contributor to energy consumption. Energy use in the road transport sector is projected to grow by 0.65 percent per year on average over the period to 2049–2050.

Table 2-4. Primary Energy Supply, by Energy Type

	2014–15 (PJ)	2034–35 (PJ)	2049–50 (PJ)	% share 2014–15	% share 2049–50	Average Annual Growth 2014–15 to 2049–50
Non-renewables	**5,675**	**7,220**	**8,078**	**94**	**95**	**1.0**
Coal	1,635	1,871	1,945	27	23	0.5
black coal	1,171	1,407	1,436	19	17	0.6
brown coal	464	464	509	8	6	0.3
Oil	2,431	3,304	3,879	40	45	1.3
Gas	1,610	2,045	2,253	27	26	1.0
Renewables	**341**	**441**	**463**	**6**	**5**	**0.9**
Hydro	68	68	66	1	1	-0.1
Wind	59	116	118	1	1	2.0
Bioenergy	195	220	231	3	3	0.5
Solar	19	23	34	<1	<1	1.7
Geothermal	0	14	14	0	<1	
Total a)	**6,016**	**7,661**	**8,541**	**100**	**100**	**1.0**

a) Numbers in the table may not add up to their totals due to rounding.
Source: Author's calculation.

At the sectoral level, the main drivers of primary energy supply are the electricity generation sector, the transport sector, and the manufacturing sector. These sectors are projected to account for 64 percent of the increase in primary energy supply from 2014–2015 to 2049–2050 (Table 2-8).

The electricity generation sector accounted for the largest share (34 percent) of primary energy supply in 2014–2015. Total primary energy supply in the power generation sector is projected to grow at only 0.3 percent per year, to increase

from 2,054 petajoules in 2014–2015 to 2,278 petajoules in 2049–2050 (Table 2-8). Further details about the electricity generation sector projections are provided below.

Table 2-5. Primary Energy Supply, by Sector

Sector	2014–15 (PJ)	2034–35 (PJ)	2049–50 (PJ)	% share 2014–15	% share 2049–50	% Average Annual Growth 2014–15 to 2049–50
Electricity generation	2,054	2,268	2,278	34	27	0.3
Agriculture	103	133	157	2	2	1.2
Mining	523	1,051	1,211	9	14	2.4
Manufacturing	1,244	1,456	1,618	21	19	0.8
Transport	1,752	2,325	2,723	29	32	1.3
Commercial & Residential	339	427	554	6	6	1.4
Australia a)	**6,016**	**7,661**	**8,541**	**100**	**100**	**1.0**

a) Numbers in the table may not add up to their totals due to rounding.
Source: Author's calculation.

The transport sector (excluding electricity used in rail transport) is expected to account for 29 percent of primary energy supply in 2014–2015 and continues to rely heavily on oil. Consumption of oil and petroleum products in the transport sector is expected to grow steadily over the projection period at an average rate of 1.3 percent per year, driven largely by economic growth (Table 2.8). Also, the share of the transport sector in primary energy supply is projected to increase marginally from 29 percent to 32 percent over the period to 2049–2050. This effect is evident due to the slow growth in two main fuel-consuming sectors in the economy – electricity generation and manufacturing.

The manufacturing sector is the third largest user of primary energy in Australia, accounting for a share of 21 percent in 2014–2015. This sector covers a number of relatively energy-intensive sub-sectors such as petroleum refining, iron and steel, aluminium smelting, and minerals processing. Whereas energy consumption in the manufacturing sector is projected to increase at an average

annual rate of 0.8 percent over the outlook period, the share of the sector in total primary energy supply is expected to decline, which reflects a progressive structural shift toward less energy-intensive sectors.

The mining sector, which contributed only 9 percent of primary energy supply in 2014–2015, is projected to have the highest energy consumption growth rate (2.4 percent per year) over the outlook period. This reflects the continuation of global demand for energy and mineral commodities and the large number of mineral and energy projects (including LNG and coal seam gas) assumed to come on stream over the outlook period. The considerable volume of investment is a major driver of the expected expansion in the mining sector and the associated growth in primary energy supply. In 2049–2050, the sector is projected to account for 14 percent of Australian primary energy supply.

3.2. Electricity Generation

- Gross electricity generation is projected to grow by nearly 30 percent (or 0.8 percent per year) from 255 TWh in 2014–2015 to 332 TWh in 2049–2050 (Table 2.6). Coal is expected to remain the dominant source of electricity generation. The share of coal in electricity generation is projected to remain broadly constant (64 percent in 2014–2015 and 65 percent in 2049–2050), growing at 0.8 percent per year.

- Due to the declining cost of renewable generation (mostly wind and solar) over the projection period, as shown in the latest Australian Energy Technology Assessment report (Syed, 2013), electricity production from renewables is expected to grow by 1.5 percent per year, with wind and solar growing at a rate of 2 percent and 3 percent, respectively, over the projection period. The share of renewables is expected to increase from 15.3 percent in 2014–15 to 22 percent in 2020, and then fall slightly, to 20.1 percent, by 2049–2050.

Table 2-6. Electricity Generation, by Energy Type (TWh)

Energy Type	2014–15	2034–35	2049–50	% share 2014–15	% share 2049–50	% Average Annual Growth 2014–15 to 2049–50
Non-renewables	**216**	**252**	**265**	**85**	**80**	**0.6**
Coal	163	200	214	64	65	0.8
black coal	117	153	163	46	49	1.0
brown coal	47	47	51	18	15	0.3
Gas	50	49	48	19	14	-0.1
Oil	3	3	3	1	1	0.0
Renewables	**39**	**63**	**67**	**15**	**20**	**1.5**
Hydro	19	19	18	7	6	-0.1
Wind	16	32	33	6	10	2.0
Bioenergy	2	5	6	1	2	3.7
Solar	2	3	6	1	2	3.0
Geothermal	0	4	4	0	1	
Total a)	**255**	**315**	**332**	**100**	**100**	**0.8**

a) Numbers in the table may not add up to their totals due to rounding.
Source: Author's calculation.

3.3. Final Energy Consumption, by Energy Type

Total final energy consumption in Australia is projected to increase from 4,399 petajoules in 2014–2015 to 6,582 petajoules in 2049–2050, a rise of 50 percent over the projection period and an average annual rate of increase of 1.2 percent (Table 2-7).

This compares with an average annual growth rate of 1.7 percent in the 10 years to 2014–2015. Electricity is projected to continue to grow strongly to meet energy demand in end-use sectors. This will reduce the relative share of gas in final energy consumption by 2050, although the amount of gas consumption is projected to increase by 35 percent between 2014–2015 and 2049–2050.

Petroleum products are projected to see the fastest growth rate, with an average rate of 1.4 percent per year over the projection period.

Since the share of petroleum products in total final energy consumption increases from 53 percent to 57 percent from the beginning to the end of the outlook period, the shares of gas, electricity, and coal fall accordingly. The decline in the share of gas is predominantly due to rising prices to 2049–2050. The demand for petroleum products increases from growing mining and residential sectors. The consumption of renewables is projected to grow moderately, at a rate of 0.7 percent per year, in the absence of carbon pricing.

3.4. Energy Production and Trade

Total production of non-uranium energy in Australia is projected to grow by 59 percent (or 1.3 percent per year) (Table 2.8) over the projection period, driven by strong growth in gas, to reach 27,567 petajoules in 2049–2050.

Although coal production is expected to continue to increase, with projected growth of 1.2 percent per year, its share in total energy production is expected to fall from 75 percent in 2014–2015 to 71 percent by the end of the projection period.

The production of gas (conventional and unconventional natural gas) is expected to grow at a rate of 2.5 percent per year over the projection period, and its share in total Australian energy production is forecast to increase from 18 percent to 27 percent from the beginning to the end of the projection period.

Australia's exports of energy are expected to grow over the projection period. In 2014–2015, the ratio of Australia's primary energy supply to energy production (excluding uranium) is estimated to be 35 percent. By 2049–2050, this ratio is projected to have fallen to 31 percent.

Table 2-7. Final Energy Consumption, by Energy Type

Energy Type	2014–15 (PJ)	2034–35 (PJ)	2049–50 (PJ)	% share 2014–15	% share 2049–50	% Average Annual Growth 2014–15 to 2049–50
Coal	119	139	152	3	2	0.7
Petroleum products	2,312	3,169	3,734	53	57	1.4
Gas	999	1,159	1,346	23	20	0.9
Renewables	186	220	240	4	4	0.7
Electricity	784	1,037	1,111	18	17	1.0
Total a)	**4,399**	**5,725**	**6,582**	**100**	**100**	**1.2**

a) Numbers in the table may not add up to their totals due to rounding.
Source: Author's calculation.

Black coal, which includes both thermal and metallurgical coal, is projected to remain Australia's dominant energy export. The projected average annual growth rate of 1.2 percent is based on expectations that global demand for coal will continue to increase in the period to 2049–2050 as a result of increased demand for electricity and steel-making raw materials, particularly in emerging market economies in Asia.

LNG exports are also projected to increase significantly. By 2049–2050, LNG exports to the western market have the potential to reach 44 million tons (2,838 petajoules), which reflects an average annual growth rate over the projection period of 2.6 percent. LNG growth is higher in Eastern Gas Market and Northern Gas Market exports, at 6.7 and 4 percent per year, respectively, over the projection period. It may be noted that LNG exports are included as exogenous variables, using the data to 2020 from BREE's internal database. International Energy Agency (IEA) projections for growth in LNG supply in Australia are used (IEA, 2013) as well.

With declining oil production and limited prospects for an expansion of refinery capacity, coupled with recent refinery closures, Australia's net trade position for

crude oil and refined petroleum products is expected to deteriorate over the outlook period. Australia's net imports of liquid fuels are projected to increase by 2.4 percent per year on average.

The main sources of energy produced in Australia on an energy content basis are coal, uranium, and gas. With the exception of crude oil and refined petroleum products, Australia is a net exporter of energy commodities. In 2014–2015, production of coal is expected to be 13,021 petajoules, or 75 percent of total energy production (excluding uranium). In physical terms, total coal production is expected to be 570 million tons. Gas is expected to account for 18 percent of total energy production, followed by crude oil and condensate and naturally occurring LPG (5 percent) and renewables (hydroelectricity, wind energy, bioenergy, and solar energy) at 2 percent. Although Australia is a significant producer of uranium oxide, it is not included in the projections as it is not consumed as a fuel in Australia and, therefore, does not affect the domestic energy balance.

Total production of energy in Australia (excluding uranium) is projected to grow at an average rate of 1.3 percent per year to 2049–2050. At this rate, Australian production of energy is projected to increase by 59 percent to reach 27,567 petajoules in 2049–2050 (Table 2-8). Gas production is projected to increase from 3,109 petajoules (57 million tons) in 2014–2015 to 7,398 petajoules (136 million tons) in 2049–2050, or 27 percent of total energy production.

At the same time, the combined share of crude oil and naturally occurring LPG is projected to be around 1 percent of total energy production (at 265 petajoules) in 2049–2050. The share of coal in total energy production is projected to fall slightly, from 75 percent in 2014–2015 to 71 percent by 2049–2050.

Table 2.8. Energy Production, by Source

	2014–15 (PJ)	2034–35 (PJ)	2049–50 (PJ)	% share 2014–15	% share 2049–50	% Average Annual Growth 2014–15 to 2049–50
Non-renewables	**17,009**	**26,492**	**27,104**	**98**	**98**	**1.3**
Coal	13,021	19,299	19,441	75	71	1.2
black coal	12,557	18,834	18,932	72	69	1.2
brown coal	464	464	509	3	2	0.3
Oil	786	348	161	5	1	-4.4
LPG	93	98	104	1	0	0.3
Gas	3109	6,748	7,398	18	27	2.5
Renewables	**341**	**441**	**463**	**2**	**2**	**0.9**
Hydro	68	68	66	0	0	-0.1
Wind	59	116	118	0	0	2.0
Bioenergy	195	220	231	1	1	0.5
Solar	19	23	34	<1	<1	1.7
Geothermal	0	14	14	0	<1	
Total	**17,350**	**26,933**	**27,567**	**100**	**100**	**1.3**

Note: Numbers in the table may not add up to their totals due to rounding.
Source: Author's calculation.

4. Conclusions

The energy sector projections presented in this report are derived using the *E4cast* model. *E4cast* is a dynamic partial equilibrium model of the Australian energy sector. It is used to project energy consumption by fuel type, industry, and state and territory to 2050, on an annual basis.

The current projections show that Australian energy consumption will continue to grow over the next 40 years, albeit at a much lower rate than in the past 20 years. This is because of the substitution of renewables for fossil fuels in electricity

generation – which require much less energy use to generate electricity – and because of expected energy efficiency improvements, and higher energy prices.

Gross electricity generation is projected to grow at a rate of 0.8 percent per year over the outlook period. This growth is dominated by coal-fired electricity generation. Coal and oil will continue to supply the bulk of Australia's energy needs, although their share in the energy mix is expected to decline. The use of gas (natural gas and coal seam gas) as final energy consumption in industries is expected to grow by 1 percent per year over the outlook period. This moderate growth is driven primarily by negative gas-fired electricity generation growth, but positive consumption of gas in LNG production. Black coal is projected to remain Australia's dominant energy export. LNG exports are also projected to increase significantly.

The share of renewable energy is projected to increase moderately at a rate of 0.9 percent per year over the projection period. The growth in renewable energy is mainly driven by strong growth in wind and solar energy. Transition to a low carbon economy will require long-term structural adjustment in the Australian energy sector. Although Australia has an abundance of energy resources, this transformation will need to be underpinned by significant investment in energy supply chains to allow for better integration of renewable energy sources and emerging technologies into our energy systems. It will be critical to ensure that the broader energy policy framework continues to support cost-effective investment in Australia's energy future, and timely adjustments to market settings in response to emerging pressures, and market developments.

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