ENERGEIA

Electric Vehicles Insights

Prepared by ENERGEIA for the Australian Energy Market Operator's 2017 Electricity Forecast Insights

September 2017

Executive Summary

The AEMO Electricity Forecasting Insights report provides electric vehicle consumption forecasts to 2050 for the National Electricity Market (NEM), and for each NEM region.

While electric vehicle uptake in Australia is still very low (approximately 0.1 of annual vehicle sales[1]), the combined impact of price declines in battery technology, the increasing introduction of new EV models into the market and both government and industry support is expected to drive rising uptake over the next 20 years.

AEMO has commissioned Energeia to prepare an Electric Vehicles Insights paper and to adopt the scenario assumptions of AEMO's recently published 2017 Electricity Forecasting Insights report as the basis for an impact assessment of the introduction of electric vehicles on Australia's electricity supply system.

Over the course of 2017, AEMO will monitor feedback on this report, and continue a work-program to enable the inclusion of electric vehicles in AEMO's major Forecasting and Planning publications in 2018.

Scope and Approach

The Electric Vehicle Insights paper provides Energeia's scenario based forecasts of EV uptake for each region of the NEM and the corresponding impact on annual electricity consumption, maximum and minimum demand because of charging of EVs from the grid.

Energeia has used its fourth generation EV forecasting model, updated to align with AEMO's scenario based assumptions regarding electricity prices as well as market and policy settings, to derive the results.

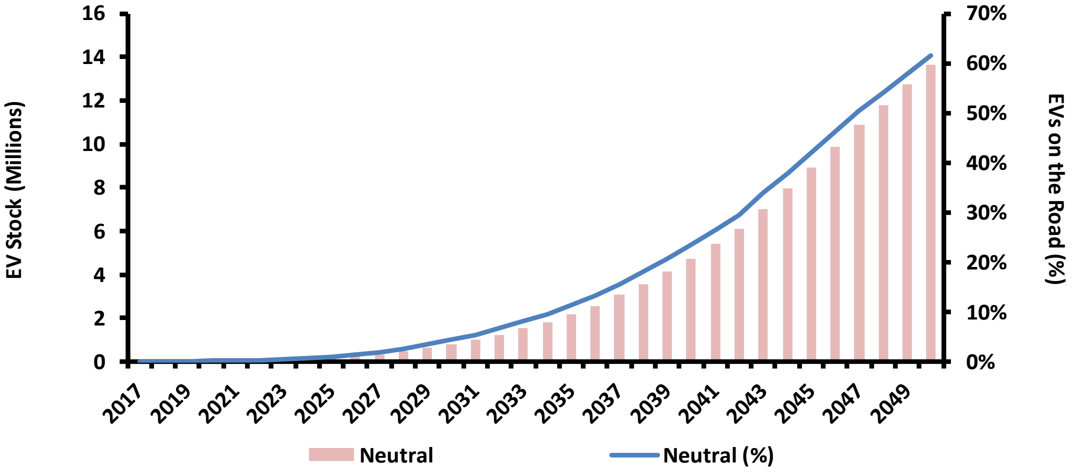
Results

The following sections reports on the results of the middle scenario. Results for the high and low scenarios are provided in Section 4.

EV Uptake

EV sales within the National Electricity Market (NEM) are forecast to reach 431,000 vehicles per annum by 2036 or 36.5 of new vehicle sales under AEMO's neutral sensitivity, increasing to 1.58 million or 90% of new vehicle sales by 2050. As a result, total EVs on the road are forecast to reach over 2.56 million or 13.2% of total new sale vehicles by 2036, moving to 13.63 million or 61.5% of all new vehicles sales by 2050, as shown in Figure 1.

Figure 1 – EV Uptake (NEM, Neutral)



Source: Energeia

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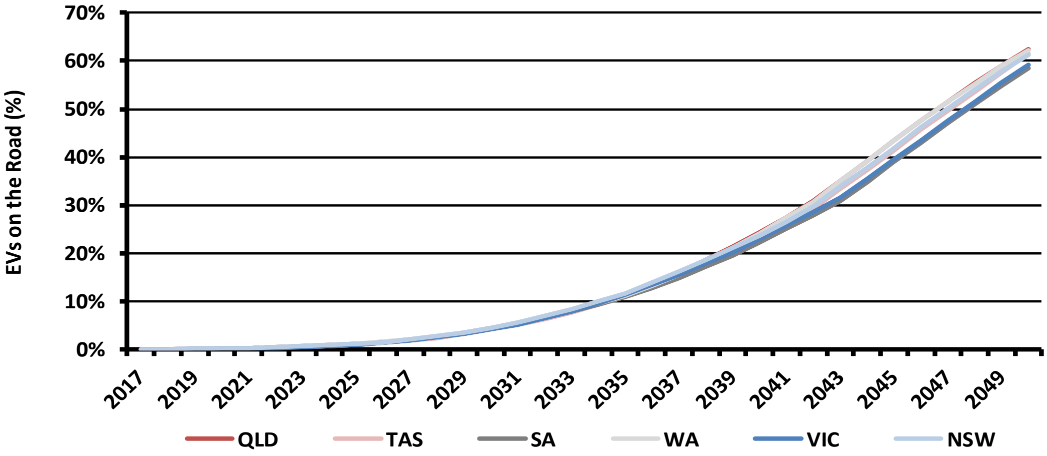
[1] ClimateWorks Australia; The state of electric vehicles in Australia; June 2017

The difference between the percentage of EVs sold and the percentage EVs on the road is due to the average length of time before Australians retire their vehicles, which currently stands at just over 22 years.[2]

The main drivers of increasing adoption rates over time are rising EV model availability, elimination of purchase premiums and falling battery storage costs.

The variation in vehicle stock forecasts shown in Figure 2 is due to the relative differential between petrol prices and electricity prices in each state, with QLD having the greatest differential due to its relatively low cost controlled load tariffs.

Figure 2 – EV Uptake by Region (Neutral)

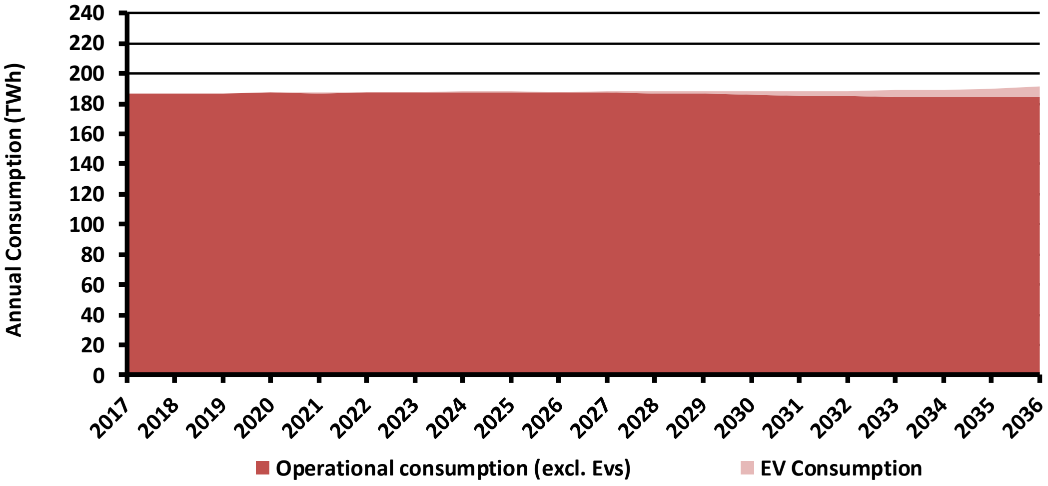


Source: Energeia

EV Consumption

Energeia's consumption forecast under the middle scenario is for EVs to consume around 7.02 TWh of grid electricity per year by 2036, increasing total consumption by around 3.8% compared to AEMO's forecasts for primary load under the neutral sensitivity as shown in Figure 3 below.

Figure 3 – EV Electricity Consumption Compared to Insights Forecast (NEM Operational, Neutral)



Source: Energeia

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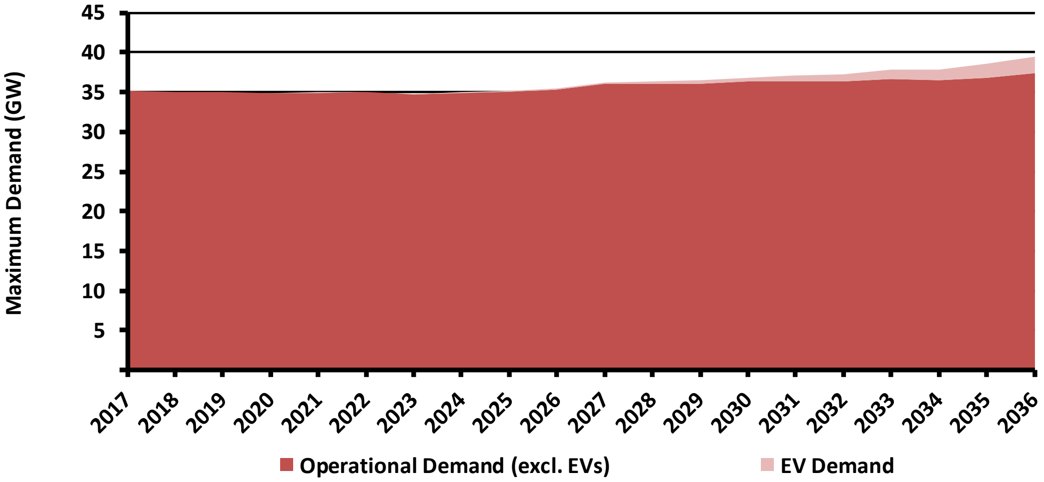
[2] ABS 9208.0 - Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016

EV Maximum Demand

Energeia forecast of non-coincident aggregated EV maximum demand by region is shown in Figure 4 below. Energeia's modelling optimises flexible electric vehicle load to avoid contributing to network and system load. This means that flexible electric vehicle peak demand is likely to occur after the typical evening peak.

Figure 4 – EV Maximum Demand by Region (NEM Operational, Neutral)



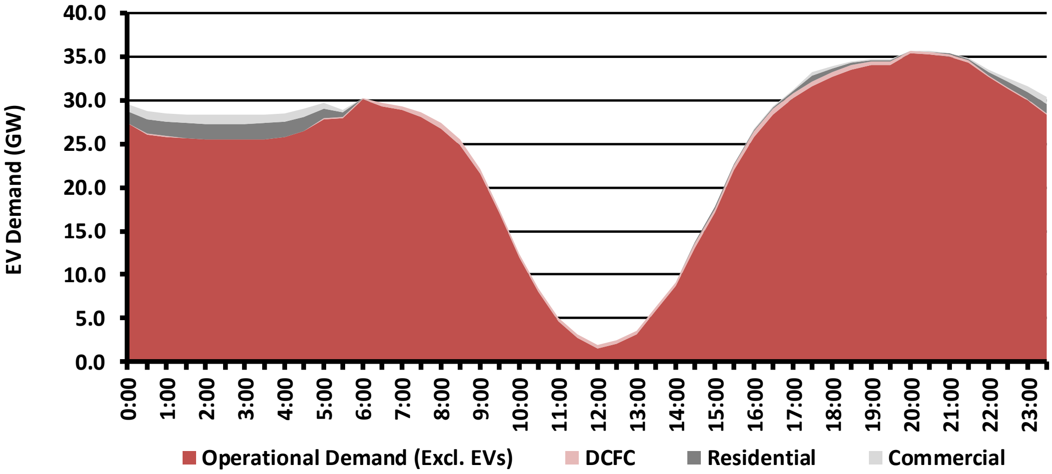
Source: Energeia

Electric vehicle charging optimisation applies to home charging of passenger vehicles and workplace charging of commercial vehicles. Fast charging is not assumed, via the charge control system, to manage demand, as the value of the service is the speed of the recharge.

Impact on Maximum and Minimum Regional Demand

Despite the increase in consumption and load from electric vehicles, Energeia's modelling shows their peak demand impacts as being limited to fast charging sub-segment only. Flexible home and workplace charging load is able to be orchestrated to avoid contributing to network or system peak demand, as shown in Figure 5 below.

Figure 5 - EV Charging Load by Charge Type (NEM, 2036)



With respect to the impact of electric vehicle load on minimum demand, Energeia's modelling shows mainly fast charging increasing minimum demand, even as it shifts to the middle of the day due to solar PV. Home charging of non-commuter vehicles is also expected to increase minimum demand. Workplace charging of commercial vehicles is not expected to impact minimum demand once it shifts to the middle of the day.

Table of Contents

1 Introduction

1.1 Background

The Electricity Forecasting Insights report provides electricity consumption forecasts over a 20-year forecast period for the National Electricity Market (NEM), and for each NEM region. In 2015, the NEFR considered the impact of uptake of electric vehicles (EVs) for the first time via the Emerging Technologies Paper accompanying the 2015 NEFR[3]. 2016 was the first year that an Electricity Forecasting Insights report was prepared.[4]

AEMO has commissioned Energeia to update the Electric Vehicles Insights report in 2017 to take account of key developments in the electric vehicle market since the 2016 report was published, including unforeseen changes in the availability of the most popular EV models including the Mitsubishi Outlander and the Nissan Leaf. This year, the scope has also been expanded to include commercial and DC fast charging vehicles.

AEMO uses the Electricity Forecasting Insights report analysis as the starting point for monitoring the emergence and use of electric vehicles in Australia, as well as an input to its modelling integration studies and the 2017 Electricity Forecasting Insights.

AEMO will monitor feedback on this report, and will continue a work-program to develop this analysis to enable the inclusion of electric vehicles in AEMO's major Forecasting and Planning publications in 2017. A further objective is to provide recommendations as to how the EV forecasts may be better integrated into the Electricity Forecasting Insights report in future years to continually improve forecasting accuracy.

1.2 Objectives

The primary objective of this Electric Vehicles Insights paper is to reduce the potential forecasting uncertainty within the main AEMO forecasts with respect to EV uptake by providing a specialist forecast of EV uptake and charging demand over time.

Specifically, the paper provides forecasts of EV uptake for each region of the NEM and the corresponding impact on annual electricity consumption and maximum and minimum demand due to charging of EVs from the grid.

1.3 Scope and Approach

The EV forecasts consider impacts from EVs taken up within the passenger vehicle and commercial sectors, excluding (heavy) articulated trucks and speciality vehicles such as bucket trucks. The passenger sector includes passenger cars and sport utility vehicles. The commercial sector includes light commercial (vans and trucks), buses, and rigid vehicles. EV forecasts include both battery electric vehicles (BEVs) and plug-in hybrid vehicles

Battery Electric Vehicle (BEV) – Powered only by energy stored in batteries with batteries charged by plugging into the grid.

Internal Combustion Engine Vehicle (ICE) – Represents most private vehicles, powered by a standard internal combustion engine using petrol, diesel or gas.

Hybrid Electric Vehicle (HEV) – Combines both an ICE with an electric engine. The electrical energy is stored in a battery that is charged by the internal combustion engine. Battery capacity is generally limited. Vehicle propulsion is a mix of the ICE and electric engine, but is predominantly powered by the ICE. Does not take energy from the electricity grid.

Plug-in Hybrid Electric Vehicle (PHEV) – Combines both an ICE with an electric engine. Electrical energy is stored in batteries by plugging into the grid. Vehicle propulsion is a mix of the ICE and electric engine, but is predominantly powered by the electric engine. The ICE is used to extend driving range beyond battery capacity for longer distances and to recharge the battery itself.

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[3] Emerging Technologies Information Paper, National Electricity Forecasting Report Published: June 2015

[4] AEMO Electricity Forecasting Insights 2016

(PHEVs) to the extent that they utilise the grid for charging. The forecasts exclude hybrid electric vehicles (HEVs) which do not charge from the grid.

Energeia has used its fourth generation EV forecasting model (described further in Section 2), updated to align with AEMO's assumptions regarding electricity prices as well as market and policy settings, to derive the results. Further specific EV assumptions were set in conjunction with AEMO as described in Section 3.

1.4 Limitations

The EV forecasts contained throughout this paper are independent of the base AEMO forecasts. That is, there is no feedback loop between the forecasted EV uptake and the corresponding response from networks, retailers or the wholesale market.

Further, there are a range of future possibilities as to how EV loads will be priced and how the EV market will integrate with the electricity market and it is foreseeable that tariff products could evolve to encourage increased charging of EVs during solar generation times. This analysis assumes initial EV tariffs for home and workplace charging reflect controlled load tariffs, which will be orchestrated to ensure they minimise peak demand impacts.

There is also likely to be some degree of interaction between solar PV, stationary battery storage and EVs at residential and workplace premises. While AEMO has separately undertaken solar PV and battery storage forecasts, these have not been integrated with the EV forecasts in this paper.

The forecasts cover EV charging loads at home for passenger vehicles and at business locations for commercial vehicles. They also cover DC fast charging loads to serve long-haul commercial vehicles like busses and articulated trucks, as well as passenger vehicles that are expected to not have access to off-street parking based home chargers, such as second and third vehicles in a given household.

The household transport model upon which the EV forecast model relies are derived from the Queensland Household Travel Survey and Victorian Managing Tariff Congestion Report. That is, while the model reflects different average driving distances between states, it assumes that travel patterns (origins, destinations, arrival times and departure times) in all regions of Australia are consistent with those of Queensland drivers for passenger vehicles with access to private parking, while travel patterns for commercial EVs and vehicles without access to private parking are consistent with drivers in Victoria.

The EV uptake model is driven in part by the financial return on investment to vehicles owners based on the EV vehicle premium and reduced operational costs. The model does not consider any costs associated with any required upgrade to the household switch board and/or service, which could add considerable cost. However, this is not expected to be a material number of households based on anecdotal evidence from pilots, etc.

While all due care has been taken in the preparation of this paper, Energeia has relied upon stakeholder provided information as well as publicly available data and information. To the extent these reliances have been made, Energeia does not guarantee nor warrant the accuracy of this paper. Furthermore, neither Energeia nor its Directors or employees will accept liability for any losses related to this paper arising from these reliances.

The forecasts derived from Energeia's EV forecast model are supplied in good faith and reflect the knowledge, expertise and experience of the consultants involved. Energeia does not warrant the accuracy of the model nor accept any responsibility whatsoever for any loss occasioned by any person acting or refraining from action as a result of reliance on the model. The model and this report are for educational purposes only.

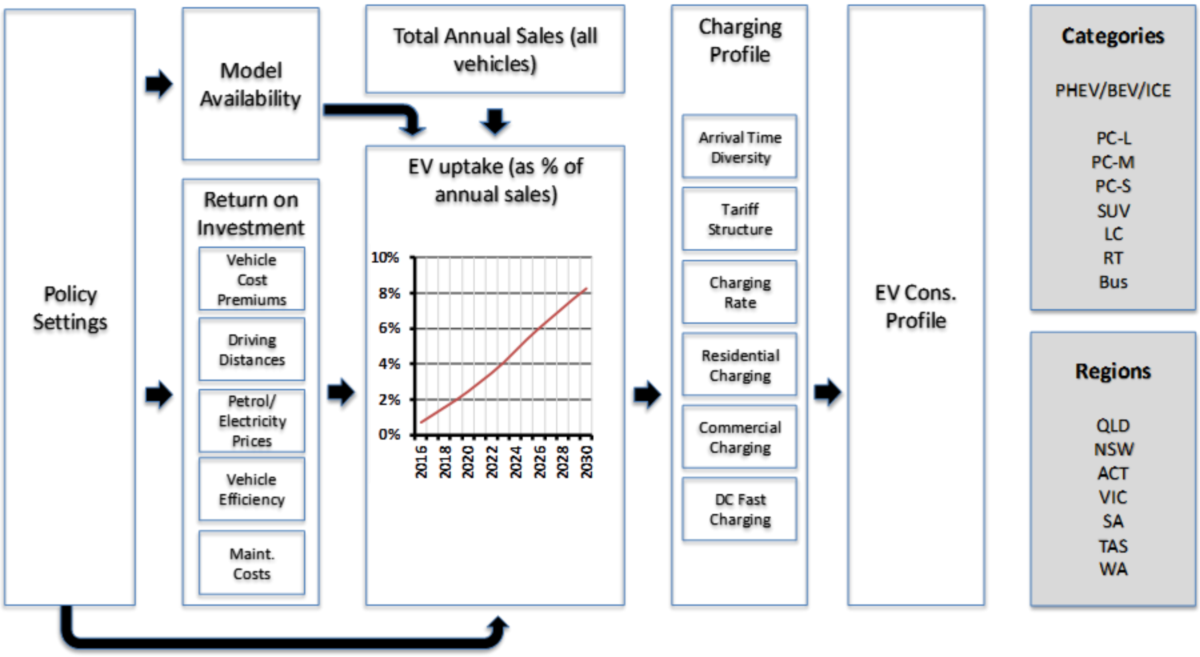
2 EV Forecasting Model Overview

The following section provides an overview of the Energeia's EV forecasting model. The model is part of Energeia's broader energy system model, but has been limited in this study to identify the (non-integrated) impacts of electric vehicles on the energy system. Detailed modelling assumptions are provided in Appendix A.

2.1 Overview

Energeia's EV forecasting model is comprised of two parts, EV uptake and EV charging as shown in Figure 6 below.

Figure 6 – Energeia EV Forecasting Model



Source: Energeia

The EV uptake module forecasts EV uptake for each category of vehicle using vehicle model availability and the vehicle owner's return on investment as inputs. The forecast is allocated on a pro-rata basis to each state based on the state's 2016 share of vehicles on the road based on ABS data.[5] The EV charging module then applies a charging regime to each vehicle adopted based on its:

- charging type,
- arrival and departure time for home and workplace charging or transportation profile for DC fast charging,
- the number of kilometres travelled and
- grid load to optimise workplace and home charging.

The model considers 8 categories of vehicle types including:

- Vehicle class
    - Passenger Car Large (PC-L)
    - Passenger Car Medium (PC-M)
    - Passenger Car Small (PC-S)

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[5] ABS 9208.0 - Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016

  - Sport Utility Vehicle Medium (SUV-M)
  - Sport Utility Vehicle Large (SUV-L)
  - Light Commercial (LC)
  - Rigid Truck (RT)
  - Bus (B)

Each of these categories have specific characteristics which drive both uptake and charging, including:

- purchase premium,
- energy consumption per km, and
- battery size.

Fuel costs and average daily driving are based on state level factors.

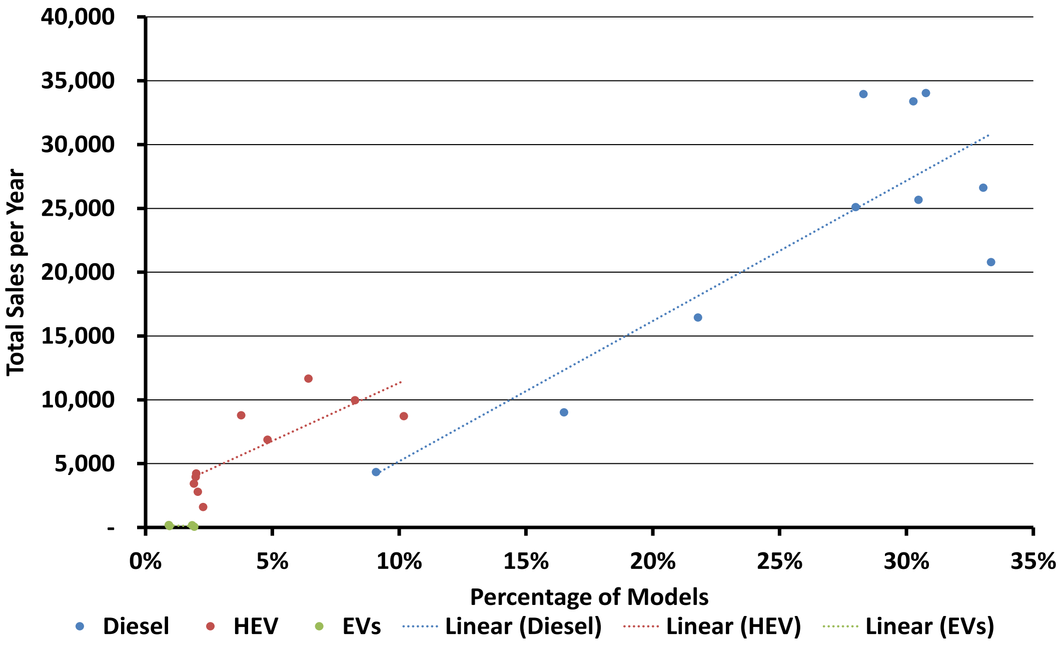
2.2 EV Uptake

EV uptake is determined by a two-parameter function that describes vehicle uptake over time based on:

- Model Availability: The percentage of models within a given vehicle class available in EV form
- Return on Investment: The first-year return to the vehicle owner investing in an EV in terms of reduced operational costs (fuel and costs) on the premium paid compared to a conventional ICE vehicle, net of any purchase incentives.

This functional form accordingly considers the supply side constraints (lack of model availability) as well as demand side drivers (reduced operational costs) in the vehicles owner's decision to adopt. The function is derived from analysis of diesel vehicle and hybrid electric vehicle adoption patterns in Australia which showed uptake was best explained by a combination of these parameters. The historical relationship between vehicle uptake and model availability in the Australia market for alternative technologies is shown in Figure 7 below.

Figure 7 – Relationship between EV Uptake and Model Availability



Source: VFACTS, Energeia

Detailed assumptions driving the EV Uptake Model are provided in Appendix A.

2.3 EV Charging

The EV charging profile is determined by aggregating the charging profile of each electric vehicle adopted by charging type and state segment as follows:

- Whether the vehicle is assigned as L2 home charging, L2 commercial charging (charges at work or depot location), or Direct Current Fast Charging (DCFC) which is defined as the EV equivalent of a gas station (1MW station with 5 min charge time by 2036)
- The average expected daily travel distance by state, which determines the amount of charge to be supplied by day type via the charging profile (i.e. the area under the curve).
- Average expected arrival time by hour (drawn from a database of home and commercial arrivals times) which dictates when charging starts in the absence of any other tariff restrictions
- Average expected departure time by hour (drawn from a database of home and commercial departure times) which dictates when charging must cease in the absence of any other tariff restrictions
- The optimised home and workplace charging profiles that deliver the required level of charge within the arrival and departure times, without impacting on grid peak demand. The DC Fast Charging profile is based on transportation demand as no flexibility is assumed due to the nature of the service.

Detailed assumptions driving the EV charging profiles are provided in Appendix A.

3 Sensitivities

Three forecast sensitivities were modelled that represent the expected pathway for Australia across weak, neutral (considered the most likely), and strong economic, technical and consumer outlooks aligned with AEMO's broader forecast sensitivities. The results of the neutral sensitivity are reported on in the main body of this paper, however, forecast uptake, consumption and peak demand are reported for all sensitivities in Appendix B4.

3.1 AEMO Sensitivities

AEMO's 2017 Electricity Forecast Insights paper uses the terms "weak", "neutral", and "strong" throughout the report to identify the three sensitivities with the neutral sensitivity considered the most likely (i.e. the 'P50'). The weak and strong sensitivities are based on dynamics affecting the total energy consumption of households and businesses and are not necessarily a low and high outcome for the consumption of grid-supplied energy, but rather an internally consistent set of assumptions aligned to strong and weak economies, technology change and consumer sentiment. The key characteristics of these sensitivities of relevance to EVs are shown in Table 1.

Table 1 – 201 AEMO Insights Sensitivity Drivers

Driver	Weak Sensitivity	Neutral Sensitivity	Strong Sensitivity
Population Growth	ABS projection C	ABS projection B	ABS projection A
Economic Growth	Weak	Neutral	Strong
Electricity Network Charges, 5 Years	Current AER determinations, fixed after 5 years		
Electricity Retail Costs and Margin	Assume current margins throughout		
Oil Prices	UD30/bbl (BR) over 5 year glide path	UD60/bbl (BR) over 5 year glide path	UD90/bbl (BR) over 5 year glide path
Climate Policy	Assume Australia's Paris commitment is achieved		

3.2 EV Sensitivities

In addition to the AEMO Electricity Forecast Insight sensitivities, the EV Forecast Insights include the additional assumptions listed in Table 2.

Detailed assumptions underpinning the EV sensitivities are provided in Appendix A.

Table 2 – Additional EV Sensitivity Drivers

Driver	Weak Sensitivity	Neutral Sensitivity	Strong Sensitivity
EV Incentive	$1,500	$2,500	$5,000
Year Incentive Applies	2023	2021	2019
EV Vehicle Parity	8	6	4
Tariff Settings (Home and Depot Charging)	Current controlled load tariffs (generally allowing overnight charging only)		
Tariff Settings (DCFC)	Vehicles without private parking available charge using DCFC charging stations		
Upper EV Limit	80%	90%	100%
Model Availability Ramp (Models/Yr)	2.5%	5%	7.5%
Vehicle Emission Standards	Commonwealth Government introduces international best practice emission standards (as fleet wide target) by 2023*	Commonwealth Government introduces international best practice emission standards (as fleet wide target) by 2021*	Commonwealth Government introduces international best practice emission standards (as fleet wide target) by 2019*

* A fleet wide standard has been assumed, rather than a minimum performance standard, as the most economically efficient means of achieving best practice greenhouse gas emission

4 Results

The results shown below describe forecast EV uptake over the period 2017 to 2050 and the corresponding contribution to energy consumption and both maximum and minimum demand at the NEM level and by state. The results are presented for the neutral sensitivity unless otherwise indicated.

Detailed forecasts by scenario and region are reported in Appendix B.

4.1 EV Uptake Forecasts

Section 4.1 presents uptake of EVs in terms of both annual sales and number of vehicles on the road (stock).

4.1.1 NEM

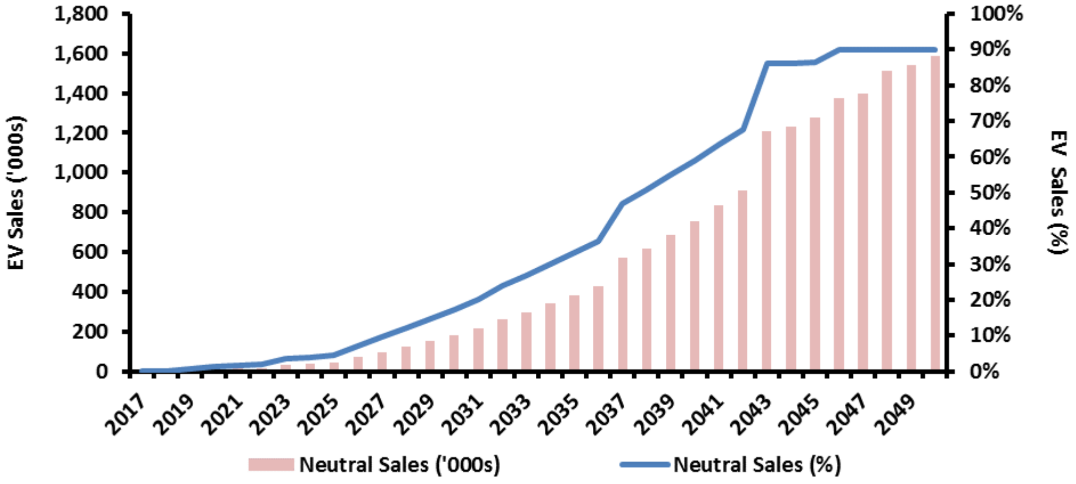
EV sales (both BEV and PHEV) are forecast to reach 431,000 vehicles per annum by 2036, increasing to 1.58 million annual new vehicle sales by 2050, or 36.5% and 90% of sales respectively as shown in Figure 8 – Annual EV Sales (Neutral)Figure 8 below.

Detailed EV modelling shows a relatively steady increase in EV sales to around 40% per annum by 2036 driven by:

- falling EV prices supported by falling battery prices,
- increased model availability by original equipment manufacturers (OEM), and
- an increasing differential between electricity and petrol prices.

Sales are forecast to see a step change in sales from 2036, when the first EVs segments begin to see two-year paybacks, reaching a market tipping point. From 2036 to 2042, annual sales growth is higher mainly due to falling battery costs. In 2043, there is another wave of EV segments reaching the 2-year payback threshold triggering a rapid market share increase up to the sensitivity limit. However, from this point, sales growth begins to taper off as the market reaches saturation.

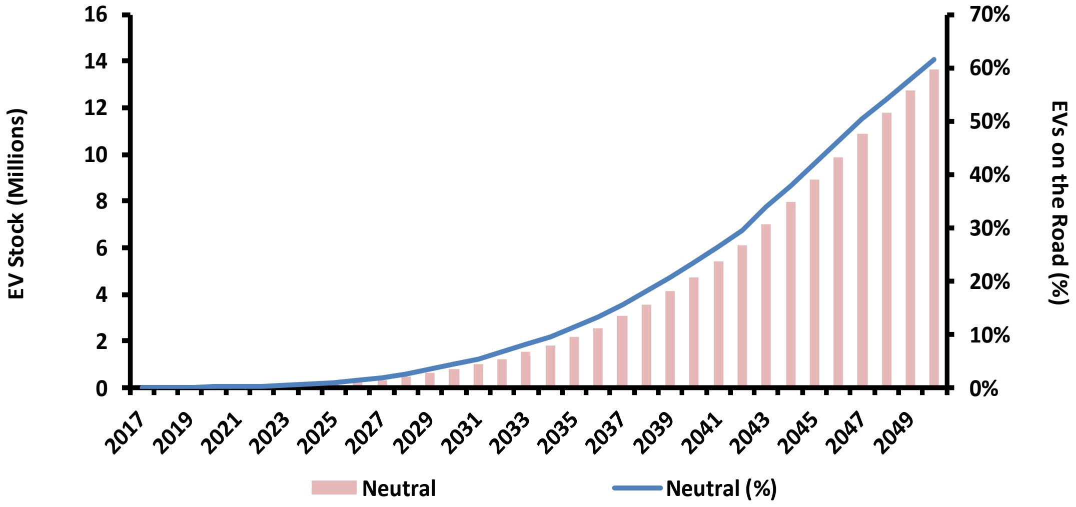
Figure 8 – Annual EV Sales (Neutral)



Source: Energeia

As a result, total vehicles on the road are forecast to reach 2.56 million by 2036 or 13.2% of vehicles. By 2050, EV uptake reaches 13.62 million vehicles, or 61.5% as shown in Figure 8.

Figure 9 – EVs on the Road (Neutral)



Source: Energeia

4.1.2 Regions

Uptake varies by region as shown in Table 3, predominantly due to market size, but also the relative differential between petrol prices and electricity prices experienced in each state in the early years, with QLD having the greatest differential due to its relatively low priced controlled load tariffs.

Table 3 – Annual EV Sales and Vehicles on the Road (Stock) by Region (Neutral)

Region	2017			2020			2030			2050		
	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)
QLD	0.1%	0.1789	0.8852	1.4%	3.438	6.262	16.8%	46.0	199.0	89.8%	440	3750
NSW	0.1%	0.3320	1.5539	1.4%	5.765	10.573	17.7%	81.0	350.9	89.8%	672	5824
VIC	0.1%	0.1655	1.2073	1.4%	3.055	5.992	17.0%	44.3	189.6	89.7%	338	2879
SA	0.1%	0.0567	0.2819	1.3%	1.003	1.856	17.2%	14.4	60.6	89.8%	114	961
TAS	0.1%	0.0171	0.0741	1.4%	0.328	0.588	16.7%	4.3	18.8	89.8%	33	293
NEM	0.1%	0.7292	4.0439	1.4%	13.265	24.794	17.3%	182.8	791.5	89.8%	1585	13627
WA	0.1%	0.1211	0.4666	1.4%	2.224	3.946	17.0%	30.2	130.8	89.7%	308	2593

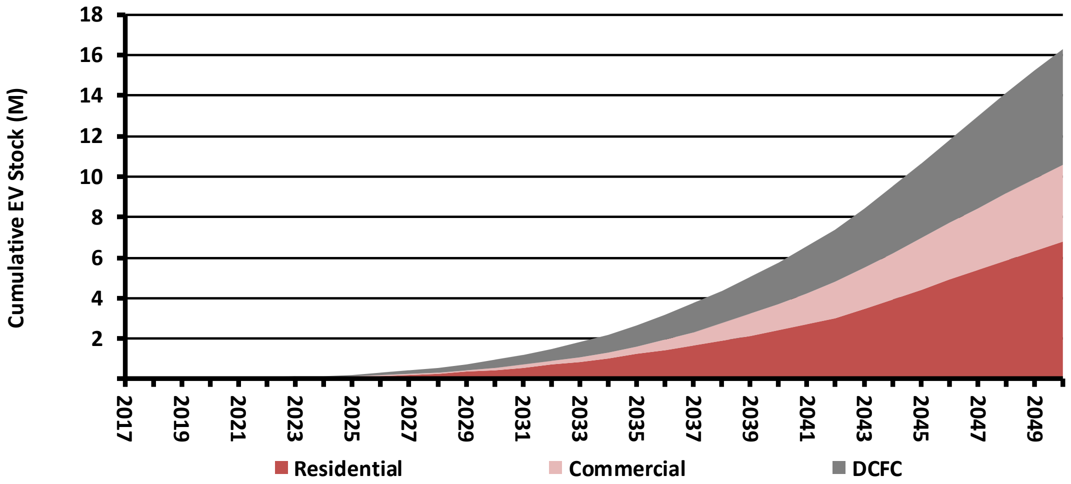
Source: Energeia

4.1.3 Charging Segment

EV Uptake by charging segment for the neutral scenario is shown in Figure 10.

The residential home charging segment is the largest market in terms of EV uptake, followed by the DCFC market and commercial markets respectively. By 2050, over 10 million of the 16 million EVs on the road will have private chargers available where they reach their destination, either home or at work. The remaining 6 million vehicles will use DCFC stations as a means to charge their vehicle.

Figure 10 - EVs on the Road by Charging Segment (Neutral)



4.1.4 Sensitivities

EV uptake forecasts vary significantly across sensitivity scenario as shown in Table 4 below for the NEM. Detailed results by region and sensitivity are presented in Appendix B.

In the strong sensitivity, EV sales initially increase at a faster rate than both the neutral or weak sensitivity due to the larger EV incentive, which applies earlier, and the earlier EV price parity. The strong sensitivity sales rate accelerates from 2024 due to a faster ramp-up of model availability driven in part by higher incentives. As a result, forecast EV stock under the strong sensitivity reaches 6.9 million vehicles by 2036, 2.7 times higher than the neutral sensitivity, and reaches 23.67 million vehicles by 2050, 1.7 times higher than the neutral scenario.

In the weak sensitivity, EV sales increase more slowly over time mostly due to a slower decline in EV price premiums and model availability. Under the weak sensitivity, the first EVs to reach the two year pay-back do so in 2042, five years later than the neutral scenario. As a result, forecast EV stock in the weak sensitivity reaches almost 1.27 million vehicles by 2036, 50% less than the neutral sensitivity. Looking further ahead, the EV stock under the weak sensitivity reaches 5.42 million vehicles by 2050, 60% less than the neutral scenario.

Table 4 – EV Uptake by Sensitivity (Neutral)

Sens.	2017			2020			2030			2050		
	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)	Yrly Sales (%)	Yrly Sales (‘000s)	Stock (‘000s)
Strong	0.1%	0.7454	4.0600	1.9%	18.990	32.368	40.8%	456.7	1839.8	99.8%	2510	23666
Neutral	0.1%	0.7292	4.0439	1.4%	13.265	24.794	17.3%	182.8	791.5	89.8%	1585	13627
Weak	0.1%	0.7135	4.0281	1.3%	12.068	23.130	9.5%	95.3	465.8	65.9%	855	5422

Source: Energeia

4.2 EV Consumption Forecasts

Section 4.2 presents the forecasts for grid electricity consumption from from Australia’s EV stock charging and assesses the impact of these on the 2017 Insights forecasts prepared by AEMO. All of the forecasts are in terms of ‘operational’ requirements (including losses) as defined by AEMO[6].

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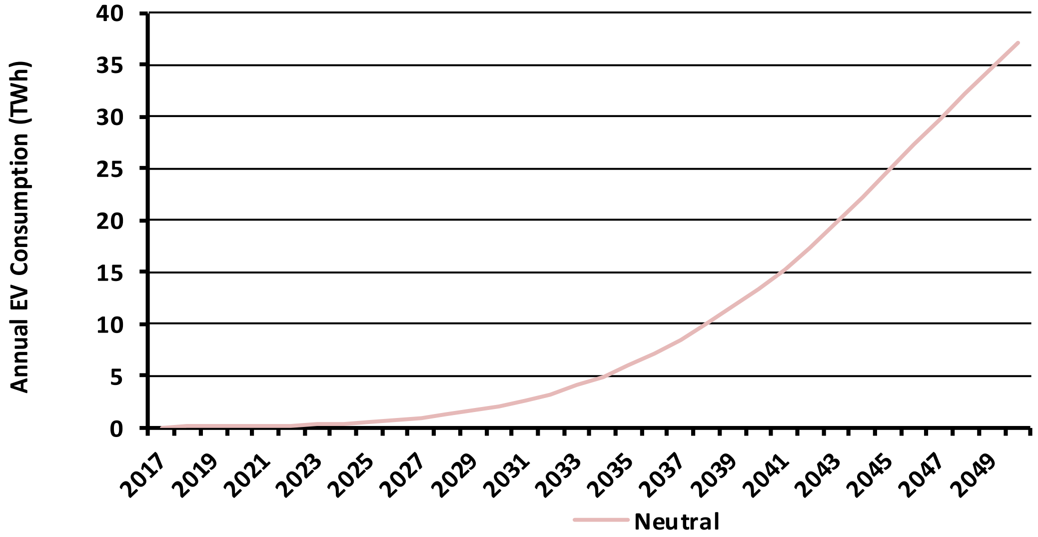
[6] AEMO Electricity Forecasting Insights 2017

4.2.1 NEM

Energeia's neutral sensitivity forecast sees EVs consuming around 7.02 TWh of electricity per year by 2036, and 37.08 TWh of electricity by 2050, as shown in Figure 12. The increase in EV consumption over time is directly related to the change in EV uptake as discussed in Section 4.1.

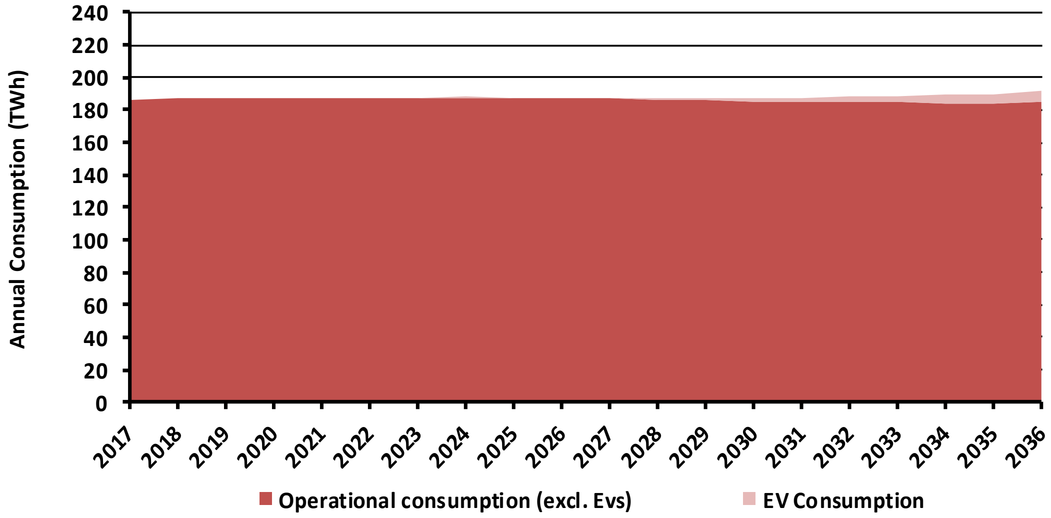
Figure 11 – EV Electricity Consumption (NEM Operational, Neutral)



Source: Energeia

The additional EV consumption is forecast to increase total consumption by around 3.81% compared to AEMO's Insights forecasts for operational load in 2036 under the neutral sensitivity as shown in Figure 13 below.

Figure 12 – EV Electricity Consumption Compared to AEMO Forecast (NEM Operational, Neutral)



Source: Energeia

4.2.2 Regions

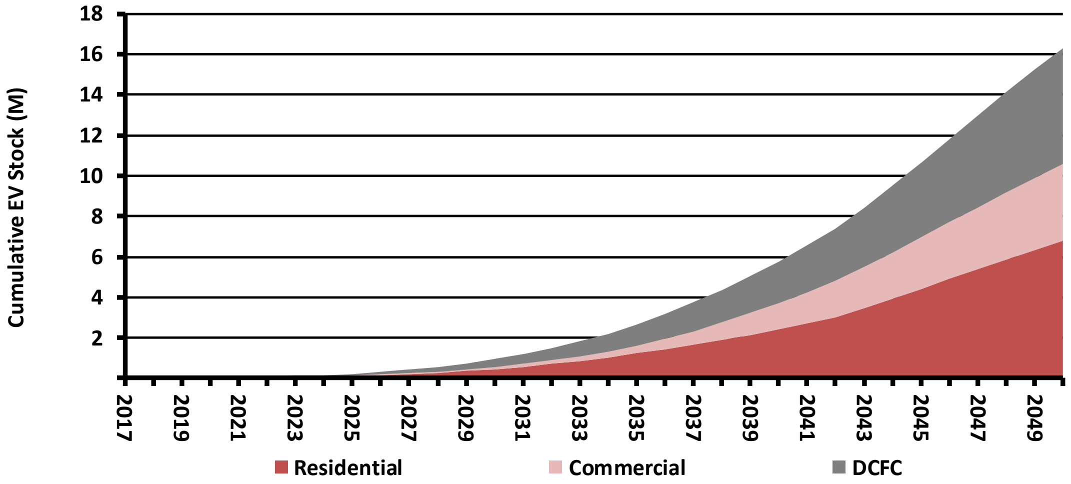
Electricity consumption by EVs is forecast to vary by region as shown in Figure 13 below.

The differences in regions are driven primarily by market size, with ACT and NSW having the largest market for new vehicles. The consumption aligns closely to EV uptake by region (as per Charging Segment

EV Uptake by charging segment for the neutral scenario is shown in Figure 10.

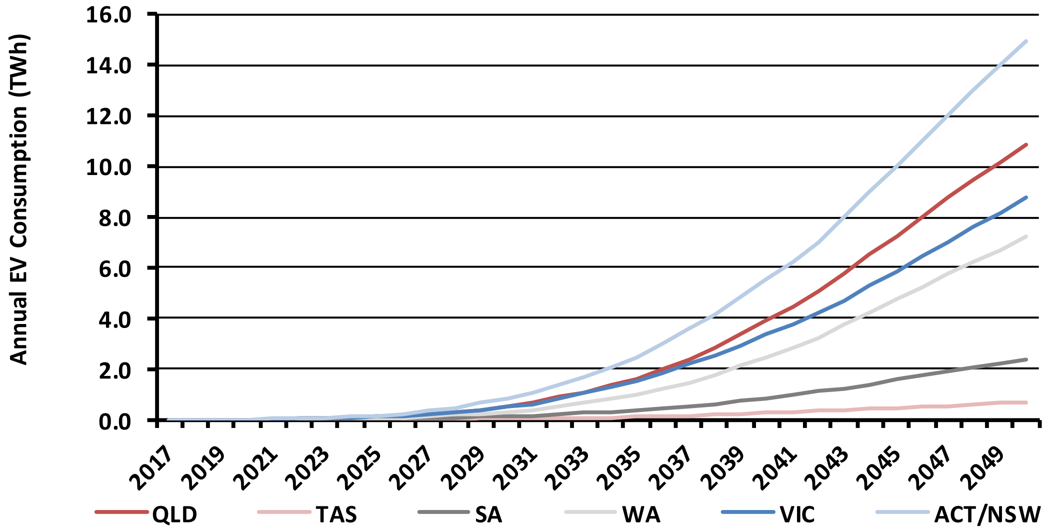
The residential home charging segment is the largest market in terms of EV uptake, followed by the DCFC market and commercial markets respectively. By 2050, over 10 million of the 16 million EVs on the road will have private chargers available where they reach their destination, either home or at work. The remaining 6 million vehicles will use DCFC stations as a means to charge their vehicle.

Figure 10 - EVs on the Road by Charging Segment (Neutral)



). Notwithstanding, EV consumption per vehicle does vary slightly by state due to the differences in average travel distances and tariff rates which in turn influence relative uptake of vehicle types (PHEV or BEV) and associated charging requirements.

Figure 13 – EV Electricity Consumption by Region (Neutral)



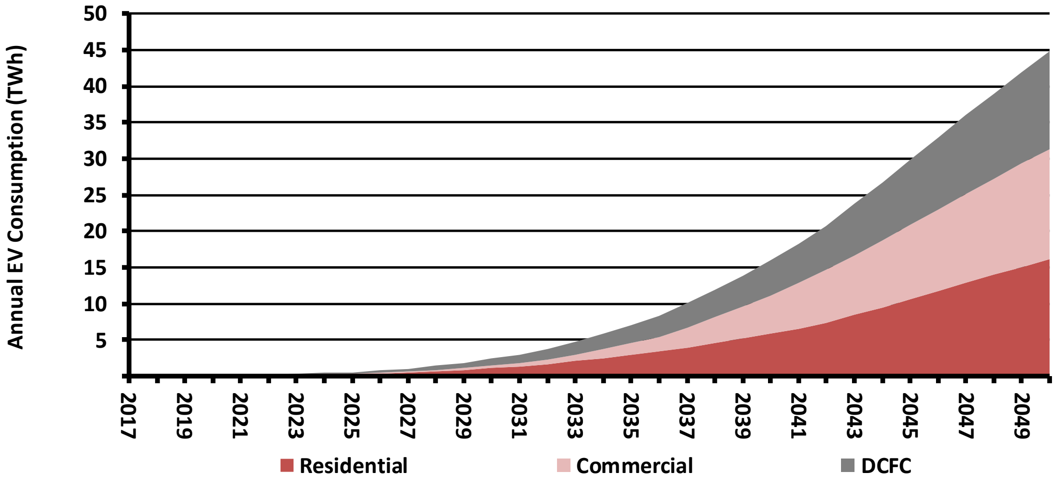
Source: Energeia

4.2.3 Charging Segment

Electricity consumption by charging segment for the neutral scenario is shown in Figure 13.

Unlike EV uptake, energy consumption between residential, commercial and DCFC is similar throughout the modelling period. Although the commercial market has around half the number of EVs on the road as the residential and DCFC market, additional distances travelled by commercial vehicles and the consumption requirements of these vehicles results in around double the energy needs of the other markets. The modelling shows that on average, residential and DCFC vehicles require 2.2MWh of electricity annually, while commercial vehicles require 4.4 MWh.

Figure 14 - EV Electricity Consumption by Charging Segment (Neutral)

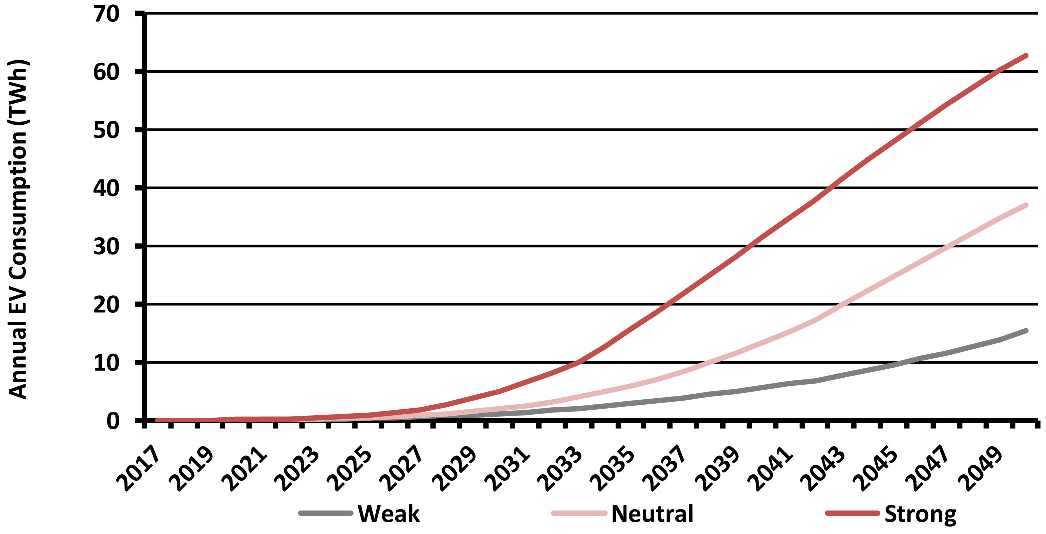


4.2.4 Sensitivities

EV electricity consumption forecasts vary significantly for the weak and strong sensitivities as shown in Figure 15 below for the NEM, as a result of the factors detailed in Section 4.1.2 on uptake.

Detailed results by region and sensitivity are presented in Appendix B.

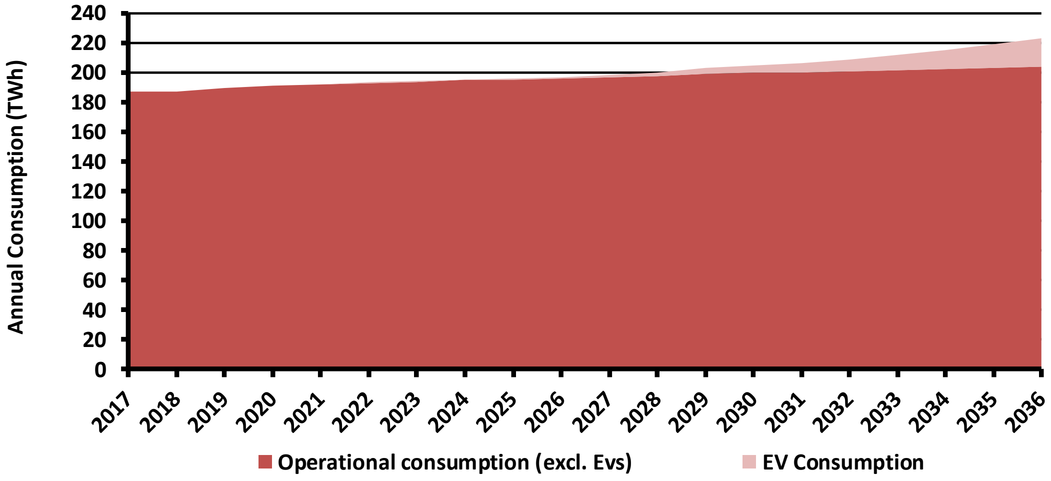
Figure 15 – EV Electricity Consumption by Sensitivity (NEM Operational)



Source: Energeia

Under the strong sensitivity, EV electricity consumption reaches 18.69 TWh per year and equates to around 9.16% of AEMO's Insights forecasts for operational load in 2036 as shown in Figure 16 below. This is around 266% above the neutral scenario, consistent with differences in uptake rates between the sensitivities.

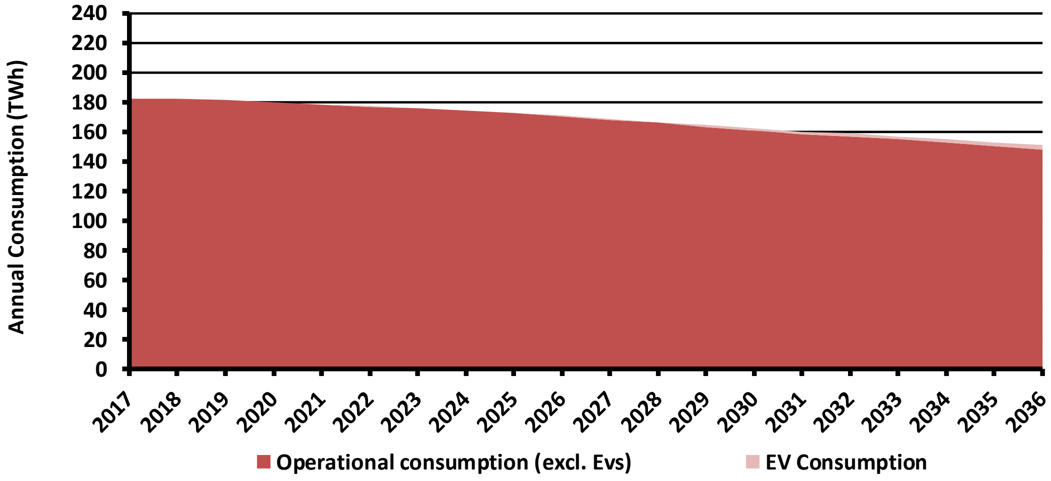
Figure 16 – EV Electricity Consumption (NEM Operational, Strong)



Source: Energeia

Under the weak sensitivity, EV electricity consumption reaches 3.34 TWh per year and equates to around 2.68% of AEMO's Insights forecasts for primary load in 2036 as shown in Figure 17 below. This is around 52% below the neutral scenario, consistent with differences in uptake rates between the sensitivities.

Figure 17 – EV Electricity Consumption (NEM Operational, Weak)



Source: Energeia

4.3 EV Maximum Demand Forecasts

Section 4.3 presents Energeia's forecasts for maximum demand by region from EV charging and assesses the impact of these on the 2017 Insights maximum demand forecasts prepared by AEMO.

Section 4.3.1 describes Energeia's forecast of aggregate EV demand including controlled EV charging and uncontrolled DC fast charging. The impact on coincident system maximum demand is then described in Section 4.3.2 by adding coincident EV demand to system demand for each half hour.

All of the forecasts present maximum demand in terms of operational requirements (including losses).

4.3.1 EV Maximum Demand

Energeia's forecast of annual maximum EV demand by region and sensitivity is presented in Table 5 below.

Half-hourly average EV charging profiles by region, charging type and scenario are provided in Appendix B.

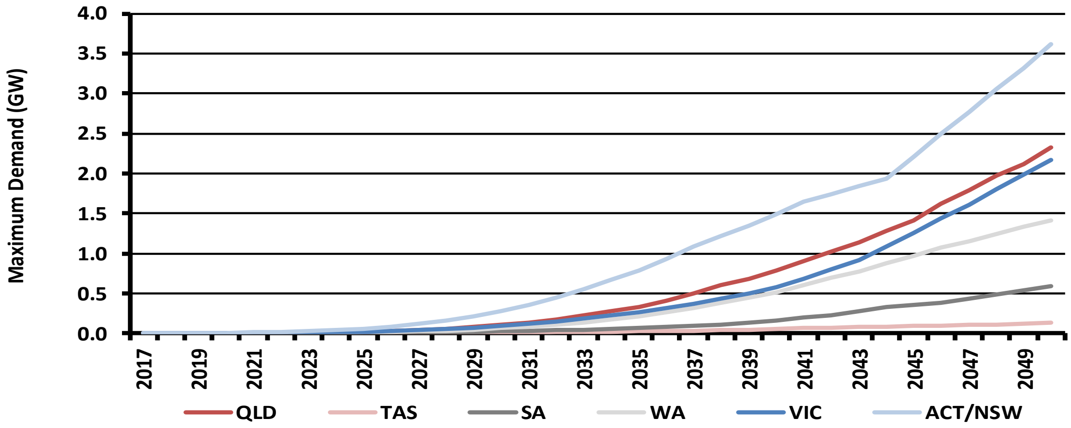
The differences in forecast regional results are driven primarily by EV uptake and EV consumption as discussed in Section 4.1 and Section 4.2, respectively. In addition, maximum demand is also influenced by the characteristics of each state's peak demand profile, which can impact on the available number of hours available for recharging flexible residential and workplace based EVs. For example, although EV consumption is significantly higher in QLD compared to VIC, there is only a minor difference between EV maximum demand. This is due to differences in peak demand profiles, with QLD's peak demand profile providing a longer period over which to recharge EVs compared to VIC.

Table 5 – EV Maximum Demand (Non-Coincident) by Sensitivity (Operational)

Region	2017 EV Max Demand (MW)			2020 EV Max Demand (MW)			2030 EV Max Demand (MW)			2050 EV Max Demand (MW)		
	Strng	Neut	Weak	Strng	Neut	Weak	Strng	Neut	Weak	Strng	Neut	Weak
QLD	0.39	0.38	0.38	5.92	4.44	4.04	301.27	104.90	61.08	4,320.3	2,321.2	943.32
NSW	1.21	1.21	1.20	14.08	10.59	9.95	643.18	278.30	169.4	5,659.2	3,612.7	1,536.0
VIC	0.52	0.52	0.52	4.91	3.96	3.75	224.48	94.52	58.31	3,424.9	2,173.1	619.06
SA	0.12	0.12	0.12	1.45	1.09	1.09	58.20	25.61	16.01	1,119.5	591.81	187.97
TAS	0.03	0.03	0.03	0.50	0.37	0.33	23.86	8.92	5.20	273.57	129.68	59.72
WA	0.19	0.19	0.19	3.51	2.60	2.32	175.67	66.46	38.00	2,658.8	1,415.1	624.97

Source: Energeia

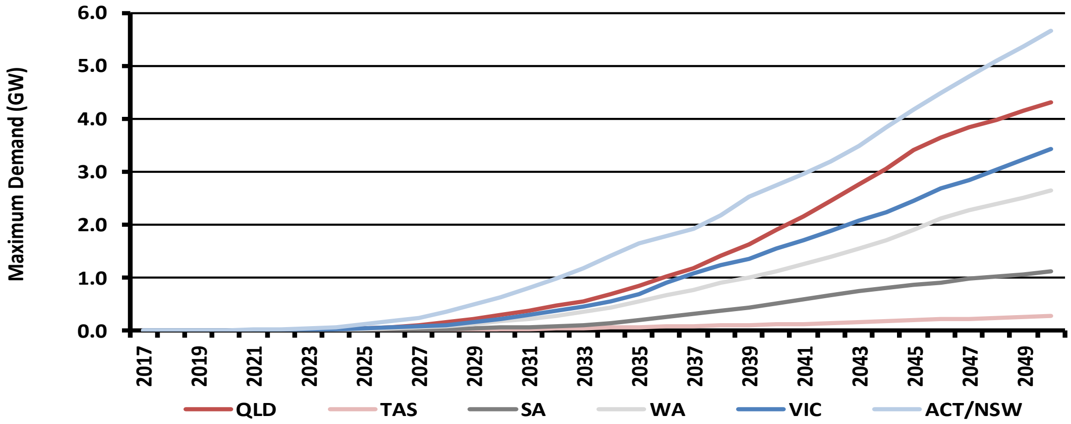
Figure 18 – EV Maximum Demand by Region (Operational, Neutral)



Source: Energeia

Figure 18, Figure 19 and Figure 20 show EV maximum demand by sensitivity. By 2036, forecast EV maximum demand under the strong sensitivity is between 2.9 and 4.2 times greater than under the neutral sensitivity, depending on region, due to the higher EV uptake. By 2050, EV maximum demand reduces to between 160% and 180% larger under the strong sensitivity when compared to the neutral sensitivity.

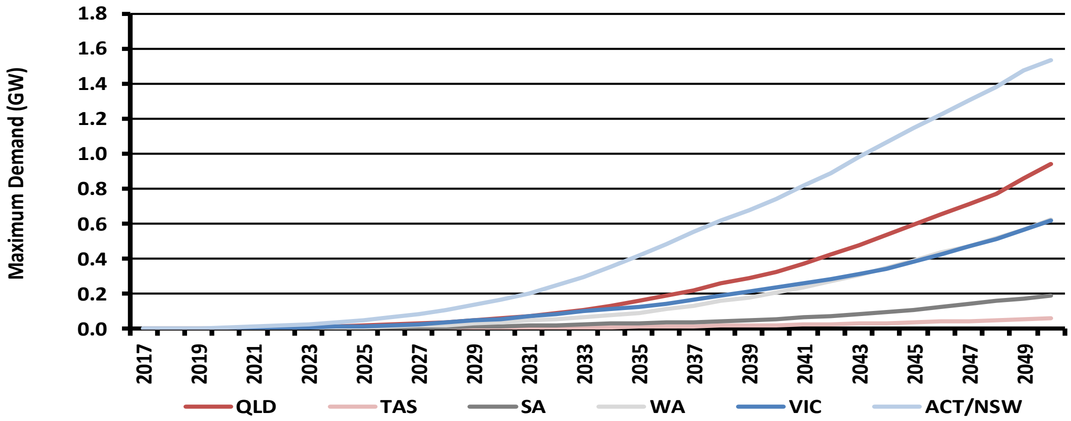
Figure 19 – EV Maximum Demand by Region (Operational, Strong)



Source: Energeia

By 2036, EV maximum demand under the weak sensitivity is between 56% and 65% less than the neutral sensitivity, depending on region, due to lower EV, uptake. By 2050, EV maximum demand shifts to between 58% and 62% smaller under the weak sensitivity when compared to neutral.

Figure 20 – EV Maximum Demand by Region (Operational, Weak)

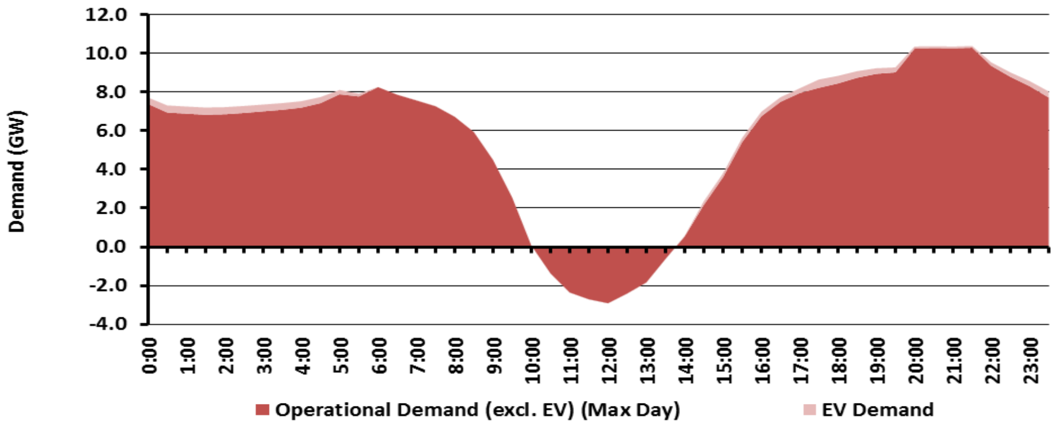


Source: Energeia

4.3.2 Impact on Maximum Demand

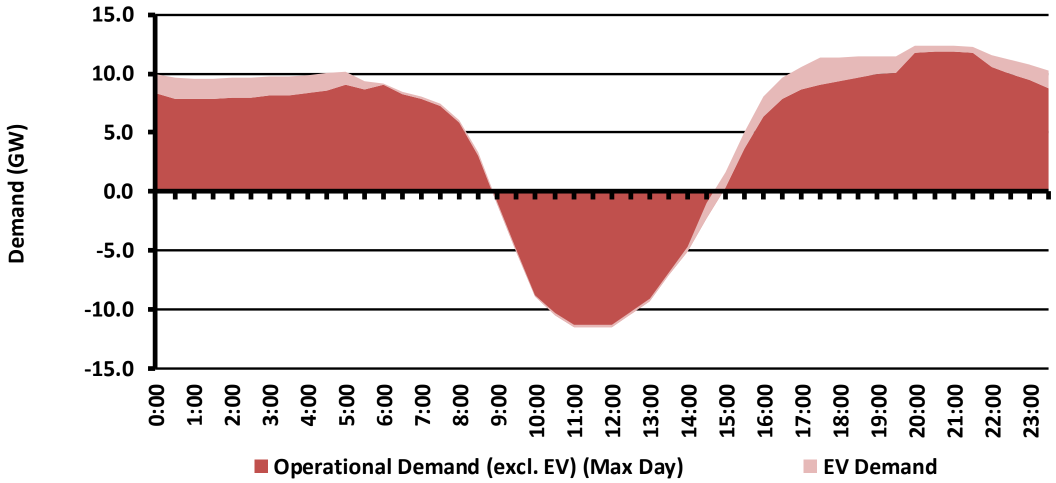
Energeia's modelling shows EV charging management avoiding increasing maximum demand in any of the regions over the period 2017 to 2036, based on our forecast of underlying operational demand. FiguresFigure 21 to Figure 29 show the contribution of EVs on the maximum demand day for each region for the neutral sensitivity.

Figure 21 – Contribution of EVs on QLD Maximum Demand Day (2036, Neutral)



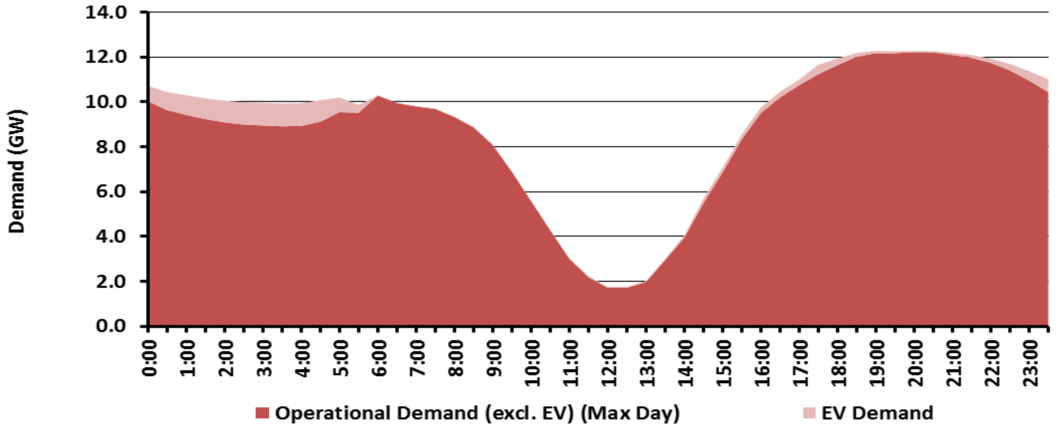
Source: Energeia

Figure 22 – Contribution of EVs on QLD Maximum Demand Day (2050, Neutral)



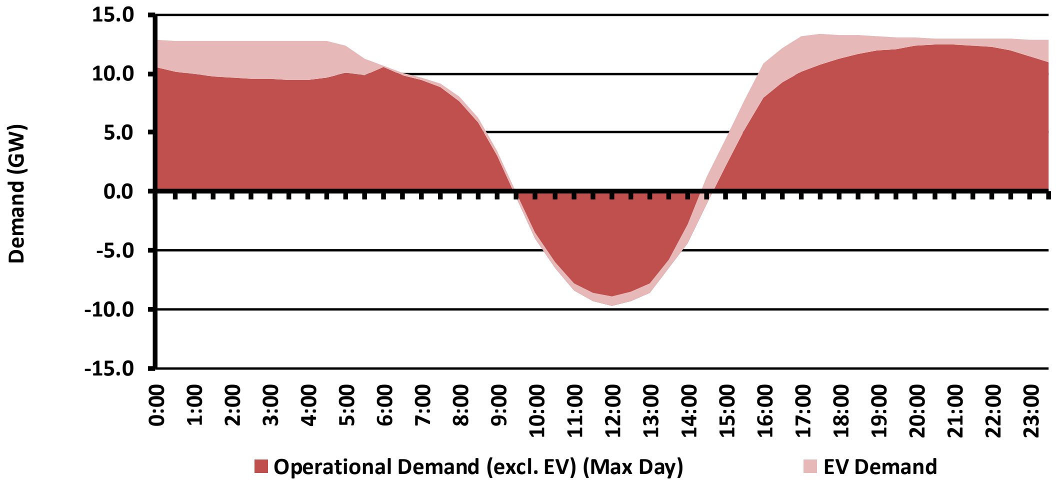
Source: Energeia

Figure 23 – Contribution of EVs on NSW Maximum Demand Day (2036, Neutral)



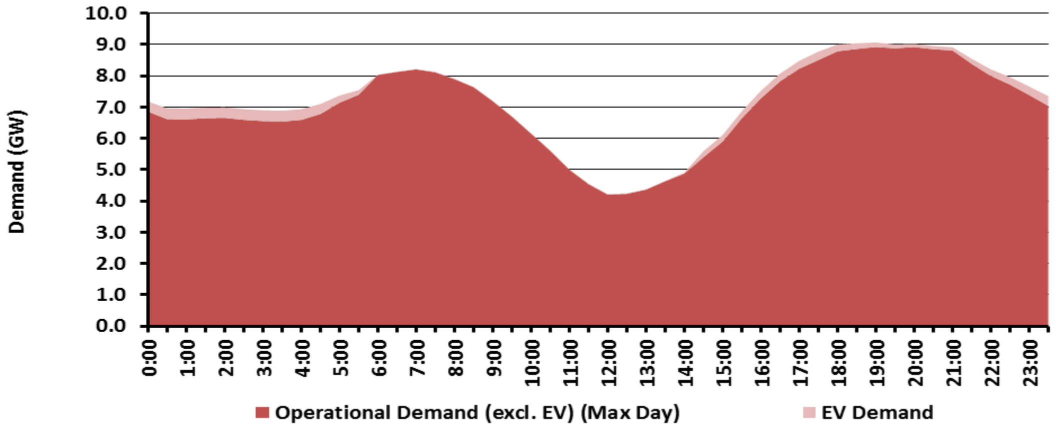
Source: Energeia

Figure 24 – Contribution of EVs on NSW Maximum Demand Day (2050, Neutral)



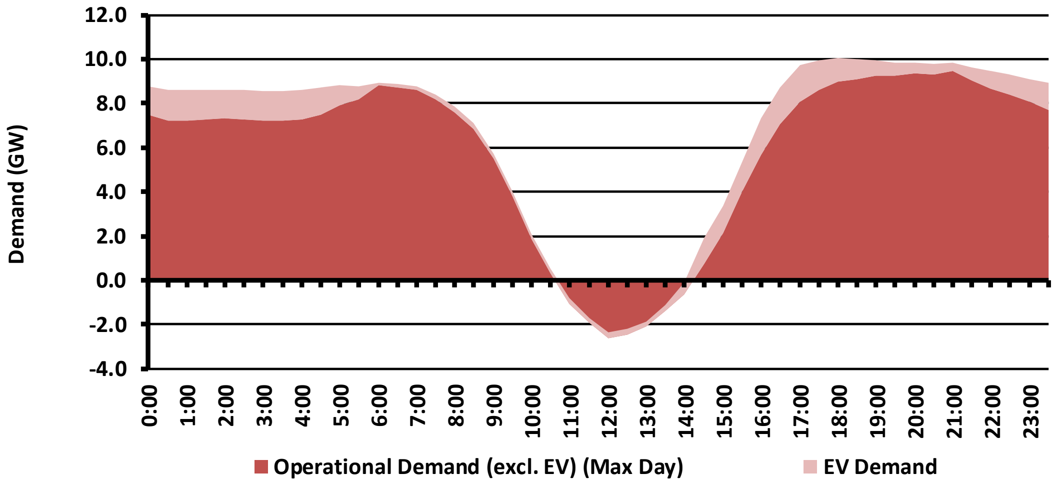
Source: Energeia

Figure 25 – Contribution of EVs on VIC Maximum Demand Day (2036, Neutral)



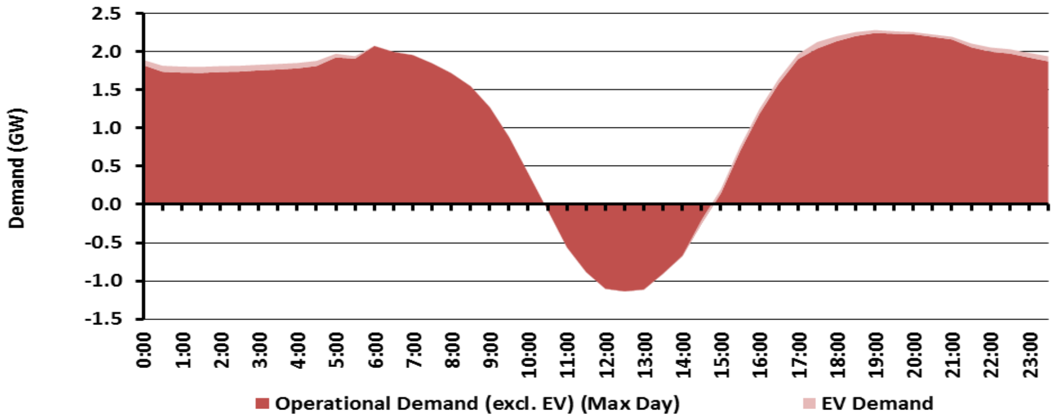
Source: Energeia

Figure 26 – Contribution of EVs on VIC Maximum Demand Day (2050, Neutral)



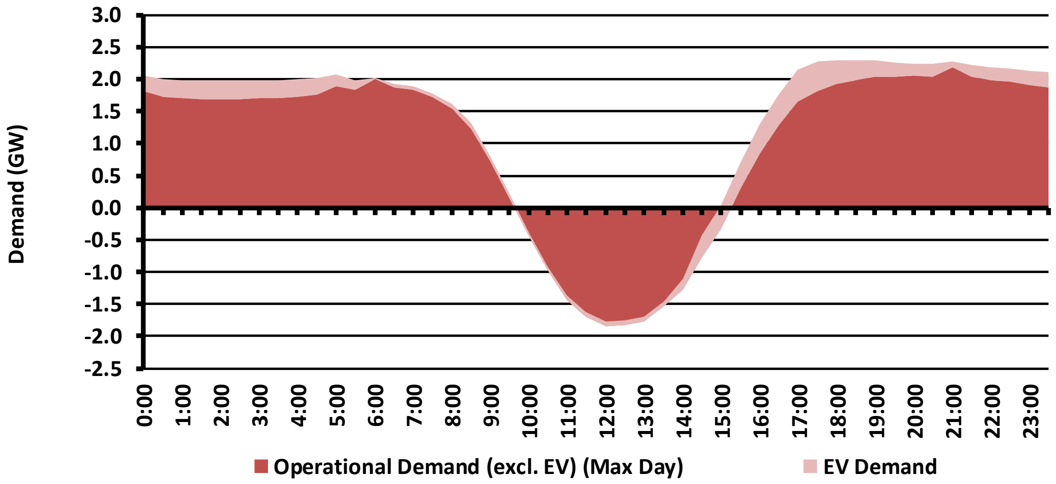
Source: Energeia

Figure 27 – Contribution of EVs on SA Maximum Demand Day (2036, Neutral)



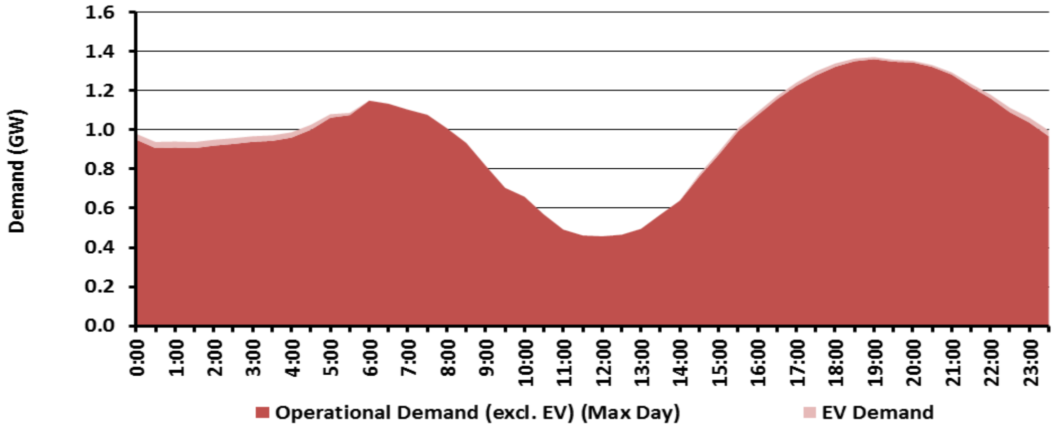
Source: Energeia

Figure 28 – Contribution of EVs on SA Maximum Demand Day (2050, Neutral)



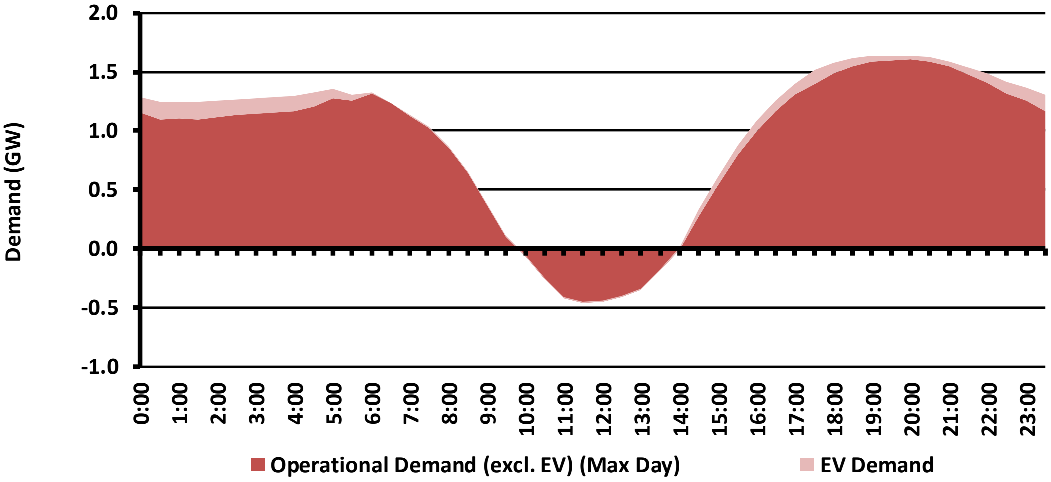
Source: Energeia

Figure 29 – Contribution of EVs on TAS Maximum Demand Day (2036, Neutral)



Source: Energeia

Figure 30 – Contribution of EVs on TAS Maximum Demand Day (2050, Neutral)

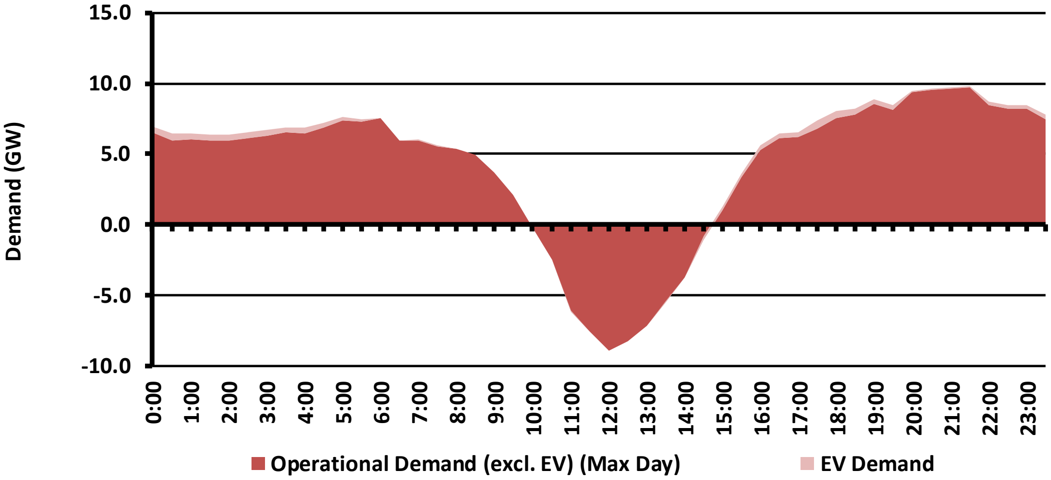


Source: Energeia

4.3.3 Impact on Minimum Demand

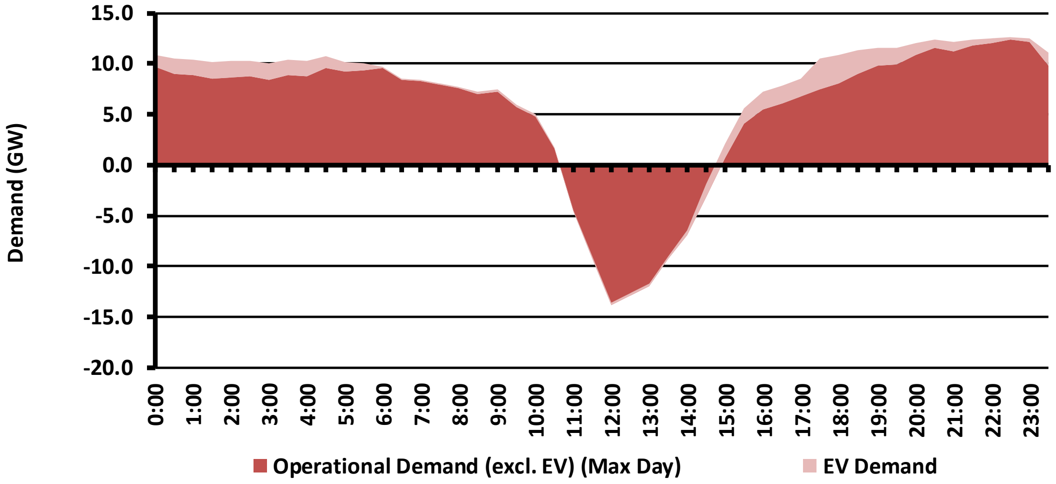
Energeia's modelling of future minimum demand shows a shift from overnight to the middle of the day by 2036 in all states as solar PV penetration increases. As a result, daytime EV charging is forecast to increase the minimum demand for all of the regions by 2036. DCFC of vehicles slightly increases minimum demand, although the effect is almost insignificant due to the majority of charging still occurring overnight as shown in Figures Figure 31 to Figure 39 Fig (although the effect on minimum demand is too small to be seen).

Figure 31 – Contribution of EVs on QLD Minimum Demand Day (2036, Neutral)



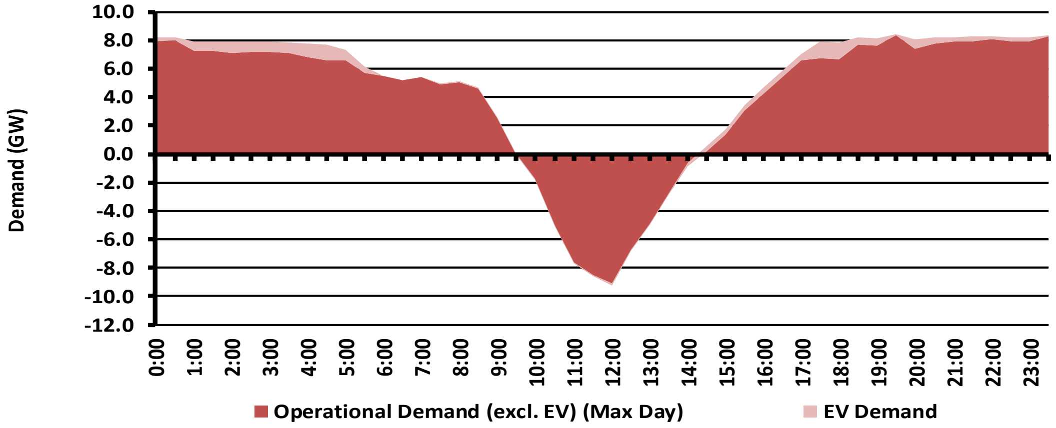
Source: Energeia

Figure 32 - Contribution of EVs on QLD Minimum Demand Day (2050, Neutral)



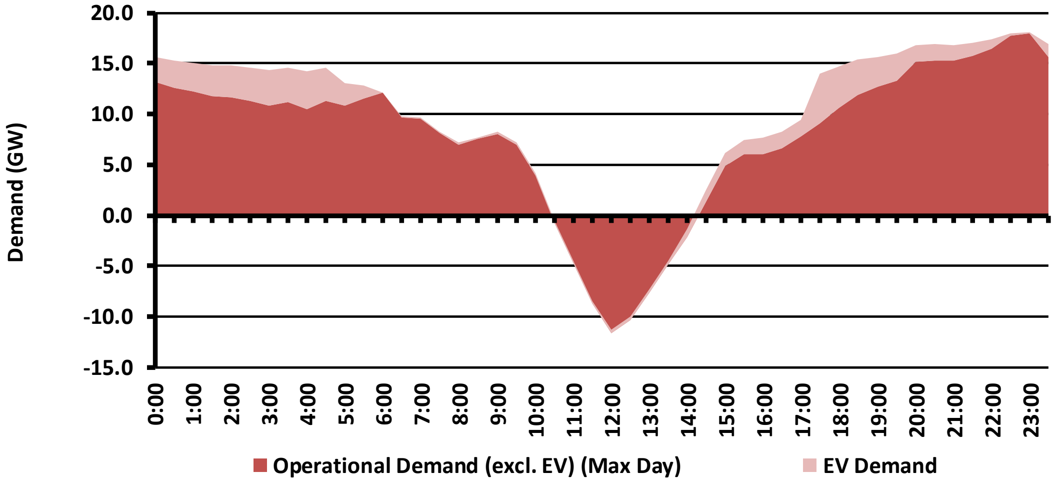
Source: Energeia

Figure 33 – Contribution of EVs on NSW Minimum Demand Day (2036, Neutral)



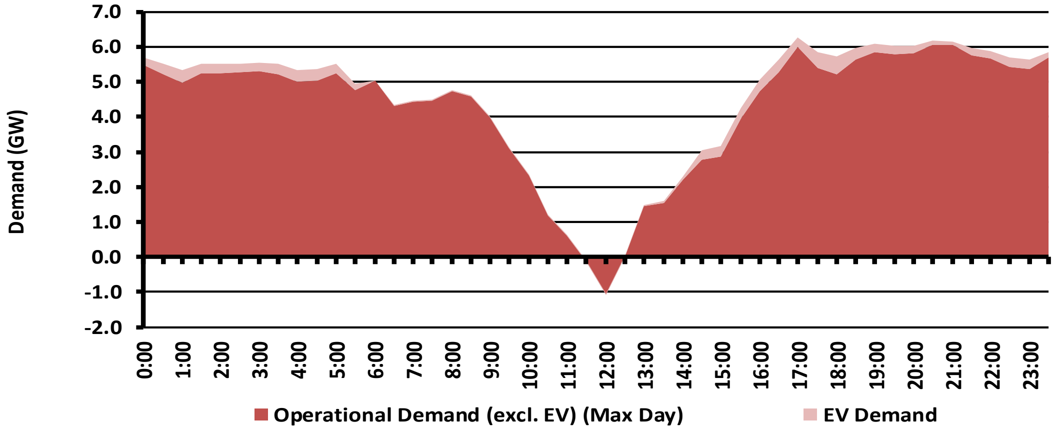
Source: Energeia

Figure 34 – Contribution of EVs on NSW Minimum Demand Day (2050, Neutral)



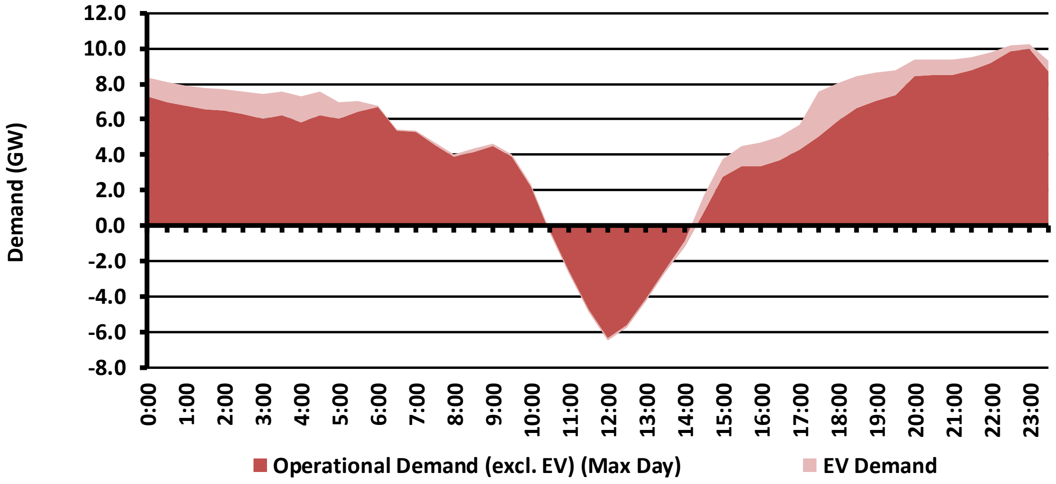
Source: Energeia

Figure 35 – Contribution of EVs on VIC Minimum Demand Day (2036, Neutral)



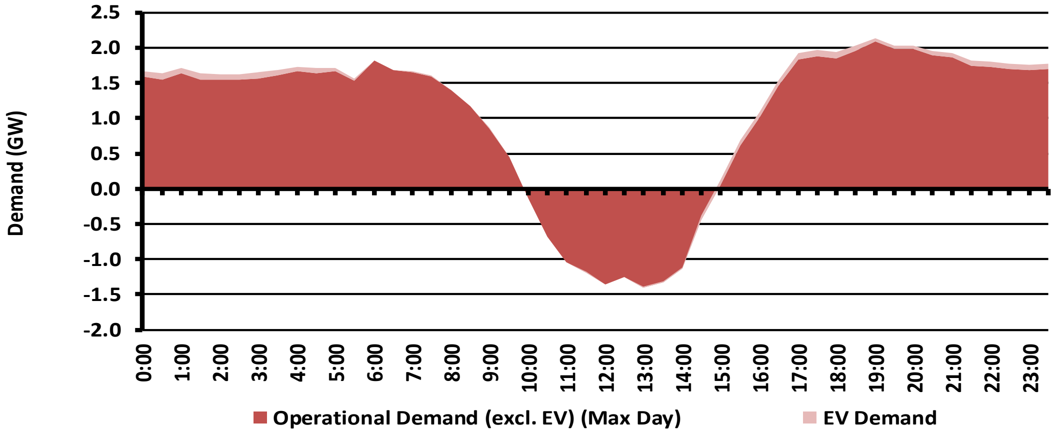
Source: Energeia

Figure 36 – Contribution of EVs on VIC Minimum Demand Day (2050, Neutral)



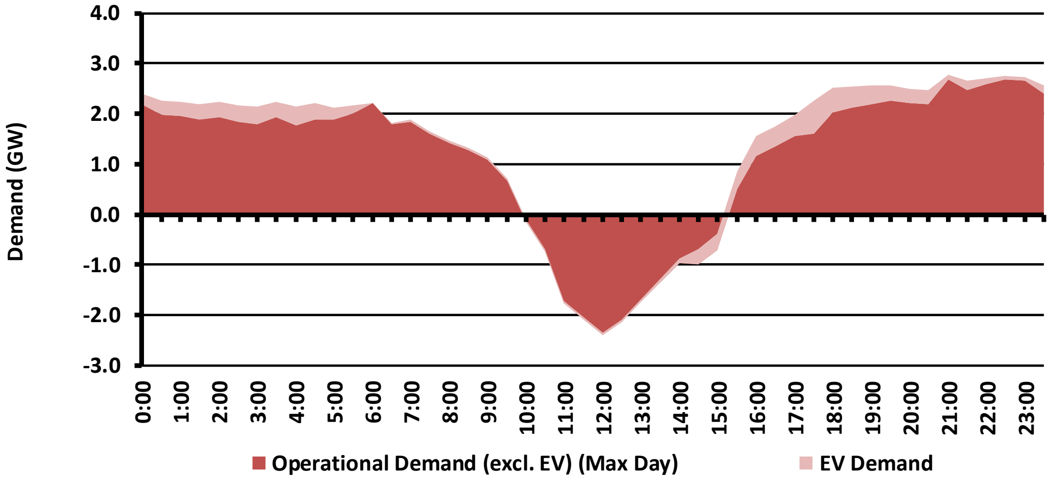
Source: Energeia

Figure 37 – Contribution of EVs on SA Minimum Demand Day (2036, Neutral)



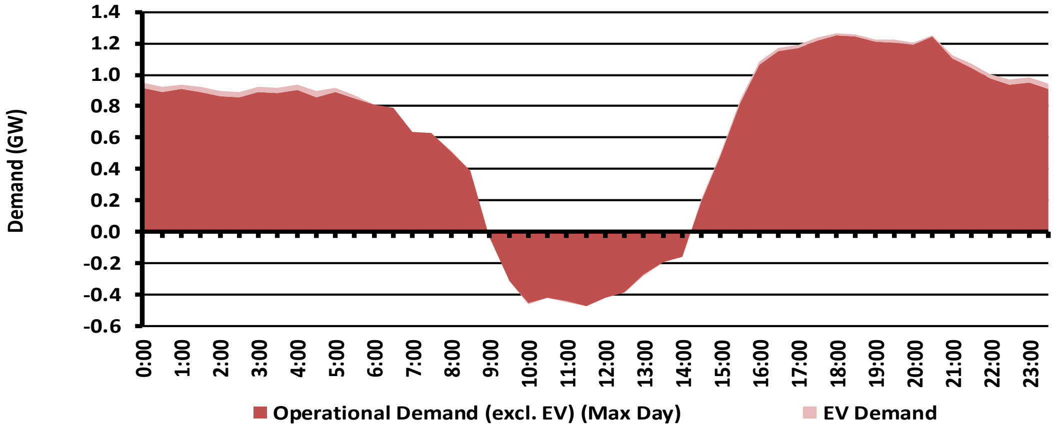
Source: Energeia

Figure 38 – Contribution of EVs on SA Minimum Demand Day (2050, Neutral)



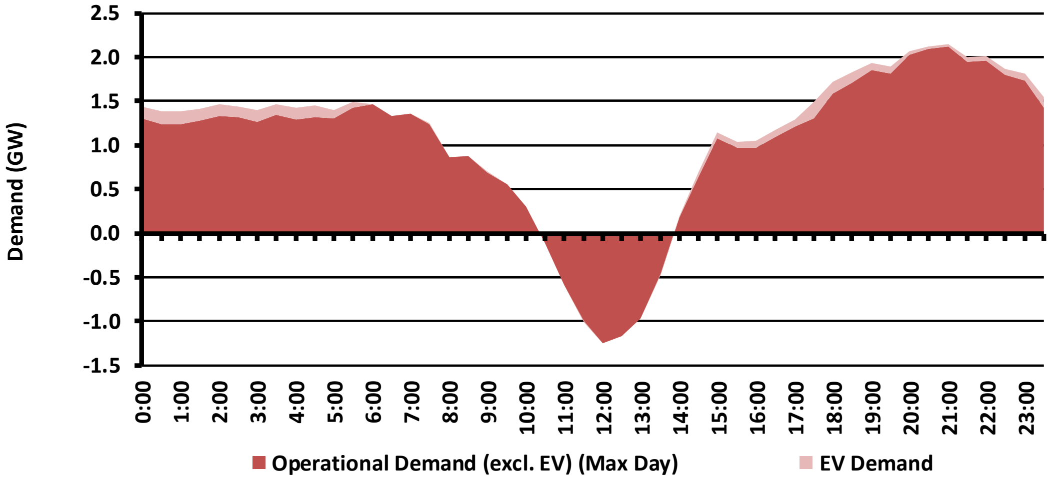
Source: Energeia

Figure 39 – Contribution of EVs on TAS Minimum Demand Day (2036, Neutral)



Source: Energeia

Figure 40 – Contribution of EVs on TAS Minimum Demand Day (2050, Neutral)



Source: Energeia

While the above results suggest an opportunity to encourage daytime EV charging, a whole of system analysis is required to determine the optimal EV charging profile. A key issue to be addressed is whether higher charging in the middle of the day will increase peak demand and augmentation costs for distribution networks, especially in commercial areas where peak demand is already set in the middle of the day.

5 Recommendations for Future Modelling

The EV forecasts contained throughout this paper have been prepared to provide insight into the potential impact of future EV uptake on AEMO forecasts. Energeia's EV forecasts have been prepared based on existing publicly available data. In future years, it is understood that AEMO intends to integrate EV forecasting into the Electricity Forecast Insights process to allow for greater feedback between the primary forecast and EV uptake drivers.

Accordingly, there are a range of key uncertainties and limitations which Energeia recommends to address and/or improv in future modelling.

5.1 Key Uncertainties

The EV forecasts within this paper contain a number of key uncertainties which affect the precision and accuracy of the results. These include:

- The structure of tariffs to be applied to EV charging and changes in these structures over time (See Section 5.2 below)
- Policy uncertainty, with respect to:
  - The mechanism and timing of introduction of a vehicle greenhouse gas emission standard
  - The application of a broader carbon price to vehicle emissions.
- The rate at which vehicle manufacturers make EV models available within the Australian market (nominated as model availability within this paper)
- The location, number and duty cycle of fast charging
- Original Equipment Manufacturer (OEM) response to Vehicle Emission Standards (VES)
- Government policy or subsidy to incentive EV uptake.

Further, the near-term EV forecasts are subject to a high degree of uncertainty due to the immaturity of the market and the short-term actions that may be taken by the private sector to accelerate uptake. For example, there is the potential for early action by industry to promote EVs via heavily subsidised tariffs[7].

In addition, there are likely to be further drivers, external to the model, relating to substitutable low emission technologies by OEMs, including natural gas and fuel cell vehicles. Consideration of the potential impacts of these have not been considered within the model in terms of the extent to which new technologies are likely to limit EV model availability. That is, the model assumes that a wholesale transition of the Australian vehicle fleet to EVs will occur due to lower operating costs, better vehicle environmental and acceleration performance and higher safety ratings for EVs when compared to their counterparts.

The impact of self-driving cars or wireless induction charging have not been considered by the model.

5.2 Changes in EV Charging Tariffs over Time

The EV forecasting model assumes that charging management change over time to compensate for shifting peak demand times from DER and increased penetration of EVs. All home charging and commercial vehicle charging is assumed to be managed by 2036.

Whether or not managed EV charging is operating during the middle of the day to mitigate excess generation of solar PV will depend on the net benefits across the industry, including the distribution, transmission and generation sectors. Whole-of-system cost-to-serve analysis is needed to determine what the optimal shape will ultimately be over time.

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[7] See for example, Vesey, Andy (@AndyVesey_AGL) "$1 a day (fully carbon offset) to charge your #EV. AGL to launch Nov 2016. $365 pa max for all your EV trips #AEW16" 5:37 PM, 20 June 2016. Tweet.

It is recommended that for future EV modelling, AEMO considers modelling a whole of system cost-to-serve to enable the least cost demand profile for EVs to be identified and incorporated into future EV load forecasts.

5.3 Integration with Primary Load

The forecasts assume that the decision to adopt an EV is made independently from any other decisions regarding primary energy consumption. In reality, there will be a subset of customers for whom the decision to purchase an EV could be made more attractive if combined with a solar PV system depending on the tariff arrangements and individual driving patterns.

Further, the present modelling assumes that the EV is not capable of any vehicle to home or vehicle to grid (V2G) charging. Where this is the case, integration with the primary load becomes critical to residential forecasts and interacts with the stationary storage uptake.

While AEMO has separately undertaken solar PV and battery storage forecasts, these have not been integrated with the EV forecasts in this paper.

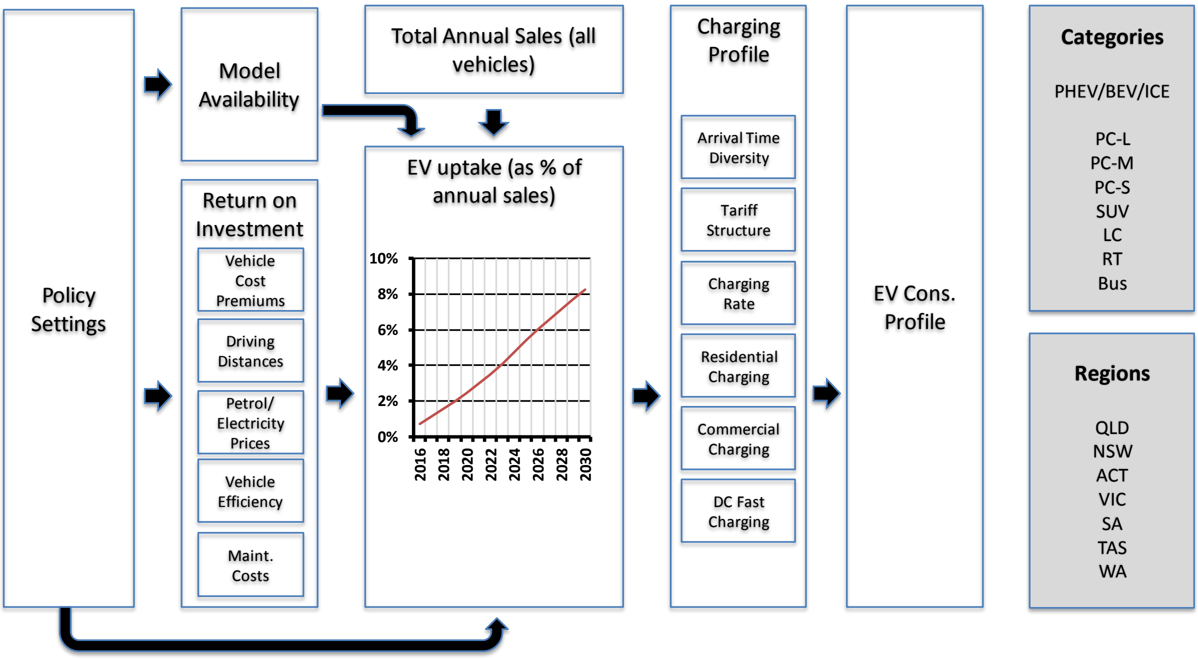
It is recommended that for future EV modelling, AEMO integrates the EV uptake and charging decisions with the broader customer decision making with respect to solar PV and stationary battery storage uptake and operation.

Appendix A: Detailed Assumptions

A.1 Overview of Model Approach

Energeia's EV forecasting model is comprised of two parts, EV uptake and EV charging as shown in Figure 41 below.

Figure 41 – Energeia EV Forecasting Model



Source: Energeia

The EV uptake module forecasts EV uptake as a percentage of annual vehicle sales for each category of vehicle type by state. This is based on vehicle model availability and the vehicle owner's return on investment.

The EV charging module then applies a charging regime to each vehicle adopted based on the arrival and departure time of the vehicle at the point of charge, the number of kilometres travelled and the least cost demand profile (managed charging only).

A.2 EV Uptake

EV uptake is determined by a two-parameter function that describes vehicle uptake over time based on:

1. EV premium payback more than two years:

$$EV\ Uptake_t = Total\ New\ Vehicle\ Sales_t * (a_t \times ROI_t + b_t \times Model\ Availability_t)$$

2. EV premium payback less than two years (tipping point):

$$EV\ Uptake_t = Total\ New\ Vehicle\ Sales_t * \ MIN(Upper\ EV\ Limit, Model\ Availability_t)$$

Where:

- $Total\ New\ Vehicle\ Sales_t$ = Total new vehicle sales within a given vehicle class in year t
- $Model\ Availability_t$ = Percentage of models within a given vehicle class available in EV form in year t. This inclusion of this factor reflects that, for the mass market, a primary driver of vehicle purchase is the availability of that model in EV form. This factor effectively places an upper bound on EV adoption, which is determined by a scenario based parameter.

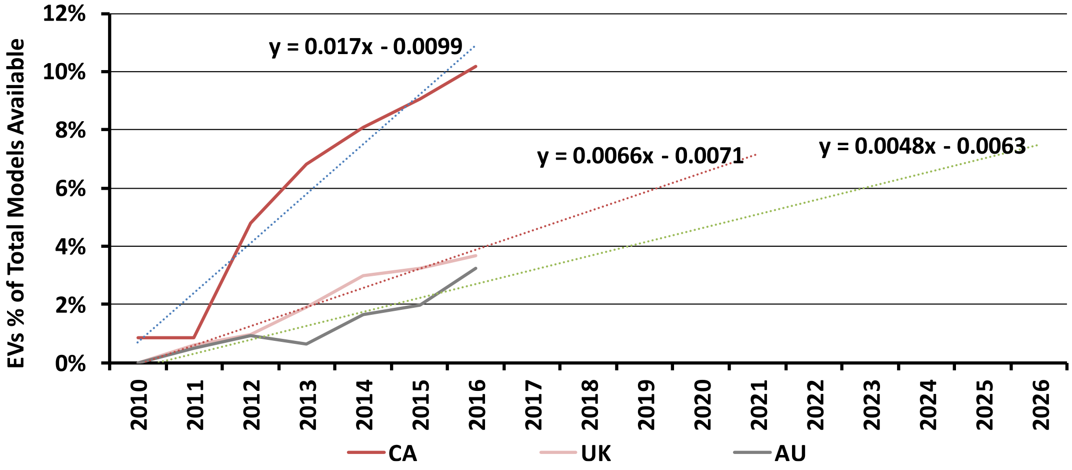
- $Upper\ EV\ Limit$ = Upper model availability limit for all vehicles within a given vehicles class
- ROI_t = The first-year return on investment for the vehicle owner investing in an EV in year t in terms of reduced operational costs (fuel) and premium paid compared to the equivalent ICE vehicle
- a_t = Model coefficient derived from historical data of diesel and hybrid electric vehicle uptake for observed ROIs
- b_t = Model coefficient derived from historical data of diesel and hybrid electric vehicle uptake for observed model availability

As seen, EV uptake depends on the functional form assumed for model availability and change in ROI over time. It should be noted that Energeia's ROI calculation does not take into account step changes in depreciation or salvage value due to increasing EV penetration. These factors are explained in further detail below.

A.2.1 Incentives Impact on Model Availability

Energeia has developed its assumed rate of EV model availability based on an empirical analysis of model availability relative to the level of jurisdictional incentives. Figure 42 below displays the results of our analysis of the UK, California and Australian markets. It shows that California, the market with the highest EV incentive at around $10,000 USD including Federal incentives, sees the fastest rate of new EV model introductions. The UK market, which offers around $5,000 USD in incentives, is higher than virtually incentive-free Australia.

Figure 42 – EV Model Availability by Year by Key Market



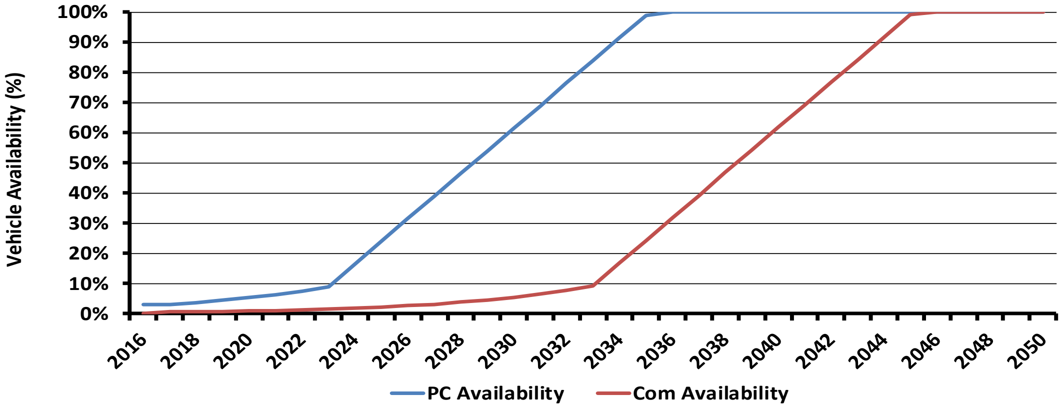
Source: Energeia

The above analysis was used to develop an EV model introduction function based on the level of assumed incentive. Scenarios with incentives comparable to California see OEM introducing new EV models at the California rate, while scenarios with incentives closer to zero see new EV models introduced at the historical Australian rate, as shown in the figure above.

A.2.2 Assumed Model Availability

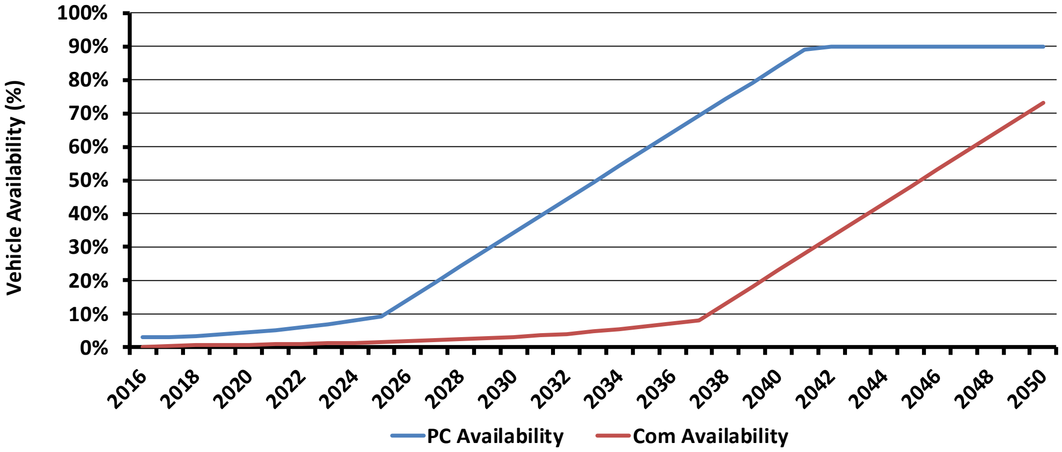
Assumed model availability varies by vehicle class and by sensitivity. A 9% of model threshold trigger for EVs hitting a maximum ramp rate shown in Figure 43, Figure 44 and Figure 45 is based on research and analysis of international EV model availability ramp rates given varying incentives over time and by region.

Figure 43 – Model Availability Strong Sensitivity



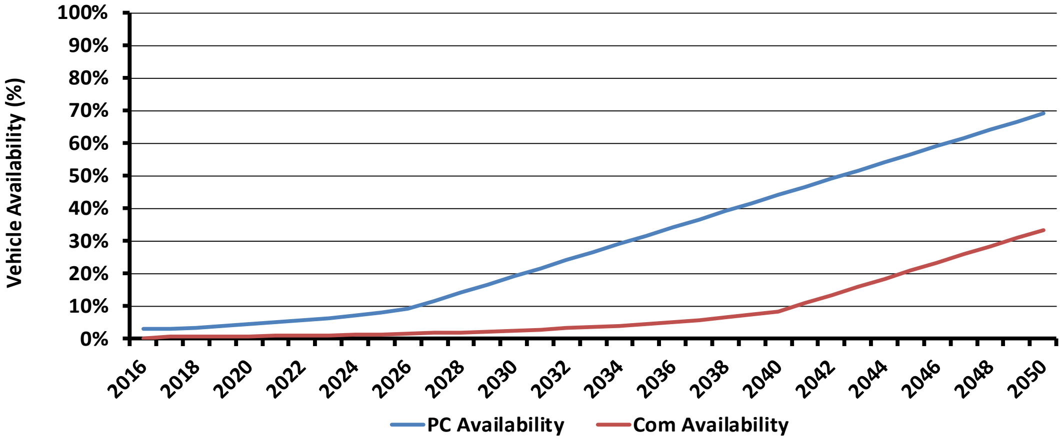
Source: Energeia

Figure *44* – Model Availability Neutral Sensitivity



Source: Energeia

Figure 45 – Model Availability Weak Sensitivity



Source: Energeia

A.2.4 Impacts of Obsolescence on Vehicle Depreciation

Energeia analysed two datasets in order to estimate the link between new vehicle technology uptake and accelerated depreciation rates of obsolete technology. The analysis looked at data on the resale value of vehicle models where new technology penetration (diesel) was clearly becoming dominant, as well as data on the resale value of vehicle models following the OEM's discontinuation of the model.

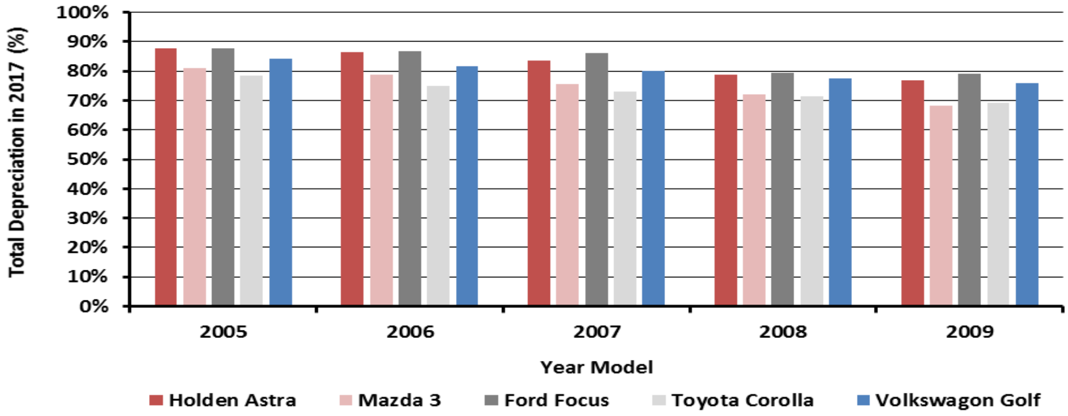
Based on this analysis, Energeia has excluded depreciation as a material input into our calculation of EV ROIs.

OEM Discontinuation Analysis

The first study compared the cumulative depreciation of discontinued models against themselves (before they were discontinued) and against comparable models.

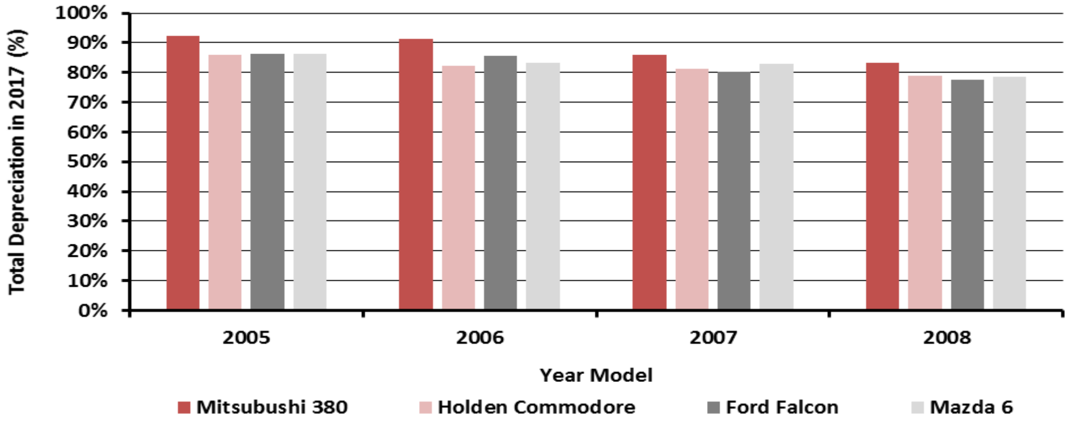
The analysis shows that even though the Astra was discontinued in 2009, the level of depreciation of the 2009 model shows only a slightly faster rate of depreciation when compared to similar sized, non-discontinued models. Analyses of other examples confirms the result. Discontinuation does not lead to significantly different rates of depreciation, with the level of depreciation between the runout and continuous remaining similar, within +/-10%.

Figure 46 – Holden Astra (2009) Runout



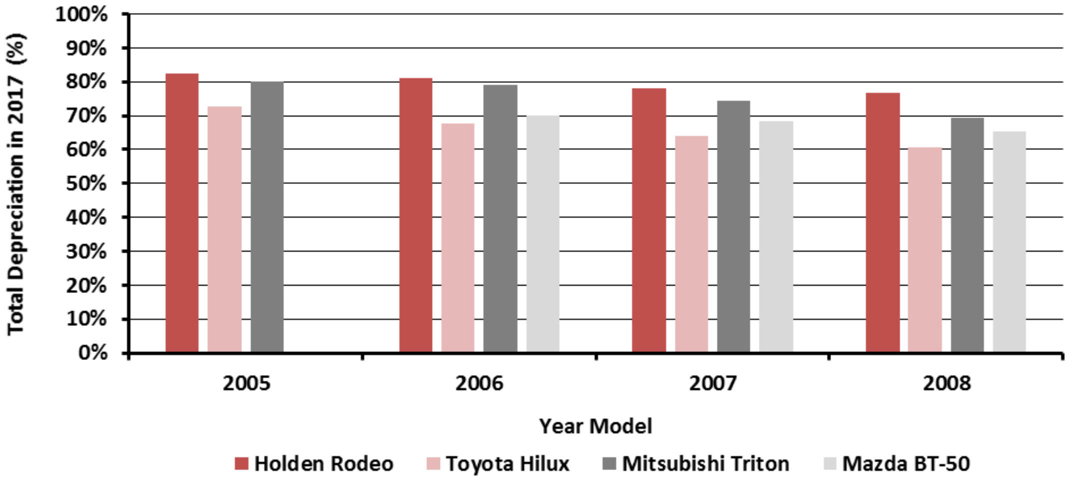
Source: VFACTS, Redbook

Figure 47 – *Mitsubishi 380 (2008) Runout*



Source: VFACTS, Redbook

Figure 48 – *Holden Rodeo (2008) Runout*

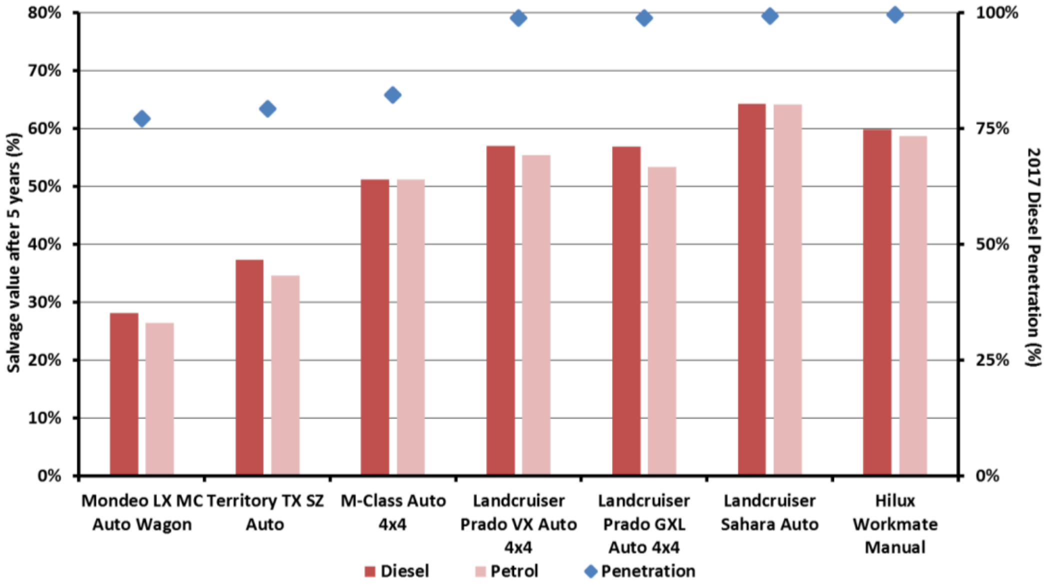


Source: VFACTS, Redbook

Market Obsolescence Analysis

The second analysis compared the resale value of ICE and diesel versions of the same vehicle model after 5 years in cases where diesel ultimately reached over 75% of the market. The results show a +/- 5% difference between the unpopular petrol and popular diesel models. Energeia speculates that this is because there remains a small but committed market niche that continues to favour the petrol model for whatever reason.

Figure 49 – *Salvage value of petrol and diesel models after 5 years*



Source: VFACTS, Redbook

Based on the above analysis, Energeia has concluded that model obsolescence does not significantly impact on vehicle resale value, all else being equal.

A.3 Operation and Maintenance Costs

A.3.1 Electricity Tariffs

The model assumes the EVs are charged on a controlled load tariff or with DCFCs. The tariffs described in Table 6 are used in the model and are not sensitivity dependent.

Table 6 – Electricity Tariffs

State	2017 Retail Price ($/kWh)
QLD	$0.1368
NSW	$0.1241
VIC	$0.1669
SA	$0.2063
TAS	$0.1160
WA	$0.1132

A.3.2 Electricity Price

Both the retail and network components of EV charging tariffs are grown over time in the EV uptake model and vary by state and by sensitivity. The model uses the retail electricity price projections developed by Jacobs for AEMO[8] in real terms.

The electricity price trend has a direct impact on EV fuel expenditure.

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[8] Jacobs, Retail electricity price history and projections – Public, June 2017

A.3.3 Petrol Price

Energeia's petrol price forecasts have been developed using historical relationships between the price of petrol and the oil price, which are then projected using the sensitivity assumption for oil prices. Our assumed inputs by state, year and sensitivity are shown in Table 7 below.

Table 7 – Fuel Price by State

Year	Low						Neutral						High					
	WA	QLD	SA	TAS	ACT/ NSW	VIC	WA	QLD	SA	TAS	ACT/ NSW	VIC	WA	QLD	SA	TAS	ACT/ NSW	VIC
2017	$1.15	$1.15	$1.14	$1.21	$1.15	$1.14	$1.15	$1.15	$1.14	$1.21	$1.15	$1.14	$1.15	$1.15	$1.14	$1.21	$1.15	$1.14
2018	$1.14	$1.13	$1.12	$1.19	$1.13	$1.12	$1.17	$1.17	$1.16	$1.22	$1.17	$1.16	$1.21	$1.20	$1.19	$1.26	$1.20	$1.19
2019	$1.12	$1.11	$1.10	$1.17	$1.11	$1.10	$1.19	$1.18	$1.17	$1.24	$1.18	$1.17	$1.26	$1.25	$1.24	$1.31	$1.25	$1.24
2020	$1.10	$1.09	$1.08	$1.15	$1.09	$1.08	$1.20	$1.20	$1.19	$1.26	$1.20	$1.19	$1.31	$1.30	$1.29	$1.37	$1.31	$1.29
2021	$1.08	$1.07	$1.06	$1.13	$1.08	$1.06	$1.22	$1.21	$1.20	$1.28	$1.22	$1.20	$1.36	$1.35	$1.34	$1.42	$1.36	$1.34
2022	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2023	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2024	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2025	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2026	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2027	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2028	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2029	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2030	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2031	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2032	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2033	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2034	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2035	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2036	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2037	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2038	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2039	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2040	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2041	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2042	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2043	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2044	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2045	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2046	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2047	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2048	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2049	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39
2050	$1.06	$1.05	$1.05	$1.11	$1.06	$1.05	$1.24	$1.23	$1.22	$1.29	$1.23	$1.22	$1.41	$1.41	$1.39	$1.48	$1.41	$1.39

Source: Energeia

A.3.4 Travel Distance

The travel distance dictates energy requirements and therefore has a direct impact on both ICE vehicles and EV annual fuel expenditure. The model adopts an average driving distance in this application to determine annual vehicle costs that vary by state and by vehicle class as summarised in Table 8.

Table 8 – Travel Distance

State	**Annual Average Distance Travelled (km/year)**	
	Light Passenger	**Light Commercial**
NSW	12,300	17,100
ACT	12,800	18,200
VIC	13,800	17,700
QLD	13,300	17,100
SA	11,600	16,700
WA	12,400	17,200
TAS	11,600	12,100

Source: ABS Survey of Motor Vehicle Use

A.3.5 Fuel Consumption

Fuel efficiency in the model is a key factor in determining energy requirements and fuel costs. The underlying fuel efficiency of ICE vehicles and EVs stay constant in the model as combustion and electric engines are well understood and established technologies.

The assumptions for fuel consumption are summarised in Table 9. These estimates have been developed based on OEM reported efficiency data.

Table 9 - Fuel Consumption

	2017 Efficiency	
Vehicle Type	**EV kWh/km**	**ICE L/km**
Passenger Car Small	0.137	0.052
Passenger Car Medium	0.178	0.063
Passenger Car Large	0.181	0.102
Sport Utility Vehicle Medium	0.181	0.064
Sport Utility Vehicle Large	0.181	0.104
Light Commercial	0.155	0.065
Rigid Truck	0.400	0.488
Bus	0.364	0.445

Source: Energeia, OEM websites

A.4 Capital Costs

The vehicle purchase price is broken down into three components in the model as shown in Table 10.

Table 10 – Capital Cost

Cost Component	ICE	BEV	PHEV
Balance of System	✓	✓	✓
Battery		✓	✓

The balance of system of a vehicle encompasses all the components of the vehicle other than the EV batteries.

Each of the above components is described in the following sections.

A.4.1 EV Premium

The model assumes an EV premium costs described in Table 11 in 2017. These estimates have been developed based on OEM reported efficiency data.

Table 11 – EV Premium

Vehicle Class	EV Premium
Passenger Car Small	$ 30,110
Passenger Car Medium	$ 15,500
Passenger Car Large	$ 22,805
Sport Utility Vehicle Medium	$ 2,398
Sport Utility Vehicle Large	$ 5,689
Light Commercial	$ 11,010
Rigid Truck	$ 42, 229
Bus	$ 583, 463

Source: Energeia and OEM websites

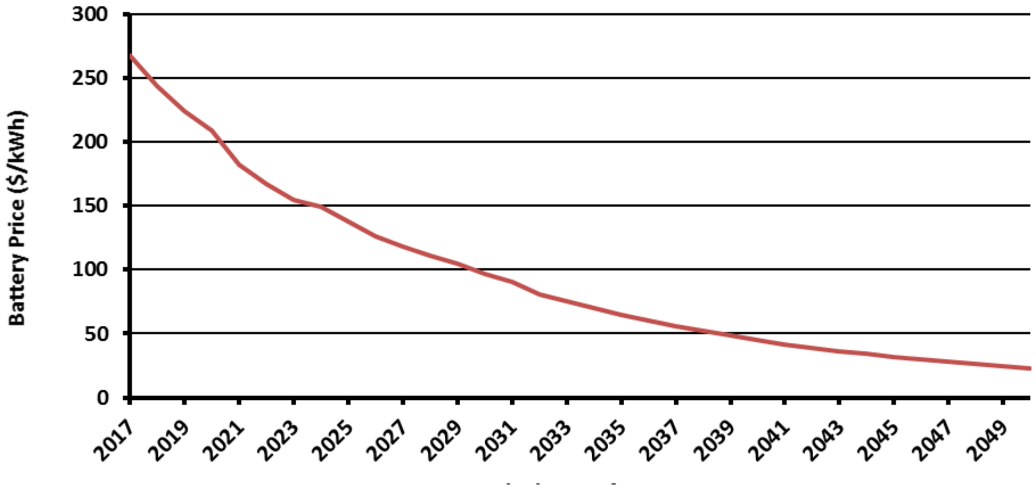
Premiums reduce over time by scenario as detailed in in Section 3.2.

A.4.2 Battery Cost

Energeia's short and medium term battery price outlook is a function of expected improvements in lithium based manufacturing and economies of scale, while the long-term battery price outlook is based on next generation storage technologies that will achieve higher energy densities with significantly less raw material.

The model assumes a decline in lithium price over the modelling period leading to the battery cost projection shown in Figure 50.This forecast is based on a consensus average among leading international lithium price forecasters. The battery price does not vary with sensitivity.

Figure 50 – EV Storage Price Outlook



Source: Energeia research

A.5 EV Charging

The EV charging profile is determined by aggregating the unique charging profile of each individual electric vehicle adopted. The individual profiles are assigned based on:

- Whether the vehicle is assigned as L2 (9.6kW) home charging, L2 commercial charging (charges at work or depot location), or Direct Current Fast Charging (DCFC) which is defined as the EV equivalent of a gas station (1MW station with 5 min charge time)
- DCFC chargers enable drivers without a garage to own an EV, encourage EV charging during hours of excess supply from solar PV, extend EV range to enable EV use for any trip type
- The daily travel distance for both weekday and weekend travel (drawn from a database of regionally specific diversified travel distances), which determines the amount of charge to be supplied by day type
- An arrival time for both weekday and weekend travel (drawn from a database of diversified times specific to either home charging or commercial charging) which dictates when charging starts, in the absence of any other tariff restrictions
- A departure time for both weekday and weekend travel (drawn from a database of diversified times specific to either home charging or commercial charging) which dictates when charging must cease in the absence of any other tariff restrictions
- For home and workplace charging, the optimal EV weekday and weekend demand profile for a given state to minimise whole-of-system cost.
- For DFCF charging, the weekday and weekend DCFC demand profile is based on the weekday and weekend transportation demand profile.

A.5.1 Type of Charging

A vehicle can be assigned to either a L2 home charger, a L2 commercial charger or DCFC.

Passenger cars allocated to DCFC reflect the percentage of households in each state with more than one vehicle. Energeia expects these vehicles will use DCFC rather than try and share private parking space. Commercial vehicles are assumed to be charged at their respective depots.

Detailed charge type assumptions are shown in Table 12.

Table 12 - Charger Type

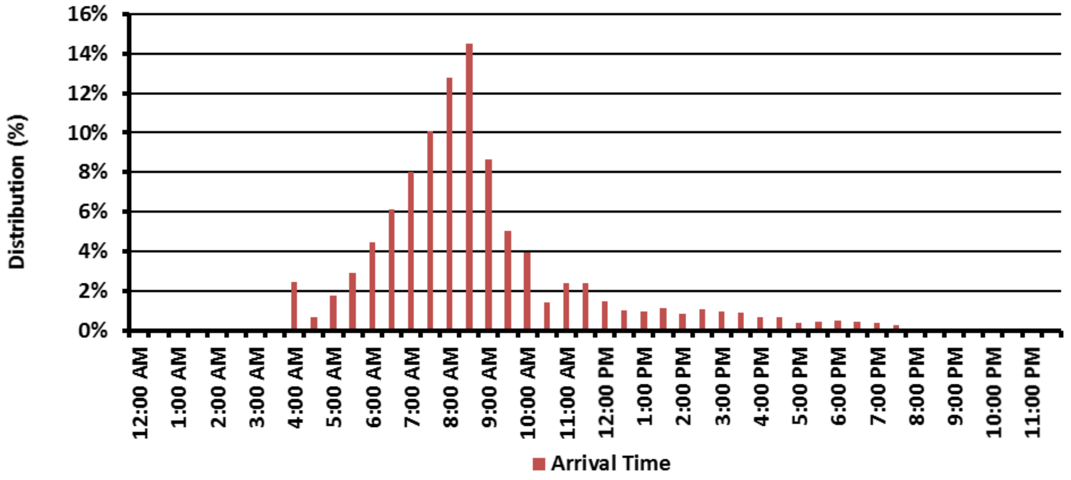
Vehicle Type	Charger Type	NSW	QLD	SA	VIC	WA	TAS
Residential	Destination (Home) Charging	41.2%	37.8%	35.3%	27.5%	15.5%	37.2%
	DCFC Public Charging	58.8%	62.2%	64.7%	72.5%	84.5%	62.8%
Commercial	Destination (Home and Depot) Charging	100%	100%	100%	100%	100%	100%

Source: Energeia

A.5.3 Destination Charging Start Times

The charging start time constraint for each managed charging EV is determined by the vehicle arrival time. The model uses the arrival time distribution shown in Figure 51.

Figure 51 – Vehicle Arrival Distribution by Vehicle Type



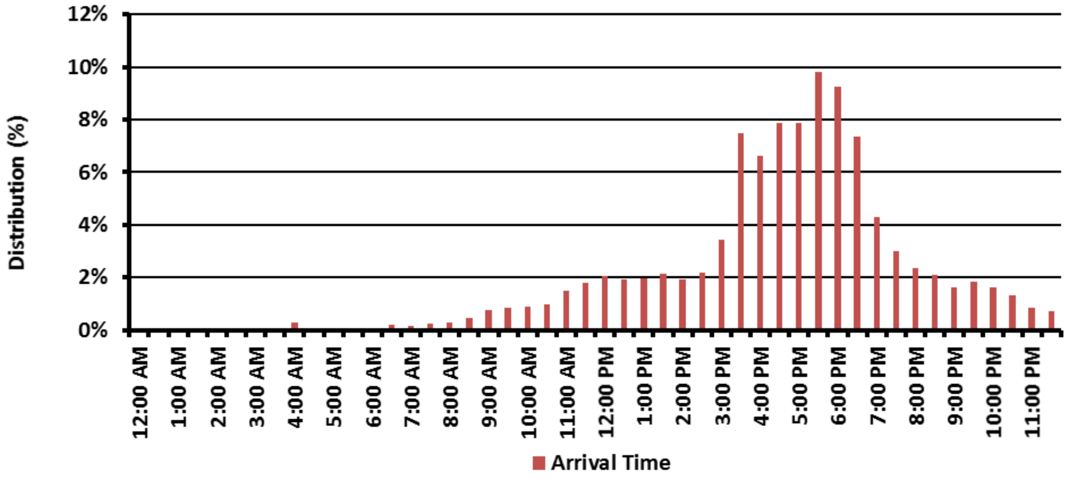
Source: Queensland Household Travel Survey

A.5.4 Destination Charging Completion Times

The charging completion time depends upon the start time, the assumed departure time, and the amount of charge required, which is in turn dependent on the daily driving distance. Generally speaking, the charging management function attempts to recharge the vehicle as quickly as possible while maximising the impact on minimum demand and minimising the impact on maximum demand.

The model uses the departure time distribution shown in Figure 52.

Figure 52 – Vehicle Departure Distribution by Vehicle Type



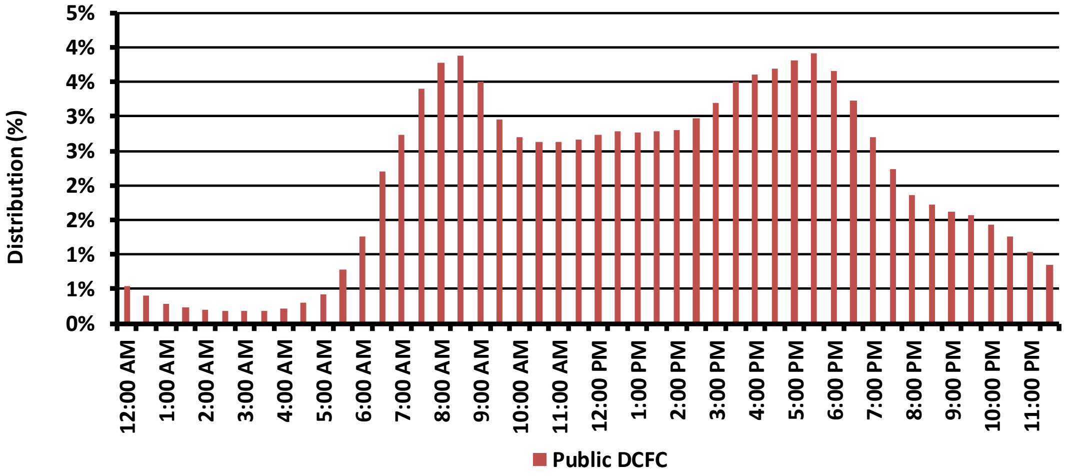
Source: Queensland Household Travel Survey

A.5.5 DCFC Charging Times

EV fast charging starts as soon as the vehicle arrives at the charging station and is completed within 5 minutes using 1MW chargers by 2036.

The charging start time is based on the Victorian Managing Traffic Congestion report and uses the traffic volume by time of day to determine the distribution of DCFC use, this is shown in Figure 53.

Figure 53 – Arrival Time Distribution



Source: Victorian Managing Tariff Congestion Report

A.6 Vehicle Stock Model

The vehicle stock model uses the following approach to determine overall change in stock for each state.

$$ICE_t = \sum^{i,j} \Big[ICE_{i,j(t-1)} + (Vehicle\ Sales_{i,j(t)} - EV\ Uptake_{i,j(t)}) - \mathrm{if}\Big(t \leq AvgLifetime\ , \frac{ICE_{i,j(0)}}{AvgLifetime}, 0\Big)\Big]$$

$$EV_t = \sum^{i,j} \Big[EV_{i,j(t-1)} + EV\ Uptake_{i,j(t)} - \mathrm{if}\Big(t \leq AvgLifetime\ , \frac{EV_{i,j(0)}}{AvgLifetime}, 0\Big)\Big]$$

Where:

- ICE_t = Total stock of ICE vehicles in year t
- EV_t= Total stock of EV vehicles in year t
- ICE_0 = Opening stock of ICE vehicles
- EV_0 = Opening stock of EV vehicles
- $ICE_{i,j(t-1)}$ = Stock of ICE vehicles in market i in class j in year t-1
- $EV_{i,j(t-1)}$ = Stock of EV vehicles in market i in class j in year t-1
- EV $Uptake_{i,j(t)}$ = % EV sales in market i in class j in year t
- Vehicle $Sales_{i,j(t)}$ = Vehicle sales in market i in class j in year t
- Average Lifetime = Average vehicle lifetime

A.6.1 Opening Stock

The opening stock of vehicles by vehicle class is sourced from VFACTS data for the calendar year 2016[9] for EV and ICE vehicles by state. The opening stock feeds into the vehicle stock model at t=0 in the above equations.

A.6.2 Market Growth

Each year, each vehicle class in their respective market is assumed to grow at a constant rate per capita based on ABS forecasts of low, neutral and high population growth.

A.6.2 Average Lifetime

Average vehicle lifetime of all ICE vehicles is assumed to be 22 years based on ABS data[10], while the average vehicle lifetime of all EVs are assumed to be 10 years.

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[9] Federal Chamber of Automotive Industry, VFACTS December National Report, 2016

[10] ABS 9208.0 - Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016

A.7 Policy Settings

A.7.1 Fuel Efficiency Standards

The Government's proposed fuel efficiency standards will improve the fuel efficiency of Australia's light vehicle fleet and bring Australia into line with international standards reducing greenhouse gas emissions from all light vehicles from the current 192gCO2/km to 105gCO2/km. That standard must be met across Australia's light vehicle fleet rather than on an individual vehicle model basis.

The proposed policy is expected to increase the average upfront cost of an ICE vehicle but reduce their average fuel expenditure over time. EVs are assumed to generate zero CO2, given their fuel is already subject to the CET or a comparable CO2 mechanism, enabling OEM's to reduce their compliance burden by selling EVs. This mechanism is expected to lead to OEM based cross-subsidisation of EVs up to the equivalent ICE cost, which the most recent analysis has found to average $1,500.[11]

The key vehicle policy assumptions and their impact on Energeia's modelling inputs are shown in Table 13 by sensitivity. The higher than $1,5000 assumptions are based on the potential for an EV multiplier to increase the value of EV based compliance. They also allow for the potential for additional, state based incentives.

Table 13 – Fuel Efficiency Standards Key Assumptions

Assumption	Weak Sensitivity	Neutral Sensitivity	Strong Sensitivity
Standard Introduction Date	2023	2021	2019
Impact on EV Incentives	$1,500	$2,500	$5,000

Source: Energeia, Climate Change Authority – Light Vehicle Emissions Standards Report 2014

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[11] ,Climate Change Authority – Light Vehicle Emissions Standards Report 2014

Appendix B: Detailed Results

B.1 EV Uptake

State	Scenario	Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
NSW	Low	Annual EVs	436	1,062	3,059	7,085	4,928	5,652	10,282	11,959	16,703	19,107	24,696	30,474	36,487	42,855	49,768	56,174	63,085	74,159	82,434	92,043	101,328	105,248	114,760	124,479	134,125	146,189	177,680	189,166	205,067	218,483	234,632	265,158	278,723	367,424
		Annual Sales Market %	0.11%	0.27%	0.77%	1.77%	1.23%	1.39%	2.51%	2.90%	4.01%	4.55%	5.82%	7.10%	8.39%	9.70%	11.03%	12.36%	13.69%	15.73%	17.19%	18.76%	20.26%	21.97%	23.64%	25.35%	27.11%	28.92%	34.57%	36.43%	38.58%	40.58%	42.77%	47.72%	49.95%	64.89%
		Cumulative EVs	1,658	2,720	5,779	12,864	17,792	23,444	33,645	45,512	61,844	80,536	104,968	135,006	170,431	210,227	252,910	304,156	361,589	425,467	495,941	571,281	653,503	734,054	818,340	906,332	997,603	1,094,025	1,215,531	1,341,612	1,472,520	1,608,569	1,751,159	1,914,989	2,088,464	2,341,128
		Total EV Market %	0.02%	0.04%	0.08%	0.19%	0.25%	0.33%	0.47%	0.63%	0.84%	1.09%	1.40%	1.79%	2.23%	2.73%	3.26%	3.88%	4.57%	5.34%	6.17%	7.05%	8.01%	8.93%	9.88%	10.86%	11.87%	12.93%	14.26%	15.64%	17.05%	18.50%	20.01%	21.75%	23.57%	26.27%
	Neutral	Annual EVs	443	1,101	3,238	7,687	6,379	7,740	14,772	17,204	20,107	31,517	43,230	55,309	67,862	81,198	99,490	114,289	130,206	150,158	168,927	214,275	242,077	257,990	286,878	317,272	349,137	396,944	510,097	522,084	542,022	591,269	625,850	644,348	652,251	672,004
		Annual Sales Market %	0.11%	0.27%	0.80%	1.88%	1.54%	1.85%	3.50%	4.03%	4.66%	7.23%	9.81%	12.41%	15.02%	17.68%	21.21%	24.14%	27.09%	30.40%	33.60%	41.81%	45.58%	49.46%	53.50%	57.68%	62.07%	67.78%	84.58%	84.72%	84.95%	89.80%	89.81%	89.82%	89.82%	89.83%
		Cumulative EVs	1,665	2,765	6,003	13,690	20,069	27,809	42,502	59,613	79,349	110,452	153,418	208,285	275,047	353,006	444,810	552,719	675,185	810,571	962,294	1,156,462	1,367,021	1,581,781	1,813,350	2,062,759	2,330,698	2,628,152	3,023,960	3,415,839	3,807,703	4,230,045	4,641,619	5,043,890	5,438,152	5,823,278
		Total EV Market %	0.02%	0.04%	0.09%	0.20%	0.28%	0.39%	0.59%	0.81%	1.07%	1.47%	2.01%	2.70%	3.53%	4.48%	5.58%	6.86%	8.30%	9.86%	11.59%	13.79%	16.14%	18.50%	21.01%	23.69%	26.52%	29.64%	33.80%	37.84%	41.82%	46.06%	50.12%	54.00%	57.74%	61.33%
	High	Annual EVs	449	1,170	4,255	11,042	8,562	10,549	20,146	37,641	56,029	75,233	95,229	120,593	162,940	190,597	223,110	253,208	288,566	447,889	509,341	541,310	601,715	606,654	637,221	682,543	709,619	750,920	785,281	817,454	965,708	1,015,491	1,034,841	1,081,752	1,068,019	1,063,663
		Annual Sales Market %	0.11%	0.29%	1.03%	2.63%	2.01%	2.45%	4.61%	8.50%	12.49%	16.55%	20.68%	25.86%	34.44%	39.52%	45.04%	50.69%	56.76%	85.29%	92.60%	93.95%	99.72%	99.74%	99.76%	99.78%	99.79%	99.81%	99.82%	99.83%	99.86%	99.87%	99.86%	99.87%	99.86%	99.86%
		Cumulative EVs	1,671	2,841	7,096	18,139	26,700	37,249	57,315	94,864	150,522	225,341	320,305	440,449	602,219	788,561	1,000,630	1,245,276	1,523,293	1,951,035	2,422,736	2,908,016	3,434,498	3,945,923	4,462,551	4,982,153	5,501,175	6,028,985	6,561,058	7,089,947	7,607,766	8,113,916	8,607,447	9,087,484	9,548,849	9,975,292
		Total EV Market %	0.02%	0.04%	0.10%	0.26%	0.38%	0.52%	0.78%	1.28%	2.00%	2.95%	4.13%	5.60%	7.55%	9.75%	12.21%	14.99%	18.10%	22.88%	28.05%	33.25%	38.78%	44.00%	49.15%	54.21%	59.14%	64.04%	68.86%	73.54%	77.98%	82.20%	86.19%	89.94%	93.43%	96.48%
VIC	Low	Annual EVs	220	572	1,649	3,832	2,680	3,094	3,930	6,627	9,208	10,598	13,769	17,053	20,508	24,184	28,206	32,002	36,082	30,500	34,052	40,681	44,813	50,343	55,463	60,750	66,106	72,784	79,379	86,301	104,266	111,075	120,687	128,225	119,044	127,043
		Annual Sales Market %	0.10%	0.26%	0.75%	1.72%	1.19%	1.36%	1.70%	2.83%	3.87%	4.39%	5.62%	6.86%	8.12%	9.39%	10.69%	11.98%	13.27%	11.00%	11.96%	13.92%	15.00%	21.32%	22.96%	24.64%	26.38%	28.16%	29.98%	31.83%	39.20%	41.08%	43.26%	45.26%	41.18%	43.09%
		Cumulative EVs	1,262	1,834	3,483	7,315	9,996	13,090	16,951	23,494	32,380	42,631	56,181	73,013	92,949	115,484	139,857	169,179	202,167	228,737	256,162	287,635	321,850	358,424	396,834	437,076	478,998	523,576	570,954	621,172	694,939	771,962	851,968	935,380	1,004,081	1,075,661
		Total EV Market %	0.03%	0.04%	0.08%	0.16%	0.22%	0.29%	0.38%	0.52%	0.72%	0.94%	1.24%	1.60%	2.03%	2.52%	3.05%	3.68%	4.39%	4.96%	5.54%	6.21%	6.93%	7.71%	8.52%	9.36%	10.24%	11.18%	12.17%	13.21%	14.76%	16.37%	18.03%	19.76%	21.18%	22.66%
	Neutral	Annual EVs	221	587	1,719	4,073	3,238	3,939	7,823	9,158	10,765	16,956	23,375	30,024	36,979	44,368	52,521	64,038	73,153	84,562	95,342	106,953	121,907	131,290	146,566	162,667	179,482	191,204	210,539	267,674	279,657	291,181	310,062	320,916	326,645	337,919
		Annual Sales Market %	0.10%	0.27%	0.78%	1.82%	1.42%	1.71%	3.35%	3.86%	4.47%	6.94%	9.43%	11.94%	14.46%	17.01%	19.65%	23.65%	26.51%	29.74%	32.82%	36.00%	39.53%	52.38%	56.45%	60.63%	64.98%	66.35%	69.69%	86.18%	86.33%	86.47%	89.70%	89.71%	89.72%	89.73%
		Cumulative EVs	1,263	1,849	3,569	7,642	10,880	14,818	22,572	31,647	42,089	58,697	81,854	111,657	148,050	190,698	239,146	299,946	369,160	445,899	532,083	628,272	733,223	841,137	957,679	1,083,366	1,218,480	1,357,163	1,503,664	1,698,186	1,893,280	2,089,119	2,292,228	2,491,237	2,686,592	2,877,946
		Total EV Market %	0.03%	0.04%	0.08%	0.17%	0.24%	0.33%	0.50%	0.70%	0.93%	1.29%	1.79%	2.43%	3.22%	4.13%	5.17%	6.46%	7.93%	9.56%	11.37%	13.40%	15.59%	17.84%	20.26%	22.86%	25.65%	28.49%	31.49%	35.47%	39.45%	43.42%	47.53%	51.53%	55.43%	59.23%
	High	Annual EVs	221	618	2,115	5,425	4,179	5,199	10,371	19,435	29,057	39,159	49,749	60,870	77,336	109,105	127,448	144,610	164,521	190,501	287,261	304,979	320,592	281,927	295,773	313,943	345,683	368,636	388,202	406,521	427,036	518,051	529,460	538,245	492,299	494,125
		Annual Sales Market %	0.10%	0.28%	0.95%	2.39%	1.82%	2.23%	4.38%	8.10%	11.91%	15.82%	19.80%	23.87%	29.81%	41.17%	46.76%	52.45%	58.49%	65.42%	94.14%	95.35%	95.63%	99.54%	99.57%	99.60%	99.65%	99.67%	99.70%	99.72%	99.74%	99.78%	99.78%	99.78%	99.75%	99.75%
		Cumulative EVs	1,263	1,880	3,995	9,420	13,599	18,798	29,100	48,452	77,187	115,999	165,528	226,178	302,896	409,886	531,909	672,340	831,661	1,011,791	1,279,617	1,555,538	1,836,971	2,069,149	2,304,052	2,540,659	2,777,237	3,018,426	3,262,018	3,504,018	3,740,553	3,971,343	4,195,824	4,413,478	4,623,850	4,822,203
		Total EV Market %	0.03%	0.04%	0.09%	0.21%	0.30%	0.42%	0.64%	1.06%	1.69%	2.53%	3.59%	4.89%	6.53%	8.80%	11.38%	14.34%	17.67%	21.42%	26.99%	32.70%	38.47%	43.18%	47.91%	52.64%	57.33%	62.09%	66.86%	71.56%	76.11%	80.52%	84.76%	88.83%	92.73%	96.35%
QLD	Low	Annual EVs	229	613	1,765	4,079	2,832	3,248	5,744	6,678	9,102	10,419	13,468	16,622	19,909	23,397	27,187	30,725	34,555	41,347	46,015	51,358	56,591	61,662	67,245	72,966	78,669	104,672	112,511	119,696	129,673	138,112	153,022	162,464	214,076	225,597
		Annual Sales Market %	0.10%	0.27%	0.77%	1.77%	1.22%	1.39%	2.43%	2.80%	3.78%	4.29%	5.49%	6.71%	7.93%	9.18%	10.45%	11.72%	13.01%	15.23%	16.68%	18.22%	19.71%	21.35%	23.01%	24.71%	26.47%	34.53%	36.54%	38.50%	40.72%	42.83%	46.62%	48.90%	63.64%	66.10%
		Cumulative EVs	935	1,548	3,313	7,392	10,224	13,472	19,167	25,789	34,675	44,853	58,177	74,570	93,866	115,499	138,607	166,499	197,806	233,409	272,746	315,002	361,174	409,368	459,990	513,047	568,319	645,804	727,590	812,731	901,058	993,155	1,094,818	1,200,691	1,353,106	1,511,458
		Total EV Market %	0.03%	0.04%	0.09%	0.19%	0.26%	0.34%	0.48%	0.63%	0.84%	1.07%	1.37%	1.74%	2.16%	2.62%	3.11%	3.70%	4.34%	5.07%	5.86%	6.69%	7.60%	8.52%	9.48%	10.47%	11.49%	12.94%	14.44%	15.98%	17.56%	19.19%	20.97%	22.80%	25.49%	28.24%
	Neutral	Annual EVs	238	655	1,931	4,583	3,746	4,537	8,324	9,707	11,357	17,809	24,443	31,291	38,441	46,059	57,490	66,175	75,383	86,859	97,885	135,111	152,124	172,861	191,361	210,744	230,958	254,890	326,500	333,882	345,534	369,484	399,674	411,410	426,488	439,675
		Annual Sales Market %	0.10%	0.27%	0.80%	1.88%	1.52%	1.82%	3.30%	3.81%	4.41%	6.84%	9.29%	11.76%	14.27%	16.83%	20.57%	23.47%	26.35%	29.61%	32.80%	44.45%	48.37%	52.39%	56.53%	60.80%	65.26%	69.19%	86.17%	86.28%	86.44%	89.69%	89.72%	89.73%	89.74%	89.75%
		Cumulative EVs	945	1,600	3,531	8,114	11,861	16,398	24,672	34,324	45,465	63,034	87,333	118,385	156,171	200,300	253,206	315,634	386,480	465,015	553,193	676,946	811,261	959,678	1,119,748	1,292,051	1,476,949	1,674,350	1,934,675	2,193,175	2,451,849	2,723,448	2,988,011	3,247,298	3,500,925	3,749,240
		Total EV Market %	0.03%	0.04%	0.09%	0.21%	0.30%	0.41%	0.60%	0.82%	1.07%	1.45%	1.98%	2.64%	3.43%	4.34%	5.40%	6.63%	8.00%	9.49%	11.13%	13.43%	15.88%	18.54%	21.35%	24.31%	27.44%	30.72%	35.05%	39.25%	43.35%	47.57%	51.58%	55.40%	59.04%	62.51%
	High	Annual EVs	248	717	2,553	6,674	5,189	6,424	11,785	22,035	32,896	44,333	59,461	90,386	107,072	125,033	146,053	165,376	187,889	279,698	317,131	336,099	365,789	400,275	434,802	453,806	471,856	498,625	520,965	542,472	628,379	659,437	671,377	690,169	697,946	720,484
		Annual Sales Market %	0.10%	0.29%	1.00%	2.59%	1.98%	2.42%	4.39%	8.10%	11.92%	15.86%	21.00%	31.53%	36.84%	42.23%	48.06%	53.99%	60.29%	87.09%	94.45%	95.71%	99.58%	99.61%	99.64%	99.66%	99.68%	99.71%	99.73%	99.75%	99.78%	99.79%	99.79%	99.79%	99.79%	99.79%
		Cumulative EVs	955	1,671	4,225	10,899	16,088	22,512	34,247	56,226	88,906	132,998	192,314	282,452	388,807	511,287	650,665	810,853	992,317	1,260,231	1,555,327	1,858,530	2,179,987	2,520,801	2,865,217	3,211,951	3,558,774	3,911,346	4,266,935	4,621,518	4,970,199	5,312,505	5,647,783	5,972,162	6,269,833	6,555,515
		Total EV Market %	0.03%	0.04%	0.11%	0.28%	0.40%	0.55%	0.81%	1.31%	2.02%	2.97%	4.20%	6.05%	8.17%	10.53%	13.15%	16.09%	19.33%	24.10%	29.22%	34.30%	39.54%	44.93%	50.21%	55.34%	60.30%	65.19%	69.96%	74.56%	78.90%	83.00%	86.85%	90.41%	93.45%	96.21%
SA	Low	Annual EVs	75	188	538	1,239	862	990	1,251	1,475	2,224	3,409	4,407	5,436	6,505	7,635	8,857	9,991	8,386	9,315	10,343	11,575	12,867	16,915	19,155	20,774	22,382	24,397	26,403	26,966	33,406	35,413	37,333	39,560	43,988	49,092
		Annual Sales Market %	0.10%	0.26%	0.74%	1.70%	1.18%	1.34%	1.68%	1.96%	2.93%	4.45%	5.70%	6.95%	8.21%	9.49%	10.78%	12.07%	9.99%	10.92%	11.93%	13.06%	14.12%	20.70%	23.13%	24.80%	26.52%	28.28%	30.09%	31.22%	38.14%	40.04%	41.93%	43.99%	46.96%	51.29%
		Cumulative EVs	300	487	1,025	2,264	3,126	4,116	5,352	6,808	8,962	12,298	16,658	22,018	28,336	35,434	43,052	52,181	59,577	67,641	76,508	85,859	95,317	107,825	121,544	135,813	150,559	166,100	182,512	201,091	225,182	250,252	276,010	302,703	329,777	359,714
		Total EV Market %	0.02%	0.04%	0.08%	0.17%	0.23%	0.30%	0.39%	0.49%	0.65%	0.88%	1.18%	1.56%	1.99%	2.47%	2.99%	3.61%	4.10%	4.63%	5.21%	5.82%	6.44%	7.25%	8.14%	9.07%	10.01%	11.01%	12.06%	13.24%	14.78%	16.38%	18.01%	19.70%	21.41%	23.29%
	Neutral	Annual EVs	76	194	567	1,337	1,056	1,277	1,950	2,284	3,576	5,603	7,683	9,822	12,037	14,378	16,928	19,420	22,109	25,195	28,266	33,392	37,946	44,371	49,300	54,469	59,876	63,521	69,040	90,352	93,500	95,862	103,331	106,248	110,861	114,184
		Annual Sales Market %	0.10%	0.27%	0.77%	1.80%	1.41%	1.68%	2.54%	2.95%	4.56%	7.07%	9.59%	12.13%	14.67%	17.24%	19.88%	22.61%	25.36%	28.31%	31.23%	35.89%	39.36%	49.85%	53.85%	57.99%	62.31%	63.85%	67.40%	85.91%	86.06%	86.20%	89.80%	89.81%	89.82%	89.82%
		Cumulative EVs	301	495	1,062	2,399	3,455	4,731	6,666	8,932	12,437	17,966	25,602	35,349	47,192	61,002	76,594	94,958	115,790	139,034	165,016	194,832	227,175	263,863	303,341	345,773	391,271	437,864	487,485	555,728	624,033	691,630	761,569	829,871	896,361	961,245
		Total EV Market %	0.02%	0.04%	0.08%	0.18%	0.25%	0.35%	0.48%	0.64%	0.88%	1.27%	1.79%	2.45%	3.25%	4.17%	5.20%	6.40%	7.75%	9.24%	10.90%	12.79%	14.82%	17.11%	19.56%	22.17%	24.95%	27.77%	30.75%	34.87%	38.95%	42.95%	47.06%	51.03%	54.85%	58.54%
	High	Annual EVs	77	206	705	1,798	1,390	1,725	2,672	6,664	9,916	13,300	16,818	20,499	24,441	33,689	40,641	46,029	52,302	60,028	93,710	99,393	104,373	104,123	108,670	113,131	122,324	130,740	136,844	143,258	148,082	179,662	183,077	185,644	182,842	184,715
		Annual Sales Market %	0.10%	0.28%	0.94%	2.36%	1.80%	2.20%	3.37%	8.29%	12.17%	16.11%	20.12%	24.22%	28.47%	38.52%	45.32%	50.86%	56.79%	63.62%	93.99%	95.22%	95.53%	99.73%	99.75%	99.76%	99.78%	99.80%	99.82%	99.83%	99.84%	99.86%	99.86%	99.86%	99.86%	99.85%
		Cumulative EVs	302	508	1,213	3,010	4,400	6,125	8,782	15,427	25,272	38,498	55,270	75,692	99,927	132,912	171,756	216,395	266,971	324,328	411,374	500,852	591,925	679,229	767,400	856,089	944,723	1,034,822	1,125,637	1,216,593	1,304,647	1,390,599	1,474,283	1,555,554	1,634,273	1,710,318
		Total EV Market %	0.02%	0.04%	0.09%	0.22%	0.32%	0.44%	0.63%	1.09%	1.77%	2.67%	3.80%	5.15%	6.73%	8.86%	11.34%	14.15%	17.29%	20.80%	26.14%	31.54%	36.93%	42.00%	47.03%	52.00%	56.89%	61.77%	66.61%	71.38%	75.89%	80.20%	84.31%	88.20%	91.89%	95.36%
TAS	Low	Annual EVs	22	58	167	387	269	309	544	633	859	983	1,271	1,569	1,880	2,209	2,569	2,908	3,275	3,710	4,128	4,844	5,344	4,556	4,987	5,430	5,872	6,444	8,560	9,114	9,813	10,463	11,763	12,529	15,566	16,416
		Annual Sales Market %	0.10%	0.27%	0.77%	1.76%	1.21%	1.38%	2.41%	2.78%	3.75%	4.25%	5.44%	6.65%	7.86%	9.09%	10.35%	11.63%	12.92%	14.31%	15.65%	17.95%	19.42%	21.22%	22.90%	24.64%	26.44%	28.32%	36.97%	38.94%	41.11%	43.23%	47.16%	49.48%	63.68%	66.14%
		Cumulative EVs	79	137	304	691	960	1,269	1,809	2,437	3,279	4,243	5,502	7,050	8,871	10,913	13,096	15,735	18,702	21,868	25,363	29,348	33,709	36,994	40,412	43,962	47,624	51,499	57,151	62,989	69,092	75,427	82,346	89,531	100,541	111,969
		Total EV Market %	0.02%	0.03%	0.07%	0.16%	0.22%	0.28%	0.41%	0.55%	0.73%	0.95%	1.23%	1.58%	1.99%	2.45%	2.94%	3.53%	4.21%	4.93%	5.73%	6.65%	7.66%	8.43%	9.24%	10.08%	10.97%	11.91%	13.27%	14.69%	16.18%	17.75%	19.47%	21.28%	24.02%	26.89%
	Neutral	Annual EVs	23	63	185	437	357	433	789	919	1,074	1,684	2,311	2,959	3,635	4,353	5,139	5,918	7,106	8,196	9,242	10,379	14,633	13,537	15,037	16,611	18,857	19,992	25,502	26,425	27,473	29,448	30,117	33,570	32,213	33,215
		Annual Sales Market %	0.10%	0.27%	0.80%	1.87%	1.51%	1.81%	3.27%	3.77%	4.36%	6.77%	9.19%	11.64%	14.13%	16.65%	19.25%	21.99%	26.01%	29.25%	32.41%	35.71%	48.63%	52.86%	57.07%	61.42%	68.16%	69.69%	86.26%	86.41%	86.58%	89.70%	89.71%	89.75%	89.74%	89.75%
		Cumulative EVs	80	143	327	765	1,122	1,555	2,340	3,255	4,312	5,977	8,276	11,212	14,785	18,953	23,654	29,215	35,889	43,296	51,619	60,923	73,872	85,097	97,175	110,151	124,655	139,509	159,092	178,410	197,687	217,893	237,631	256,568	275,244	293,423
		Total EV Market %	0.02%	0.03%	0.07%	0.17%	0.25%	0.34%	0.51%	0.71%	0.94%	1.29%	1.78%	2.41%	3.16%	4.04%	5.03%	6.20%	7.60%	9.14%	10.88%	12.82%	15.53%	17.87%	20.38%	23.09%	26.11%	29.21%	33.29%	37.33%	41.35%	45.58%	49.71%	53.68%	57.60%	61.42%
	High	Annual EVs	24	69	249	644	492	606	1,118	2,091	3,121	4,207	5,349	6,561	9,941	12,069	14,084	15,936	18,117	26,881	30,477	32,301	35,140	32,467	33,913	37,398	39,426	41,894	43,940	45,929	54,040	56,944	58,014	60,035	56,486	54,931
		Annual Sales Market %	0.10%	0.29%	1.01%	2.58%	1.95%	2.37%	4.32%	7.98%	11.75%	15.64%	19.65%	23.81%	35.60%	42.43%	48.25%	54.17%	60.54%	87.14%	94.50%	95.76%	99.58%	99.61%	99.63%	99.67%	99.70%	99.72%	99.74%	99.76%	99.80%	99.80%	99.80%	99.81%	99.79%	99.78%
		Cumulative EVs	81	150	400	1,044	1,535	2,142	3,256	5,343	8,447	12,634	17,971	24,508	34,379	46,199	59,639	75,083	92,594	118,356	146,743	175,922	206,855	233,973	261,325	288,783	316,140	343,950	371,954	399,765	426,925	453,391	479,104	503,999	528,018	549,036
		Total EV Market %	0.02%	0.03%	0.09%	0.23%	0.33%	0.46%	0.70%	1.14%	1.78%	2.64%	3.73%	5.04%	7.02%	9.36%	11.99%	14.99%	18.35%	23.30%	28.69%	34.17%	39.91%	44.86%	49.79%	54.69%	59.51%	64.36%	69.18%	73.92%	78.49%	82.87%	87.07%	91.07%	94.86%	98.08%
WA	Low	Annual EVs	153	393	1,129	2,603	1,802	2,067	3,718	4,319	5,914	6,762	8,735	10,775	12,891	15,132	17,562	19,818	22,261	25,231	28,063	33,240	36,570	43,302	47,104	50,990	54,833	70,793	76,055	80,870	86,725	92,209	99,781	109,745	118,440	156,462
		Annual Sales Market %	0.10%	0.27%	0.76%	1.75%	1.21%	1.37%	2.45%	2.82%	3.83%	4.34%	5.56%	6.78%	8.02%	9.27%	10.55%	11.83%	13.12%	14.56%	15.95%	18.50%	20.00%	21.61%	23.27%	24.96%	26.71%	33.90%	35.88%	37.80%	39.89%	41.95%	44.30%	48.19%	50.64%	65.96%
		Cumulative EVs	499	892	2,021	4,624	6,426	8,493	12,184	16,472	22,274	28,926	37,597	48,218	60,716	74,720	89,679	107,695	127,889	149,402	173,146	200,471	230,279	264,845	301,175	339,274	378,975	432,205	488,441	547,050	608,544	672,691	739,232	812,407	887,546	996,903
		Total EV Market %	0.02%	0.04%	0.09%	0.20%	0.27%	0.36%	0.50%	0.66%	0.88%	1.12%	1.43%	1.80%	2.23%	2.70%	3.19%	3.77%	4.40%	5.06%	5.78%	6.59%	7.46%	8.46%	9.48%	10.53%	11.60%	13.06%	14.56%	16.10%	17.68%	19.30%	20.95%	22.75%	24.56%	27.26%
	Neutral	Annual EVs	162	424	1,249	2,965	2,430	2,942	5,497	6,408	7,488	11,727	16,082	20,575	25,248	30,211	35,649	43,626	49,615	57,102	64,224	85,981	96,791	119,062	131,693	144,902	158,707	173,322	227,085	231,913	239,589	256,142	273,542	280,944	298,665	307,742
		Annual Sales Market %	0.10%	0.27%	0.79%	1.86%	1.51%	1.81%	3.34%	3.85%	4.46%	6.91%	9.38%	11.87%	14.39%	16.96%	19.61%	23.82%	26.71%	29.99%	33.18%	43.65%	47.52%	51.43%	55.51%	59.73%	64.14%	68.00%	85.96%	86.07%	86.24%	89.64%	89.67%	89.69%	89.71%	89.72%
		Cumulative EVs	507	931	2,181	5,146	7,576	10,518	15,987	22,364	29,739	41,356	57,374	77,788	102,611	131,573	164,257	205,453	252,126	303,732	361,548	440,041	525,105	628,084	739,202	858,856	987,352	1,125,025	1,308,484	1,490,782	1,673,269	1,865,187	2,052,748	2,236,901	2,416,504	2,592,552
		Total EV Market %	0.02%	0.04%	0.10%	0.22%	0.32%	0.43%	0.64%	0.87%	1.13%	1.53%	2.08%	2.76%	3.56%	4.47%	5.47%	6.71%	8.07%	9.53%	11.13%	13.30%	15.58%	18.31%	21.17%	24.17%	27.32%	30.61%	35.02%	39.26%	43.36%	47.57%	51.55%	55.32%	58.86%	62.21%
	High	Annual EVs	170	468	1,676	4,380	3,408	4,216	7,859	14,682	21,877	29,422	37,308	55,601	69,273	80,847	94,400	106,847	121,365	183,337	207,800	220,122	239,817	279,212	300,246	315,766	327,711	345,312	359,911	373,791	431,916	452,194	459,924	474,585	498,555	509,033
		Annual Sales Market %	0.10%	0.28%	1.00%	2.57%	1.97%	2.41%	4.42%	8.16%	12.00%	15.94%	19.97%	29.40%	36.15%	41.44%	47.18%	53.02%	59.25%	86.87%	94.22%	95.49%	99.53%	99.55%	99.59%	99.61%	99.63%	99.66%	99.68%	99.70%	99.74%	99.75%	99.75%	99.76%	99.76%	99.76%
		Cumulative EVs	515	983	2,659	7,039	10,446	14,663	22,494	37,145	58,909	88,221	125,465	180,896	249,701	328,872	418,893	522,332	639,480	814,959	1,008,076	1,206,321	1,416,716	1,658,620	1,903,265	2,149,759	2,396,623	2,647,534	2,900,597	3,153,023	3,401,603	3,645,997	3,885,798	4,120,567	4,339,910	4,548,697
		Total EV Market %	0.02%	0.04%	0.12%	0.30%	0.43%	0.58%	0.87%	1.40%	2.15%	3.14%	4.34%	6.09%	8.20%	10.53%	13.08%	15.92%	19.03%	23.69%	28.64%	33.50%	38.48%	44.08%	49.51%	54.75%	59.77%	64.69%	69.45%	73.99%	78.26%	82.26%	85.99%	89.46%	92.45%	95.11%

Source: Energeia

B.2 EV Consumption

State	Scenario	Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
NSW	Low	Annual Energy (MWh)	3,756	6,248	13,429	30,078	41,668	54,962	79,325	107,677	146,825	191,657	250,142	322,028	406,769	502,036	604,349	727,086	864,697	1,039,963	1,233,302	1,440,586	1,666,803	1,889,319	2,122,926	2,367,595	2,622,586	2,892,509	3,235,585	3,592,537	3,954,297	4,330,848	4,725,558	5,174,273	5,649,139	6,277,071
	Neutral	Annual Energy (MWh)	3,770	6,352	13,953	32,016	47,097	65,429	100,662	141,702	189,039	263,396	365,928	496,790	655,945	841,865	1,091,272	1,383,294	1,714,467	2,080,913	2,491,072	3,021,181	3,596,800	4,184,273	4,818,029	5,500,331	6,232,484	7,034,834	8,020,200	8,997,019	9,974,865	11,018,170	12,035,768	13,032,472	14,011,441	14,969,588
	High	Annual Energy (MWh)	3,785	6,529	16,574	42,727	63,028	88,070	136,248	225,932	358,671	537,084	763,558	1,086,338	1,525,279	2,030,778	2,605,166	3,264,148	4,009,214	5,070,158	6,241,240	7,447,391	8,745,259	10,005,775	11,281,090	12,566,087	13,852,470	15,162,395	16,485,298	17,803,087	19,096,873	20,363,259	21,599,620	22,803,794	23,927,645	24,951,417
VIC	Low	Annual Energy (MWh)	3,244	4,760	9,128	19,282	26,387	34,589	44,895	62,579	86,672	114,473	151,129	196,629	250,486	311,396	377,351	456,613	545,807	616,981	690,318	795,744	910,384	1,034,501	1,165,343	1,302,923	1,447,003	1,600,315	1,763,303	1,936,072	2,180,474	2,435,892	2,693,396	2,962,133	3,190,601	3,428,861
	Neutral	Annual Energy (MWh)	3,245	4,804	9,370	20,191	28,837	39,370	60,449	85,121	113,497	158,427	220,910	301,246	399,272	514,158	644,679	836,859	1,055,265	1,297,486	1,568,905	1,871,138	2,201,165	2,553,703	2,934,634	3,345,290	3,786,308	4,238,594	4,710,319	5,282,186	5,856,174	6,432,748	7,026,402	7,609,699	8,182,508	8,744,867
	High	Annual Energy (MWh)	3,247	4,891	10,545	25,087	36,301	50,270	78,344	130,713	208,275	312,964	446,512	610,080	852,876	1,188,860	1,571,352	2,009,142	2,503,368	3,059,385	3,823,872	4,612,109	5,416,737	6,104,724	6,802,017	7,505,977	8,212,035	8,932,594	9,661,790	10,388,564	11,102,416	11,801,207	12,483,165	13,146,845	13,790,884	14,366,652
QLD	Low	Annual Energy (MWh)	2,322	3,918	8,512	19,137	26,517	34,984	49,989	67,447	90,917	117,816	152,941	196,135	246,943	303,926	364,845	438,358	520,909	633,151	757,102	890,656	1,036,534	1,189,409	1,350,532	1,519,943	1,697,294	1,942,258	2,201,057	2,471,137	2,744,067	3,029,034	3,341,534	3,667,242	4,092,351	4,534,941
	Neutral	Annual Energy (MWh)	2,347	4,053	9,080	21,023	30,824	42,711	64,577	90,089	119,546	165,786	229,586	311,052	410,113	525,822	690,761	884,339	1,103,797	1,347,286	1,620,120	2,000,013	2,412,821	2,869,648	3,362,603	3,893,078	4,461,795	5,062,696	5,792,418	6,518,302	7,245,732	8,004,261	8,744,683	9,472,533	10,186,182	10,886,798
	High	Annual Energy (MWh)	2,372	4,237	10,908	28,403	42,012	58,886	89,952	147,730	233,465	349,105	531,543	807,126	1,131,861	1,505,718	1,930,417	2,415,895	2,963,153	3,710,538	4,534,697	5,382,702	6,276,722	7,226,370	8,187,894	9,158,080	10,131,197	11,122,071	12,123,677	13,125,332	14,114,037	15,086,745	16,041,434	16,941,016	17,758,282	18,537,752
SA	Low	Annual Energy (MWh)	660	1,090	2,326	5,175	7,158	9,437	12,297	15,674	20,694	28,515	38,723	51,275	66,059	82,683	100,550	121,945	139,184	157,985	178,677	200,504	222,573	252,009	288,296	326,166	365,492	407,035	450,980	500,417	566,059	634,442	704,854	777,863	852,007	932,046
	Neutral	Annual Energy (MWh)	662	1,108	2,412	5,485	7,923	10,877	15,390	20,677	28,899	41,836	59,678	82,446	110,100	142,364	178,810	221,740	270,464	324,858	385,703	462,810	546,613	644,381	749,658	862,793	983,987	1,108,005	1,239,208	1,403,990	1,569,130	1,732,791	1,900,343	2,064,252	2,223,759	2,379,629
	High	Annual Energy (MWh)	664	1,138	2,763	6,922	10,143	14,147	20,359	35,906	58,917	89,841	129,073	176,894	233,690	314,321	416,722	533,834	665,929	814,877	1,023,700	1,238,583	1,457,521	1,666,240	1,877,309	2,089,951	2,302,855	2,519,526	2,738,258	2,957,688	3,170,608	3,378,639	3,581,333	3,778,337	3,969,405	4,154,151
TAS	Low	Annual Energy (MWh)	173	299	662	1,504	2,089	2,762	3,979	5,393	7,304	9,492	12,344	15,847	19,970	24,599	29,561	35,542	42,264	49,425	57,332	67,716	79,071	87,719	96,753	106,170	115,941	126,295	140,527	155,259	170,672	186,688	203,616	221,210	246,252	272,289
	Neutral	Annual Energy (MWh)	175	312	713	1,664	2,452	3,408	5,191	7,267	9,666	13,426	18,609	25,220	33,259	42,643	53,233	65,732	82,819	101,767	123,000	146,672	178,396	205,989	235,712	267,666	303,336	339,848	384,952	429,296	473,595	519,859	565,135	608,716	651,822	693,861
	High	Annual Energy (MWh)	178	329	878	2,297	3,383	4,722	7,248	11,949	18,921	28,309	40,256	54,873	76,655	105,501	138,260	175,763	218,123	277,002	341,964	408,846	479,567	541,677	604,442	667,584	730,660	794,885	859,699	924,191	987,337	1,048,934	1,108,835	1,166,899	1,223,061	1,272,798
WA	Low	Annual Energy (MWh)	1,174	2,153	4,966	11,455	15,950	21,106	30,384	41,169	55,776	72,533	94,331	121,024	152,410	187,589	225,192	270,484	321,279	375,418	435,226	517,497	607,227	711,420	821,266	936,795	1,057,708	1,220,256	1,392,078	1,571,549	1,759,939	1,956,617	2,155,732	2,373,050	2,596,455	2,889,184
	Neutral	Annual Energy (MWh)	1,194	2,251	5,365	12,759	18,836	26,207	39,986	56,056	74,648	103,814	143,949	195,067	257,187	329,681	411,498	533,234	671,051	823,649	994,340	1,227,390	1,480,293	1,786,527	2,117,011	2,472,628	2,853,969	3,259,453	3,752,042	4,242,320	4,733,717	5,246,530	5,748,414	6,242,496	6,725,071	7,199,215
	High	Annual Energy (MWh)	1,213	2,379	6,566	17,547	26,095	36,690	56,471	93,240	147,776	221,231	314,614	459,313	662,378	895,972	1,161,101	1,463,966	1,805,135	2,274,319	2,791,156	3,322,343	3,882,412	4,527,439	5,180,859	5,840,522	6,502,781	7,176,847	7,858,024	8,539,274	9,212,450	9,875,617	10,527,562	11,167,116	11,762,059	12,305,856

Source: Energeia

B.3 EV Demand

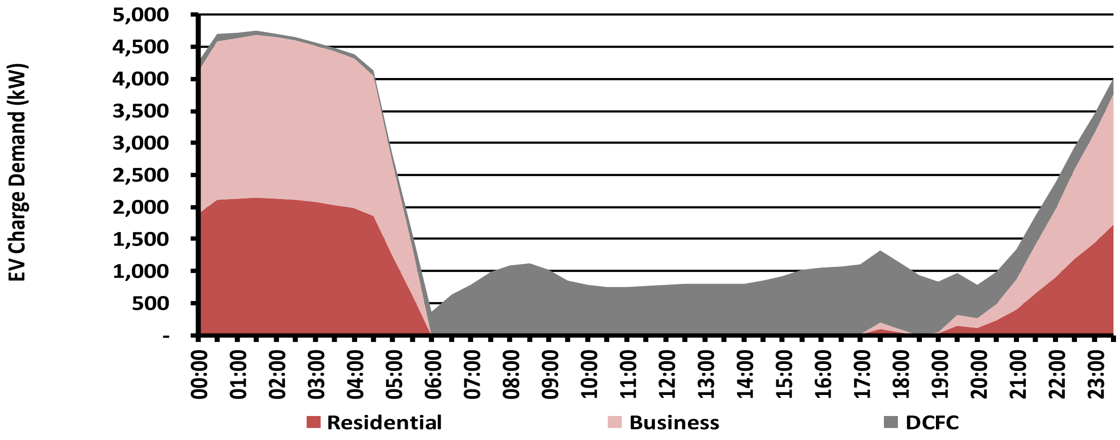
State	Scenario	Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
NSW	Low	Max Demand (MW)	1	2	4	10	14	18	26	36	49	65	84	108	137	169	205	248	295	357	419	484	554	617	675	744	818	891	983	1,067	1,144	1,226	1,304	1,384	1,473	1,536
	Neutral	Max Demand (MW)	1	2	5	11	16	22	33	47	63	88	122	165	218	278	359	454	557	670	786	932	1,084	1,222	1,351	1,498	1,650	1,735	1,844	1,937	2,204	2,492	2,776	3,052	3,320	3,613
	High	Max Demand (MW)	1	2	5	14	21	29	45	74	118	177	250	352	491	643	808	992	1,182	1,423	1,660	1,794	1,933	2,184	2,526	2,753	2,957	3,202	3,481	3,840	4,176	4,490	4,800	5,098	5,374	5,659
QLD	Low	Max Demand (MW)	0	1	2	4	6	8	11	14	19	23	30	37	49	61	75	91	108	132	160	192	222	261	291	328	370	427	475	538	593	657	710	774	858	943
	Neutral	Max Demand (MW)	0	1	2	4	7	9	14	18	24	32	44	57	81	105	141	181	223	274	333	416	496	600	686	789	906	1,028	1,142	1,286	1,420	1,623	1,791	1,973	2,124	2,321
	High	Max Demand (MW)	0	1	2	6	9	13	19	30	47	68	102	159	227	301	382	469	563	698	855	1,019	1,188	1,422	1,633	1,903	2,154	2,456	2,770	3,065	3,403	3,639	3,838	3,989	4,159	4,320
SA	Low	Max Demand (MW)	0	0	0	1	1	2	3	3	4	6	8	10	13	16	19	23	26	29	33	37	41	46	52	57	66	74	83	95	109	128	144	158	173	188
	Neutral	Max Demand (MW)	0	0	0	1	2	2	3	4	5	8	11	15	20	26	33	41	50	59	69	81	95	112	136	167	195	232	276	326	364	386	442	486	542	592
	High	Max Demand (MW)	0	0	1	1	2	3	4	7	11	17	24	33	42	58	76	95	115	146	198	256	322	383	445	527	601	675	749	817	872	910	977	1,033	1,072	1,120
TAS	Low	Max Demand (MW)	0	0	0	0	0	1	1	1	2	2	3	3	4	5	6	7	9	10	12	14	16	18	20	22	24	26	30	33	37	41	45	49	55	60
	Neutral	Max Demand (MW)	0	0	0	0	1	1	1	2	2	3	4	5	7	9	11	14	17	21	25	30	37	44	50	57	65	73	81	88	95	102	109	116	123	130
	High	Max Demand (MW)	0	0	0	0	1	1	2	3	4	6	9	12	17	24	32	40	50	61	73	84	95	105	115	124	134	146	163	179	197	215	233	246	261	274
VIC	Low	Max Demand (MW)	1	1	2	4	5	7	9	12	17	22	29	37	47	58	70	84	100	112	126	146	167	189	213	236	261	286	312	340	383	426	471	511	563	619
	Neutral	Max Demand (MW)	1	1	2	4	6	8	12	16	22	30	42	57	74	95	117	151	189	229	272	318	367	431	498	580	686	801	922	1,085	1,262	1,442	1,614	1,799	1,994	2,173
	High	Max Demand (MW)	1	1	2	5	7	10	15	25	39	59	84	113	157	224	297	376	460	548	696	904	1,077	1,232	1,366	1,549	1,713	1,890	2,079	2,237	2,460	2,680	2,855	3,046	3,230	3,425
WA	Low	Max Demand (MW)	0	0	1	2	3	4	6	8	11	14	18	23	30	38	47	57	67	79	93	113	132	158	180	206	235	274	308	351	390	437	473	518	565	625
	Neutral	Max Demand (MW)	0	0	1	3	4	5	8	11	14	20	26	36	51	66	85	111	138	171	209	261	313	385	447	521	604	693	778	882	970	1,072	1,149	1,239	1,331	1,415
	High	Max Demand (MW)	0	0	1	4	5	8	11	18	28	41	58	87	128	176	231	292	354	447	553	665	767	907	1,013	1,133	1,262	1,397	1,558	1,712	1,911	2,113	2,270	2,396	2,508	2,659

Source: Energeia

B.4 EV Load Profiles

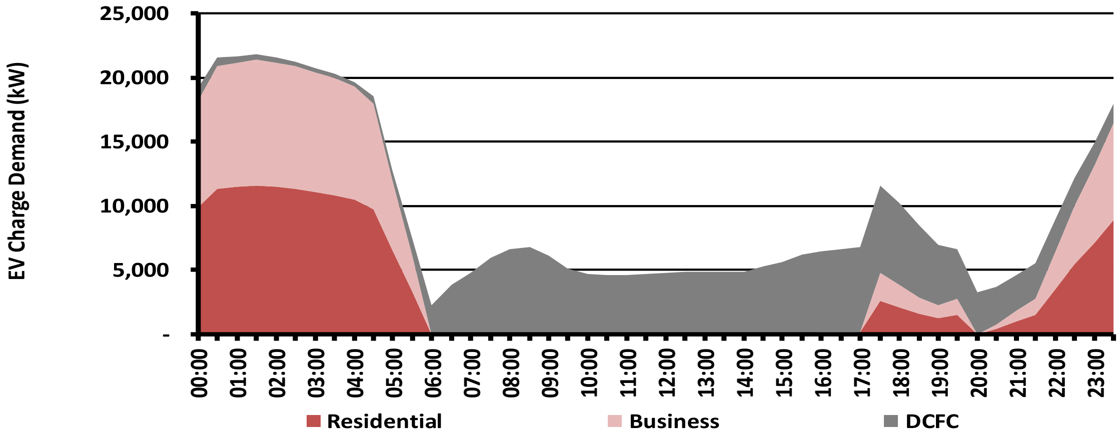
B.3.1 Queensland - Neutral

2020



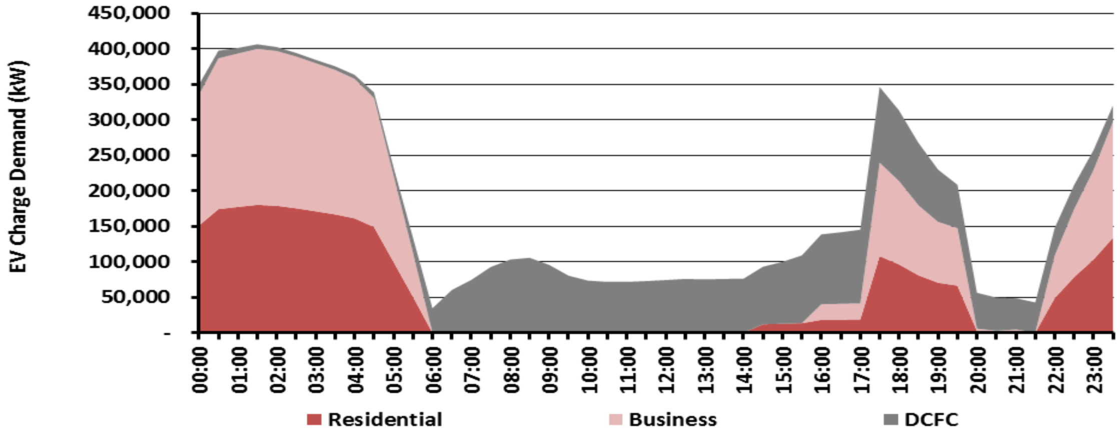
Source: Energeia

2025



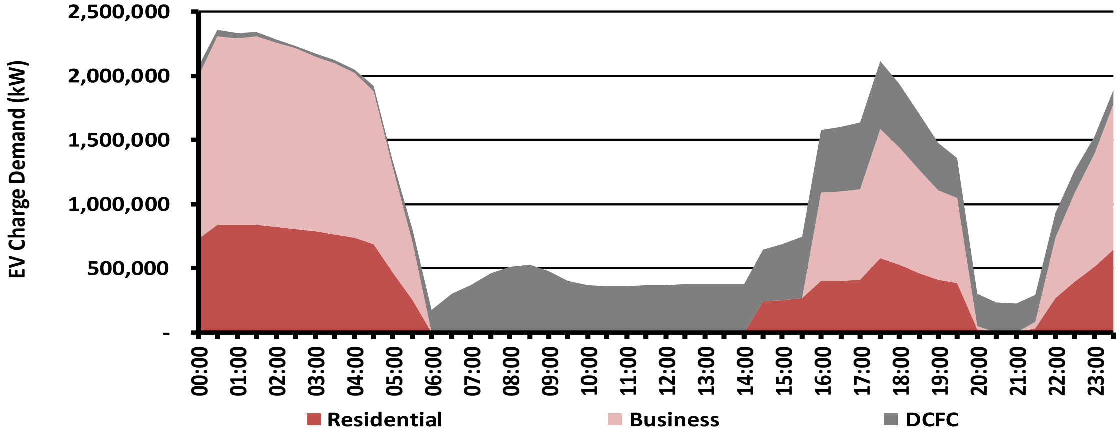
Source: Energeia

2036



Source: Energeia

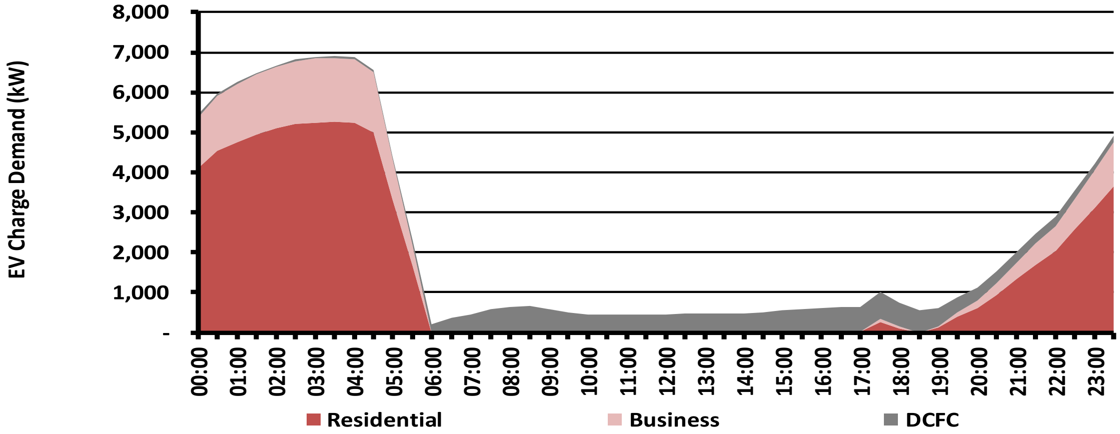
2050



Source: Energeia

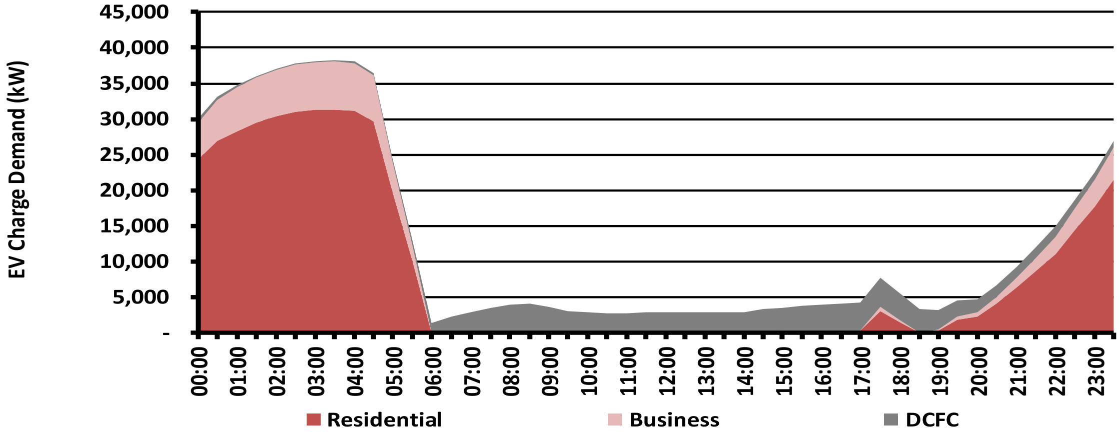
B.3.2 New South Wales - Neutral

2020



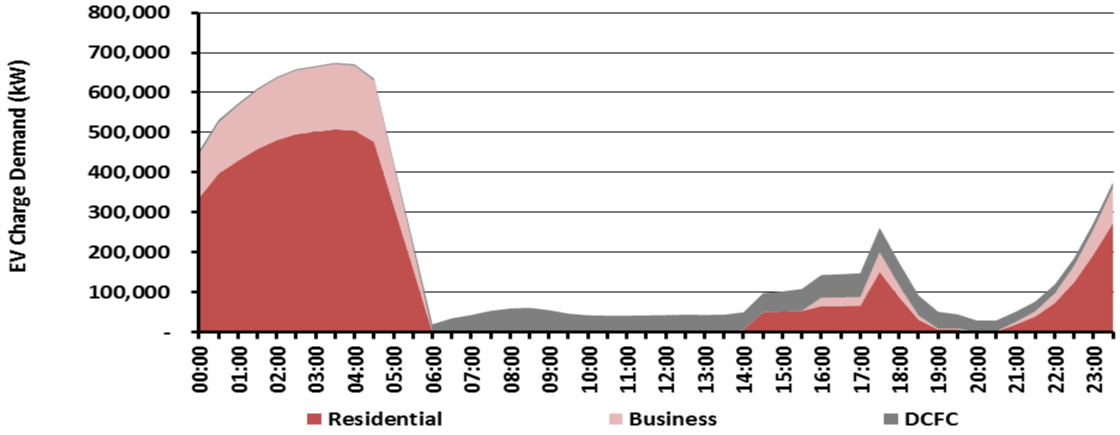
Source: Energeia

2025



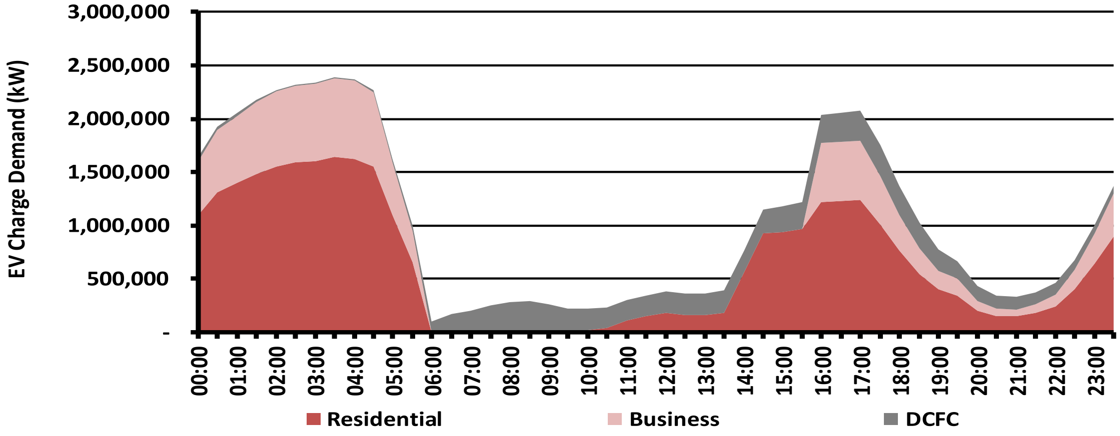
Source: Energeia

2036



Source: Energeia

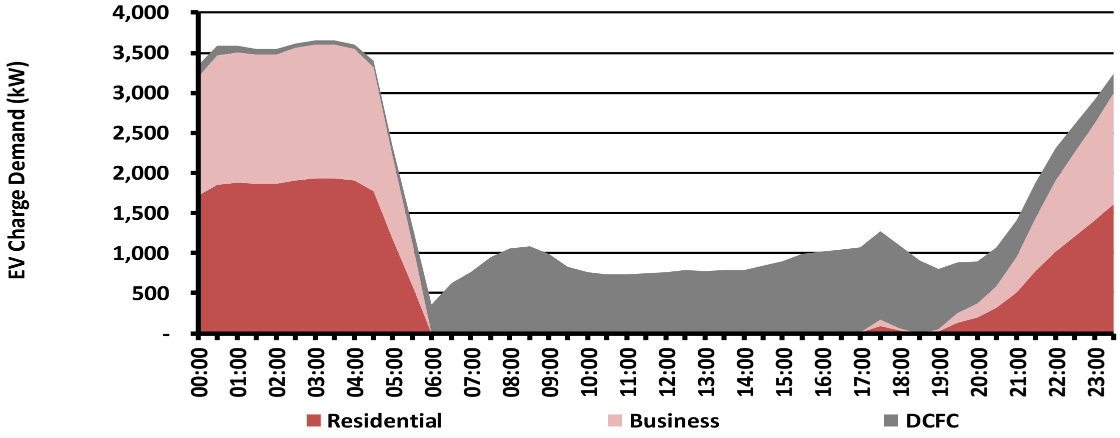
2050



Source: Energeia

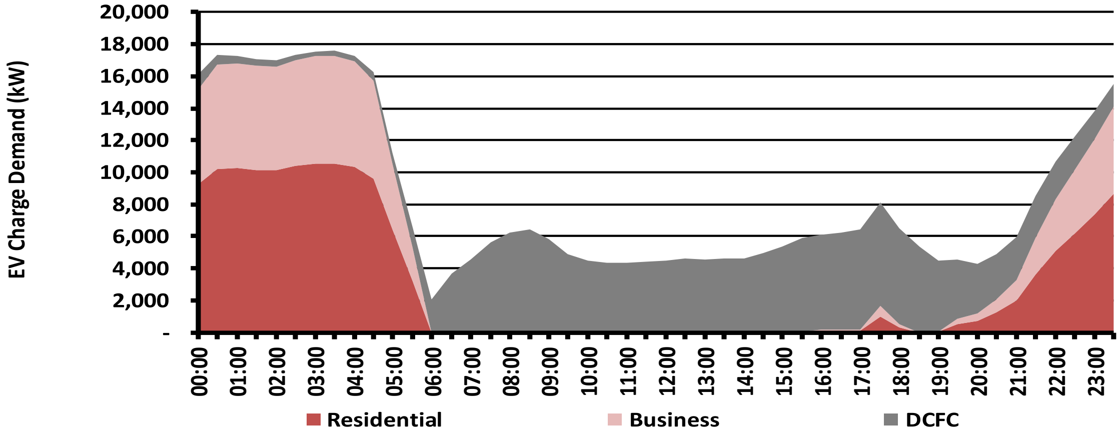
B.3.3 Victoria – Neutral

2020



Source: Energeia

2025



Source: Energeia

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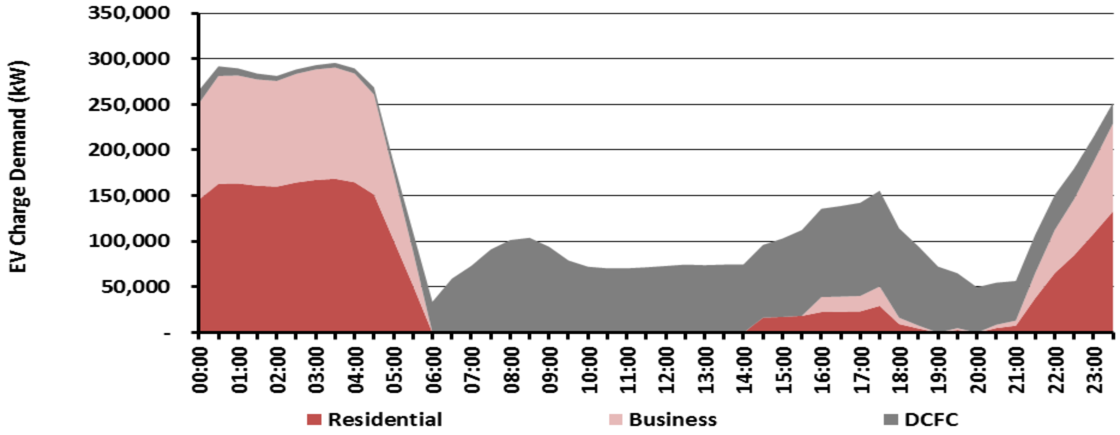
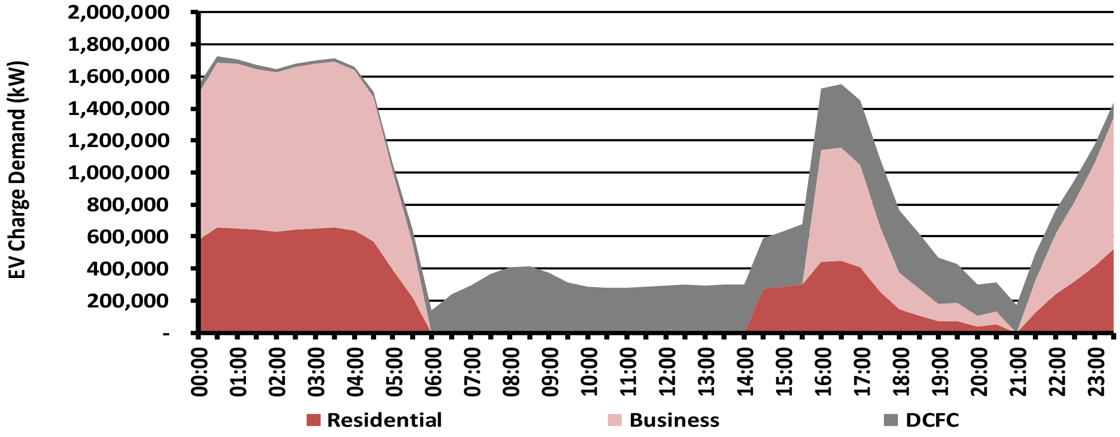


Source: Energeia

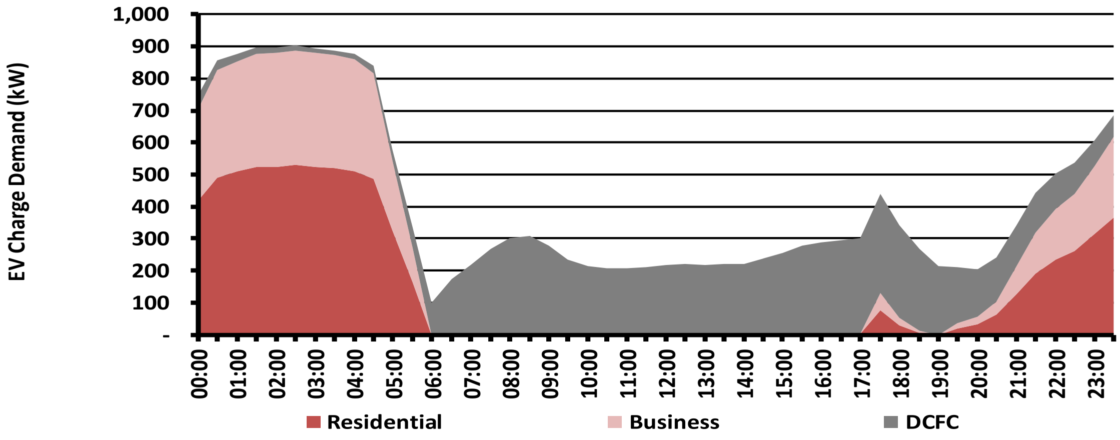
2050



Source: Energeia

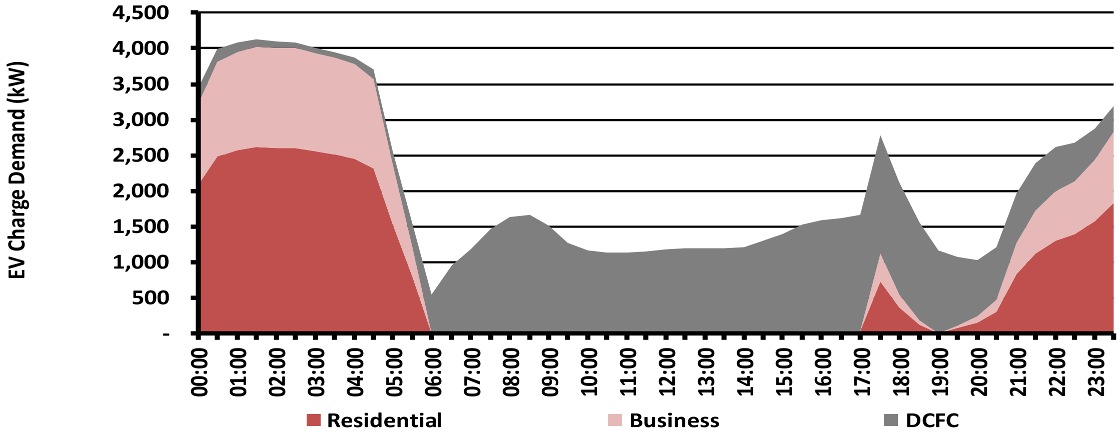
B.3.4 South Australia - Neutral

2020



Source: Energeia

2025



Source: Energeia

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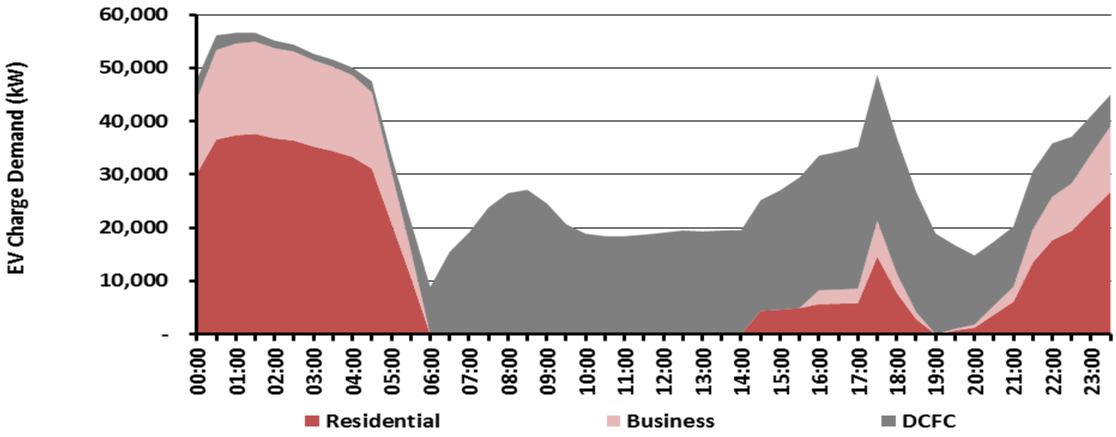

Source: Energeia

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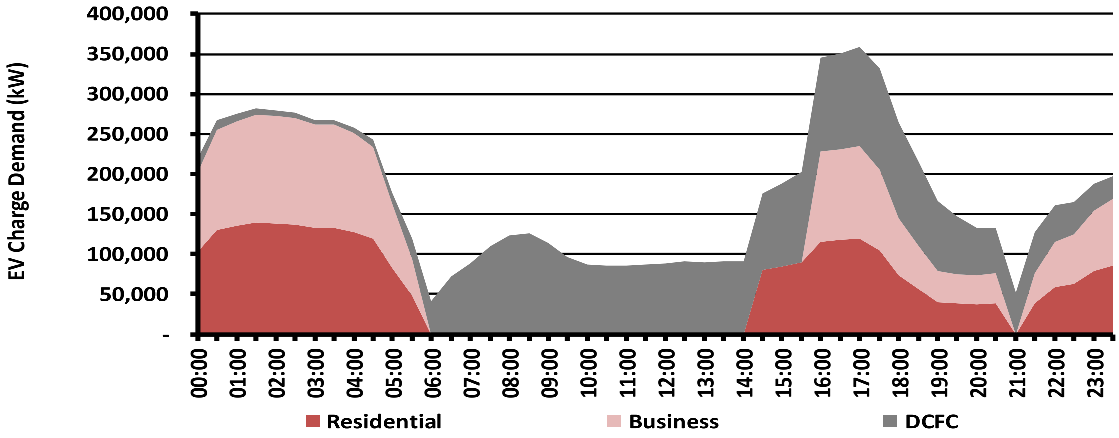
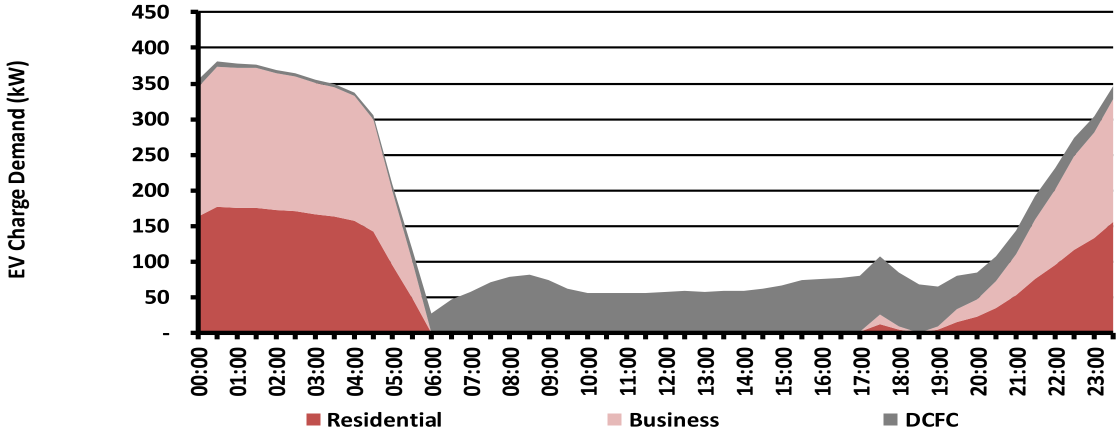


Source: Energeia

B.3.5 Tasmania - Neutral

2020



Source: Energeia

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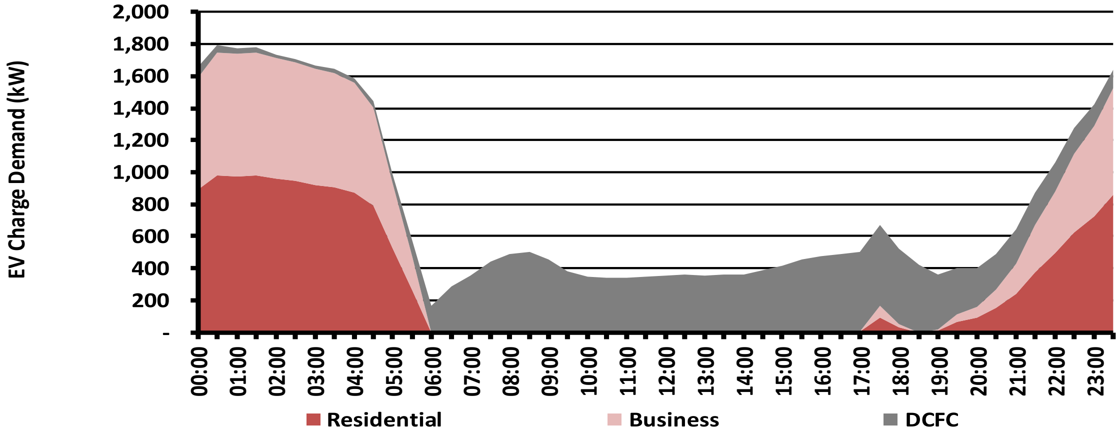
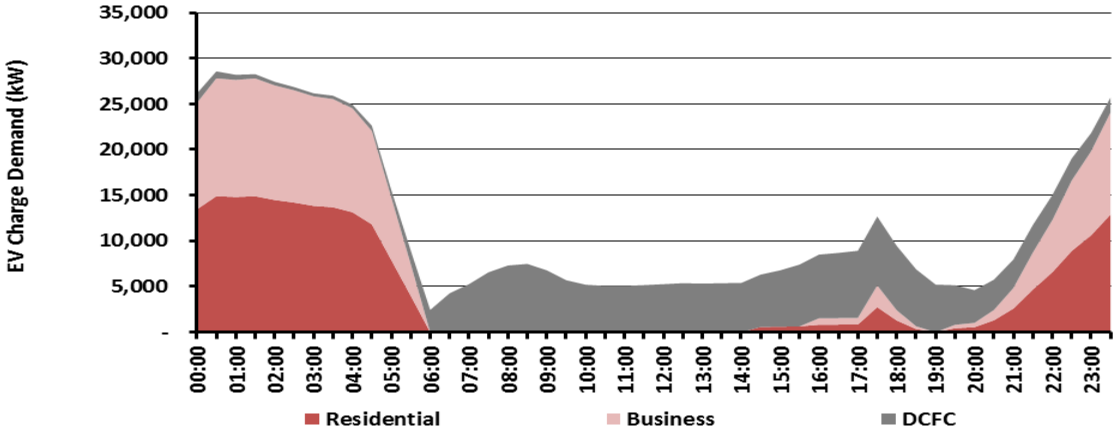


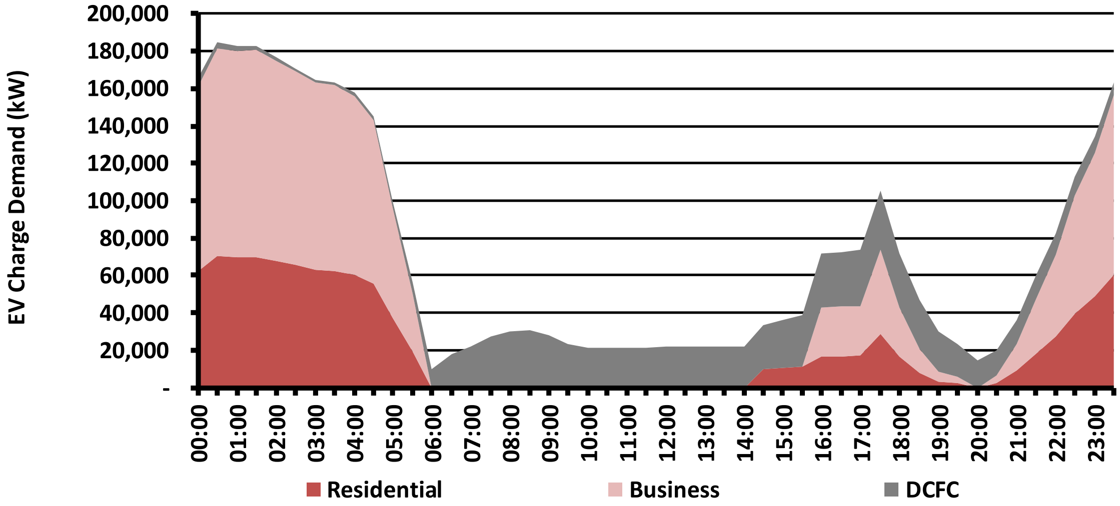
Source: Energeia

2036



Source: Energeia

2050



Source: Energeia