Maximum demand forecasts for United Energy terminal stations to 2030

Summer and winter and coincident and non-coincident

A report for
UNITED ENERGY DISTRIBUTION

Prepared by the
National Institute of Economic and Industry Research (NIEIR)
ABN: 72 006 234 626
Ground Floor, Unit 1, 663 Victoria Street, Abbotsford, Victoria, 3067
Telephone: (03) 9488 8444; Facsimile: (03) 9482 3262
Email: admin@nieir.com.au

July 2018

TON881-UE-MD/United/2018/July

Contents

			Page no.
1.	**Introduction**		**1**
2.	**The economy outlook for Australia to 2029-30**		**2**
	2.1	Introduction	2
	2.2	Summary of world and Australian economic outlooks	4
	2.3	The world economy	5
	2.3.1	Current fiscal policy settings	6
	2.3.2	Effects of quantitative easing policies	7
	2.3.3	Emerging market debt	7
	2.3.4	The medium term (mid-2020s to mid-2030s)	7
	2.4	The Australian economic outlook	9
	2.4.1	Interest rates	9
	2.4.2	Household savings and debt	9
	2.4.3	The balance of payments and the current account deficit	10
	2.4.4	Inflation and wages	10
	2.4.5	Population and immigration	10
	2.4.6	The public sector borrowing constraint	11
	2.4.7	Gross Domestic Product (GDP) growth	11
3.	**The outlook for Victoria to 2029-30**		**16**
	3.1	Introduction	16
	3.2	Summary of scenarios	16
	3.3	The base scenario outlook for Victoria to 2023-24	18
	3.3.1	Gross State Product	18
	3.3.2	Private consumption expenditure	19
	3.3.3	Private dwelling expenditures	19
	3.3.4	Private business investment	20
	3.3.5	Population and employment	21
4.	**The outlook for the United Energy region to 2030**		**24**
	4.1	The economic structure of the United Energy region	24
	4.2	Population	26
	4.3	Gross regional product	27
	4.4	Dwelling stock	28
5.	**Methodology for developing maximum demand forecasts for terminal stations**		**29**
	5.1	Introduction	29
	5.2	Data and definitions	29
	5.3	Victoria and United Energy – coincidence of MDs	31
	5.4	Forecasting methodology – overall approach	32
	5.4.1	Forecasts of total distribution business system maximum demand	32
	5.4.2	Maximum non-coincident demand forecast methodology	37

Contents (cont.)

Page no.

5. Continued

5.5 The sensitivity of United Energy terminal station maximum demands to ambient temperature 39
5.6 Temperature percentiles 41
5.7 United Energy coincident maximum demand forecasts 42
5.8 Structural change in the output elasticity of electricity demand 47
5.8.1 Methodology 49
5.8.2 Estimation results 51

6. Policy and technological impacts on energy consumption and maximum demand, Victoria 2018 to 2030 54

6.1 Introduction 54
6.2 Victorian Energy Efficiency Target 54
6.3 Plug-in electric vehicles 59
6.3.1 The market for plug-in electric vehicles 59
6.3.2 Limits of plug-in electric vehicle ownership 62
6.3.3 Forecast uptake of plug-in electric vehicles 64
6.3.4 Grid impacts for plug-in electric vehicles 66
6.4 Minimum Energy Performance Standards for air conditioners 68
6.4.1 Energy efficiency improvements in air conditioners 69
6.5 Building lighting 71
6.6 Demand response 73
6.7 Small-scale photovoltaics and battery storage 75

7. Energy forecasts for United Energy terminal stations to 2029-30 81

7.1 Introduction 81
7.2 Energy forecasts to 2029-30 81

8. Maximum demand forecasts for the total United Energy region to 2029-30 84

8.1 Introduction 84
8.2 Forecasts of summer and winter total United Energy maximum demands 84

9. Maximum non-coincident demand forecasts to 2029-30 for the United Energy terminal stations 88

9.1 Introduction 88
9.2 Forecasts of terminal station maximum demand – summary of approach 88
9.3 Forecasts of summer and winter maximum non-coincident demands in the United Energy region 88

Contents (cont.)

Page no.

10. Maximum coincident demand forecasts to 2029-30 for the United Energy terminal stations **98**

10.1 Introduction 98
10.2 Forecasts of terminal station maximum demand – summary of approach 98
10.3 Forecasts of summer and winter maximum coincident demands in the United Energy region 98

Appendix A: Reconciliation of Local Government Areas with the United Energy distribution area **108**

Appendix B: PeakSim summer maximum demand forecasts **109**

B.1 Introduction 109
B.2 Forecast comparison 111
B.3 Temperature sensitive load 113

List of tables

		Page no.
2.1	Australian GDP growth under each scenario	3
2.2	Formation of Australian GDP	12
3.1	Projected Australian and Victorian GDP growth rate by scenario – 2010-11 to 2029-30	17
3.2	Macroeconomic aggregates and selected indicators – Victoria	18
4.1	Regional economic structure – total United Energy Network region 2017-18	25
5.1	United Energy terminal stations – total energy including embedded (native)	30
5.2	Maximum demands – summer and winter – Victoria and United Energy	31
5.3	The sensitivity of maximum daily demands to ambient temperature – United Energy terminal stations summer	39
5.4	The sensitivity of maximum daily demands to ambient temperature – United Energy terminal stations winter peaks	40
5.5	Melbourne's average temperatures associated with alternative percentiles	41
5.6	United Energy terminal stations – coincidence factors – winter	43
5.7	United Energy terminal stations – coincidence factors – summer	45
5.8	Total Electricity Consumption Ordinary Least Squares Estimator results	52
5.9	Total Electricity Consumption Full Information Maximum Likelihood Estimator results	53
5.10	Output and price elasticities for the NEM electricity demand excluding aluminium but including and excluding small-scale PV own use	53
6.1	Overview of Victorian Energy Efficiency Target, Victoria region	55
6.2	Overview of Victorian Energy Efficiency Target, United Energy region	56
6.3	VEET post-modelling adjustment for peak demand	58
6.4	Summary of plug-in electric vehicles available in Australia	61
6.5	Release schedule for new plug-in electric vehicle models	62
6.6	Plug-in electric vehicle market – Sales and stock of battery electric vehicles and plug-in hybrids vehicles, Victoria	65
6.7	Post-modelling adjustments for plug-in electric vehicles, Victoria and United Energy	67
6.8	Coolers in dwellings	68
6.9	Phase out of inefficient lighting in Australia	71
6.10	Comparison of lighting technologies	71
6.11	ARENA funded demand response pilot programs	73
6.12	Victorian potential and UED estimated demand response	74
6.13	Key PV modelling assumptions – United Energy	76
6.14	United Energy: Base scenario – Small-scale PV	77
6.15	United Energy: High scenario – Small-scale PV	77
6.16	United Energy: Low scenario – Small-scale PV	78
6.17	United Energy: Base scenario – Small-scale battery storage	79
6.18	United Energy: High scenario – Small-scale battery storage	79
6.19	United Energy: Low scenario – Small-scale battery storage	80

List of tables (cont.)

		Page no.
7.1	United Energy terminal stations – energy	82
8.1	Components of the UE winter MD – 10th, 50th, 90th percentiles	86
8.2	Summer non-coincident demands – United Energy	87
9.1	United Energy terminal stations – winter 10th non-coincident	90
9.2	United Energy terminal stations – winter 50th non-coincident	92
9.3	United Energy terminal stations – summer 10th non-coincident	94
9.4	United Energy terminal stations – summer 50th non-coincident	96
10.1	United Energy terminal stations – winter 10th coincident	100
10.2	United Energy terminal stations – winter 50th coincident	102
10.3	United Energy terminal stations – summer 10th coincident	104
10.4	United Energy terminal stations – summer 50th coincident	106
B.1	PeakSim summer coincident maximum demand forecasts by scenario	110

List of figures

		Page no.
2.1	Australian GDP growth by scenario	2
2.2	World GDP growth rate	5
2.3	Australia – Real GDP growth rate	13
2.4	Nominal and real wages growth and CPI inflation rate	13
2.5	$A/$US and weighted average exchange rate	14
2.6	Real and nominal 90 day bill rate	14
2.7	Employment growth and unemployment	15
2.8	Australia's international borrowing requirement and gross debt	15
3.1	Victorian GSP growth by scenario – 2010-11 to 2029-30	16
3.2	Private consumption expenditure growth – Victoria	19
3.3	Private new dwelling approvals – Victoria	20
3.4	Private business investment as a share of Victorian GSP	21
3.5	Components of population change – Victoria	22
3.6	Employment by industry – Victoria – absolute change in employment 2011-12 to 2017-18	23
4.1	Population growth by region – Base scenario – 2019-2030	26
4.2	Gross regional product growth – Base scenario – 2019-2030	27
4.3	Dwelling stock growth by region – Base scenario – 2019-2030	28
5.1	Average summer temperatures, Victoria	34
5.2	Total summer temperature sensitive Victorian load	35
5.3	Estimated annual increase in Victorian summer temperature sensitive load	36
5.4	Total summer temperature sensitive load – United Energy distribution region	36
5.5	NEM electricity demands – 1999 to 2017	47
5.6	Victorian electricity demands – 1999 to 2017	48
5.7	Index of nominal and real electricity prices – Residential sector	49
6.1	Victorian Energy Efficiency Certificates – Actual and Target	57
6.2	Australian cumulative sales of plug-in electric vehicles	60
6.3	Cost of battery storage	63
6.4	Efficiency of non-ducted split systems 0 to 4kW	70
6.5	Monthly PV installations – UED distribution area (number)	75
6.6	Monthly PV installations – UED distribution area (MW)	76
7.1	Energy at United Energy terminal stations – Base scenario	81
8.1	United Energy winter maximum demand – Base scenario – 50th percentile day	85
8.2	United Energy summer maximum demand – Base scenario – 50th percentile day	85
9.1	Winter non-coincident peak demand – 50th percentile	89
9.2	Summer non-coincident peak demand – 50th percentile	89
10.1	Winter coincident peak demand – 50th percentile	99
10.2	Summer coincident peak demand – 50th percentile	99

List of figures (cont.)

Page no.

B.1	PeakSim summer maximum demand forecasts 2018 versus 2017	111
B.2	Forecast 2018-19 POE10 – NIEIR 2017 versus NIEIR 2018	112
B.3	Historical trends in temperature sensitivity	114
B.4	Victorian air conditioner sales 2001 to 2018	116
B.5	Victorian air conditioners sales 2001 to 2018	116

1. Introduction

United Energy invited the National Institute of Economic and Industry Research (NIEIR) to prepare forecasts of maximum demand for the United Energy terminal stations to 2027-28.

The main requirements of the study are to:

- develop forecasts of the United Energy maximum demand 11 terminal stations for 10 years (2019-2030);
- develop maximum non-coincident demand for the summer and winter peaks for each terminal station under the baseline economic scenario;
- develop maximum demand forecasts for two weather scenarios, the 10 per cent weather probability and the 50 per cent weather probability; and
- develop coincident demand forecasts for summer and winter for each terminal station under alternative probabilities of exceedence (10^{th} and 50^{th} percentiles).

NIEIR's national, state and regional economic projection models were used to drive the forecasts. A brief summary of the outlook for Australia and Victoria by scenario is presented in Section 2 and 3. The outlook for the United Energy region is summarised in Section 4.

Section 5 describes the methodologies adopted in developing the forecasts for United Energy terminal stations. Section 6 outlines the key policy impacts on the forecasts, both in terms of energy and peak demands.

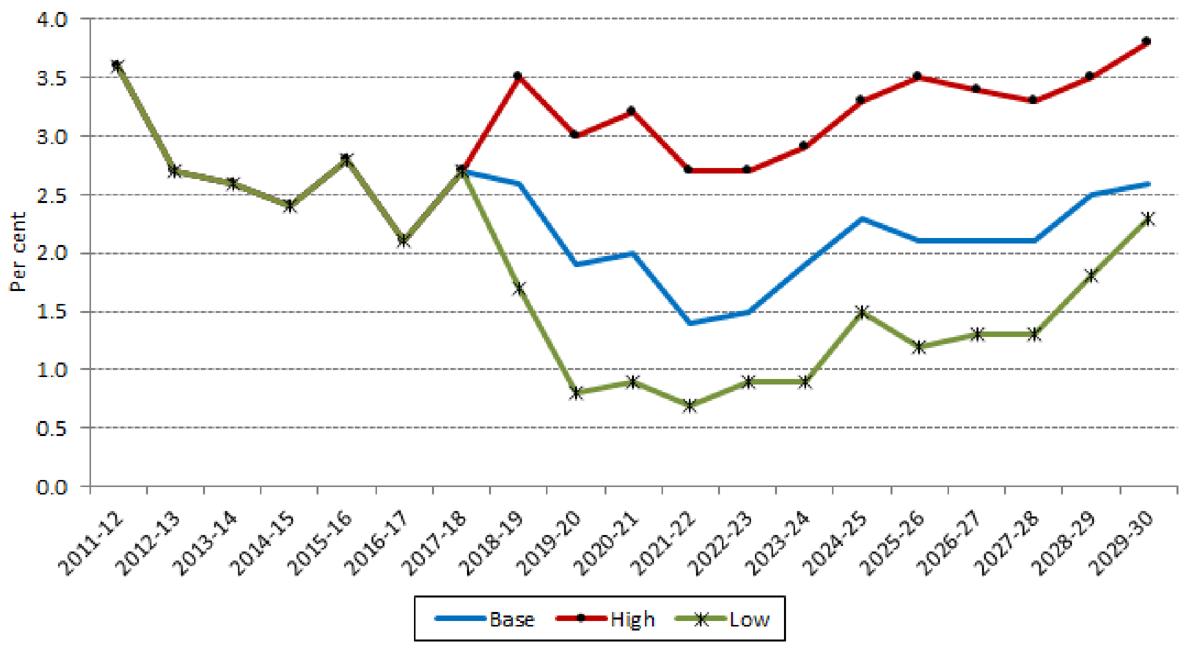
Energy forecasts by terminal station are presented in Section 7. Section 8 presents forecasts of maximum summer and winter demand for the total United Energy region for alternative probabilities of exceedence. Section 9 presents non-coincident forecasts for United Energy terminal stations for summer and winter. Coincident peaks at United Energy terminal stations are presented in Section 10.

2. The economic outlook for Australia to 2029-30

2.1 Introduction

This section provides an outline of the economic outlook for Australia to 2029-30. Figure 2.1 shows the outlook for Australian gross domestic product to 2029-30 by scenario. Table 2.1 shows the projected annual Australian GDP growth rates to 2029-30 for each of the scenarios. These economic forecasts were prepared in March 2018.

Figure 2.1: Australian GDP growth by scenario (annual per cent change)



Note: Financial years ending June.

The cyclical profiles in Figure 2.1 reflect the cycle in the world economy.

Table 2.1	Australian GDP growth under each scenario (per cent)		
Financial year	**Base**	**High**	**Low**
2011-12	3.6	3.6	3.6
2012-13	2.7	2.7	2.7
2013-14	2.6	2.6	2.6
2014-15	2.4	2.4	2.4
2015-16	2.8	2.8	2.8
2016-17	2.1	2.1	2.1
2017-18	2.7	2.7	2.7
2018-19	2.6	3.5	1.7
2019-20	1.9	3.0	0.8
2020-21	2.0	3.2	0.9
2021-22	1.4	2.7	0.7
2022-23	1.5	2.7	0.9
2023-24	1.9	2.9	0.9
2024-25	2.3	3.3	1.5
2025-26	2.1	3.5	1.2
2026-27	2.1	3.4	1.3
2027-28	2.1	3.3	1.3
2028-29	2.5	3.5	1.8
2029-30	2.6	3.8	2.3
Compound average annual change			
2017-18 to 2021-22	2.0	3.1	1.0
2021-22 to 2029-30	2.2	3.3	1.2
2017-18 to 2029-30	2.1	3.1	1.1

2.2 Summary of world and Australian economic outlooks

The short-term outlook for the world and Australian economies are satisfactory. With the recovery in the European economies world economic growth, which averaged 3.0 per cent over 2013 to 2015, accelerated to 3.5 per cent in 2017. The European economy is projected to grow at 3.8 per cent for the 2018 and 2019 calendar years as a result of a recovery in the United States growth rate and the continued high growth rates in China and India. The growth rates for the Australian economy over the 2018 and 2019 fiscal years is estimated at 2.6 per cent per annum, or the same as the 2013 to 2016 period average growth rates and an improvement in the 2017 fiscal year outcome of 2.1 per cent.

New projects being commenced, dwelling construction being maintained at elevated levels and the ending of the mining investment contraction by the beginning of 2018 results in reasonably high levels construction activity.

After 2019, however, the economic growth rates are expected to decline due to strong headwinds which will constrain economic activity.

The headwinds facing the world economy are:

(i) the unwinding of excess liquidity created by quantitative easing policies;

(ii) the implementation of inappropriate fiscal policy in the United States; and

(iii) political economy risk from friction between China and the United States.

The headwinds facing the Australian economy are:

(i) the upswing in the interest rate cycle;

(ii) relatively low current household savings ratios and higher household debt to income levels. A fundamental requirement for longer term sustainability of the Australian economy is that the household debt to income ratio be stabilised over the medium-term;

(iii) government spending is currently at the limit of their fixed capacity if zero borrowing for current government expenditure is the objective;

(iv) the ending of the export growth surge from the end of the mining boom by 2019 and the threats for world trade growth, including Chinese economic warfare tactics against Australia;

(v) the peaking of the dwelling construction cycle; and

(vi) the decade long-run decline in manufacturing capacity resulting in the large share of the growth in goods demand being directly channelled overseas as compared to the situation that existed in the first decade of the century.

The consequences of these headwinds for Australia will be:

(i) weakening domestic drivers of growth to 2024 and hence low economic growth expected over the 2020 to 2024 period; and

(ii) the return of high current account deficits which will constrain the ability of governments to undertake expansionary policies.

As a result the average annual growth rate in national GDP is projected to average 1.7 per cent between 2020 and 2024 before recovering to 2.1 to 2.5 per cent per annum late in the projection period.

2.3 The world economy

An important feature of recent world economic growth is the rapid rise in China's share of world GDP and its contribution to world growth. Before 2005 China's share was less than 10 per cent. By 2017 China's share of world GDP had increased to 19 per cent. That is, a doubling of its share of world GDP in a dozen years.

The Chinese economic growth rate is projected to fall from its current level of a little over 6 per cent to under 4 per cent by the end of the projection period. Nevertheless, currently China's growth is explaining a third of total world growth and is projected to make an average contribution of just under 30 per cent to world growth over the 2020 to 2028 period.

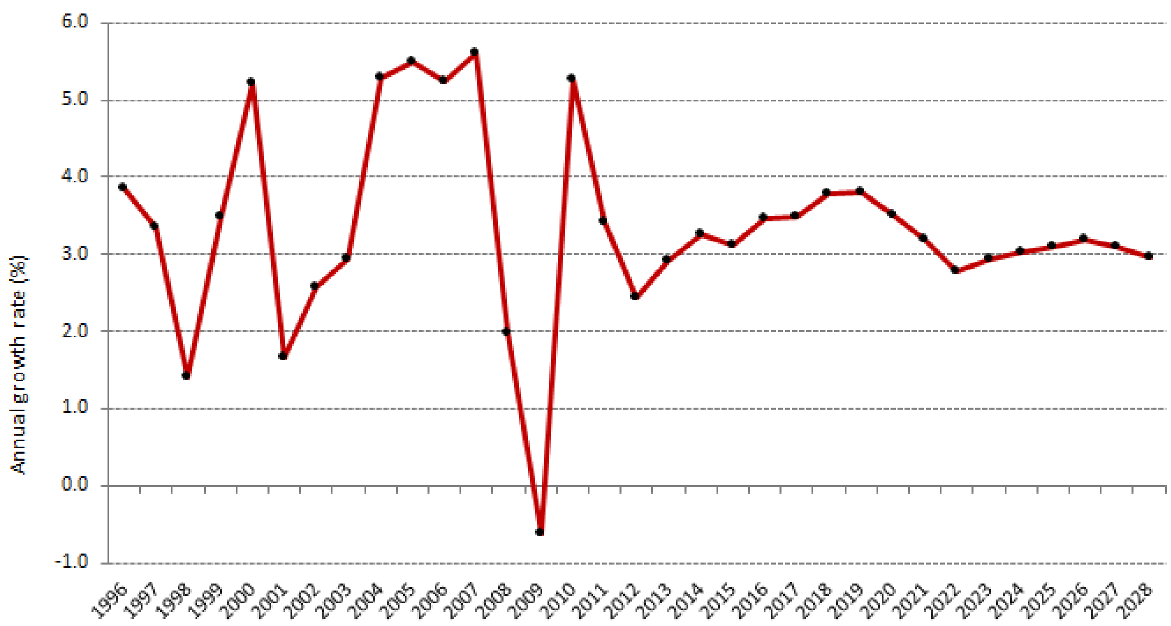
The next most important contribution to world growth is India. Currently India is contributing approximately 16 per cent of world growth with a GDP growth rate of 7 per cent. Despite the growth rate falling to the 5 to 6 per cent range over the projection period, India's contribution to world GDP growth will approach 20 per cent by the end of the projection period.

The United States, which contributed a quarter to world GDP growth rates over the 1995 to 2005 period, is currently, and to 2019, projected to average an average annual GDP growth rate of 2.5 to 2.7 per cent. However, its contribution to world GDP growth has fallen to just above 10 per cent.

While it is true that over 2017 and into 2019 the Eurozone has returned to growth rates above 2 per cent. In 2018 Germany is projected to grow by 2.3 per cent and France by 2 per cent. However, the contribution of these two countries to world growth in 2018 will be less than 3 per cent.

The analysis indicates, from Figure 2.2, that the acceleration in world GDP growth since 2015 was significantly driven by the fact that the faster growing economies have largely sustained their growth rates with the result that their increasing share in world GDP has resulted in a steadily higher overall world GDP growth rate. It peaks at 3.8 per cent over 2018 and 2019. After this date world GDP growth is projected to fall to approximately 2.8 per cent by 2022. The reasons for this are outlined below.

Figure 2.2: World GDP growth rate (per cent)



2.3.1 Current fiscal policy settings

Over December 2017 to February 2018 the US administration introduced a significant fiscal stimulus in the form of tax reductions. The direct impact of this is to reduce net public sector revenue by US$1.6 trillion over a decade, while for the next two to three years expenditure increases of US$0.3 trillion were also agreed to. The combined direct impact on the budget deficit will be to increase it from 3.4 per cent of GDP in 2017 to 5.4 per cent by 2019, although this will be reduced to around 5 per cent of GDP once the feedback effects of higher GDP are taken into account.

This fiscal stimulus is being imposed on an economy which has the headline unemployment rate at 4 per cent and a growth in capacity output of between 1.6 and 1.7 per cent per annum. This lower growth in capacity output is partly due to the low growth in producer capital stock installed since the GFC and the underlying low growth in the workforce.

The low growth in production capacity is due to the:

(i) high unutilised capacity rates resulting from the GFC;

(ii) the failure to maintain general fiscal stimulus after 2010 until nominal capacity utilisation rates were achieved over 2012 to 2014; and

(iii) the low trend growth in demand since the GFC.

Given the capacity constraints, the fiscal stimulus will have relatively low multipliers. Even so, the stimulus is likely to increase US GDP by between 0.8 and 1.0 per cent in 2019. Given an output gap of 0.7 per cent, estimated by the OECD before the fiscal stimulus with a GDP growth of 2.1 per cent, this would increase the output gap to 1.7 percentage points and near 3 percentage points in 2020 if the stimulus was continued. This would take the US output gap to the levels that prevailed just before the 2001 and 2008-2009 recessions.

Part of the reason for the constraints on the growth on capacity is the underlying growth in the workforce. If current trends in participation rates are maintained, the growth in the workforce will be around 135,000 a month, or less than half the rate to support a 3 per cent GDP growth rate. However, this falls in the 2020s to less than 90,000 if historical trends in the growth in the participation rate are reverted to. This means that given the fiscal stimulus the unemployment rate is likely to be 3.7 per cent by 2019 and 3.4 per cent in 2020 or 2021.

The strong conclusion from the analysis is that if interest rates, as appears likely, would have risen by between 1.5 and 2.0 percentage points over the next two to three years, the US fiscal stimulus is likely to put the increase at between 2.0 and 2.5 percentage points. This will have substantial implications for economies such as Australia.

It is not simply the US economy that will be subject to capacity constraints relatively early in the world economic activity upswing. Producer capacity growth in non-China OECD over 2018-2019 will be significantly less than the headline GDP growth. This means that the European Central Bank and the Bank of Japan will join the US Federal Reserve in raising interest rates, albeit at a slower rate. Australia with its high foreign debt will be forced to follow irrespective of domestic economic conditions.

A fiscal and interest crises in all probability will occur in the United States in the early 2020s.

2.3.2 Effects of quantitative easing policies

A factor which is likely to accelerate the interest rate cycle is the free reserves in the US banking system. This is a direct consequence of the post-2008 quantitative easing policies which involved not only the US, but also Europe and Japan. The Central Banks financed public sector deficits by injecting liquidity into the banking system since the private sector net purchases of public securities was low. At the beginning of 2018 the free reserves of the US banking system stood at US$2.1 trillion. At a minimum required reserve holding of 10 per cent this would finance an additional level of credit that exceeds the current nominal level of GDP.

Up until 2018 this has not been a problem because economic conditions have been subdued and corporate cash flows strong. However, if strong “boom time” conditions emerge, and if the expectation forms that inflation in the future is likely to be significantly higher than currently, then there will be a rapid drawdown in free reserves as they are transferred into loans. This would place additional pressure on the US Federal Reserve to raise interest rates faster than they might otherwise desire.

2.3.3 Emerging market debt

Another consequence of quantitative easing policies and the creation of excess liquidity was the outflow of funds from Western economies to emerging markets. Emerging market governments and corporations could borrow at favourable interest rates. The problem is that much of this debt was taken out in foreign currency and $US in particular. Total foreign currency market borrowing in foreign currency usually stands at 30 per cent of GDP, more than what prevailed for those economies subject to the Asian crisis of 1997. Emerging economies that are particularly vulnerable are Turkey and Brazil.

The risk is that as Western economy interest rates increase and the US dollar and other Western currencies appreciate, this could trigger a wave of corporate bankruptcies in emerging economies leading to default on foreign debts with the additional risk that a number of countries may be forced into default as they cannot roll over their international debt either private or public. This could trigger extensive market volatility which could aggravate other forms of instability caused by the interest rate upswing with additional negative consequences for the world economic growth.

2.3.4 The medium term (mid-2020s to mid-2030s)

The obstacles to world economic growth from the 2020s onwards stem from the increasing dominance of China in the world economy. By 2036 China will be capturing 23 per cent of world GDP, or the level achieved by the US over the 1960 to 1980 decades. In contrast, the US share will have fallen to 14 per cent. Extrapolating these trends to 2061, albeit at a reduced rate of change, would result in China capturing 26 per cent of the world economy while the US’s share would be around 10 to11 per cent.

China’s superiority could be greater than this. The projection assumes that China’s rate of productivity growth will decline as its GDP per capita approaches that of the US. That is, it will find that the technological opportunities for productivity growth will decline. However, China is determined to mitigate this constraint by becoming a world leader across a wide range of technologies. It’s a multi-objective strategy in that not only is the objective to move industry up the value added chain to pass Western best practice, but also to retain low to medium technology manufacture in China that otherwise would have been transferred to low-wage Southern Asian economies as Chinese real wages rise. This does not mean a made by china program will not be implemented in selected developing countries. However this will be largely restricted by countries considered to be firmly in the Chinese orbit.

The Chinese Plan recognises that enhancement in supply chain efficiency logistics and infrastructure can more than compensate for rising real wage costs in maintaining industry competitiveness. The Chinese rapid expansion of e-commerce is one instrument being deployed to enhance supply chain efficiencies for local suppliers by establishing world best practice in terms of lead times.

Secondly, China is giving priority to advances in automation and artificial intelligence so that robots can establish a competitive advantage in low technology activities such as clothes-making at a significantly higher Chinese standard of income. The standard response from Chinese producers to rising wage costs will not be to transfer production to lower wage cost countries, but to invest in labour displacing technology.

The impact of the "strong import substitution" tendencies of the Chinese economy have already been credited as the key cause of the relative low growth of world trade relative to world GDP since the turn of the century compared to the last quarter of the 20th Century. Over the latter period world trade growth was twice world GDP growth. However, in recent years this has fallen to 1.3 to 1.5 times world GDP growth. A major reason for this slowdown was the strengthening of Chinese local industry supply chains by import substitution.

China will secure a role similar to the US in 1900, where its competitive dominance across many technologies and industries rapidly reduced the export opportunities for European and East Asian economies, encouraging the strategy of securing controlled colonial markets which in turn led to the First and Second World Wars

China's defence spending, which is growing faster than GDP, will establish an average quantitative equality with the US by the early 2020s and quantitative superiority by the early 2030s. As the US also has European defence responsibilities, it means that in the absence of a very large regional defence expansion China will establish clear military hegemony by the mid to late 2020s in the region.

The key question is, what will China do with the political power associated with its economic and military hegemony status? The most likely answer to this is that it will attempt to establish a control system in the region similar to what the US imposed over the Western Hemisphere when it was at the zenith of its power. This will be a system of unfettered access of Chinese capital and labour to economies and the requirements of local industry to adjust to Chinese supply chain requirements. Large economies that attempt to resist will be subject to political instability and economic sanctions.

The rules which China will apply have already been established over the last seven years in China's disputes with Vietnam, South Korea, Taiwan, Japan, Norway, and the Philippines.

2.4 The Australian economic outlook

Before analysing the aggregate economic outcomes it is useful to first analyse the headwinds that will be operating to constrain economic activity.

2.4.1 Interest rates

The 90 day bill rate fell from 4.9 per cent in 2010-11 to an average of 1.8 per cent in 2016-17 and 2017-18. However, interest rates are expected to start to rise in the second half of 2018 due to market forces, with an official rise in interest rates occurring in the first half of 2019 and rising by a full percentage point over 2018-19. Over 2019, interest rates are projected to increase by a full percentage point compared to current levels. Interest rates peak at 3.7 per cent for the 90 day bill rate by the end of 2020. With growth in this period falling to between 1 and 2 per cent per annum the policy authorities will have little incentive to increase interest rates in terms of domestic economic conditions as defined by growth and labour market outcomes.

It will be a different story in terms of the inflation objective. By the beginning of 2021 the inflation rate is projected to be at the top end of the inflation target range. That is, at just under 3 per cent per annum. From this perspective the rise in interest rates is only sufficient to maintain interest rates at current levels.

However, the main driver of the increase in interest rates will be the return of current account deficits in excess of 6 per cent of GDP. In order to attract foreign capital to fund the deficit and give an incentive to roll over maturing debt the policy authorities will have little option but to follow the rise in world interest rates, albeit at a slower rate of increase. The irony of this will be that the rise in world interest will be one of the key reasons for the increase in the current account deficit.

It will only be when the current account deficit trends downwards over the middle of the 2020s that the policy authorities will have the capacity to reduce rates, tempered by the fact that inflation in the target range and the maintenance of a relatively high current account deficit will maintain interest rates above 3 per cent per annum for the remainder of the projection period.

2.4.2 Household savings and debt

In relation to the household sector a couple of statistics demonstrates the unsustainable nature of the current growth dynamics of the Australian economy. Between the end of 2015 and the end of 2017 total household Australian debt has increased, on average, by $130 billion at annual rates. In contrast net disposable income has increased by an average of $5 billion annual rates. Not surprisingly the ratio of household financial liabilities to net disposable income has increased from 195 per cent in the middle of 2015 to 210 per cent towards the end of 2017.

Part of the reason for the increase in household debt, other than for the purposes of financing investment expenditures for dwellings and other investment, has been the decline in the gross household savings ratio. This has declined from 15 per cent at the end of 2015 to 12 per cent by the end of 2017. If modest growth rates and consumption expenditures are maintained over the next two years the household savings ratio is projected to fall to just under 10 per cent. It is unlikely to be able to go any lower, thereby removing any cushion further reductions in savings ratio could have made to compensate for the rise in interest rates on private household consumption expenditure.

As a result for the Australian economy, consumption expenditure will not be able to rely on further debt stimulus to drive growth with the result that growth and overall expenditure will be constrained to the growth in real household disposable income, which in turn will be adversely impacted on by the rise in interest rates. This largely explains why household consumption expenditure for the 2020 to 2024 period will be constrained to less than 2 per cent per annum and only show a modest recovery post 2024.

This subdued outcome is reinforced by the growth in household wealth, especially over the period to 2024 where the rise in interest rates will prevent any further increase in the household wealth to income ratio because of the impact on dwelling prices. That is, dwelling prices are projected at best to be stable and in all probability show a decline, at least to the middle of the decade.

2.4.3 The balance of payments and the current account deficit

The other important factor in Australia's subdued economic outlook is the decline in the manufacturing sector. The manufacturing sector output peaked in the middle of 2008. Since then manufacturing output has steadily declined to the extent that by the end of 2017 manufacturing output was 14 per cent below its peak value. The weaknesses this has created in the current account deficit has been disguised by current low world interest rates. This situation will not continue. The result is a return in the current account to over 6 per cent of GDP by 2021. The contribution of the decline of the manufacturing sector to this outcome, by the trend increase in the import ratio and decline in non-mining exports, cannot be under-estimated.

The lack of manufacturing capacity in the early part of the next decade will also be a significant factor in explaining why only a modest recovery can be expected over the second half of the projection period.

The return of high current account deficits will result in the net foreign debt to GDP ratio increasing from 57 per cent in 2018 to just under 70 per cent towards the end of the projection period. This poor foreign account outcome is the major factor explaining the projected decline in the Australian exchange rate, especially to the middle of the decade.

2.4.4 Inflation and wages

The decline in the currency is one of the major factors explaining why the inflation rate accelerates from the current level of approximately 2 per cent per annum to 2.8 per cent per annum by 2021. This in turn will stimulate exploration in the growth of nominal wages to between 2.5 and 3.5 per cent over the first half of the 2020s.

This outcome is consistent with the assumption that net immigration is reduced, thereby weakening the impact of subdued economic growth on labour market conditions which in turn would constrain inflation to around current levels.

2.4.5 Population and immigration

A major part of Australia's immigration intake program is driven by labour market conditions. Over the cycle Australia's level of net immigration is basically adjusted to maintain an unemployment rate of between 5 and 6 per cent.

The decline in the growth of employment from 2.8 per cent per annum for the 2018 fiscal year to a little over 1 per cent by 2020 will result in a decline in the migration intake. As a result net foreign arrivals are projected to decline from 246,000 in 2016 to 183,000 by 2021. As a consequence the rate of Australian population growth will decline from 1.6 per cent in the 2017 fiscal year to 1.2 per cent by 2021. Given the increase in hostility immigration over the last couple of years, basically arising from the pressure of population growth on infrastructure resources, it would not surprise if net immigration fell towards the 150,000 mark.

For much of the projection period post 2022 the employment growth rate remains close to the 1 per cent per annum benchmark. Nevertheless, net immigration is projected to steadily increase over the second half of the 2020s reaching 245,000 by 2028. This is due to the ageing of the population with the result that a steady increase in the absolute net intake will be required to maintain the unemployment rate at around 5.5 per cent.

2.4.6 The public sector borrowing constraint

The policy objectives of reducing government borrowing from consumption expenditure to near zero is likely to result in relatively low rates of growth of government consumption expenditure over the 2019 to 2022 period, at which time of course it would be most needed to stimulate the economy.

Currently the growth in government consumption expenditure is running at between 3 and 4 per cent per annum. However, for the 2020 to 2024 period this falls to an average growth rate of between 1 and 2 per cent per annum. The return of plus 2 per cent growth after 2024 will enable public consumption expenditure growth to return to the 2.5 to 3.0 per cent range by the end of the projection period.

2.4.7 Gross Domestic Product (GDP) growth

Given the above, it is not surprising that the projected GDP growth is relatively weak by historical standards. An economic growth rate of around 2.7 per cent is expected for the next two years, that is, for the 2018 and 2019 fiscal years. The contributing factors to this outcome are strong growth in private and public investment (with the former also reflecting partnerships with the public sector), strong export growth of between 4 and 5 per cent for the two years and a private consumption growth rate of 2.7 per cent for 2018, although under the impact of rising debt levels and interest rates falling to a growth rate 1.8 per cent in 2019. Further, for both years dwelling investment makes a positive contribution to growth.

By 2020 to 2022, however, most of these growth drivers will have weakened or turned negative. Dwelling investment is forecast to make a negative contribution to growth while export growth will decline to between 2 and 3 per cent as the pipeline of uncompleted mining projects declines. Private and public investment will, at best, contribute on average a small positive contribution to growth while private consumption expenditure is projected to grow at less than 2 per cent per annum on the trend basis.

As a result, the average annual GDP growth rate over the 2020 to 2024 period is projected at 1.7 per cent per annum. On this basis, if Australia is to experience another recession, the first since 1991, it will be in 2022.

A modest recovery in growth is projected after 2024 with GDP growth averaging 2.1 per cent per annum for the remainder of the projection period. However, the recovery will be modest. The maintenance of high debt levels in conjunction with interest rates returning to normal levels will be a major constraint on growth, both for the household sector and the economy generally.

Table 2.2 Formation of Australian GDP (per cent)											
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
International											
World GDP (fiscal year)	3.1	3.5	3.5	3.8	3.8	3.5	3.2	2.8	2.9	3.0	3.1
Demand											
Private consumption	2.4	2.8	2.6	2.7	1.8	1.7	2.0	1.5	2.8	3.0	2.0
Business investment	-7.3	-12.5	-9.4	10.9	4.6	4.2	2.4	-2.0	0.9	1.9	3.1
Housing	9.4	10.5	2.8	-3.7	-0.8	-2.4	-4.1	-5.3	-5.4	0.2	5.4
Public consumption expenditure	2.4	4.2	3.9	3.7	2.7	1.9	1.1	1.2	1.2	1.3	1.6
Public capital expenditure	-5.7	4.2	16.1	5.8	6.9	0.4	4.6	-4.1	-2.4	0.1	5.7
Total expenditure	0.9	1.4	2.3	3.4	2.3	1.7	1.6	0.3	1.6	2.2	2.4
GDP	2.4	2.8	2.1	2.7	2.6	1.9	2.0	1.4	1.5	1.9	2.3
External sector											
Current account deficit ($B)	-60.3	-74.7	-37.2	-47.5	-87.0	-137.9	-155.1	-149.3	-145.6	-151.9	-153.9
CAD as per cent of nominal GDP	-3.7	-4.5	-2.1	-2.6	-4.6	-7.1	-7.7	-7.1	-6.5	-6.5	-6.3
Labour market											
Employment	1.3	2.3	1.4	2.8	1.1	1.2	1.5	1.8	1.7	1.3	1.1
Unemployment rate (%)	6.2	5.9	5.7	5.5	5.6	5.7	5.9	6.1	6.0	5.8	5.6
Participation rate (%)	64.8	65.1	64.8	65.5	65.2	65.2	65.5	65.9	66.2	66.0	65.6
Finance											
90 day bank bill (%)	2.5	2.2	1.8	1.8	2.5	3.2	3.7	3.6	2.7	2.5	3.2
10 year bond rate (%)	3.0	2.6	2.4	2.7	3.1	3.8	4.4	4.2	3.4	3.1	3.9
$US/$A	83.7	72.8	75.6	78.6	75.6	72.0	69.2	68.9	68.7	69.4	70.5
Wages and prices											
Average weekly earnings	2.3	1.6	2.2	2.2	2.7	3.2	2.5	2.4	3.5	3.3	2.9
CPI	1.7	1.4	1.7	2.1	2.0	2.5	2.8	2.6	2.6	2.5	2.5
Population growth	1.5	1.5	1.6	1.5	1.3	1.2	1.2	1.2	1.3	1.3	1.3

Figure 2.3: Australia – Real GDP growth rate (per cent)

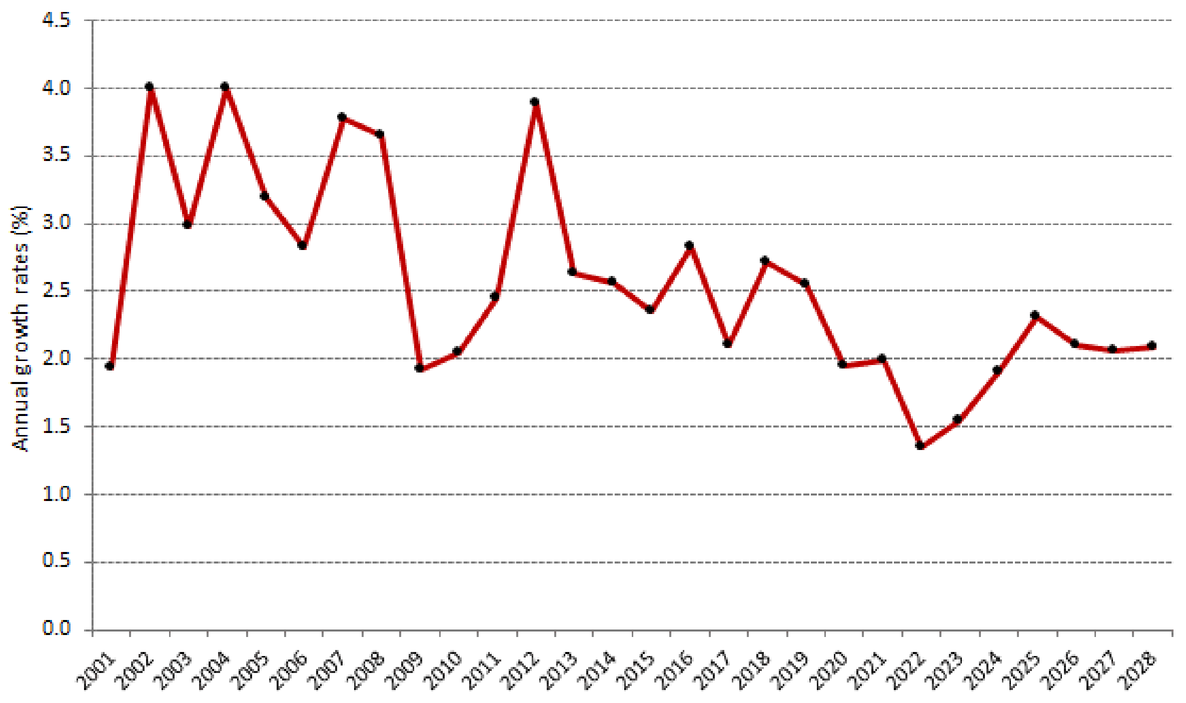


Figure 2.4: Nominal and real wages growth and CPI inflation rate – cumulative four quarter span basis (per cent)

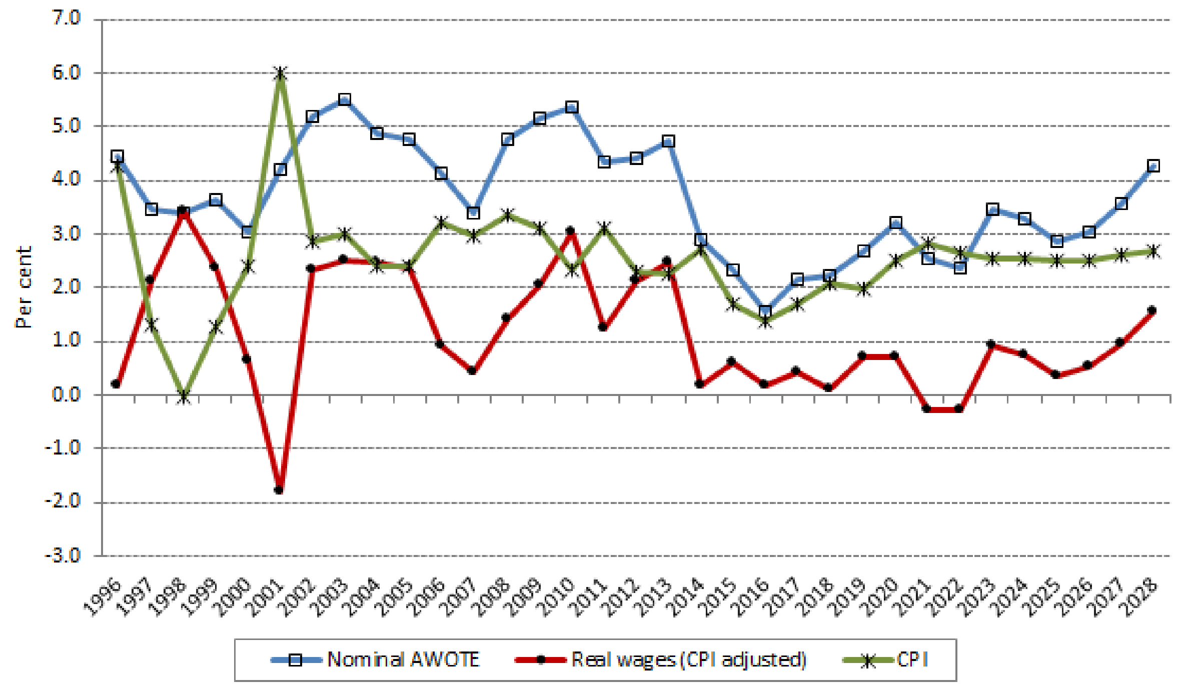


Figure 2.5: $A/$US and weighted average exchange rate

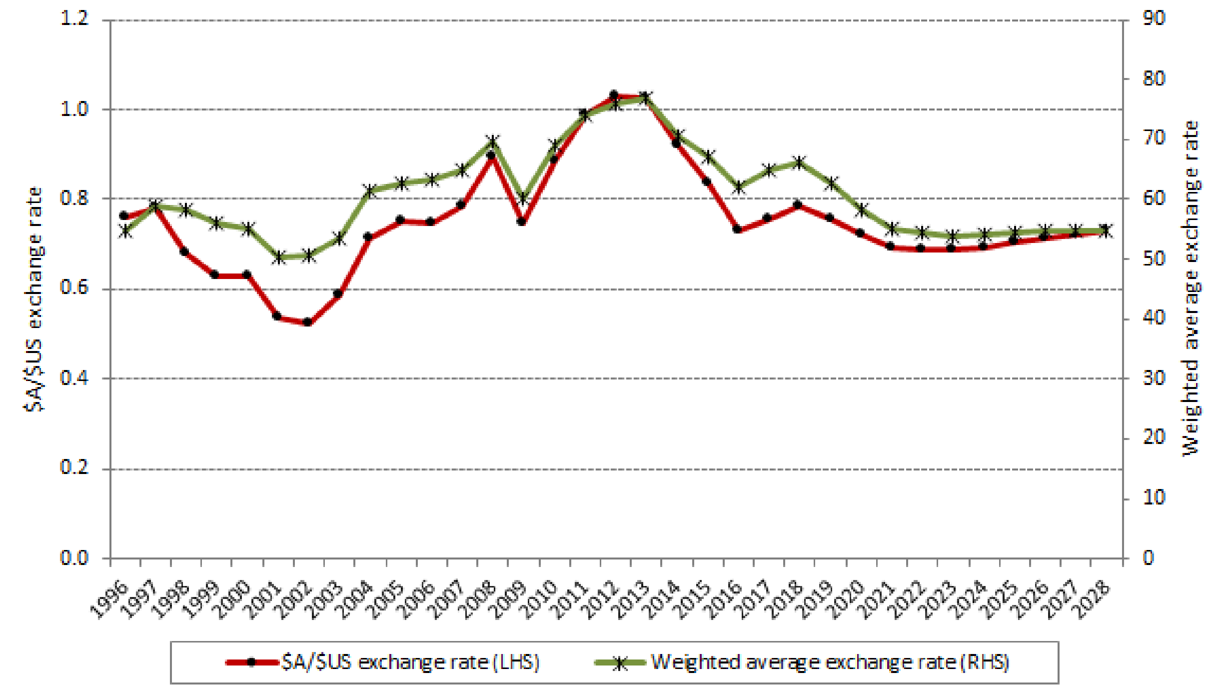


Figure 2.6: Real and nominal 90 day bill rate

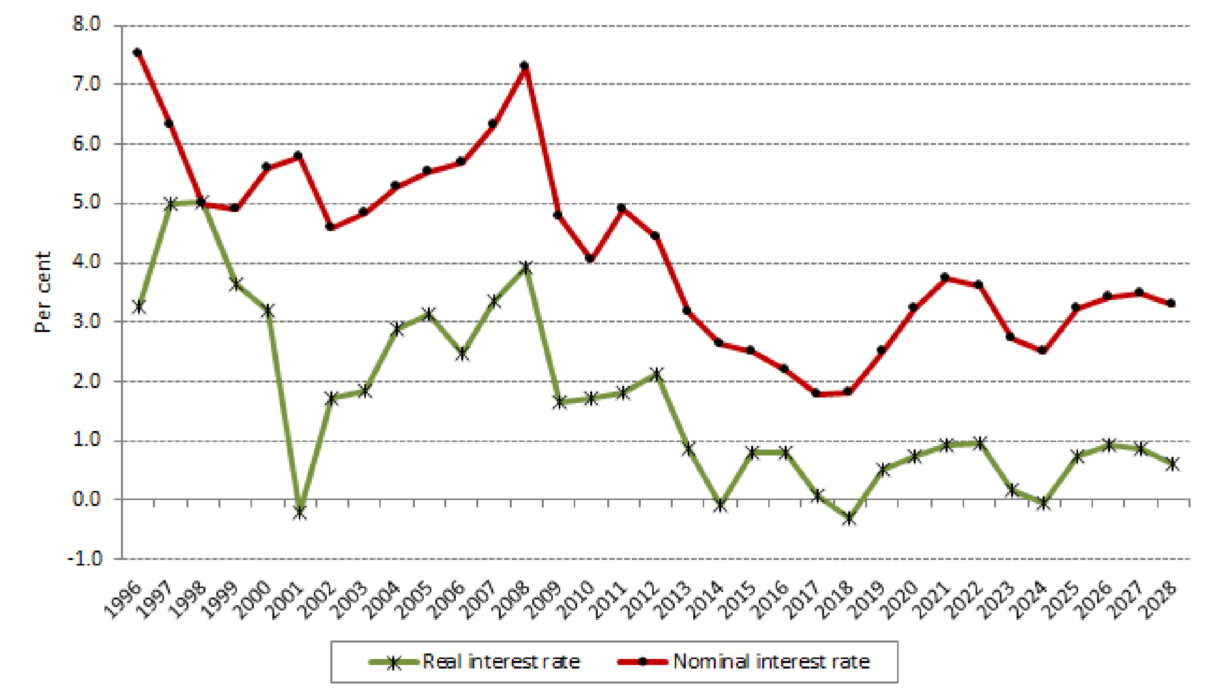


Figure 2.7: Employment growth and unemployment (per cent)

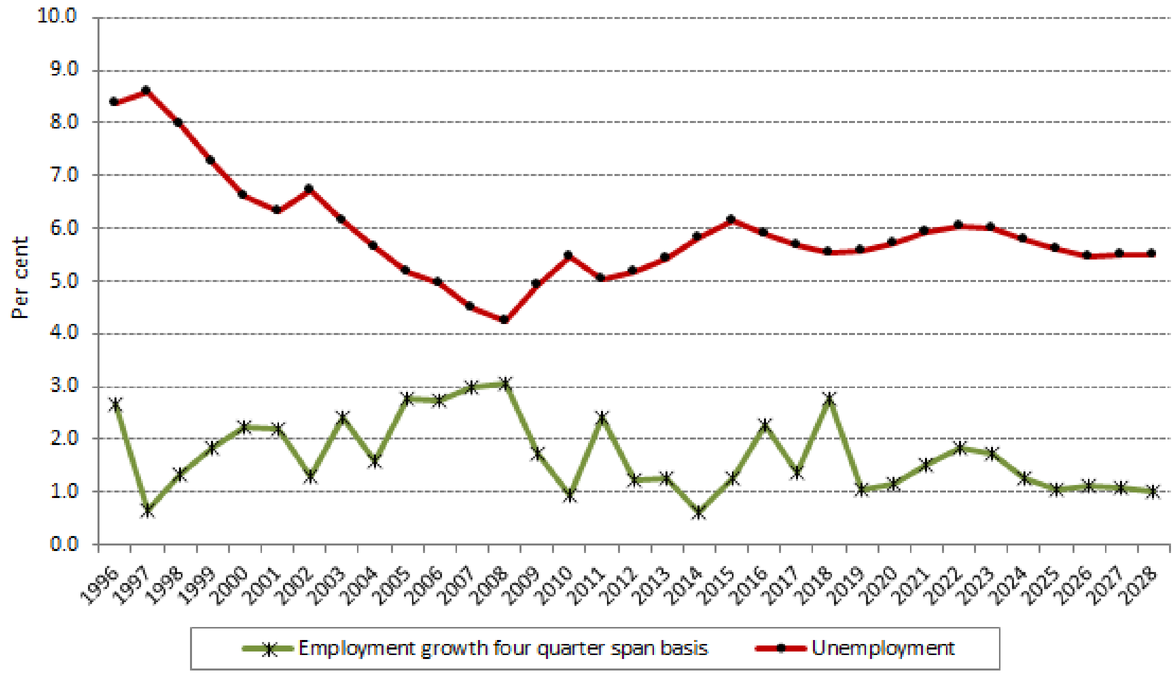
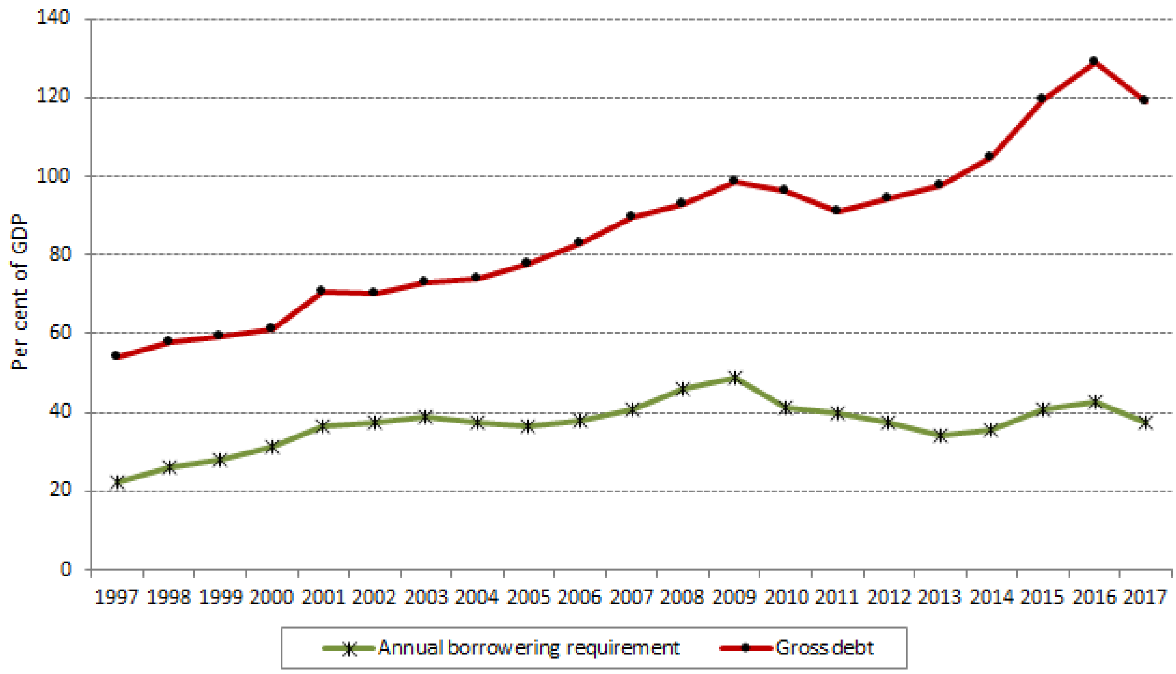


Figure 2.8: Australia's international borrowing requirement and gross debt (per cent of GDP)



3. The outlook for Victoria to 2029-30

3.1 Introduction

This section outlines the economic outlook for Victoria to 2029-30.

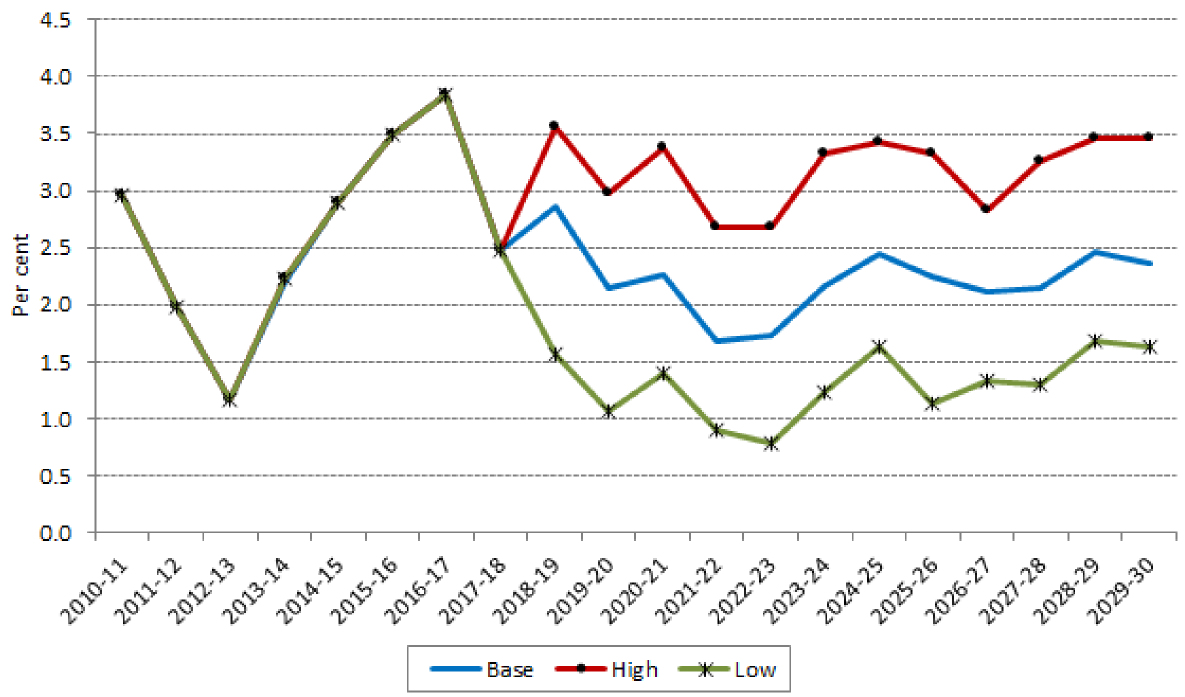
3.2 Summary of scenarios

Figure 3.1 shows the outlook for Victorian GSP growth over the period to 2029-30 by scenario. Between 2017-18 and 2029-30 Victorian GSP growth is projected to average:

- 2.2 per cent per annum under the Base scenario;
- 3.1 per cent under the High scenario; and
- 1.2 per cent under the Low scenario.

Table 3.1 shows the projected annual economic growth rates projected for Australia and Victoria by scenario for the period 2010-11 to 2029-30.

Figure 3.1: Victorian GSP growth by scenario – 2010-11 to 2029-30



Source: NIEIR and ABS.

Table 3.1	Projected Australian and Victorian GDP growth rate by scenario – 2010-11 to 2029-30					
	Australia			Victoria		
	Base	High	Low	Base	High	Low
Per cent change						
2010-11	2.5	2.2	2.2	3.0	3.0	3.0
2011-12	3.9	3.6	3.6	2.0	2.0	2.0
2012-13	2.6	2.7	2.7	1.2	1.2	1.2
2013-14	2.6	2.6	2.6	2.2	2.2	2.2
2014-15	2.4	2.4	2.4	2.9	2.9	2.9
2015-16	2.8	2.8	2.8	3.5	3.5	3.5
2016-17	2.1	2.1	2.1	3.8	3.8	3.8
2017-18	2.7	2.7	2.7	2.5	2.5	2.5
2018-19	2.6	3.5	1.7	2.9	3.6	1.6
2019-20	1.9	3.0	0.8	2.1	3.0	1.1
2020-21	2.0	3.2	0.9	2.3	3.4	1.4
2021-22	1.4	2.7	0.7	1.7	2.7	0.9
2022-23	1.5	2.7	0.9	1.7	2.7	0.8
2023-24	1.9	2.9	0.9	2.2	3.3	1.2
2024-25	2.3	3.3	1.5	2.4	3.4	1.6
2025-26	2.1	3.5	1.2	2.3	3.3	1.1
2026-27	2.1	3.4	1.3	2.1	2.8	1.3
2027-28	2.1	3.3	1.3	2.1	3.3	1.3
2028-29	2.5	3.5	1.8	2.5	3.5	1.7
2029-30	2.6	3.8	2.3	2.4	3.5	1.6
Average annual compound growth rate (per cent)						
2017-18 to 2021-22	2.0	3.1	1.0	2.2	3.1	1.2
2021-22 to 2029-30	2.2	3.3	1.2	2.3	3.2	1.3
2017-18 to 2029-30	2.1	3.1	1.1	2.2	3.1	1.2

Source: NIEIR and ABS.

3.3 The base scenario outlook for Victoria to 2023-24

Table 3.2 presents selected economic aggregates for Victoria to 2023-24 for the Base scenario.

Table 3.2 Macroeconomic aggregates and selected indicators – Victoria (per cent change)

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Average annual compound growth 2017-18 to 2023-24
Private consumption	3.49	3.46	2.00	1.62	1.91	1.53	2.44	3.03	2.1
Private dwelling investment	6.40	-1.40	8.33	-3.80	-11.60	-8.09	-0.30	2.94	-2.1
Business investment	2.14	5.96	-4.52	-5.65	-1.56	-1.39	3.36	-1.03	-1.8
Government consumption	4.55	4.52	2.79	2.74	2.68	2.87	2.84	2.35	2.7
Government investment	15.54	11.97	-3.05	-4.98	-0.87	-1.67	2.34	-1.96	-1.7
State final demand	4.13	3.99	1.79	0.32	0.39	0.58	2.38	2.33	1.3
Gross state product	3.84	2.48	2.86	2.14	2.27	1.68	1.74	2.16	2.1
Population	2.24	2.10	1.56	1.71	1.57	1.54	1.55	1.56	1.6
Employment	3.87	2.68	2.13	1.64	1.58	1.40	0.94	1.42	1.5

Source: NIEIR and ABS.

3.3.1 Gross State Product

Victorian gross state product (GSP) rose by 2.5 per cent in 2017-18, following growth of 3.8 per cent in 2016-17. Victorian GSP growth was higher than national GDP growth over the 2014-15 to 2016-17 period by 1 percentage point per annum.

Victorian economic growth was weak between 2011-12 and 2013-14 when the high exchange rate led to industry closures in Victoria, particularly in manufacturing. Recent growth has been fuelled by strong population and employment growth leading to rises in household expenditure growth and a stimulus to the dwelling construction sector in Victoria.

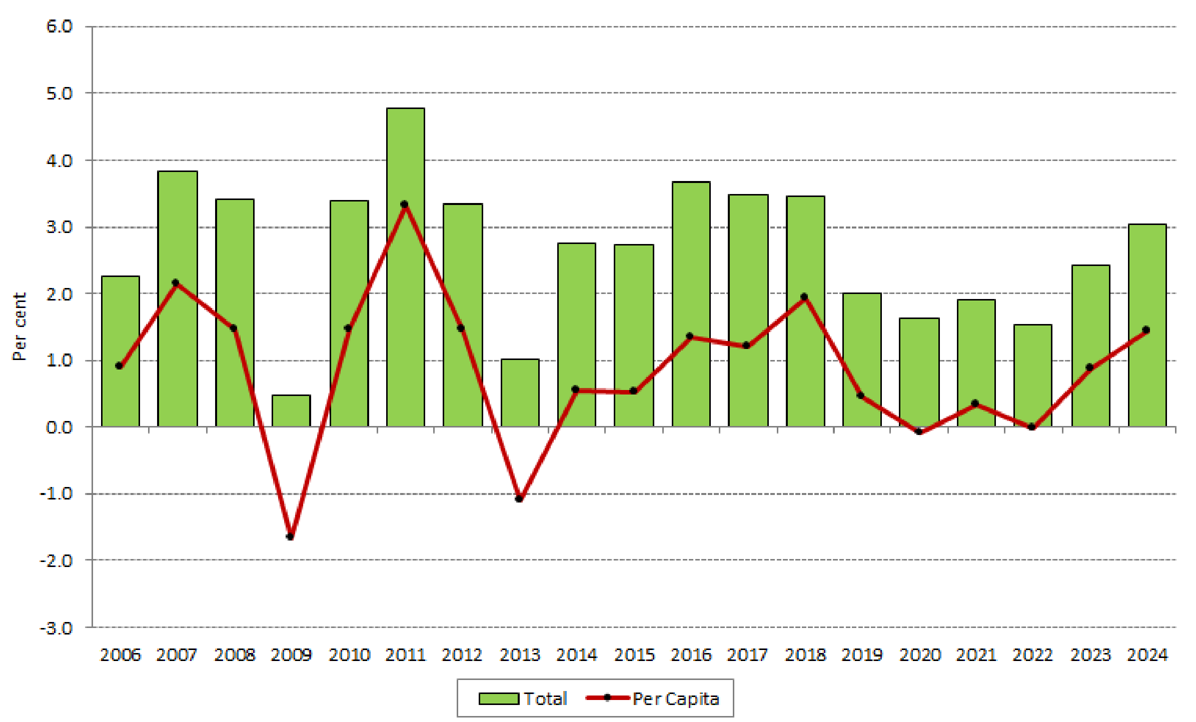
Victorian GSP growth averages 2.2 per cent over the 2017-18 to 2023-24 period. GSP growth peaks at 2.9 per cent in 2018-19 slowing to 1.7 per cent in 2022-23 and 2023-24.

3.3.2 Private consumption expenditure

Victorian private consumption expenditure grew by 3.5 per cent in 2017-18. This reflects strong average employment growth in Victoria over the last three years of 3.1 per cent and associated strong income growth.

Household expenditure growth slows over the 2018-19 to 2022-23 period, slowing to around 2 per cent per annum. The household savings ratio rises by around 5 percentage points which sets the foundation for future economic growth. The rise in the household savings ratio does indicate that Victorian consumption expenditure growth could be stronger than forecast.

Figure 3.2: Private consumption expenditure growth – Victoria



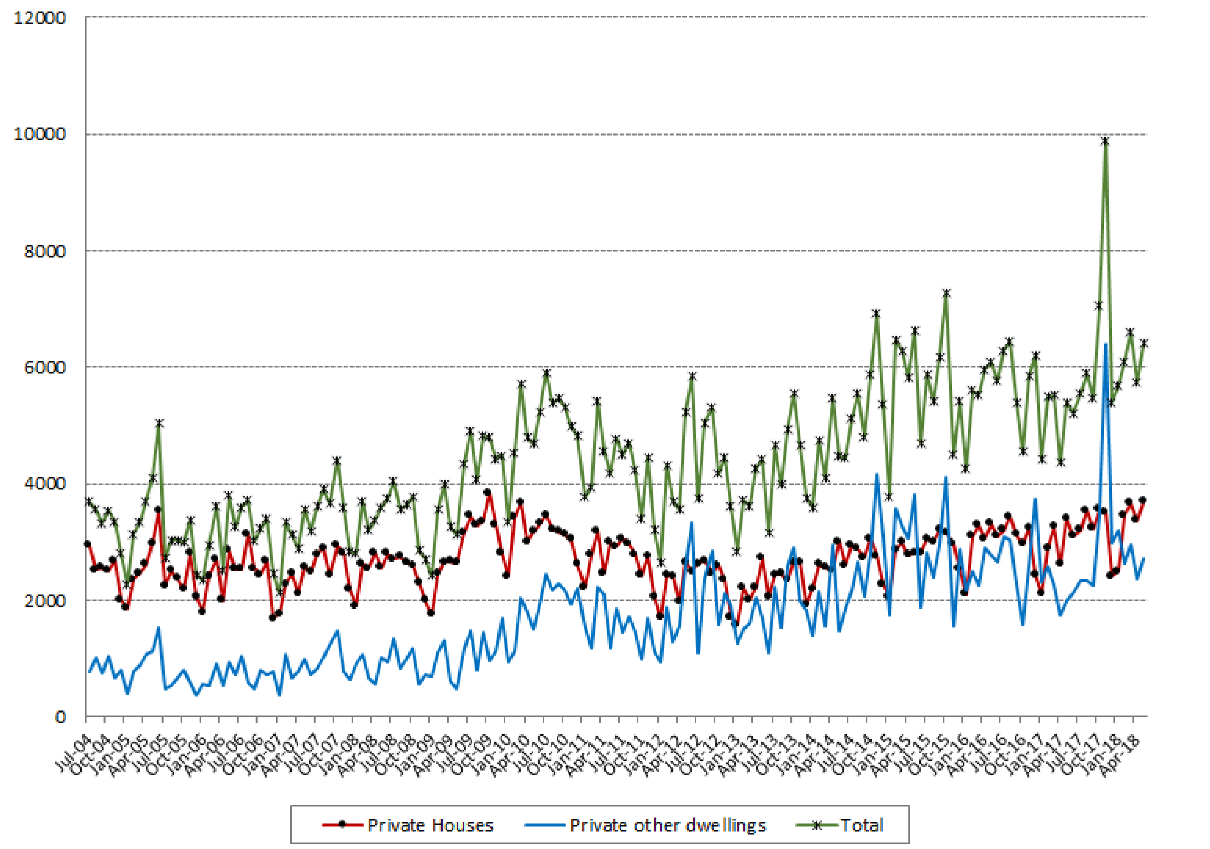
3.3.3 Private dwelling expenditures

Fuelled by stronger population growth, private dwelling expenditure has increased significantly over the last four years. Total expenditure was $29.7 billion in 2016-17 and $28.7 billion in 2017-18.

Total private dwelling approvals fell slightly in 2016-17 from 67,895 units to 65,112 units. Approvals, however, rose again in 2017-18 to around 69,700 units. House approvals were 56 per cent of total private dwelling approvals in Victoria.

Total private dwelling investment expenditure is forecast to rise in 2018-19 before falling by around 25 per cent over the 2019-20 to 2022-23 period. Expenditure levels reach a low of $24.2 billion in 2022-23.

Figure 3.3: Private new dwelling approvals – Victoria

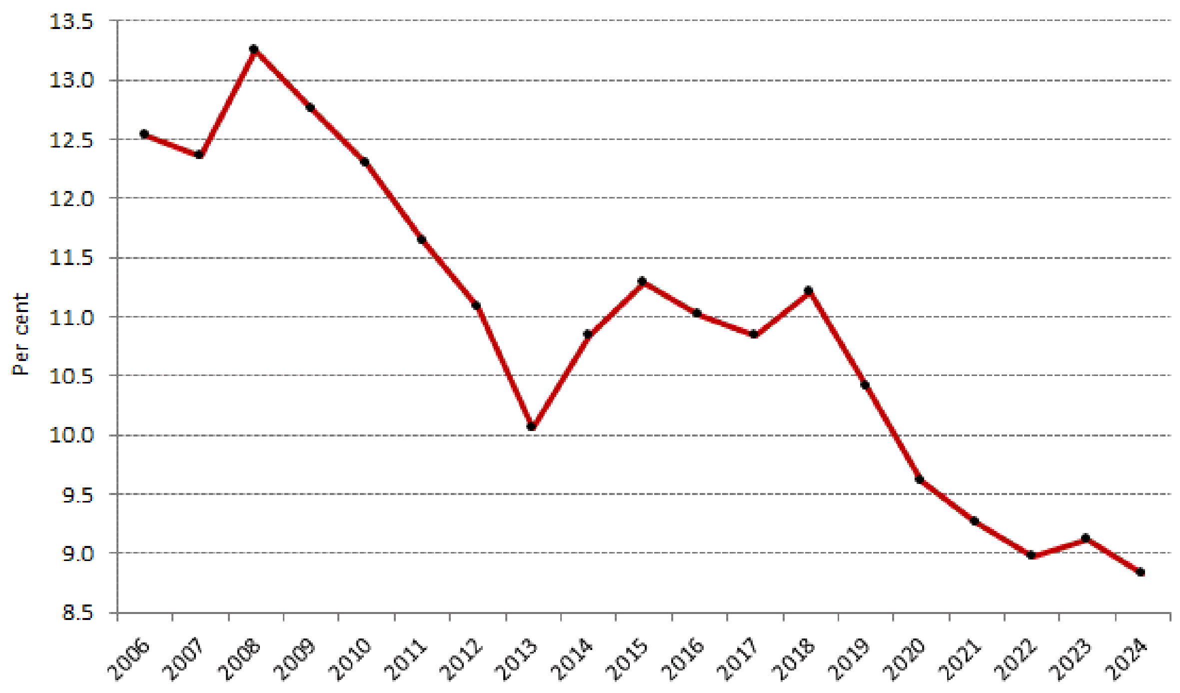


3.3.4 Private business investment

Private business investment in Victoria rose by 6 per cent in 2017-18. The level of expenditure in 2017-18 was $46.1 billion, the highest on record.

Private business investment expenditure fell over the next four years before increasing again in 2022-23. Private business investment, as a share of Victorian gross state product, falls from 11.2 per cent in 2017-18 to 8.8 per cent by 2023-24.

Figure 3.4: Private business investment as a share of Victorian GSP



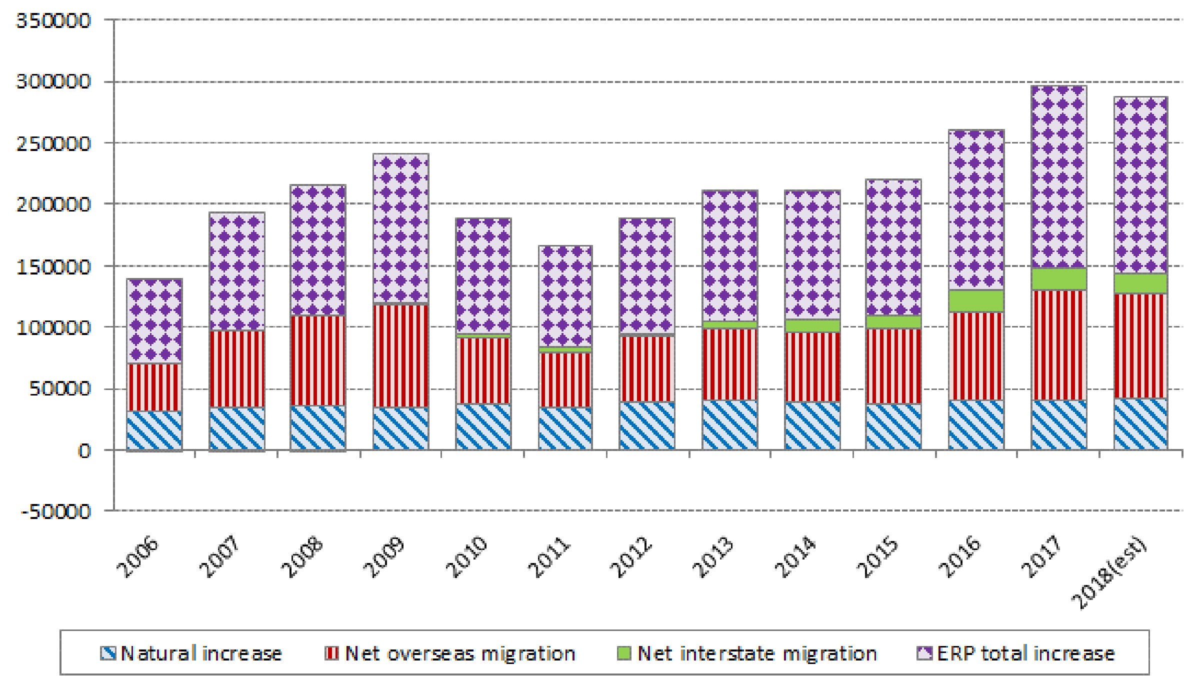
3.3.5 Population and employment

Victorian population growth has been very rapid over recent years. Over the last five years Victoria's average population growth has been 2.2 per cent per annum.

Stronger population growth in Victoria has been underpinned by rising net overseas migration gains and higher net interstate migration gains. Net overseas migration gains reached over 90,000 in 2016-17, compared to around 44,000 persons in 2010-11. Net interstate migration gains increased to over 18,000 persons in 2016-17.

The natural increase in Victoria's population (total births less deaths) is also adding to Victorian population growth. The natural increase in population for 2017-18 is expected to be over 42,000 persons. Victoria's population growth rate is forecast to slow to 1.6 per cent per annum between 2017-18 and 2023-24.

Figure 3.5: Components of population change – Victoria



Employment growth in Victoria has been relatively strong over recent years. Average growth was around 3 per cent per annum between 2014-15 and 2017-18. The unemployment rate in Victoria has fallen from 6.5 per cent in 2014-15 to 5.8 per cent in 2017-18.

Over the last six years (2011-12 to 2017-18), there were significant increases in employment in the following industries:

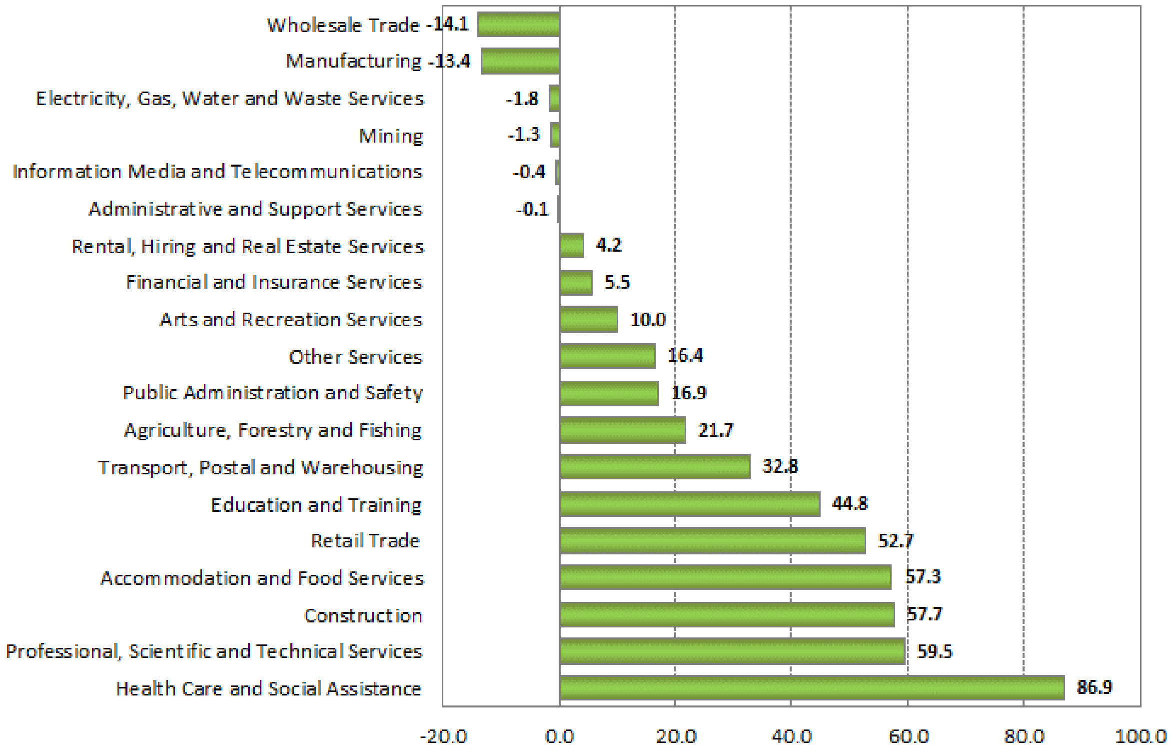
- Health care and social assistance (86,900);
- Construction (57,700);
- Professional, scientific and technical services (59,500); and
- Accommodation and food services (57,30).

Over the same period there were significant contractions in employment in the following industries:

- Manufacturing (-13,400);
- Wholesale trade (-14,100); and
- Mining (-1,300).

Of the total increase in employment in Victoria over this period around 45 per cent of all new jobs were part-time employment.

Figure 3.6: Employment by industry – Victoria – Absolute change in employment 2011-12 to 2017-18



4. The outlook for the United Energy region to 2030

This section outlines the baseline projections for population, gross regional product, and other indicators for the United Energy region to 2029-30. The commentary focuses on the base scenario to 2029-30.

4.1 The economic structure of the United Energy region

Table 4.1 shows a snapshot of the United Energy region for selected key economic indicators for 2017-18. The United Energy region comprises of customers located in Melbourne's south-eastern suburbs and the Mornington Peninsula. In terms of ABS statistical regions and Local Government Areas (LGAs) it includes:

- Bayside;
- Frankston (part);
- Glen Eira;
- Greater Dandenong;
- Kingston;
- Manningham;
- Monash;
- Mornington Peninsula;
- Port Phillip (part);
- Knox (part);
- Stonnington (part); and
- Whitehorse.

The key features of the United Energy distribution region are:

- it represents 23.0 per cent of Victoria's population and 23.1 per cent of the Victorian dwelling stock;
- it has very small shares of the agriculture and mining sectors;
- manufacturing activity accounts for 26.5 per cent of total Victoria;
- machinery and equipment manufacturing in the United Energy region is 33.0 per cent of the State total;
- other manufacturing sectors within the United Energy region which represent more than 30 per cent of the State total are pulp and paper manufacturing, non-metallic mineral manufacturing and metal product manufacturing;
- the wholesale and retail trade sector represents 30.8 per cent of the State total, reflecting major suburban shopping centres within the United Energy region and wholesale distribution centres; and
- total gross output for the United Energy distribution region represented 21.3 per cent of the Victorian total in 2017-18.

Table 4.1	Regional economic structure – total United Energy Network region 2017-18				
	United Energy		Victoria		Per cent share
Population (2018)	1,462,073		6,346,520		23.0
Dwelling stock (2018)	598,547		2,588,048		23.1
	United Energy		Victoria		
Industry structure	GRP 2017-18 (2015-16 $m)	Percentage share of GRP (%)	GRP 2017-18 (2015-16 $m)	Percentage share of GRP (%)	UED share of industry in VIC GSP (%)
Agriculture, Forestry and Fishing	799.4	1.0	12373.6	3.3	6.5
Mining	129.9	0.2	1408.3	0.4	9.2
Food Beverage, Tobacco Product Manufacturing	2982.4	3.7	14483.3	3.9	20.6
Textiles, Clothing and Footwear	497.1	0.6	2229.5	0.6	22.3
Wood Product Manufacturing	308.5	0.4	1216.5	0.3	25.4
Pulp and Paper manufacturing	719.5	0.9	1817.8	0.5	39.6
Basic Chemical and Chemical Product Manufacturing	1851.9	2.3	7151.2	1.9	25.9
Non-Metallic Mineral Product Manufacturing	511.2	0.6	1684.1	0.4	30.4
Primary Metal and Metal Product Manufacturing	182.5	0.2	549.1	0.1	33.2
Fabricated Metal Product Manufacturing	1273.5	1.6	3424.8	0.9	37.2
Transport Equipment Manufacturing	719.6	0.9	2702.8	0.7	26.6
Machinery and Equipment Manufacturing	1120.1	1.4	3394.1	0.9	33.0
Other Manufacturing Furniture Leather	467.8	0.6	1545.1	0.4	30.3
Electricity Gas and Water Supply	1721.4	2.2	11140.0	3.0	15.5
Construction	8451.0	10.6	38602.3	10.3	21.9
Wholesale and Retail Trade	12246.4	15.3	39748.9	10.6	30.8
Transport and Communication Services	5645.7	7.1	33398.9	8.9	16.9
Finance, Property Business Services	18625.0	23.3	102718.7	27.3	18.1
Public Administration, Defence and Community Services	16270.8	20.3	71736.1	19.1	22.7
Recreational, Personal Services, Accommodation	5465.5	6.8	24621.3	6.5	22.2
Total	**79989.1**	**100.0**	**375946.4**	**100.0**	**21.3**

4.2 Population

Victoria's population growth averages 1.6 per cent per annum over the 2019 to 2030 period.

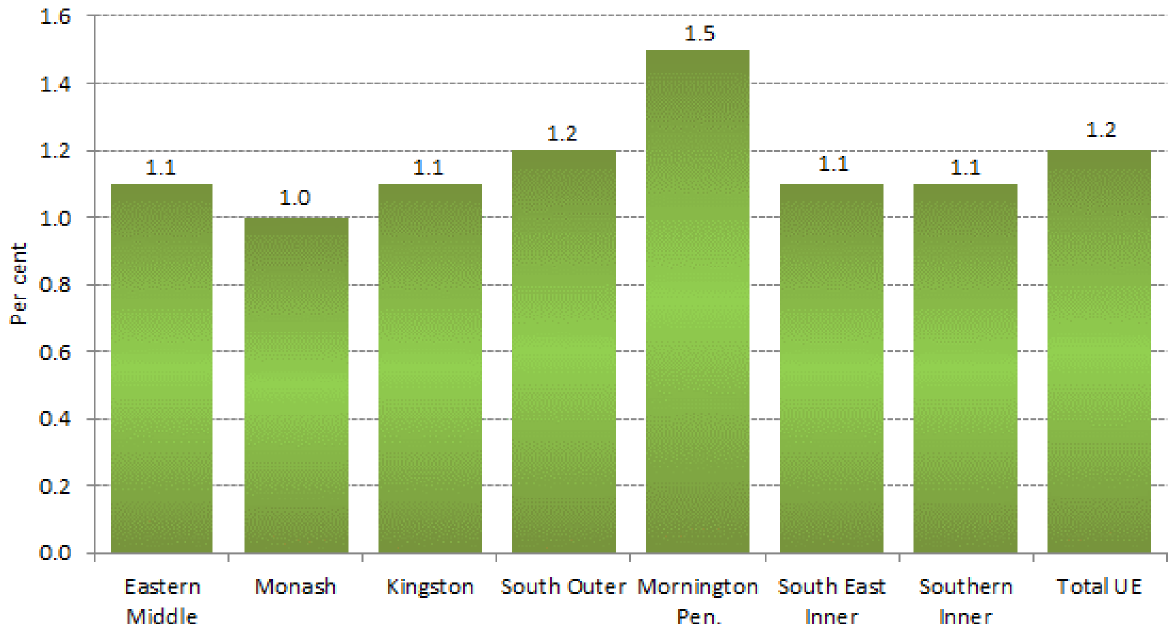
Projections of population for the United Energy region are presented in Figure 4.1. Total population in the United Energy region is expected to increase moderately over the projection period. An increase of around 123,000 persons is projected between 2019 and 2030 under the base scenario, giving an average annual growth rate of 1.2 per cent compared to 1.6 per cent average for Victoria.

The strongest increases in population over the 2018 to 2028 period are in:

- Mornington Peninsula (1.5 per cent per annum); and
- Kingston (1.1 per cent per annum).

Figure 4.1 shows the outlook by the seven sub-regions within United Energy's distribution area in NIEIR's model.

Figure 4.1: Population growth by region – Base scenario – 2019-2030



Eastern Middle denotes Whitehorse and Manningham. South Outer denotes Frankston and Greater Dandenong.
South East Inner denotes Glen Eira and Stonnington. Southern Inner denotes Bayside and Port Phillip.

4.3 Gross regional product

Total gross regional product (GRP) for the United Energy region is expected to rise by an average rate of 1.8 per cent between 2019 and 2030, 0.4 percentage points below the forecast Victorian average growth rate of 2.2 per cent over this period.

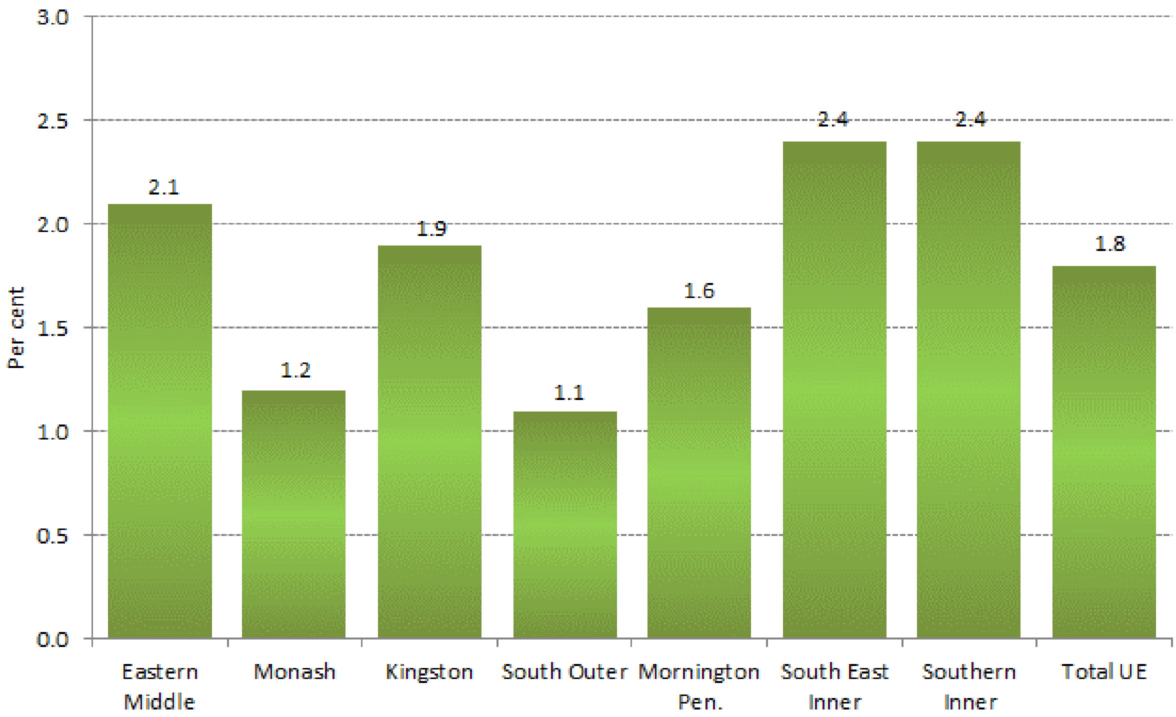
The profile for GRP across the individual regions between 2019 and 2030 is illustrated in Figure 4.2.

In terms of the individual regions, the strongest growth in GRP between 2019 and 2030 is forecast in:

- Whitehorse and Manningham (2.1 per cent per annum);
- Glen Eira and Stonnington (2.4 per cent per annum); and
- Bayside and Port Phillip (2.4 per cent per annum).

The Mornington Peninsula Outer region's growth is mainly sourced from relatively strong population growth.

Figure 4.2: Gross regional product growth – Base scenario – 2019-2030



Eastern Middle denotes Whitehorse and Manningham. South Outer denotes Frankston and Greater Dandenong. South East Inner denotes Glen Eira and Stonnington. Southern Inner denotes Bayside and Port Phillip.

4.4 Dwelling stock

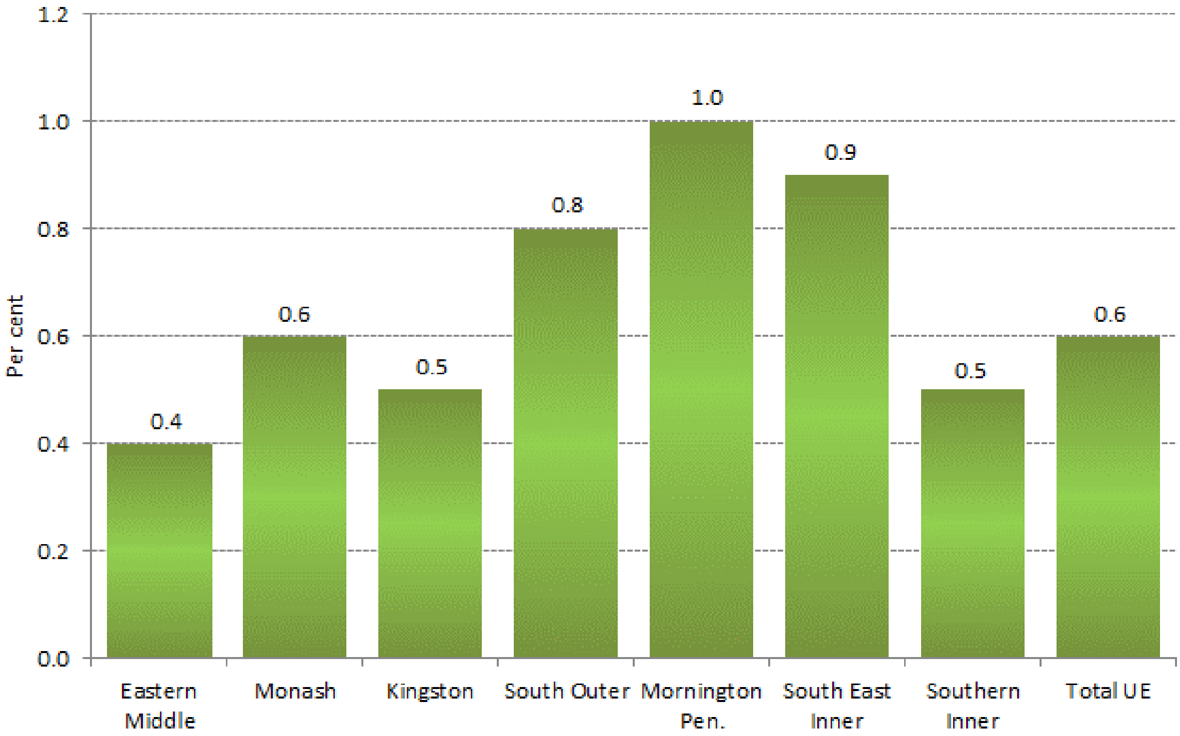
The total dwelling stock within the United Energy region is forecast to grow by an average rate of 0.6 per cent under the baseline scenario between 2019 and 2030. This compares to a growth rate across total Victoria of 1.2 per cent per annum over the same period. The projections are presented in Figure 4.3.

All regions within the United Energy region are expected to record an increase in the dwelling stock reflecting:

- increases in multi-unit and dual occupancy developments;
- releases and the development of previously occupied private and public land within Melbourne; and
- existing Victorian Government policy towards urban consolidation.

Growth in dwelling stock is spread relatively evenly across regions in the United Energy distribution region. The strongest region is Mornington Peninsula with average growth of 1.0 per cent per annum.

Figure 4.3: Dwelling stock growth by region – Base scenario – 2019-2030



Eastern Middle denotes Whitehorse and Manningham. South Outer denotes Frankston and Greater Dandenong.
South East Inner denotes Glen Eira and Stonnington. Southern Inner denotes Bayside and Port Phillip.

5. Methodology for developing maximum demand forecasts for terminal stations

5.1 Introduction

This section outlines the methodologies used in developing projections of maximum demands for United Energy terminal stations to 2030.

Maximum demands for United Energy terminal stations were developed for the following:

- the summer non-coincident demands;
- the winter non-coincident demands; and
- the summer and winter coincident demands.

5.2 Data and definitions

United Energy provided NIEIR with the following data:

- half hour electricity demand for the United Energy region terminal stations from 1 July 1998 to 31 March 2018. These data include distribution losses; and
- NIEIR obtained data for Victoria from the AEMO. This was the half hour native electricity demand (generated basis) for the Victorian inter-connected system over the same period.

The definition of maximum demand at the state level is as follows.

> System Maximum Demand is the maximum half hour average Victorian system requirement at generator terminals dispatched by AEMO. This demand for the relevant half hour, expressed as an average power comprises:
>
> - total Victorian end-use sales (i.e. electricity demand met by Victorian purchases from the Pool);
> - power used in power stations;
> - open cut mine load;
> - area works load;
> - transmission and distribution losses; and
>
> excluding:
>
> - buy-back (supplying sales) from cogeneration/generation embedded in the distribution network (and not dispatched by AEMO);
> - own use supplying load directly from cogeneration/generation embedded in the distribution network (i.e. not drawn from network and not sales); and
> - export (i.e. interstate end-use demand).

United Energy connection points/terminal stations are shown in Table 5.1 below. NIEIR aggregated these terminal stations across half hourly intervals to obtain the total half hourly load for the United Energy distribution region.

Table 5.1 United Energy terminal stations – total energy including embedded (native)		
Station	**Energy 2016-17 (GWh)**	**Percentage share of energy 2016-17 (per cent)**
Cranbourne 66KV (CBTS)	651.2	8.2
East Rowville 66KV (ERT)	1403.4	17.7
Heatherton 66KV (HTS)	1297.0	16.4
Malvern 22KV (MT2)	137.0	1.7
Malvern 66KV (MT6)	598.9	7.6
Richmond 66KV (RT6)	225.3	2.8
Ringwood 22KV (RW2)	119.0	1.5
Ringwood 66KV (RW6)	425.6	5.4
Springvale 66KV (SVT6)	1677.5	21.2
Templestowe 66KV (TST)	445.0	5.6
Tyabb 66KV (TBT)	950.5	12.0
UED Total TS	**7,930.3**	**100.0**

5.3 Victoria and United Energy – coincidence of MDs

Table 5.2 presents summer and winter maximum demands for Victoria and the United Energy region. As indicated in Table 5.2, the maximum summer demand for United Energy is generally coincident with the Victorian MD, although not to the relevant half hour. The winter MD has also been generally coincident with the Victorian peak.

Table 5.2 Maximum demands – summer and winter – Victoria and United Energy

	Victoria[1]				United Energy[2]			
	Load (MW)	Date	Time	Temper-ature (average daily °C)	Load (MW)	Date	Time	Temper-ature (average daily °C)
Winter MD								
2007	8,129.0	17/07/2007	6:00 PM	8.1	1,543	17/07/07	6:00 PM	8.1
2008	8,065.5	28/07/2008	6:30 PM	9.9	1,460	21/07/08	6:30 PM	11.0
2009	7,906.8	10/06/2009	6:00 PM	9.2	1,501	09/06/09	6:00 PM	9.9
2010	7,936.2	28/06/2010	6:00 PM	7.7	1,508	29/06/10	6:00 PM	8.3
2011	8,179.0	7/06/2011	6:00 PM	9.0	1,520	07/06/11	6:30 PM	9.0
2012	7,950.5	21/06/2012	6:00 PM	9.6	1,488	21/06/12	6:00 PM	9.6
2013	7,894.6	24/06/2013	6:00 PM	7.1	1,462	24/06/13	6:00 PM	7.1
2014	7,520.6	15/07/2014	6:00 PM	10.4	1,443	01/08/14	6:30 PM	8.2
2015	7,525.0	14/07/2015	6:00 PM	9.1	1,514	14/07/15	6:00 PM	9.1
2016	7,520.0	26/07/2016	6:30 PM	8.9	1,462	13/07/16	6:30 PM	8.4
2017	7,224.0	3/08/2017	6:30 PM	6.1	1,433	20/07/17	6:30 PM	9.4
Summer MD								
2007-08	9818.0	17/03/2008	4:00 PM	29.7	1,918	17/03/08	4:00 PM	29.7
2008-09	10493.0	29/01/2009	12:30 PM	35.0	2,084	29/01/09	1:00 PM	35.0
2009-10	10106.8	11/01/2010	4:00 PM	31.3	2,016	11/01/10	4:00 PM	31.3
2010-11	9915.6	1/02/2011	12:30 PM	32.4	1,962	01/02/11	1:00 PM	32.4
2011-12	9176.7	24/01/2012	4:00 PM	27.7	1,700	24/01/12	4:00 PM	27.7
2012-13	9774.6	12/03/2013	4:30 PM	29.3	1,982	12/03/13	4:00 PM	29.3
2013-14	10312.4	28/01/2014	4:30 PM	32.6	2,066	16/01/14	5:00 PM	34.8
2014-15	8626.0	22/01/2015	4:00 PM	27.8	1,736	22/01/15	4:00 PM	27.8
2015-16	9505.0	13/01/2016	5:00 PM	30.1	1,963	13/01/16	4:30 PM	30.1
2016-17	8713.0	9/02/2017	1:30 PM	28.8	1,858	09/02/17	1:30 PM	28.8
2017-18	9153.0	19/01/2018	4:00 PM	32.1	1,911	19/01/18	3:30 PM	32.1

Notes:

1. All Victorian demand data refers to the relevant half hour average demand, including embedded wind generation. The temperatures are based on Melbourne regional office and Melbourne Olympic Park weather stations.
2. The summer/winter MDs for United Energy are based on the half hourly data supplied to NIEIR by United Energy. The temperatures are based on Melbourne regional office and Melbourne Olympic Park weather stations.

5.4 Forecasting methodology – overall approach

NIEIR's overall methodological approach consisted of three key elements:

(i) developing maximum demand forecasts for summer and winter for the total United Energy region;

(ii) developing maximum coincident and non-coincident demand forecasts for summer and winter for each United Energy terminal station; and

(iii) developing energy forecasts for each terminal station.

Most of the remainder of this section outlines the approach to developing total summer and winter MDs for United Energy and maximum non-coincident demand forecasts for United Energy terminal stations. The approach adopted to coincident demand forecasts is outlined in Section 5.8.

5.4.1 Forecasts of total distribution business system maximum demand

The summer MD

Forecast of total distribution business maximum demands for summer were produced using a methodological approach which is similar to the methodological approach used by AEMO. The PeakSim model is outlined briefly below.

Maximum demand projections

NIEIR has developed a probabilistic methodology for modelling and forecasting summer and winter peak demands. The model developed by NIEIR is known as PeakSim.

The PeakSim model uses half-hourly demand and temperature data, (ideally) spanning at least 10 years. Each half-hourly period during the day is modelled separately to capture the intra-daily dynamics between demand and temperature. The PeakSim model generates probability distributions of peak demand from synthetically generated distributions of temperature and demand. This contrasts with more deterministic models that conditions peak demand forecasts on given temperature levels.

Major embedded generation (e.g. wind generators), where applicable, were added back into the terminal station demands on a half hourly basis. Smaller embedded generators (e.g. waste gas, cogeneration at hospitals) were also included in the terminal station half hourly data.

NIEIR also simulates half-hourly PV generation using half-hourly air temperature, solar irradiation and a conversion rate of solar energy to electrical energy. The half-hourly PV generation series is added back onto the total network demand prior to modelling, and removed again post-modelling. The new demand series represents the true underlying demand that is met by both grid and embedded generation. The underlying demand (native demand) is the series that is used for PeakSim.

NIEIR segments maximum demand into two distinct parts:

- temperature insensitive demand; and
- temperature sensitive demand.

Temperature insensitive demand is the part of demand that would occur irrespective of the weather conditions (also known as base load). The level of temperature insensitive demand is roughly approximated by demand on a mild weather day.

Temperature sensitive demand is the part of demand that occurs due to the prevailing weather conditions. This part of demand reflects the intensity of heating or cooling equipment use and can vary significantly.

The proportions of temperature insensitive demand and temperature sensitive demand are estimated (for any given year) using regression analysis. Specifically, the temperature insensitive part of demand can be inferred from the intercept and the temperature sensitive part can be inferred from the product of the temperature coefficient (the slope) and the temperature variable. Other variables are used to account for time of year impacts, such as public holidays and weekends.

Synthetic distributions of demand for each half-hour period are generated from the estimated models using synthetically-generated temperature and residual series. Synthetic temperature series are generated from historical temperature data using sampling methods that preserve the observed patterns in the historical data and allow for the effects of urban and global warming on recent and future climatic conditions. Similarly, synthetic residuals series are generated using sampling methods that ensure consistency with the model structure and the historical events.

The regression equations are combined with the synthetic temperature and residual series to simulate demand. The PeakSim model outputs thousands of synthetic demands for each half-hour period over each forecasted season. Probability of exceedence levels are drawn directly from this simulated data. In additional to the conventional metrics of 10%, 50% and 90% probability of exceedence levels, the PeakSim model can generate projections for the full probability spectrum.

Forward estimates of intercept and weather coefficients are the key drivers of the maximum demand projections. As the economy evolves and the use and stock of electrical equipment increases, the intercept and temperature coefficients will change accordingly.

The intercept is projected forward using estimated future growth in underlying economic factors like population growth and economic activity (energy forecasts).

The temperature coefficient is projected forward using forecasts of air-conditioning stock and other temperature sensitive equipment. NIEIR monitors and forecasts air conditioner stocks and this information is incorporated into the PeakSim model.

Summer maximum demand projections are presented as probability distribution of maximum demand levels (i.e. probability of exceedance levels). The probability distribution captures the impacts of different weather extremes and general randomness of consumer behaviour on maximum demand events.

The forecasts of the coefficients on temperature sensitive load and temperature insensitive load are combined with the simulated temperature and residual series in the forecast years. Maximum demands are selected from each of the simulated series to fill out the probability distributions of maximum demand.

Federal and state government policies, new technologies and other programs are estimated as a separate adjustment on demand, where applicable. The policy and technology adjustment can in some cases be applied directly within the PeakSim modelling framework (air conditioner MEPS, carbon pricing), or in other cases be applied as a post-modelling adjustment (VEET, electric vehicles, battery storage). The need for a post-modelling adjustment to demand is assessed for each program and applied if necessary.

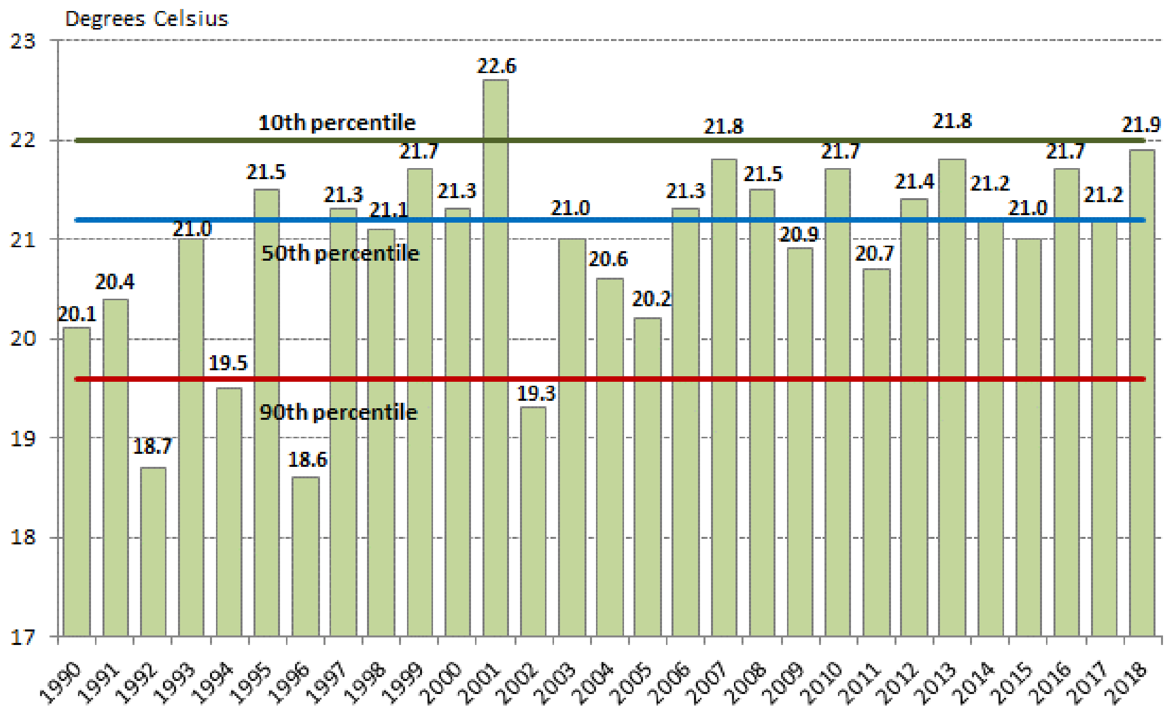
For the summer MD, which typically occurs at 4:00 or 4:30 p.m. (summer time) on a weekday in February in Victoria, the temperature sensitive load or additional demand is unambiguously associated with cooling appliances such as air conditioners, refrigeration units and fans. For the winter MD, which typically occurs at 6:00 p.m. or 6:30 p.m. in June or July, the temperature sensitive load is associated with primary and secondary electrical heating load. In the case of winter, however, the additional electricity load is not unambiguously associated with space heating load since utilisation of other electrical end-uses such as lighting, cooking appliances and entertainment appliances would also increase at this time of day.

Victoria's summer MD has increased significantly over recent years reflecting:

- strong recorded economic growth; and
- increases in the penetration of space cooling equipment.

As indicated in Figure 5.1 below, Victoria has also experienced a large number of very hot summers over the last 10 years. This figure shows Victoria's average summer temperatures in terms of probabilities based on the last 50 summers in Victoria.

Figure 5.1: Average summer temperatures, Victoria



The penetration of space cooling equipment has increased dramatically in Victoria since the mid-1990s reflecting:

(i) the impact of a number of very hot summers (between 1997 and 2001, and again in 2007, 2010, 2013 and 2018) on discretionary purchases of space cooling equipment;

(ii) improved marketing penetration and technological advances in space cooling equipment;

(iii) the coincident increase in construction activity in both the commercial and residential sectors. The increase in townhouse and apartment construction for residential dwellings are particularly suited to reverse cycle AC units;

(iv) the continued ageing of the population and the associated expansion in retirement villages for senior persons.

Figure 5.2 shows the estimated summer temperature sensitive load for the period 1990-91 to 2017-18 for Victoria. Figure 5.3 shows the annual increase in summer temperature sensitive load for a 10th percentile day. The figures highlights the rapid increase in temperature sensitive load in Victoria over recent years which directly effects increased penetration of space cooling and in particular, refrigerative AC units into Victoria.

Figure 5.4 shows total temperature sensitive load for the United Energy distribution region from 2000-01 to 2017-18. This effectively represents total installed capacity for the UE region. This data was estimated by NIEIR from actual sales of air conditioning equipment in Victoria, energy efficiency indices including MEPS, and half hourly electricity demand data. Total temperature sensitive load in the United Energy distribution region has risen from around 730 MW in 2000-01 to over 1,476 MW in 2017-18.

Figure 5.2: Total summer temperature sensitive Victorian load

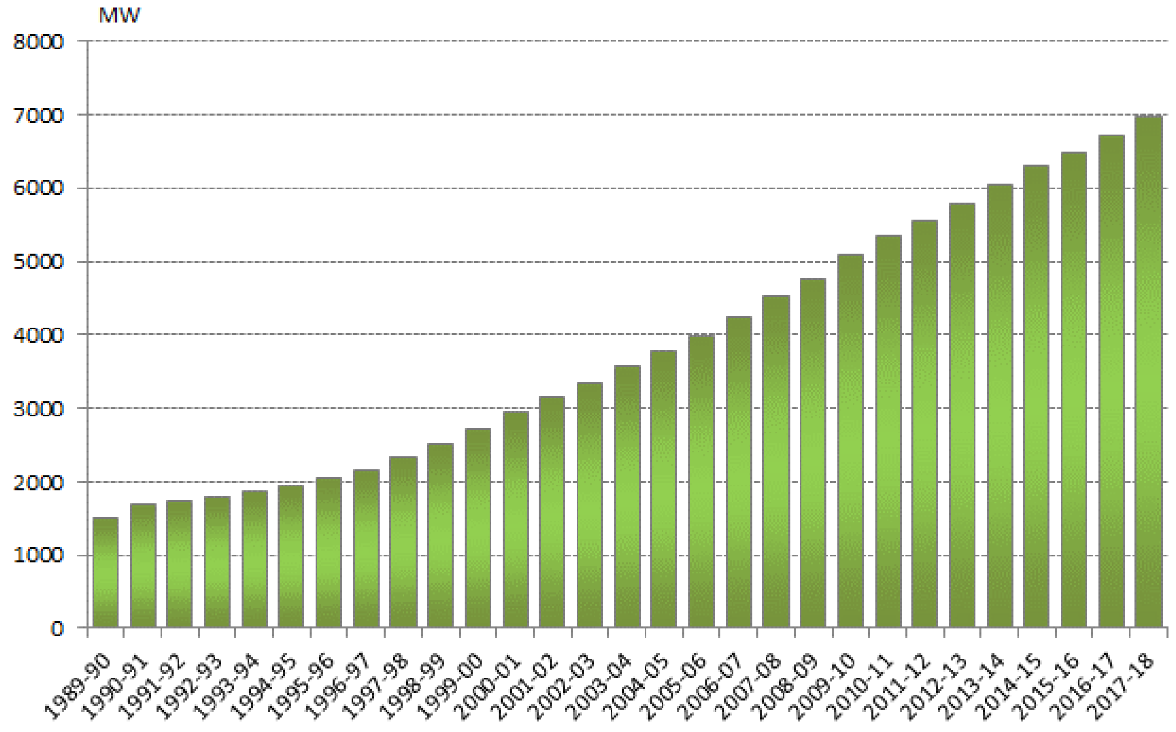


Figure 5.3: Estimated annual increase in Victorian summer temperature sensitive load

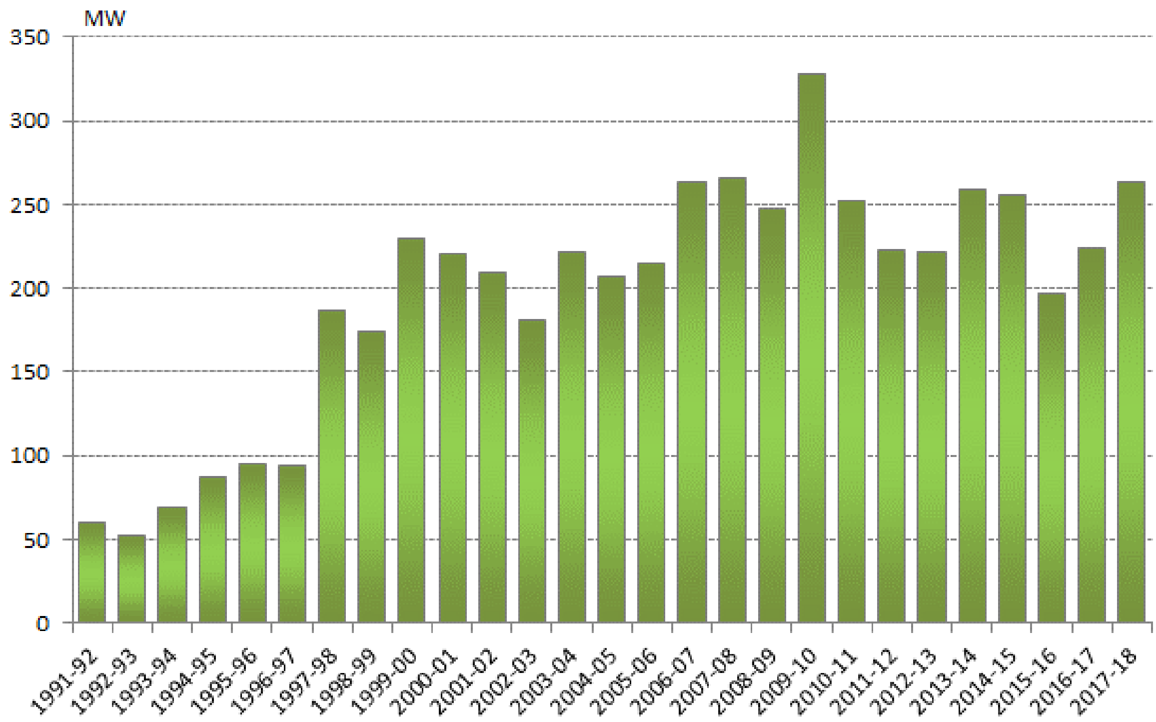
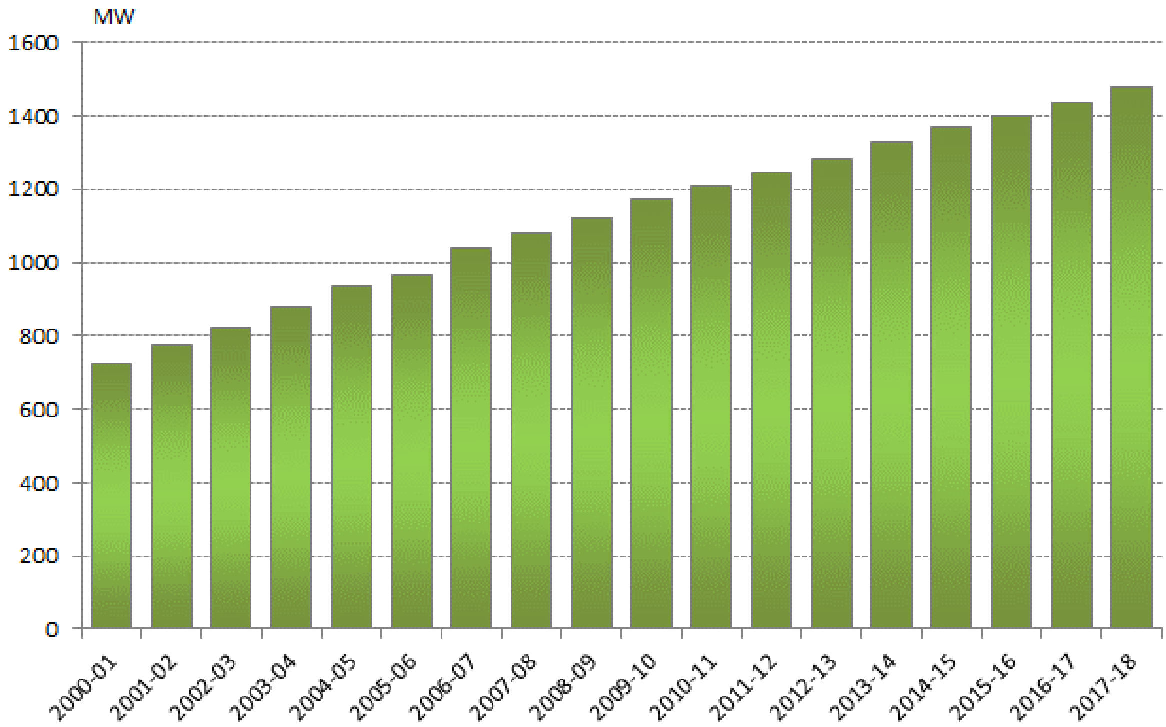


Figure 5.4: Total summer temperature sensitive load – United Energy distribution region



The winter MD

Forecasts of the total winter MD for United Energy were estimated from regression models relating electrical load to average daily temperature. These models were based upon the time of the typical peak for each winter MD.

The increase in reverse cycle air conditioner sales in Victoria over recent years may contribute to higher recorded winter MDs and sales over the next few years. The impact would depend upon the level of utilisation of this equipment. Two important factors that could increase the utilisation of this equipment are:

- the increase in smaller dwellings (floor area) such as townhouses and dual occupancy units which may be perceived to be more efficient to heat and cool using electrical equipment rather than gas equipment; and
- continuing warm to hot ambient summer temperatures.

There are some additional uncertainties associated with the winter MD in Victoria. A continuing sequence of relatively warm winters means it is difficult to accurately assess potential demand under much cooler winter conditions. In addition, the relationship between ambient temperature and recorded winter MDs has become less stable over the last five years.

5.4.2 Maximum non-coincident demand forecast methodology

The key stages to (ii) above, developing maximum demand forecasts for each United Energy terminal station are:

(i) extracting the peak non-coincident demands for each season by terminal station and the corresponding ambient temperatures;

(ii) calculating probabilities of exceedence (10^{th} and 50^{th} percentiles) for each relevant Bureau of Meteorology weather recording station (see Section 5.6);

(iii) determining the temperature sensitivity of United Energy terminal stations by season (see Section 5.5); and

(iv) specifying an equation for each MD by United Energy terminal station.

As noted above, (ii) and (iii) are outlined in more detail below.

The functional specification of each maximum demand equation for United Energy terminal stations followed the functional specification used by NIEIR in its work for AEMO and other TNIs in the NEM.

NIEIR estimated regression equations which identified the sensitivity of peak demand by terminal station and season (see Section 5.5). The United Energy peak demand equations by terminal station were specified as effectively load factors, so forecast energy growth is an important determinant of peak demand growth by season.

Total summer and winter non-coincident peaks were also constrained to the total peak for United Energy. This was done by calculating a diversity factor for each respective MD and percentile (10^{th} and 50^{th}).

Energy forecasts by terminal station

Energy by terminal station was calculated from the half hourly data supplied by United Energy.

The forecasts of energy by terminal station were derived by:

- calculating from data supplied by distribution business' energy sales by class and terminal station;
- constraining these forecasts to the total United Energy energy forecast (and ensuring they are consistent with the energy projections; and
- linking these regional forecasts to individual terminal stations.

Initial estimates of sales by class were developed from data supplied by distribution businesses and projecting them forward using suitable regression equations for electricity consumption. The wholesale and retail trade equation was used for the commercial class and the food, beverages, and tobacco equation for the industrial class. Regional specific output growths were used, however, to drive these sales estimates.

The total class sales data both historically and in the projection to 2027-28 by region were then constrained to the total United Energy class projection. The classes covered in the regional models included the following:

- residential;
- commercial; and
- industrial.

The final stage of the energy forecast was to link the regional based electricity forecasts for the United Energy region to United Energy terminal stations. This was done using maps of United Energy terminal stations and ABS statistical regions.

5.5 The sensitivity of United Energy terminal station maximum demands to ambient temperature

Using data provided by United Energy and other Victorian data, NIEIR estimated the sensitivity of maximum daily demand (at specific peak times) to ambient temperature for the last five years.

In each case, although the functional form was generally similar, each equation was adjusted for outliers.

The temperature sensitivity of maximum demands to MDs for terminal stations, total United Energy and Victoria, was estimated for daily peaks over the following months:

(i) June, July and August for the winter MDs; and

(ii) December, January and February for the summer MD.

The temperature data used for each terminal station refers to the average daily temperature at the respective BOM weather station. (Section 5.6 shows a concordance between United Energy terminal stations and BOM weather recording stations used in this study.) Daily peaks refer to weekdays only, excluding designated public holidays. The summer peak regression equations also excluded the Christmas holiday period (20 December to 20 January).

Table 5.3 shows the temperature sensitivity results for summers 2013-14 to 2017-18 by United Energy terminal station. The data in this table shows the average change in maximum daily load per degree change in average daily temperature for summer. Similarly, Table 5.4 shows the temperature sensitivity coefficients for United Energy terminal stations for winter. Temperature sensitivity coefficients are determined at a typical non-coincident peak time for each terminal station.

Table 5.3 The sensitivity of maximum daily demands to ambient temperature – United Energy terminal stations summer (MW per degree Celsius)

Terminal station	Non-coincident peak time	2014	2015	2016	2017	2018
Cranbourne 66KV (CBTS)	[4:00 PM]	4.83	5.13	6.03	5.79	4.85
East Rowville 66KV (ERT)	[1:30 PM]	5.10	7.66	6.80	6.50	6.67
Frankston 66KV (FTS)	[4:30 PM]					
Heatherton 66KV (HTS)	[3:00 PM]	8.47	8.93	11.62	11.58	10.53
Malvern 22KV (MT2)	[5:00 PM]	1.08	1.12	1.35	1.35	1.03
Malvern 66KV (MT6)	[4:00 PM]	5.95	5.79	7.47	7.10	6.23
Malvern Total	[4:30 PM]	7.19	7.00	8.68	8.58	7.17
Richmond 66KV (RT6)	[5:30 PM]	2.14	1.79	2.25	2.34	1.81
Ringwood 22KV (RW2)	[4:00 PM]	1.11	1.11	1.61	1.28	1.31
Ringwood 66KV (RW6)	[4:00 PM]	3.20	3.06	3.65	3.63	3.16
Ringwood Total	[4:00 PM]	4.31	4.17	5.26	4.91	4.47
Springvale 66KV (SVT6)	[3:00 PM]	9.72	11.13	12.95	11.97	10.82
Templestowe 66KV (TST)	[5:00 PM]	4.85	4.85	5.91	5.64	4.17
Tyabb 66KV (TBT)	[4:00 PM]	7.66	7.18	8.17	8.35	7.14
United Energy Total TS	**[3:30 PM]**	**54.77**	**57.53**	**69.84**	**66.74**	**60.33**

Table 5.4	The sensitivity of maximum daily demands to ambient temperature – United Energy terminal stations winter peaks (MW per degree Celsius)					
Terminal station	**Non-coincident peak time**	**2013**	**2014**	**2015**	**2016**	**2017**
Cranbourne 66KV (CBTS)	[6:30 PM]	2.32	2.05	2.90	2.42	1.79
East Rowville 66KV (ERT)	[9:30 AM]	4.43	3.63	2.00	4.66	3.17
Frankston 66KV (FTS)	[6:30 PM]					
Heatherton 66KV (HTS)	[6:00 PM]	4.71	3.43	5.37	5.14	3.81
Malvern 22KV (MT2)	[6:30 PM]	0.62	0.44	0.59	0.44	0.27
Malvern 66KV (MT6)	[7:00 PM]	2.63	2.41	3.10	2.88	2.03
Malvern Total	[6:30 PM]	3.31	2.83	3.68	3.37	2.21
Richmond 66KV (RT6)	[7:30 PM]	1.44	1.30	1.70	1.38	1.03
Ringwood 22KV (RW2)	[6:30 PM]	0.47	0.42	0.57	0.47	0.47
Ringwood 66KV (RW6)	[6:00 PM]	1.42	0.94	1.73	1.25	0.81
Ringwood Total	[6:00 PM]	1.93	1.33	2.32	1.77	1.29
Springvale 66KV (SVT6)	[10:00 AM]	4.74	4.60	4.56	5.34	3.93
Templestowe 66KV (TST)	[6:30 PM]	1.91	1.77	1.52	2.13	0.99
Tyabb 66KV (TBT)	[6:30 PM]	3.24	3.33	4.00	3.67	2.68
United Energy Total TS	**[6:30 PM]**	**24.75**	**21.15**	**27.67**	**26.00**	**17.70**

Note: All winter coefficients assume a negative sign.

Taking into account the temperature sensitivity coefficients in Tables 5.3 and 5.4, NIEIR made an assessment of the overall sensitivity to be used for modelling and forecasting purposes.

5.6 Temperature percentiles

In terms of completing a terminal station MD forecast for United Energy, temperature data was obtained for each terminal from the National Climate Centre. Daily temperature data for the United Energy region was used from the BOM Melbourne Regional Office and Melbourne Olympic Park from 1960 to 2017.

The variation maximum demands for summer and winter principally depend upon:

- the ambient maximum temperature for a specific day(s); and
- the ambient minimum temperature overnight or in the previous day(s).

NIEIR's approach was to calculate the probabilities associated with different average daily temperatures in each season. The average temperature was defined as the arithmetic average of the overnight minimum and the daily maximum. These probabilities are based on both weekday and weekend temperatures.

The seasons were defined to include the following months:

- summer: November to March but excluding public holidays and 20 December to 20 January in each year; and
- winter: June, July and August (excluding public holidays).

NIEIR undertook to calculate the following temperature percentiles for maximum demands:

- 10th percentile exceeded once in every 10 years; and
- 50th percentile exceeded once in every two years.

The probabilities/percentiles were calculated on the basis of the temperature in any one season exceeding a given level. This results in considerably higher temperatures than if one considered the probability that any one day in any one season exceeds a given temperature. The percentiles for summer MDs are not relevant as PeakSim uses the joint probability distribution of demand and temperatures to model demands for United Energy.

Table 5.5 shows the 10th, 50th and 90th summer and winter daily temperature percentiles.

Table 5.5 Melbourne's average temperatures associated with alternative percentiles

	Winter[1]	Summer[2]
10th percentile	6.8	34.0
50th percentile	7.9	30.8
90th percentile	8.7	28.6

Notes: 1. Calculated over June to August, 1960-2018.
2. Calculated over December to February, 1959-60 to 2017-18, but excluding 20 December to 20 January in each year.

5.7 United Energy coincident maximum demand forecasts

Maximum coincident demand forecasts for United Energy terminal stations were partly developed using coincidence factors calculated for each United Energy terminal station for each respective MD, i.e. summer and winter peaks.

Coincidence factors were used to obtain initial estimates of the coincident MD at each terminal. Overall coincident MDs over the whole of United Energy were constrained to the total peak for United Energy. This constraint applies to summer and winter MDs for each probability of exceedence.

Tables 5.6 and 5.7 show the actual and forecast coincidence factors for each United Energy terminal station.

As indicated in Table 5.7, for the summer MD, the following terminal stations are generally coincident:

Cranbourne	66 KV
Heatherton	66 KV
Malvern	22 KV and 66 KV
Ringwood	22 KV and 66 KV
Springvale	66 KV
Templestowe	66 KV
Tyabb	66 KV

For the winter peak, tabulated in Table 5.6, the following United Energy terminal stations are generally coincident:

Cranbourne	66 KV
East Rowville	66 KV
Heatherton	66 KV
Malvern	22 KV and 66 KV
Richmond	66 KV
Ringwood	22 KV and 66 KV
Springvale	66 KV
Templestowe	66 KV

Table 5.6 United Energy Terminal stations - Coincidence Factors- Winter

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	***********************		RATIO	*************************			
BASE							
2015	0.97	0.85	0.00	1.00	0.93	0.95	0.93
2016	0.98	0.81	0.00	0.98	1.00	0.96	0.96
2017	0.99	0.80	0.00	0.96	0.91	0.98	0.95
2018	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2019	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2020	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2021	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2022	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2023	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2024	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2025	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2026	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2027	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2028	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2029	0.99	0.83	0.00	0.99	0.95	0.97	0.95
Percentage changes							
2015	-1.04	13.47	0.00	2.83	9.06	-5.24	-2.33
2016	0.56	-3.83	0.00	-1.90	7.33	1.44	3.32
2017	1.98	-1.54	0.00	-2.25	-8.29	2.39	-0.50
2018	-0.56	3.35	0.00	3.15	4.51	-1.10	0.18
2019	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2020	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2021	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2025	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2026	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2027	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2028	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2029	0.01	0.01	0.00	0.01	0.01	0.01	0.01
Compound growth rate (per cent) -							
2019-2025	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2019-2029	0.01	0.01	0.00	0.01	0.01	0.01	0.01
HIGH - Levels							
2018	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2019	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2020	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2021	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2022	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2023	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2024	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2025	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2026	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2027	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2028	0.99	0.83	0.00	0.99	0.95	0.97	0.96
2029	0.99	0.83	0.00	0.99	0.95	0.97	0.96
Compound growth rate (per cent) -							
2019-2025	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2019-2029	0.01	0.01	0.00	0.01	0.01	0.01	0.01
LOW - Levels							
2018	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2019	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2020	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2021	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2022	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2023	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2024	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2025	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2026	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2027	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2028	0.99	0.83	0.00	0.99	0.95	0.97	0.95
2029	0.99	0.83	0.00	0.99	0.95	0.97	0.95
Compound growth rate (per cent) -							
2019-2025	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019-2029	0.00	0.00	0.00	0.00	0.00	0.00	0.00

All data are for the calendar year ending in December of the year specified.

Table 5.6 United Energy Terminal stations - Coincidence Factors - Winter (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)
Unit	****************		RATIO		*****************
BASE					
2015	1.00	1.00	1.00	1.00	0.99
2016	0.91	0.98	0.96	0.99	0.99
2017	0.87	1.00	0.96	1.00	0.98
2018	0.93	1.00	0.98	1.00	1.00
2019	0.93	1.00	0.98	1.00	1.00
2020	0.93	1.00	0.98	1.00	1.00
2021	0.93	1.00	0.98	1.01	1.00
2022	0.93	1.00	0.98	1.01	1.00
2023	0.94	1.00	0.98	1.01	1.00
2024	0.94	1.00	0.98	1.01	1.00
2025	0.94	1.00	0.98	1.01	1.00
2026	0.94	1.00	0.98	1.01	1.00
2027	0.94	1.00	0.98	1.01	1.00
2028	0.94	1.00	0.98	1.01	1.00
2029	0.94	1.00	0.98	1.01	1.00
Percentage changes					
2015	3.71	0.82	6.14	-0.12	-0.79
2016	-9.09	-1.83	-3.93	-0.87	-0.56
2017	-4.40	1.41	0.28	0.76	-0.67
2018	7.55	0.62	2.11	0.72	1.58
2019	0.01	0.01	0.01	0.01	0.01
2020	0.01	0.01	0.01	0.01	0.01
2021	0.01	0.01	0.01	0.01	0.01
2022	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00
2024	0.01	0.01	0.01	0.01	0.01
2025	0.01	0.01	0.01	0.01	0.01
2026	0.01	0.01	0.01	0.01	0.01
2027	0.01	0.01	0.01	0.01	0.01
2028	0.01	0.01	0.01	0.01	0.01
2029	0.01	0.01	0.01	0.01	0.01
Compound growth rate (per cent) -					
2019-2025	0.01	0.01	0.01	0.01	0.01
2019-2029	0.01	0.01	0.01	0.01	0.01
HIGH - Levels					
2018	0.93	1.00	0.98	1.00	1.00
2019	0.93	1.00	0.98	1.00	1.00
2020	0.93	1.00	0.98	1.00	1.00
2021	0.93	1.00	0.98	1.01	1.00
2022	0.94	1.00	0.98	1.01	1.00
2023	0.94	1.00	0.98	1.01	1.00
2024	0.94	1.00	0.98	1.01	1.00
2025	0.94	1.00	0.98	1.01	1.00
2026	0.94	1.00	0.98	1.01	1.00
2027	0.94	1.00	0.98	1.01	1.00
2028	0.94	1.00	0.98	1.01	1.00
2029	0.94	1.00	0.99	1.01	1.00
Compound growth rate (per cent) -					
2019-2025	0.01	0.01	0.01	0.01	0.01
2019-2029	0.01	0.01	0.01	0.01	0.01
LOW - Levels					
2018	0.93	1.00	0.98	1.00	1.00
2019	0.93	1.00	0.98	1.00	1.00
2020	0.93	1.00	0.98	1.00	1.00
2021	0.93	1.00	0.98	1.00	1.00
2022	0.93	1.00	0.98	1.00	1.00
2023	0.93	1.00	0.98	1.00	1.00
2024	0.93	1.00	0.98	1.00	1.00
2025	0.93	1.00	0.98	1.00	1.00
2026	0.93	1.00	0.98	1.00	1.00
2027	0.93	1.00	0.98	1.00	1.00
2028	0.93	1.00	0.98	1.00	1.00
2029	0.93	1.00	0.98	1.00	1.00
Compound growth rate (per cent) -					
2019-2025	0.00	0.00	0.00	0.00	0.00
2019-2029	0.00	0.00	0.00	0.00	0.00

All data are for the calendar year ending in December of the year specified.

Table 5.7 United Energy Terminal stations - Coincidence Factors - Summer

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	************************		RATIO	************************			
BASE							
2015	0.91	0.96	51.31	1.00	1.00	0.98	0.98
2016	1.00	0.94	51.29	0.99	0.96	1.00	0.95
2017	0.89	1.00	51.16	0.96	0.88	0.99	0.94
2018	0.95	0.89	51.37	0.96	0.87	0.91	0.89
2019	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2020	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2021	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2022	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2023	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2024	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2025	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2026	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2027	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2028	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2029	0.95	0.99	51.28	1.01	0.95	1.00	0.97
2030	0.95	0.99	51.28	1.01	0.95	1.00	0.97
Percentage changes							
2015	-6.48	10.33	0.32	3.31	7.89	-1.63	-1.48
2016	9.22	-2.96	-0.04	-1.34	-3.92	1.76	-2.70
2017	-10.76	6.84	-0.26	-2.68	-8.59	-1.06	-1.22
2018	7.09	-10.74	0.41	-0.18	-1.05	-7.47	-5.66
2019	0.01	10.71	-0.17	5.32	9.33	9.09	9.39
2020	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2021	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2022	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2023	0.03	0.03	0.00	0.03	0.03	0.03	0.03
2024	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2025	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2026	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2027	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2028	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2029	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2030	0.02	0.02	0.00	0.02	0.02	0.02	0.02
Compound growth rate (per cent) -							
2019-2025	0.02	0.02	0.00	0.02	0.02	0.02	0.02
2019-2030	0.02	0.02	0.00	0.02	0.02	0.02	0.02
HIGH - Levels							
2019	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2020	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2021	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2022	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2023	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2024	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2025	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2026	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2027	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2028	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2029	0.95	0.99	52.72	1.01	0.95	1.00	0.97
2030	0.95	0.99	52.72	1.01	0.95	1.00	0.97
Compound growth rate (per cent) -							
2019-2025	0.01	0.01	0.00	0.01	0.01	0.01	0.01
2019-2030	0.01	0.01	0.00	0.01	0.01	0.01	0.01
LOW - Levels							
2019	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2020	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2021	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2022	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2023	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2024	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2025	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2026	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2027	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2028	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2029	0.95	0.99	50.77	1.01	0.95	1.00	0.97
2030	0.95	0.99	50.77	1.01	0.95	1.00	0.97
Compound growth rate (per cent) -							
2019-2025	0.03	0.03	0.00	0.03	0.03	0.03	0.03
2019-2030	0.03	0.03	0.00	0.03	0.03	0.03	0.03

All data are for the financial year ending in June of the year specified.

Table 5.7 United Energy Terminal stations - Coincidence Factors – Summer (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)
Unit	*******************		RATIO	***************	
BASE					
2015	0.99	0.99	0.99	0.96	0.79
2016	0.98	1.00	1.00	1.00	0.95
2017	0.95	0.97	1.00	0.95	0.71
2018	0.89	0.96	1.00	0.94	0.84
2019	0.98	1.01	1.04	0.99	0.81
2020	0.98	1.01	1.04	0.99	0.81
2021	0.98	1.01	1.04	0.99	0.81
2022	0.98	1.01	1.04	0.99	0.81
2023	0.98	1.01	1.04	0.99	0.81
2024	0.98	1.01	1.04	0.99	0.81
2025	0.98	1.01	1.04	0.99	0.81
2026	0.98	1.01	1.04	0.99	0.81
2027	0.98	1.01	1.04	0.99	0.81
2028	0.98	1.01	1.04	0.99	0.81
2029	0.98	1.01	1.04	0.99	0.81
2030	0.98	1.01	1.04	0.99	0.81
Percentage changes					
2015	0.54	1.01	1.44	-3.89	-20.87
2016	-1.12	1.30	0.67	3.80	20.26
2017	-2.93	-2.63	0.00	-4.92	-25.27
2018	-6.93	-1.48	0.00	-0.94	18.57
2019	10.46	5.28	3.53	4.87	-3.79
2020	0.02	0.02	0.02	0.02	0.02
2021	0.02	0.02	0.02	0.02	0.02
2022	0.02	0.02	0.02	0.02	0.02
2023	0.03	0.03	0.03	0.03	0.03
2024	0.02	0.02	0.02	0.02	0.02
2025	0.02	0.02	0.02	0.02	0.02
2026	0.02	0.02	0.02	0.02	0.02
2027	0.02	0.02	0.02	0.02	0.02
2028	0.02	0.02	0.02	0.02	0.02
2029	0.02	0.02	0.02	0.02	0.02
2030	0.02	0.02	0.02	0.02	0.02
Compound growth rate (per cent) -					
2019-2025	0.02	0.02	0.02	0.02	0.02
2019-2030	0.02	0.02	0.02	0.02	0.02
HIGH - Levels					
2019	0.98	1.01	1.04	0.99	0.81
2020	0.98	1.01	1.04	0.99	0.81
2021	0.98	1.01	1.04	0.99	0.81
2022	0.98	1.01	1.04	0.99	0.81
2023	0.98	1.01	1.04	0.99	0.81
2024	0.98	1.01	1.04	0.99	0.81
2025	0.98	1.01	1.04	0.99	0.81
2026	0.98	1.01	1.04	0.99	0.81
2027	0.98	1.01	1.04	0.99	0.81
2028	0.98	1.01	1.04	0.99	0.81
2029	0.98	1.01	1.04	0.99	0.81
2030	0.98	1.01	1.04	0.99	0.81
Compound growth rate (per cent) -					
2019-2025	0.01	0.01	0.01	0.01	0.01
2019-2030	0.01	0.01	0.01	0.01	0.01
LOW - Levels					
2019	0.98	1.01	1.04	0.99	0.81
2020	0.98	1.01	1.04	0.99	0.81
2021	0.98	1.01	1.04	0.99	0.81
2022	0.98	1.01	1.04	0.99	0.81
2023	0.98	1.01	1.04	0.99	0.81
2024	0.98	1.01	1.04	0.99	0.81
2025	0.98	1.01	1.04	0.99	0.81
2026	0.98	1.01	1.04	0.99	0.81
2027	0.98	1.01	1.04	0.99	0.81
2028	0.98	1.01	1.04	0.99	0.81
2029	0.98	1.01	1.04	0.99	0.81
2030	0.98	1.01	1.04	0.99	0.81
Compound growth rate (per cent) -					
2019-2025	0.03	0.03	0.03	0.03	0.03
2019-2030	0.03	0.03	0.03	0.03	0.03

All data are for the financial year ending in June of the year specified.

5.8 Structural change in the output elasticity of electricity demand

Australian electricity markets have been subject to significant change since 2010. These include the following: the widespread take-up of photovoltaic systems, a sharp increase in real electricity prices, significant energy efficiency improvement, and a contraction in manufacturing production following the high exchange rate regime that existed over 2012 and 2013.

Some analysts have claimed that the relationship between Australian gross product growth (or GDP) and electricity sales has been broken. This section refutes this claim, but provides empirical evidence to support the hypothesis that there has been a structural change in the relationship between electricity sales, gross product growth and electricity prices in the Australian (NEM) and Victorian state context.

Electricity is a key input into household and business economic activity. Electricity key is a factor input into domestic production whether that be low value added activities such as coffee making or high value added activities such as steel production.

Electricity usage in Australia has traditionally increased with Australian economic growth. Post 2010, electricity sales growth begun to stagnate and even fall. From an economic perspective the key drivers of electricity sales growth are gross state product growth, weather and electricity prices. The following analysis demonstrates that economic growth, real electricity, prices and weather conditions remain the key drivers of electricity sales.

Figures 5.5 and 5.6 demonstrate the declining trend in electricity demand since around 2010 for both NEM wide and Victorian electricity demand.

Figure 5.5: NEM electricity demands – 1999 to 2017 (quarterly basis)

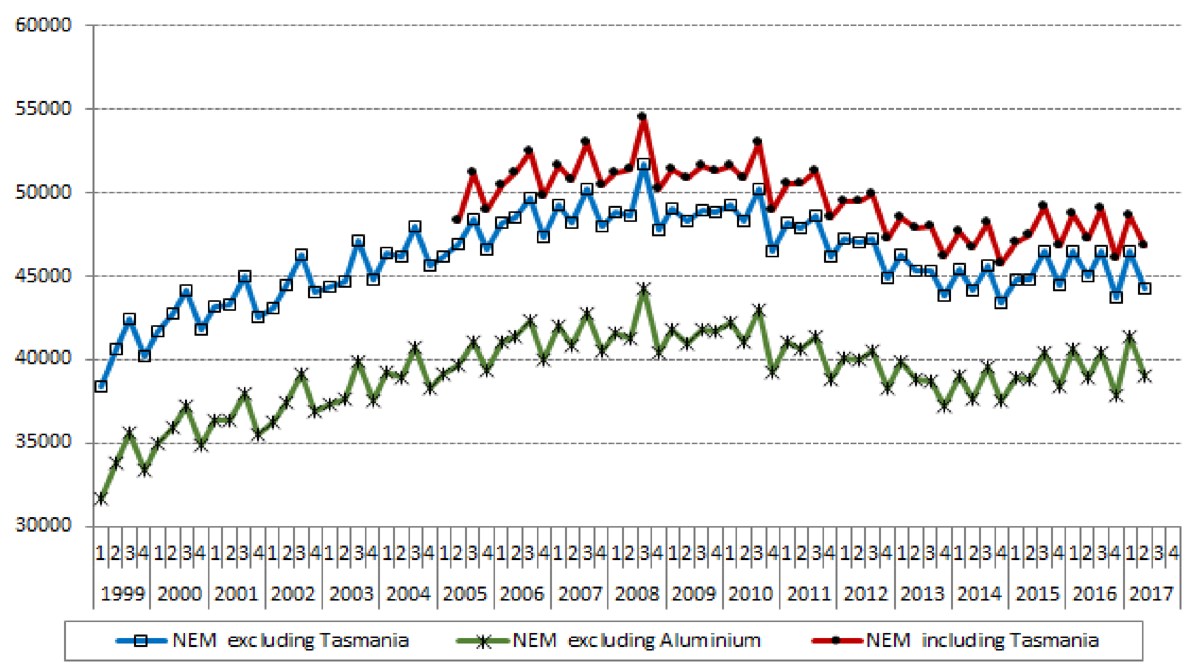


Figure 5.6: Victorian electricity demands – 1999 to 2017 (quarterly basis)

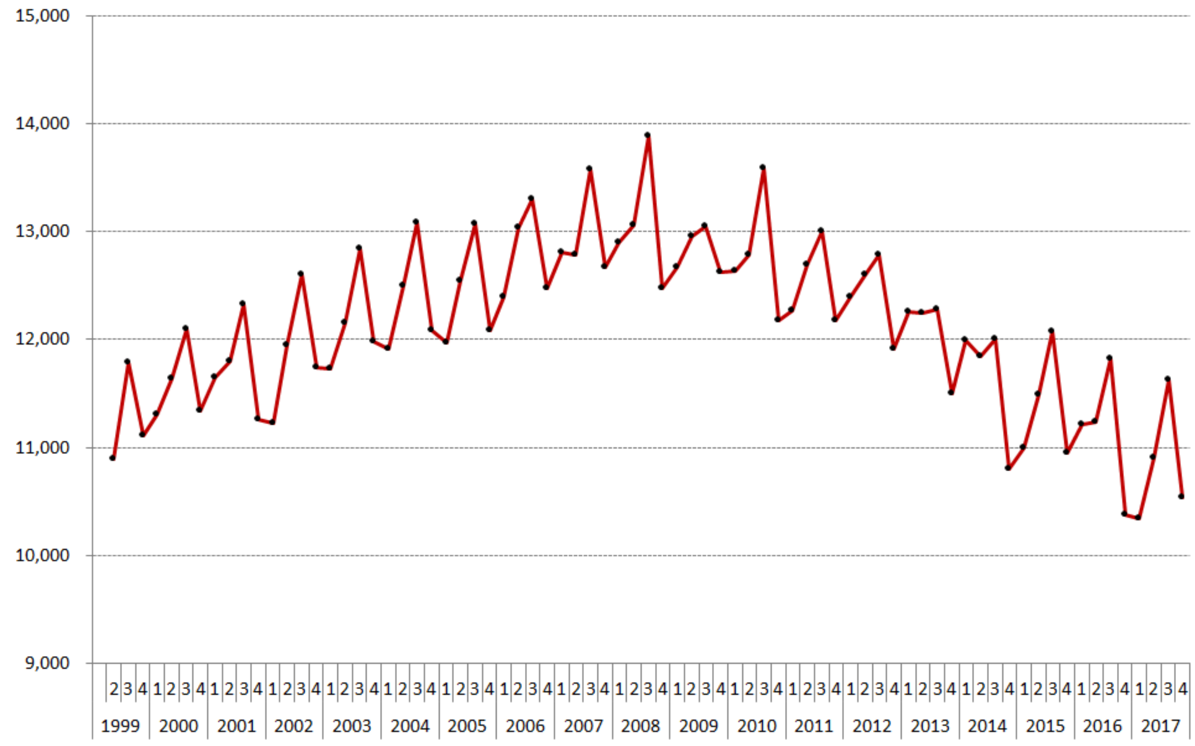
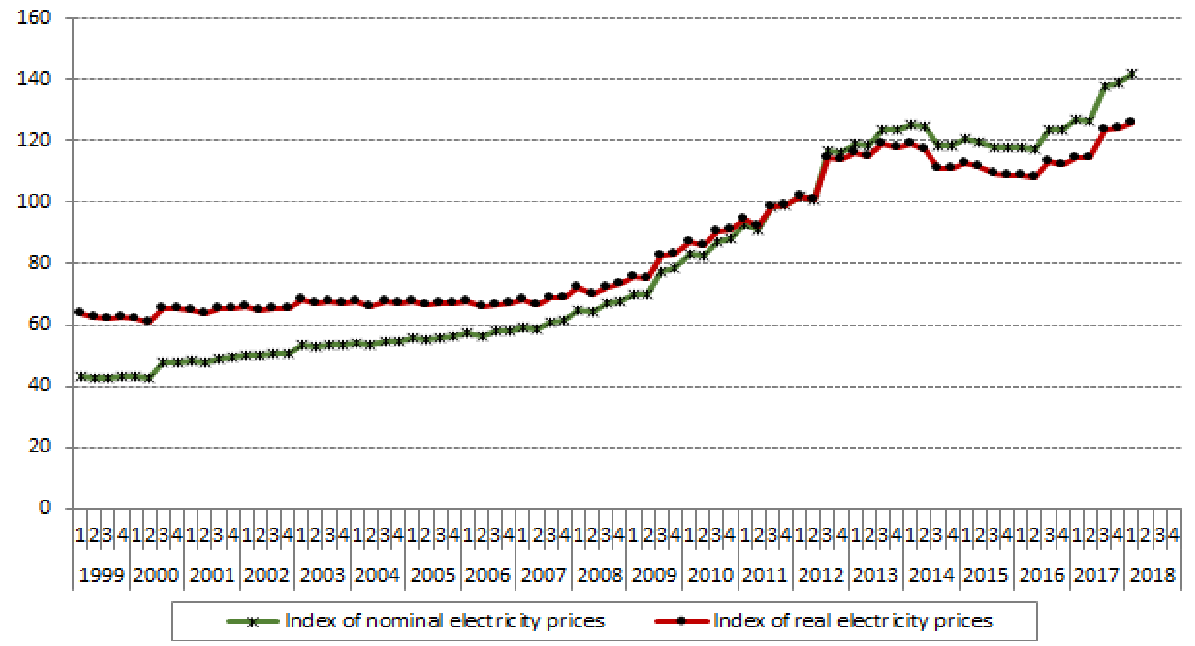


Figure 5.7 shows nominal and real electricity for the residential sector. Real prices were relatively flat over the 1999-2008 period. Prices rose sharply between 2009 and 2012 increasing by nearly 54 per cent in real terms. The size of this increase was unprecedented. Since 2012, electricity price increases have moderated, although they have still been increasing slightly. Between 2017 and 2012, real prices rose by a further 6.6 per cent.

Figure 5.7: Index of nominal and real electricity prices – Residential sector (quarterly basis)



5.8.1 Methodology

Data sources

Electricity sales data by state was sourced from the Australian Energy Market Operator (AEMO) and the Energy Networks Association (ENA). Financial year data for electricity sales was obtained for the following classes:

- residential;
- industrial;
- public lighting; and
- total.

The AEMO sales data was operational demand by state, converted into a quarterly periodicity. Data on electricity sales was also adjusted for electricity use in Aluminium production and electricity use by small-scale PV systems in Australia. These regression results in this section are presented for Victorian and the total NEM.

Economic data for the study was sourced from the Australian Bureau of Statistics (ABS) including the following by state:

- electricity price indices;
- consumer price indices;
- national gross domestic product;
- Gross State Product; and
- household disposable income.

Weather data was sourced from the Bureau of Meteorology (BOM). Temperature readings from the BOM were used to generate Heating Degree day indices and Cooling Degree indices for each State capital city. Capital city weather data was used as a proxy for State weather conditions.

Photovoltaic data was sourced from the Clean Energy Regulator and some of the aluminium data was sourced from publicly available data from AEMO.

Model specification

The general form of the aggregate electricity consumption model is shown below.

$$lnED = a1*C + a2*lnGSP + a3*lnRP + a4*HDD + a5*CDD$$

Where:

ln is the natural logarithm;

ED is quarterly total electricity sales by NEM State;

GSP is quarterly Gross State Product by State;

RP is a three year weighted average real electricity price by State;

C is a constant;

HDD is heating degree days per quarter by State;

CDD is cooling degree days per quarter by State; and

$a1, a2, a3, a4, a5$ are parameters to be estimated.

The inclusion of HDD and CDD variables in the specification means quarterly seasonal dummy variables are not required in the regression model. The seasonality in electricity sales is mainly due to weather variations.

There were two main variants of the electricity demand model estimated. First, the dependent variable was re-calculated so that it excluded Aluminium electricity use. Second, the dependent variable was re-calculated so that it included an estimate of own use from small-scale photovoltaic systems (SSPV).

Aluminium production is an electricity intensive and smelters are located in New South Wales, Victoria, Queensland, and Tasmania. There have been significant changes in aluminium production in Australia over the last decade, with significant production cuts at some smelters and the closure of Kurri Kurri in New South Wales and Alcoa's Anglesea smelter in Victoria.

Estimation techniques and hypothesis testing

Two alternative estimators were used in this section. These include single equation least squares and Full Information Maximum Likelihood (FIML).

Single equation ordinary least squares (OLS) is the standard estimator for linear models. It minimises the sum of squared residuals.

OLS computes the regression coefficients and associated statistics such as the standard error of the residuals, the Durbin -Watson statistic, and the mean and standard deviation of the dependant variable. The R-Squared and adjusted R-Squared, and F-Statistic are also provided. The R-Squared statistic is the squared correlation coefficient between the dependent and independent variables.

The Durbin-Watson statistic is a test statistic for autocorrelation. That is, the residuals are correlated amongst themselves.

The Chow test is an F test that checks the stability of the regression coefficients over two sub-samples of the data. This statistic tests whether there has been structural change in the coefficients between two periods of time. It does this by comparing the sum of squared residuals.

FIML is a systems estimator and is asymptotically efficient for both linear and non-linear models. The electricity consumption equations for each state are estimated jointly and as an efficient estimator, the standard errors on individual coefficients should be lower under FIML estimation than OLS. Electricity demand equations were estimated jointly using the FIML estimator for New South Wales, Victoria, Queensland, and South Australia.

5.8.2 Estimation results

Tables 5.8 and 5.9 provide the estimation results for Victoria and the total National Electricity market. These tables show the single equation estimation results and the FIML results for total electricity demand excluding own use of small-scale PV, and for equations estimated based on total demands excluding aluminium smelter demand.

The results are reasonably robust with correct signs on most equations and the correct order of magnitude coefficients. The estimated equations including PV improve the goodness of fit marginally as expected. The output elasticities are generally a little higher, while the price elasticities are a little lower.

The adjusted R square statistic is also summarised alongside the model results to give an indication of the fit of the equation. The supporting Chow and Durbin-Watson statistical tests are also summarised.

The Chow test for structural change was tested on the following samples.

- 2001:4 to 2011:4; and
- 2012:1 to 2017:1.

The Chow statistics presented in Tables 5.8 suggest we cannot accept the hypothesis that there no structural change in Victoria and the NEM. This is not an unexpected empirical result.

In addition, the Durbin Watson statistics indicate the estimated equations are impacted by first order autocorrelation. The NEM wide equation in some cases is an exception. The Cochrane-Orcutt procedure was used to eliminate the autocorrelation problem. There is a significant improvement in the Victorian equation when aluminium is excluded.

Table 5.10 shows the implied output and price for Victoria, the total NEM and the United Energy Distribution network. The output elasticities for the other states have also been included for comparison. These results exclude aluminium electricity use. In NIEIR's experience, the output elasticity over the 1960-2000 period would have been about 0.8.

Modelling results suggest that the output elasticity for electricity demand has fallen from around 0.8 to around 0.5 for the National Electricity Market as a whole. The Victorian output elasticity is around 0.44 without PV and 0.47 including PV. The United Energy Distribution network output and price elasticities differ from the Victorian average elasticities in part due to a higher concentration of manufacturing activity.

The decrease in the output elasticity of electricity demand partly reflects the demise of the manufacturing sector in Australia over the 2011-2014 period. The own price elasticity for electricity demand seems to have remained fairly stable at around -0.3. The own price elasticity has been demonstrated to be as high as -0.5 under incidences of rapid price increases.

Table 5.8	Total Electricity Consumption Ordinary Least Squares Estimator results						
Region	R^2 adjusted	Durbin Watson statistic	Chow Test statistic	Output elasticity	Own price elasticity	Heating DD	Cooling DD
Series: Total electricity consumption							
VIC	0.72	0.29	48.71	0.33	-0.28	0.00031	0.00027
t value				4.27	-8.31	6.28	3.48
NEM	0.91	0.94	8.4	0.39	-0.26	0.000063	0.000056
t value				4.49	-9.22	9.99	8.22
Series: Total electricity consumption excluding aluminium							
VIC	0.89	0.87	16.66	0.51	-0.23	0.00037	0.00036
t value				11.98	-12.51	13.81	8.39
NEM	0.92	1.51	2.68	0.48	-0.26	0.00008	0.000075
t value				6.43	-10.54	14.74	12.73
Total electricity consumption by State including SSPV own use							
VIC	0.73	0.3	47.45	0.33	-0.26	0.0003	0.00027
t value				4.68	-8.36	6.7	3.82
NEM	0.92	1.09	6.15	0.43	-0.24	0.000063	0.000059
t value				6.21	-10.66	12.73	10.91
Total electricity consumption excluding aluminium electricity use by State including SSPV own use							
VIC	0.91	1.03	13.24	0.51	-0.21	0.00036	0.00036
t value				13.59	-12.75	15.34	9.57
NEM	0.93	1.8	1.71	0.53	-0.24	0.000081	0.000078
t value				8.69	-11.86	18.47	16.49

Table 5.9	Total Electricity Consumption Full Information Maximum Likelihood Estimator results						
Region	R^2 adjusted	Durbin Watson statistic	Chow Test statistic	Output elasticity	Own price elasticity	Heating DD	Cooling DD
Series: Total electricity consumption							
VIC	0.73	0.27	0.19	-0.21	0.00029	0.00024	0.00027
t value			1.65	-4.79	4.72	2.76	3.48
NEM	0.9	0.94	0.39	-0.26	0.000063	0.000056	0.000056
t value			4.12	-7.43	9.36	8	8.22
Series: Total electricity consumption excluding aluminium							
VIC	0.89	0.89	0.44	-0.2	0.00033	0.00029	0.00036
t value			6.69	-6.09	9.02	5.21	8.39
NEM	0.91	1.51	0.48	-0.26	0.00008	0.000075	0.000075
t value			6.7	-10.2	12.5	10.79	12.73
Total electricity consumption by State including SSPV own use							
VIC	0.74	0.28	0.24	-0.22	0.0003	0.00026	0.00027
t value			2.2	-4.94	5.8	3.68	3.82
NEM	0.92	1.09	0.43	-0.24	0.000063	0.000058	0.000059
t value			5.89	-8.84	12.56	11	10.91
Total electricity consumption excluding aluminium electricity use by State including SSPV own use							
VIC	0.91	1.06	0.47	-0.19	0.00034	0.00031	0.00036
t value			8.01	-7.33	10.13	6.29	9.57
NEM	0.93	1.8	0.53	-0.24	0.000081	0.000078	0.000078
t value			8.6	-11.1	17.71	15.33	16.49

Table 5.10	Output and price elasticities for the NEM electricity demand excluding aluminium but including and excluding small-scale PV own use			
	Output elasticity		Own price elasticity	
	No PV	Including SSPV	No PV	Including SSPV
New South Wales	0.93	1.01	-0.41	-0.43
Victoria	0.44	0.47	-0.20	-0.19
Queensland	0.67	0.65	-0.27	-0.21
South Australia	0.16	0.21	-0.24	-0.18
Tasmania	-0.03	0.0078	-0.19	-0.17
NEM	0.48	0.53	-0.26	-0.24
United Energy Distribution		0.60		-0.15

6. Policy and technological impacts on energy consumption and maximum demand, Victoria 2018 to 2030

6.1 Introduction

This section reviews key policy and technological developments that are expected to influence future electricity demand. The technology and programs that are reviewed are those that may require a post-modelling adjustment to econometric forecasts. Well established energy efficiency programs, such as 6 star building standards, are likely to already be adequately represented in historical trends and hence forecasting equations.

The technologies and policies this section focuses on include:

- small-scale solar photovoltaics;
- battery storage;
- Victorian Energy Efficiency Target;
- demand response programs;
- plug-in electric vehicles; and
- Minimum Energy Performance Standards for air conditioners and lighting.

6.2 Victorian Energy Efficiency Target

The Victorian Energy Efficiency Target (VEET) scheme is a white certificate program that provides incentives for residential and business consumers to install energy efficient technologies. These technologies, such as LED down lights, reduce the amount of carbon equivalent emissions (CO_2-e) generated over the asset lifetime compared with less efficient technologies, such as halogen down lights. This reduces residential and commercial energy demand compared to business as usual. A post-modelling adjustment may be required where part or all of the future developments of VEET are outside the scope of econometric modelling.

The VEET scheme has been through a first phase covering 2009 to 2011, and a second phase covering 2012 to 2014. The annual targets are set at the beginning of each phase, with the first phase years targeting 2.7 million tonnes CO_2-e and the second phase years targeting 5.4 million tonnes CO_2-e. The current government continued VEET into 2015 at the second phase targets before completing a review of VEET over 2015. VEET will continue for another 5-year phase from 2016 to 2020 with increasing targets. The Victorian government has yet to make any firm announcement on the post-2020 future of VEET.

Table 6.1 provides a comparison of the targeted certificate creation to the achieved levels of certificate creation within a given calendar year. The first phase of the scheme broadly reached the targets. The second phase started with 8.7 million certificates registered, but some were related to 2011 activities/relevant entity liabilities. The following 2013 and 2014 years had less certificates created than target that corrected for the oversupply created during 2012. 2015 was fairly balanced between target and actual certificate creation, while 2016 exceeded the target by 2.5 million certificates created, partly due to a significant uptake in commercial lighting. In 2017 around 2 million certificates were created in excess of the target, and 2018 is already running above target.

Table 6.1	Overview of Victorian Energy Efficiency Target, Victoria region						
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Victorian actual certificates	8,709,273	5,232,139	3,447,179	5,266,491	7,858,517	7,820,645	2,893,391
Victorian target certificates	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,900,000	6,100,000
Activity category (per cent)[1]							
Water heating	4.9	4.8	6.0	3.3	4.0	4.5	4.1
Space heating and cooling	2.7	2.2	2.1	1.1	0.6	0.3	0.3
Space conditioning	2.4	11.1	6.5	0.5	0.2	0.1	0.0
Refrigerator/freezer	0.9	2.4	1.5	0.9	0.5	0.6	0.7
Shower rose	2.2	6.8	4.1	1.2	0.9	0.3	0.2
Lighting	7.6	22.0	76.7	91.8	92.5	93.5	94.4
Standby power controllers	79.2	50.2	1.4	0.2	0.1	0.0	0.1
Other	0.0	0.5	1.8	1.1	1.1	0.8	0.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Sector (per cent)[2]							
Residential	98.1	93.6	87.1	87.3	40.5	10.9	13.4
Business	1.9	6.4	12.9	12.7	59.5	89.1	86.6

Notes: 1. Activity proportions for Victoria are derived from certificates register.
2. Residential and business proportions are derived from activities register.
All years are calendar years.

Source: Essential Services Commission, Register of Victorian Energy Efficiency Certificates, accessed 7 June 2018.

The first phase of the scheme targeted only the residential sector, and was dominated by lighting related activities. This comprised of replacing inefficient incandescent light bulbs with compact fluorescent lighting (CFLs). Lighting made up about 80 per cent during the first two years. Water heating related activities accounted for about 17 per cent of certificates registered with households replacing electric water heaters with gas or solar boosted water heaters.

Standby power controllers were introduced in 2011 and comprised of about 32.1 per cent of the third year of VEET. Standby power controllers are a power board that turns off the power to appliances when they are not in use, this saves energy on the residual amount of energy used for appliances on standby. The technology proved popular during the first two years of the second phase of VEET in 2012 and 2013 making up 79.2 per cent and 50.2 per cent of the scheme respectively. In response to criticism about the actual impact of standby power controllers, the activity was reviewed by the Essential Services Commission and standby power controller abatement factors were discounted by 55 to 62 per cent[1] in late 2013. Since then, standby power controllers have only been a marginal activity.

The late second phase saw a return to lighting based activities in the residential sector with 22 per cent of the scheme in 2013 and 76.7 per cent in 2014. The 2015 transitional year was heavily dominated by lighted related activities, with these making up 90 per cent of the scheme for the year. Within the lighting category, the most popular was the replacement of halogen downlights with LED downlights, by itself this single activity made up 75 per cent out of the total scheme for the year. 2016 and 2017

1 *Information Bulletin – Adjustment to abatement factors for advanced AV and IT standby power controllers (06/09/2013),* Essential Services Commission.

have been increasingly concentrated in lighting. Since 2015 around 93 per cent of the scheme was related to lighting.

The second phase also expanded VEET to include the small business sector. Most residential activities were offered to businesses as well. There are currently a few exclusive activities for businesses including replacing refrigerated display cabinets and commercial lighting upgrades. Business represents an increasing proportion of total certificates with almost 13 per cent of the total in 2015.

In 2016, the commercial sector has made significant gains especially for replacement lighting. According to the activities database, the commercial sector in 2017 made up around 89 per cent of the scheme, and 87 per cent in 2018 to date. The significant uptake of commercial lighting in VEET is due to favourable revisions in 2016 to the methodology to calculate deemed savings, which in turn leads to a greater financial incentive for installers.

Table 6.2 provides an indication of the proportion of scheme total certificates created within the United Energy Distribution region. The Victorian distributors were allocated according to the postcodes within each network using the activities data.

The United Energy Region makes up around 25 per cent of certificates registered on average over the past 5 years. United Energy had below average years in 2010 and 2011 when lighting was the main activity, and an above average certificate creation in 2015 to 2018 when lighting has been the dominant activity and the scheme has shifted toward the business sector. The United Energy Region has tracked total Victorian trends quite closely with most of the scheme standby power controllers and lighting.

Table 6.2 Overview of Victorian Energy Efficiency Target, United Energy region

Year	2012	2013	2014	2015	2016	2017	2018
Victoria actual certificates	8,709,273	5,232,139	3,447,179	5,266,491	7,858,517	7,820,645	2,893,391
Victoria target certificates	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,900,000	6,100,000
Activity category (per cent of Victoria)[1]							
Water heating	0.6	0.5	0.8	0.5	0.3	0.4	0.3
Space heating and cooling	0.1	0.2	0.2	0.2	0.1	0.1	0.1
Space conditioning	0.7	2.5	0.8	0.1	0.0	0.0	0.0
Refrigerator/freezer	0.2	0.3	0.3	0.1	0.1	0.1	0.1
Shower rose	0.3	0.9	0.6	0.3	0.1	0.0	0.1
Lighting	2.0	5.2	18.0	25.3	24.6	22.7	27.7
Standby power controllers	18.6	11.3	0.1	0.0	0.0	0.0	0.0
Other	0.0	0.2	0.3	0.3	0.2	0.1	0.0
United Energy certificates (per cent of Victoria)	**22.4**	**21.0**	**21.1**	**26.8**	**25.3**	**23.4**	**28.4**
Sector (per cent)[2]							
Business	0.4	1.3	3.3	3.0	16.2	21.4	25.6
Residential	22.0	19.8	17.8	23.7	9.1	2.0	2.7
United Energy certificates (per cent of Victoria)	**22.4**	**21.0**	**21.1**	**26.8**	**25.3**	**23.4**	**28.4**

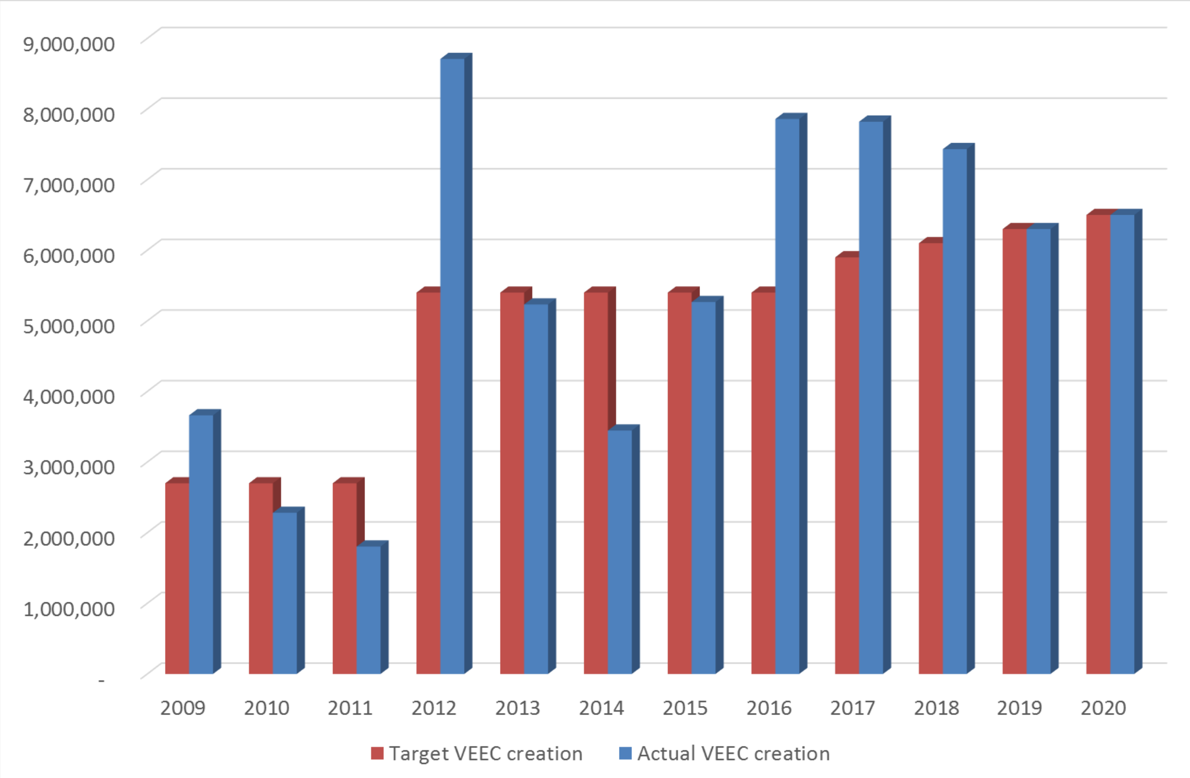
Notes: 1. Activity proportions for Victoria are derived from certificates register.
2. Residential and business proportions are derived from activities register.
All years are calendar years.

Source: Essential Services Commission, Register of Victorian Energy Efficiency Certificates, accessed 6 June 2018.

Post-modelling adjustments for VEET

Figure 6.1 contains the evolution of actual and target certificate creation from 2009 to 2020. On average, surplus and deficit certificate creation are intended to balance each other out with surplus certificate creation able to be applied against future VEET liabilities for relevant entities. As such, it is assumed that actual certificate creation meets target certificate creation over the forecast 2019 to 2020 period, and certificates are expected to be slightly above target in 2018.

Figure 6.1: Victorian Energy Efficiency Certificates – Actual and Target (number)



Source: Essential Services Commission, NIEIR.

The VEET model is structured around the certificates created by the current and past 40 energy efficient activities. The first stage of the model forecasts an unconstrained future level of certificate generation for years 2017 to 2020 based on trend analysis of the past certificates registered by activity. These linear estimates serve as the starting point to reallocate certificates based on likely future trends that include, saturation effects, ramping up of new activities, closure of old activities and an increasing proportion of business related activities. These are constrained to target so there is no under or over supply of certificates.

Each VEET activity generates Victorian Energy Efficiency Certificates (VEECs), which are deemed, these are equivalent to the total CO_2-e the activity is expected to save over the energy efficient activity's useful life. One VEEC is equivalent to one tonne of CO_2-e abatement. The second stage of the model estimates the Victorian energy impacts by converting the forecast number certificates into electricity saved per annum. These include:

- proportion of the activity that leads to electricity savings (rather than gas);
- certificates are translated into energy savings at a rate of 963 tonnes of CO_2-e per GWh;

- total lifetime theoretical energy savings are divided by years the activity is expected to last; and
- annual new energy savings are discounted by around 50 per cent on average to account for rebound, compliance, additionality and actual in use considerations.

The third stage of the model estimates peak demand impacts by deriving average demand impacts from assumed annual running hours. A distribution of the proportion of these energy efficient technologies running at peak is used to derive the demand impacts.

Total energy and peak demand post-modelling adjustments are taken by summing all of the activities over each year.

The future energy impacts are currently estimated to be greater than the impacts on summer peak demand. This is because most of the scheme is lighting related. Most residential lighting will not be in use on a summer afternoon when peak demand occurs. In the residential sector, a small amount of lighting is assumed to remain switched on in peak of around 8 per cent, while a greater amount of lighting remains on in the commercial sector at 25 per cent. Other parts of the scheme relate to activities that are outside of summer peak times also – such as water heating (displacing off peak electricity) and space heating (winter).

United Energy specific impacts are derived for each activity from the Victorian totals by using the mapped activities by distributor region.

Table 6.3 VEET post-modelling adjustment for peak demand (MW)

	Victoria		United Energy		
Calendar year	Annual impact	Cumulative impact	Annual impact	Cumulative impact	Effective annual proportion of Victoria
2019	32.0	32.0	7.05	9.02	22.0%
2020	30.6	62.6	7.11	17.24	23.3%
2021	15.6	78.2	3.63	21.43	23.3%
2022	0	78.2	0	21.43	0
2023	0	78.2	0	21.43	0
2024	0	78.2	0	21.43	0
2025	0	78.2	0	21.43	0
2026	0	78.2	0	21.43	0
2027	0	78.2	0	21.43	0
2028	0	78.2	0	21.43	0
2029	0	78.2	0	21.43	0
2030	0	78.2	0	21.43	0

6.3 Plug-in electric vehicles

There are three types of electric vehicles available to purchase in Australia. These include:

- Hybrid Electric Vehicles (HEV);
- Battery Electric Vehicles (BEV); and
- Plug-in Hybrid Electric Vehicles (PHEV).

Hybrid electric vehicles have been available since the early 2000s and combine the use of an internal combustion engine as well as an electric engine for propulsion. HEVs have improved fuel efficiency by utilising techniques such as regenerative breaking to store and power the electric engine. These do not place any additional load onto electricity networks as they do not plug-into a charger for electricity as it is internally generated.

Battery Electric Vehicles use only an electric engine for propulsion by using stored electricity from a battery pack. These need to plug-into a charger. Plug-in Hybrid Vehicles combine both an electric and an internal combustion engine, but are able to charge their batteries by plugging in. Both of these also make use of fuel efficient techniques to capture waste energy (braking, idling etc.). Collectively these are known as Plug-in Electric Vehicles (PEVs).

The PEV market in Australia is currently a very small niche within the car market. While future penetration still remains uncertain, PEVs do have the potential to have a substantial impact on energy sales and peak demand.

Hydrogen Fuel Cell Electric Vehicles are also starting to go on sale with the Hyundai Tucson Fuel Cell introduced into the US in 2015. These could displace some demand for clean vehicles that would otherwise be taken by PEVs. In 2018, PEV technology seems to be the dominant clean vehicle technology.

6.3.1 The market for plug-in electric vehicles

The global stock of PEV's increased by around 57 per cent in 2017 as global sales reached around 1.1 million vehicles. The global stock of electric vehicles is now estimated to be over 3 million on the road at the end of 2017, up from around 2 million by the end of 2016[2].

China was once again the highest selling PEV market with around 580,000 PEVs sold in 2017. Collectively, Europe is the second highest selling market with about 275,000 sold in 2017, followed by the US with around 200,000 PEV's. Most jurisdictions had increasing sales levels in 2017 over 2016.

Sales in these markets are driven largely by non-economic factors with most major markets continuing to be supported by government incentives and programs. Reasons for early adoption of PEV's include:

- generous government incentives that reduce the costs of ownership (USA). The USA offers incentives that reduce the cost premium of PEVs, and some states also subsidise private charging infrastructure; and
- concern over air quality, urban pollution and a means to reduce carbon emissions (China, California).

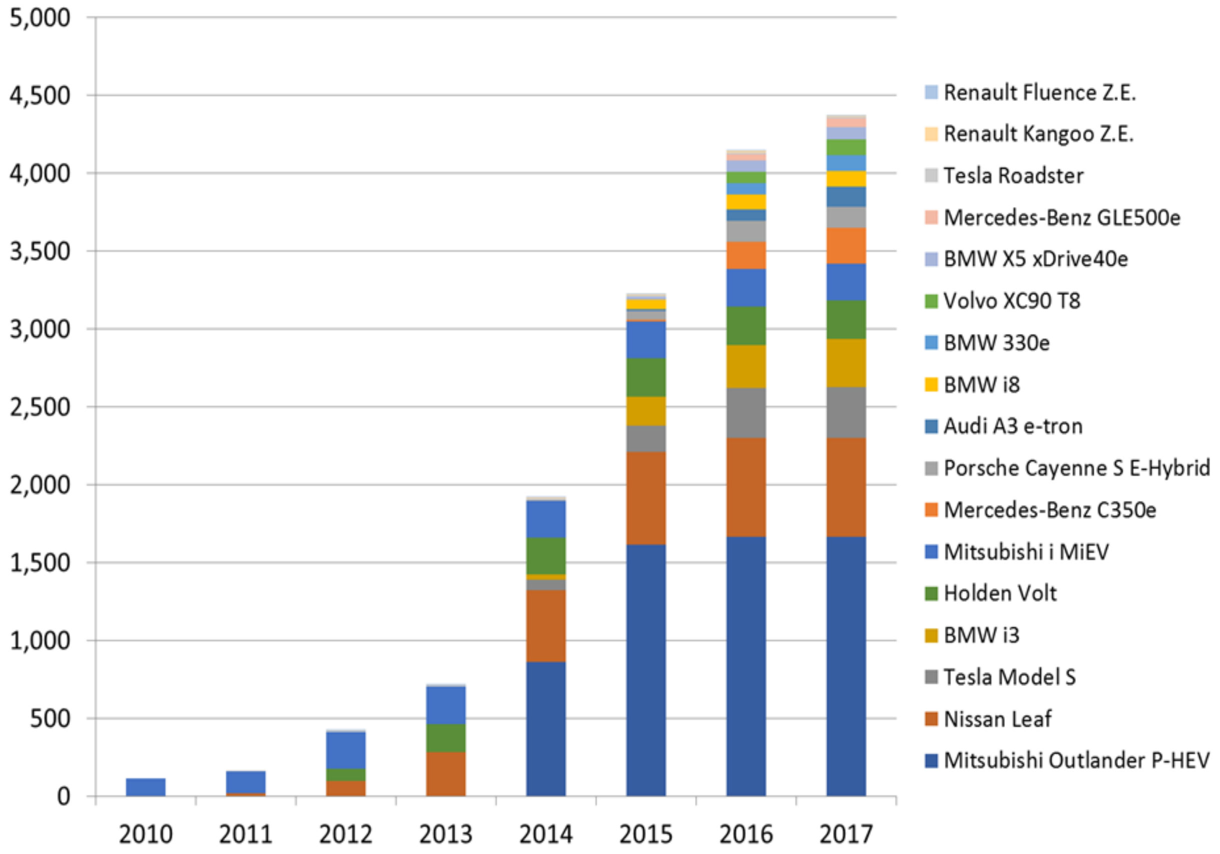
[2] Global EV Outlook 2018:Towards cross-model electrification, International Energy Agency (2018).

By comparison Australia represents only a very small proportion of on road plug-in electric vehicles. By the end of 2017 there were only about 6,500 PEVs sold to date. The market however is shifting toward the luxury niche rather than directed toward the mass market as early models have been. Luxury brands include Tesla, BMW, Mercedes, Porsche and Audi. Many of the Model S vehicles have been sold in Victoria and New South Wales, where Tesla has focused on building the early stages of the supercharger network that connects main highways along the east coast of Australia.

Figure 6.2 summarises the cumulative sales of electric vehicles on Australian roads by the end of 2016, and into early 2017. This shows the number of PEV cars on Australian roads doubling from 2013 to 2014. The Australian market differs from the leading markets by the absence of any substantial government incentive program. However, there are small incentives available in Victoria and the ACT that reduce on road costs. Victorians are eligible for a discount on registration, and PEVs registered in the ACT are exempt from stamp duty and luxury vehicle taxes.

Over 2014 to 2016 PHEV type vehicles have accounted for around 80 per cent of plug-in electric vehicle sales, with the remaining 20 per cent being BEVs. Models introduced into Australia in recent years have continued a trend of moving toward SUV's, luxury vehicles and plug-in-hybrid rather than fully battery powered vehicles. Vehicle manufacturers have been reluctant to introduce mass market BEVs that are available internationally given the lack of local market interest and incentives. 2016 was the first year in which sales of plug in electric vehicles declined year on year, further narrowing the electric vehicle niche to the luxury market. However, by the end of 2017 PEV sales in Australia are reportably around 2,400 for the year to the end of December.

Figure 6.2: Australian cumulative sales of plug-in electric vehicles



Note: Data not available for 2018.
Source: Compiled from various sources, as of April 2017.

The on-road vehicles are currently comprised of around 60 per cent plug-in hybrid vehicles, and 40 per cent battery electric vehicles.

Table 6.4 summarises the vehicles currently available for purchase in Australia, and the range, energy consumption per kilometre and battery size for each vehicle. The cheapest PEV on the market remained the Nissan Leaf at 36,000 before on-road costs in 2017, but has since been withdrawn from the market in anticipation of the second generation Leaf expected to arrive in 2019.

Over the past two years first entrants into Australia have started to withdraw models from the market due to low sales. The Mitsubishi i-Miev stopped selling in 2014, and Holden has no plans of offering the next Volt model to Australian customers, with the last Volt sold in early 2015. The withdrawal of these vehicles provides some evidence that the small car market is too expensive for the ordinary consumer (more price elastic/income constraints), with price premiums on a Nissan Leaf to a comparable petrol car of around $15,000 to $20,000. The second generation leaf, by some reports, is expected to cost around $50,000.

Following the success of the Tesla Model S and the Mitsubishi Outlander, the majority of the new release vehicles into the Australian market over 2016 targeted the luxury car market, SUV market or both markets. This trend continues with the new models released in 2017, and expected to come in 2019 and 2020. There is little on offer for small to medium passenger commuters. Smaller cars such as the Model 3 and second generation Leaf release date has been delayed.

This suggests that the plug-in electric vehicle market will remain a niche market in the short-term catering to higher income consumers.

Table 6.5 summarises the release schedule for new plug-in electric vehicles.

Table 6.4 Summary of plug-in electric vehicles available in Australia

Make and model	Type	Release year	Wh per km	Range (km)	Battery capacity (kWh)	2015 Sale price ($AUD)[2]
Tesla Roadster	BEV	2010	231	340	53	191,888
Mitsubishi i-Miev	BEV	2010	135	150	16	48,800
Nissan Leaf	BEV	2011	173	175	24	36,000
Holden Volt	PHEV	2012	135	87	16.5	59,990
Porsche Panamera S E-Hybrid	PHEV	2013	162	36	9.4	299,200
Renault Kangoo[1]	BEV	2014	155	170	22	n/a
Tesla Model S	BEV	2014	181	390	60	91,400
Tesla Model S	BEV	2014	181	502	85	103,400 to 119,900
Tesla Model X	BEV	2016	217	467		
Mitsubishi Outlander	PHEV	2014	134	52	4.5	47,490 to 52,490
BMW i3	BEV	2014	129	190	22	63,900
BMW i3	PHEV	2014	115	170	22	69,900
BMW i8	PHEV	2015	119	37	7.1	299,000
Audi A3 e-tron	PHEV	2016	124	49	8.8	63,000
Volvo XC90 T8	PHEV	2016	182	43	9.6	129,000
Mercedes-Benz C350e	PHEV	2016	116	30	6.2	76,000
Mercedes-Benz GLE500e	PHEV	2016	167	30	6.2	125,000

Notes:
1. Renault Kangoo currently in limited trials in Melbourne.
2. If not available for sale in 2015, price is the latest new car price available. Excludes government charges and on-road costs.
3. Includes discontinued models.

Source: Model and technical details from *Green Vehicle Guide*. Sales pricing data compiled from various sources.

Table 6.5 Release schedule for new plug-in electric vehicle models			
Make and Model	**Type**	**Body**	**Timing**
Aston Martin RapidE	BEV	Sedan	2019
Audi e-tron SUV	BEV	SUV	2019
Audi e-tron Sportback	PHEV	Sedan	2020
Audi e-tron GT	PHEV	Sedan	2021
BMW iX3	BEV	SUV	2019
Hyundai Ioniq	BEV/PHEV	Hatch	2018
Jaguar I-PACE	PHEV	SUV	2018
Jaguar XJ	PHEV	Coupe	2018
Maserati GranSport	BEV	Coupe	2020
Mazda	PHEV	TBD	2019/2020
Mercedes-Benz EQ	BEV	SUV	2019
Nissan Leaf	BEV	Hatch	2019
Tesla Model 3	BEV	sedan	2019
Volkswagon e-Gold	BEV	Hatch	TBC
Volkswagon I.D.	BEV	Coupe	2020

Source: Motoring.com.au, New Car Calendar.

6.3.2 Limits of plug-in electric vehicle ownership

PEV's currently sell at a substantial premium in comparison to similar vehicles with an internal combustion engine. For example, a consumer going to purchase a small car could purchase a Nissan Leaf for $39,990 or a new Nissan Pulsar for around $20,000 to $25,000. This represents a prohibitive purchase premium of $15,000 to $20,000.

A large proportion of the purchase premium is due to the cost of battery storage technology which is expected to fall substantially over the next five years. Battery costs in Figure 6.3 compiled by Nykvist and Nilsson (2015) show an exponential decline in historical costs.[3] With the 2014 cost of storage approximately $450 USD per kWh (based on all estimates) or around $350 USD per kWh based on reported Nissan and Tesla numbers. The cost of battery storage for electric vehicles is estimated to be around $190 to $240 USD/kWh in 2018[4].

Further cost improvements could be driven by increasing interest in battery storage for stationary applications, for example, coupled with photovoltaic systems in residential or commercial sectors. A separate post-modelling adjustment is estimated to account for displaced exports during the middle of the day to charge the battery, and discharge during peak times.

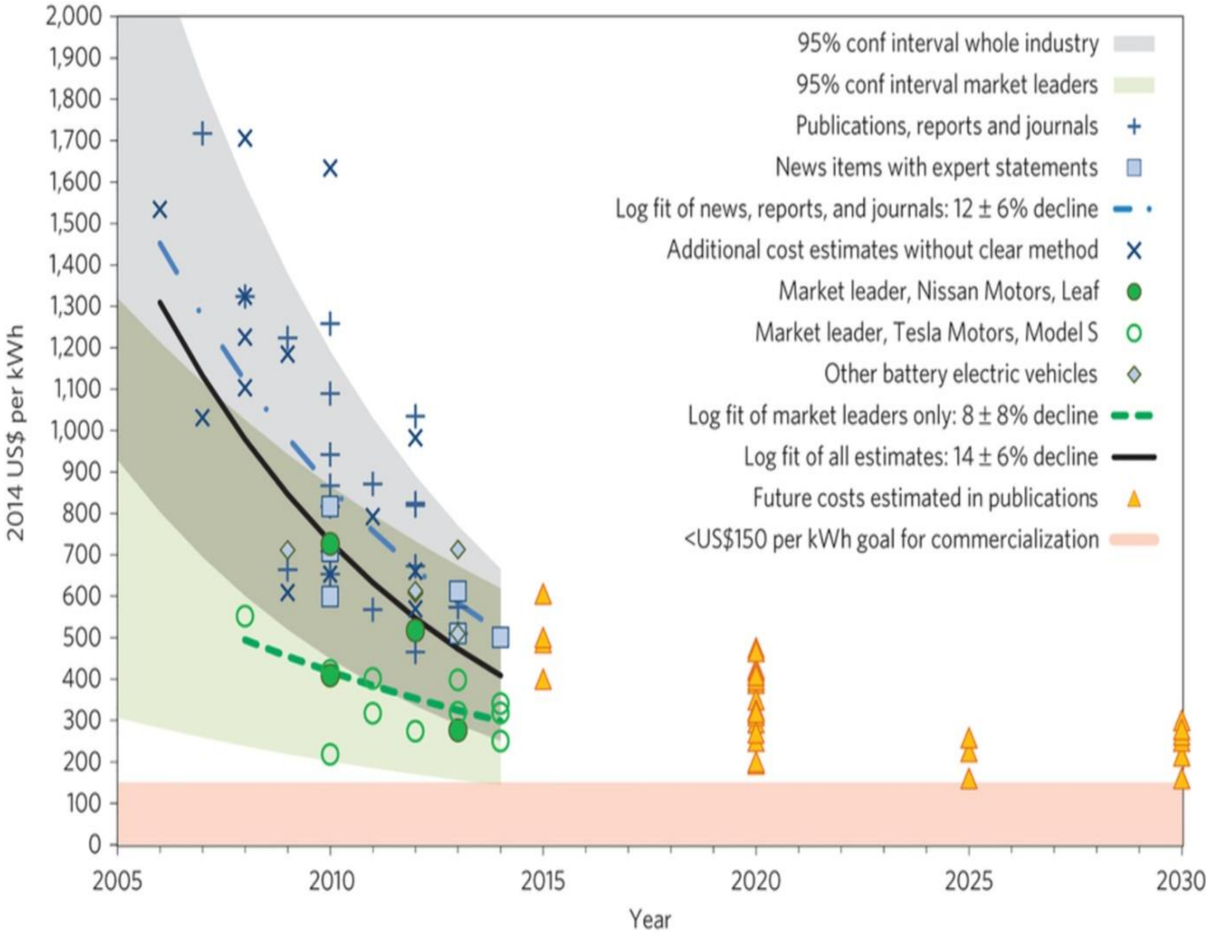
The Mitsubishi Outlander has a relatively small purchase premium in part due to the small battery pack of 4.5 kWh. However, the premium is still around $10,000 to $15,000 as the PHEV requires equipment for both electric and petrol engines.

The paybacks of an electric vehicle will also be affected by the price and source of electricity used to charge the battery. Australia has one of the highest grid prices of electricity, which acts as a barrier when compared to other countries. However, many early adopters of PEV's are also likely to have rooftop PV systems. In this case, the operational charging cost of an electric vehicle would be close to zero if it was able to be charged from electricity generated by the sun.

[3] Exponential trend may be overstated due to greater uncertainty of earlier battery costs.

[4] Global EV Outlook 2018:Towards cross-model electrification, International Energy Agency (2018)

Figure 6.3: Cost of battery storage



Source: Nykvist and Nilsson (2015), "*Rapidly falling costs of battery packs for electric vehicles*", Nature Climate Change 5 329-332.

The kilometre range of the PEVs is limited by the expense and effectiveness of current battery technology. Further distances require a larger and more expensive battery. The rated distance for a top of the range Tesla Model S is 502 kilometres, with a massive 85 kWh battery system. While the Nissan Leaf currently can achieve a total 175 kilometres from a 24 kWh battery system, which is more typical of most PEVs. The next generation of PEVs is expected to have an improved range. For example, the Chevrolet Bolt will have a range of about 300 kilometres while being more affordable than a Tesla. At this stage it is uncertain whether Holden will bring the Bolt to the Australian market.

However, the actual distance travelled from a fully charged battery is likely to be much less under real world conditions. Performance is affected by road conditions and climate controls for heating and cooling.

Other limits and barrier to penetration include:

- length of time to charge the battery;
- relative upfront and operating costs (price of oil) of internal combustion engine vehicles;
- availability of public charging infrastructure; and
- cost of installing faster private charging stations at residence.

6.3.3 Forecast uptake of plug-in electric vehicles

In the absence of any substantial government incentive, adoption of electric vehicles in Australia is limited by the cost of ownership and the purchasing preferences of Australian consumers. Wide spread adoption could be delayed until PEV's become cost competitive through market forces alone. NIEIR have downgraded the short-term forecasts to account for the lack of current sales, and concentration in the luxury market which is unlikely to change of the next couple of years. Accordingly, the PEV market is expected to remain a growing niche of the total car sales market over the next five years. Total PEV sales by 2020 are expected to account for 0.5 per cent of overall Victorian annual vehicle sales.

With the introduction of more mass market PEVs, reduced battery costs and more favourable economics, sales penetration is expected to accelerate over the 10 years following 2020. PEV sales will account for around 11.3 per cent of total sales by 2030. In Victoria, annual sales are expected to increase from around 379 in 2017 toward 47,730 per annum by 2030.

The fleet of Victorian plug-in electric vehicles on road will reach 164,870 by 2030 or about 1.22 per cent of Victoria's vehicle fleet. PEV's are assumed to have an average life of around 10 years.

Over the short term, PHEVs are assumed to be the most popular type of electric vehicle sold. Most new models to be released over 2016, with the exception of Tesla vehicles, are PHEVs. PHEVs may help alleviate consumer concerns about the current limited electric range. As battery technology becomes more competitive, and more mass market BEVs are released, the share of BEV and PHEV will be balanced.

Due to favourable travel economics there is expected to be increased penetration into light commercial and taxi vehicle types. As these vehicles have higher annual travel kilometres, and the more one travels the greater the realised running cost savings (savings on maintenance and repairs, and fuel cost compared to petrol engines).

Table 6.6	Plug-in electric vehicle market – Sales and stock of battery electric vehicles and plug-in hybrids vehicles, Victoria								
	VIC New vehicle sales	Sales penetration - BEV	Sales penetration - PHEV	Sales penetration - Total PEV	Annual sales - BEV	Annual sales - PHEV	Total PEV sales	Total PEV stock	PEV share of VIC vehicle stock
	number	per cent	per cent	per cent	number	number	number	number	per cent
2018	332,342	0.03	0.08	0.13	114	265	379	2,127	0.01
2019	339,747	0.09	0.20	0.28	290	678	968	3,095	0.02
2020	347,152	0.16	0.30	0.46	561	1,043	1,604	4,698	0.03
2021	354,557	0.21	0.39	0.60	738	1,371	2,110	6,805	0.04
2022	361,961	0.33	0.61	0.94	1,185	2,200	3,384	10,184	0.06
2023	369,366	0.53	0.53	1.06	1,962	1,962	3,925	14,099	0.10
2024	376,771	0.68	0.68	1.36	2,562	2,562	5,124	19,207	0.14
2025	384,176	0.82	0.82	1.64	3,152	3,152	6,303	25,484	0.19
2026	391,580	1.46	1.46	2.92	5,709	5,709	11,417	36,839	0.28
2027	398,985	2.31	2.31	4.62	9,208	9,208	18,416	55,111	0.42
2028	406,390	3.37	3.37	6.74	13,697	13,697	27,393	82,193	0.62
2029	413,795	4.43	4.43	8.87	18,343	18,343	36,686	118,266	0.89
2030	421,200	5.67	5.67	11.33	23,865	23,865	47,730	164,870	1.22

6.3.4 Grid impacts for plug-in electric vehicles

Estimates of annual energy requirements are achieved by applying annual travel kilometres and energy requirements per kilometre to the stock of PEVs.

Annual energy consumption for the PEV fleet depends upon the annual travel characteristics of Victorian electric vehicle users. Victorian annual travel characteristics were taken from the ABS (2015) *Survey of Motor Vehicle Use.* Most of the travel is assumed to be around capital cities, rather than interstate and regional. An extensive fast charging network may change this dynamic. Tesla has already begun building an east coast network that contains superchargers along major interstate highways.

PEV's are rated by the *Green Vehicle Guide* in terms of the energy requirement per kilometre. Forecasts of on-road energy usage for BEV and PHEV types were developed by applying results from trials and simulations to the tested ranges from the *Green Vehicle Guide*. Forecasts include an efficiency improvement of around 1 per cent per annum.

Summer maximum demand impacts are estimated by applying a weighted average demand for PEV chargers to the number of electric vehicles charging at summer or winter peak demand. These are informed by current and future charger availability and use. The following assumptions apply to public and private charging stations:

- public weighted average charging: 14.6 kW; and
- private weighted average charging: 4.1 kW.

NIEIR have developed theoretical intra-daily profiles of PEV charging by private or public/workplace locations. These are informed by trial results, and literature on electric vehicles.[5] Robinson et al (2013) found in a trial involving data from 7,704 vehicles that there was minimal charging during off peak hours (time-of-use tariffs were available in region).

Collectively, load from privately owned PEVs is expected to peak during the early evening when people return home from work, and a smaller secondary peak mid-morning when arriving at work.

Electric vehicles can either charge at a public/workplace location or at a private residence. Public and workplace charging stations have the capability of achieving a much higher demand, and faster charge. Fast chargers of up to 50 kW are available to use. Maximum for a private residence is around 7 kW that would require additional charging infrastructure installed in the garage or the side of a house.

The percentage of plug in electric vehicles charging at system peak varies with the mix of vehicle types and sectoral use of vehicles. Over 2016 to 2027, between 10 and 11 per cent are charging at the time of summer peak demand.

[5] For example, AusGrid –Smart Grid, Smart City and "Analysis of electric vehicle driver recharging demand profiles and subsequent impacts on the carbon content of electric vehicle trips" by Robinson et al (2013).

Table 6.7	Post-modelling adjustments for plug-in electric vehicles, Victoria and United Energy			
	Annual energy (GWh)		Maximum demand (MW)	
Year	Victoria	United Energy	Victoria	United Energy
2019	11	2.6	2.3	0.6
2020	16	3.9	3.7	0.9
2021	24	5.7	5.7	1.4
2022	35	8.5	9.0	2.2
2023	48	11.6	13.1	3.1
2024	65	15.6	17.3	4.2
2025	86	20.6	23.1	5.5
2026	123	29.6	33.4	8.0
2027	183	44.0	50.1	12.0
2028	273	65.4	74.8	18.0
2029	392	94.0	107.7	25.9
2030	545	130.8	124.4	29.9

6.4 Minimum Energy Performance Standards for air conditioners

In 2014, as can be seen in Table 6.8 below, 78.4 per cent of households reported having at least one space cooler in use, up from 75.5 per cent in 2011, 69.5 per cent in 2008 and 60.1 per cent in 2005. Over the next ten years, penetration could continue to increase.

Many households now have more than one air conditioner unit which are now mainly reverse cycle units which can also be used for space heating. On this basis (more than one unit per household), the overall penetration could exceed 100 per cent.

Table 6.8 Coolers in dwellings

	Per cent of household with cooler, Victoria
1994	36.9
1999	43.5
2002	52.9
2005	60.1
2008	69.5
2011	75.5
2014	78.4

Source: ABS Catalogue No. 4602.0.55.001, from Table 4.11, page 63

ABS 4602.0, 2011, also reports that space cooling periods have increased from 59.1 per cent reporting cooling use of less than 1 month in 2002 to only 13.7 per cent reporting cooling use of less than 1 month in 2008, while use for 1-3 months increased to 45.4 per cent in 2008 from 30.9 per cent in 2002. That is, as well as maximum demands increasing, annual energy use of air conditioner units is also increasing.

ABS 4602.0, 2011, also reports that space cooling periods have increased from 59.1 per cent reporting cooling use of less than 1 month in 2002 to only 13.7 per cent reporting cooling use of less than 1 month in 2008, while use for 1-3 months increased to 45.4 per cent in 2008 from 30.9 per cent in 2002. That is, as well as maximum demands increasing, annual energy use of air conditioner units is also increasing.

Note also that the dominant air conditioner units sold are reverse cycle air conditioners which can be, and are increasingly, used for space heating in apartments and small townhouses. Efficiencies of air conditioning units have been improving over the past 15 years.

The main policy tools used to achieve reductions in energy use from these products are mandatory Minimum Energy Performance Standards (MEPS) and Energy Rating Labels. Energy rating labels were first implemented in 1987 for air conditioners and developed through the 1990s and steadily upgraded and extended to a greater range of appliances and products. MEPS have been in place for residential air conditioners since 2004 and since 2001 for large three phase air conditioners that are used mainly for non-residential purposes.

Since October 2012, Australia's Greenhouse and Energy Minimum Standards (GEMS) legislation has commenced under the Equipment Energy Efficiency (E3) program.[6] Under the new legislation, the Australian GEMS Regulator will replace state regulators in enforcing regulations and creates a national framework by replacing seven overlapping pieces of state legislation within the Equipment Energy Efficiency (E3) framework. This framework aims to provide enhanced monitoring, verification and enforcement, as well as allowing the scope of the previous energy efficiency improvement initiatives to be expanded.

Regulatory requirements for air conditioners and heat pumps are set under the GEMS Determination 2013, this Determination came into force from 1 April 2014. This Determination will regulate multi-split air conditioners and heat pumps for the first time by calling up requirements set out in AS 3823.2-2013.

Latest MEPS actions are[7]:

- **1 October 2011:** More stringent MEPS, as defined within AS/NZS 3823.2 – 2011, for all applicable products except ducted systems (from 10 kW to <19 kW, both single and three phase); and
- **1 April 2012:** More stringent MEPS, as defined within AS/NZS 3823.2 – 2011, for ducted systems (from 10 kW to <19 kW, both single and three phase).

In early 2016, a Regulatory Impact Statement (RIS) was released outlining potential new MEPS and zoned energy rating labelling for air conditioners. New MEPS under consideration for portable air conditioners and evaporative coolers, which are currently not subject to standards. The introduction of MEPS on portable air conditioners could suppress growth in air conditioner loads in the low income and rental markets. However, potential impacts are likely to be small.

Further regulatory restrictions for air conditioners are expected to be introduced around April 2019 as a result of the 2016 RIS consultation process. A draft determination for air conditioners up to 65 kW was released in March 2018 with revised MEPS.

6.4.1 Energy efficiency improvements in air conditioners

A separate post-modelling adjustment for MEPS for air conditioners has not been exogenously estimated, as the schedule of MEPS has now run over 10 years and should be captured in historical data trends. Furthermore, the continued efficiency improvement in air conditioners is directly incorporated into the temperature sensitive load forecasts of maximum demand.

As a part of the E3 program, appliance data is available from the energy rating website of which the energy efficiency ratio (EER) was extracted. The EER is used to measure a units cooling output to input, and a time series was constructed back to 2004 to use for forecasting. Figure 6.4 gives an example of one particular class of air conditioner, a non-ducted split system with a 0 to 4 kW output. This shows how the energy efficient ratio (EER) and coefficient of performance (COP) have evolved over time and in response to the introduction of more stringent MEPS standards (highlighted in yellow).

Over 2004 to 2012, there was a significant increase in the average energy efficiency of these smaller units. Since 2012, energy efficient improvement has been slower. Generally, energy efficient gains have been the most pronounced for smaller system sizes than larger system sizes. Most classes of air conditioner that are subject to MEPS follow a similar energy efficiency improvement path as in the

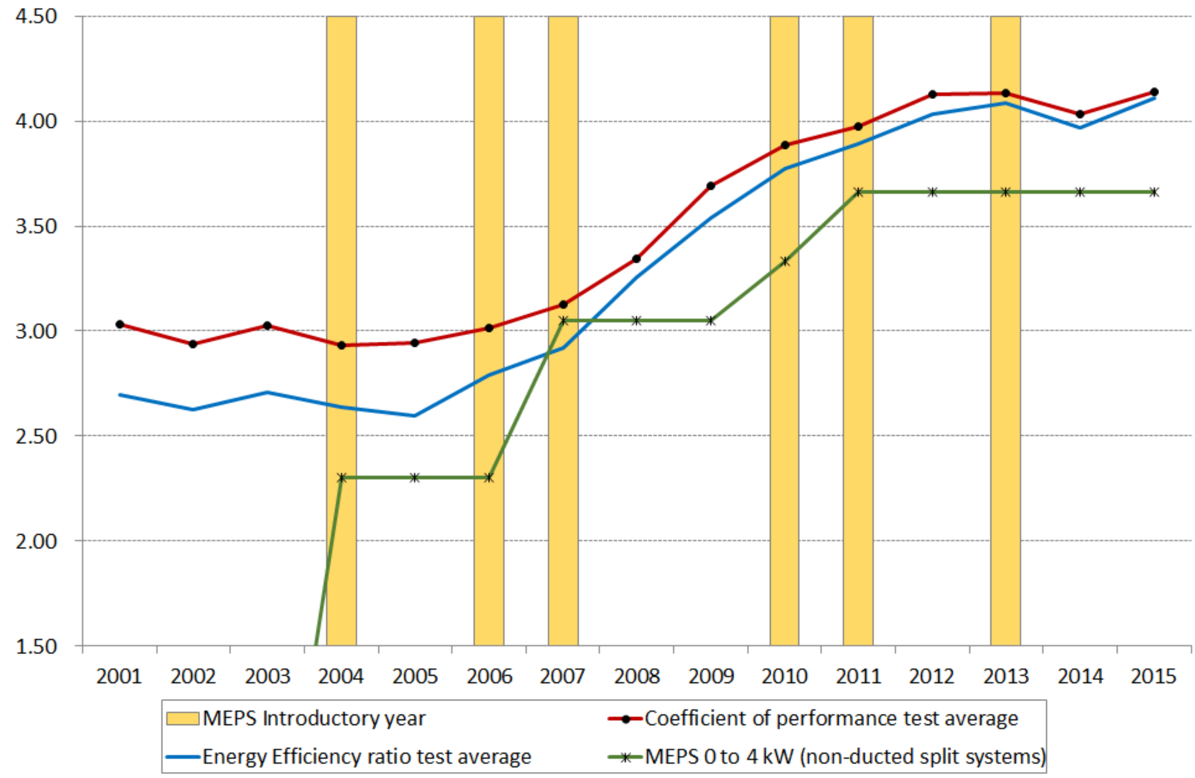
---

[6] E3 is a joint initiative of the Australian Commonwealth, State and Territory Governments and the New Zealand Government.

[7] A summary of current MEPS requirements for air conditioners can be found on http://www.energyrating.gov.au/products-themes/cooling/air-conditioners/meps/.

example in Figure 6.4. Further analysis in 2017 reveals that efficiency gains on new model air conditioners remain modest.

Figure 6.4: Efficiency of non-ducted split systems 0 to 4kW



Source: energyrating.gov.au

6.5 Building lighting

Since 2000 compact fluorescent lamps (CFLs) have been penetrating Australian residential lighting markets and fluorescent fittings of higher energy efficiency have been penetrating business (commercial, industrial) markets. This lighting energy efficiency improvement has accelerated since 2006. In 2010 imports of most incandescent lamps were banned (some speciality incandescents, <40W, were exempt) and higher efficiency lamps (CFLs, later LEDs) were subsidised in New South Wales (from 2006), Victoria and South Australia from 2009 under "white certificate" programs. New energy efficient lighting continues to improve in price, making it an attractive low cost option for energy savings.

Table 6.9 contains a summary of the schedule of lighting sales restrictions in place since 2009. The *LED lighting Product Profile* also contains a proposed schedule over 2017 to 2018 to phase out more types of incandescent/halogen lamps.

Table 6.9 Phase out of inefficient lighting in Australia

Lamp type	Sales restriction from
Tungsten filament incandescent general lighting service (GLS) light bulbs. Extra low voltage (ELV) halogen non-reflector lamps. Self-ballasted compact fluorescent lamps (CFLs).	1 November 2009
Greater than 40W candle, fancy round and decorative lamps. ELV halogen reflector lamps (the average measured wattage shall be no more than 37W – effective 14 April 2012).	1 October 2010
Mains voltage halogen (MVH) non-reflector lamps (until 30 September 2016, when tested in accordance with AS/NZS 4934.1, MVH non-reflector lamps may comply with a reduced initial efficacy requirement).	1 January 2011
Greater than 25W candle fancy round and decorative lamps.	1 October 2012

Source: energyrating.gov.au.

Table 6.10 shows the improvement in input (W) across technologies given a fixed level of lighting output (lumens).

Table 6.10 Comparison of lighting technologies

	Power (watts)			
Output (lumens)	Incandescent	Mains Voltage Halogen	CFL	LED
250	25	18	4 – 6	3 – 4
500	40	28	7 – 9	5 – 8
800	60	42	11 – 14	8 – 12
1100	75	52	14 – 17	11 – 17
1500	100	70	19 – 23	15 – 23

Source: energyrating.gov.au.

E3 continues to pursue further options to improve standards for lighting. In late 2015, E3 released *Commercial Lighting Product Profile* and *LED lighting product profile* with the intention of producing a Regulatory Impact Statement (RIS) in the near future.

The *Commercial Lighting Product Profile* mentions a number of policy options to increase or improve MEPS for commercial lighting in 2 to 3 years, these include increasing MEPS on linear fluorescent lights and introducing new MEPS for circular fluorescent lights. Although lighting represents a large proportion of commercial end-use, E3 estimates relatively small impacts from policy action with an increase on MEPS for linear fluorescent lights worth 11.1 to 47.5 GWh per annum depending on the action. In Victoria, this would amount to around 2.5 to 11 GWh per annum.

Introduction at this stage remains uncertain and subject to a future RIS. If current trends continue in VEET, any adjustment due to commercial lighting will likely be covered by this program.

The *LED Lighting Product Profile* recognises that there are still significant opportunities to reduce end use lighting energy consumption in the residential sector by encouraging the adoption of LED lighting in place of remaining incandescent and halogen lights. E3 estimate a 91.8 kWh saving per Australian household under a scenario with households having 75 per cent LED lights.

Following on from these reports E3 have released a regulatory impact statement in November 2016 *Consultation Lighting Regulation Impact Statement* which forms the basis of future action on lighting efficiency improvement. Potential pathways for lighting include:

- the introduction of MEPS for LEDs, integrated luminaires or non-integrated commercial luminaires;
- Increasing current MEPS on incandescent and halogen lighting; and/or
- Introduce mandatory labelling for residential lighting.

The continue introduction of energy efficient lighting is likely to only have a minimal impact of United Energy summer maximum demand.

6.6 Demand response

Demand response programs are designed to reduce consumer demand (kW) during peak intervals. The first common type of demand response programs offer incentives to individual customers to reduce their electricity demand during peak intervals. Incentives could be in the form or price signals or financial payment. The second common type of demand response program uses technology, such as smart meters or smart controllers, to temporarily reduce customer load during peak times. Technology based solutions may or may not offer incentives to customers to load reduction.

The Australian Renewable Energy Agency together with AEMO have awarded funding to ten pilot projects in New South Wales, Victoria and South Australia. Together these programs are expected to make available 200 MW in capacity savings during peak periods by 2020, with up to 143 MW available in summer 2019 during peak periods.

ARENA and AEMO have awarded funding to a diverse range of projects that have been initiated by distributors, retailers, and technology companies. These projects have a diverse set of customers that cover residential, commercial and industrial customer classes.

Table 6.11 summarises the ten pilot projects across Australia, with the Victorian projects of particular relevance to the United Energy demand forecasts.

Table 6.11 ARENA funded demand response pilot programs

Project	State	Funding ($million)	Details
AGL	NSW	5.25	Measures for retail customers – residential, commercial and industrial.
EnergyAustralia	NSW	3.94	Measures for retail customers – residential, commercial and industrial.
EnerNOC	NSW	3.6	Industrial and commercial customers load reduction.
Flow Power	NSW	2.64	Smart controller for 95 commercial and industrial customers.
United Energy Distribution Pty. Ltd.	VIC	5.76	Voltage reduction at substations, using substation and customer smart meters.
EnerNOC	VIC	5.4	Industrial and commercial customers load reduction.
Powershop Australia Pty. Ltd.	VIC	0.995	Incentives to reduce load for retail customers.
EnergyAustralia	VIC and SA	6.93	Measures for retail customers – residential, commercial and industrial.
Zen Ecosystems	VIC and SA	1.96	Thermostat to control heating and cooling load for commercial and residential buildings.
Intercast & Forge	SA	0.323	Single industrial customer of metal castings. Power down furnaces during peak intervals.

Source: ARENA, https://arena.gov.au/blog/demand-response-4/.

Demand response impact at UE peak demand

Table 6.12 contains the estimated post-modelling adjustment required for the United Energy summer peak demand.

The MW reduction was estimated for each project at the Victorian level taking into account:

- the targeted MW demand response capacity of each program for Victoria only;
- current and forecast customer numbers of the retailers;
- customer take-up and potential average load reduction per customer; and
- coincidence to the United Energy summer peak demand.

The United Energy specific impacts for the United Energy demand response program were provided to NIEIR by United Energy.

Table 6.12 Victorian potential and UED estimated demand response (MW)

	Victorian total potential demand response (MW)		
Project	**2019**	**2020**	**2021**
United Energy Distribution	21.0	30.0	30.0
EnerNOC	19.5	19.5	19.5
Powershop Australia	5.0	5.0	5.0
EnergyAustralia	18.0	18.0	18.0
Zen Ecosystems	7.5	11.3	11.3
Total	**71.0**	**83.8**	**83.8**
	United Energy demand response at summer peak demand (MW)		
Project	**2019**	**2020**	**2021**
United Energy Distribution	11.5	12.2	13.1
EnerNOC	3.8	3.8	3.8
Powershop Australia	0.5	0.6	0.6
EnergyAustralia	3.2	3.1	3.1
Zen Ecosystems	1.5	2.2	2.2
Total	**20.5**	**21.9**	**22.8**

6.7 Small-scale photovoltaics and battery storage

United Energy provided NIEIR with monthly data on small and large-scale solar covering customer numbers and panel capacity (kW). NIEIR have also independently obtained small-scale solar installations and panel capacity by postcode from the Clean Energy Regulator. This data was mapped into the United Energy region and used as a comparative data set to data previously provided by United Energy. Due to limitations from United Energy's current database on solar installations, the CER mapped postcode data was used.

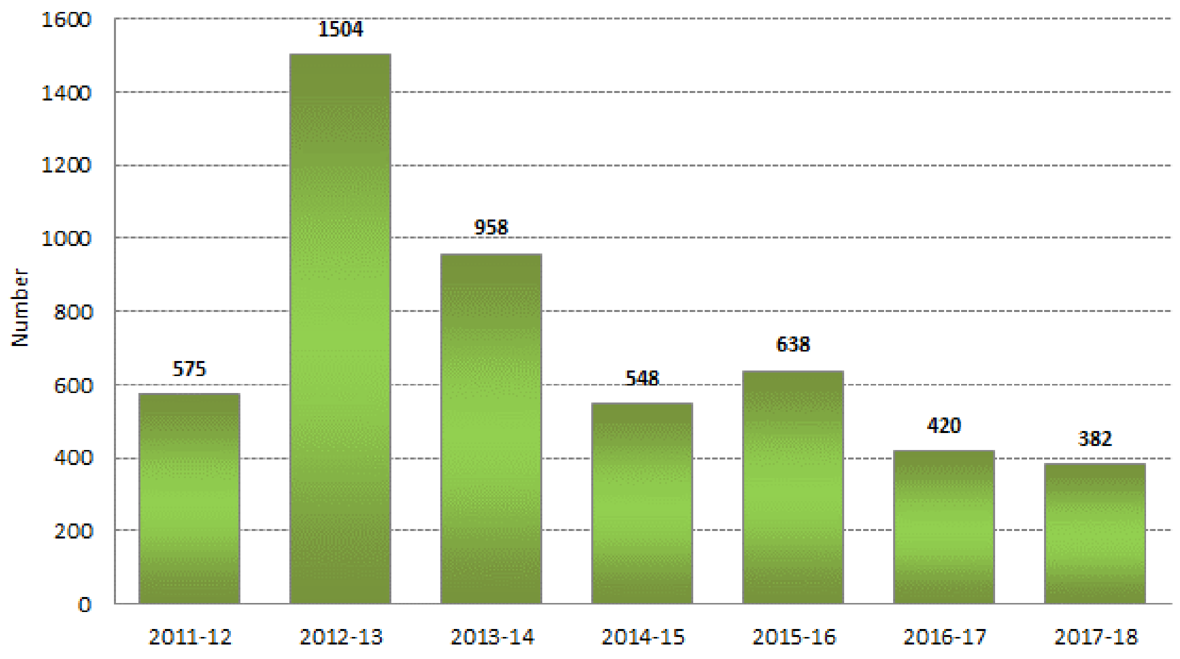
For previous work in 2014, NIEIR received additional data on PV from the revenue section of the business covering PV capacity and customer numbers by network tariff. This data allowed a residential and business split of the PV data.

Forecasts of PV installations in the United Energy region were developed using a model that takes into account:

- the payback period for typical PV installations under alternative RET multipliers and/or Feed-in-Tariffs for PV and their costs; and
- non-price factors, such as socioeconomic variables, including age distribution, urban density, retirees, home ownership and rental, etc.

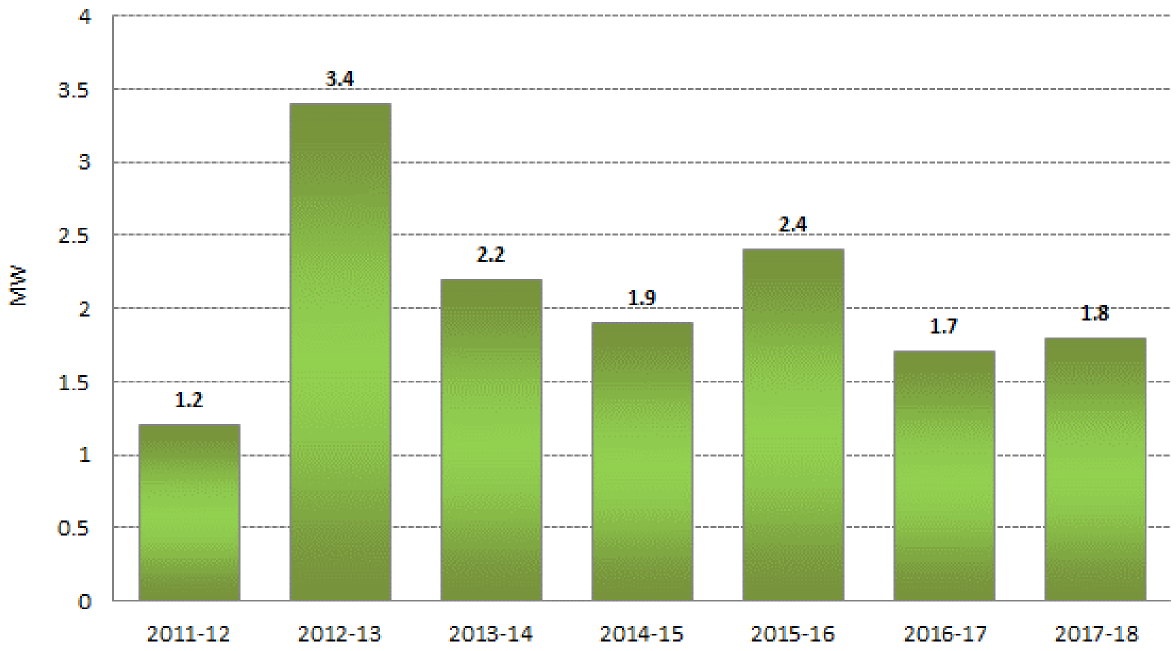
PV take-up rates in the United Energy distribution region have remained stagnant over the past two years. This reflects a number of factors, including the abolition of RET multipliers, lower feed-in-tariffs, and a curtailment in the fall in installed costs. In 2014 NIEIR estimated the payback for a 1.5 kW system was around six years. Monthly installation rates in the UED distribution area were close to 1,500 systems in 2012-13, 960 in 2013-14, and have fluctuated around 400 to 600 installations per month since 2013-14. Figure 6.5 shows historical installation rates for PV in the UED distribution area.

Figure 6.5: Monthly PV installations – UED distribution area (number)



Source: United Energy.

Figure 6.6: Monthly PV installations – UED distribution area (MW)



The assumed installation rates for each scenario are summarised below.

- For the Base scenario, the monthly PV installation rate is 400 per month in 2018-19 and, falling to 360 per month by 2020-21 but rising back to 380 per month by 2026-27.
- For the High scenario, the monthly PV installation rate rises to 450 per month by 2018-19, reaching 540 per month by 2020-21 and falling to 525 by 2021-22 and 480 by 2026-27.
- For the Low scenario, the monthly PV installation rate initially drops to 285 installations per month and gradually falls to 220 per month by 2021-22 and down to 200 by 2026-27 and to 180 by 2028-29.

Table 6.13 summarises the key modelling assumptions for United Energy.

Table 6.13 Key PV modelling assumptions – United Energy		
1. Energy assumptions (number)		
Average generation/kW (KWhs generated per installed kW)		1,267
In-house usage (kWhs per kW installed)		866
2. Peak demand assumptions (per cent)		
Discount (per cent) for inverter/panel size mismatch		20
Discount (per cent) for availability of PV output at maximum demand		70

The key uncertainties regarding PV penetration in Victoria are:

- future PV system costs relative to electricity prices (these could increase or reduce paybacks);
- possible introduction of new Solar Bonus type schemes; and
- potential changes to RET and the introduction of battery storage.

Table 6.14 United Energy: Base scenario – Small-scale PV

Calendar years	All PV customers (number)	Capacity (kW)	Average capacity (kW)	Own-use (GWh)	Exports (GWh)	Total (GWh)	Impact on summer peak demand (MW)
2014-15	43862	113344	2.6	87.8	37.6	125.5	27.2
2015-16	51804	147224	2.8	115.5	49.5	165.0	35.3
2016-17	57184	179598	3.1	144.9	62.1	207.0	43.1
2017-18	62153	212144	3.4	173.7	74.4	248.1	50.9
2018-19	67337	238428	3.5	199.8	85.6	285.4	57.2
2019-20	72521	265024	3.7	223.2	95.7	318.9	63.6
2020-21	77201	289846	3.8	246.0	105.4	351.5	69.6
2021-22	81881	314949	3.8	268.2	114.9	383.1	75.6
2022-23	86513	339035	3.9	290.0	124.3	414.2	81.4
2023-24	91145	363399	4.0	311.5	133.5	444.9	87.2
2024-25	95777	388042	4.1	333.2	142.8	476.0	93.1
2025-26	100385	412311	4.1	354.9	152.1	507.0	99.0
2026-27	105233	437619	4.2	376.9	161.5	538.4	105.0
2027-28	110081	463219	4.2	399.4	171.2	570.6	111.2
2028-29	114881	487803	4.2	421.7	180.7	602.4	117.1
2029-30	119681	512675	4.3	443.6	190.1	633.7	123.0

Table 6.15 United Energy: High scenario – Small-scale PV

Calendar years	All PV customers (number)	Capacity (kW)	Average capacity (kW)	Own-use (GWh)	Exports (GWh)	Total (GWh)	Impact on summer peak demand (MW)
2018-19	68057	243418	3.6	202.0	86.6	288.6	58.4
2019-20	74561	276825	3.7	230.7	98.9	329.5	66.4
2020-21	81497	310767	3.8	260.5	111.7	372.2	74.6
2021-22	88253	344580	3.9	290.6	124.5	415.1	82.7
2022-23	94961	377501	4.0	320.2	137.2	457.4	90.6
2023-24	101669	410825	4.0	349.5	149.8	499.3	98.6
2024-25	108377	444551	4.1	379.3	162.5	541.8	106.7
2025-26	115037	477379	4.1	408.8	175.2	584.0	114.6
2026-27	121157	508891	4.2	437.3	187.4	624.7	122.1
2027-28	127277	540771	4.2	465.4	199.5	664.9	129.8
2028-29	133373	572365	4.3	493.6	211.5	705.1	137.4
2029-30	139469	604325	4.3	521.7	223.6	745.3	145.0

Table 6.16	United Energy: Low scenario – Small-scale PV						
Calendar years	All PV customers (number)	Capacity (kW)	Average capacity (kW)	Own-use (GWh)	Exports (GWh)	Total (GWh)	Impact on summer peak demand (MW)
2018-19	65837	231149	3.5	196.6	84.2	280.8	55.5
2019-20	69041	248953	3.6	212.9	91.2	304.1	59.7
2020-21	72077	265295	3.7	228.0	97.7	325.7	63.7
2021-22	74909	280626	3.7	242.1	103.7	345.8	67.4
2022-23	77717	295479	3.8	255.4	109.5	364.9	70.9
2023-24	80525	310501	3.9	268.7	115.2	383.8	74.5
2024-25	83333	325691	3.9	282.1	120.9	403.0	78.2
2025-26	86117	340399	4.0	295.3	126.6	421.9	81.7
2026-27	88661	354512	4.0	308.1	132.1	440.2	85.1
2027-28	91205	368777	4.0	320.7	137.4	458.1	88.5
2028-29	93485	381766	4.1	332.8	142.6	475.4	91.6
2029-30	95765	394892	4.1	344.4	147.6	492.0	94.8

Battery storage installations within the United Energy network are currently limited with an estimated 127 installations by the end of 2017-18. Interest in battery storage remains high, but the significant cost of installing a system and the low paybacks represent a high barrier to mass market uptake. However, the future market for future installations could be significant with purported reductions in the cost of battery storage technologies. NIEIR has revised upwards its uptake of battery storage.

NIEIR have made the following assumptions about the uptake of battery storage into the United Energy network:

- battery storage installations are linked exclusively to new small-scale PV installations. This is because the majority of existing installations are too small to extract the full benefit of back up energy storage;
- in the Base scenario, 0.03 per cent of new PV installations in 2017-18 will have battery storage. This take up rate rises 6 per cent per annum by 2022-23 and to 16 per cent by 2027-28 of new solar systems come equipped with battery backup;
- in the High scenario, 3 per cent of new small-scale PV installation will have battery storage by 2019-20 rising to nearly 25 per cent in 2027-28 and only 11 per cent of new PV installations will have battery storage in 2027-28 in the low scenario;
- batteries are assumed to only have 80 per cent usable capacity (depth of discharge); and
- batteries will be able to be charged on approximately 300 days per annum;

The forecasts for battery storage are presented in the following tables for the base, high and low scenarios.

Table 6.17 United Energy: Base scenario – Small-scale battery storage								
							Impact on peak demand	
Fiscal years	Customers 30th June (number)	Capacity gross total per year (GWh)	Average battery unit size (kWh)	Total energy stored (GWh)	Export to grid (GWh)	Additional in-house usage (GWh)	Summer (MW)	Winter (MW)
2015-16	16	0.2	11.6	0.1	0.0	0.1	0.0	0.0
2016-17	35	0.3	8.5	0.2	0.0	0.2	0.1	0.0
2017-18	127	1.2	9.4	0.8	0.0	0.7	0.2	0.1
2018-19	218	2.1	9.6	1.3	0.1	1.3	0.4	0.1
2019-20	329	3.2	9.8	2.1	0.1	2.0	0.6	0.2
2020-21	458	4.6	10.0	2.9	0.1	2.8	0.8	0.3
2021-22	634	6.5	10.2	4.2	0.2	3.9	1.1	0.4
2022-23	900	9.4	10.4	6.0	0.3	5.7	1.5	0.5
2023-24	1259	13.4	10.6	8.6	0.4	8.1	2.1	0.7
2024-25	1711	18.5	10.8	11.9	0.6	11.3	2.9	1.0
2025-26	2252	24.9	11.0	15.9	0.8	15.1	3.8	1.3
2026-27	2919	32.8	11.2	21.0	1.0	19.9	4.9	1.6
2027-28	3683	42.1	11.4	27.0	1.3	25.6	6.2	2.1
2028-29	4439	51.7	11.6	33.1	1.7	31.4	7.5	2.5
2029-30	5195	61.5	11.8	39.4	2.0	37.4	8.7	2.9

Table 6.18 United Energy: High scenario – Small-scale battery storage								
							Impact on peak demand	
Fiscal years	Customers 30th June (number)	Capacity gross total per year (GWh)	Average battery unit size (kWh)	Total energy stored (GWh)	Export to grid (GWh)	Additional in-house usage (GWh)	Summer (MW)	Winter (MW)
2018-19	242	2.3	9.6	1.5	0.1	1.4	0.4	0.1
2019-20	408	4.0	9.8	2.6	0.1	2.4	0.7	0.2
2020-21	640	6.4	10.0	4.1	0.2	3.9	1.1	0.4
2021-22	954	9.8	10.2	6.3	0.3	5.9	1.6	0.5
2022-23	1535	16.0	10.4	10.3	0.5	9.7	2.6	0.9
2023-24	2383	25.4	10.6	16.2	0.8	15.4	4.0	1.3
2024-25	3500	37.9	10.8	24.3	1.2	23.1	5.9	2.0
2025-26	4875	53.8	11.0	34.5	1.7	32.7	8.2	2.7
2026-27	6262	70.4	11.2	45.0	2.3	42.8	10.5	3.5
2027-28	7770	88.9	11.4	56.9	2.8	54.1	13.1	4.4
2028-29	9273	107.9	11.6	69.1	3.5	65.6	15.6	5.2
2029-30	10776	127.6	11.8	81.7	4.1	77.6	18.1	6.0

Table 6.19	United Energy: Low scenario – Small-scale battery storage							
							Impact on peak demand	
Fiscal years	Customers 30th June (number)	Capacity gross total per year (GWh)	Average battery unit size (kWh)	Total energy stored (GWh)	Export to grid (GWh)	Additional in-house usage (GWh)	Summer (MW)	Winter (MW)
2018-19	169	1.6	9.6	1.0	0.1	1.0	0.3	0.1
2019-20	213	2.1	9.8	1.3	0.1	1.3	0.4	0.1
2020-21	263	2.6	10.0	1.7	0.1	1.6	0.4	0.1
2021-22	324	3.3	10.2	2.1	0.1	2.0	0.5	0.2
2022-23	412	4.3	10.4	2.8	0.1	2.6	0.7	0.2
2023-24	529	5.6	10.6	3.6	0.2	3.4	0.9	0.3
2024-25	673	7.3	10.8	4.7	0.2	4.4	1.1	0.4
2025-26	872	9.6	11.0	6.2	0.3	5.9	1.5	0.5
2026-27	1105	12.4	11.2	7.9	0.4	7.6	1.9	0.6
2027-28	1389	15.9	11.4	10.2	0.5	9.7	2.3	0.8
2028-29	1643	19.1	11.6	12.2	0.6	11.6	2.8	0.9
2029-30	1897	22.5	11.8	14.4	0.7	13.7	3.2	1.1

7. Energy forecasts for United Energy terminal stations to 2029-30

7.1 Introduction

This section presents forecasts of energy for financial years to 2029-30 for the eight United Energy terminal stations. The methodology for developing these energy forecast was outlined in Section 5.

7.2 Energy forecasts to 2029-30

Table 7.1 shows the forecast energy growth by terminal station within the United Energy distribution area. Electricity sales by class (residential, commercial and industrial) were modelled on a terminal station basis. Section 5 explained the methodological approach in more detail. Figure 7.1 shows the forecast energy growth between 2018-19 and 2029-30 by terminal station.

Figure 7.1: Energy at United Energy terminal stations – Base scenario (percentage growth 2018-19 to 2029-30)

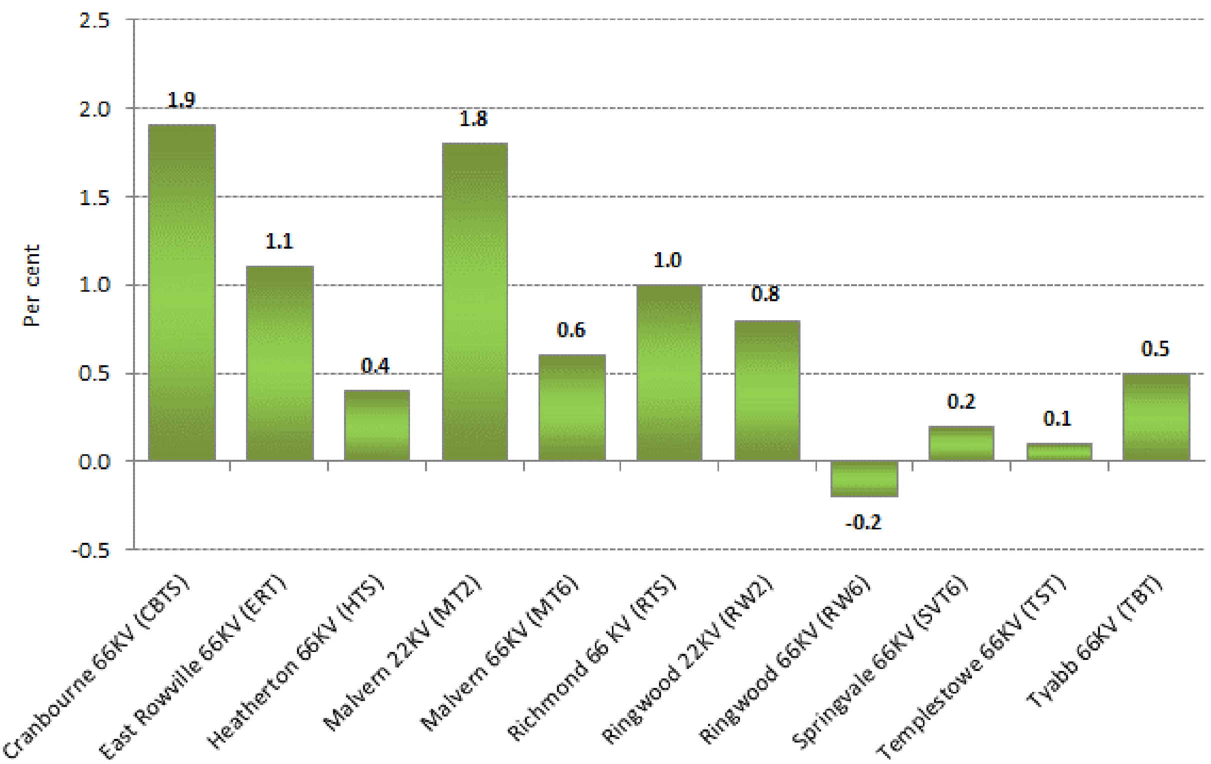


Table 7.1 United Energy Terminal stations - Energy

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	****************************			GWH	****************************		
BASE							
2015	641.24	1435.14	0.00	1236.11	125.08	593.02	237.23
2016	647.03	1452.44	0.00	1298.71	130.09	591.71	239.25
2017	651.24	1403.38	0.00	1296.98	136.97	598.93	225.32
2018	666.31	1419.95	0.00	1303.52	139.73	603.57	228.52
2019	681.01	1439.10	0.00	1310.14	141.99	607.66	230.63
2020	693.17	1452.92	0.00	1312.59	144.23	609.22	231.90
2021	704.55	1466.43	0.00	1314.61	146.23	610.26	232.43
2022	715.81	1478.08	0.00	1315.74	148.68	611.36	233.64
2023	726.39	1486.05	0.00	1314.73	151.38	612.06	235.52
2024	739.57	1499.46	0.00	1317.89	154.28	615.30	238.17
2025	756.72	1522.74	0.00	1327.28	157.10	621.39	241.28
2026	772.26	1543.27	0.00	1335.03	159.90	626.73	244.39
2027	789.45	1567.62	0.00	1346.27	163.21	633.57	248.10
2028	805.54	1589.80	0.00	1355.22	166.37	639.40	251.40
2029	821.03	1610.63	0.00	1362.79	169.51	644.69	254.51
2030	834.61	1627.47	0.00	1367.07	172.28	648.60	257.20
Percentage changes							
2015	1.85	-1.71	0.00	1.50	-9.37	-0.74	-4.78
2016	0.90	1.21	0.00	5.06	4.01	-0.22	0.85
2017	0.65	-3.38	0.00	-0.13	5.29	1.22	-5.82
2018	2.31	1.18	0.00	0.50	2.01	0.77	1.42
2019	2.21	1.35	0.00	0.51	1.61	0.68	0.92
2020	1.79	0.96	0.00	0.19	1.58	0.26	0.55
2021	1.64	0.93	0.00	0.15	1.39	0.17	0.23
2022	1.60	0.79	0.00	0.09	1.68	0.18	0.52
2023	1.48	0.54	0.00	-0.08	1.81	0.12	0.81
2024	1.82	0.90	0.00	0.24	1.92	0.53	1.12
2025	2.32	1.55	0.00	0.71	1.83	0.99	1.31
2026	2.05	1.35	0.00	0.58	1.78	0.86	1.29
2027	2.23	1.58	0.00	0.84	2.07	1.09	1.52
2028	2.04	1.41	0.00	0.66	1.94	0.92	1.33
2029	1.92	1.31	0.00	0.56	1.88	0.83	1.24
2030	1.65	1.05	0.00	0.31	1.64	0.61	1.06
Compound growth rate (per cent) -							
2019-2025	1.77	0.95	0.00	0.22	1.70	0.37	0.76
2019-2030	1.87	1.12	0.00	0.39	1.77	0.59	1.00
HIGH - Levels							
2019	696.98	1465.92	0.00	1339.06	145.34	622.43	237.29
2020	715.29	1487.08	0.00	1350.57	148.87	629.82	241.22
2021	733.21	1508.02	0.00	1360.34	152.19	636.01	244.38
2022	752.21	1531.16	0.00	1371.17	155.86	643.30	248.38
2023	770.87	1552.10	0.00	1380.88	159.53	650.30	252.90
2024	789.43	1571.00	0.00	1390.57	163.46	657.90	257.95
2025	813.08	1603.16	0.00	1408.64	167.36	669.57	263.60
2026	836.56	1634.33	0.00	1425.82	171.30	680.72	269.33
2027	861.44	1667.80	0.00	1445.28	175.64	692.96	275.52
2028	880.24	1689.30	0.00	1454.05	178.80	700.19	279.69
2029	902.07	1716.33	0.00	1467.78	182.60	709.59	284.74
2030	921.29	1738.19	0.00	1477.52	185.89	716.97	289.13
Compound growth rate (per cent) -							
2019-2025	2.60	1.50	0.00	0.85	2.38	1.22	1.77
2019-2030	2.57	1.56	0.00	0.90	2.26	1.29	1.81
LOW - Levels							
2019	671.92	1425.87	0.00	1292.70	139.11	596.37	225.29
2020	679.25	1432.21	0.00	1286.60	139.98	592.29	223.92
2021	685.90	1438.79	0.00	1280.00	140.50	587.62	221.74
2022	692.91	1445.06	0.00	1273.81	141.53	584.06	220.43
2023	699.16	1448.19	0.00	1266.27	142.78	580.78	219.77
2024	708.10	1456.69	0.00	1262.83	144.59	579.73	220.25
2025	720.17	1472.83	0.00	1264.28	146.63	580.45	221.36
2026	731.67	1488.08	0.00	1265.70	148.67	580.94	222.44
2027	743.90	1504.91	0.00	1269.46	151.01	582.36	223.80
2028	754.97	1519.41	0.00	1270.77	153.19	582.74	224.74
2029	765.60	1533.26	0.00	1270.46	155.39	582.70	225.55
2030	777.92	1550.68	0.00	1272.76	157.99	584.00	227.02
Compound growth rate (per cent) -							
2019-2025	1.16	0.54	0.00	-0.37	0.88	-0.45	-0.29
2019-2030	1.34	0.77	0.00	-0.14	1.16	-0.19	0.07

All data are for the financial year ending in June of the year specified.

Table 7.1 United Energy Terminal stations – Energy (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Total UED
Unit	***********************		GWH	***********************		
BASE						
2015	116.62	441.68	1718.88	439.98	936.63	7921.62
2016	124.63	439.72	1701.00	445.22	950.78	8020.58
2017	119.00	425.58	1677.49	445.00	950.45	7930.34
2018	120.64	426.37	1687.98	448.51	958.18	8003.29
2019	121.64	426.67	1694.82	449.34	962.49	8065.49
2020	122.27	425.74	1697.24	448.78	964.50	8102.55
2021	122.46	424.12	1696.71	446.47	964.71	8128.99
2022	123.03	422.41	1697.06	445.28	967.33	8158.40
2023	124.03	420.56	1698.63	445.61	972.77	8187.73
2024	125.30	419.59	1703.45	446.85	979.65	8239.52
2025	126.72	420.40	1713.30	448.50	987.09	8322.51
2026	128.03	420.11	1719.41	449.49	993.30	8391.91
2027	129.61	420.61	1728.95	451.28	1001.62	8480.31
2028	130.98	420.29	1735.49	452.13	1008.36	8554.98
2029	132.21	419.44	1740.17	452.37	1014.27	8621.63
2030	133.17	417.36	1740.33	451.60	1017.88	8667.59
Percentage changes						
2015	-3.05	-1.15	-2.52	-0.20	-1.41	-1.15
2016	6.87	-0.44	-1.04	1.19	1.51	1.25
2017	-4.52	-3.22	-1.38	-0.05	-0.03	-1.13
2018	1.38	0.19	0.63	0.79	0.81	0.92
2019	0.83	0.07	0.41	0.19	0.45	0.78
2020	0.52	-0.22	0.14	-0.12	0.21	0.46
2021	0.15	-0.38	-0.03	-0.51	0.02	0.33
2022	0.46	-0.40	0.02	-0.27	0.27	0.36
2023	0.81	-0.44	0.09	0.08	0.56	0.36
2024	1.03	-0.23	0.28	0.28	0.71	0.63
2025	1.13	0.19	0.58	0.37	0.76	1.01
2026	1.03	-0.07	0.36	0.22	0.63	0.83
2027	1.24	0.12	0.56	0.40	0.84	1.05
2028	1.05	-0.08	0.38	0.19	0.67	0.88
2029	0.94	-0.20	0.27	0.05	0.59	0.78
2030	0.73	-0.49	0.01	-0.17	0.36	0.53
Compound growth rate (per cent) -						
2019-2025	0.68	-0.25	0.18	-0.03	0.42	0.52
2019-2030	0.83	-0.20	0.24	0.05	0.51	0.66
HIGH - Levels						
2019	124.52	431.95	1717.92	460.63	980.24	8222.28
2020	126.24	431.94	1725.55	464.31	988.08	8308.97
2021	127.54	431.52	1731.15	466.46	994.48	8385.30
2022	129.20	431.20	1737.93	469.39	1003.30	8473.10
2023	131.16	430.80	1745.30	473.29	1014.06	8561.19
2024	133.33	429.86	1751.28	477.76	1025.05	8647.58
2025	135.62	430.99	1763.38	482.42	1037.66	8775.48
2026	137.93	431.69	1773.81	486.87	1049.72	8898.08
2027	140.42	432.72	1785.79	491.73	1063.04	9032.36
2028	141.85	430.34	1783.88	492.66	1068.35	9099.35
2029	143.68	429.06	1786.82	494.83	1076.80	9194.29
2030	145.13	426.21	1783.58	495.52	1081.97	9261.40
Compound growth rate (per cent) -						
2019-2025	1.43	-0.04	0.44	0.77	0.95	1.09
2019-2030	1.40	-0.12	0.34	0.67	0.90	1.09
LOW - Levels						
2019	119.48	423.39	1682.41	441.46	948.73	7966.73
2020	119.11	420.78	1679.04	437.38	944.38	7954.94
2021	118.26	417.52	1672.72	431.53	937.77	7932.35
2022	117.86	414.59	1668.86	427.11	934.41	7920.62
2023	117.81	411.40	1665.39	423.95	933.15	7908.64
2024	118.30	409.58	1667.71	422.68	935.35	7925.81
2025	118.94	408.75	1673.02	421.93	937.44	7965.81
2026	119.52	407.43	1676.67	420.87	938.48	8000.47
2027	120.24	406.50	1682.23	420.18	940.77	8045.35
2028	120.75	404.79	1685.07	418.63	941.56	8076.63
2029	121.17	402.75	1687.15	416.73	942.02	8102.79
2030	121.91	401.43	1693.01	415.88	944.71	8147.30
Compound growth rate (per cent) -						
2019-2025	-0.08	-0.58	-0.09	-0.75	-0.20	0.00
2019-2030	0.18	-0.48	0.06	-0.54	-0.04	0.20

All data are for the financial year ending in June of the year specified.

8. Maximum demand forecasts for the total United Energy region to 2029-30

8.1 Introduction

This section presents maximum demand forecasts for the total United Energy region to 2030 for summer and winter. The methodology underlying these forecasts was outlined in Section 5 of this report.

Forecasts of total summer and winter maximum demands for United Energy are presented for the following:

- the 10th percentile: exceeded once in 10 years; and
- the 50th percentile: exceeded once in two years.

Temperature data used for the total United Energy MDs was Melbourne Regional Office and Melbourne Olympic Park.

8.2 Forecasts of summer and winter total United Energy maximum demands

Table 8.1 presents forecasts of maximum winter demand forecasts for the total United Energy region to 2029. Figure 8.1 shows the 50th percentile winter forecast under the base economic scenario.

Table 8.2 shows the forecast for the United Energy summer MDs at alternative probabilities of exceedence.

Figure 8.2 shows the summer peaks for total United Energy for the base scenario.

The base scenario

The base scenario for the 50th percentile MD has the following features:

- under the base scenario the winter MD rises to 1,523 MW by winter 2018 and to 1,667 MW by winter 2029;
- the summer MD under the base scenario is 2,009 MW by summer 2018-19 and around 2,254 MW by summer 2029-30; and
- the summer MD under the base scenario rises by an average annual rate of 1.1 per cent per annum between 2018-19 and 2029-30, compared to average annual growth in total energy over the same period of 0.7 per cent per annum.

Figure 8.1: United Energy winter maximum demand
Base scenario – 50th percentile day

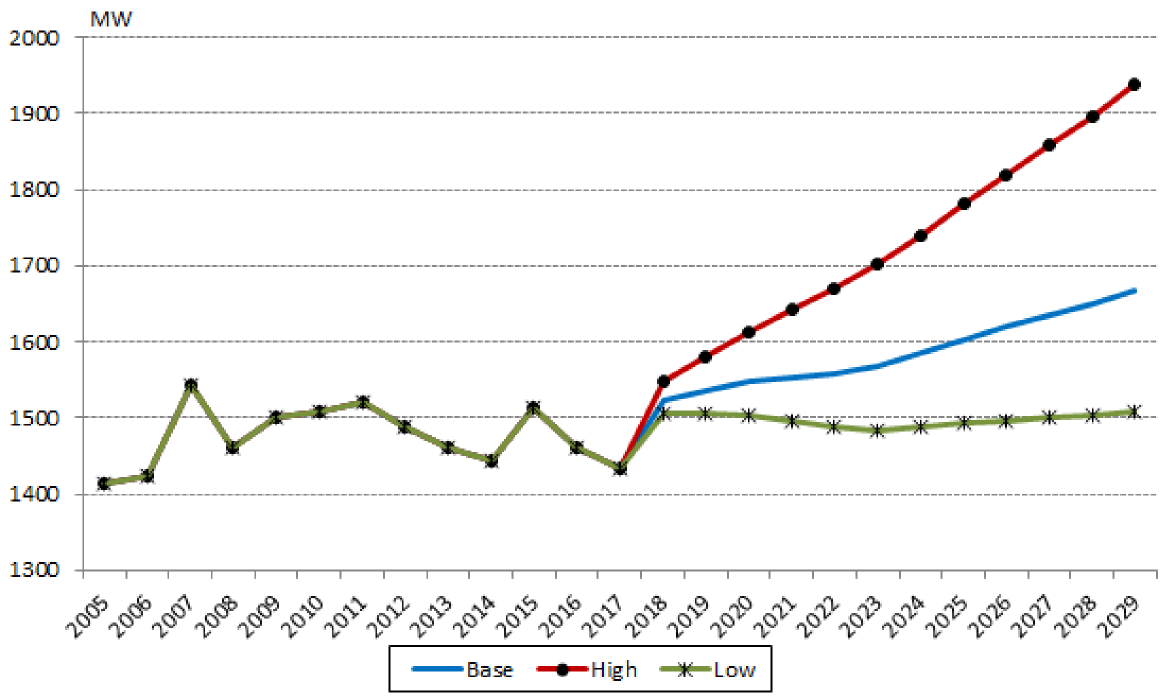


Figure 8.2: United Energy summer maximum demand
Base scenario – 50th percentile day

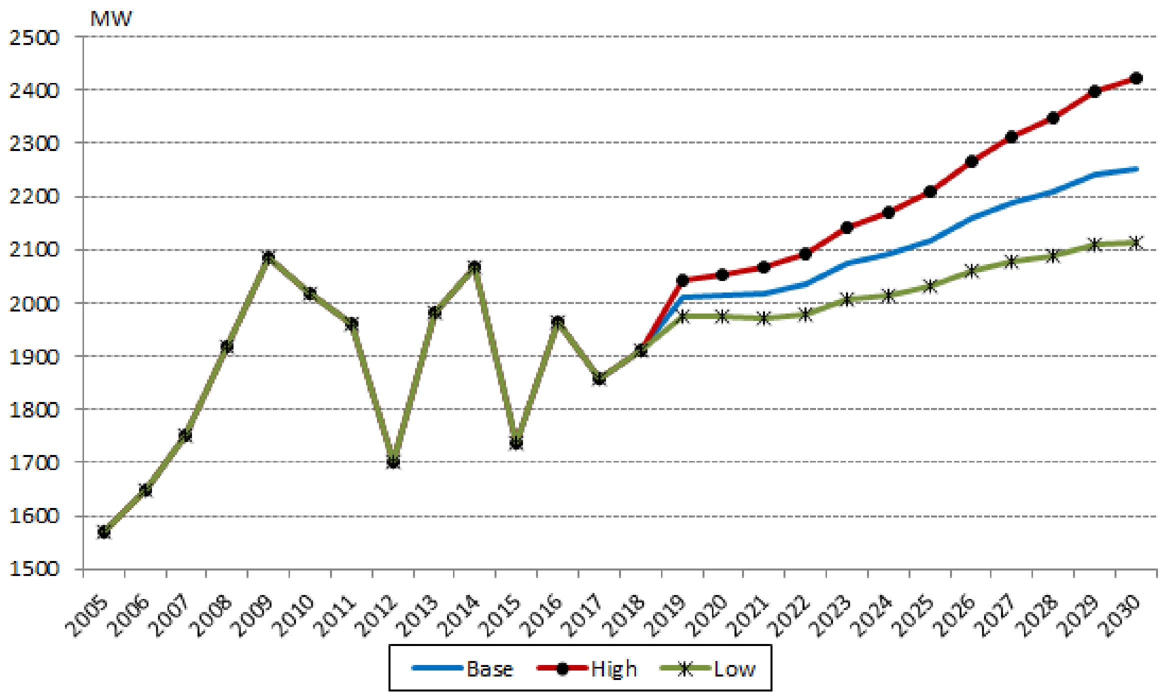


TABLE 8.1 Components of the UE Winter MD - 10th, 50th, 90th Percentiles

	10th Percentile			50th Percentile			90th Percentile		
	Reverse Cycle AC Load	Residual Winter Load	Total Winter MD	Reverse Cycle AC Load	Residual Winter Load	Total Winter MD	Reverse Cycle AC Load	Residual Winter Load	Total Winter MD
Unit	MWs								
BASE									
2015	382.13	1131.61	1513.74	382.13	1131.61	1513.74	382.13	1131.61	1513.74
2016	395.16	1066.64	1461.80	395.16	1066.64	1461.80	395.16	1066.64	1461.80
2017	407.66	1024.86	1432.52	407.66	1024.86	1432.52	407.66	1024.86	1432.52
2018	418.88	1133.42	1552.30	393.92	1129.17	1523.08	369.56	1123.96	1493.52
2019	430.22	1136.20	1566.42	404.58	1131.23	1535.82	379.57	1124.81	1504.38
2020	441.73	1137.32	1579.05	415.41	1131.66	1547.07	389.73	1124.03	1513.76
2021	453.43	1133.19	1586.61	426.40	1126.92	1553.33	400.04	1118.14	1518.18
2022	465.32	1126.13	1591.44	437.59	1119.32	1556.91	410.53	1109.42	1519.95
2023	477.42	1125.43	1602.86	448.97	1117.98	1566.95	421.21	1106.91	1528.12
2024	489.76	1132.28	1622.04	460.57	1124.04	1584.61	432.10	1111.72	1543.82
2025	502.34	1138.74	1641.09	472.41	1129.71	1602.12	443.20	1116.15	1559.35
2026	515.20	1144.22	1659.41	484.49	1134.40	1618.90	454.54	1119.59	1574.13
2027	528.33	1148.69	1677.02	496.85	1138.10	1634.95	466.13	1122.05	1588.18
2028	541.77	1152.21	1693.98	509.48	1140.86	1650.34	477.98	1123.57	1601.55
2029	555.52	1156.75	1712.27	522.42	1144.62	1667.04	490.12	1126.06	1616.18
Percentage changes									
2015	2.86	5.61	4.90	2.86	5.61	4.90	2.86	5.61	4.90
2016	3.41	-5.74	-3.43	3.41	-5.74	-3.43	3.41	-5.74	-3.43
2017	3.16	-3.92	-2.00	3.16	-3.92	-2.00	3.16	-3.92	-2.00
2018	2.75	10.59	8.36	-3.37	10.18	6.32	-9.35	9.67	4.26
2019	2.71	0.24	0.91	2.71	0.18	0.84	2.71	0.08	0.73
2020	2.68	0.10	0.81	2.68	0.04	0.73	2.68	-0.07	0.62
2021	2.65	-0.36	0.48	2.65	-0.42	0.40	2.65	-0.52	0.29
2022	2.62	-0.62	0.30	2.62	-0.67	0.23	2.62	-0.78	0.12
2023	2.60	-0.06	0.72	2.60	-0.12	0.65	2.60	-0.23	0.54
2024	2.58	0.61	1.20	2.58	0.54	1.13	2.58	0.43	1.03
2025	2.57	0.57	1.17	2.57	0.50	1.10	2.57	0.40	1.01
2026	2.56	0.48	1.12	2.56	0.42	1.05	2.56	0.31	0.95
2027	2.55	0.39	1.06	2.55	0.33	0.99	2.55	0.22	0.89
2028	2.54	0.31	1.01	2.54	0.24	0.94	2.54	0.14	0.84
2029	2.54	0.39	1.08	2.54	0.33	1.01	2.54	0.22	0.91
Compound growth rate (per cent) -									
2019-2025	2.62	0.04	0.78	2.62	-0.02	0.71	2.62	-0.13	0.60
2019-2029	2.59	0.18	0.89	2.59	0.12	0.82	2.59	0.01	0.72
HIGH - Levels									
2018	429.27	1150.98	1580.25	403.69	1143.93	1547.62	378.73	1137.29	1516.02
2019	441.57	1174.16	1615.73	415.25	1166.06	1581.31	389.58	1158.01	1547.59
2020	454.01	1194.52	1648.53	426.96	1185.40	1612.35	400.56	1175.94	1576.50
2021	466.62	1212.93	1679.56	438.82	1202.80	1641.61	411.69	1191.93	1603.62
2022	479.42	1230.24	1709.66	450.85	1219.11	1669.96	422.98	1206.82	1629.79
2023	492.41	1250.67	1743.08	463.07	1238.47	1701.54	434.44	1224.71	1659.15
2024	505.62	1278.45	1784.07	475.49	1265.03	1740.53	446.10	1249.70	1695.80
2025	519.07	1307.02	1826.09	488.14	1292.34	1780.48	457.96	1275.41	1733.37
2026	532.77	1334.70	1867.47	501.02	1318.76	1819.78	470.05	1300.19	1770.23
2027	546.74	1361.64	1908.38	514.16	1344.42	1858.57	482.37	1324.18	1806.55
2028	561.00	1388.01	1949.00	527.57	1369.49	1897.05	494.95	1347.56	1842.51
2029	575.56	1416.29	1991.85	541.26	1396.41	1937.68	507.80	1372.75	1880.55
Compound growth rate (per cent) -									
2019-2025	2.73	1.80	2.06	2.73	1.73	2.00	2.73	1.62	1.91
2019-2029	2.69	1.89	2.11	2.69	1.82	2.05	2.69	1.72	1.97
LOW - Levels									
2018	398.75	1135.03	1533.77	374.99	1131.95	1506.94	351.80	1127.34	1479.14
2019	407.92	1124.63	1532.55	383.61	1121.05	1504.65	359.89	1115.33	1475.22
2020	417.26	1114.15	1531.41	392.40	1110.05	1502.45	368.14	1103.23	1471.37
2021	426.80	1099.13	1525.93	401.37	1094.60	1495.97	376.55	1086.75	1463.30
2022	436.55	1082.48	1519.03	410.54	1077.58	1488.11	385.16	1068.72	1453.87
2023	446.52	1069.30	1515.83	419.92	1063.97	1483.88	393.95	1054.10	1448.05
2024	456.74	1064.37	1521.10	429.52	1058.47	1487.98	402.96	1047.52	1450.48
2025	467.21	1059.74	1526.95	439.36	1053.27	1492.63	412.20	1041.25	1453.45
2026	477.95	1054.16	1532.11	449.46	1047.13	1496.59	421.68	1034.06	1455.73
2027	488.97	1047.72	1536.69	459.83	1040.15	1499.98	431.41	1026.04	1457.44
2028	500.31	1040.56	1540.86	470.49	1032.47	1502.96	441.40	1017.33	1458.73
2029	511.96	1034.30	1546.26	481.45	1025.67	1507.13	451.69	1009.51	1461.20
Compound growth rate (per cent) -									
2019-2025	2.29	-0.99	-0.06	2.29	-1.03	-0.13	2.29	-1.14	-0.25
2019-2029	2.30	-0.83	0.09	2.30	-0.89	0.02	2.30	-0.99	-0.10

All data are for the calendar year ending in December of the year specified.

TABLE 8.2 Summer Non-Coincident Demands - United Energy

	Base Load	10th Percentile MD: Temperature Sensitive MW (eg AC)	10th Percentile MD: Total UED MD	50th Percentile MD: Temperature Sensitive MW (eg AC)	50th Percentile MD: Total UED MD	90th Percentile MD: Temperature Sensitive MW (eg AC)	90th Percentile MD: Total UED MD
Unit	***************************** MWs ***********************************						
BASE							
2015	1005.68	730.67	1736.35	730.67	1736.35	730.67	1736.35
2016	995.79	967.71	1963.50	967.71	1963.50	967.71	1963.50
2017	1010.06	848.44	1858.50	848.44	1858.50	848.44	1858.50
2018	1021.05	890.29	1911.34	890.29	1911.34	890.29	1911.34
2019	1037.41	1186.05	2223.46	971.43	2008.84	784.03	1821.44
2020	1053.30	1188.64	2241.94	958.96	2012.26	771.67	1824.97
2021	1061.38	1187.00	2248.38	956.56	2017.94	767.78	1829.16
2022	1078.93	1179.85	2258.78	956.06	2034.99	779.58	1858.51
2023	1094.53	1198.08	2292.61	978.23	2072.76	784.86	1879.39
2024	1114.31	1192.28	2306.59	976.29	2090.60	786.11	1900.42
2025	1135.23	1220.05	2355.28	981.95	2117.18	798.07	1933.30
2026	1155.33	1245.66	2400.99	1004.79	2160.12	825.14	1980.47
2027	1172.61	1271.70	2444.31	1016.91	2189.52	819.63	1992.24
2028	1186.27	1275.97	2462.24	1024.20	2210.47	821.02	2007.29
2029	1201.80	1279.69	2481.49	1038.82	2240.62	841.17	2042.97
2030	1217.48	1295.84	2513.32	1035.99	2253.47	842.25	2059.73
Percentage changes							
2015	-1.78	-29.88	-15.96	-29.88	-15.96	-29.88	-15.96
2016	-0.98	32.44	13.08	32.44	13.08	32.44	13.08
2017	1.43	-12.33	-5.35	-12.33	-5.35	-12.33	-5.35
2018	1.09	4.93	2.84	4.93	2.84	4.93	2.84
2019	1.60	33.22	16.33	9.11	5.10	-11.94	-4.70
2020	1.53	0.22	0.83	-1.28	0.17	-1.58	0.19
2021	0.77	-0.14	0.29	-0.25	0.28	-0.50	0.23
2022	1.65	-0.60	0.46	-0.05	0.84	1.54	1.60
2023	1.45	1.55	1.50	2.32	1.86	0.68	1.12
2024	1.81	-0.48	0.61	-0.20	0.86	0.16	1.12
2025	1.88	2.33	2.11	0.58	1.27	1.52	1.73
2026	1.77	2.10	1.94	2.33	2.03	3.39	2.44
2027	1.50	2.09	1.80	1.21	1.36	-0.67	0.59
2028	1.17	0.34	0.73	0.72	0.96	0.17	0.76
2029	1.31	0.29	0.78	1.43	1.36	2.45	1.78
2030	1.30	1.26	1.28	-0.27	0.57	0.13	0.82
Compound growth rate (per cent) -							
2019-2025	1.51	0.47	0.96	0.18	0.88	0.30	1.00
2019-2030	1.47	0.81	1.12	0.59	1.05	0.65	1.12
HIGH - Levels							
2019	1040.51	1219.20	2259.71	1002.48	2042.99	813.43	1853.94
2020	1059.33	1226.09	2285.42	992.84	2052.17	802.67	1862.00
2021	1071.50	1229.04	2300.54	994.05	2065.55	801.11	1872.61
2022	1093.35	1228.20	2321.55	998.28	2091.63	816.80	1910.15
2023	1114.35	1254.38	2368.73	1026.56	2140.91	826.29	1940.64
2024	1140.87	1254.01	2394.88	1028.92	2169.79	830.84	1971.71
2025	1168.49	1289.09	2457.58	1039.67	2208.16	846.83	2015.32
2026	1196.39	1324.79	2521.18	1070.11	2266.50	880.33	2076.72
2027	1222.68	1359.44	2582.12	1089.06	2311.74	879.44	2102.12
2028	1245.18	1373.14	2618.32	1103.88	2349.06	886.86	2132.04
2029	1268.54	1386.81	2655.35	1127.82	2396.36	915.61	2184.15
2030	1292.28	1409.76	2702.04	1128.79	2421.07	919.60	2211.88
Compound growth rate (per cent) -							
2019-2025	1.95	0.93	1.41	0.61	1.30	0.67	1.40
2019-2030	1.99	1.33	1.64	1.08	1.56	1.12	1.62
LOW - Levels							
2019	1034.01	1152.58	2186.59	940.22	1974.23	754.59	1788.60
2020	1049.80	1150.81	2200.61	924.99	1974.79	740.81	1790.61
2021	1052.66	1143.96	2196.61	918.41	1971.07	734.11	1786.77
2022	1066.86	1130.37	2197.23	913.20	1980.06	742.10	1808.96
2023	1078.29	1140.15	2218.44	928.87	2007.16	742.93	1821.22
2024	1092.90	1128.46	2221.36	922.25	2015.15	740.57	1833.47
2025	1108.75	1148.24	2256.99	922.28	2031.03	748.03	1856.78
2026	1123.44	1163.70	2287.14	937.65	2061.09	768.84	1892.28
2027	1134.33	1183.37	2317.70	945.27	2079.60	761.17	1895.50
2028	1141.80	1181.50	2323.30	948.42	2090.22	760.03	1901.83
2029	1151.89	1179.52	2331.41	957.99	2109.88	775.88	1927.77
2030	1162.77	1189.10	2351.87	951.77	2114.54	774.49	1937.26
Compound growth rate (per cent) -							
2019-2025	1.17	-0.06	0.53	-0.32	0.47	-0.15	0.63
2019-2030	1.07	0.28	0.66	0.11	0.63	0.24	0.73

All data are for the financial year ending in June of the year specified.

9. Maximum non-coincident demand forecasts to 2029-30 for the United Energy terminal stations

9.1 Introduction

This section presents maximum non-coincident demand forecasts for summer and winter for the United Energy terminal stations to 2030. The methodology for forecasting maximum demands for summer and winter is outlined in Section 5.

9.2 Forecasts of terminal station maximum demand – summary of approach

Forecasts of maximum non-coincident summer and winter demands by United Energy terminal stations (MDs) to 2030 are presented for the following:

- the 10^{th} percentile: exceeded once in 10 years; and
- the 50^{th} percentile: exceeded once in two years.

The analysis of temperature data for the United Energy regions were reported in Section 5. The temperatures associated with these percentiles were reported in Table 5.6.

9.3 Forecasts of summer and winter maximum non-coincident demands in the United Energy region

Tables 9.1 to 9.4 present forecasts of winter and summer maximum non-coincident demands for United Energy terminal stations for alternative probabilities of exceedence.

Tables 9.1 and 9.2 show the winter peak for the 10^{th} and 50^{th} percentile by United Energy terminal station.

Tables 9.3 and 9.4 show the summer peak for the 10^{th} and 50^{th} percentile by United Energy terminal station.

The data in the winter tables extends to 2029. The forecast for winter MDs are on a calendar year basis. The forecasts for summer MDs are on a financial year basis.

Figures 9.1 and 9.2 summarise the forecast growth for the 50^{th} percentile MD for winter and summer.

Figure 9.1: Winter non-coincident peak demand – 50th percentile – Base scenario (percentage growth 2019-2029)

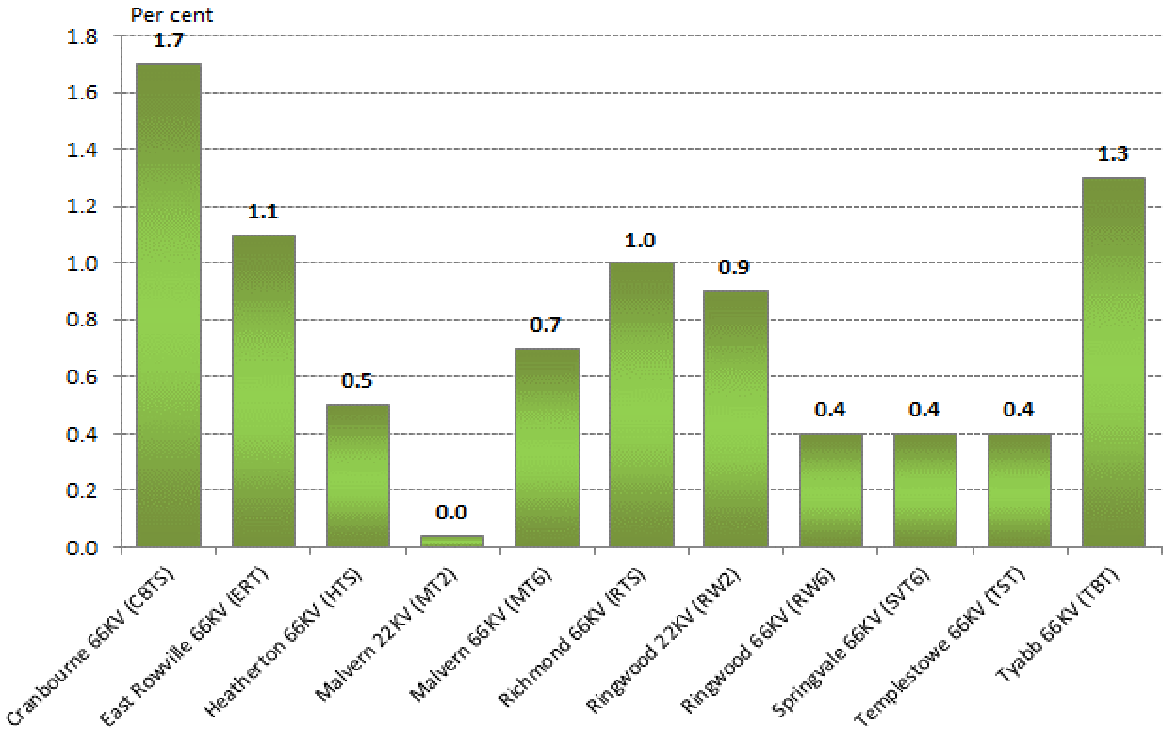


Figure 9.2: Summer non-coincident peak demand – 50th percentile – Base scenario (percentage growth 2019-2030)

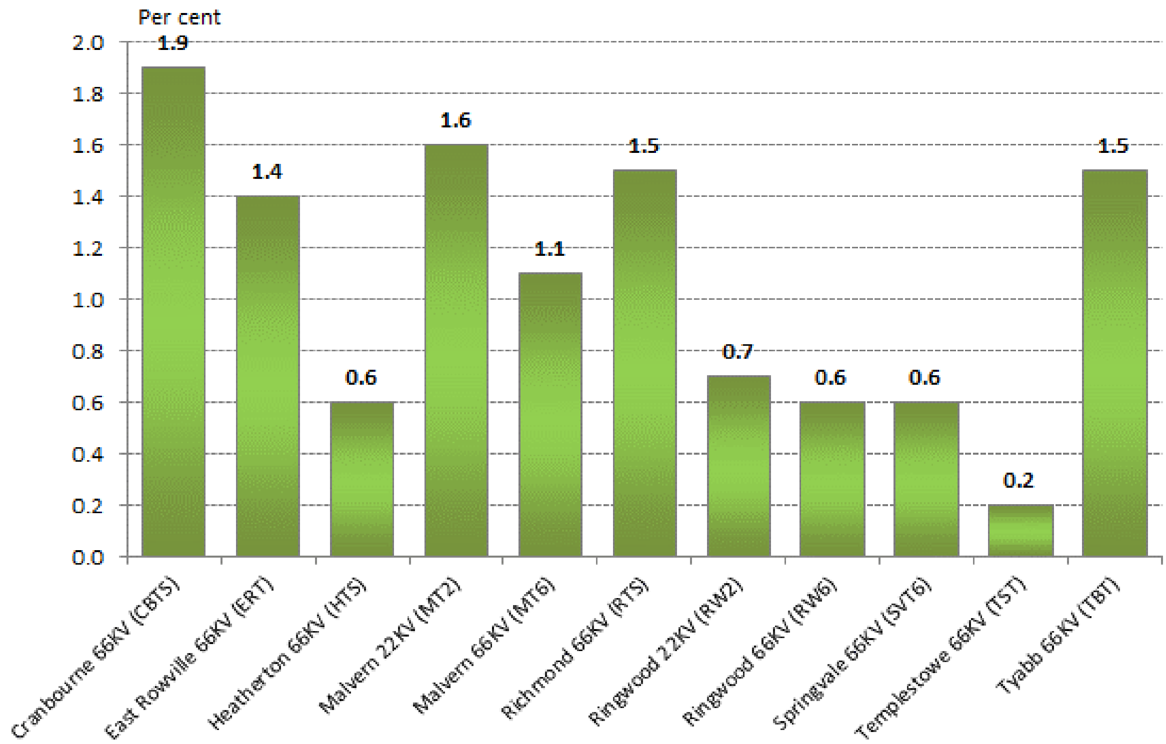


Table 9.1 United Energy Terminal stations - Winter 10th Non-Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	****************************			MW	****************************		
BASE							
2015	133.78	273.96	0.00	258.24	29.23	131.39	58.33
2016	126.61	273.30	0.00	253.38	30.53	125.20	54.73
2017	127.58	272.22	0.00	256.27	30.09	120.97	49.03
2018	133.71	283.53	0.00	261.31	36.53	132.43	56.36
2019	136.32	287.10	0.00	262.93	36.57	133.37	56.89
2020	138.80	290.64	0.00	264.51	36.56	134.24	57.31
2021	140.77	292.84	0.00	265.01	36.49	134.64	57.64
2022	142.37	293.94	0.00	264.72	36.39	134.76	57.98
2023	144.66	296.49	0.00	265.62	36.39	135.55	58.55
2024	147.84	301.14	0.00	268.01	36.44	137.04	59.30
2025	150.93	305.71	0.00	270.46	36.52	138.58	60.13
2026	153.93	310.19	0.00	272.86	36.60	140.05	60.91
2027	156.88	314.57	0.00	275.12	36.67	141.47	61.68
2028	159.76	318.83	0.00	277.25	36.75	142.85	62.44
2029	162.76	323.28	0.00	279.59	36.85	144.38	63.29
Percentage changes							
2015	6.69	-3.08	0.00	11.26	-5.37	3.93	7.90
2016	-5.36	-0.24	0.00	-1.88	4.45	-4.71	-6.17
2017	0.77	-0.40	0.00	1.14	-1.44	-3.38	-10.41
2018	4.81	4.16	0.00	1.97	21.41	9.47	14.95
2019	1.95	1.26	0.00	0.62	0.09	0.71	0.94
2020	1.82	1.23	0.00	0.60	-0.02	0.65	0.74
2021	1.42	0.76	0.00	0.19	-0.19	0.30	0.57
2022	1.14	0.38	0.00	-0.11	-0.27	0.09	0.58
2023	1.61	0.87	0.00	0.34	0.00	0.58	0.99
2024	2.20	1.57	0.00	0.90	0.14	1.10	1.29
2025	2.09	1.52	0.00	0.91	0.23	1.12	1.39
2026	1.99	1.47	0.00	0.89	0.21	1.06	1.31
2027	1.91	1.41	0.00	0.83	0.20	1.01	1.26
2028	1.84	1.35	0.00	0.78	0.20	0.98	1.23
2029	1.88	1.40	0.00	0.84	0.28	1.08	1.37
Compound growth rate (per cent) -							
2019-2025	1.71	1.05	0.00	0.47	-0.02	0.64	0.93
2019-2029	1.79	1.19	0.00	0.62	0.08	0.80	1.07
HIGH - Levels							
2018	136.38	288.23	0.00	266.29	37.27	135.09	57.63
2019	141.32	295.78	0.00	271.41	37.78	138.01	59.16
2020	146.12	303.11	0.00	276.05	38.22	140.64	60.52
2021	150.78	310.14	0.00	280.25	38.62	143.13	61.89
2022	155.30	316.64	0.00	284.08	38.98	145.49	63.32
2023	160.13	323.49	0.00	288.50	39.44	148.24	64.96
2024	165.89	332.67	0.00	294.43	39.91	151.74	66.74
2025	171.81	342.05	0.00	300.50	40.41	155.30	68.61
2026	177.72	351.35	0.00	306.51	40.90	158.82	70.47
2027	183.62	360.60	0.00	312.41	41.39	162.36	72.37
2028	189.56	369.87	0.00	318.32	41.86	165.85	74.25
2029	195.73	379.56	0.00	324.62	42.37	169.56	76.27
Compound growth rate (per cent) -							
2019-2025	3.31	2.45	0.00	1.71	1.13	1.99	2.50
2019-2029	3.31	2.53	0.00	1.81	1.15	2.08	2.57
LOW - Levels							
2018	132.01	280.36	0.00	257.97	36.03	130.46	55.46
2019	132.82	280.57	0.00	257.53	35.75	130.14	55.14
2020	133.65	281.11	0.00	257.30	35.46	129.88	54.75
2021	134.00	280.48	0.00	256.14	35.11	129.30	54.29
2022	134.08	279.07	0.00	254.54	34.77	128.64	53.88
2023	134.51	278.37	0.00	253.47	34.49	128.28	53.64
2024	135.86	279.78	0.00	254.02	34.37	128.63	53.67
2025	137.22	281.28	0.00	254.80	34.28	129.06	53.74
2026	138.48	282.59	0.00	255.59	34.17	129.46	53.78
2027	139.66	283.78	0.00	256.24	34.08	129.82	53.80
2028	140.79	284.91	0.00	256.71	33.99	130.15	53.81
2029	142.03	286.28	0.00	257.34	33.92	130.56	53.87
Compound growth rate (per cent) -							
2019-2025	0.55	0.04	0.00	-0.18	-0.70	-0.14	-0.43
2019-2029	0.67	0.20	0.00	-0.01	-0.52	0.03	-0.23

All data are for the calendar year ending in December of the year specified.

Table 9.1 United Energy Terminal stations - Winter 10th Non-Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Diversity Factor
Unit	******************		MW	****************		per cent
BASE						
2015	24.73	80.83	297.46	89.60	197.29	4.04
2016	25.09	78.72	294.68	88.44	196.08	5.81
2017	28.72	73.62	288.53	85.68	190.65	6.34
2018	31.50	82.84	307.50	87.25	207.63	4.40
2019	31.79	83.31	309.14	87.64	210.28	4.40
2020	32.02	83.68	310.33	87.76	212.69	4.40
2021	32.19	83.75	310.58	87.74	214.77	4.40
2022	32.38	83.66	310.49	87.83	216.94	4.40
2023	32.67	83.88	311.53	88.24	219.80	4.40
2024	33.05	84.54	313.96	88.88	223.19	4.40
2025	33.46	85.14	316.17	89.52	226.69	4.40
2026	33.83	85.68	318.23	90.10	230.05	4.40
2027	34.19	86.17	320.07	90.60	233.39	4.40
2028	34.55	86.61	321.73	91.04	236.71	4.40
2029	34.95	87.09	323.52	91.57	240.32	4.40
Percentage changes						
2015	6.46	4.31	-5.76	1.86	1.19	-45.99
2016	1.46	-2.61	-0.93	-1.29	-0.61	43.99
2017	14.47	-6.48	-2.09	-3.12	-2.77	9.11
2018	9.67	12.53	6.57	1.84	8.91	-30.61
2019	0.93	0.57	0.53	0.44	1.28	0.00
2020	0.71	0.45	0.39	0.13	1.15	0.00
2021	0.55	0.08	0.08	-0.01	0.98	0.00
2022	0.59	-0.11	-0.03	0.10	1.01	0.00
2023	0.91	0.26	0.34	0.46	1.32	0.00
2024	1.16	0.79	0.78	0.72	1.54	0.00
2025	1.22	0.71	0.70	0.72	1.57	0.00
2026	1.11	0.64	0.65	0.64	1.48	0.00
2027	1.08	0.57	0.58	0.56	1.45	0.00
2028	1.04	0.51	0.52	0.49	1.42	0.00
2029	1.17	0.56	0.56	0.57	1.52	0.00
Compound growth rate (per cent) -						
2019-2025	0.85	0.36	0.38	0.35	1.26	0.00
2019-2029	0.95	0.44	0.46	0.44	1.34	0.00
HIGH - Levels						
2018	32.15	84.02	312.17	89.18	211.38	4.40
2019	32.87	85.27	317.66	90.94	216.62	4.40
2020	33.49	86.41	322.60	92.39	221.52	4.40
2021	34.10	87.37	327.03	93.76	226.38	4.40
2022	34.74	88.28	331.37	95.23	231.45	4.40
2023	35.48	89.29	336.17	96.99	237.09	4.40
2024	36.27	90.68	342.18	98.85	243.20	4.40
2025	37.10	92.11	348.27	100.77	249.51	4.40
2026	37.90	93.47	354.15	102.61	255.74	4.40
2027	38.73	94.77	359.66	104.37	262.09	4.40
2028	39.53	96.02	365.08	106.07	268.36	4.40
2029	40.39	97.35	370.71	107.88	275.05	4.40
Compound growth rate (per cent) -						
2019-2025	2.04	1.29	1.55	1.72	2.38	0.00
2019-2029	2.08	1.33	1.56	1.72	2.42	0.00
LOW - Levels						
2018	31.07	82.07	304.69	86.03	205.11	4.40
2019	31.12	82.05	303.07	85.62	206.17	4.40
2020	31.12	82.03	301.32	85.03	207.13	4.40
2021	31.08	81.74	298.78	84.34	207.82	4.40
2022	31.07	81.34	296.03	83.78	208.66	4.40
2023	31.13	81.12	294.07	83.48	209.96	4.40
2024	31.31	81.33	293.56	83.54	211.96	4.40
2025	31.52	81.55	293.04	83.64	214.02	4.40
2026	31.70	81.71	292.40	83.67	215.98	4.40
2027	31.88	81.84	291.60	83.66	217.95	4.40
2028	32.05	81.94	290.75	83.62	219.95	4.40
2029	32.25	82.08	290.20	83.66	222.11	4.40
Compound growth rate (per cent) -						
2019-2025	0.21	-0.10	-0.56	-0.39	0.62	0.00
2019-2029	0.36	0.00	-0.43	-0.23	0.75	0.00

All data are for the calendar year ending in December of the year specified.

Table 9.2 United Energy Terminal stations - Winter 50th Non-Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	MW						
BASE							
2015	133.78	273.96	0.00	258.24	29.23	131.39	58.33
2016	126.61	273.30	0.00	253.38	30.53	125.20	54.73
2017	127.58	272.22	0.00	256.27	30.09	120.97	49.03
2018	131.99	279.89	0.00	257.96	35.04	130.73	55.64
2019	134.49	283.21	0.00	259.35	35.05	131.55	56.12
2020	136.86	286.51	0.00	260.71	35.03	132.31	56.49
2021	138.71	288.48	0.00	261.00	34.94	132.61	56.78
2022	140.21	289.36	0.00	260.51	34.84	132.63	57.07
2023	142.38	291.66	0.00	261.19	34.82	133.30	57.59
2024	145.43	296.06	0.00	263.35	34.86	134.67	58.29
2025	148.38	300.36	0.00	265.56	34.92	136.09	59.07
2026	151.25	304.57	0.00	267.72	34.98	137.44	59.80
2027	154.07	308.68	0.00	269.74	35.04	138.73	60.51
2028	156.82	312.66	0.00	271.64	35.10	139.99	61.22
2029	159.68	316.84	0.00	273.73	35.18	141.40	62.02
Percentage changes							
2015	6.69	-3.08	0.00	11.26	-5.37	3.93	7.90
2016	-5.36	-0.24	0.00	-1.88	4.45	-4.71	-6.17
2017	0.77	-0.40	0.00	1.14	-1.44	-3.38	-10.41
2018	3.46	2.82	0.00	0.66	16.44	8.06	13.48
2019	1.89	1.19	0.00	0.54	0.05	0.63	0.87
2020	1.76	1.16	0.00	0.52	-0.07	0.58	0.66
2021	1.36	0.69	0.00	0.11	-0.23	0.23	0.50
2022	1.08	0.30	0.00	-0.19	-0.31	0.01	0.51
2023	1.55	0.80	0.00	0.26	-0.03	0.51	0.92
2024	2.14	1.51	0.00	0.83	0.10	1.03	1.22
2025	2.03	1.45	0.00	0.84	0.19	1.05	1.32
2026	1.94	1.40	0.00	0.81	0.17	0.99	1.24
2027	1.86	1.35	0.00	0.76	0.17	0.94	1.20
2028	1.79	1.29	0.00	0.70	0.16	0.91	1.16
2029	1.82	1.34	0.00	0.77	0.24	1.01	1.31
Compound growth rate (per cent) -							
2019-2025	1.65	0.98	0.00	0.39	-0.06	0.57	0.86
2019-2029	1.73	1.13	0.00	0.54	0.04	0.72	1.00
HIGH - Levels							
2018	134.38	283.99	0.00	262.38	35.68	133.10	56.78
2019	139.18	291.24	0.00	267.23	36.17	135.89	58.25
2020	143.83	298.28	0.00	271.61	36.58	138.39	59.55
2021	148.35	305.01	0.00	275.54	36.95	140.75	60.87
2022	152.72	311.22	0.00	279.12	37.28	142.97	62.23
2023	157.40	317.75	0.00	283.27	37.72	145.59	63.81
2024	163.00	326.60	0.00	288.91	38.16	148.93	65.53
2025	168.75	335.64	0.00	294.68	38.63	152.34	67.33
2026	174.48	344.58	0.00	300.39	39.09	155.70	69.11
2027	180.20	353.47	0.00	305.99	39.55	159.09	70.94
2028	185.96	362.38	0.00	311.59	39.99	162.42	72.75
2029	191.94	371.69	0.00	317.58	40.47	165.96	74.69
Compound growth rate (per cent) -							
2019-2025	3.26	2.39	0.00	1.64	1.10	1.92	2.44
2019-2029	3.27	2.47	0.00	1.74	1.13	2.02	2.52
LOW - Levels							
2018	130.49	277.13	0.00	255.00	34.59	128.96	54.82
2019	131.21	277.15	0.00	254.37	34.30	128.55	54.46
2020	131.96	277.51	0.00	253.96	34.00	128.19	54.04
2021	132.21	276.70	0.00	252.62	33.64	127.52	53.54
2022	132.22	275.12	0.00	250.84	33.29	126.77	53.11
2023	132.56	274.24	0.00	249.59	33.02	126.32	52.82
2024	133.81	275.45	0.00	249.94	32.88	126.57	52.82
2025	135.08	276.75	0.00	250.52	32.77	126.90	52.85
2026	136.23	277.86	0.00	251.10	32.66	127.19	52.85
2027	137.32	278.85	0.00	251.55	32.55	127.45	52.83
2028	138.35	279.77	0.00	251.81	32.45	127.67	52.80
2029	139.48	280.94	0.00	252.24	32.38	127.98	52.83
Compound growth rate (per cent) -							
2019-2025	0.49	-0.02	0.00	-0.25	-0.76	-0.22	-0.50
2019-2029	0.61	0.14	0.00	-0.08	-0.58	-0.04	-0.30

All data are for the calendar year ending in December of the year specified.

Table 9.2 United Energy Terminal stations - Winter 50th Non-Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Diversity Factor
Unit	******************		MW	****************		per cent
BASE						
2015	24.73	80.83	297.46	89.60	197.29	4.04
2016	25.09	78.72	294.68	88.44	196.08	5.81
2017	28.72	73.62	288.53	85.68	190.65	6.34
2018	30.06	81.78	303.54	86.13	204.96	4.90
2019	30.32	82.17	304.93	86.45	207.42	4.90
2020	30.51	82.47	305.86	86.48	209.63	4.90
2021	30.65	82.47	305.86	86.40	211.52	4.90
2022	30.81	82.31	305.54	86.42	213.52	4.90
2023	31.07	82.46	306.33	86.75	216.17	4.90
2024	31.41	83.04	308.48	87.31	219.35	4.90
2025	31.78	83.56	310.41	87.88	222.62	4.90
2026	32.11	84.02	312.19	88.37	225.76	4.90
2027	32.44	84.43	313.75	88.80	228.87	4.90
2028	32.75	84.79	315.13	89.16	231.95	4.90
2029	33.11	85.19	316.64	89.60	235.33	4.90
Percentage changes						
2015	6.46	4.31	-5.76	1.86	1.19	-45.99
2016	1.46	-2.61	-0.93	-1.29	-0.61	43.99
2017	14.47	-6.48	-2.09	-3.12	-2.77	9.11
2018	4.68	11.08	5.20	0.53	7.51	-22.73
2019	0.86	0.49	0.46	0.36	1.20	0.00
2020	0.62	0.36	0.31	0.05	1.07	0.00
2021	0.47	0.00	0.00	-0.09	0.90	0.00
2022	0.52	-0.19	-0.11	0.02	0.94	0.00
2023	0.85	0.18	0.26	0.39	1.24	0.00
2024	1.10	0.71	0.70	0.65	1.47	0.00
2025	1.15	0.62	0.63	0.65	1.49	0.00
2026	1.05	0.55	0.57	0.56	1.41	0.00
2027	1.01	0.49	0.50	0.48	1.38	0.00
2028	0.97	0.43	0.44	0.41	1.35	0.00
2029	1.10	0.47	0.48	0.49	1.45	0.00
Compound growth rate (per cent) -						
2019-2025	0.78	0.28	0.30	0.27	1.19	0.00
2019-2029	0.88	0.36	0.38	0.36	1.27	0.00
HIGH - Levels						
2018	30.64	82.78	307.58	87.87	208.27	4.90
2019	31.31	83.95	312.75	89.54	213.28	4.90
2020	31.88	85.00	317.38	90.90	217.96	4.90
2021	32.45	85.88	321.49	92.18	222.58	4.90
2022	33.04	86.70	325.52	93.56	227.42	4.90
2023	33.73	87.62	329.99	95.23	232.81	4.90
2024	34.47	88.92	335.65	96.99	238.65	4.90
2025	35.24	90.25	341.38	98.80	244.69	4.90
2026	35.98	91.51	346.89	100.55	250.65	4.90
2027	36.75	92.71	352.04	102.20	256.71	4.90
2028	37.49	93.86	357.08	103.80	262.69	4.90
2029	38.30	95.08	362.33	105.50	269.07	4.90
Compound growth rate (per cent) -						
2019-2025	1.99	1.21	1.47	1.65	2.32	0.00
2019-2029	2.04	1.25	1.48	1.65	2.35	0.00
LOW - Levels						
2018	29.69	81.12	301.18	85.04	202.75	4.90
2019	29.71	81.05	299.36	84.57	203.65	4.90
2020	29.68	80.96	297.41	83.91	204.44	4.90
2021	29.62	80.61	294.68	83.16	204.97	4.90
2022	29.58	80.15	291.75	82.54	205.65	4.90
2023	29.61	79.87	289.60	82.18	206.78	4.90
2024	29.76	80.01	288.88	82.18	208.60	4.90
2025	29.94	80.16	288.15	82.21	210.46	4.90
2026	30.09	80.25	287.30	82.17	212.23	4.90
2027	30.23	80.31	286.30	82.09	214.01	4.90
2028	30.37	80.34	285.24	81.98	215.80	4.90
2029	30.53	80.41	284.48	81.96	217.76	4.90
Compound growth rate (per cent) -						
2019-2025	0.13	-0.18	-0.63	-0.47	0.55	0.00
2019-2029	0.27	-0.08	-0.51	-0.31	0.67	0.00

All data are for the calendar year ending in December of the year specified.

Table 9.3 United Energy Terminal stations - Summer 10th Non-Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	***************************			MW	***************************		
BASE							
2015	155.56	295.95	0.00	282.63	36.45	145.38	52.52
2016	165.51	303.74	0.00	331.67	40.06	166.69	63.68
2017	160.20	322.36	0.00	354.01	38.38	162.19	56.64
2018	165.37	317.47	0.00	335.11	39.64	179.49	62.65
2019	186.19	350.34	0.00	374.01	44.77	202.49	70.96
2020	189.43	354.63	0.00	375.42	45.36	204.16	71.74
2021	191.68	357.32	0.00	375.11	45.70	204.81	72.04
2022	194.20	360.13	0.00	375.14	46.21	205.78	72.60
2023	198.62	365.83	0.00	378.53	47.27	208.79	74.07
2024	201.48	368.81	0.00	378.77	47.86	210.12	74.92
2025	207.73	378.55	0.00	384.96	49.01	214.63	76.78
2026	213.63	387.69	0.00	390.75	50.16	218.99	78.66
2027	219.34	396.65	0.00	396.23	51.29	223.09	80.46
2028	222.81	401.49	0.00	397.56	51.93	224.93	81.45
2029	226.44	406.55	0.00	399.05	52.62	226.93	82.49
2030	231.22	413.51	0.00	402.54	53.61	230.20	84.02
Percentage changes							
2015	-5.15	-12.78	0.00	-14.83	-13.75	-20.63	-24.85
2016	6.40	2.63	0.00	17.35	9.90	14.66	21.25
2017	-3.21	6.13	0.00	6.74	-4.19	-2.70	-11.06
2018	3.23	-1.52	0.00	-5.34	3.28	10.67	10.61
2019	12.59	10.35	0.00	11.61	12.94	12.82	13.27
2020	1.74	1.22	0.00	0.38	1.31	0.82	1.09
2021	1.19	0.76	0.00	-0.08	0.75	0.32	0.42
2022	1.32	0.78	0.00	0.01	1.12	0.47	0.78
2023	2.27	1.58	0.00	0.91	2.28	1.46	2.03
2024	1.44	0.82	0.00	0.06	1.25	0.64	1.15
2025	3.10	2.64	0.00	1.63	2.40	2.15	2.49
2026	2.84	2.41	0.00	1.50	2.35	2.03	2.44
2027	2.68	2.31	0.00	1.40	2.26	1.87	2.30
2028	1.58	1.22	0.00	0.33	1.24	0.82	1.22
2029	1.63	1.26	0.00	0.38	1.34	0.89	1.28
2030	2.11	1.71	0.00	0.87	1.87	1.44	1.86
Compound growth rate (per cent) -							
2019-2025	1.84	1.30	0.00	0.48	1.52	0.98	1.32
2019-2030	1.99	1.52	0.00	0.67	1.65	1.17	1.55
HIGH - Levels							
2019	189.53	355.52	0.00	380.34	45.63	206.21	72.47
2020	194.33	361.79	0.00	382.28	46.33	208.37	73.56
2021	198.35	366.71	0.00	382.42	46.80	209.51	74.21
2022	202.94	372.68	0.00	383.36	47.43	211.20	75.17
2023	209.77	382.37	0.00	388.32	48.60	215.19	77.09
2024	214.79	388.28	0.00	389.86	49.41	217.44	78.47
2025	223.49	401.73	0.00	397.74	50.76	223.11	80.89
2026	232.41	415.36	0.00	405.68	52.18	228.85	83.41
2027	241.23	428.71	0.00	413.24	53.57	234.36	85.87
2028	247.80	437.74	0.00	416.74	54.49	237.85	87.55
2029	254.59	447.18	0.00	420.50	55.45	241.35	89.26
2030	262.37	458.15	0.00	425.83	56.62	245.84	91.36
Compound growth rate (per cent) -							
2019-2025	2.78	2.06	0.00	0.75	1.79	1.32	1.85
2019-2030	3.00	2.33	0.00	1.03	1.98	1.61	2.13
LOW - Levels							
2019	183.00	344.83	0.00	367.63	43.90	198.55	69.47
2020	185.21	347.55	0.00	369.06	44.41	199.97	70.00
2021	185.96	347.86	0.00	367.73	44.53	199.83	69.86
2022	186.99	348.46	0.00	366.86	44.81	200.13	69.97
2023	189.62	351.63	0.00	369.09	45.57	202.37	70.90
2024	190.76	352.09	0.00	368.12	45.95	202.85	71.29
2025	195.01	358.73	0.00	372.82	46.96	206.25	72.72
2026	198.77	364.49	0.00	376.79	47.88	209.22	74.00
2027	202.55	370.30	0.00	380.98	48.84	212.23	75.31
2028	204.14	372.08	0.00	380.98	49.30	213.00	75.80
2029	205.97	374.30	0.00	381.19	49.85	214.00	76.38
2030	208.92	378.69	0.00	383.32	50.68	216.06	77.39
Compound growth rate (per cent) -							
2019-2025	1.06	0.66	0.00	0.23	1.13	0.64	0.77
2019-2030	1.21	0.86	0.00	0.38	1.31	0.77	0.99

All data are for the financial year ending in June of the year specified.

Table 9.3 United Energy Terminal stations - Summer 10th Non-Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Diversity Factor
Unit	*******************		MW	*****************		per cent
BASE						
2015	27.70	94.91	362.91	115.73	257.77	5.25
2016	36.69	101.47	388.53	129.62	281.04	2.30
2017	31.28	93.53	377.74	123.75	269.57	7.06
2018	38.07	99.82	385.15	134.55	302.83	7.79
2019	43.05	112.38	420.10	147.81	338.04	3.00
2020	43.25	113.04	421.97	147.91	342.29	3.00
2021	43.15	113.05	421.34	146.97	344.65	3.00
2022	43.21	113.19	421.52	146.49	348.07	3.00
2023	43.82	114.47	426.32	147.88	355.79	3.00
2024	44.01	114.70	427.23	147.86	360.03	3.00
2025	44.76	116.70	434.39	149.69	368.73	3.00
2026	45.49	118.44	440.65	151.35	377.23	3.00
2027	46.15	120.02	446.43	152.75	385.21	3.00
2028	46.33	120.31	447.42	152.52	389.35	3.00
2029	46.55	120.62	448.52	152.34	393.81	3.00
2030	47.03	121.47	451.64	152.98	400.50	3.00
Percentage changes						
2015	-20.47	-15.73	-15.33	-19.62	-11.12	45.52
2016	32.45	6.91	7.06	12.00	9.03	-56.15
2017	-14.75	-7.82	-2.78	-4.53	-4.08	206.55
2018	21.71	6.73	1.96	8.73	12.34	10.33
2019	13.09	12.59	9.07	9.86	11.63	-61.47
2020	0.45	0.59	0.45	0.07	1.25	0.00
2021	-0.22	0.01	-0.15	-0.64	0.69	0.00
2022	0.13	0.13	0.04	-0.32	0.99	0.00
2023	1.40	1.13	1.14	0.95	2.22	0.00
2024	0.44	0.20	0.21	-0.01	1.19	0.00
2025	1.71	1.74	1.68	1.24	2.42	0.00
2026	1.62	1.49	1.44	1.11	2.30	0.00
2027	1.45	1.34	1.31	0.92	2.12	0.00
2028	0.40	0.24	0.22	-0.15	1.07	0.00
2029	0.46	0.26	0.25	-0.12	1.15	0.00
2030	1.02	0.70	0.70	0.42	1.70	0.00
Compound growth rate (per cent) -						
2019-2025	0.65	0.63	0.56	0.21	1.46	0.00
2019-2030	0.81	0.71	0.66	0.31	1.55	0.00
HIGH - Levels						
2019	43.87	113.80	425.80	150.75	343.58	3.00
2020	44.13	114.21	429.24	151.95	347.79	3.00
2021	44.14	114.10	430.64	152.25	350.41	3.00
2022	44.29	114.18	432.92	152.94	354.08	3.00
2023	45.02	115.50	440.16	155.57	362.20	3.00
2024	45.39	115.67	443.21	156.96	367.24	3.00
2025	46.31	117.61	452.67	160.17	376.83	3.00
2026	47.26	119.53	462.06	163.44	386.65	3.00
2027	48.15	121.25	470.79	166.45	395.97	3.00
2028	48.61	121.70	474.49	167.91	402.00	3.00
2029	49.06	122.13	478.27	169.30	407.93	3.00
2030	49.71	122.91	483.41	171.35	415.57	3.00
Compound growth rate (per cent) -						
2019-2025	0.91	0.55	1.03	1.01	1.55	0.00
2019-2030	1.14	0.70	1.16	1.17	1.74	0.00
LOW - Levels						
2019	42.27	110.79	414.27	145.11	332.35	3.00
2020	42.46	111.66	414.98	144.45	336.88	3.00
2021	42.24	111.58	412.05	142.36	338.51	3.00
2022	42.16	111.67	410.12	140.74	341.23	3.00
2023	42.56	112.75	412.11	140.73	347.67	3.00
2024	42.61	112.87	410.83	139.57	351.06	3.00
2025	43.22	114.61	415.31	140.25	358.80	3.00
2026	43.74	116.02	418.57	140.57	365.69	3.00
2027	44.25	117.42	421.89	140.84	372.62	3.00
2028	44.29	117.52	420.58	139.58	375.72	3.00
2029	44.38	117.73	419.76	138.45	379.34	3.00
2030	44.70	118.49	421.30	138.05	384.83	3.00
Compound growth rate (per cent) -						
2019-2025	0.37	0.57	0.04	-0.57	1.28	0.00
2019-2030	0.51	0.61	0.15	-0.45	1.34	0.00

All data are for the financial year ending in June of the year specified.

Table 9.4 United Energy Terminal stations - Summer 50th Non-Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	****************************			MW	****************************		
BASE							
2015	155.56	295.95	0.00	282.63	36.45	145.38	52.52
2016	165.51	303.74	0.00	331.67	40.06	166.69	63.68
2017	160.20	322.36	0.00	354.01	38.38	162.19	56.64
2018	165.37	317.47	0.00	335.11	39.64	179.49	62.65
2019	173.45	330.38	0.00	342.95	40.98	182.35	63.70
2020	175.34	332.19	0.00	341.93	41.26	182.62	63.98
2021	177.47	334.67	0.00	341.59	41.58	183.19	64.25
2022	180.54	338.55	0.00	342.86	42.22	184.74	65.00
2023	185.32	345.07	0.00	347.10	43.36	188.08	66.58
2024	188.49	348.67	0.00	348.11	44.03	189.74	67.54
2025	192.75	354.84	0.00	350.84	44.73	192.22	68.67
2026	198.43	363.66	0.00	356.36	45.83	196.30	70.43
2027	202.88	370.37	0.00	359.74	46.67	199.11	71.76
2028	206.58	375.67	0.00	361.69	47.37	201.20	72.82
2029	211.20	382.54	0.00	365.11	48.30	204.17	74.21
2030	214.19	386.33	0.00	365.67	48.88	205.66	75.08
Percentage changes							
2015	-5.15	-12.78	0.00	-14.83	-13.75	-20.63	-24.85
2016	6.40	2.63	0.00	17.35	9.90	14.66	21.25
2017	-3.21	6.13	0.00	6.74	-4.19	-2.70	-11.06
2018	3.23	-1.52	0.00	-5.34	3.28	10.67	10.61
2019	4.89	4.07	0.00	2.34	3.37	1.59	1.68
2020	1.09	0.55	0.00	-0.30	0.68	0.15	0.44
2021	1.21	0.75	0.00	-0.10	0.78	0.31	0.41
2022	1.73	1.16	0.00	0.37	1.56	0.85	1.18
2023	2.65	1.92	0.00	1.24	2.70	1.81	2.42
2024	1.71	1.04	0.00	0.29	1.54	0.88	1.44
2025	2.26	1.77	0.00	0.78	1.58	1.31	1.67
2026	2.95	2.48	0.00	1.58	2.46	2.12	2.57
2027	2.24	1.84	0.00	0.95	1.84	1.43	1.89
2028	1.83	1.43	0.00	0.54	1.50	1.05	1.48
2029	2.23	1.83	0.00	0.94	1.96	1.48	1.90
2030	1.41	0.99	0.00	0.16	1.19	0.73	1.18
Compound growth rate (per cent) -							
2019-2025	1.77	1.20	0.00	0.38	1.47	0.88	1.26
2019-2030	1.94	1.43	0.00	0.59	1.62	1.10	1.51
HIGH - Levels							
2019	176.68	335.39	0.00	349.00	41.80	185.88	65.14
2020	179.95	338.88	0.00	348.33	42.17	186.57	65.70
2021	183.70	343.37	0.00	348.38	42.61	187.57	66.30
2022	188.64	350.09	0.00	350.38	43.36	189.75	67.42
2023	195.65	360.22	0.00	355.97	44.58	193.96	69.40
2024	200.83	366.55	0.00	358.18	45.45	196.48	70.86
2025	207.24	375.97	0.00	362.35	46.32	199.97	72.48
2026	215.66	388.82	0.00	369.73	47.65	205.26	74.82
2027	222.95	399.55	0.00	375.03	48.73	209.38	76.75
2028	229.57	408.77	0.00	378.97	49.69	212.97	78.46
2029	237.31	419.98	0.00	384.62	50.88	217.42	80.51
2030	242.87	427.14	0.00	386.69	51.61	219.92	81.86
Compound growth rate (per cent) -							
2019-2025	2.69	1.92	0.00	0.63	1.72	1.23	1.80
2019-2030	2.93	2.22	0.00	0.94	1.93	1.54	2.10
LOW - Levels							
2019	170.38	325.06	0.00	336.87	40.15	178.61	62.27
2020	171.44	325.64	0.00	336.07	40.38	178.74	62.36
2021	172.19	325.95	0.00	334.80	40.49	178.55	62.20
2022	173.94	327.94	0.00	335.38	40.93	179.54	62.56
2023	177.14	332.24	0.00	338.70	41.81	182.23	63.63
2024	178.71	333.53	0.00	338.63	42.28	183.12	64.16
2025	181.25	337.05	0.00	340.14	42.87	184.67	64.93
2026	185.05	342.92	0.00	344.19	43.79	187.55	66.18
2027	187.79	346.86	0.00	346.46	44.49	189.40	67.06
2028	189.82	349.45	0.00	347.34	45.05	190.57	67.69
2029	192.69	353.61	0.00	349.51	45.84	192.56	68.62
2030	194.21	355.39	0.00	349.11	46.30	193.11	69.08
Compound growth rate (per cent) -							
2019-2025	1.04	0.61	0.00	0.16	1.10	0.56	0.70
2019-2030	1.20	0.81	0.00	0.33	1.31	0.71	0.95

All data are for the financial year ending in June of the year specified.

Table 9.4 United Energy Terminal stations - Summer 50th Non-Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Diversity Factor
Unit	*******************		MW	*****************		per cent
BASE						
2015	27.70	94.91	362.91	115.73	257.77	5.25
2016	36.69	101.47	388.53	129.62	281.04	2.30
2017	31.28	93.53	377.74	123.75	269.57	7.06
2018	38.07	99.82	385.15	134.55	302.83	7.79
2019	38.70	100.39	379.10	127.72	309.50	4.00
2020	38.62	100.30	378.32	126.96	311.25	4.00
2021	38.53	100.27	377.73	126.09	313.29	4.00
2022	38.73	100.75	379.32	126.14	317.54	4.00
2023	39.42	102.22	385.03	127.80	325.70	4.00
2024	39.70	102.65	386.83	128.12	330.34	4.00
2025	40.04	103.57	390.11	128.66	335.44	4.00
2026	40.73	105.17	396.07	130.19	343.36	4.00
2027	41.15	106.09	399.52	130.83	348.98	4.00
2028	41.41	106.54	401.28	130.92	353.39	4.00
2029	41.85	107.39	404.57	131.51	359.40	4.00
2030	41.99	107.34	404.50	131.11	362.85	4.00
Percentage changes						
2015	-20.47	-15.73	-15.33	-19.62	-11.12	45.52
2016	32.45	6.91	7.06	12.00	9.03	-56.15
2017	-14.75	-7.82	-2.78	-4.53	-4.08	206.55
2018	21.71	6.73	1.96	8.73	12.34	10.33
2019	1.64	0.57	-1.57	-5.08	2.20	-48.62
2020	-0.20	-0.09	-0.21	-0.60	0.57	0.00
2021	-0.23	-0.02	-0.16	-0.68	0.66	0.00
2022	0.52	0.48	0.42	0.04	1.36	0.00
2023	1.78	1.45	1.50	1.31	2.57	0.00
2024	0.71	0.42	0.47	0.25	1.43	0.00
2025	0.88	0.89	0.85	0.41	1.54	0.00
2026	1.72	1.55	1.53	1.20	2.36	0.00
2027	1.02	0.87	0.87	0.49	1.64	0.00
2028	0.64	0.43	0.44	0.07	1.27	0.00
2029	1.06	0.80	0.82	0.45	1.70	0.00
2030	0.33	-0.05	-0.02	-0.30	0.96	0.00
Compound growth rate (per cent) -						
2019-2025	0.57	0.52	0.48	0.12	1.35	0.00
2019-2030	0.74	0.61	0.59	0.24	1.46	0.00
HIGH - Levels						
2019	39.47	101.69	384.42	130.46	314.78	4.00
2020	39.44	101.33	384.88	130.66	316.36	4.00
2021	39.45	101.19	386.07	130.92	318.60	4.00
2022	39.73	101.57	389.41	132.00	322.95	4.00
2023	40.51	103.03	397.15	134.74	331.33	4.00
2024	40.96	103.39	400.84	136.35	336.68	4.00
2025	41.45	104.22	405.96	138.03	342.49	4.00
2026	42.33	105.94	414.54	140.96	351.46	4.00
2027	42.96	106.97	420.57	143.00	358.32	4.00
2028	43.46	107.53	424.62	144.56	364.42	4.00
2029	44.13	108.48	430.41	146.62	371.85	4.00
2030	44.41	108.32	431.79	147.32	376.00	4.00
Compound growth rate (per cent) -						
2019-2025	0.82	0.41	0.91	0.94	1.42	0.00
2019-2030	1.08	0.58	1.06	1.11	1.63	0.00
LOW - Levels						
2019	37.95	98.92	373.69	125.22	304.08	4.00
2020	37.89	99.07	372.09	123.84	306.28	4.00
2021	37.68	98.97	369.47	121.94	307.67	4.00
2022	37.77	99.45	369.34	121.00	311.41	4.00
2023	38.28	100.78	372.67	121.44	318.53	4.00
2024	38.43	101.14	372.56	120.75	322.45	4.00
2025	38.67	101.86	373.66	120.35	326.83	4.00
2026	39.19	103.23	377.17	120.78	333.47	4.00
2027	39.47	103.99	378.58	120.47	338.21	4.00
2028	39.62	104.33	378.46	119.68	341.84	4.00
2029	39.93	105.08	379.99	119.38	347.08	4.00
2030	39.96	105.05	378.96	118.24	349.70	4.00
Compound growth rate (per cent) -						
2019-2025	0.31	0.49	0.00	-0.66	1.21	0.00
2019-2030	0.47	0.55	0.13	-0.52	1.28	0.00

All data are for the financial year ending in June of the year specified.

10. Maximum coincident demand forecasts to 2029-30 for the United Energy terminal stations

10.1 Introduction

This section presents maximum coincident demand forecasts for summer and winter for the United Energy region to 2030. The methodology for forecasting maximum demands for summer and winter is outlined in Section 5.

10.2 Forecasts of terminal station maximum demand – summary of approach

Forecasts of maximum coincident summer and winter demands (MDs) to 2029-30 are presented for the following:

- the 10th percentile: exceeded once in 10 years; and
- the 50th percentile: exceeded once in two years.

Maximum coincident demands for United Energy terminal stations were derived by applying the calculated or assumed coincidence factors for each terminal station presented in Section 5.8.

10.3 Forecasts of summer and winter maximum coincident demands in the United Energy region

Tables 10.1 to 10.4 present forecasts of winter and summer maximum coincident demands for United Energy terminal stations for alternative probabilities of exceedence.

Tables 10.1 and 10.2 show the winter peak for the 10th and 50th percentile by United Energy terminal station.

Tables 10.3 and 10.4 show the summer peak for the 10th and 50th percentile by United Energy terminal station.

The data in the winter tables extends to 2029. The forecast for winter MDs are on a calendar year basis. The forecasts for summer MDs are on a financial year basis.

Figures 10.1 and 10.2 summarise the projected growth by terminal station for winter and summer for the 50th percentile.

Figure 10.1: Winter coincident peak demand – 50th percentile – Base scenario (percentage growth 2019-2029)

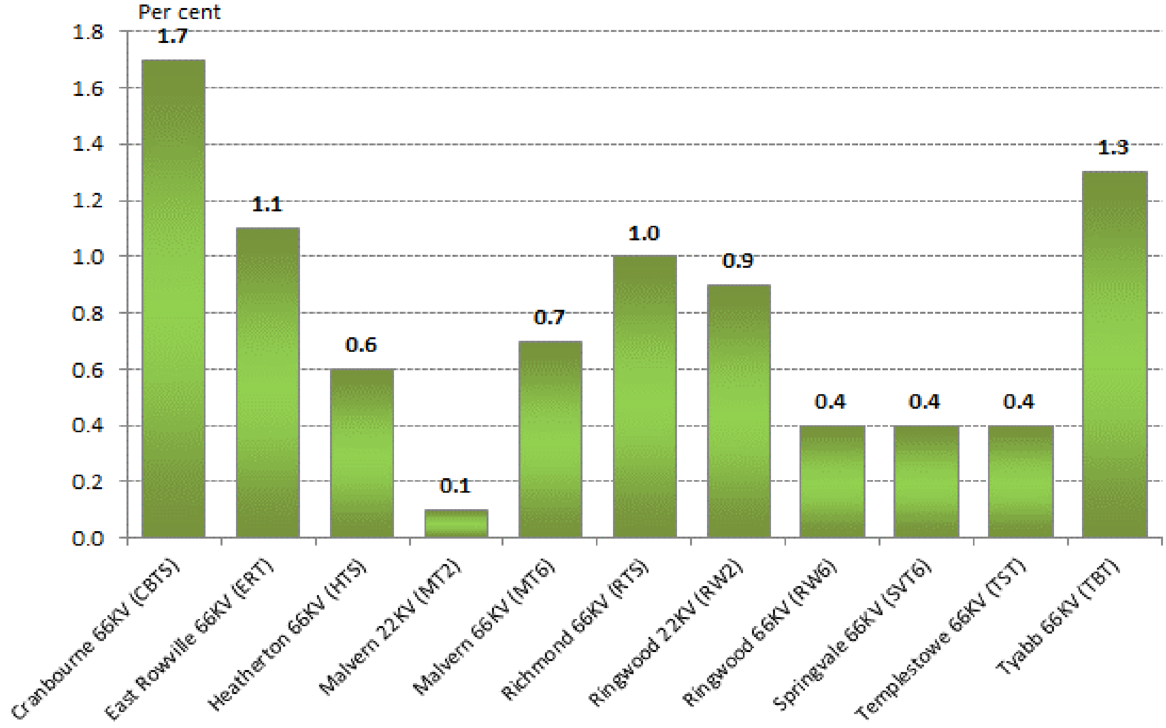


Figure 10.2: Summer coincident peak demand – 50th percentile – Base scenario (percentage growth 2019-2030)

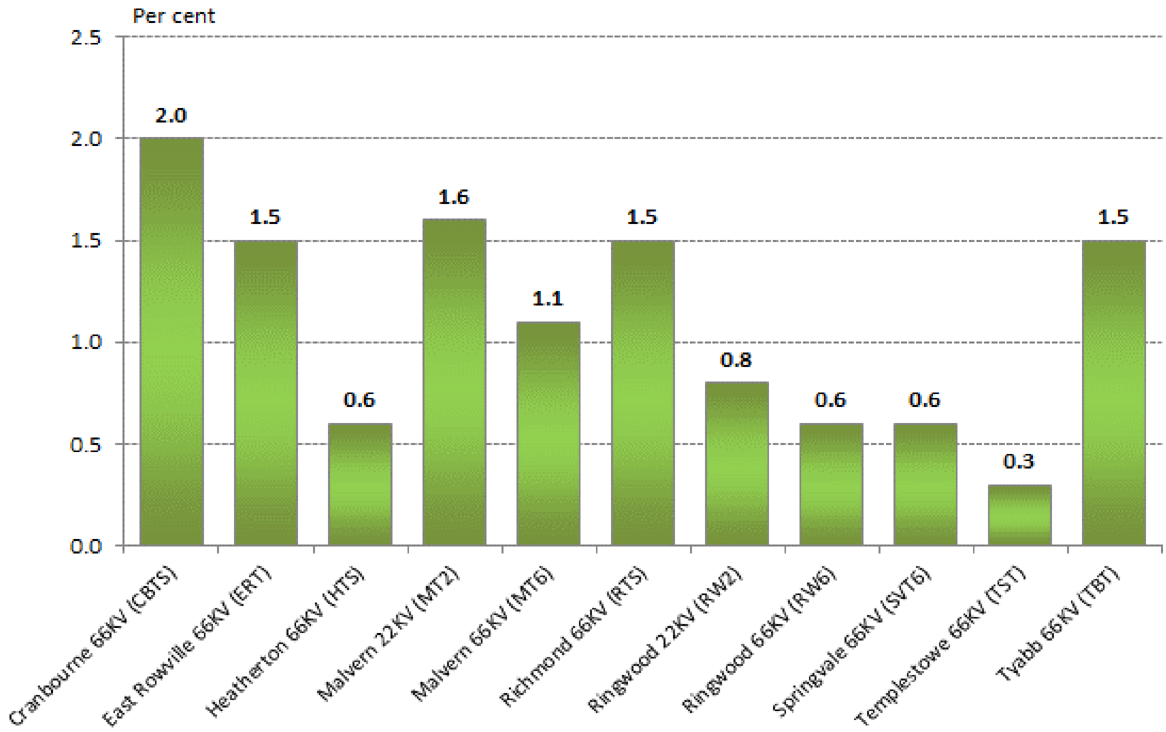


Table 10.1 United Energy Terminal stations - Winter 10th Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	***************************			MW	***************************		
BASE							
2015	129.72	231.89	0.00	258.24	27.10	124.51	54.03
2016	123.46	222.47	0.00	248.56	30.38	120.35	52.38
2017	126.87	218.17	0.00	245.73	27.46	119.06	46.69
2018	132.22	234.84	0.00	258.46	34.84	128.90	53.77
2019	134.81	237.82	0.00	260.08	34.88	129.82	54.28
2020	137.29	240.78	0.00	261.67	34.87	130.69	54.69
2021	139.24	242.62	0.00	262.19	34.81	131.09	55.01
2022	140.83	243.54	0.00	261.90	34.72	131.21	55.33
2023	143.10	245.65	0.00	262.80	34.72	131.98	55.87
2024	146.25	249.54	0.00	265.20	34.77	133.45	56.60
2025	149.32	253.34	0.00	267.64	34.85	134.96	57.39
2026	152.31	257.09	0.00	270.05	34.93	136.40	58.15
2027	155.24	260.74	0.00	272.31	35.00	137.79	58.89
2028	158.11	264.29	0.00	274.45	35.07	139.15	59.62
2029	161.10	268.01	0.00	276.79	35.18	140.66	60.44
Percentage changes							
2015	5.58	9.97	0.00	14.41	3.20	-1.51	5.38
2016	-4.83	-4.06	0.00	-3.75	12.10	-3.34	-3.05
2017	2.76	-1.93	0.00	-1.14	-9.61	-1.07	-10.86
2018	4.22	7.64	0.00	5.18	26.88	8.26	15.16
2019	1.96	1.27	0.00	0.63	0.10	0.72	0.95
2020	1.84	1.24	0.00	0.61	-0.01	0.66	0.75
2021	1.42	0.77	0.00	0.20	-0.18	0.31	0.58
2022	1.14	0.38	0.00	-0.11	-0.27	0.09	0.58
2023	1.61	0.87	0.00	0.34	0.01	0.59	0.99
2024	2.21	1.58	0.00	0.91	0.15	1.11	1.30
2025	2.10	1.53	0.00	0.92	0.24	1.13	1.40
2026	2.00	1.48	0.00	0.90	0.22	1.07	1.32
2027	1.92	1.42	0.00	0.84	0.21	1.02	1.27
2028	1.85	1.36	0.00	0.79	0.21	0.99	1.24
2029	1.89	1.41	0.00	0.85	0.29	1.08	1.38
Compound growth rate (per cent) -							
2019-2025	1.72	1.06	0.00	0.48	-0.01	0.65	0.93
2019-2029	1.80	1.20	0.00	0.62	0.08	0.81	1.08
HIGH - Levels							
2018	134.86	238.72	0.00	263.37	35.54	131.48	54.97
2019	139.76	245.00	0.00	268.46	36.04	134.34	56.44
2020	144.52	251.10	0.00	273.09	36.46	136.92	57.75
2021	149.15	256.96	0.00	277.27	36.84	139.36	59.07
2022	153.63	262.37	0.00	281.09	37.19	141.67	60.43
2023	158.42	268.06	0.00	285.48	37.63	144.36	62.00
2024	164.14	275.71	0.00	291.39	38.09	147.78	63.71
2025	170.02	283.52	0.00	297.43	38.57	151.27	65.50
2026	175.90	291.27	0.00	303.43	39.04	154.72	67.28
2027	181.75	298.97	0.00	309.30	39.51	158.19	69.11
2028	187.66	306.70	0.00	315.19	39.97	161.61	70.91
2029	193.79	314.77	0.00	321.48	40.46	165.24	72.85
Compound growth rate (per cent) -							
2019-2025	3.32	2.46	0.00	1.72	1.14	2.00	2.51
2019-2029	3.32	2.54	0.00	1.82	1.16	2.09	2.59
LOW - Levels							
2018	130.54	232.22	0.00	255.16	34.36	126.99	52.91
2019	131.34	232.39	0.00	254.72	34.10	126.68	52.60
2020	132.17	232.86	0.00	254.52	33.82	126.43	52.24
2021	132.52	232.34	0.00	253.37	33.49	125.87	51.80
2022	132.60	231.17	0.00	251.78	33.16	125.23	51.41
2023	133.02	230.58	0.00	250.71	32.90	124.87	51.17
2024	134.36	231.76	0.00	251.27	32.78	125.21	51.20
2025	135.71	233.01	0.00	252.05	32.69	125.64	51.27
2026	136.95	234.10	0.00	252.83	32.60	126.02	51.31
2027	138.13	235.09	0.00	253.48	32.51	126.38	51.33
2028	139.25	236.03	0.00	253.95	32.42	126.70	51.34
2029	140.47	237.17	0.00	254.59	32.36	127.11	51.40
Compound growth rate (per cent) -							
2019-2025	0.55	0.04	0.00	-0.18	-0.70	-0.14	-0.43
2019-2029	0.67	0.20	0.00	-0.01	-0.52	0.03	-0.23

All data are for the calendar year ending in December of the year specified.

Table 10.1 United Energy Terminal stations - Winter 10th Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Total
Unit	************************		MW	*********************		
BASE						
2015	24.73	80.83	297.46	89.49	195.74	1513.74
2016	22.81	77.28	283.10	87.56	193.45	1461.80
2017	24.96	73.29	277.98	85.47	186.83	1432.51
2018	29.44	82.98	302.51	87.67	206.68	1552.30
2019	29.72	83.46	304.15	88.06	209.33	1566.42
2020	29.93	83.84	305.36	88.19	211.76	1579.05
2021	30.10	83.91	305.63	88.18	213.84	1586.61
2022	30.27	83.82	305.54	88.27	216.01	1591.44
2023	30.55	84.05	306.58	88.68	218.87	1602.86
2024	30.91	84.72	309.01	89.34	222.27	1622.04
2025	31.29	85.32	311.21	89.99	225.77	1641.09
2026	31.64	85.88	313.26	90.58	229.14	1659.41
2027	31.98	86.37	315.11	91.09	232.49	1677.02
2028	32.32	86.82	316.77	91.55	235.81	1693.98
2029	32.70	87.31	318.57	92.08	239.43	1712.27
Percentage changes						
2015	10.40	5.17	0.03	1.74	0.39	4.90
2016	-7.76	-4.39	-4.83	-2.16	-1.17	-3.43
2017	9.43	-5.16	-1.81	-2.39	-3.42	-2.00
2018	17.95	13.22	8.82	2.57	10.62	8.36
2019	0.94	0.58	0.54	0.45	1.29	0.91
2020	0.72	0.46	0.40	0.14	1.16	0.81
2021	0.55	0.09	0.09	-0.01	0.98	0.48
2022	0.59	-0.11	-0.03	0.10	1.02	0.30
2023	0.92	0.27	0.34	0.47	1.32	0.72
2024	1.17	0.80	0.79	0.73	1.55	1.20
2025	1.23	0.71	0.71	0.73	1.58	1.17
2026	1.12	0.65	0.66	0.65	1.49	1.12
2027	1.09	0.58	0.59	0.57	1.46	1.06
2028	1.05	0.52	0.53	0.50	1.43	1.01
2029	1.18	0.57	0.57	0.58	1.53	1.08
Compound growth rate (per cent) -						
2019-2025	0.86	0.37	0.38	0.36	1.27	0.78
2019-2029	0.96	0.45	0.46	0.45	1.35	0.89
HIGH - Levels						
2018	30.05	84.15	307.10	89.60	210.40	1580.25
2019	30.72	85.42	312.53	91.38	215.64	1615.73
2020	31.31	86.57	317.43	92.84	220.55	1648.53
2021	31.89	87.55	321.83	94.23	225.41	1679.56
2022	32.49	88.46	326.13	95.72	230.48	1709.66
2023	33.18	89.47	330.88	97.50	236.11	1743.08
2024	33.92	90.89	336.84	99.37	242.23	1784.07
2025	34.70	92.33	342.88	101.32	248.55	1826.09
2026	35.45	93.70	348.71	103.19	254.79	1867.47
2027	36.23	95.02	354.18	104.97	261.15	1908.38
2028	36.99	96.29	359.56	106.69	267.43	1949.00
2029	37.80	97.63	365.16	108.52	274.13	1991.85
Compound growth rate (per cent) -						
2019-2025	2.05	1.30	1.56	1.74	2.40	2.06
2019-2029	2.10	1.35	1.57	1.73	2.43	2.11
LOW - Levels						
2018	29.04	82.21	299.75	86.44	204.17	1533.77
2019	29.09	82.19	298.17	86.03	205.24	1532.55
2020	29.09	82.17	296.46	85.44	206.20	1531.41
2021	29.06	81.88	293.97	84.75	206.89	1525.93
2022	29.05	81.48	291.26	84.18	207.72	1519.03
2023	29.10	81.26	289.32	83.88	209.01	1515.83
2024	29.27	81.47	288.83	83.94	211.01	1521.10
2025	29.46	81.69	288.33	84.04	213.06	1526.95
2026	29.63	81.85	287.70	84.08	215.02	1532.11
2027	29.80	81.98	286.92	84.07	216.99	1536.69
2028	29.97	82.09	286.09	84.03	218.98	1540.86
2029	30.15	82.23	285.56	84.08	221.14	1546.26
Compound growth rate (per cent) -						
2019-2025	0.22	-0.10	-0.56	-0.39	0.63	-0.06
2019-2029	0.36	0.01	-0.43	-0.23	0.75	0.09

All data are for the calendar year ending in December of the year specified.

Table 10.2 United Energy Terminal stations - Winter 50th Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	***************************			MW	***************************		
BASE							
2015	129.72	231.89	0.00	258.24	27.10	124.51	54.03
2016	123.46	222.47	0.00	248.56	30.38	120.35	52.38
2017	126.87	218.17	0.00	245.73	27.46	119.06	46.69
2018	129.90	230.71	0.00	253.91	33.26	126.63	52.82
2019	132.36	233.48	0.00	255.31	33.27	127.45	53.29
2020	134.71	236.22	0.00	256.68	33.25	128.20	53.65
2021	136.55	237.87	0.00	256.99	33.18	128.50	53.92
2022	138.02	238.59	0.00	256.50	33.08	128.51	54.20
2023	140.16	240.50	0.00	257.19	33.07	129.17	54.70
2024	143.18	244.15	0.00	259.34	33.10	130.52	55.37
2025	146.11	247.72	0.00	261.54	33.17	131.90	56.11
2026	148.95	251.22	0.00	263.70	33.23	133.22	56.81
2027	151.73	254.64	0.00	265.71	33.29	134.49	57.50
2028	154.46	257.95	0.00	267.61	33.34	135.72	58.17
2029	157.29	261.42	0.00	269.70	33.43	137.10	58.94
Percentage changes							
2015	5.58	9.97	0.00	14.41	3.20	-1.51	5.38
2016	-4.83	-4.06	0.00	-3.75	12.10	-3.34	-3.05
2017	2.76	-1.93	0.00	-1.14	-9.61	-1.07	-10.86
2018	2.39	5.75	0.00	3.33	21.11	6.36	13.14
2019	1.90	1.20	0.00	0.55	0.06	0.64	0.88
2020	1.78	1.18	0.00	0.53	-0.06	0.59	0.67
2021	1.36	0.70	0.00	0.12	-0.23	0.24	0.51
2022	1.08	0.31	0.00	-0.19	-0.31	0.01	0.52
2023	1.55	0.80	0.00	0.27	-0.03	0.51	0.92
2024	2.15	1.52	0.00	0.84	0.11	1.04	1.23
2025	2.04	1.46	0.00	0.85	0.20	1.06	1.33
2026	1.95	1.41	0.00	0.82	0.18	1.00	1.25
2027	1.87	1.36	0.00	0.77	0.18	0.95	1.21
2028	1.80	1.30	0.00	0.71	0.17	0.92	1.17
2029	1.83	1.35	0.00	0.78	0.25	1.02	1.32
Compound growth rate (per cent) -							
2019-2025	1.66	0.99	0.00	0.40	-0.05	0.57	0.86
2019-2029	1.74	1.14	0.00	0.55	0.05	0.73	1.01
HIGH - Levels							
2018	132.24	234.09	0.00	258.26	33.87	128.93	53.91
2019	136.98	240.09	0.00	263.07	34.33	131.64	55.31
2020	141.58	245.92	0.00	267.41	34.73	134.08	56.55
2021	146.04	251.51	0.00	271.32	35.08	136.38	57.81
2022	150.36	256.65	0.00	274.86	35.40	138.55	59.11
2023	154.98	262.05	0.00	278.96	35.82	141.09	60.61
2024	160.51	269.39	0.00	284.56	36.24	144.36	62.25
2025	166.19	276.88	0.00	290.28	36.69	147.68	63.97
2026	171.87	284.29	0.00	295.95	37.13	150.96	65.68
2027	177.52	291.67	0.00	301.50	37.58	154.27	67.43
2028	183.22	299.05	0.00	307.06	38.00	157.52	69.15
2029	189.14	306.78	0.00	313.01	38.46	160.97	71.01
Compound growth rate (per cent) -							
2019-2025	3.27	2.40	0.00	1.65	1.11	1.93	2.46
2019-2029	3.28	2.48	0.00	1.75	1.14	2.03	2.53
LOW - Levels							
2018	128.42	228.45	0.00	251.01	32.83	124.92	52.05
2019	129.13	228.47	0.00	250.40	32.56	124.53	51.71
2020	129.87	228.78	0.00	250.01	32.27	124.19	51.31
2021	130.13	228.12	0.00	248.70	31.94	123.54	50.84
2022	130.13	226.81	0.00	246.94	31.60	122.82	50.43
2023	130.46	226.07	0.00	245.70	31.34	122.37	50.16
2024	131.70	227.08	0.00	246.05	31.21	122.62	50.15
2025	132.95	228.16	0.00	246.63	31.11	122.94	50.18
2026	134.09	229.08	0.00	247.21	31.01	123.23	50.18
2027	135.17	229.90	0.00	247.66	30.91	123.48	50.17
2028	136.18	230.67	0.00	247.93	30.81	123.70	50.15
2029	137.30	231.64	0.00	248.35	30.74	124.00	50.17
Compound growth rate (per cent) -							
2019-2025	0.49	-0.02	0.00	-0.25	-0.76	-0.21	-0.50
2019-2029	0.62	0.14	0.00	-0.08	-0.57	-0.04	-0.30

All data are for the calendar year ending in December of the year specified.

Table 10.2 United Energy Terminal stations - Winter 50th Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Total
Unit	*************************		MW	*********************		
BASE						
2015	24.73	80.83	297.46	89.49	195.74	1513.74
2016	22.81	77.28	283.10	87.56	193.45	1461.80
2017	24.96	73.29	277.98	85.47	186.83	1432.51
2018	27.97	81.52	297.19	86.12	203.04	1523.08
2019	28.21	81.92	298.58	86.45	205.50	1535.82
2020	28.39	82.23	299.53	86.50	207.72	1547.07
2021	28.52	82.23	299.55	86.42	209.60	1553.33
2022	28.67	82.08	299.23	86.44	211.58	1556.91
2023	28.91	82.23	300.02	86.78	214.23	1566.95
2024	29.24	82.82	302.16	87.35	217.39	1584.61
2025	29.58	83.34	304.08	87.92	220.66	1602.12
2026	29.89	83.81	305.85	88.42	223.79	1618.90
2027	30.20	84.23	307.42	88.86	226.90	1634.95
2028	30.49	84.59	308.80	89.22	229.98	1650.34
2029	30.83	85.00	310.31	89.67	233.34	1667.04
Percentage changes						
2015	10.40	5.17	0.03	1.74	0.39	4.90
2016	-7.76	-4.39	-4.83	-2.16	-1.17	-3.43
2017	9.43	-5.16	-1.81	-2.39	-3.42	-2.00
2018	12.05	11.23	6.91	0.77	8.68	6.32
2019	0.87	0.49	0.47	0.37	1.21	0.84
2020	0.63	0.37	0.32	0.06	1.08	0.73
2021	0.47	0.00	0.01	-0.09	0.91	0.40
2022	0.52	-0.19	-0.10	0.02	0.94	0.23
2023	0.85	0.18	0.26	0.39	1.25	0.65
2024	1.11	0.72	0.71	0.66	1.48	1.13
2025	1.16	0.63	0.64	0.66	1.50	1.10
2026	1.06	0.56	0.58	0.57	1.42	1.05
2027	1.02	0.50	0.51	0.49	1.39	0.99
2028	0.98	0.44	0.45	0.42	1.36	0.94
2029	1.11	0.48	0.49	0.50	1.46	1.01
Compound growth rate (per cent) -						
2019-2025	0.79	0.29	0.30	0.28	1.19	0.71
2019-2029	0.89	0.37	0.39	0.37	1.28	0.82
HIGH - Levels						
2018	28.50	82.52	301.14	87.86	206.32	1547.62
2019	29.12	83.69	306.23	89.54	211.30	1581.31
2020	29.67	84.75	310.80	90.91	215.96	1612.35
2021	30.19	85.64	314.87	92.21	220.57	1641.61
2022	30.75	86.46	318.84	93.60	225.39	1669.96
2023	31.39	87.38	323.24	95.27	230.74	1701.54
2024	32.08	88.70	328.83	97.04	236.57	1740.53
2025	32.80	90.03	334.49	98.87	242.59	1780.48
2026	33.50	91.30	339.94	100.63	248.52	1819.78
2027	34.22	92.51	345.02	102.30	254.57	1858.57
2028	34.92	93.68	350.01	103.91	260.53	1897.05
2029	35.67	94.90	355.21	105.62	266.90	1937.68
Compound growth rate (per cent) -						
2019-2025	2.00	1.22	1.48	1.67	2.33	2.00
2019-2029	2.05	1.27	1.49	1.67	2.36	2.05
LOW - Levels						
2018	27.62	80.87	294.89	85.04	200.85	1506.94
2019	27.63	80.79	293.11	84.57	201.75	1504.65
2020	27.61	80.71	291.22	83.92	202.55	1502.45
2021	27.55	80.37	288.55	83.17	203.07	1495.97
2022	27.52	79.91	285.68	82.54	203.75	1488.11
2023	27.55	79.62	283.57	82.18	204.86	1483.88
2024	27.69	79.77	282.87	82.18	206.67	1487.98
2025	27.85	79.92	282.16	82.21	208.52	1492.63
2026	27.99	80.01	281.33	82.18	210.28	1496.59
2027	28.13	80.07	280.36	82.10	212.05	1499.98
2028	28.26	80.11	279.33	81.99	213.83	1502.96
2029	28.41	80.18	278.60	81.97	215.77	1507.13
Compound growth rate (per cent) -						
2019-2025	0.13	-0.18	-0.63	-0.47	0.55	-0.13
2019-2029	0.28	-0.08	-0.51	-0.31	0.67	0.02

All data are for the calendar year ending in December of the year specified.

Table 10.3 United Energy Terminal stations - Summer 10th Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	***************************			MW	***************************		
BASE							
2015	141.78	285.46	0.00	282.28	36.45	142.38	51.46
2016	164.76	284.30	0.00	326.81	38.49	166.12	60.71
2017	142.32	322.36	0.00	339.46	33.71	159.93	53.34
2018	157.33	283.37	0.00	320.75	34.45	163.76	55.66
2019	177.16	346.19	0.00	377.04	42.54	201.54	68.97
2020	180.28	350.50	0.00	378.54	43.11	203.23	69.73
2021	182.46	353.23	0.00	378.30	43.44	203.93	70.04
2022	184.90	356.08	0.00	378.41	43.94	204.94	70.60
2023	189.16	361.82	0.00	381.94	44.95	208.00	72.05
2024	191.93	364.87	0.00	382.27	45.53	209.38	72.89
2025	197.91	374.57	0.00	388.59	46.63	213.91	74.72
2026	203.58	383.68	0.00	394.51	47.73	218.29	76.56
2027	209.06	392.62	0.00	400.12	48.82	222.42	78.33
2028	212.41	397.49	0.00	401.53	49.43	224.29	79.30
2029	215.91	402.57	0.00	403.12	50.11	226.33	80.34
2030	220.52	409.55	0.00	406.74	51.05	229.64	81.84
Percentage changes							
2015	-11.30	-3.78	0.00	-12.01	-6.94	-21.93	-25.97
2016	16.21	-0.41	0.00	15.78	5.60	16.67	17.98
2017	-13.62	13.39	0.00	3.87	-12.42	-3.73	-12.14
2018	10.55	-12.10	0.00	-5.51	2.20	2.39	4.35
2019	12.61	22.17	0.00	17.55	23.49	23.07	23.91
2020	1.76	1.24	0.00	0.40	1.33	0.84	1.11
2021	1.21	0.78	0.00	-0.06	0.77	0.34	0.44
2022	1.34	0.81	0.00	0.03	1.15	0.50	0.80
2023	2.30	1.61	0.00	0.93	2.31	1.49	2.06
2024	1.47	0.84	0.00	0.09	1.28	0.66	1.17
2025	3.12	2.66	0.00	1.65	2.42	2.16	2.50
2026	2.86	2.43	0.00	1.52	2.37	2.05	2.46
2027	2.69	2.33	0.00	1.42	2.28	1.89	2.32
2028	1.60	1.24	0.00	0.35	1.25	0.84	1.24
2029	1.65	1.28	0.00	0.40	1.36	0.91	1.30
2030	2.13	1.74	0.00	0.90	1.89	1.46	1.88
Compound growth rate (per cent) -							
2019-2025	1.86	1.32	0.00	0.50	1.54	1.00	1.34
2019-2030	2.01	1.54	0.00	0.69	1.67	1.19	1.57
HIGH - Levels							
2019	180.35	351.32	0.00	383.44	43.36	205.25	70.43
2020	184.94	357.56	0.00	385.44	44.03	207.43	71.50
2021	188.79	362.47	0.00	385.63	44.49	208.59	72.14
2022	193.18	368.43	0.00	386.64	45.09	210.30	73.08
2023	199.73	378.08	0.00	391.71	46.21	214.31	74.97
2024	204.54	383.99	0.00	393.34	46.98	216.60	76.33
2025	212.85	397.34	0.00	401.34	48.28	222.27	78.69
2026	221.37	410.87	0.00	409.40	49.63	228.02	81.15
2027	229.80	424.14	0.00	417.08	50.96	233.54	83.55
2028	236.10	433.13	0.00	420.68	51.85	237.05	85.20
2029	242.61	442.54	0.00	424.53	52.76	240.57	86.87
2030	250.06	453.46	0.00	429.98	53.89	245.08	88.93
Compound growth rate (per cent) -							
2019-2025	2.80	2.07	0.00	0.76	1.81	1.34	1.87
2019-2030	3.02	2.35	0.00	1.05	2.00	1.63	2.14
LOW - Levels							
2019	174.12	340.74	0.00	370.60	41.72	197.61	67.51
2020	176.27	343.51	0.00	372.13	42.21	199.07	68.05
2021	177.03	343.90	0.00	370.89	42.33	198.98	67.92
2022	178.06	344.60	0.00	370.11	42.61	199.34	68.05
2023	180.62	347.84	0.00	372.49	43.35	201.63	68.97
2024	181.76	348.40	0.00	371.62	43.72	202.18	69.38
2025	185.86	355.06	0.00	376.46	44.69	205.62	70.79
2026	189.49	360.85	0.00	380.56	45.58	208.62	72.06
2027	193.14	366.69	0.00	384.88	46.51	211.68	73.34
2028	194.70	368.54	0.00	384.97	46.96	212.50	73.84
2029	196.49	370.84	0.00	385.28	47.49	213.56	74.43
2030	199.36	375.28	0.00	387.53	48.29	215.66	75.43
Compound growth rate (per cent) -							
2019-2025	1.09	0.69	0.00	0.26	1.16	0.66	0.79
2019-2030	1.24	0.88	0.00	0.41	1.34	0.80	1.01

All data are for the financial year ending in June of the year specified.

Table 10.3 United Energy Terminal stations - Summer 10th Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Total
Unit	************************		MW	********************		
BASE						
2015	27.45	93.69	360.50	111.23	203.66	1736.34
2016	35.95	101.47	388.53	129.32	267.04	1963.50
2017	29.75	91.07	377.74	117.39	191.42	1858.49
2018	33.70	95.76	385.15	126.44	254.98	1911.35
2019	42.10	113.50	434.91	145.67	273.83	2223.46
2020	42.30	114.19	436.94	145.79	277.32	2241.94
2021	42.21	114.22	436.37	144.89	279.29	2248.38
2022	42.28	114.39	436.65	144.46	282.13	2258.78
2023	42.88	115.71	441.76	145.86	288.47	2292.61
2024	43.08	115.97	442.81	145.88	291.98	2306.59
2025	43.83	118.02	450.31	147.71	299.09	2355.28
2026	44.55	119.80	456.88	149.38	306.04	2400.99
2027	45.20	121.42	462.96	150.78	312.57	2444.31
2028	45.39	121.74	464.07	150.59	315.99	2462.24
2029	45.61	122.08	465.30	150.45	319.67	2481.49
2030	46.09	122.96	468.64	151.10	325.17	2513.32
Percentage changes						
2015	-20.04	-14.87	-14.11	-22.75	-29.67	-15.96
2016	30.97	8.30	7.78	16.26	31.12	13.08
2017	-17.25	-10.25	-2.78	-9.23	-28.32	-5.35
2018	13.28	5.15	1.96	7.71	33.20	2.84
2019	24.92	18.53	12.92	15.21	7.39	16.33
2020	0.47	0.61	0.47	0.09	1.27	0.83
2021	-0.20	0.03	-0.13	-0.62	0.71	0.29
2022	0.16	0.15	0.06	-0.30	1.02	0.46
2023	1.43	1.15	1.17	0.97	2.25	1.50
2024	0.47	0.22	0.24	0.01	1.22	0.61
2025	1.72	1.76	1.69	1.25	2.44	2.11
2026	1.64	1.51	1.46	1.13	2.32	1.94
2027	1.47	1.36	1.33	0.94	2.13	1.80
2028	0.42	0.26	0.24	-0.13	1.09	0.73
2029	0.48	0.28	0.27	-0.10	1.17	0.78
2030	1.05	0.72	0.72	0.44	1.72	1.28
Compound growth rate (per cent) -						
2019-2025	0.67	0.65	0.58	0.23	1.48	0.96
2019-2030	0.83	0.73	0.68	0.33	1.57	1.12
HIGH - Levels						
2019	42.90	114.93	440.83	148.57	278.33	2259.71
2020	43.16	115.37	444.45	149.77	281.77	2285.42
2021	43.18	115.27	445.96	150.09	283.93	2300.54
2022	43.33	115.37	448.38	150.79	286.95	2321.55
2023	44.05	116.72	455.97	153.41	293.58	2368.73
2024	44.42	116.92	459.22	154.81	297.73	2394.88
2025	45.32	118.89	469.07	157.99	305.54	2457.58
2026	46.26	120.85	478.86	161.24	313.53	2521.18
2027	47.13	122.60	487.97	164.23	321.13	2582.12
2028	47.59	123.07	491.88	165.70	326.08	2618.32
2029	48.04	123.53	495.87	167.09	330.93	2655.35
2030	48.69	124.34	501.28	169.14	337.18	2702.04
Compound growth rate (per cent) -						
2019-2025	0.92	0.57	1.04	1.03	1.57	1.41
2019-2030	1.16	0.72	1.18	1.19	1.76	1.64
LOW - Levels						
2019	41.33	111.89	428.87	143.00	269.21	2186.59
2020	41.53	112.80	429.71	142.39	272.95	2200.61
2021	41.32	112.74	426.79	140.36	274.34	2196.61
2022	41.26	112.87	424.90	138.81	276.62	2197.23
2023	41.67	113.99	427.11	138.84	281.94	2218.44
2024	41.73	114.15	425.91	137.74	284.77	2221.36
2025	42.33	115.95	430.66	138.45	291.13	2256.99
2026	42.85	117.40	434.15	138.80	296.79	2287.14
2027	43.36	118.84	437.70	139.09	302.48	2317.70
2028	43.41	118.98	436.44	137.88	305.07	2323.30
2029	43.51	119.21	435.70	136.80	308.09	2331.41
2030	43.83	120.01	437.40	136.44	312.63	2351.87
Compound growth rate (per cent) -						
2019-2025	0.40	0.59	0.07	-0.54	1.31	0.53
2019-2030	0.54	0.64	0.18	-0.43	1.37	0.66

All data are for the financial year ending in June of the year specified.

Table 10.4 United Energy Terminal stations - Summer 50th Coincident

	Cranbourne 66KV (CBTS)	East Rowville 66KV (ERT)	Frankston 66KV (FTS)	Heatherton 66KV (HTS)	Malvern 22KV (MT2)	Malvern 66KV (MT6)	Richmond 66KV (RT6)
Unit	***************************			MW	***************************		
BASE							
2015	141.78	285.46	0.00	282.28	36.45	142.38	51.46
2016	164.76	284.30	0.00	326.81	38.49	166.12	60.71
2017	142.32	322.36	0.00	339.46	33.71	159.93	53.34
2018	157.33	283.37	0.00	320.75	34.45	163.76	55.66
2019	163.49	323.41	0.00	342.49	38.57	179.79	61.33
2020	165.31	325.24	0.00	341.54	38.84	180.10	61.61
2021	167.35	327.74	0.00	341.26	39.15	180.69	61.88
2022	170.28	331.61	0.00	342.61	39.77	182.26	62.62
2023	174.84	338.09	0.00	346.95	40.85	185.61	64.16
2024	177.88	341.71	0.00	348.04	41.49	187.29	65.09
2025	181.92	347.81	0.00	350.82	42.16	189.77	66.19
2026	187.32	356.51	0.00	356.42	43.20	193.83	67.91
2027	191.55	363.15	0.00	359.86	44.01	196.64	69.20
2028	195.09	368.42	0.00	361.87	44.67	198.74	70.24
2029	199.48	375.24	0.00	365.36	45.56	201.71	71.59
2030	202.34	379.03	0.00	366.01	46.11	203.24	72.45
Percentage changes							
2015	-11.30	-3.78	0.00	-12.01	-6.94	-21.93	-25.97
2016	16.21	-0.41	0.00	15.78	5.60	16.67	17.98
2017	-13.62	13.39	0.00	3.87	-12.42	-3.73	-12.14
2018	10.55	-12.10	0.00	-5.51	2.20	2.39	4.35
2019	3.92	14.13	0.00	6.78	11.96	9.79	10.18
2020	1.11	0.56	0.00	-0.28	0.70	0.17	0.46
2021	1.23	0.77	0.00	-0.08	0.80	0.33	0.43
2022	1.75	1.18	0.00	0.39	1.58	0.87	1.20
2023	2.68	1.95	0.00	1.27	2.73	1.84	2.45
2024	1.73	1.07	0.00	0.32	1.57	0.91	1.46
2025	2.28	1.79	0.00	0.80	1.60	1.32	1.69
2026	2.97	2.50	0.00	1.59	2.48	2.14	2.59
2027	2.26	1.86	0.00	0.97	1.86	1.45	1.91
2028	1.85	1.45	0.00	0.56	1.51	1.07	1.50
2029	2.25	1.85	0.00	0.96	1.98	1.49	1.92
2030	1.44	1.01	0.00	0.18	1.21	0.76	1.20
Compound growth rate (per cent) -							
2019-2025	1.80	1.22	0.00	0.40	1.49	0.90	1.28
2019-2030	1.96	1.45	0.00	0.61	1.64	1.12	1.53
HIGH - Levels							
2019	166.54	328.33	0.00	348.55	39.35	183.28	62.71
2020	169.64	331.78	0.00	347.92	39.70	183.98	63.26
2021	173.21	336.23	0.00	348.01	40.12	185.00	63.85
2022	177.89	342.85	0.00	350.06	40.83	187.17	64.93
2023	184.53	352.84	0.00	355.71	41.99	191.35	66.86
2024	189.46	359.10	0.00	357.99	42.82	193.88	68.28
2025	195.53	368.37	0.00	362.19	43.64	197.35	69.84
2026	203.49	381.01	0.00	369.61	44.90	202.59	72.10
2027	210.40	391.56	0.00	374.96	45.92	206.67	73.98
2028	216.68	400.66	0.00	378.95	46.84	210.26	75.63
2029	224.01	411.71	0.00	384.66	47.97	214.68	77.62
2030	229.29	418.80	0.00	386.79	48.66	217.18	78.93
Compound growth rate (per cent) -							
2019-2025	2.71	1.94	0.00	0.64	1.74	1.24	1.81
2019-2030	2.95	2.24	0.00	0.95	1.95	1.55	2.11
LOW - Levels							
2019	160.60	318.19	0.00	336.41	37.79	176.09	59.95
2020	161.63	318.84	0.00	335.69	38.01	176.27	60.05
2021	162.38	319.22	0.00	334.51	38.13	176.13	59.91
2022	164.08	321.26	0.00	335.18	38.56	177.15	60.27
2023	167.15	325.58	0.00	338.61	39.39	179.87	61.33
2024	168.68	326.95	0.00	338.64	39.85	180.80	61.86
2025	171.12	330.47	0.00	340.24	40.42	182.37	62.61
2026	174.75	336.31	0.00	344.37	41.29	185.27	63.83
2027	177.37	340.25	0.00	346.71	41.96	187.14	64.70
2028	179.34	342.87	0.00	347.68	42.50	188.33	65.32
2029	182.10	347.04	0.00	349.94	43.26	190.35	66.23
2030	183.58	348.87	0.00	349.63	43.71	190.94	66.69
Compound growth rate (per cent) -							
2019-2025	1.06	0.63	0.00	0.19	1.13	0.59	0.73
2019-2030	1.22	0.84	0.00	0.35	1.33	0.74	0.97

All data are for the financial year ending in June of the year specified.

Table 10.4 United Energy Terminal stations - Summer 50th Coincident (continued)

	Ring-wood 22KV (RW2)	Ring-wood 66KV (RW6)	Spring-vale 66KV (SVT6)	Temple-stowe 66KV (TST)	Tyabb 66KV (TBT)	Total
Unit	************	************	MW	************	************	
BASE						
2015	27.45	93.69	360.50	111.23	203.66	1736.34
2016	35.95	101.47	388.53	129.32	267.04	1963.50
2017	29.75	91.07	377.74	117.39	191.42	1858.49
2018	33.70	95.76	385.15	126.44	254.98	1911.35
2019	37.48	100.44	388.80	124.68	248.36	2008.84
2020	37.41	100.37	388.06	123.97	249.81	2012.26
2021	37.33	100.36	387.53	123.15	251.50	2017.94
2022	37.54	100.86	389.26	123.22	254.97	2034.99
2023	38.21	102.36	395.22	124.88	261.59	2072.76
2024	38.50	102.82	397.17	125.23	265.39	2090.60
2025	38.84	103.75	400.61	125.77	269.53	2117.18
2026	39.51	105.38	406.80	127.29	275.94	2160.12
2027	39.93	106.31	410.42	127.94	280.51	2189.52
2028	40.19	106.79	412.30	128.05	284.11	2210.47
2029	40.62	107.66	415.76	128.65	288.99	2240.62
2030	40.76	107.63	415.78	128.28	291.83	2253.47
Percentage changes						
2015	-20.04	-14.87	-14.11	-22.75	-29.67	-15.96
2016	30.97	8.30	7.78	16.26	31.12	13.08
2017	-17.25	-10.25	-2.78	-9.23	-28.32	-5.35
2018	13.28	5.15	1.96	7.71	33.20	2.84
2019	11.23	4.88	0.95	-1.39	-2.60	5.10
2020	-0.18	-0.07	-0.19	-0.58	0.58	0.17
2021	-0.21	0.00	-0.14	-0.66	0.68	0.28
2022	0.54	0.50	0.45	0.06	1.38	0.84
2023	1.81	1.48	1.53	1.34	2.60	1.86
2024	0.74	0.45	0.49	0.28	1.45	0.86
2025	0.89	0.91	0.87	0.43	1.56	1.27
2026	1.74	1.57	1.55	1.21	2.38	2.03
2027	1.04	0.89	0.89	0.51	1.65	1.36
2028	0.65	0.45	0.46	0.09	1.28	0.96
2029	1.07	0.82	0.84	0.47	1.72	1.36
2030	0.35	-0.03	0.00	-0.28	0.98	0.57
Compound growth rate (per cent) -						
2019-2025	0.59	0.54	0.50	0.14	1.37	0.88
2019-2030	0.77	0.63	0.61	0.26	1.48	1.05
HIGH - Levels						
2019	38.24	101.74	394.27	127.37	252.61	2042.99
2020	38.21	101.40	394.79	127.58	253.91	2052.17
2021	38.22	101.27	396.05	127.85	255.74	2065.55
2022	38.50	101.66	399.54	128.92	259.27	2091.63
2023	39.27	103.14	407.56	131.63	266.04	2140.91
2024	39.71	103.52	411.42	133.22	270.39	2169.79
2025	40.19	104.37	416.72	134.87	275.09	2208.16
2026	41.05	106.10	425.58	137.76	282.33	2266.50
2027	41.66	107.15	431.82	139.77	287.86	2311.74
2028	42.16	107.72	436.04	141.31	292.81	2349.06
2029	42.81	108.69	442.05	143.34	298.83	2396.36
2030	43.09	108.54	443.53	144.06	302.21	2421.07
Compound growth rate (per cent) -						
2019-2025	0.83	0.43	0.93	0.96	1.43	1.30
2019-2030	1.09	0.59	1.08	1.13	1.64	1.56
LOW - Levels						
2019	36.76	98.96	383.23	122.24	244.00	1974.23
2020	36.71	99.14	381.68	120.92	245.84	1974.79
2021	36.52	99.06	379.09	119.10	247.01	1971.07
2022	36.61	99.57	379.07	118.22	250.08	1980.06
2023	37.12	100.94	382.61	118.68	255.88	2007.16
2024	37.28	101.32	382.61	118.05	259.11	2015.15
2025	37.52	102.07	383.83	117.69	262.69	2031.03
2026	38.03	103.47	387.54	118.13	268.09	2061.09
2027	38.32	104.26	389.07	117.86	271.97	2079.60
2028	38.46	104.62	389.04	117.11	274.95	2090.22
2029	38.78	105.41	390.71	116.84	279.23	2109.88
2030	38.82	105.40	389.74	115.76	281.41	2114.54
Compound growth rate (per cent) -						
2019-2025	0.34	0.52	0.03	-0.63	1.24	0.47
2019-2030	0.50	0.57	0.15	-0.49	1.31	0.63

All data are for the financial year ending in June of the year specified.

Appendix A: Reconciliation of Local Government Areas with the United Energy distribution area

Local Government Area	Percentage of area United Energy
Bayside	100.0
Frankston	68.0
Glen Eira	100.0
Greater Dandenong	99.0
Kingston	100.0
Knox	16.0
Manningham	98.0
Monash	100.0
Mornington Peninsula	100.0
Port Phillip	41.0
Stonnington	49.0
Whitehorse	100.0

Appendix B: PeakSim summer maximum demand forecasts

B.1 Introduction

This section provides a further discussion on the historical and forecast summer coincident maximum demands for the United Energy Distribution network. In particular, this section reviews the significant key changes to drivers of summer maximum demand in NIEIR's 2018 forecasts.

The NIEIR 2018 summer coincident maximum demand forecasts for United Energy are presented in Table B.1. These forecasts were completed for base, high and low scenarios representing different assumptions regarding:

- economic scenario;
- air conditioner stock and usage;
- uptake of alternative technologies; and
- government energy related policies.

The majority of the historical period has been characterised by negative, weak or modest annual growth in underlying summer maximum demand for United Energy. The last strong year of demand growth in the past ten summers occurred in 2010, with a growth rate of approximately 2.4 per cent over 2009. This continued on from a period of strong demand growth in the 2000s that was characterised by:

- significant economic growth; and
- increasing penetrations of air conditioners due to increased efficiency and lower cost.

From 2011 to 2014 there was a period of slightly negative growth in the 10^{th} probability of exceedance. This downturn is in part attributed to:

- flow-on effects from stronger MEPS for appliances, including air conditioners;
- strong AUD exchange rate reducing competitiveness of local industry;
- significant uptake of small-scale PV, due to generous incentives;
- electricity price increases; and
- other energy efficiency programs for lighting, buildings, and VEET.

Table B.1	PeakSim summer coincident maximum demand forecasts by scenario									
Financial Year	Actual MD	Base scenario			High scenario			Low scenario		
		10th	50th	90th	10th	50th	90th	10th	50th	90th
2009	2,084	2,093	1,893	1,765	2,093	1,893	1,765	2,093	1,893	1,765
2010	2,016	2,143	1,932	1,781	2,142	1,931	1,779	2,142	1,931	1,779
2011	1,962	2,127	1,923	1,778	2,126	1,922	1,777	2,126	1,922	1,777
2012	1,700	2,115	1,944	1,787	2,116	1,944	1,787	2,116	1,944	1,787
2013	1,982	2,110	1,928	1,782	2,111	1,930	1,784	2,111	1,930	1,784
2014	2,066	2,084	1,903	1,746	2,084	1,904	1,746	2,084	1,904	1,746
2015	1,736	2,114	1,879	1,730	2,114	1,879	1,730	2,114	1,879	1,730
2016	1,963	2,113	1,895	1,747	2,113	1,895	1,747	2,113	1,895	1,747
2017	1,858	2,167	1,942	1,783	2,167	1,942	1,783	2,167	1,942	1,783
2018	1,911	2,199	1,984	1,822	2,199	1,985	1,823	2,199	1,985	1,823
2019		2,223	2,009	1,821	2,260	2,043	1,854	2,187	1,974	1,789
2020		2,242	2,012	1,825	2,285	2,052	1,862	2,201	1,975	1,791
2021		2,248	2,018	1,829	2,301	2,066	1,873	2,197	1,971	1,787
2022		2,259	2,035	1,859	2,322	2,092	1,910	2,197	1,980	1,809
2023		2,293	2,073	1,879	2,369	2,141	1,941	2,218	2,007	1,821
2024		2,307	2,091	1,900	2,395	2,170	1,972	2,221	2,015	1,833
2025		2,355	2,117	1,933	2,458	2,208	2,015	2,257	2,031	1,857
2026		2,401	2,160	1,980	2,521	2,266	2,077	2,287	2,061	1,892
2027		2,444	2,190	1,992	2,582	2,312	2,102	2,318	2,080	1,896
2028		2,462	2,210	2,007	2,618	2,349	2,132	2,323	2,090	1,902
2029		2,481	2,241	2,043	2,655	2,396	2,184	2,331	2,110	1,928
2030		2,513	2,253	2,060	2,702	2,421	2,212	2,352	2,115	1,937

In 2015 and 2016 summer maximum demand at the 10th probability of exceedance level reached 2,114 MW and 2,117 MW respectively. These two years appear to show a reversal from the period of declining demands.

In 2017, underlying electricity demand at the 10th probability of exceedance level reached 2,167 MW in the UED network. This suggests that underlying demand has now exceeded the peak reached in 2010, and maximum demand has continued to grow in summer 2018. In recent years there are signs that the driving factors of growth in summer maximum demand have outweighed demand (distributor) reduction measures. This can partly be attributed to:

- strong economic activity; and
- record sales of air conditioners.

These factors will continue to influence growth in forecast summer maximum demand in the short-term.

B.2 Forecast comparison

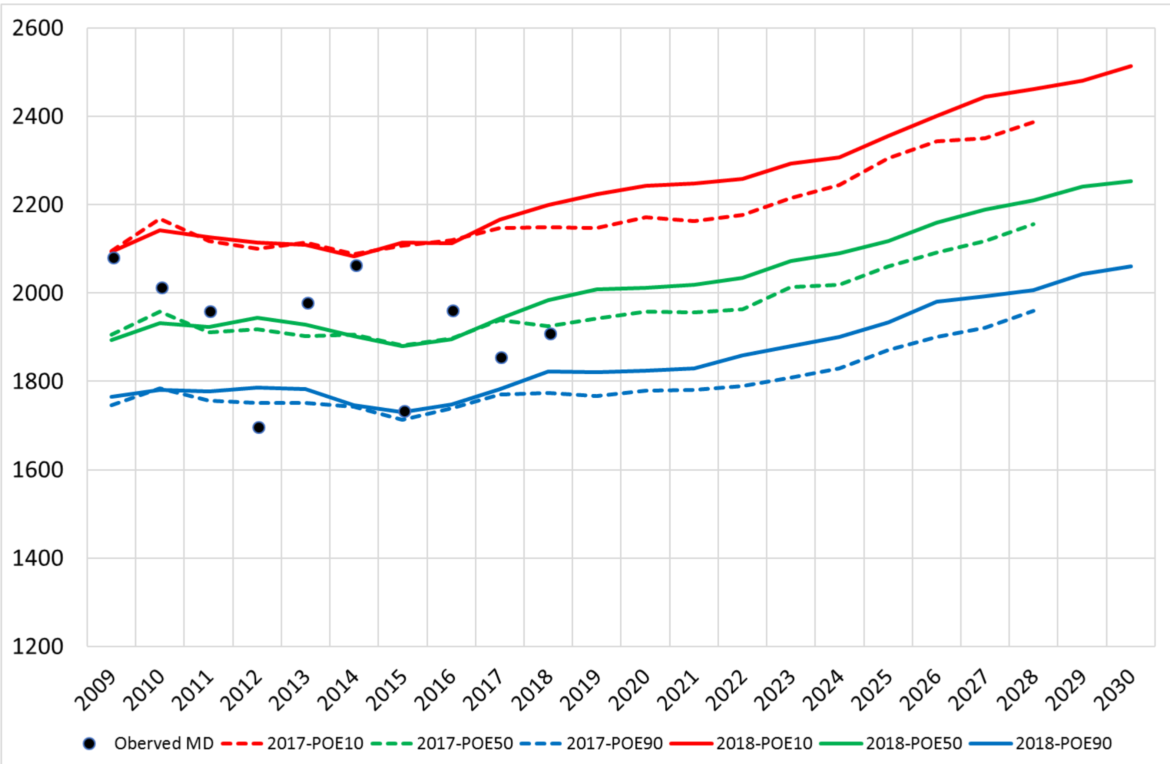
Figure B.1 contains a comparison of the NIEIR 2018 summer coincident maximum demand forecasts against the NIEIR 2017 summer coincident forecasts for the United Energy region from 2009 to 2030. The PeakSim model simulates distributions of maximum demand for both the historical and forecast periods. The distributions are presented at the 10th, 50th and 90th probability of exceedance levels for the base scenario.

The most notable difference between the NIEIR 2017 and NIEIR 2018 forecasts is that the NIEIR 2018 forecasts have been significantly revised upwards across all years. The NIEIR 2018 summer maximum demand forecasts are greater by a range of 51 to 94 MW at the 10th probability of exceedance levels across 2019 to 2028.

Over the 2021 to 2025 review period, the difference ranges from 86 MW in 2021 and decreasing to 51 MW by 2025. This is an average difference of around 70 MW over the 2021 to 2025 period. However, the profile of forecast demand between the two iterations of forecasts is broadly similar. The 2017 forecasts grew on average at 1.2 per cent over this period, while the 2018 forecasts grow at around 1.0 per cent per annum over the 2021 to 2025 period.

The historical series of POE demand distributions also differs slightly between the NIEIR 2017 and NIEIR 2018 forecasts over 2009 to 2017. This is merely due to the re-simulation of temperature, residuals and therefore demands between the forecast versions. This difference is not significant.

Figure B.1: PeakSim summer maximum demand forecasts 2018 versus 2017



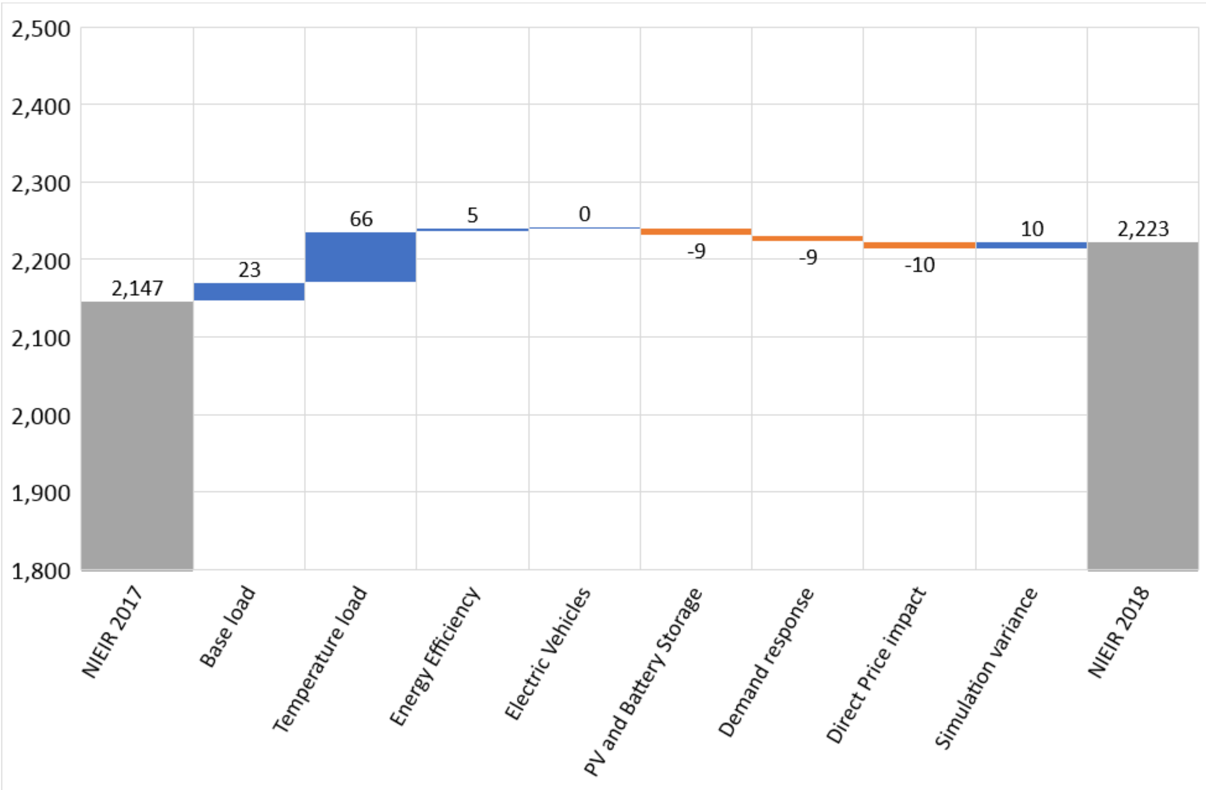
Source: NIEIR.

The key revision in the NIEIR 2018 forecasts is derived from re-modelling the 2017-18 summer season maximum demand using an updated series of 2018 terminal station data. Subsequent changes to the 2017-18 underlying demand distributions flow on to the 2018-19 summer maximum demand forecast. The 2017-18 was the first forecast year in the NIEIR 2017 forecasts, and the most recent historical season in the NIEIR 2018 forecasts.

The difference in forecasts are largely due to increases in temperature sensitive load at summer maximum demand. For the past two years temperature sensitive load has been growing at a high scenario rate.

Figure B.2 contains a summary of revisions to the forecasts for the 2018-19 10th probability of exceedance levels. Temperature sensitive load is around 66 MW higher than what was predicted in NIEIR 2017, while base load in 2018-19 is 23 MW higher. Offsetting these upwards revisions are forecast greater PV and battery storage penetrations, demand response programs, and strong increases in Victorian electricity prices. These offsetting factors account for around 23 MW of reduced demand at the system peak.

Figure B.2: Forecast 2018-19 POE10 – NIEIR 2017 versus NIEIR 2018 (MW)



Source: NIEIR.

B.3 Temperature sensitive load

NIEIR's PeakSim model segments demand into a framework of temperature insensitive demand (base load) and temperature sensitive demand.

Temperature insensitive demand is the segment of demand that exists regardless of temperature conditions. This demand is made up of everyday household and business activity, and can be approximated by demand on a mild temperature day.

Temperature sensitive demand is the segment of demand that exists because of the use of temperature related equipment such as air conditioners and fans. In summer within the United Energy region, demands increase as temperatures increase. This is due to more air conditioners being switched on and greater utilisation of air conditioning equipment at higher temperatures.

United Energy temperature sensitive demand is directly driven by:

- the total stock of air conditioners within the network; and
- how these air conditioner units are used.

The PeakSim model runs separate regression equations across each half-hourly interval, and during each summer season. This approach allows for the analysis of change in base load and temperature sensitive load during the day, and across years.

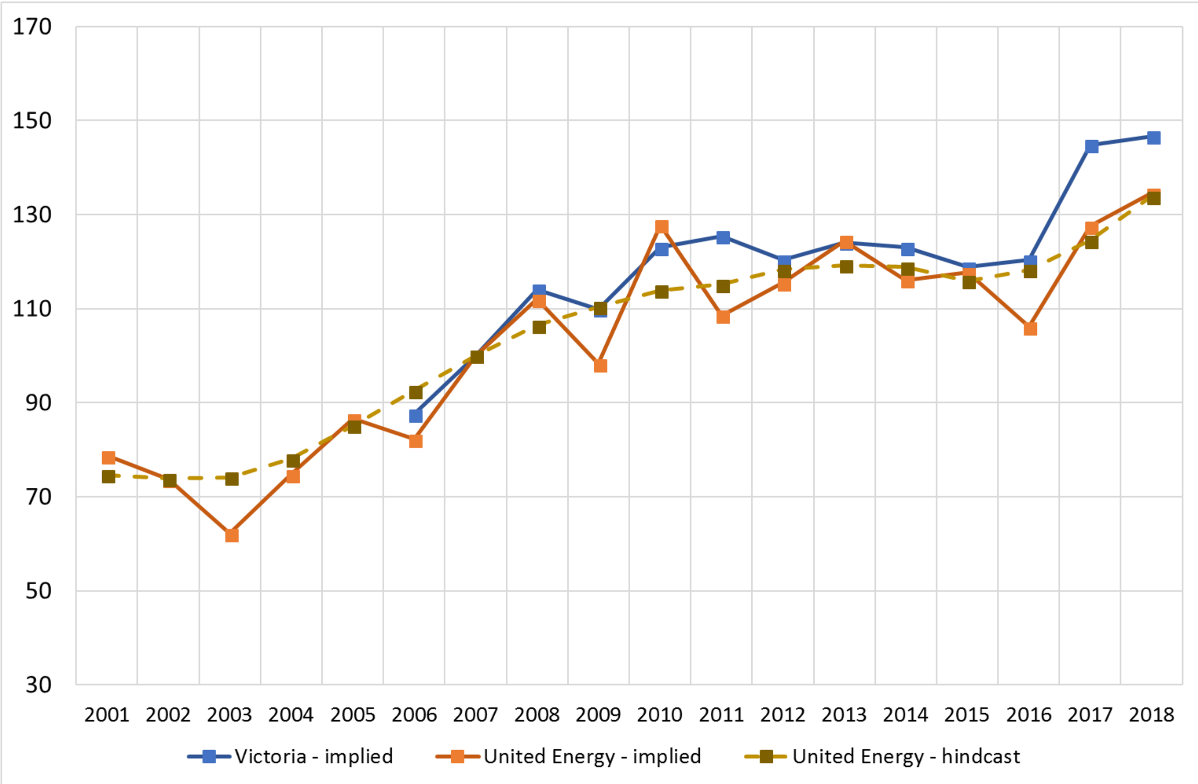
In the United Energy region, temperature sensitive load makes up just over half of the load at the system peak. So any change in these direct drivers has a large influence on the underlying distributions of demand.

Figure B.3 demonstrates that temperature sensitive load has undergone significant growth over 2017 and 2018. This chart shows an index of modelled temperature sensitivity for the total Victoria and United Energy regions.

The "implied" series shows the raw estimated temperature sensitive parameters. This series is shown for both Victoria and United Energy. This series gives a good indication of trends in temperature sensitive load. However, the implied series can fluctuate between years depending on the overall seasonal climactic conditions (and how air conditioners are used in response).

The "hindcast" series attempts to smooth out the fluctuations by combining together the implied series and the estimated stock of air conditioners within the United Energy Network (based on air conditioners sales and other data). This is used to represent a more stable series of temperature sensitivity over time.

Figure B.3: Historical trends in temperature sensitivity (index 2007 = 100)



Note: Temperature sensitivity is summarised for the 5pm interval.
Source: PeakSim modelling output (NIEIR).

Trends in Victorian and United Energy Temperature sensitivity have broadly followed each other. These trends also track well with growth in underlying summer maximum demand distributions, reinforcing the importance of temperature sensitivity in demand forecasting.

Temperature sensitivity underwent a period of rapid growth from 2004 to 2012 that was underpinned by increasing air conditioner sales (Figure B.4). This meant that the penetration of air conditioners into households and business grew quickly; air conditioners were installed in spaces that previously had no air conditioner. Sales of air conditioners appear to have flattened out after 2010, but still remained historically high.

The temperature sensitivity historical profile from 2004 to 2012 can also be seen to be growing at a diminishing rate. This is partly due to an aggressive schedule of MEPS in the 2000s that placed a floor on the required level of efficiency (as measured by the coefficient of performance). The last significant MEPS regulations were put in place in 2011, with more minor alterations put in place in the two years afterwards.

NIEIR analysis of E3 appliance data on new air conditioner models shows that the efficiency of air conditioners underwent a period of fast improvement coinciding with improved reverse cycle technology and MEPS. In the most recent years, the efficiency improvement of new models of air conditioners has slowed or even stabilised. This is significant for the replacement market for air conditioners.

The stock of air conditioners is determined by new sales, and the retirement/replacement of old stock. In 2018 sales of air conditioners reached a record level in Australia and Victoria. This record year of sales followed on from a strong year of sales in 2017. This combination has helped to boost temperature sensitivity over the past two summer seasons.

Not only have there been increased sales, but the unit size of the new installations has been steadily increasing again from 2014 (Figure B.5).

Part of the new sales will go into increasing the penetration of air conditioners in both new and existing dwellings. The other segment goes into replacing old or existing units.

Air conditioners have an expected life of around seven years on average. Generally speaking, newer units will be more efficient than the older units that they are replacing. This is most commonly a net reduction in load.

Figure B.5 shows the average input capacity of new sales of air conditioners since 2001. On average, if a household were to replace an air conditioner over 2011 to 2015, they were likely be replacing a relatively inefficient unit. The net reduction in load impact was therefore likely to be large. This impact helped suppress temperature sensitivity growth over this period.

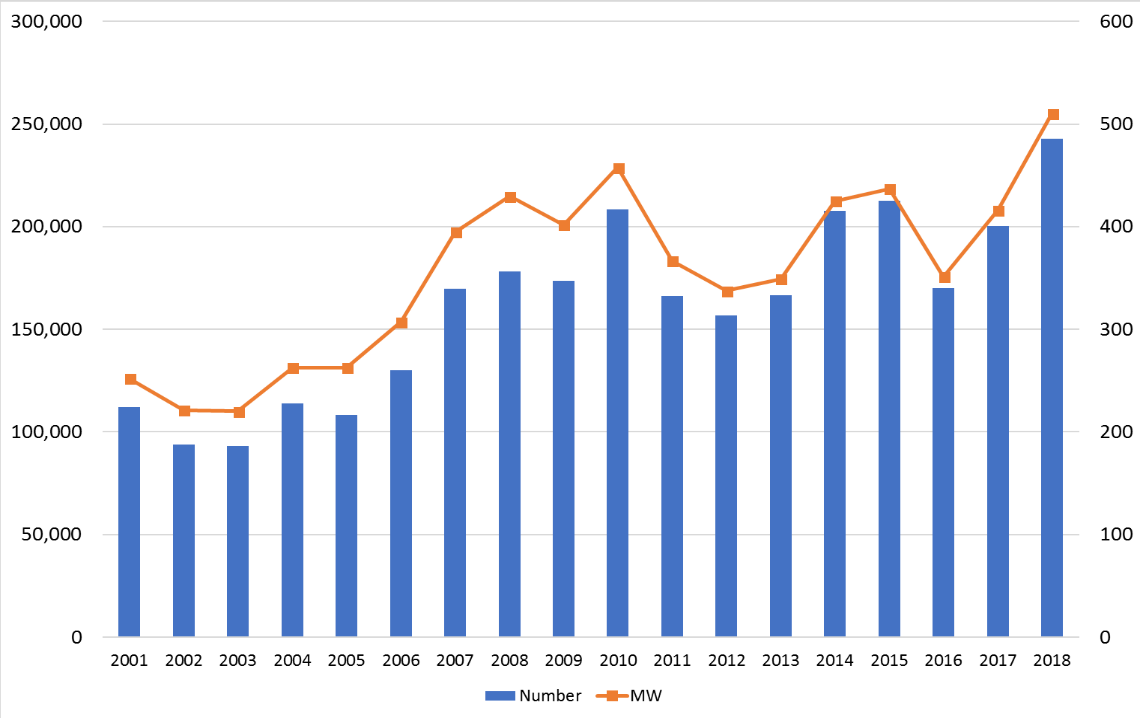
In 2017 and 2018 replacement units are potentially replacing units that were installed after the last significant MEPS were in place, if a seven year asset life is assumed. This means that the current replacement market is replacing air conditioner units that have a similar kW load on the grid and efficiency. The net reduction in load impact in 2017 and 2018 from the replacement market is likely to be smaller than it once was.

In summary, the 2017 and 2018 summer seasons had strong temperature sensitive load growth due to:

- strong sales of air conditioners;
- preference for large air conditioner units; and
- less efficiency improvement in the replacement market.

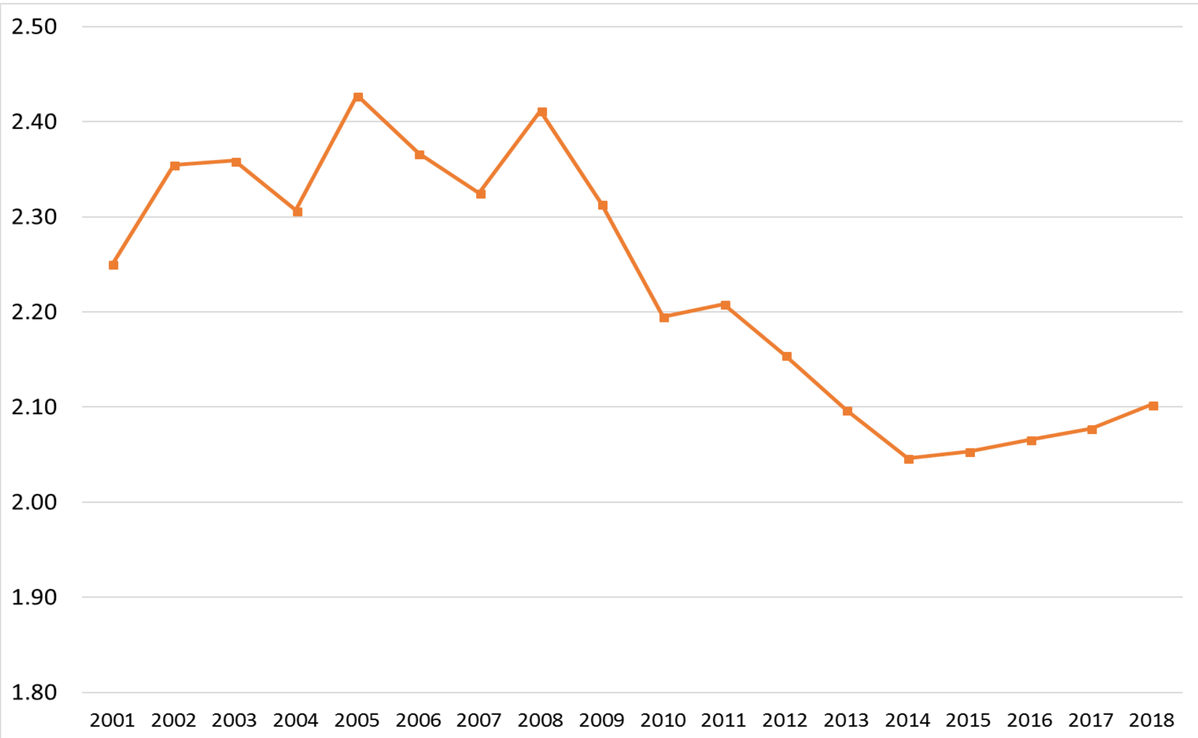
Relatively strong temperature sensitive load growth is expected to continue in the short term, and diminish when new MEPS are introduced in 2019, and the air conditioner sales market may enter a lower part of the sales cycle.

Figure B.4: Victorian air conditioner sales 2001 to 2018 (number and MW)



Note: Year to March.
Source: Industry sales data, NIEIR.

Figure B.5: Victorian air conditioners sales 2001 to 2018 (average sales input kW)



Source: Industry sales data, NIEIR.