Australian Energy Market Commission

REVIEW

ISSUES PAPER

Energy Market Arrangements for Electric and Natural Gas Vehicles

Commissioners

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Submissions due 23 February 2012. Reference: EMO0022
Issues Paper

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About the AEMC

The Council of Australian Governments, through its Ministerial Council on Energy (MCE), established the Australian Energy Market Commission (AEMC) in July 2005. The AEMC has two principal functions. We make and amend the national electricity and gas rules, and we conduct independent reviews of the energy markets for the MCE.

Foreword

On 28 July 2011, the Australian Energy Market Commission (AEMC) was directed by the Ministerial Council on Energy (MCE) to review the energy market arrangements applying to an electric vehicle (EV) and to a natural gas vehicle (NGV). We are required to advise the MCE on the appropriate energy market arrangements necessary to facilitate the economically efficient take up of EVs and NGVs.

In providing our advice to the MCE we are ultimately guided by the National Electricity Objective and the National Gas Objective. This means that the key principles guiding our approach are that we seek to:

- facilitate consumer choice in the ways they can utilize such technologies;
- allocate costs appropriately to the party that causes these costs, in as much as is feasible;
- to ensure that the security, safety and reliability of the electricity system and the supply of natural gas is maintained; and
- foster competition and innovation, including innovation among business models, in the provision of services supporting these technologies.

Today we publish our Issues Paper in relation to this review. The Issues Paper presents our draft findings on the:

- potential take up of EVs and impacts of EVs on energy markets, particularly in relation to energy consumption, peak demand and system costs; and
- potential take up of NGVs and impacts of NGVs on energy markets.

Given these draft findings, we then present and discuss the suite of issues associated with the energy market arrangements needed to facilitate the efficient take up of EVs and NGVs.

In relation to EVs, the suite of issues we discuss includes:

- general energy market issues related to metering, charge management options and pricing;
- network issues related to connections and reinforcements;
- retail issues; and
- specific issues relating to Western Australia's electricity market.

In relation to NGVs, we discuss issues arising to home and commercial refuelling of these vehicles.

We are keen to receive stakeholder input. This Issues Paper seeks stakeholder input to comment upon and guide our work. We have drafted questions to facilitate detailed input throughout the Issues Paper. Submissions received will directly inform the development of our Draft and Final Advice to the MCE.

Submissions are due to be provided to us no later than 23 February 2012.

Contents

1 Introduction

On 28 July 2011, the Australian Energy Market Commission received a Request for Advice from the MCE[1] with respect to the energy market arrangements for EVs and NGVs. The MCE asked us to investigate the costs and benefits on the energy markets that such vehicles cause and to identify the energy market arrangements necessary to facilitate the efficient take up of these vehicles.

This Issues Paper is designed to:

- provide our draft findings on the potential take up of EVs and NGVs up to 2030;
- comment on the potential impacts that EVs and NGVs have on the energy markets based on a set of scenarios; and
- canvass the key issues relating to the appropriate energy market arrangements needed to facilitate the efficient uptake of EVs and NGVs. We draw upon the issues emerging through our analysis and in submissions to the Approach Paper.[2]

Stakeholder comments are appreciated through this process and submissions to this Issues Paper should be provided by 23 February 2012.

We acknowledge all of the submissions we received in relation to the Approach Paper. We received 20 submissions, which are available on our website. We thank all stakeholders for their contributions. All submissions received have helped to inform this Issues Paper.

We would also like to acknowledge the AutoCRC for their contribution in providing us with useful information on EV and NGV technology.[3]

1.1 Context for the Request for Advice

In the context of more concerted attempts to address climate change and concerns about energy security, it is envisaged that EVs and NGVs will play a more prominent role in Australia's transport mix. In addition, the economic viability of these vehicles is improving due to technological advancements and because of the concomitant increase in the price of conventional fuel substitutes, namely petroleum and diesel. Indeed, from an international perspective, there is growing momentum for the development of low emissions vehicles.

With these forces at play, this is an opportune time to assess the impacts and to ensure that Australia's energy markets properly support the efficient uptake of EVs and NGVs. Given this, the Federal Government asked the MCE to instruct us to identify the energy market arrangements needed to facilitate the take up of EVs and NGVs. Consequently, the MCE developed its Request for Advice.

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1 On 10 June 2011, the Council of Australian Governments (COAG) announced that it would amalgamate the MCE and the Ministerial Council on Mineral and Petroleum Resources and establish the Standing Council on Energy and Resources (SCER).

2 Our Approach Paper was published on 22 September 2011. It is available at www.aemc.gov.au.

3 Further information on the AutoCRC is available at www.autocrc.com

Further, there are a range of related trials and programs currently underway across Australia. These trials and programs include the Victorian government's Electric Vehicle Trial; the Queensland government's development of an Electric Vehicle Roadmap; the South Australian government's Low Emission Vehicle Strategy; the Western Australia Electric Vehicle Trial; and the Australian government's Smart Grid, Smart City trial. We also note that the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is conducting research on electric cars through its Electric Driveway Project.[4] We will have regard to the lessons emerging from these trials and research in developing our advice to the MCE.

Our work on the Power of Choice review is directly relevant to this Request for Advice.[5] The Power of Choice review aims to identify opportunities for consumers to make informed choices about the way they use electricity and to encourage efficient demand side participation in the National Electricity Market. Electric Vehicles are a source of extra demand to be managed and also could become a potential source of storage of electricity, which could then be exported back into the grid. The Power of Choice review will have common issues with this Request for Advice and so we intend to manage these two work streams together to provide consistent and comprehensive advice.

1.2 MCE Request for Advice

The MCE's Request for Advice requires us to highlight the conditions that will enable Australia's energy markets to support the adoption of EVs and NGVs in the most economically efficient manner. In relation to EVs and NGVs, we are required to provide observations on the potential costs and high level benefits on energy market arrangements, namely the National Electricity Rules, Western Australia's electricity market arrangements and the National Gas Rules.[6]

We consider that our primary objective is to advise the MCE on how energy market frameworks can support the uptake of EVs and NGVs in the most economically efficient manner.

4 http://www.csiro.au/resources/Electric-Driveway-reports.html (accessed 13 September 2011)

5 http://www.aemc.gov.au/Market-Reviews/Open/Stage-3-Demand-Side-Participation-Review-Facilitating-consumer-choices-and-energy-efficiency.html

6 A copy of the MCE Request for Advice is available at www.aemc.gov.au.

1.2.1 Our responsibility to promote the National Electricity Objective and the National Gas Objective

We must provide our advice in a manner that promotes the achievement of the National Electricity Objective (NEO) and the National Gas Objective (NGO) – the national objectives. Under section 32 of the National Electricity Law, we are required to have regard to the NEO. The NEO states:

Box 1.1: National Electricity Objective

The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to —

(a) price, quality, safety, reliability and security of supply of electricity; and

(b) the reliability, safety and security of the national electricity system.

Under section 72 of the National Gas Law, we are required to have regard to the NGO. In similar terms to the NEO, the NGO states:

Box 1.2: National Gas Objective

The objective of this Law is to promote efficient investment in, and efficient operation and use of, natural gas services for the long term interests of consumers of natural gas with respect to price, quality, safety, reliability and security of supply of natural gas.

1.2.2 Assessment criteria

The NEO and NGO are founded on the concept of economic efficiency, with explicit emphasis on the long term interests of consumers. This encompasses not only the price at which services are provided, but also the quality, reliability, safety and security of the network and pipeline systems.

We have also taken the view that the scope of the NEO and NGO covers the means by which regulatory arrangements operate as well as their intended results. Hence, the Commission seeks to apply the principles of good regulatory design and practice in order to promote stability and predictability of the regulatory framework, minimise operational interventions in the market, and promote transparency. Therefore, regulatory design and practice will be a significant consideration for the Review as it is important that any reforms are robust over the longer term.

We recognise that governments can establish a range of social and environmental objectives. Where such objectives have relevance to the energy markets, the NEO and NGO are designed to ensure that the energy market arrangements support the achievement of such objectives in the most economically efficient manner for the long term interest of consumers.

We have identified a number of important criteria consistent with the national objectives that are relevant in testing how the energy market arrangements can support the uptake of EVs and NGVs in the most economically efficient manner. These principles are the ability of the arrangements to:

- facilitate consumer choice in the way they use these technologies;
- appropriately allocate costs to the party that causes these costs, in as much as is feasible;
- ensure that the security, safety and reliability of the electricity system and the supply of natural gas is maintained. This requires the arrangements being able to promote efficient investment in network and pipeline services; and
- minimise the costs and risks of regulation to service providers and electricity and gas users.

This means that when we provide our advice in relation to the arrangements that promote the 'economically efficient' take up of EVs we refer to the fulfilment of the above principles.

1.2.3 Scope of our advice

In providing our advice to the MCE, we will focus on Australia's energy markets for electricity and natural gas in accordance with our duties to promote the NEO and NGO. Therefore, broader economy-wide issues relating to EV or NGV technologies and arguments for rebates, tax concessions and other forms of government assistance for these technologies are treated as out of scope.[7] Also, issues relating to technical and safety standards of low emissions vehicles are treated as out of scope for this Request of Advice.[8]

Our investigations will require us to examine the National Electricity Market (NEM) and the Western Australia (WA) electricity market regulatory arrangements as well as Australia's natural gas markets. Any overlapping issues in electricity and gas markets will be addressed as well.

While there will be unique issues pertaining separately to EVs and NGVs, there are some common issues that we are required to investigate. These include (but are not limited to):

- The potential usage patterns and penetration rates, including any peak demand impacts;
- Metering requirements, protocols and settlement issues;
- Network protection/balancing requirements;
- Connection and new network infrastructure implications; and
- Potential implications for tariff arrangements.

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7 Broader EV market issues were raised in the submission from General Electric (GE) and Westport Innovations.

8 EV technical standards are being addressed by Standards Australia under the AS Technical Committee EVO 001.

The MCE has asked for a high level investigation into the energy market arrangements for EVs and NGVs. This means that not all of the detailed issues relating to how EVs and NGVs interact with energy markets will be covered in our advice. We will focus on key issues in accordance with the Request for Advice.

1.3 Proposed analytical framework

Our analytical framework sets out the methodology we will adopt to address the issues in the Request for Advice.

As stated above, we consider that our primary objective is to advise the MCE on how energy market frameworks can support the take up of EVs and NGVs in the most economically efficient manner.

In order to achieve this primary objective, we will apply the following analytical framework:

Table 1.1 Analytical Framework

Stage of Approach	Objective
Step 1	Identify and describe the technology (either EV or NGV).
Step 2	Assess the potential uptake of EVs and NGVs.
Step 3	Identify the costs and benefits of EVs and NGVs to the energy markets.
Step 4	Identify the appropriate electricity market or natural gas market regulatory arrangements necessary to facilitate the economically efficient uptake of EVs and NGVs.
Step 5	Identify the changes required to achieve the appropriate electricity market or natural gas market regulatory arrangements and propose recommendations.

The Issues Paper focuses on Steps 1, 2 and 3 of the analytical framework and raises the issues that need to be addressed in Steps 4 and 5 of the analytical framework.

We have engaged AECOM to provide us with advice in relation to Steps 2, 3, 4 and 5 of our analytical framework. AECOM's draft findings in relation to Steps 2 and 3 of the analytical framework are published as a separate report to this Issues Paper.

1.4 Time frames

We are required to provide our advice to the MCE by mid-2012. We will prepare our advice in tandem with our Power of Choice review. Therefore, the draft and final Advice in relation to EVs and NGVs will coincide with the draft and final report for the Power of Choice review to ensure our advice is consistent and comprehensive.

Accordingly, we intend to undertake this Request for Advice to the following time frames:

Table 1.2 Time frames for the Request for Advice

Publication Milestone	Proposed Date of Publication
Draft Advice	May 2012
Final Advice	September 2012

1.5 Purpose and Structure of the Issues Paper

We are keen to receive stakeholder feedback throughout the Issues Paper and we have provided questions to guide submissions.

Chapter 2 - relates to EVs and briefly defines EV technology for the purposes of our advice (Step 1 of our analytical framework) and conveys our findings on the likely take up of EVs (Step 2 of our analytical framework

Chapter 3 - relates to EVs and discusses the impacts (in terms of cost and benefits) that EVs could have on energy markets (Step 3 of our analytical framework).

Chapter 4 - relates to EVs and canvasses general issues with the appropriate energy market arrangements (Step 4 of our analytical framework).

Chapter 5 - relates to EVs and canvasses specific issues with the appropriate energy market arrangements (Step 4 of our analytical framework).

Chapter 6 - relates to NGVs and briefly defines NGV technology for the purposes of our advice (Step 1 of our analytical framework) and conveys our findings on the likely take up of NGVs (Step 2 of our analytical framework).

Chapter 7 - relates to NGVs and discusses the impacts (in terms of costs and benefits) that NGVs could bring to bear on energy markets (Step 3 of our analytical framework) and issues with the appropriate energy market arrangements (Step 4 of our analytical framework).

Chapter 8 – concludes and specifies a way forward to address these issues.

1.6 Consultation and Submissions to this Issues Paper

All stakeholders will have the opportunity to provide submissions to us following the publication of the Issues Paper and Draft Advice.

In addition, the Request for Advice specifically requires us to consult with:

- The Australian Energy Market Operator;
- The Australian Energy Regulator;
- Industry groups and representatives from energy networks and energy retailers;
- The Cooperative Research Centre for Advanced Automotive Technology; and
- Relevant Commonwealth and jurisdictional departments.

For this Issues Paper, receipt of submissions is due by 23 February 2012. Submissions should contain the project reference code **'EMO0022'** in the subject heading.

Submissions may be sent electronically through the Commission's website at www.aemc.gov.au or in hard copy to:

Australian Energy Market Commission

PO Box A2449

Sydney South NSW 1235.

2 Electric Vehicles - EV technology and assessing the take up

This Chapter discusses EV technology (Step 1 of our analytical framework) and provides our draft findings on the potential take up of EVs (Step 2 of our analytical framework). The discussion of EV technology defines the particular technologies that are pertinent to this Request for Advice and highlights its salient technological features. To assess the potential take up of EVs, we devised a set of scenarios. Using these scenarios, the study on the take up of EVs was completed by AECOM and their report is published separately.[9]

2.1 EV technology

The term 'electric vehicle' can be used to describe any vehicle where the propulsion system contains one or more electric motors that contribute, partly or entirely, toward providing the motive force to drive the vehicle. For the purposes of this Request for Advice, we will focus solely upon those electric vehicles which have the capability to re-charge using electricity supplied through the distribution network. Therefore hybrid electric vehicles (HEVs) will not be part of our assessment as these vehicles do not require charging by electricity supplied via the distribution network.

Consequently, our response to the Request for Advice will focus on two main types of EVs - battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). The sole source of energy for BEVs is the electricity contained in the battery system and must be recharged when depleted. The batteries in a BEV are typically larger than those in PHEVs. In addition to the battery system, PHEVs include an internal combustion engine (ICE) to allow extended driving even with a fully depleted battery. Hence PHEVs would have less impact on the electricity market than BEVs.

There are various estimates on battery costs. CSIRO estimates battery costs to range of $800 to $1000 per kWh of storage capability and are expected to fall significantly in the coming years.[10] Other studies have reported that BEV battery packs cost for 2012 are in the range of $450 to $680 per kilo Watt hour (kWh) of storage capability.[11]

The vehicle driving range for BEVs varies between 100-300km for most passenger cars depending on the vehicle size. PHEVs, which can use both the internal combustion engine power train and the electric power train, will have a larger vehicle driving range at around 500-550km. However given the extensive range of petrol stations the effective range of PHEVs is unlimited. While it is forecasted that EV range will grow over time due to improvement in batteries and fuel efficiency, the relative

9 AECOM, *Impact of Electric Vehicles and Natural Gas Vehicles on the Energy Markets*, report to the AEMC, December 2011.

10 Usher, J., Horgan, C., Dunstan, C., Paevere, P., *Plugging in: A Technical and Institutional Assessment of Electric Vehicles and the Grid in Australia.* Prepared for Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), by the Institute for Sustainable Futures, UTS: Sydney, 2011, p 62.

11 C.Shulock, E. Pike, 'Vehicle Electrification Policy Study – Task 1 Report, Technology Status' The International Council on Clean Transportation, Washington DC, February 2011

competitiveness of EVs will depend upon giving EV users similar levels of comfort and certainty regarding driving range.

2.1.1 Where will EVs charge?

EVs could be charged in the following locations:

- Home/residential charging where an EV is charged at an EV user's home;
- Business charging where an EV is charged at the EV user's workplace;
- Commercial charging - public/other premises (such as car parks, shopping centres and street parking); and
- Commercial charging at dedicated commercial premises (such as by providing fast charge facilities either through a battery swap or a quick DC charge).

We recognise the range of charging options available and we do not seek to preclude or favour one model of charging, but rather seek to ensure that the energy market arrangements are able to facilitate a diversity of charging options.

2.1.2 How much power will EV chargers require?

At present, it is generally recognised that there are three levels of EV charging.

Figure 2.1 Levels of EV charging

Level	Voltage / Current	Power
Level 1	15A, 240V AC	3.6 kW
Level 2	32A, 240V AC	7.7 kW
Level 3	125A, 400V – 600V DC	>50-75 kW

Source: ChargePoint presentation, Early Driver Challenges of EV Transportation

There are two methods to charge EVs:

- AC charging – alternating current (AC) is supplied via a mains supply to a receptacle on-board the vehicle where the on -board charging system converts it to charge the battery; and
- DC charging – a high capacity AC electrical supply is converted to direct current (DC) off-board the vehicle by a charging station and delivered directly to the vehicle's battery. In these stations, the AC to DC conversion is undertaken in a dedicated unit and will allow for much faster charging at higher electrical currents.

The nature and availability of the charging infrastructure will be crucial aspect to EV development. All commercially available EVs have the capability for AC charging and this is widely seen as the dominant form of vehicle charging. Most residential and public charging will occur at power levels ranging from less than 1 kW to as much as 19.2 kW and full charge times of 3 to 8 hours. DC charging (also known as 'fast charging' or 'quick charging') could be used for higher rate, faster charging applications.

Blade Electric Vehicles raised the potential for 'ultra fast charging' in the future where EVs can be recharged in under 6 minutes at a transfer rate of 250-500kW.[12]

2.2 Assessing the take up of EVs

This section discusses the contributing factors and presents AECOM's findings on the take up of EVs.

2.2.1 Factors affecting take up

Submissions identified three sets of factors affecting the take up of EV. Firstly, there were factors affecting the total number of vehicles sold, specifically:

- Global production of EVs and related supply constraints;[13]
- Transport policy at both State and Federal levels; and[14]
- Economic growth.

Secondly, there were factors related to the relative competitiveness of EVs compared to ICE vehicles (and HEVs), specifically:

- Relative price of batteries;[15]
- Relative price of vehicles in terms of purchasing and maintenance costs;[16]
- Relative price of fuel;[17]
- Efficiency improvement in current technologies;[18]
- Availability of EV charging infrastructure;[19]
- Reliability and safety of EVs;[20]
- Vehicle driving range; and

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12 Blade Electric Vehicles 2011, Submission to Approach Paper, p. 3.

13 Chargepoint 2011, Submission to Approach Paper; Energy Networks Association 2011, Submission to Approach Paper; Western Power 2011, Submission to Approach Paper; SP AusNet 2011, Submission to Approach Paper; University of South Australia 2011, Submission to Approach Paper.

14 Energy Networks Association 2011, Submission to Approach Paper; SP AusNet 2011, Submission to Approach Paper; Automobile Association of Australia 2011, Submission to Approach Paper.

15 Ausgrid 2011, Submission to Approach Paper; Automobile Association of Australia 2011, Submission to Approach Paper; Energy Networks Association 2011, Submission to Approach Paper.

16 Ausgrid 2011, Submission to Approach Paper; betterplace 2011, Submission to Approach Paper; Energy Networks Association 2011, Submission to Approach Paper; Ergon Energy 2011, Submission to Approach Paper; SP AusNet 2011, Submission to Approach Paper.

17 Automobile Association of Australia 2011, Submission to Approach Paper; Government of South Australia 2011, Submission to Approach Paper; SP AusNet 2011, Submission to Approach Paper; University of South Australia 2011, Submission to Approach Paper.

18 Ausgrid 2011, Submission to Approach Paper; Energy Networks Association 2011, Submission to Approach Paper; Government of South Australia 2011, Submission to Approach Paper.

19 Ausgrid 2011, Submission to Approach Paper; Automobile Association of Australia 2011, Submission to Approach Paper; betterplace 2011, Submission to Approach Paper; Chargepoint 2011, Submission to Approach Paper.

20 Automobile Association of Australia 2011, Submission to Approach Paper.

- Consumer preferences, needs and incomes.[21]

Finally, there were also factors relating to government policy considerations:

- Energy security provided by EVs relying on electricity rather than dependency on oil and related fuels;[22] and
- Emissions benefits of EVs and contribution to reducing air pollution.[23]

2.2.2 Draft findings on the take up of EVs

In undertaking this analysis and given the inherent uncertainty in forecasting take up, we requested that AECOM undertake a scenario based approach. Accordingly, three scenarios were devised:

- A central take up scenario, which represents a likely take up scenario given currently available information and central assumptions on key factors;
- A low level of take up scenario, which represents a lower bound on take up if all of the key factors are unfavourable to supporting the take up of EVs; and
- A high level of take up scenario, which represents an upper bound on take up if all of the key factors are favourable to supporting the take up of EVs.

These scenarios were defined on the basis of a number of variables affecting the take up of vehicles such as:

- vehicle sales using long term trend annual growth of around 1 per cent to 2.5 per cent depending on the state;
- vehicle purchase price;
- fuel cost;
- vehicle range; and
- availability of charging infrastructure.[24]

A vehicle choice model was used to forecast the likely take up under each of these scenarios. The data used was from New South Wales and Victoria and this data was used as a proxy for the other states and territories.

AECOM's analysis found that EVs could have a significant presence in the Australian market within 10 to 15 years. Initially, due to high upfront costs and supply constraints, take up is expected to be slow and could account for 1 to 2 per cent of sales until 2015. However, once EV prices fall, global supply constraints ease and infrastructure availability increases, take up is likely to increase.

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21 Energy Networks Association 2011, Submission to Approach Paper; Ausgrid 2011, Submission to Approach Paper; betterplace 2011, Submission to Approach Paper.

22 Government of South Australia 2011, Submission to Approach Paper; AGL Energy 2011, Submission to Approach Paper.

23 Origin Energy 2011, Submission to Approach Paper; University of South Australia 2011, Submission to Approach Paper.

24 A complete list and discussion of assumptions is available at AECOM, *Impact of Electric Vehicles and Natural Gas Vehicles on the Energy Markets*, report to the AEMC, December 2011.

Under the central scenario, they found that vehicle sales are expected to be around 20 per cent by 2020 and rising to around 45 per cent of sales by 2030. If EV prices take longer to reach parity with ICE vehicles and supply constraints persist, then EV take up could be slower under the low scenario. Conversely, take up could be higher if, for example, factors such as battery prices decrease sooner than expected and supply constraints ease earlier. Figure 2.2 below sets out the estimated annual EV sales in the NEM and the Western Australian South West Interconnected System (SWIS) as a proportion of new sales.

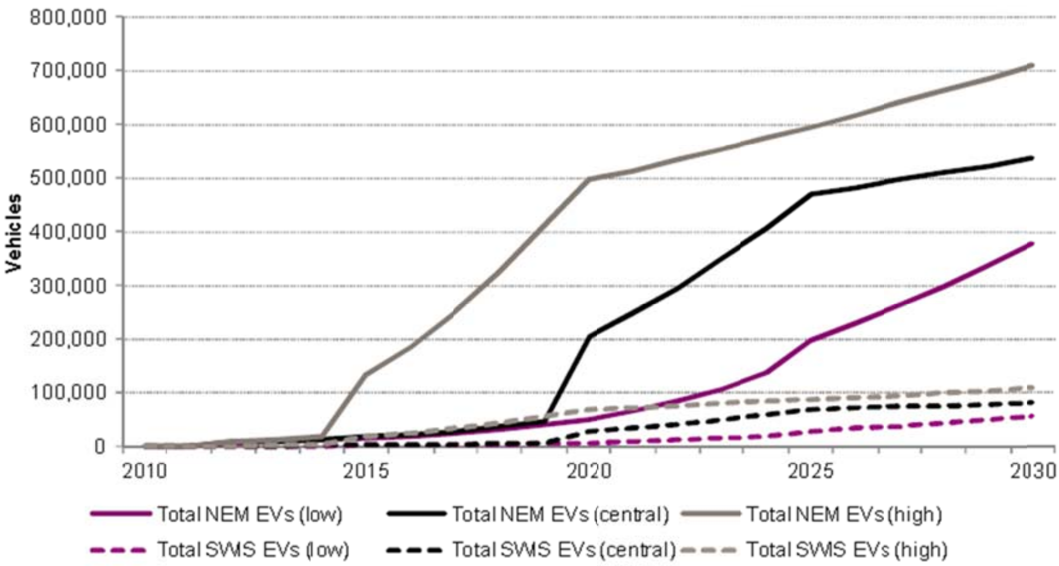
Figure 2.2 Estimated percentage of annual sales of EVs in the NEM and SWIS as a proportion of new sales

	Central			Low			High		
	2015	2020	2030	2015	2020	2030	2015	2020	2030
NEM									
PHEV	1.3%	18.7%	36.3%	1.4%	4.6%	31.0%	13.0%	41.0%	38.0%
BEV	0.7%	1.5%	7.6%	0.3%	0.6%	2.6%	1.3%	6.0%	15.4%
Total	2.0%	20.2%	43.9%	1.7%	5.3%	33.6%	14.4%	47.0%	53.4%
SWIS									
PHEV	1.3%	18.7%	37.5%	1.3%	4.4%	32.2%	12.8%	42.0%	38.6%
BEV	0.7%	1.6%	8.4%	0.3%	0.6%	2.9%	1.4%	6.6%	17.0%
Total	2.0%	20.3%	45.9%	1.7%	5.1%	35.1%	14.2%	48.6%	55.7%
Total									
PHEV	1.3%	18.7%	36.5%	1.3%	4.6%	31.2%	13.0%	41.1%	38.0%
BEV	0.7%	1.5%	7.7%	0.3%	0.6%	2.6%	1.3%	6.0%	15.6%
Total	2.0%	20.2%	44.2%	1.7%	5.2%	33.8%	14.3%	47.2%	53.6%

Source: AECOM

Figure 2.3 illustrates this take up for the NEM and the SWIS (South West Interconnected System) in Western Australia in absolute numbers of estimated new sales of EVs.

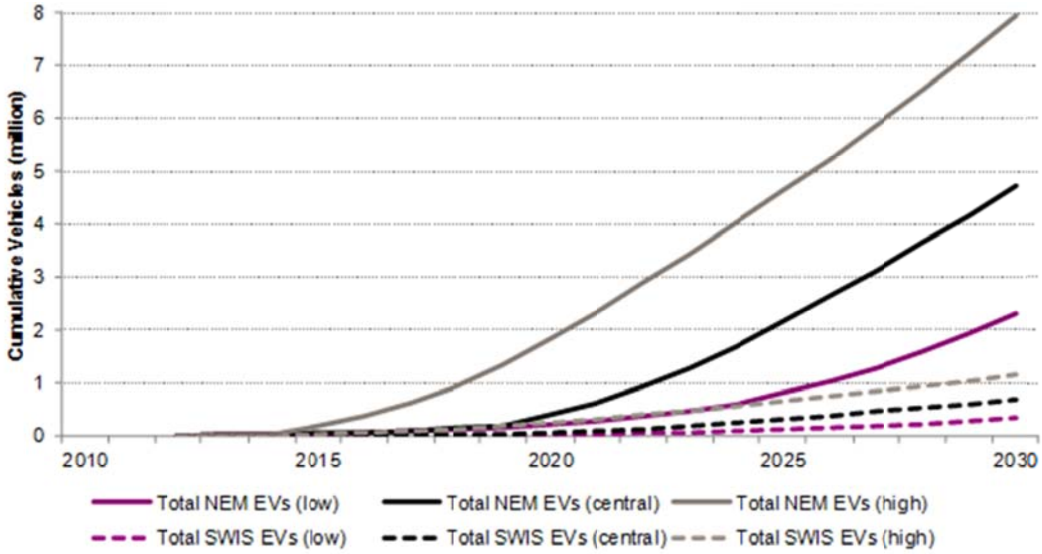
Figure 2.3 Estimated annual sales of EVs in NEM and SWIS



Source: AECOM

AECOM also estimated the cumulative number of EVs in the NEM and SWIS as demonstrated in Figure 2.4:

Figure 2.4 Estimated cumulative number of EVs in the NEM and SWIS



Source: AECOM

With respect to the estimated take up of EVs, AECOM made the following observations:

- There would be a higher take up of PHEVs (relative to BEVs) initially and this would minimise the impact on the electricity market. This would reduce the impact of EVs on the electricity market (including impact on peak demand) because PHEVs can rely on dual electricity and petrol. However, once BEVs prices reach parity with ICE vehicles and with battery improvements and availability of charging infrastructure, there would be an increase in BEVs;
- There would be a higher take up of smaller EVs initially and this would minimise the initial impact on the electricity market. At present, smaller EVs are less expensive compared to larger EVs and will require less charging. In principle this could mean that the overall impact on peak demand is relatively small in the short term. However, as vehicle range increases, vehicle prices fall and charging infrastructure improves, then there should be increased take up in larger EVs and vehicles that travel longer distances;
- There would be a greater number of EVs in New South Wales, Victoria and Queensland because these states make up the majority of vehicle sales; and
- There could be spatial clustering of EVs in the early years, which means that initial take up of EVs will be found in relatively affluent urban areas with typically a more educated, environmentally conscious and technologically aware demographic.

2.2.3 Comparing AECOM's findings with other estimates of EV take up

AECOM's findings are broadly consistent with those presented in other studies.[25] AECOM compared their findings based on the three scenarios with the figures on the penetration of EVs provided by ChargePoint and AGL. AECOM's central scenario is broadly consistent with Chargepoint's estimates on the percentage of EV sales by 2020. However, AECOM's estimation of EV sales under its central scenario is substantially higher that AGL's medium take up scenario assumption. In fact, AECOM's central scenario aligns closely with AGL's high take up scenario assumption. Relative to AGL's assumed take up scenarios, this may suggest that AECOM's central scenario provides conservatively higher estimates regarding the impact of EVs on the electricity market.

AECOM's estimated take up is also comparable to targets set by international governments.[26]

Question 1 Assessing the take up of EVs

Is the range of estimates provided by AECOM appropriate for assessing the potential impacts of EVs on the electricity market and developing our advice? Does the range of scenario estimates provide a credible view on the potential penetration of EVs?

25 AECOM, *Impact of Electric Vehicles and Natural Gas Vehicles on the Energy Markets*, report to AEMC, December 2011, p 36-37.

26 A table of international government targets is available at J Jarvinen, F Orton and T Nelson, 'Electric Vehicles in the NEM: energy market and policy implications' *AGL Applied Economic and Policy Research*, Sydney, 2011, p 3. This is available on the AEMC website - it is an attachment to AGL's submission to the Approach Paper.

3 Electric Vehicles - Impacts on Energy Markets

In this chapter, we discuss the impacts that EVs are likely to impose on Australia's energy markets (Step 3 of our analytical framework) given our findings on the estimated take up of EVs outlined in the previous chapter. These impacts can be expressed in terms of both the costs and benefits that such technologies bring to bear on those markets. This chapter incorporates both AECOM's findings and views contained in submissions.

3.1 Estimated impact on electricity consumption

AECOM estimated the energy consumption of EVs (including separate figures for PHEVs and BEVs) under each of the three scenarios for both the NEM and the SWIS. Under the central scenario, AECOM found that energy consumption of EVs as a proportion of total energy in the NEM is 0.2 per cent by 2020 and 2.2 per cent by 2030 in the NEM. For the SWIS, energy consumption is 0.2 per cent by 2020 and 2.6 per cent by 2030. Figure 3.1 and Figure 3.2 present these results.

Figure 3.1 Estimated energy consumption from EVs in selected years - NEM[27]

EVs	2015		2020		2030	
	MWh	% of total MWh in NEM	MWh	% of total MWh in NEM	MWh	% of total MWh in NEM
Central take up scenario						
PHEV	40,400	0.0%	462,200	0.2%	6,907,600	1.8%
BEV	48,000	0.0%	186,600	0.1%	1,629,100	0.4%
Total	88,300	0.0%	648,800	0.2%	8,536,700	2.2%
Low take up scenario						
PHEV	40,100	0.0%	240,200	0.1%	3,588,700	0.9%
BEV	26,300	0.0%	83,500	0.0%	450,700	0.1%
Total	66,400	0.0%	323,700	0.1%	4,039,300	1.1%
High take up scenario						
PHEV	190,700	0.1%	2,418,100	0.9%	10,335,100	2.7%
BEV	82,400	0.0%	617,400	0.2%	3,926,200	1.0%
Total	273,100	0.1%	3,035,400	1.1%	14,261,400	3.7%

27 Source: AECOM

Figure 3.2 Estimated energy consumption from EVs in selected years - SWIS[28]

EVs	2015		2020		2030	
	MWh	% of total MWh in SWIS	MWh	% of total MWh in SWIS	MWh	% of total MWh in SWIS
Central take up scenario						
PHEV	4,800	0.0%	57,100	0.1%	937,600	2.1%
BEV	5,600	0.0%	23,700	0.1%	236,200	0.5%
Total	10,400	0.0%	80,900	0.2%	1,173,800	2.6%
Low take up scenario						
PHEV	4,800	0.0%	28,700	0.1%	481,800	1.1%
BEV	3,000	0.0%	10,200	0.0%	64,000	0.1%
Total	7,800	0.0%	38,900	0.1%	545,800	1.2%
High take up scenario						
PHEV	22,600	0.1%	306,400	0.8%	1,380,500	3.0%
BEV	10,000	0.0%	82,600	0.2%	568,100	1.2%
Total	32,600	0.1%	389,000	1.0%	1,948,700	4.3%

The energy usage of EVs depends on the size of the vehicle and the distance travelled. Small EVs travelling short distances may use less than 1 Mega Watt hour (MWh) per annum, whereas large EVs travelling longer distances could use around 10 MWh per annum.[29] The proportion of vehicle size and average distance travelled varies by state. On this point, AECOM's study uses the proportion of vehicle type and Vehicle Kilometres Travelled (VKT) from New South Wales and Victoria and applies this to other states as data was not available for other states within the study period. Figure 3.3 presents the average annual energy usage in Victoria and New South Wales by passenger vehicle type and distance travelled.

Figure 3.3 Average annual energy usage in Victoria and New South Wales by passenger vehicle type and distance travelled, 2011[30]

Passenger vehicle type	kWh/100km	Victoria		New South Wales	
		Average annual VKT	Average annual MWh per vehicle	Average annual VKT	Average annual MWh per vehicle
Small car, low VKT	19	3,622	0.7	4,160	0.8
Small car, medium VKT	19	13,422	2.6	14,342	2.7
Small car, high VKT	19	48,565	9.2	40,598	7.7
Medium car, low VKT	16.5	3,621	0.6	4,135	0.7
Medium car, medium VKT	16.5	13,600	2.2	14,719	2.4
Medium car, high VKT	16.5	52,811	8.7	42,475	7.0
Large car, low VKT	21.5	4,037	0.9	4,220	0.9
Large car, medium VKT	21.5	14,785	3.2	14,665	3.2
Large car, high VKT	21.5	52,484	11.3	45,907	9.9
LCV	18.5	22,742	4.2	23,518	4.4
Taxi	21.5	116,079	25.0	130,029	28.0

28 Source: AECOM

29 The University of South Australia reported that the annual energy consumption for a Nissan Leaf is 2.6 MWh and an i-MIEV is 2.0 MWh.

30 Source: AECOM

3.2 Estimated impact of EVs on system peak demand

To determine the impact on peak demand[31], we asked AECOM to model three charge management options in addition to the base case of un-managed charging. These options are:

- **Un-managed charging**, where charging occurs when convenient with EV drivers and typically coincides with times of peak demand. AECOM modelled un-managed charging by assuming that 80 per cent of EVs (including PHEVs) are charged during existing periods of peak demand (typically between 3-8pm) using a Level 1 charger (15 Amp);
- **Controlled charging**, where charging is controlled by a service provider (either a Distribution Network Service Provider (DNSP), a retailer, an aggregator or a EV charging services provider) and charging would occur in off-peak periods. This means that the EV user has agreed to delegate its option as to when to charge to another party. Controlled charging already exists in the NEM via ripple control technology for hot water heating;
- **Time of Use (TOU) charging**, where the structure of prices incentivises some EV users to charge off-peak. This means that relatively lower prices would apply in times of lower demand, which could incentivise EV users to charge at these off-peak times. TOU pricing produces fixed prices that vary for particular time-bands (e.g., peak, shoulder, off-peak); and
- **Smart meter charging**, where a smart meter with communication capabilities optimises charging behaviour based on real-time information. This enables dynamic pricing to occur because the EV user can respond to price signals in real-time based on information about the network and system demand. It is assumed that smart meter charging would provide more accurate pricing signals than TOU charging and hence the customer response is expected to be greater.

If we assume that EV take up is significant and that there is un-managed charging of EVs, then there are likely to be significant impacts on peak demand, which would impose additional costs on the users of the electricity system.

While AECOM has found that the proportion of peak demand brought about by EVs relative to the overall projected growth in peak demand is relatively small - given the expected growth in peak demand over the medium term - it advises that such an increase can still have significant costs to the market. In the central take up scenario, AECOM found that the take up of EVs could start to have a material impact on peak demand by around 2020 if charging is un-managed.

While this may provide sufficient time for the energy market to adapt and provide the necessary investment, in practice this will depend on the ability to accurately forecast the take up of EVs (which could require regular market monitoring) and that there are the right signals in both the generation market and networks for this investment to occur. The impact on the market will also depend upon the ability of the energy

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31 We examine overall system peak demand, while noting that there would be differences with localised network peak demands.

market arrangements to appropriately allocate costs to the party that causes these costs, consistent with assessment criteria set out in section 1.2.2.

We also note that our analysis of peak demand refers to system peak demand in the NEM states or SWIS. We acknowledge that system peak demand does not necessarily coincide with more localised network peak demand.

3.2.1 Estimated impact of EVs on system peak demand in the NEM

AECOM estimated the additional system peak demand under each charge management scenario and found that there were significant potential benefits from encouraging off-peak charging in the NEM. This is illustrated in the Table 3.1.

Table 3.1 also states the percentage of additional EV related peak demand as a proportion of estimated growth in peak demand. Estimated growth in peak demand was based on AEMO's 2011 Electricity Statement of Opportunities summer maximum demand projections for 50 per cent Probability of Exceedence. From an actual 2010/11 peak demand of 36,081 MW AEMO is forecasting an additional 10 066 MW by 2020 and 23 570 MW by 2030 of NEM-wide overall peak demand growth. AECOM found that extra peak demand caused by EVs would contribute a relatively small percentage to overall peak demand even if there is unmanaged charging. In addition, if there is managed charging, then the percentages are even smaller.

For un-managed charging, as described above this refers to 80 per cent of EV users undertaking Level 1 (15 Amp) charging when they arrive home and where this charging occurs at times of peak demand. Further, AECOM found that if 100 per cent of charging occurs in peak periods and every EV user has a level 2 charger (32 Amp) this results in a 150 per cent increase in the additional peak load. (thereby increasing the 2020 estimated additional EV related peak demand from 740 MW to 1110 MW).

Table 3.1 Estimated additional peak demand in the NEM for various charge management options under the central take up scenario[32]

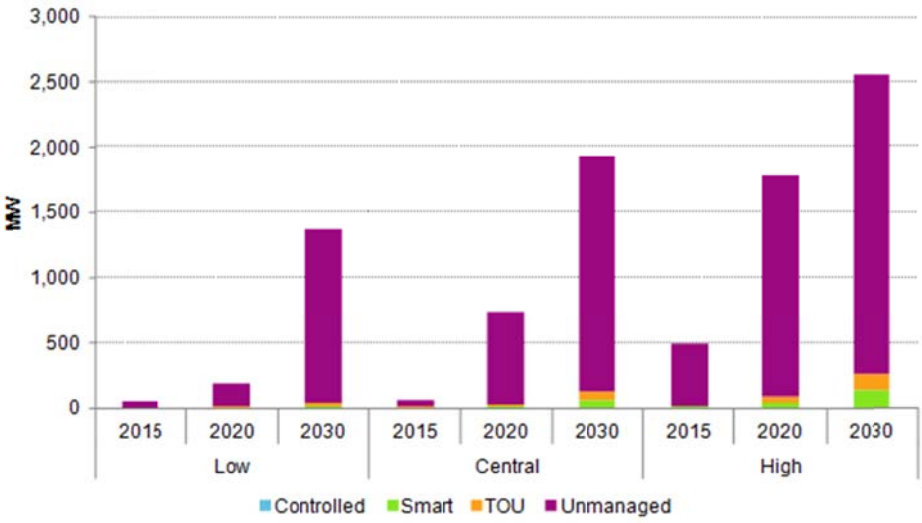
Charge management option	Estimated additional EV related peak demand in 2020 (MW)	Estimated additional EV related peak demand as a percentage of estimated growth in overall peak demand in 2020 (per cent)	Estimated additional EV related peak demand in 2030 (MW)	Estimated additional EV related peak demand as a percentage of estimated growth in overall peak demand in 2030 (per cent)
Un-managed charging	740	7.3	1900	8.2
Time of Use charging	20	0.2	120	0.5
Smart meter charging	10	0.1	60	0.3
Controlled charging	0	0	0	0

We note that while these figures relate to the NEM overall, we recognise that there are local factors or factors specific to particular NEM states that determine the magnitude and materiality of costs of additional investment and hence produce differing impacts. Each NEM state has its own peak. Appendix A of AECOM's report provides details of impacts on peak demand for each state.

Figure 3.4 depicts the estimated additional system peak demand in the NEM for each charge management option under the three take up scenarios.

32 Source: AECOM

Figure 3.4 Estimated additional system peak demand in the NEM



Source: AECOM. Note: The above chart shows estimated additional peak demand, with increments attributable to each charging type. For example, under the central take up scenario, by 2030, with unmanaged charging 1,900 additional MW are required; for TOU charging this is 120MW and for smart charging an additional 60MW.

3.2.2 AEMO's estimate of additional system peak demand in the NEM

On December 14 2011, AEMO released its National Transmission Network Development Plan (NTNDP). The 2011 NTNDP contained AEMO's estimates of additional system peak demand –brought about by EVs under two scenarios: an un-managed or 'uncontrolled' charging scenario and a 'smart' charging[33] scenario. Under the un-managed charging scenario AEMO assumed that there would be 1 million EVs in 2030 (described as EV1 in the graphs below) while the 'smart' charging scenario assumed 1 million EVs in 2030 with half of these vehicles using a form of managed charging, such as charging at off-peak times (described as EV2 in the graphs below). Maximum system peak demand was estimated for both summer and winter system peaks.

In both scenarios (and as illustrated in the following graphs) and for both winter and summer peak demand, AEMO found that there was an increase in the level of peak demand. Under un-managed summer peak demand, EV charging increases the 2030 peak by 914 MW and under un-managed winter peak demand EV charging increases the 2030 peak by 1460 MW. Under 'smart' charging EV increases summer peak demand by 456 MW and winter peak demand by 730 MW. Further, the increase in the peak is greater in winter than in summer because the winter peak tends to happen later in the day when the assumed EV load is higher.

While there are differences in the take up assumptions between the two studies, the trends in AEMO's findings are broadly consistent with AECOM's findings.

33 AEMO have referred to 'smart charging' in their analysis, which translates to a combination of controlled charging, TOU charging and smart meter charging for the purposes of this Issues Paper.

Figure 3.5 AEMO 2011 NTNDP estimate of summer demand under EV take up scenarios for NSW –in 2030

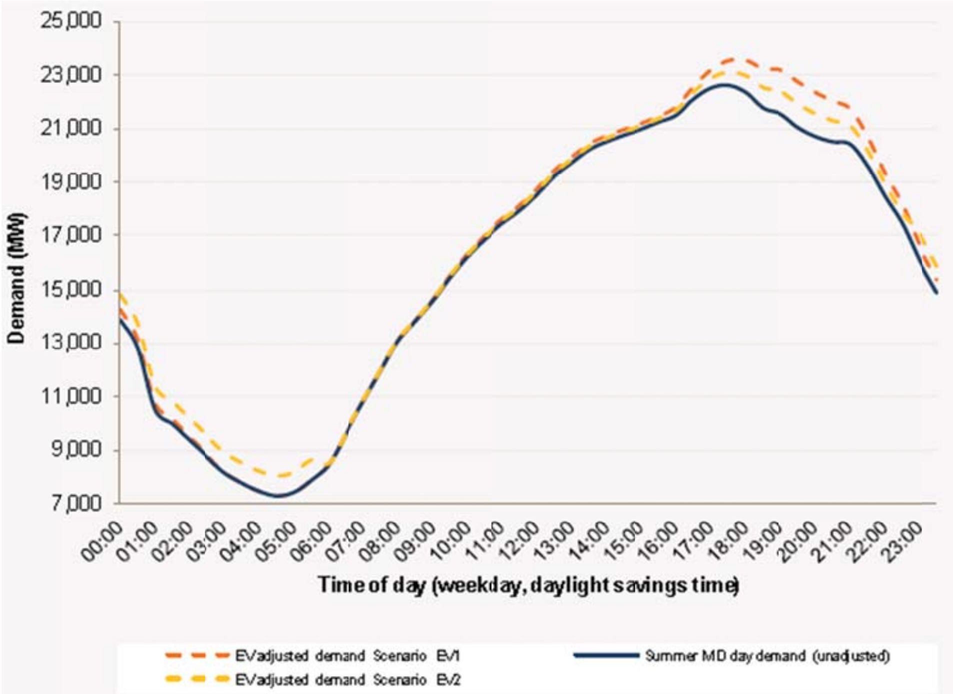
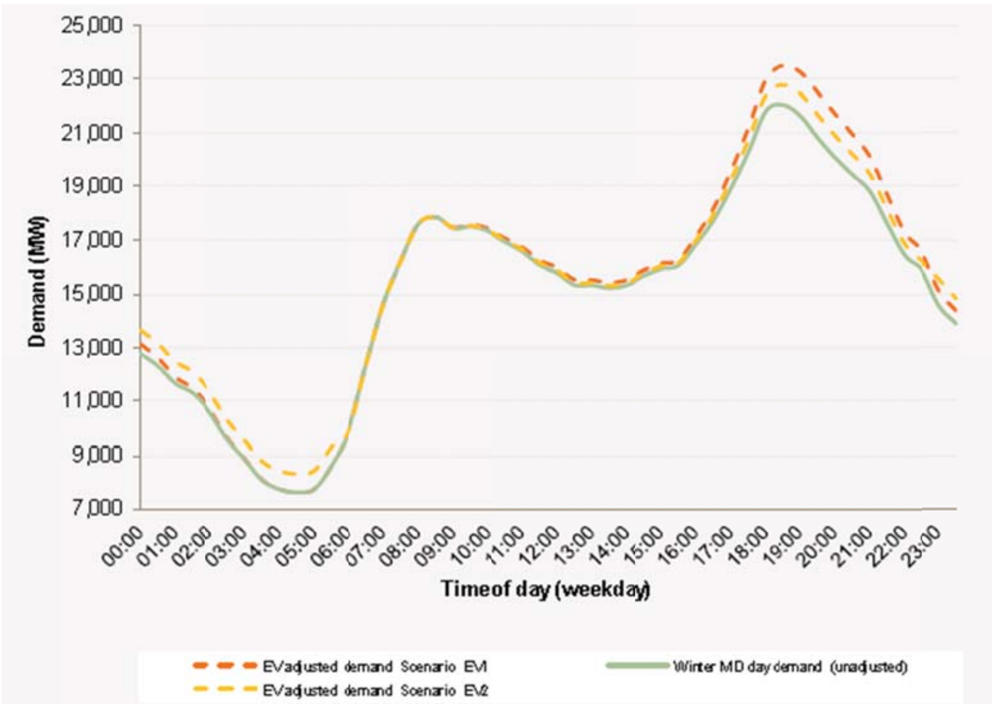


Figure 3.6 AEMO 2011 NTNDP estimate of winter maximum demand by EV take up scenarios for NSW in 2030



3.2.3 Estimated impact of EVs on system peak demand in the SWIS

AECOM also estimated the additional peak demand under each charge management scenario in the SWIS. AECOM's results are found in the Table 3.2.

Table 3.2 also states the percentage of additional EV related peak demand as a proportion of estimated growth in peak demand. Estimated growth in peak demand was based on IMO’s 2011 Electricity Statement of Opportunities summer maximum demand projections under normal economic growth with 50 per cent Probability of Exceedence.[34] AECOM found that EVs could contribute a relatively small percentage to overall peak demand if there is unmanaged charging. In addition, if there is managed charging, then the percentages are even smaller.

Table 3.2 Estimated additional system peak demand in the SWIS for various charge management options under the central take up scenario[35]

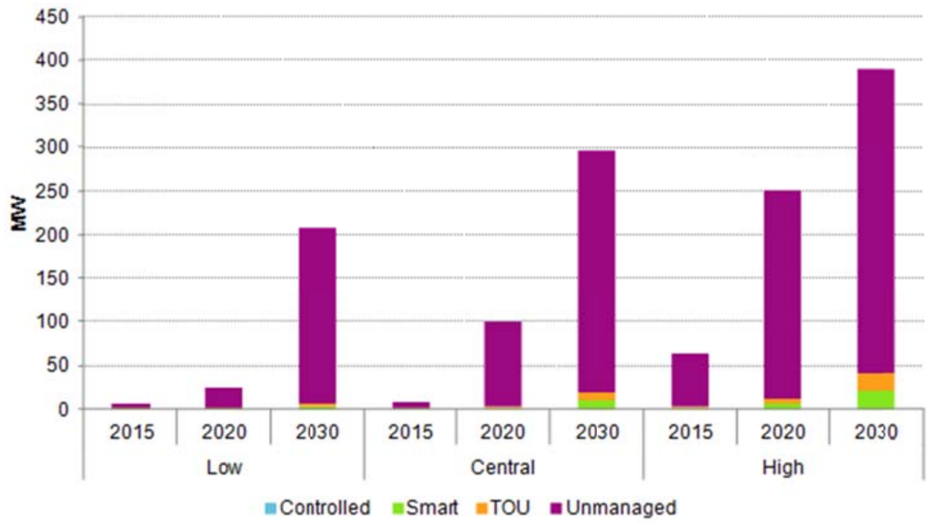
Charge management option	Estimated additional EV related peak demand in 2020 (MW)	Estimated additional EV related peak demand as a percentage of estimated growth in overall peak demand in 2020 (per cent)	Estimated additional EV related peak demand in 2030 (MW)	Estimated additional EV related peak demand as a percentage of estimated growth in overall peak demand in 2030 (per cent)
Un-managed charging	100	4.9	300	6.4
Time of Use charging	3	0.1	20	0.4
Smart meter charging	1	0.1	10	0.2
Controlled charging	0	0	0	0

Figure 3.7 depicts the estimated additional system peak demand in the SWIS for each charge management option under the three take up scenarios.

34 For further information refer to Appendix 3 at http://www.imowa.com.au/f176,1270555/2011_SOO_rev0.pdf

35 Source: AECOM

Figure 3.7 Estimated additional system peak demand in the SWIS



Source: AECOM

3.3 Estimated cost of additional system peak demand

Based upon these estimations of the expected additional peak demand the next step of analysis was to quantify the expected additional costs brought about by this additional peak demand. Additional costs refer to the costs for generation and network upgrade to cope with the additional peak demand under each of the charge management options. We note that AECOM did a static analysis of the energy market impacts; a dynamic modelling exercise to examine how an increase in energy consumption and peak demands feeds through into changes to the wholesale market was not completed.

In this section, we acknowledge that there could be significant costs of integrating EVs into the electricity market given its impacts on peak demand. How such costs are allocated to EV users may affect the relative costs of EVs compared to other vehicles, which in turn may dampen the take-up of EVs. For the purposes of its modelling AECOM has ignored this circularity and has assumed that there will be measures in place to minimise the impact of peak demand and that additional costs will be spread across all electricity consumers.[36] However in reality, appropriate charging management arrangements and greater cost reflective prices could be implemented in order to better allocate the additional costs onto the appropriate party. In this case, the costs of EVs could increase which would affect the take up of EVs.

A key question for this Request for Advice is how to allocate such costs in the manner which is consistent with the NEO and the assessment criteria set out in section 1.2.2. We note that the costs of generation and the change in generation mix caused by EVs may be difficult, if not impossible, to directly allocate such costs to EV users and could be passed through to all electricity consumers. In practice it may be less difficult to allocate increased network costs solely to EV users, via appropriate cost reflective network tariffs and connection charges. It could also be done through separate levy

36 The exemption to this is that AECOM's modelling assumes that the cost of the dedicate EV charging unit in the residential premises is paid for by the EV user.

however this would depend upon the ability to correctly identify and segment EV users.

We also recognise that the increase in energy consumption and potential peak demand caused by the EV load would have implications for generation. Such impacts could include changing the generation mix, affecting the carbon intensity of the sector, and potentially influencing the Renewable Energy Certificate (REC) market. At this stage we do not consider that there is any need to amend the current arrangements to facilitate EV load, however we appreciate stakeholder views on this matter.

3.3.1 Estimated cost to meet additional system peak demand in the NEM

AECOM analysed the estimated cost under each charge management option under the central take up scenario in the NEM and the results are found in Table 3.3.

Table 3.3 Estimated cost to meet additional system peak demand in the NEM[37]

Charge management option	Estimated cost to meet additional system peak demand in 2020 ($)	Estimated cost to meet additional system peak demand in 2030 ($)
Un-managed charging	3.4 billion	8.9 billion
Time of Use charging	90 million	550 million
Smart meter charging	50 million	270 million
Controlled charging	0	0

AECOM's analysis assumes that 80 per cent of charging occurs in peak periods and every EV owner has a level 1 charger (15 Amp). However if 100 per cent of charging occurs in peak periods and every EV owner has a level 2 charger (32A) this results in a 150 per cent increase in the additional cost of peak load. The largest component of this cost will be driven by investment in distribution, which will account for between 60 per cent and 75 per cent depending on the state. Generation accounts for around 15 per cent to 25 per cent and transmission accounts for around 10 per cent to 20 per cent.

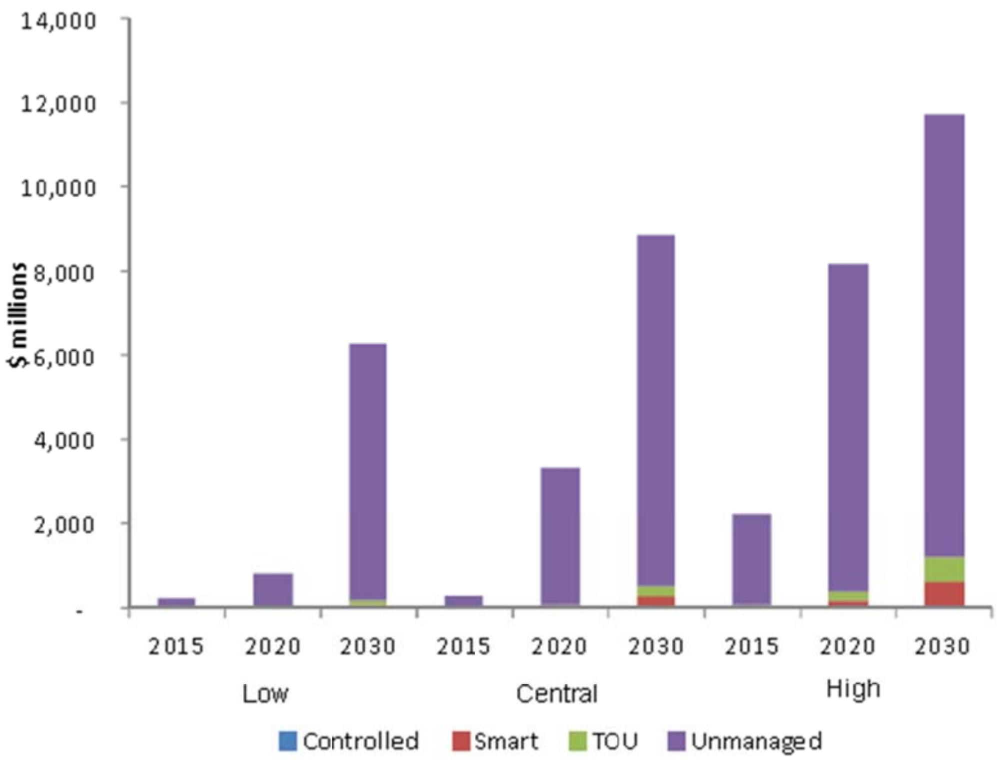
The impacts and costs vary significantly by state depending on the take up of vehicles in a particular state. AECOM found that New South Wales, Queensland and Victoria would have the largest take up of EVs, and therefore the impacts will be larger in those states. While the initial take up of EVs is likely to cluster in urban areas given the greater availability of charging option, we note that with further geographic dispersion of EVs, this could result in marked differences in the costs among states arising from a need to increase network capacity. For example, costs to increase network capacity could be higher in rural areas of Queensland because of the larger and more dispersed areas that these networks cover.

37 Source: AECOM. These estimates are in 2010 values and have not been discounted to reflect timing of investments.

AECOM modelling has only assessed the costs of the capital investment necessary to service the extra peak demand. Hence under the three types of managed charging there is a significant reduction in such investment. However we recognise that shifting the EV load away from the peak times is unlikely to be cost-free. There will be two types of costs: a) the direct costs associated with the charging management arrangements (e.g., metering) and b) associated costs caused by the additional consumption on the system. For example, greater utilisation of the existing infrastructure may create additional operational maintenance costs and also could lead to such infrastructure being needed to be replaced sooner.

Figure 3.8 depicts the estimated cost of additional system peak demand in the NEM.

Figure 3.8 Estimated cost of additional system peak demand in the NEM



Source: AECOM

3.3.2 Estimated cost to meet additional system peak demand in the SWIS

AECOM also estimated the cost to meet additional peak demand in the SWIS for each of the charge management options under the central take up scenario. AECOM's results are stated in Table 3.4.

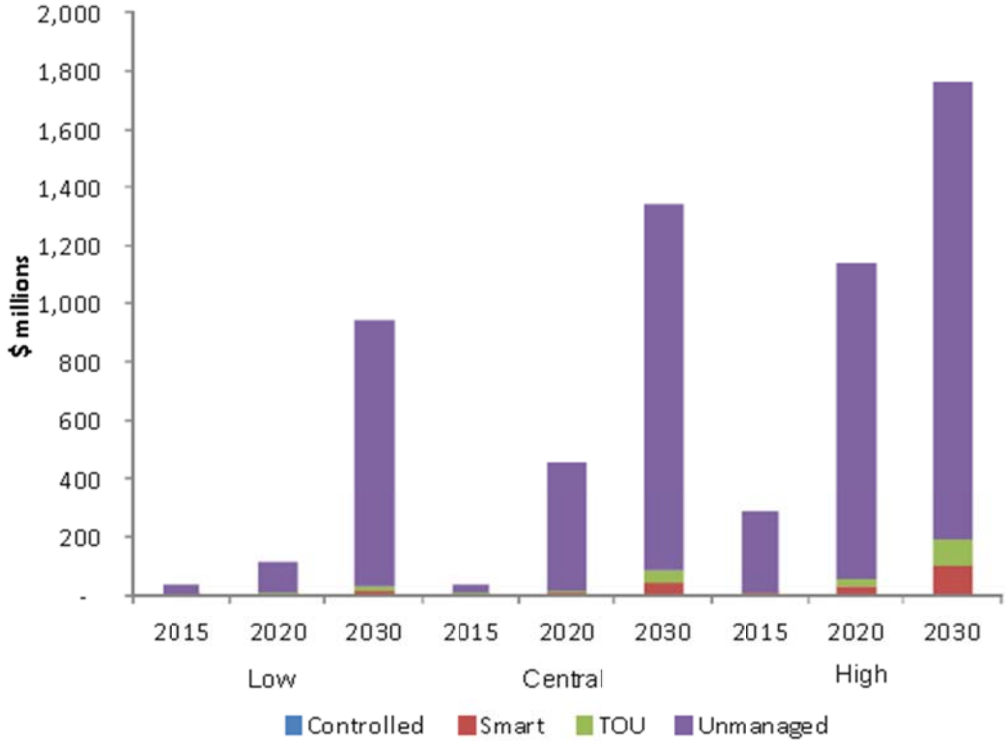
Table 3.4 Estimated cost to meet additional system peak demand in the SWIS[38]

Charge management option	Estimated cost to meet additional peak demand in 2020 ($)	Estimated cost to meet additional peak demand in 2030 ($)
Un -managed charging	460 million	1.3 billion
Time of Use charging	10 million	90 million
Smart metering	6 million	40 million
Controlled charging	0	0

These estimates have not been discounted to reflect timing of investments.

Figure 3.9 depicts the estimated cost to meet additional system peak demand in the SWIS under the three take up scenarios.

Figure 3.9 Estimated cost of additional system peak demand in the SWIS



Source: AECOM

38 Source: AECOM

Question 2 Cost of additional system peak demand

Are these estimates on the cost of additional peak demand provide the correct magnitude of the potential impacts of EVs? Are there any categories of costs not included in this discussion?

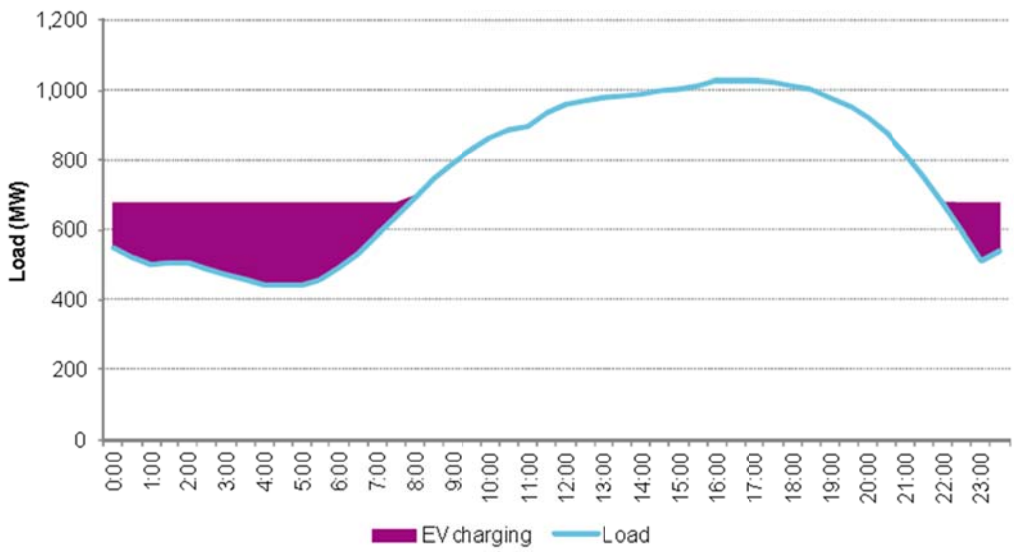
3.4 Effect of additional system peak demand on reliability and load shape

AECOM concluded that additional peak demand brought through the penetration of EVs under each of the take up scenarios is unlikely to have any impact on system (both network and generation) reliability. AECOM reached this conclusion on the basis that:

- EV take up is likely to be gradual;
- The increase in energy consumption is relatively small compared to the expected growth in peak demand without EVs;
- There should be sufficient incentives for generation and network businesses to respond to the take up of EVs.

Even in a high take up scenario and under a 'peaky' daily load profile, AECOM found that networks should be able to accommodate EV charging during off-peak periods without increasing the peak load. AECOM reached this conclusion by testing it against the 'peakiest' net system load profile for South Australia, which has the least available off-peak charging during the day. AECOM also found these results in other states as well. AECOM's conclusion assumes there are no energy supply constraints applying to generation at those off-peak times (for example, constraints arising due to network or plant maintenance). Figure 3.10 illustrates this result:

Figure 3.10 Accommodating EV charging without increasing peak load, South Australia



Source: Net Service Load Profiles from AEMO (2011a), EV charging AECOM

3.5 Other costs to the electricity market

In addition, the penetration of EVs will impose other costs on the electricity market such as:

- If EVs charge simultaneously, there could be an increased need for the system operator[39] to utilise Frequency Control Ancillary Services (FCAS) to keep the frequency of the power system within the regulated range during normal operation. This circumstance could arise in TOU charging, controlled charging and smart charging behaviours. However, this issue could be addressed if the switching of EV charging is staggered or graduated over time. However, load staggering will require the development of a mechanism which schedules users appropriately and in an equitable manner. .
- EVs could have a large impact on distribution networks if charging is un-managed. This impact would be felt at the low voltage end of the distribution network[40]and at the transformer and zone sub-station level.[41] This is because there are higher costs in increasing capacity and, in addition, the diversity of use is lower in the distribution network.
- A significant penetration of EVs may also accelerate the need to replace ageing infrastructure.[42]
- EV uptake may cluster at particular locations or display geographical differences.[43] This could lead to overloading of the distribution network at those locations. This effect may also apply under a TOU pricing regime where multiple EVs simultaneously charge off-peak. This would require an upgrade to the local network with the costs being spread across all consumers served by the DNSP. This issue could potentially be addressed through coordination of EV charging between EV users and their local DNSP. SP AusNet suggested that a staggered controlled load may be required to minimise outages or damage to network assets.[44]
- While take up of EVs in rural regions is expected to be slow, when it does occur the impact on the network would be greater. This is because the cost of upgrading rural networks is higher. Also the risk of overloading networks in rural regions is greater because these networks typically have lower capacity.[45]
- If EVs were used for vehicle to grid/home capability, the take up of EVs could also have impacts on network protection equipment particularly if there is a

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39 The Australian Energy Market Operator (AEMO) or Western Australia's Independent Market Operator (IMO).

40 Energex 2011, Submission to Approach Paper, p. 4.

41 Ergon Energy 2011, Submission to Approach Paper, p. 4.

42 Chargepoint 2011, Submission to Approach Paper, p. 3.

43 A Higgins and Paevere P, Diffusion modelling of Electric Vehicle Uptake: Methodology and Case Study for Victoria, Australian Commonwealth Scientific and Industrial Research Organisation, 2011.

44 SP AusNet 2011, Submission to Approach Paper, p. 12.

45 SP AusNet 2011, Submission to Approach Paper, p. 8.

rapid take up of EVs.[46]We note that these issues are not unique to EVs and would apply to any distributed energy source.

- There would also be costs associated with metering and EV charge control systems particularly under controlled or smart charging. These costs would include the development of new IT and communications systems, development of EV tariffs for controllable and smart charging, and potentially separate metering costs if different tariff arrangements were applied to EVs against the rest of the household.[47]

Question 3 Costs imposed by EVs on electricity markets

Does this discussion capture all the potential costs impacts that EVs could impose on the electricity market?

3.6 Benefits of EVs on energy markets

The key benefits that the penetration of EVs may provide to the energy markets are to, firstly, improve the load factor of networks (that is, enhance asset utilisation) and secondly, to harness the flexibility benefits of EVs in terms of managing networks, managing wholesale price risks and more efficient use of renewable/intermittent generation.

3.6.1 Improved load factor or increasing asset utilisation

Load factor is defined as the ratio between average demand to peak demand and is a measure of the degree that network assets are used efficiently.[48] AECOM and submissions recognised the value that EVs could provide by enhancing the load factor of networks.[49] By increasing the load factor of networks, the fixed costs of the network are spread across a larger consumer base, resulting in downward pressure on average network tariffs and, when passed through, could result in reductions in retail prices.

However, there is a limit to the extent of increasing the asset utilisation as the system always requires some redundancy capability (e.g. to facilitate maintenance) plus, this downward pressure on prices may be offset by an increase in costs due to the extra investment needed to service the extra peak demand. Further, SP AusNet recognised that EVs may not necessarily increase asset utilisation when applied to rural networks.[50]

46 Energex 2011, Submission to Approach Paper, p. 4.

47 TRUenergy 2011, Submission to Approach Paper, p. 2.

48 AECOM's modelling does not include the impact of losses.

49 Energex 2011, Submission to Approach Paper, pp. 4- 5; Ergon Energy 2011, Submission to Approach Paper, p. 4; Origin Energy 2011, Submission to Approach Paper, pp. 10-11; Western Power 2011, Submission to Approach Paper, p. 4

50 SP AusNet 2011, Submission to Approach Paper, p 10.

3.6.2 Flexibility benefits of EVs

The flexibility of EV loads refers to the ability to respond to changes in the electricity system. As a type of potential discretionary load, the charging of EVs raises the potential to be used in network management and in optimising the use of renewable generation. We note that it is difficult to quantify these benefits.

Network management, smart networks and wholesale price risk

EVs may assist in the management of transmission and distribution networks. This can be accomplished through dynamic EV charging where EVs (either used for electricity storage or with V2G capability) can help reduce system stress at times of peak demand, during planned outages and in the event of asset failures.

EVs may be used to manage wholesale price risk faced by retailers. This could occur under smart charging where EV users may respond to the current retail price thus lowering average prices for EV users and reducing price risk for retailers.

EVs may also be used to manage price risk through the controlled charging option. However this depends on who is responsible for managing the load. Currently, controlled load of hot water heating is directly managed by DNSPs and is generally directed over whole areas rather than at specific retail customers. It may seem then that such application of a controlled load may not be as effective in managing wholesale price risk as the network business may be only focusing on local network constraints.

This situation reflects the different incentives applying to the management of controlled loads as between networks, retailers and indeed other parties (e.g. aggregators and EV charging service providers). It also reflects a matter which is relevant to all forms of demand side participation, which is that DSP will deliver multiple benefits to a range of market participants across the supply chain. The question is how can the DSP provider – in this case the EV user – capture the value of all these benefits.

This matter is being considered as part of the AEMC Power of Choice Review. In the situation of the EV user, the key issue is not which party should be responsible for controlling the charging load but how the framework can facilitate the appropriate contracts to capture the full value of controlling the EV charging. This may require arrangements enabling coordination of the decisions to control the load across parties such that the full benefits of controlling the load is utilised, or the introduction of intermediaries (i.e., energy services companies) which can act on the consumer's behalf to offer the value of controlled load to the appropriate parties.

In addition, the introduction of EVs with smart charging capabilities (that is, with a smart meter), may stimulate the broad introduction and development of smart grid infrastructure to other appliances in the house. This scenario is envisioned to be a 'smart home' solution.[51]

Integrating renewable generation

51 Origin Energy 2011, Submission to Approach Paper, p. 1.

EVs may be used to recharge at times that coincide with the availability of renewable generation.[52] This means that EV charging may potentially benefit from the relatively lower electricity price at that time. Efficiency in the wholesale or ancillary services market could also be improved by aggregators matching uncertain supply, such as renewable generation, with variable load, such as EVs. In order for EVs to be matched with renewable generation, this will require some form of managed charging, such as controlled or smart meter charging and TOU price signals.[53] Importantly, it is necessary that there be a certain level of certainty or firmness to the EV load so that it can better integrate with renewable generation.

If there is an economic value from integrating EV load with the output of renewable generation, when under effective market arrangements, commercial relationships should be developed which allows the relevant parties to trade and capture such value. There should be no need for regulated arrangements to be imposed as a substitute for such commercial relationships.

3.7 Vehicle to Grid/Vehicle to Home

Vehicle-to-Grid (V2G) or Vehicle-to-Home (V2H) technologies use EV batteries to provide energy storage and a flexibly energy supply. V2G provides the same flexibility benefits of smart charging and, in addition, can provide ancillary services. However, V2G poses challenges and may require additional investments.

Also, the success of V2G is dependent on a critical mass of EVs. However, AECOM's analysis suggests that significant take up of EVs is not expected in the short term but may start to occur in 10 to 15 years.

3.7.1 Benefits of V2G

V2G may enhance efforts to address peak demand by supplying into the grid at times of system stress (and very high prices) and thus assist in alleviating peak load. In addition, EVs can provide ancillary services; EV users could contract with the network operator to offer FCAS services in the market. Further, V2G could be used as a storage technology and thus play some role in the integration of renewable generation.

3.7.2 Requirements for V2G

In order to deploy V2G in a way that maximises net benefits the following requirements should be met:

- V2G may need smart metering charging or some form of controlled charging so that V2G services can be delivered at the appropriate times with least cost to EV users. There must be a mechanism for the V2G services provided by EVs to be centrally controlled or be self-regulated in response to price or other signals. V2G technologies must also meet the requirements of the system operators so that they can viably provide ancillary services;

52 SP AusNet 2011, Submission to Approach Paper, p. 8; University of South Australia 2011, Submission to Approach Paper, p. 1

53 Origin Energy 2011, Submission to Approach Paper, p. 11; Western Power 2011, Submission to Approach Paper, p. 4.

- V2G will require investments from DNSPs to be able to use V2G to actively manage their network. These investments include compatible IT and communications equipment as well as appropriate incentive schemes;
- EV users will need to make investments in V2G technology, however the costs and benefits are variable. As battery prices fall and cost of electricity rises, the viability of V2G is likely to improve. However, further work on the impacts of V2G on battery life is needed and it would be necessary to devise appropriate incentives to EV users so that they can capture a share of the benefits that V2G provides to the electricity market; and
- There must also be a mechanism for managing vehicle availability to provide ancillary services. This is because the degree to which ancillary services can be provided depends on numerous variables related to driving and charging behaviour of EV owners as well as the geographical distribution of EV owners. There may be a role for aggregators to assist in this respect.

3.7.3 Views on V2G raised in submissions

There were a range of views that speculated on the requirements for and implications of V2G on the electricity market. With respect to the impacts, the Energy Networks Association stated that V2G as a form of embedded generation within 'microgrids' needs to be assessed, while recognising that V2G discharges at less than 100 per cent capacity and at different levels of the distribution network.[54] As a part to play in broad demand management, AGL argued that V2G is still uncertain as deregulated retail pricing is required to facilitate widespread adoption of V2G technology and a critical mass of EV take up is required before it can help reduce peak demand.[55]

Other submissions commented on the technological features of EVs that may be necessary for V2G. For example, there is the possibility that there could be 'on board' metering on the EV, which could thus negate the need for DNSPs to implement new infrastructure.[56] Also, the metering requirements for V2G required the ability to distinguish between EVs and other loads, which may suggest separate metering while noting the cost implications of that approach.

3.7.4 V2H

Vehicle-to-home (V2H) utilises EV energy storage capabilities and feeds electricity to be used in other household appliances rather than relying on the grid. V2H could be set up either stand-alone or in conjunction with the V2G system. Energex states that V2H will have all of the benefits and none of the problems associated with V2G on distribution networks.[57] However, V2H may still require some infrastructure investment in the house, such as modifications to the switchboard in the home. In

54 Energy Networks Association 2011, Submission to Approach Paper, p. 4

55 Jarvinen J, F Orton and T Nelson (2011), 'Electric Vehicles in the NEM: energy market and policy implications', AGL Applied Economic and Policy Research, Working Paper No. 27. p . 20.

56 Energy Networks Association 2011, Submission to Approach Paper, p. 4

57 Energex 2011, Submission to Approach Paper, p. 4

addition, EV customers would need to be informed on the effective use of this technology.

Question 4 Benefits of EVs on the electricity market

Have we correctly identified the range of benefits of EVs on the electricity market? What are stakeholders view on the materially of these benefits and the appropriate arrangements of capturing such benefits?

4 Electric Vehicles - General issues relating to the appropriate energy market arrangements

This chapter discusses the general issues relating to the appropriate energy market arrangements that are necessary to facilitate the efficient take up of EVs.

This chapter addresses Step 4 of our analytical framework; that is, it investigates the appropriate energy market arrangements to facilitate the efficient take up of EVs. The outcomes of our analysis in Step 4 will provide the basis for any recommendations to change the energy market arrangements . Our Draft Report will set out the proposed recommendations to change the energy market arrangements (i.e., Step 5 of our analytical framework).

We encourage stakeholders to provide detailed input into the questions that are raised throughout this chapter.

In this chapter we discuss the following issues:

- The nature of the service being provided when an EV is charged;
- Should EVs be treated differently in the electricity market regulatory arrangements as against other loads or Demand Side Participation (DSP);
- Metrology (metering and data management) issues;
- Different options of EV battery charging;
- Pricing of services for EV battery charging; and
- Challenges in the forecasting of EV loads for the system operator and a Network Service Provider (NSP).

The first two issues are threshold issues that may have significant implications for subsequent issues for consideration.

While we present these issues in a discrete format, we are aware of the necessary interdependencies that exist between these issues (eg. the metering capability of an EV will affect the pricing arrangements for EVs).

4.1 Nature of the service provided when an EV is charged

This issue can be expressed as: when an EV is charged, is the service provided the sale of electricity or some other service? The Australian Energy Regulator (AER) notes that a sale of energy occurs when a person passes on a charge for energy as a separate charge. However, when that energy is part of another charge (for example, a hotel tariff which includes consideration of energy costs in the charged amount), then this does not constitute a sale of energy. In an EV context, there are divergent views on this issue. On one hand, the business model proposed by Better Place involves them purchasing electricity from retailers, which they in turn sell as part of their packaged product. Better Place states that the product they provide to EV users is the sale of kilometres; that is, they claim they are not selling electricity to EV users. On the other hand, ChargePoint states that 'the underlying energy for electric vehicles will be supplied through existing retail accounts'.[58]Given these differing approaches, the nature of the service provided when an EV is charged is likely to depend on the EV charging business model that is applied. It is possible that both commercial models could exist in parallel.

If the EV charging service constitutes the sale of electricity, then the EV charging service provider would either need to acquire a retail licence or obtain an exemption (from acquiring a retail licence). In the NEM, under the National Energy Retail Law (which forms part of the National Energy Customer Framework), a person is prohibited from engaging in the sale of energy unless the person has obtained a retailer authorisation or is selling energy pursuant to an exemption from the requirement to hold an authorisation. The AER is responsible for regulating retailer exemptions and has recently published its exempt selling guideline.[59] In addition, there are jurisdictional requirements that need to be satisfied to obtain a retail licence.

However, if the EV charging service being provided does not constitute the sale of electricity, then the possible outcome would be that the EV charging service is not subject to certain energy market regulations. The question is whether this is appropriate from a regulatory perspective if or when there is a significant take up of EVs.

Given this we appreciate stakeholders' views as to whether it is appropriate for the decision on whether the EV charging product represents a sale of electricity to be left to the AER's legal interpretation of the NEL. Our initial view, is that all forms of electricity consumption by a household should be classified as a sale of electricity and that the issue should instead be whether the EV charging service provider would either need to acquire a retail licence or obtain an exemption.

Question 5 Nature of service provided when an EV is charged

Does the EV charging service need to be prescribed as a sale of electricity? What are the implications for consumers and EV charging service business models if EV charging was not classified as a sale of electricity?

4.2 Should EVs be treated differently as against other loads or DSP?

An EV can be considered as an electrical load that is used by residential, commercial and industrial customers. An EV could have particular value as a source of DSP and can be used to store electricity and may potentially be able to export back to the grid or provide onsite power. Submissions have suggested that an EV is another appliance or another load and therefore do not require specific regulation[60] or should be considered under arrangements to enhance demand side participation, including the

58 ChargePoint 2011, Submission to Approach Paper, p. 2.

59 7 December 2011, AER Exempt Selling Guideline – Notice of Final Instrument. For more information on the AER's approach to retail exemptions, see www.aer.gov.au/content/index.phtml/itemId/751080

60 AGL Energy 2011, Submission to Approach Paper, p. 2.

Commission's Power of Choice review.[61] Moreover, it has been argued that the best outcome for EVs is to treat them as part of an integrated smart home solution, rather than solely focusing on EVs.[62] Linked to this position is the view that the regulatory arrangements should be technology neutral and not favour particular technologies.[63]

In contrast, others have submitted that there are deficiencies in the current arrangements in the areas of metering and tariff regulations, and proposes reforms to facilitate the uptake of EVs.[64]

The main characteristic of EVs that may suggest that they be treated differently is that EV loads are large and mobile. Each individual EV may be charged and discharged in a variety of different locations. These may include locations in different distribution areas and perhaps in different States and Territories. Other large loads have a single location, and a single energy retailer and a distributor that is uniquely associated with the load. New business models may emerge that seek to have one party responsible for the electricity of an EV across multiple locations.

The estimated annual average household electricity consumption is between 5-7 MWh. Therefore, home charging of an EV (which can be between 1 MWh to 10 MWh) would represent a significant addition to an average household's electricity consumption. Further, there is the possibility that EVs may be clustered in certain residential areas, and perhaps in business areas. This means that it is possible that there is limited load diversification with respect to the timing and location of EV charging, which in turn could result in network augmentation.

While this may be seen to be another characteristic of EVs that is different, we need to consider whether the size of the load really makes such a difference as compared with other large loads. For example, air conditioning has similar characteristics. Air-conditioning is generally undiversified in behaviour, larger units are clustered in specific suburbs, and air conditioning units keep getting larger. Air conditioning loads are, of course, not mobile, but the similarities with air conditioning need to be considered when analysing in-home EV charging.

If different arrangements are to be made for EVs, there may be a question of whether these arrangements can be applied to other loads as well. We note that our Power of Choice review will be reviewing the potential for and the appropriate arrangements that are needed to facilitate residential loads as DSP.

Question 6 Should EVs be treated differently as against other loads

Should the treatment of EVs in the electricity market regulatory arrangements be different in respect of any or all of their potential uses?

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61 TRUenergy 2011, Submission to Approach Paper, p. 2.

62 Energy Retailers Association of Australia 2011, Submission to Approach Paper, p. 1; Origin Energy 2011, Submission to Approach Paper, p.1.

63 Energex 2011, Submission to Approach Paper, p.8; Energy Retailers Association of Australia 2011, Submission to Approach Paper, p. 1; TRUenergy 2011, Submission to Approach Paper,p.1

64 Better Place 2011, Submission to Approach Paper, p. 3

4.3 Metering arrangements

In principle a range of different metering arrangements may be adopted by some EV users or preferred by some EV suppliers. This section discusses the types of metering arrangements that could potentially be used to manage the potentially high penetration of EVs that is anticipated in the next 10 to 15 years.

The large scale adoption of electric vehicles (EVs) could potentially have significant impacts on the peak loading of the associated distribution networks and the peak demand in a region. It is therefore important to determine whether the metering arrangements for EVs are able to facilitate incentives to manage these potentially adverse impacts, including the ability to treat EV loads differently to other loads. This will enable EVs users, suppliers, EV charging service providers, distribution network service providers, electricity retailers and electricity generators to develop the most cost effective arrangements for the adoption of EVs. Hence metering arrangements have a primary role to play in ensuring that costs to the electricity market are allocated to the appropriate party (by ascertaining which parties are responsible for costs to the electricity system arising through the usage of EVs).

The following discussion of various metering arrangements to support the adoption of EVs should be predicated on the principle of facilitating consumer choice and encouraging competition in the provision of electricity services, consistent with our assessment criteria for this review. In part, this means that we must develop arrangements that allow innovation in the range of business models to service the needs of EV consumers. The objective is not to pick a deemed best metering solution for EVs but instead for the arrangements to encourage various appropriate metering mechanisms consistent with consumer preferences and efficient cost.

To discuss and develop recommendations on these issues, AEMC staff plan to hold a metering workshop (which may emerge into a series of workshops) in late February/early March where all interested parties are invited to attend. Registration details will be posted on the AEMC website. The outcomes of this metering workshop(s) will contribute directly to our Draft Advice in May 2012.

No metering

An EV could simply be treated like a typical appliance load and charged at an existing connection point such as a residence or workplace. This would not require any special arrangements, provided a suitable electrical outlet is installed at the premises.

If EVs are treated as a standard appliance then a single energy retailer would be responsible for all electricity use at the premise, including EV charging. ChargePoint notes that the cost and complexity of segregation will rise significantly if different retailers provide different parts of the single residential load. These costs include, but are not limited to, additional capital required for metering, ongoing metering costs, reconciliation of power usage and customer servicing costs. Economically the separation of EV energy consumption requiring separate metering, and administration will create additional overheads as well as operational complexity. These costs of this will be passed back to the consumer[65] which will affect the costs of EV loads relative to non EV loads.

However, with no method for separately measuring the charging load of the EV, simply using existing connection points means that it would not be possible to effectively apply specific incentives to encourage EV operators to charge at periods of low demand or network loading except if the EV household was subject to a general TOU tariff. In addition, the lack of a separate measurement of the charging load may limit the development of some potential business models, such as packages that include energy usage as well as the provision of the EV.

The absence of a separate measurement of the supply to an EV also means that it could be problematic to use the EV to feed energy back into the network at times of high demand or network loading. This would be the case particularly when the feed-in from the EV exceeded the consumption at the connection point and the domestic meter is not suitable for bi-directional energy flows.[66]

Profiling of electric vehicle charging demand

Most residential loads are metered using an average profile rather than measuring the actual consumption on a time of use (TOU) basis. Such average profiles are then used for the NEM settlement and for developing network charges for these residential loads.

One option might be to use profiling as a proxy for separately metering an EV load. Under such an arrangement the charging load of an EV would be estimated from a profile of typical charging behaviour. The application of this option would need some form of administrative process for registering the location of EV users in the network.

The use of profiling to estimate the charging load of EVs would be unlikely to be regarded as appropriate as the charging behaviour of different EV users is likely to vary significantly depending on the:

- size of the EV and its associated technology;
- distance travelled on a typical day;
- time when charging occurs, which is likely to relate to the time the user arrives home from commuting;
- availability of alternative charging points (such as at the place of work); and
- frequency of occasions when charging occurs away from home, such as vacations etc.

In addition to this, a key disadvantage to load profiling is that it could make cost reflective tariffs ineffective as the consumer would not be able to receive the benefit from changing their charging behaviour. Also the use of profiling to estimate the charging load of EVs would not be conducive to potential business models that rely on accurate measurement of the charging load of an EV. In addition, the use of profiling is

65 ChargePoint 2011, Submission to Approach Paper, p. 5.

66 The connection of solar photo-voltaic panels, which can also fed back into the distribution network, would require am bi-directional interval meter for their output where the feed-in-tariff operates on a gross export basis.

unlikely to effectively manage the use of EVs to supply energy back into the network at times of high demand or network loading.

Separate metering

The most direct approach to measuring the charging load of an EV to is to install a dedicated meter and national metering identifier (NMI).[67] This would involve a separate meter alongside the existing metering at the residence or workplace.[68]

Such an approach would facilitate the ability of both EV users and also EV service providers to choose its own electricity retailer for the supply of the EV consumption load. Hence they will not be tied to the EV user's existing retailer. [69]

The use of a separate TOU meter (either a smart meter or an interval meter) to measure the charging load of, and potentially feed-in from, an EV dramatically increases the flexibility of the arrangements for managing the connection of an EV. For example, a separate meter for an EV's supply means the energy used for charging can be sourced from a separate retailer or an EV supplier. This allows:

- the retailer or EV supplier to supply energy from specific sources, such as renewable generation for zero emission motoring;
- the EV owner, or the entity responsible for the cost of its charging, to be different to the entity responsible for the energy consumed at the existing connection point;
- EVs provided by an employer to be charged at home, with the costs separately accounted for;
- self employed EV owners that require separate costing of EV costs for taxation purposes;
- the vendor to package the provision of an EV with its associated energy for charging; and
- timing of use pricing to provide incentives for the charging of the EV at times of low price and low network utilisation.

However, the cost of separate metering at an existing connection point may be substantial. Better Place claim that the cost of establishing a new market meter and NMI is likely to be between $1,000 and $8,000 per residence or workplace, and that

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67 NMIs are used throughout the NEM to uniquely identify a meter installation. The SWIS also uses a unique identifier for each meter installation, as described in clause 8.7.1(a) of the SWIS Market Rules. Throughout this document the term NMI is to apply to meter identifiers in both the NEM and the SWIS.

68 Ausgrid 2011, Submission to Approach Paper, page 10: "Ausgrid believes that separate metering and control of EV charging is highly desirable and should not be prevented or inhibited by electricity market regulatory arrangements."

69 Better Place indicated that it wishes to buy the electricity that is used to power the EVs for its drivers from the electricity retailer(s) of its choice. Better Place does not wish to have any particular relationship with the existing retailer at the workplaces or residences where its chargers are installed. Better Place 2011, Submission to Approach Paper, p. 4.

there can be lengthy delays.[70] Also, Better Place cites cases at some commercial sites where it has been unable to establish a new market meter and NMI because:[71]

- the request for a new market meter and NMI triggered the local distributor to identify a capacity constraint that required an upgrade to the capacity of the local distribution network, while charging the EV under the existing meter and NMI would not trigger such a requirement;
- there was no physical access to the existing unmetered supply to establish a new meter and NMI; or
- significant disruption would be caused by accessing the unmetered supply to establish a new meter and NMI.

While separate metering is potentially a solution to metering the charging load of an EV, the associated costs and issues could have implications for the universal adoption of this approach.

The Commission also notes that accumulation meters are still being used for many residential and small businesses. Therefore, while there may be benefits of providing separate meters for EVs, it is possible that further benefits could potentially be captured if similar incentives and meters are applied to the remainder of the load at the residence or workplace. If this is the case then both the household and EV meters would need to have interval or smart meters (such meters are amenable to TOU pricing). The Commission is considering the role of efficient price signals in promoting DSP more generally as part of the Power of Choice Review.[72]

Sub-metering

An alternative to capturing the benefits of a separate meter is the use of sub-metering, which is also known as subtractive or parent-child metering. Under sub-metering the existing meter and NMI (the parent) measures the total load at the residence or workplace while a second meter and NMI (the child) measures just the charging load of the EV.[73] The energy consumed by the residence or workplace is hence the measurement from the child meter subtracted from the measurement from the parent meter. This adjustment to the measurement at the parent meter would be performed by AEMO in its market settlement and transfer solution (MSATS) systems.

The potential benefits of using sub-metering instead of a separate meter include:

- it is likely to be more cost effective;[74]
- not necessarily requiring physical access to the existing unmetered supply to establish a new meter and NMI; and

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70 Better Place 2011, Submission to Approach Paper, p. 2.

71 Better Place 2011, Submission to Approach Paper, p. 13-4.

72 http://www.aemc.gov.au/Market-Reviews/Open/Stage-3-Demand-Side-Participation-Review-Facilitating-consumer-choices-and-energy-efficiency.html

73 The sub-meter, or child, needs to be an interval meter or smart meter to be able to capture the increased flexibility associated with separate metering.

74 Better Place submission, pp. 13 to 19.

- not necessarily causing an interruption to the supply to the associated residence or workplace.

However, Energex Energy commented that, while parent-child metering arrangements may be easier from an installation perspective, they suffer from greater complexity and/or difficulties with respect to ongoing roles and responsibilities under the National Electricity Rules. For example, who is the responsible person[75] for the child meter and would the parent-child arrangement be treated under the AEMO Embedded Network Guideline[76] as an embedded network?[77]

The responsible person for small meter installations is generally the local network service provider.[78] Ausgrid[79] considers that, in the case of the child, it is not connected directly to its network so it is not required to be the associated responsible person. The Commission intends to consider which entity should be the responsible person should sub-metering be adopted for EVs, and what obligations should be placed on the responsible person for a sub-meter.

Ausgrid is concerned that the use of an embedded network framework with parent and child NMIs, as has been proposed by some service providers, should be carefully reviewed as Ausgrid has already highlighted problems with the current regulatory arrangements and Retailer of Last Resort provisions.[80]

Roaming NMI

The use of a separate meter or sub-meter at an existing connection point works well when the EV is always charged at a single location. However, drivers are likely to want to charge their EVs at a number of locations, each of which would require a separate meter or sub-meter installation or separate payment facilities. This could potentially lead to difficulties reconciling the metering data from each sub-meter NMI to the EVs being charged, so that the EV charging load can be correctly allocated to the owner or supplier, unless technology is adopted to identify the EVs to the charging point sub-meter.

Ausgrid also reported that the Smart Grid, Smart City project is exploring an alternative roaming NMI model for EV charging and market settlements.[81] This model is similar to sub-metering except that the child meter is not uniquely assigned to a single parent meter, rather the child meter roams (with the car) between a number of

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75 The responsibilities of the responsible person are specified in clause 7.2.1 of the National Electricity Rules. These responsibilities are for the provision, installation and maintenance of the meter installation; and the collection of data from the meter installation.

76 Available on the AEMO website.

77 Energex 2011, Submission to Approach Paper, p. 7.

78 A typical EV would require less than 100MWh per annum and would therefore, in many States, require a type 5 meter under the National Electricity Rules. Under clause 7.2.3(a)(2) of the National Electricity Rules, the responsible person for a type 5 meter is the distribution network provider that supplies the connection point. Where a type 4 meter is used then, under clause 7.2.3(a)(1), the local network service provider need not be the responsible person

79 Ausgrid 2011, Submission to the Approach Paper, p. 2.

80 Ausgrid 2011, Submission to Approach Paper, p. 10.

81 Ausgrid 2011, Submission to Approach Paper, p. 2.

parent meters where the EV is being charged. This has the potential to reduce meter costs as a single meter would be required for each EV, rather than one for each possible place where it may get charged. Similarly, the delays associated with a metering installation and NMI could also be reduced.

However, using roaming NMIs would raise a number of new issues including:

- ensuring that the metering data from the roaming child is subtracted from the correct parent meter data;
- who the responsible person would be for the child meter, given that it would not necessarily be uniquely associated with a single distribution network service provider;
- that an EV may operate in multiple States which may have different metering requirements that may require some degree of standardisation; and
- that an EV may operate both inside and outside the NEM or Western Australian market

At a minimum the arrangements for roaming NMIs would require the collection and processing of geographical data alongside metered consumption data.

Confidentiality of metering data

Metering data, including the energy consumed, is generally treated as confidential in the NEM. That is, the metering data, including the energy consumed, is only available to those entities that have a financial interest in the data, the associated network service provider, associated regulators such as the AER.[82] However, in the case of EVs there may be other entities that could have an interest in the metering data. Such entities could potentially include the EV driver, the EV owner (if not the same), the EV supplier. Therefore, the Commission is interested in identifying whether the existing confidentiality arrangements for metering data are appropriate.[83]

Question 7 EV metering issues

- **Should EVs be treated as a standard appliance load or should they be separately metered from other load at the premises?**
- **Could sub-metering and roaming NMIs be an effective solution to the costs and time issues associated with a separate metering installation? Are these metering options mutually exclusive or can they coexist thus allowing EV suppliers and customers to choose the solutions that best meet their needs?**
- **Should metering costs for EVs be recovered any differently than for other existing metering equipment?**
- **Are the existing metering data confidentiality arrangements appropriate for EVs and, if not, what modifications should be considered?**

82 The entitlement to metering data and access to metering installations is defined in rule 7.7 of the National Electricity Rules.

83 The MCE is currently examining customer protection issues arising from smart meters.

4.4 Different options for EV charging

The key reason for considering different arrangements for EVs are the effects that un-managed charging could have on peak demand and the cost on the electricity system infrastructure.[84] We consider four EV charging options:[85]

- Un-managed charging
- Controlled charging
- Time of Use (TOU) charging
- Smart meter charging

There is a variety of EV charging options available and the EV charging option deployed may depend on the take up of EVs, the business models available and regulatory objectives. If in the initial years, EV take up is not significant, then there may not be a significant impact on the electricity system and therefore un-managed charging may not be problematic. However, over time, the take up of EVs may reach a critical level, and this creates a need to deploy managed charging (namely, controlled charging, TOU charging and smart meter charging) to minimise the impact on the electricity system.

We consider that there will a need to put in appropriate robust arrangements at the advent of the market in order to foster the development of various business models and provide certainty to EV users, market participants and investors. It would also ensure equitable treatment for all EV users irrespective of when they purchase the EV. This section considers the regulatory aspects of each of these EV charging options. The pricing of services for EV battery charging is dependent on the EV charging option that is deployed. The specific issues regarding pricing of services for each of these scenarios are discussed in the section 4.1.5.

Un-managed charging

Un-managed charging allows the customer to charge their battery whenever they want. Most electrical appliances are used in this way. While this gives the customer the maximum flexibility, increases in the use of electricity at times of peak demand can add to infrastructure (both generation and network) costs. As shown by AECOM's modelling, EV charging load could have significant costs to the market and hence it is desirable for EVs to be charged away from peak times. This is true of all electrical appliances. From a regulatory perspective, un-managed charging can be implemented without any changes. Effectively, EVs would be treated like any existing un-managed load and it may be difficult to directly allocate the costs of network upgrades necessary to support EV to the appropriate parties.

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84 Please refer to our findings in Chapter 2 that estimate the impact on peak demand and cost.

85 Detailed definitions of each of these charging options are provided in section 3.2 of this Issues Paper.

TOU charging

Under TOU charging, EV users are incentivised to charge at off-peak times and at lower prices, however EV users may still choose to charge at peak times but would be subject to higher prices. TOU charging will require an interval meter, which may either be available as a separate meter to or on-board the EV or be part of a household metering arrangement. Pricing arrangements with TOU are discussed more thoroughly in the next section.

Controlled charging

Under controlled charging, EV users' choice on when to charge is delegated or contracted to a third party. Controlled charging may require separate metering capabilities if different rates were charged. Submissions from DNSPs have indicated that the discretion to control of EV charging loads is critical in order for the potential impacts on network security to be managed.[86]

An important issue with controlled charging is the incentives facing the party which is in control of the EV load. Conceivably, this could be the DNSP, the retailer or a third party aggregator, or an EV charging service provider. The timing of controlled charging may vary depending on which party is in control. For example, a DNSP may control charging in accordance with network peaks whereas an aggregator (including an EV charging service provider) may charge according to avoid wholesale price peaks. We note that network and wholesale price peaks do not necessarily coincide.

The party controlling the EV charging would trigger the control charging when doing so in its commercial interests. Whether that party would considered the all implications on the energy market (and ensures that the EV is only charged during off-peak periods to minimise the system impacts) would depend upon the tariff structure and whether that party faces all the costs associated with EV charging at peak times. As discussed in section 3.6.2, the issue is can the framework facilitate the appropriate contracts to capture the full value of controlling the EV charging.

Controlled charging requires mechanisms to activate and manage the controlled loads, and to wire the circuits on-site for EV charging into those control systems. There may be need for regulations to address the risk of EV users by-passing controlled charging arrangements. However such regulations may not turn out to be practical .

At present, controlled loads (for example, for off-peak water) are commonly implemented through direct load control techniques such as ripple control where a high frequency signal is injected into the electricity supply and detected by switching equipment. Direct load control has two forms: one form involves interruption of load for an extended period of time so that the entire load is moved out of the peak period; another approach entails remote cycling or 'on-off' switching of large numbers of appliances for short periods of time.

Controlled charging for EVs may raise particular technical issues for distributors that differ from controlled charging for other appliances. SP AusNet stated in their

86 Ausgrid 2011, Submission to Approach Paper, p.3; Ergon Energy 2011, Submission to Approach Paper, p 10; SP AusNet 2011, Submission to Approach Paper p. 12; Western Power 2011, Submission to Approach Paper,

submission the desirability for the staggered scheduling of EV load to minimise the risk of outages and damage to assets.[87] Ergon Energy proposed a range of approaches for controlling load, which varied by sophistication, and suggested that, at a minimum, circuit level switching for EV charging should be mandated.[88]

Smart-meter charging

Smart meter charging involves charging with sophisticated communication and load management, enabling EV charging to be turned on or off based on dynamic prices and real-time information from a variety of data sources. EV users would have better access to real time electricity pricing, including incentive based load or emergency load reduction price signals.[89]In its submission, the Australian Automobile Association raised the notion of 'swarm logic' where EVs can be charged and communicate with each other so that charging can be managed dynamically. These points are generally related to the role of EVs in the operation of smart grids.[90]

Question 8 Options for EV charging

- **To what extent are changes required to the regulatory arrangements to allow different battery charge management scenarios to increase efficiency?**
- **How should the arrangements ensure that the party in control of charging faces the all system costs? Who should be providing the information for decision making for smart meter charging?**

4.5 Pricing of services for EV charging

The discussion here on pricing of services for EV battery charging is predicated on the issues that were discussed above:

- The nature of the service being provided when an EV is charged. If the service being provided is not electricity supply, then regulated retail electricity prices would not apply to the ultimate customer;
- Whether EVs are treated differently in the electricity market regulatory arrangements as against other loads. If they are not treated differently, the opportunity for different retail price regulations to apply will not arise;
- Metrology arrangements: if the EV load is not metered separately then again the opportunity to price the electricity differently from all other electricity usage occurring at the same time will not arise; and
- Some of the EV charging options are highly dependent on the availability of pricing incentives.

87 SP AusNet 2011, Submission to Approach Paper, p. 12.

88 Ergon Energy 2011, Submission to Approach Paper, p. 7

89 Australian Automobile Association 2011, Submission to Approach Paper, p. 7.

90 Ergon Energy 2011, Submission to Approach Paper, p. 8.

Further, under the Australian Energy Market Agreement (AEMA), retail pricing regulation remains a jurisdictional responsibility and is not handled under the National Electricity Rules. On this basis, there are different rules across the NEM in regard to retail price regulation and the structure of the electricity tariffs that are offered, particularly to residential and small business consumers.

Retail Price Regulation

Currently, there is regulated retail pricing, at least for residential and small business customers, if not for larger customers as well, in all Australian jurisdictions outside Victoria. One of the reasons for regulated prices is because these prices provide a "safety net" for customers to have access to an essential service at a regulated price. Regulated prices come coupled with an obligation on one or more retailers to offer all customers electricity supply at relevant regulated prices.

While it seems unlikely that the supply of electricity to EVs would be deemed to be an essential service, it is also noted that current regulations do not distinguish between the supply of electricity to a premise for essential use (such as heating and cooling) as against non-essential use (such as a home cinema system). Regulated prices apply equally to all such uses.

In its submission, Origin Energy cautioned against separate retail pricing of EV loads before there was community acceptance, understanding and experience with whole of house TOU pricing.[91] This submission suggested that separate initial EV retail pricing may confuse consumers and result in decreased take up of TOU pricing generally.[92]However, this potential confusion with customers should be weighed against the potential benefits from increased consumer choice.

Jurisdication regulations regarding retail pricing may act as an impediment to providing efficient pricing signals to EV users. In addition, existing variations in approaches across jurisdictions will create additional costs for EV service providers and could result in different business models for EV services being developed on a state basis and not on a national basis.

Question 9 Retail pricing and EVs

In an area where the sale of electricity is subject to retail price regulation and given the appropriate metering capability, should the sale of electricity for recharging be treated any differently to other loads? If so, why?

The structure of retail pricing for EVs

Given AECOM's findings on the effects on the electricity system with un-managed charging, it may be desirable for EV charging to be encouraged to be undertaken at off-peak times of day to minimise the projected impact on electricity network infrastructure. To a large extent, that is true of other loads as well. There are

91 Origin Energy 2011, Submission to Approach Paper, p. 18.

92 Ibid.

commercial drivers for encouraging off-peak pricing: the cheaper the cost of charging, then, all other things being equal, the higher the uptake of EVs.

Submissions suggested that we should consider how to incentivise the bulk of recharging in off-peak periods through innovative charging regimes or through demand side management programs where utilities can directly influence load profile.[93]

It is important to carefully consider the rationale for any different tariffs that might be devised for EV charging. Specifically, what is different about EV charging that merits a different tariff, when other loads (such as air conditioning) are not afforded their own tariff? Generally, retailers do not charge differently depending on how the electricity is used, just as regulators and governments do not generally administer retail price regulation differently depending on how the electricity is used, as discussed immediately above.

However, there are precedents for having different tariffs for different loads, for example some forms of water heating have their own tariffs, most notably where the service is designed and delivered in such a way as to provide certainty and control to a third party – for example, the network operator – who benefits from the ability to exercise control. EV specific tariffs could be tied to different models for EV charging. The motivation on the retailer to pass through specific time sensitive network tariffs to the end consumers is an important factor to also consider in these circumstances.

One possible alternative to having separate prices for EV consumption is to require time sensitive tariffs for households whose total peak demand is above a certain threshold. This would ensure that those households who place the most stress on the network at peak times are exposed to cost reflective tariffs and avoids the need to distinguish between different types of load. The AEMC is considering such an approach, along other models, as part of its Power of Choice Review. We also note that the concept of a peak demand threshold is being developed by the AER in its connection charging guidelines for retail customers.[94]

Question 10 Structure of retail pricing for EVs

How are rules regarding the availability of TOU pricing likely to affect efficient uptake of EVs? Should there be a requirement to offer TOU tariffs for EVs? Should other forms of pricing apply to EVs to discourage charging at peak times, such as critical peak tariffs or other dynamic tariff structures? Should EVs be treated any differently from any other load in this regard?

93 Ausgrid 2011, Submission to Approach Paper, p.10; Ergon Energy 2011, Submission to Approach Paper, p.6; Energy Retailers Association of Australia 2011, Submission to Approach Paper, p.1; GE Energy 2011, Submission to Approach Paper, p 2; University of South Australia 2011, Submission to Approach Paper, p. 5; Western Power 2011, Submission to Approach Paper, p. 4.

94 AER, Proposed Connection charge guidelines under chapter 5A of the NER, Explanatory Statement, 22 December 2011.

Network pricing for EVs

Network pricing is determined under the National Electricity Rules and is within scope of this work. While retail pricing tariff structures and levels are generally underpinned by equivalent network tariffs, submissions have noted that there can also be discrepancies between network and retail tariff structures in the context of retail price regulation.[95]However, as network charges make up a significant component of a customer's final bill, it may be possible to incentivise particular retail tariff structures through the setting of the underlying network tariff structures.

Energex suggested that the efficient uptake of EVs requires TOU capacity based pricing (kVA) rather than volumetric (kWh) pricing.[96] Energex also suggested that there should be a means to allocate the costs for upgrading the network to individual consumers where their actions result in potential peak loads exceeding the capacity at the low voltage network.[97]

Question 11 Network pricing and EVs

Are new or bespoke network tariffs warranted for EV charging? If so, what form should these network tariffs take? How can these network tariffs be better integrated with overall retail tariffs?

If there are to be separate tariffs for EV tariffs, should there be regulations for identifying the EV household and for monitoring consumption? If so, how?

4.6 Challenges in forecasting the take up of EVs for the system operator and NSPs

As discussed in previous chapters, the take up of EVs is inherently uncertain. This is because the take up of EVs are dependent on consumer preferences and a range of other variables.[98] This uncertainty is particularly an issue for system operators[99] and NSPs. It is an issue for NSPs who need to undertake forward planning to develop and maintain their networks. It is also an issue for network operators to be able to forecast and plan the expected load in the coming years. For example, the network operator may incur additional costs in procurement of voltage or frequency support to avoid system stability issues that may otherwise arise because of large loads coming onto the system within very short periods of time. In the NEM, AEMO has begun to forecast the impact of EVs on system demand in the 2011 NTNDP.[100]

The question here is what measures need to be in place to facilitate the better forecasting of EV take up for system operators and NSPs? Is there a need for certain

95 Energy Retailers Association of Australia 2011, Submission to Approach Paper, p. 2; Origin Energy 2011, Submission to Approach Paper, p. 14.

96 Energex 2011, Submission to Approach Paper, p.8.

97 ibid. Also, connection charges are discussed in Chapter 5.

98 Refer to Chapter 2 of this Issues Paper for factors affecting take up.

99 In the SWIS, the IMO is the network operator. In the NEM, it is AEMO.

100 Please refer to 3.2.2 for discussion on AEMO's findings in its 2011 NTNDP in relation to EVs and peak demand.

working groups between the system operator and NSPs to be formed to address this issue?

Question 12 Forecasting the take up of EVs for the network operator and NSP

Are measures required to facilitate more effective forecasting of EV take up for network operator and NSPs?

5 Electric Vehicles - Specific issues relating to the energy market arrangements

This chapter discusses specific issues relating to the appropriate energy market arrangements that are necessary to facilitate the efficient take up of EVs (Step 4 of our analytical framework). In this chapter we discuss the following issues:

- Network infrastructure issues;
- Retail Market issues;
- Generation infrastructure issues;
- Vehicle to Grid; and
- Western Australia specific issues.

While some of these issues are stand-alone issues affecting EVs, we note that other issues are dependent on the level of take up of EVs.

We encourage stakeholders to provide detailed input into the questions that are raised throughout this chapter.

5.1 Network Infrastructure Issues

An increase in the penetration of EVs may result in network infrastructure issues, particularly in circumstances where the timing and location of EV charging is concentrated. This section discusses issues associated with connection to the distribution network, and network reinforcement and augmentation.

Consistent with the assessment criteria set out in chapter 1, the energy market arrangements should where feasible, allocate the costs to the appropriate parties for EVs connecting to the distribution network while maintaining the safety, security and reliability of the electricity system.

5.1.1 Connection Services

This issue relates to the connection of EVs to the distribution network and includes connection charging. The MCE has endorsed the introduction of a new chapter 5A – electricity connection for retail customers – to the National Electricity Rules. Under the new chapter 5A, the AER will be required to develop and publish connection charge guidelines to codify how electricity distributors should charge new electricity customers for connecting to their networks. Distributors will be required to develop their connection policies for approval by the AER based on the guidelines. The connection policies must set out the circumstances in which connection charges are payable and the basis for determining the amount of these charges.[101]

This Request for Advice will consider whether the current regulatory arrangements and the proposed new rules for connections to the distribution system are adequate or whether they should differ for EV charging infrastructure. We will consider whether

101 For more information on the AER's consultation for establishing a national connection charge guideline, see http://www.aer.gov.au/content/index.phtml/itemId/746777

connections for EV charging may need higher capacity than standard connections for small customers.

There may be costs or inefficiencies that arise in current arrangements because they were not designed and implemented with EVs in mind. For example:

- There may be a need to define a new connection service with defined service levels and timeframes for completion of work for connecting EV charging infrastructure and other EV related requirements, similar to the arrangements to be introduced for small scale micro generation, like solar photo voltaic (PV), if the current arrangements are not adequate;
- Different types of connection might be required to support different charging rates (faster or slower charging);
- Existing connection capacity may differ between different premises even in the same class (such as residential premises), and existing usage at the site will differ. Thus installing the same type of charger in apparently equivalent premises may have different process and cost implications for the site owner;
- Consideration might be given to what may be required work for the distribution network as against a registered electrical contractor;
- The current Connection Agreements and Use of System Agreements and other arrangements may not be adequate or appropriate for the connection services and cost recovery required for EV charging infrastructure. For example, if a household buys an EV, does it need to change its connection agreement with the distribution network?;
- The current regulatory arrangements may not be clear and efficient as to what are considered distribution network assets in regard to a connection for EV charging as against those assets that are owned by the customer at the premise or some other party, such as a bundled service provider or EV charging service provider. This question arises in particular in considering EVs used to provide power or network support to the electricity network;
- Issues may arise in regard to responsibilities for the maintenance of, and for fixing of faults. Also how to allocate liabilities in the case of damage being caused through the installation or use of EV charging infrastructure or connection points where an EV may extend the DNSP's responsibilities into the house;
- Moving premises or changing supplier may result in stranding dedicated connection assets in ways that do not currently exist in regard to other electrical appliances or connections. Regulatory issues may arise for cost recovery of assets that are stranded that have not been paid for upfront; and
- It may be appropriate for EV charging infrastructure providers to be subject to some form of licence requirement.

> **Question 13 Network Issues: Connection services**
>
> **What issues arise in regard to connection services for EVs? Are there further connection issues if additional capabilities such as Vehicle to Grid arise? How should these issues be addressed?**

5.1.2 Network reinforcement and augmentation

Network infrastructure is built to meet maximum peak demands. EV charging could put strains on the existing infrastructure.[102] This could occur through creating new peak demands, and through creating system stability issues requiring voltage or frequency support because of large loads coming onto the system within very short periods of time. Both of these characteristics are already present in some electricity networks where there is weather related demand for air conditioning services or where solar PV installations provide a significant input into the local network. Un-managed EV charging may thus have adverse financial implications for electricity consumers as a class – not just EV owners – as a result of the current cost recovery approach where costs of network augmentation are smeared across all customers.

We note, however, that under the proposed Chapter 5A of the National Electricity Rules, a 'basic connection service' does not pay augmentation costs. The appropriate arrangements for classifying a connection service to a retail consumer which has a EV (or amending an existing connection service, once the consumer purchases a EV), is a relevant matter and we seek stakeholder comments on this.

Alternatively, appropriately timed charging / discharging and other DSP involving EVs could increase the efficiency of use of existing network infrastructure. Unlike other loads, EVs may also provide network and retail benefits, particularly as penetration increases and more ambitious scenarios for managed charging can be supported.

The impacts of EVs on network infrastructure, including network benefits that arise, provides the basis for determining the costs of network reinforcement that may be required to support EV charging, and who should pay for such reinforcement. Different network operators may apply different parameters and take different views, and some national consistency may be appropriate. Some issues include:

- Should the recovery of costs for reinforcement required for faster charging of EVs be treated differently to any other requirement for reinforcement? In practice, it may be difficult to distinguish the 'causers' of network augmentation and may create the need for capacity (kVA) charging. There may also be equity issues, reflecting the current approach to recovering the costs of network investments by smearing costs across customers; and
- Moving premises or changing supplier may result in stranding of assets inside or outside the premise in ways that do not currently exist in regard to other electrical appliances. These may include assets in the network that the customer may be paying for over a period of time. Regulatory issues may arise for cost recovery of assets that are stranded but have not already been paid.

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102 Refer to Chapter 3 of this Issues Paper for discussion of impacts.

Question 14 Network Issues: Network reinforcement and augmentation

What new issues arise regarding requirements for network reinforcement and augmentation to support EV charging and recovery of the costs incurred, and how should they be addressed?

How should the connection services for EV households be classified? It is necessary to differentiate between EV and non-EV households?

Does the take up of EVs require a departure from the current method of recovering the costs of grid augmentation from small customers, with the costs spread across all customers, towards a "causer pays" approach?

5.2 Retail Market Issues

Some threshold general market issues were discussed previously in Chapter 4. These include discussion on the nature of the service when an EV is charged, considering whether EVs be treated differently in the electricity market regulatory arrangements as against other loads or DSP and metrology issues. This section now considers retail market issues specifically by examining the nature of the supplier of EV battery charging services. That supplier may be a traditional retailer with a retailer authorisation and licensed at a jurisdictional level. Alternatively, an exemption to retailer authorisation may be warranted. Or, if the service being provided is unconventional a new market participant category may be warranted to cover the new role.

In coming to a resolution on retail market issues (such as, retail licensing, embedded networks, and settlement issues), we seek to devise arrangements that foster innovation and not limiting business models which in turn will lead to greater consumer choice in the use of EVs.

5.2.1 Retailer and NSP exemptions and embedded (private) networks

The issue of retailer exemptions was discussed in the previous chapter in the discussion on whether the EV charging service sold is the sale of electricity or some other service. In this section, we briefly discuss retailer exemptions in the context of embedded (private) networks. We also discuss network service provider (NSP) exemptions. These issues apply to EV charging service providers who charge EVs in the context of commercial charging in public spaces (e.g., carparks, shopping centres) or at dedicated commercial premises (e.g., EV fast charging stations) or even at business premises.

A retailer exemption is commonly required in situations where energy is being 'on sold'. Energy on-selling, also known as reselling, occurs where a person (the exempt seller) makes arrangements to acquire energy from an authorised retailer and then on-sells this energy to other persons. This energy on-selling may occur within the bounds of an embedded (private) network. An embedded (private) network is defined as a network that is connected to the main distribution network through a single connection point. Examples of embedded networks where on-selling occurs are shopping centre complexes, caravan parks and retirement villages. Potential applicants for retailer exemptions are therefore likely to include the owners and operators of these sites. Other likely on-sellers include bodies corporate/owners' corporations.

Retailer exemptions and embedded networks are relevant to particular scenarios of EV charging. One scenario is where an EV charging service provider establishes a public charging station (for example in a car park), or establishes a commercial charging station. Another scenario may be a charging point in a private staff car park where the business owner wants to charge staff for use of the charging point. In each case, the service provider purchases electricity at its single connection point to the electricity distribution network, and there are several other connection points at the site where drivers refuel their vehicles and thereby purchase electricity for their vehicles at those points. Under current regulatory arrangements, the provider may be engaging in on-selling (and therefore require a retailer exemption from the AER), and may effectively have an embedded (private) network between the various connection points. The threshold issue discussed above as to whether the commodity being sold is electricity is also relevant.

In addition, a NSP exemption may also be required. This situation arises if the EV charging service provider is selling electricity within an embedded network, and is also the owner or operator of the embedded network. In this situation, the operator of the embedded network is likely to require an exemption from the requirement to register as a network service provider.[103]

The issue here is whether the current regulatory arrangements for retailer and NSP exemptions and embedded networks, which may not have been designed with EVs in mind, are nevertheless appropriate for EVs.

Question 15 Retail issues: Retailer and NSP exemptions and embedded networks

Should the provision of commercial charging (both in public spaces and in dedicated charging stations) be classified as on-selling? Do retailer and NSP exemptions and embedded networks provide an appropriate framework to apply to EV charging? What would be the preferable arrangements?

5.2.2 Allocation of EV charging loads to suppliers - wholesale settlement

Existing electricity market regulatory arrangements assign a single Responsible Person to each NMI at any given time. All loads at the NMI are assigned to that Responsible Person, without distinction. As discussed above, new business models are emerging whereby new businesses may want to be responsible for the electricity consumed by an EV at the NMI but not for other electrical load at the premise. Under current arrangements, this might be handled through a new connection being made for allocation of a new NMI. Other possible models have been considered under our discussion on metrology issues under section 4.1.3.

103 For more information on the AER's approach to network service provider exemptions, including a current consultation on revising the electricity NSP registration exemption guideline, see www.aer.gov.au/content/index.phtml/itemId/658904

There may also be requirements for settlement between parties such as between retailers. For example, there may be a business model where a driver charges his EV at a public charging point and the customer is charged for his activity on his home (or business) electricity bill by his home (or business) retailer who may not be the same retailer as the retailer who provides electricity to the charging station. This will require settlement between retailers. That may be implemented as part of the existing wholesale settlement or it could be settled off-market. It needs to be considered whether there are any current regulatory arrangements that preclude such settlement or other business models, or may make them unnecessarily inefficient.

Question 16 Retail issues: Settlement

What new issues for wholesale settlement arise with EVs, and to what extent do they depend on the metrology arrangements in place? How can these issues be addressed?

5.2.3 Licensing arrangements

Licensing arrangements remain jurisdictional. Therefore, this section is for directional guidance only.[104] The submission from the Australian Capital Territory (ACT) government noted in this context that the potential licensing of electric vehicle energy providers will need clarification.[105]

We need to consider whether the current licensing arrangements for retailers are appropriate or necessary for EV charging service providers. Different issues may arise depending on where the charging occurs, such as at a home or private business premise or at a dedicated charging station.

We discussed above whether a new business might be responsible only for supply to EVs at a premise. If so, and if a licence is required, it may not be appropriate for such a business to be subject to the full provisions of existing electricity retail licences. An EV charging service provider may not be required to provide the same billing information to a customer that other retailers are required to provide – such as electricity consumption and tariff information. If a licence is considered necessary, a new class of retail licence may be required for those service providers that only service EVs but do not offer electricity for general site use.

The appropriateness of the retail licensing exemptions framework currently under discussion can be illustrated in considering the case of a business that passes on to employees the costs of charging their EV at a work premise. If the business charges its employees based on the electricity consumed, it is likely to be considered to be selling electricity and to require either a licence or an exemption.

A licence may not even be the appropriate regulatory instrument for a supplier that only provides electricity for EVs, given the threshold issue discussed in Chapter 4 as to whether the commodity being sold is electricity.

104 It is not specifically within scope of our Terms of Reference.

105 ACT Government 2011, Submission to Approach Paper, p 3.

There may be equity issues as between a retailer that provides electricity for all site use including EV charging, as against a supplier who only provides EV charging and is subject to different regulatory arrangements. There may be equity issues for the customers concerned if their rights differ depending on the licensed status of the supplier.

One of the challenges for licensing arrangements is the incorporation of new business models into the traditional relationships between energy market participants. One submission raised this in the context of the role that aggregators can play in facilitating the participation of EV load subject to rules that ensure the safe operation of the network and the protection of consumers.[106]

Question 17 Retail issues: Licensing arrangements

What licensing issues arise with EVs, if licences are required? Do new issues arise because of the nature of EV loads or from new business models for EV charging? Are the existing licensing arrangements still appropriate?

5.3 Vehicle to grid (V2G) and Vehicle to Home (V2H)

As discussed in section 3.7, EVs can discharge electricity, which may be exported to the grid (V2G) or may be used within the home or business premise to which the EV charging point is connected (V2H). Better Place indicated that it could use EV load to sell demand response services to retailers in the NEM and offer ancillary services for network support.[107] Distribution businesses recognised the opportunity for EVs to be a form of distributed energy resource while recognising that the safe operation of EVs if used in a generation capacity is paramount.[108] Technology providers have also argued for pricing incentives such as critical peak pricing[109] to encourage distributed storage solutions brought by EVs.[110] The issue of feed-in tariffs and their applicability to EVs providing V2G/H services was also raised in submissions.[111]Notably, vehicle discharging can be controlled and managed as against other forms of small scale generation such as solar PV or wind generation.

106 SP AusNet 2011, Submission to Approach Paper, p.12.

107 Better Place 2011, Submission to Approach Paper, p. 4

108 Energex 2011, Submission to Approach Paper, p. 4; SP AusNet 2011, Submission to Approach Paper, p. 10-11.

109 Pricing that occurs in response to a 'critical peak' event (for example, a very hot summer day) for a short duration..

110 Blade Electric Vehicles 2011, Submission to Approach Paper, p 4 -5.

111 SP AusNet 2011, Submission to Approach Paper, p. 14

Question 18 Vehicle to Grid/Home issues

What additional issues arise from EV discharging and to what extent are those issues different from those that arise from any other on-site small scale generation? Are there any unique issues or requirements if the electricity is only provided to the home and not exported to the grid? Who should control discharging schedules? How can the right incentives be provided to facilitate the use of EV discharging to support DSP?

5.4 Issues specific to Western Australia

While the regulatory arrangements in Western Australia (WA) are different compared to those in the NEM, the issues raised above may apply equally in both the NEM and in WA. Western Australia's Wholesale Electricity Market (WEM) has a capacity market mechanism, unlike the NEM.[112] Therefore in considering energy market effects both models have to be considered: markets with and without capacity arrangements. Issues related to Western Australia were raised by Western Power.

Western Power’s submission highlights a few specific issues for WA including the need to ensure that EVs (primarily as a source of storage of energy) can participate in the upcoming half hourly ahead market for balancing that will arise out of the WA Independent Market Operator’s Market Evolution Program (MEP), and in the provision of load following ancillary services.[113]

Western Power’s submission highlighted the need for risk based mechanisms to be built into the regulatory instruments of the Electrical Network Access Code (ENAC) and Technical Rules (TR), and better alignment to the WEM rules, to prevent the deterioration of stability margins in the SWIS.[114]

Western Power also outlined issues similar to those already covered previously including the need for an agreement of metering framework, managed charging capability and domestic TOU energy pricing.

We agree with Western Power that there are important issues here to be addressed as part of this review.

Question 19 Issues specific to Western Australia

Are there any additional issues in WA as against in the NEM? How might these issues be addressed?

112 Refer to Appendix A which briefly describes the Western Australian electricity market.

113 Western Power 2011, Submission to Approach Paper, p. 3.

114 Western Power 2011, Submission to Approach Paper, p. 5-6.

6 Natural Gas Vehicles - NGV Technology and assessing the take up

This Chapter discusses NGV technology (Step 1 of our analytical framework) and provides our findings on the potential take up of NGVs (Step 2 of our analytical framework). The discussion of NGV technology defines the particular technologies that are pertinent to this Request for Advice and highlights its salient technological features.

6.1 NGV technology

For the purposes of this Request for Advice, we define a 'natural gas vehicle' as either a vehicle that uses compressed natural gas (CNG) or liquefied natural gas (LNG). CNG refers to natural gas that has been compressed to around 20 to 25 mega Pascals. CNG fuelled vehicles typically have a lower range than petrol or diesel vehicles because of the lower density of the gaseous fuel when compressed (144kg/m3), and storage weight and space constraints. In the case of LNG vehicles, the LNG that is used is natural gas that has been converted to liquid form by condensing it, at atmospheric pressure, to minus 162 degrees Celsius. Compared to EVs, which tend to be used as passenger vehicles, NGVs have the potential to service the demand for industrial and commercial freight vehicles.

There are differences in the way that CNG vehicles and LNG vehicles interact with the gas markets. At a high level, vehicles that use CNG are able to acquire natural gas through the gas distribution networks (reticulated gas networks). This means that vehicles using CNG can recharge their vehicle using refuelling units in their household or at commercial refuelling stations. For example, Sydney buses run on CNG and refuel at commercial refuelling stations at their base. Vehicles that rely on CNG typically include fleets of buses and other vehicles that operate on a ‘return to base’ cycle within a limited range.

In contrast, LNG production facilities acquire gas in bulk via the gas transmission networks. However, smaller scale LNG production facilities may rely on distribution networks for their supply of natural gas. Vehicles that rely on LNG are typically heavy duty vehicles (such as trucks and locomotive trains for industrial applications) where LNG is often a substitute for diesel. In fact, a submission from Westport Innovation described the commercial availability of NGV engine technology that matched the high performance and efficiency of diesel engines.[115]

In terms of the numbers of NGVs, submissions state that there are fewer than 3000 NGVs in Australia, which accounts for less than 0.02 per cent of the national vehicle fleet, and comprises mainly of buses and trucks.[116]

Other features of NGVs include the fact that NGVs emit lower carbon dioxide emissions than conventional petrol or diesel vehicles because of the lower proportion of carbon in natural gas. A petrol engine converted to run on CNG will produce 25 per

115 Westport Innovation (Australia) 2011, Submission to Approach Paper, p.1.

116 SP AusNet 2011, Submission to Approach Paper, p.19.

cent lower carbon dioxide emissions than petrol. Also, almost all passenger vehicle NGVs are dual fuel, with initial engine starting and warm-up using petrol.

Further, heavy vehicles converted to LNG actually operate on CNG. The natural gas is stored in liquid form, and evaporated prior to injection into the engine. Most systems involve the delivery of a mix of diesel and natural gas into the engine, with a natural gas proportion between 70 to 95 per cent depending on the conversion.

Vehicles that operate on liquefied petroleum gas (LPG) are out of scope in relation to this Request for Advice.

6.2 Assessing the take up of NGVs

This section discusses the contributing factors and presents AECOM's findings on the take up of NGVs.

6.2.1 Factors affecting take up

From a broad perspective, the factors affecting the take up of NGVs include the desire for energy security, which relates to diversifying one's energy mix and reducing dependence on oil-based fuels.[117]Moreover, in the context of climate change, one of the positive factors affecting the take up of NGVs (particularly fleets of NGVs, such as buses) was the potential for these technologies to reduce greenhouse gas emissions.[118] It has been suggested that a carbon tax may improve the competitive pricing of NGVs.[119] In addition, state and federal government transport policies have a role to play, including the presence of taxes/excises and subsidies that affect the take up of NGVs.[120]

There are some practical impediments affecting the take up of NGVs. In relation to CNG vehicles, the requirement for storage tanks in these vehicles and the need for more frequent refilling makes it less convenient and limits vehicle range, particularly for smaller vehicles.[121] If CNG vehicles are refuelled at home, there may be a need to modify domestic gas supply infrastructure.[122] In addition, there may be safety issues with NGVs.[123] Notably, in relation to CNG buses, the ACT government stated that the high capital and maintenance costs of these technologies (relative to diesel buses) militated against their future adoption in a government vehicle fleet.[124]

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117 Energy Networks Association 2011, Submission to Approach Paper, p7; Westport Innovations (Australia) 2011, Submission to Approach Paper, p. 3

118 Government of South Australia 2011, Submission to Approach Paper, p. 2.; SP AusNet 2011, Submission to Approach Paper, p. 21; Westport Innovations (Australia) 2011, Submission to Approach Paper, p. 3.

119 SP AusNet 2011, Submission to Approach Paper, p. 21.

120 TRUenergy 2011, Submission to Approach Paper, p. 2; Westport Innovations (Australia) 2011, Submission to Approach Paper, p.6.

121 SP AusNet 2011, Submission to Approach Paper, p .21

122 Australian Automobile Association 2011, Submission to Approach Paper, p. 4.

123 Australian Automobile Association 2011, Submission to Approach Paper, p.6; SP AusNet 2011, Submission to Approach Paper, p. 16.

124 ACT Government 2011, Submission to Approach Paper, p. 3

Nevertheless, there is the view that the take up of NGVs could be more readily available in a commercial context where vehicle fleet operators manage fleets of NGVs and use depots with refuelling capability.[125]

6.2.2 AECOM's findings on the take up of NGVs

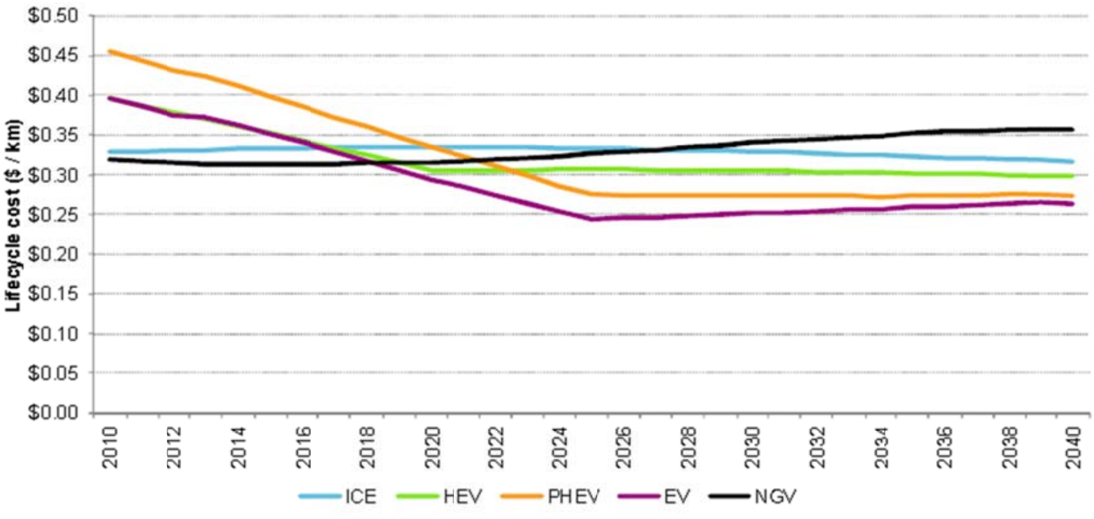
The Commission engaged AECOM to provide an assessment of the likely take up of NGVs. AECOM segmented the NGVs into two categories for analysis: 1) passenger (ie medium cars) and light commercial NGVs and 2) NGV buses and trucks.

Passenger and light commercial NGVs

AECOM applied a vehicle choice model to estimate the take up of passenger and light commercial NGVs. This model was based on a number of variables affecting the take up of NGVs including vehicle price, fuel costs, available infrastructure, vehicle range and preferences for environmentally-friendly vehicles. AECOM did not adopt a scenario based approach because the take up was considered to be too low for this approach to be meaningful.

AECOM found in its analysis of life-cycle costs that passenger NGVs are only competitive against ICE vehicles and EVs for travelling large distances in the short term. In the long term, NGVs are uncompetitive against ICE vehicles and EVs. Figure 6.1demonstrates this result.

Figure 6.1 Lifecycle costs - medium car, high VKT

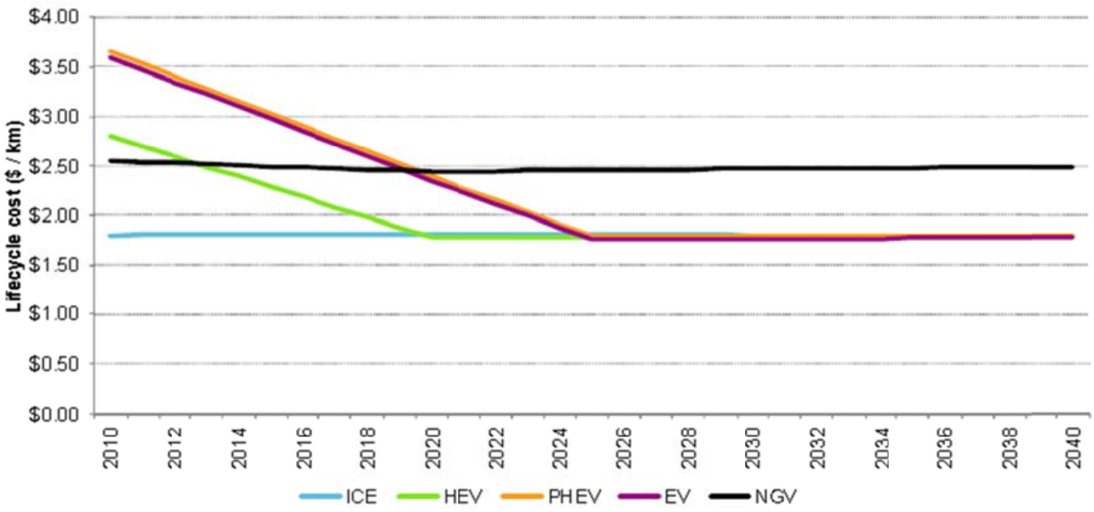


Source: AECOM

For vehicles travelling short distances, NGVs are uncompetitive with ICE vehicles for all years and only competitive against EVs in the short to medium term. The following Figure 6.2 demonstrates this result.

125 Australian Automobile Association 2011, Submission to Approach Paper, p. 4.

Figure 6.2 Lifecycle costs - medium car, low VKT



Source: AECOM

In the long term, EVs will be more competitive than NGVs when EV prices fall.[126] AECOM concludes that passenger NGV take up will be low except for those NGVs that travel large distances. However, from 2020 when EV supply constraints ease, EV efficiency improves and gas prices increase, then the relative competitiveness of passenger NGVs diminishes.

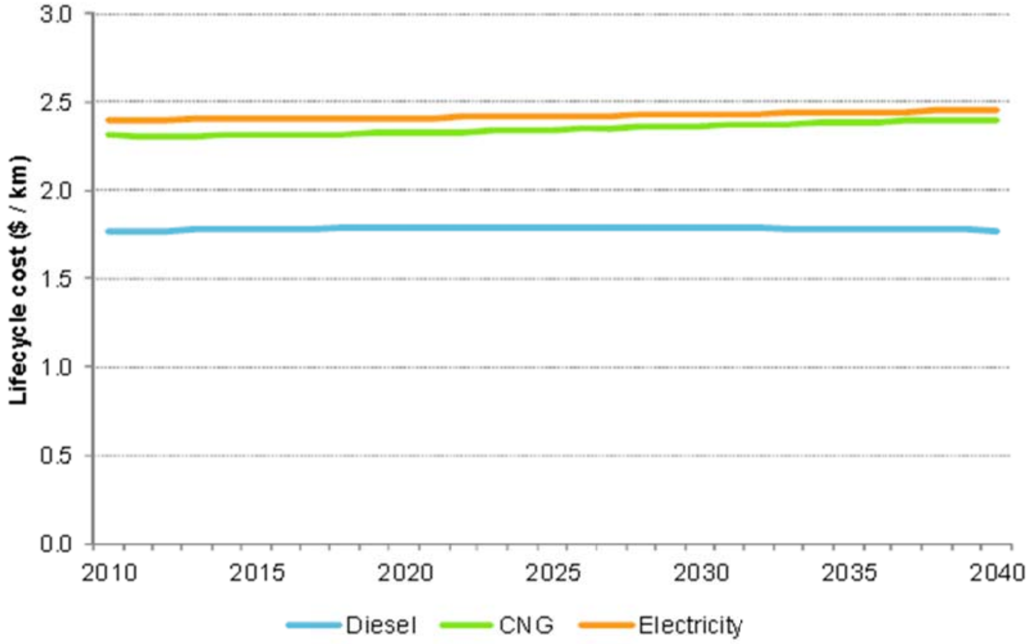
CNG Buses and LNG Trucks

In estimating the take up of CNG buses and LNG trucks, AECOM noted that the purchase of these vehicles on purely financial grounds. Therefore the methodology AECOM applied was to consider the financial costs over the operating life of the vehicle. In developing their estimates of the take up of these vehicles, AECOM included a range of variables such as purchase price, fuel consumption (compared against diesel consumption), fuel price, vehicle life, annual distance travelled, maintenance costs and projected vehicle sales.

AECOM found that CNG buses were not financially viable to purchase and operate compared with diesel buses. Therefore, based on purely financial decision, take up of CNG buses is likely to be low. However, CNG buses may be taken up due to their lower greenhouse gas emissions. Figure 6.3 depicts the lifecycle cost of CNG buses.

126 AECOM 2011, Impact of Electric and Natural Gas Vehicles on Energy Markets, p 78.

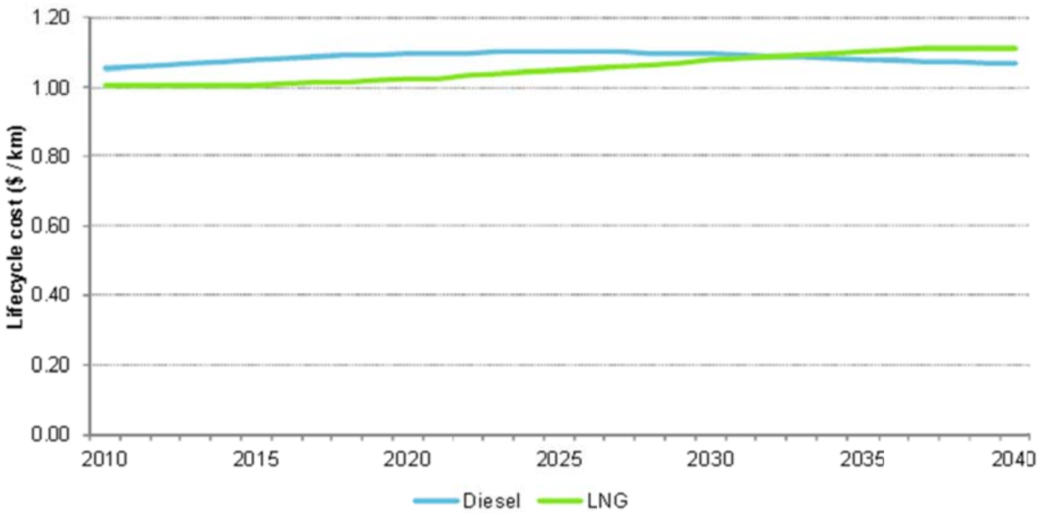
Figure 6.3 Lifecycle cost of CNG buses



Source: AECOM

AECOM found that for LNG trucks, the decision to purchase such a vehicle depends mainly on the annual amount of kilometres travelled. However, the financial viability of LNG trucks is marginal at best. Figure 6.4 below show the lifecycle cost of LNG trucks.

Figure 6.4 Lifecycle costs of LNG trucks



Source: AECOM

In order to assess the impact that NGVs could have on the gas markets (including Western Australia), AECOM applied three scenarios of low, central and high take up of

CNG buses and LNG trucks.[127] Figure 6.5 below describes these scenarios. The percentages in the table are based on the proportion of CNG bus sales and LNG truck sales relative to the overall annual bus and truck sales, respectively.

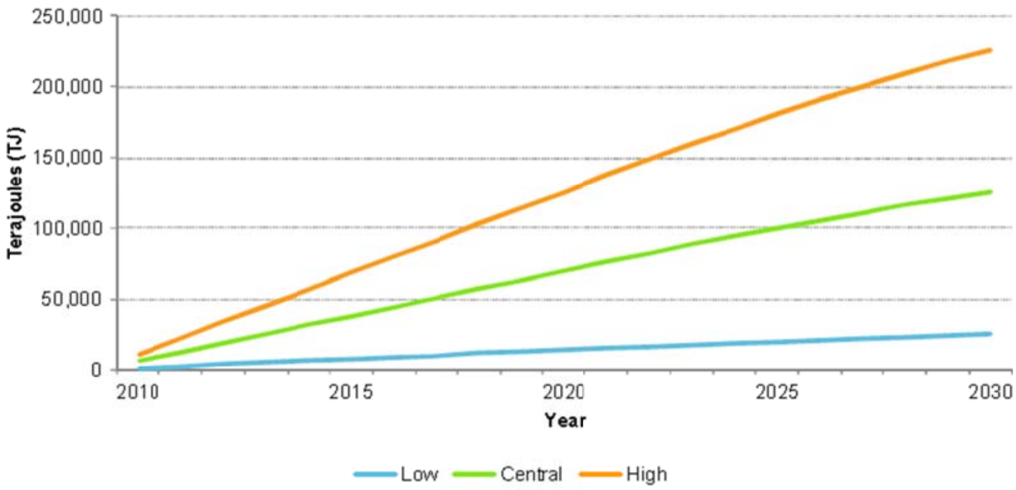
Figure 6.5 Take up scenarios for CNG buses and LNG trucks

Scenario	Bus – CNG sales (%)	Truck – LNG sales (%)
Low	10%	10%
Central	50%	20%^
High	90%	40%

Source: AECOM. ^ Based on Westport submission (Westport, 2011)

Using the above take up of CNG buses and LNG trucks, AECOM estimated the annual consumption of gas for CNG buses and LNG trucks.[128] Under the central scenario, the total gas required could be around 65 Peta Joule (PJ) (65,000 Tera Joule (TJ)) of gas by 2015, rising to around 120 PJ of gas by 2020 and around 215 PJ of gas by 2030. In the high take up scenario, volumes could be 120 PJ of gas by 2015, rising to around 225 PJ of gas by 2020 and around 400 PJ of gas by 2030. Figure 6.6 and Figure 6.7 below illustrate CNG bus gas consumption and LNG truck gas consumption, respectively.

Figure 6.6 CNG bus gas consumption

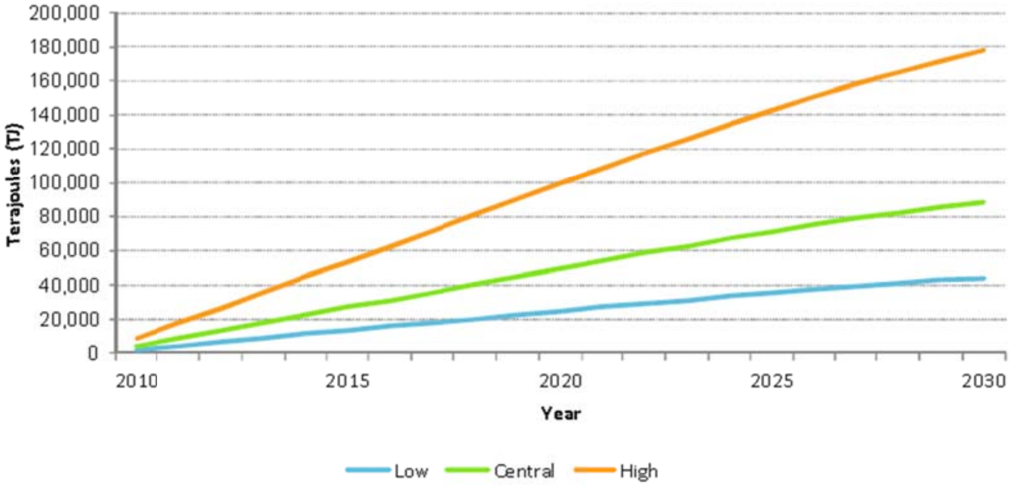


Source: AECOM

127 A scenario based approach was not applied to passenger and light commercial NGVs because take up of these vehicles was estimated to be too low for this approach to be meaningful.

128 Note that, by comparison, the take up of passenger NGVs is expected to be relatively insignificant.

Figure 6.7 LNG truck gas consumption



Source: AECOM

Question 20 Assessing the take up of NGVs

What are your views on AECOM's methodology for assessing the take up of NGVs? What are your views in relation to their findings on the expected take up of NGVs?

7 NGVs - Impacts on the energy market and the appropriate energy market arrangements

In this Chapter we discuss the impacts that NGVs could have on the national gas markets (Step 3 of our analytical framework) given our findings on the take up of NGVs outlined in the previous Chapter. The findings on impacts are drawn from AECOM's analysis and from views contained in submissions. As explained in chapter 1, consideration of the appropriate safety standards for refuelling of NGV at residential premises is out of scope for this review.

This Chapter also discusses the issues associated with the appropriate energy market arrangements that are necessary to facilitate the efficient take up of NGVs (Step 4 of our analytical framework).

7.1 Impact of NGVs on energy markets

According to both AECOM's analysis and views contained in submissions, the impact of NGVs on energy markets is likely to be minimal. For example, the Energy Networks Association considered that it is unlikely that there would be gas supply constraints given Australia's abundant gas reserves and low take up of NGVs.[129] Indeed, as discussed in the previous Chapter, AECOM's analysis found that the take up of passenger NGVs is likely to be minimal and therefore the impacts on distribution networks is likely to be low. With respect to commercial NGVs (principally, CNG buses and LNG trucks), the refuelling stations for these vehicles are likely to be connected to the transmission and sub-transmission networks. However, the impacts of these refuelling stations on gas transmission networks are also likely to be low because:

- LNG facilities are likely to already require high capacity connections to transmission or sub-transmission pipelines;
- There are clear price signals to withdraw gas from high capacity connections. Also any additional load is likely to be predictable based on daily gas balancing[130] and there is adequate scope for line-pack within high capacity gas networks; and
- Facilities will require storage for CNG and LNG prior to distribution to refuelling and are thus able to manage withdrawals to reduce network impacts and costs;
- Metering and billing issues were unlikely as this would be dealt with under commercial customer arrangements.[131]

In addition, SP AusNet argued that the growth in NGVs will likely be concentrated in fleet vehicles where network augmentations are likely to be funded by the customer and hence impacts on residential customer tariffs are unlikely to be affected.[132]

129 Energy Networks Association, Submission to Approach Paper, p. 6

130 Energy Networks Association 2011, Submission to Approach Paper, p. 6.

131 Energy Networks Association 2011, Submission to Approach Paper, p. 6.

132 SP AusNet 2011, Submission to Approach Paper, p. 22.

7.2 Appropriate energy market arrangements for NGVs

This section considers the key issues and questions that we consider need to be addressed in identifying the appropriate gas market regulatory arrangements to facilitate the economically efficient uptake of NGVs. The questions and issues are designed to be responsive to a range of actual and potential NGV business models.

With the fulfilment of the NGO as being of paramount importance, when we analyse the energy market arrangements that would facilitate the efficient take up of NGVs, the principles that we apply are to:

- ensure that costs are allocated to the appropriate party;
- ensure that the reliability, safety and security of the natural gas system is maintained;
- foster innovation with respect to natural gas services; and to ultimately
- facilitate consumer choice with respect to these technologies.

7.2.1 Issues relating to NGV refuelling at the home

Although it has been estimated that there is unlikely to be a material demand for NGV refuelling at the home, there is still a requirement to understand what issues may arise should home refuelling be a desirable option for certain customers or NGV service providers.

A NGV is a gas load, as are other appliances and equipment used by households such as cook tops, gas heaters, fuel cells and gas hot water. An NGV load could also represent a material proportion of a typical home's consumption and could be the only gas consumption at a home. AECOM estimates that a typical passenger NGV could use approximately 0.6 Giga Joule (GJ) of gas for 300km of driving; assuming an average driving distance of 15,000km per annum, this would equate to approximately 30 GJ of gas consumption in a year. A typical gas customer with central heating has an annual consumption in the range of 60 to 80 GJ per annum, while one with hot water and cooking only may have gas consumption in the range of 20 to 30 GJ per annum.

Our analysis of the energy market regulatory arrangements suggests that gas markets are suitable to meet the needs of customers seeking to refuel their NGV at their home. We assessed whether there are processes and regulatory arrangements in place that could facilitate the installation of NGV related infrastructure and service provision at a customer's home should a customer require this service.

Our assessment is based on the following:

- If gas is already connected to the home, then there are existing processes and regulatory arrangements to facilitate the installation of new gas appliances at the home, including processes and arrangements to upgrade the meter for a customer should this be required and / or assessing any gas pressure or other technical delivery requirements. Submissions identified that the installation of refuelling equipment at a customer's home may require a modification to a customer's gas infrastructure;[133]

- If gas is not already connected to the home, then there are processes to facilitate gas connection including connection timeframes, connection costs and, where the customer's connection requires a longer than standard connection to the network, a framework to recover network augmentation costs. If gas is unavailable in the customer's area, then the inability to refuel an NGV is in the same category as the customer's inability to utilise gas cooking or gas water heating;[134]
- NGV connections at the home are unlikely to cause material impacts on the local gas network. Submission also argued that the additional load from NGVs is likely to be predictable in the context of daily gas balancing and the demand for new network infrastructure is not likely to be significant.[135]
- If the customer purchases gas for refuelling from their existing gas retailer, then there is no requirement for new billing, metering or tariff arrangements as the current regulatory arrangements adjust to changes to customers' loads due to the installation of new appliances
- If the customer purchases gas for refuelling from a different service provider than their gas provider at their home, this can also be accommodated:
  - The customer / service provider can request a new meter to be installed at the customer's premise to facilitate the separate recording of gas consumption. There are existing processes and regulatory arrangements to facilitate this connection and the associated cost recovery;
  - If the NGV service provider is not already a gas retailer, the service provider could either obtain a gas retail licence or seek an exemption from the AER through the exemption guidelines and framework;
  - Once the customer is connected and the required licences or exemptions obtained (if required) then the current regulatory arrangements for billing, metering and settlement can facilitate the provision of the refuelling service.

In conclusion, we consider that there does not seem to be any major issues with connecting NGV related infrastructure and services at a customer's home.

Question 21 NGV refuelling at the home

Are the current regulatory arrangements in gas suitable to facilitate the limited forecast uptake of NGVs at a home? If uptake for NGVs increases at a faster rate than predicted would this cause any material issues? What could be a suitable trigger or test to determine what level of uptake may cause a re-consideration of the gas market regulatory arrangements for NGVs?

133 Australian Automobile Association 2011, Submission to Approach Paper, p 4.

134 We note that ICE vehicles, which rely on petrol, cannot be refuelled either.

135 SP AusNet 2011, Submission to Approach Paper, p. 6.

7.2.2 Issues relating to commercial refuelling of NGVs

In this section we discuss issues relating to commercial refuelling of NGVs as follows:

- General issues;
- Network related issues;
- Retail related issues.

In considering these issues, the objective is whether the energy market arrangements facilitate the demand for commercial NGV refuelling services in an economically efficient manner.

General issues relating to commercial refuelling of NGVs

AECOM's analysis identified that there was unlikely to be a material issue in relation to access to adequate gas reserves and domestic gas supply to facilitate the uptake of commercially refuelled NGVs. This view was also generally supported by the Energy Networks Association and the South Australian Government in their submissions.[136] The Energy Networks Association submission highlighted that an issue for NGVs was the future projected increases in the adoption of large scale gas fired generation, which will have an impact on gas supply and gas prices which may impact on the uptake of NGVs.[137]

There are current market processes and regulatory arrangements to monitor the adequacy of gas supply. AEMO publishes an annual Gas Statement of Opportunities which assesses the supply/demand balance for gas as well as the adequacy of gas reserves to meet demand, and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) also publishes detailed data and projections for gas resources.

Question 22 Commercial refuelling of NGVs: general issues

Are there any general gas market regulatory issues due to the likely take up of commercially refuelled NGVs? Is there a need to change the monitoring of local gas reserves and domestic supply specifically for NGVs?

Network issues relating to commercial refuelling of NGVs

Dedicated commercial refuelling facilities may be located on a transmission pipeline or connected to a distribution network or, in the case of LNG, may rely on alternative methods of receiving and storing fuel to service their customers, for example, by transporting fuel in tankers and storing it on-site.

Existing pipeline regulation for both transmission and distribution pipelines provides a model for connections, extensions, augmentations and customer contributions where the existing network requires modification to meet customers' demands. SP AusNet

136 Energy Networks Association 2011, Submission to Approach Paper, p 6; Government of South Australia 2011, Submission to Approach Paper, p 2.

137 Energy Networks Association 2011, Submission to Approach Paper, p6.

indicated in their submission that any network augmentation requirements for commercial refuelling would be funded by the customer.[138]

For LNG, competition between modes of fuel delivery – by pipeline or alternate methods – could be expected to act as a constraint on the connection and shipping costs chargeable by a transmission pipeline or a distribution network, suggesting that existing regulatory arrangements are unlikely to require significant change.[139]

Question 23 Commercial refuelling of NGVs: network related issues

Are there any network issues such as connection, metering or system augmentation that are currently inefficient or need to be handled differently for NGVs as compared with any other large commercial gas customer?

Retail issues relating to commercial refuelling of NGVs

The current gas market regulatory arrangements enable a larger commercial customer to choose to source its fuel from a retailer, from a producer or from the relevant local gas market. These choices are available to all commercial customers: a customer's preference for one over the other is a function of the customer's size, the significance of the fuel cost in their total costs and the costs of using an intermediary, among other things. Relationships between gas suppliers – either retailers or gas producers – and larger commercial customers are typically not subject to material energy market regulation. This is because the contractual relationship is transactional and competitive in a commercial context. Consequently, the protections available to small customers under the National Energy Customer Framework, would either not apply or, if so, would only apply minimally, to large commercial customers.

In Victoria, for example, the refueller is considered to be an energy retailer as this activity would fall within the scope of the licence. The refueller would need to apply for an exemption from the retail licensing requirements in order not to be required to meet the regulated responsibilities of an energy retailer.

Question 24 Commercial refuelling of NGVs: retail issues

- **Are there any issues raised by commercial refuelling for the choice of supply – from a retailer or other intermediary, from a producer or from the relevant spot market;**
- **Should NGV refuellers be treated differently from other commercial customers who purchase gas?;**
- **Should NGV refuelling be included within the scope of existing gas retailing licences? Alternatively, is another category of licence required? Or none at all?**

138 SP AusNet 2011, Submission to Approach Paper, p. 22.

139 To the extent that LNG and CNG are substitutes, this option for LNG will provide competitive pressures on arrangements for CNG.

7.3 Overlapping Issues between NGVs and electricity markets

In Ausgrid's submission, they presented their view that a significant take up of NGVs could have the following impacts on Australia's electricity markets:[140]

- It could change the take up of EVs as a competing transport mode;
- It could change the demand for and cost of gas supply, both as a source of electricity generation and as a substitute for electricity in major customer end-uses (e.g., heating, cooking etc); and
- Add a new electricity load for gas transport and refuelling.

However, given AECOM's findings on the likely take up of NGVs, these issues may not be material.

Question 25 NGVs and the electricity market

What is the materiality of the issues identified relating to the impact of NGVs on electricity markets?

140 Ausgrid 2011, Submission to Approach Paper, p. 10.

8 The Way Forward

This chapter summarises our initial views on the impacts between the estimated take up of electric and natural gas vehicles and the energy markets, and also identifies the key issues that need to be addressed as the Commission progresses this Request for Advice.

With respect to EVs, our findings, which are based upon a range of credible scenarios, indicate that EVs will account for a substantial share of the Australian new car market in the long term. While penetration will be gradually over the next ten years, it is likely that EV will lead to a sizeable increase in consumption across Australia. Whether this leads to significant costs on the market will depend upon what arrangements are put in place to manage or incentivise the times when such vehicles are charged. AECOM's modelling shows that the charging of EV will add to the increasing peak demand in the market, if a large proportion of the charging occurs at peak times.

In light of the NEO and the need for the energy market arrangements to support the economically efficient uptake of such vehicles, we consider that arrangements need to be put in place to influence the charging of EVs in order to for EV users to face the efficient cost signals and to minimise costs to non-EV users in the electricity market. In addition, the regulatory arrangements need to ensure that the safety, reliability and security of the electricity market are maintained.

However this must be done in a manner that caters for innovation and competition in the market and thereby promotes consumer choice and supports consumer behaviour. We recognise that a variety of business models will emerge and also that consumers are diverse and will have different preferences about how and when to charge their electric vehicles. It is appropriate that the market develops in response to customer demand instead of a single regulatory solution being imposed.

Given this, in order to design the appropriate regulatory arrangements, we must step through and resolve the following issues:

- Should EV loads be treated differently to other loads?
- If yes, then how can EV loads be separated from non-EV loads?
- How can any technical barriers to EV services be addressed? For example, efficient metrology arrangements or licensing conditions.
- How should the market allocate costs consistent with the causer-pays principle to ensure that inefficient cross-subsidies are minimised? For example, EV-related costs for connecting to the distribution network.
- If it is not possible to allocate costs, what is the optimal way of incentivising EVs in order to minimise their impact on peak demand?

While the impact on electricity consumption and potentially on peak demand will only become significant once the penetration of EVs reaches a critical mass, there will still be a need to put in appropriate arrangements at the advent of the market in order to foster the development of various business models and provide certainty to market participants and investors.

We aim to resolve these issues and come to a position as to the optimal regulatory arrangements in light of the NEO using the assessment criteria identified in chapter one. Accordingly, we would appreciate detailed submissions on these issues and in the questions we have drafted throughout the Issues paper. Both the submissions we receive and our analysis will form the basis for the regulatory arrangements we present in the Draft Advice.

With respect to NGVs, we consider that the take up of NGVs is likely to be low. We have found that passenger and light commercial NGVs are unlikely to be competitive in the long term compared to EVs and ICE vehicles. Also, the take up of CNG buses and LNG trucks is not likely to be material. Our initial view is that the current regulatory arrangements are sufficient to cope with the use of this transport technology. We therefore consider that minimal or no changes need to be made to the current regulatory arrangements to support the take up of NGVs. We appreciate stakeholders' views on this as well.

Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AC	alternating current
ACT	Australian Capital Territory
AEMA	Australian Energy Market Agreement
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BEV	battery electric vehicle
CNG	compressed natural gas
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DC	direct current
DNSP	Distribution Network Service Provider
DSP	Demand Side Participation
ENAC	Electrical Network Access Code
ERA	Economic Regulatory Authority
EV	electric vehicle
FCAS	Frequency Control Ancillary Services
GJ	Giga Joule
HEV	hybrid electric vehicle
ICE	internal combustion engine
IMO	Independent Market Operator
kWh	kilo Watt hour
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MAC	Market Advisory Committee
MCE	Ministerial Council on Energy
MEP	Market Evolution Program

MWh	Mega Watt hour
NEM	National Electricity Market
NEO	National Electricity Objective
NGO	National Gas Objective
NGV	natural gas vehicle
NMI	national metering identifier
NSP	Network Service Provider
PHEV	plug-in hybrid electric vehicle
PJ	Peta Joule
PV	photo voltaic
SCER	Standing Council on Energy and Resources
STEM	Short Term Energy Market
SWIS	South West Interconnected System
TEC	Tariff Equalisation Contribution
TJ	Tera Joule
TR	Technical Rules
VKT	Vehicle Kilometres Travelled
WA	Western Australia
WEM	Wholesale Electricity Market

A Overview of Western Australia's electricity market

Western Australia’s electricity supply industry is comprised of several distinct systems, none of which are interconnected to the NEM. The South-West Interconnected System (SWIS) around Perth and the south-west of the State is by far the largest of these, and is the only system in Western Australia to support a wholesale market. Western Australia introduced the Wholesale Electricity Market (WEM) into the SWIS in September 2006. This reform was designed to provide consumers with choice of competitively priced energy products and services, and to attract private investment into the market.

A.1 Governance and market structure

Several key governance bodies exist in the WEM:

- Independent Market Operator (IMO) - the market operator who maintains and develops the Market Rules and procedures, registers Rule Participants and operates the Short Term Energy Market (STEM) and the Reserve Capacity Mechanism;
- System Management – a ring-fenced entity within Western Power responsible for operating the power system to maintain security and reliability;
- Economic Regulatory Authority (ERA) – the jurisdictional regulator, responsible for economic regulation and market monitoring; and
- Market Advisory Committee – an industry and consumer group convened by the IMO to advise on changes to Market Rules and procedures.

In terms of market structure, while there are numerous market participants registered as market generators, market customers or as both, the dominant participants in the market are:

- Western Power networks - responsible for operating the transmission and distribution system;
- Synergy – the incumbent retailer and is the only retailer allowed to serve customers that do not have an interval meter;
- Verve Energy – the largest market generator in the SWIS. In addition, it is required to make its capacity available to System Management to provide ancillary services and must balance the entire system in real time; and
- Horizon Power - is responsible for all of the functions of generating or procuring, transmitting and retailing electricity to customers outside of the SWIS.

A.2 Key WEM mechanisms

A.2.1 Reserve Capacity Mechanism

Unlike the NEM, which is an energy only market, the WEM has a Reserved Capacity Mechanism. This Reserve Capacity Mechanism is administered by the IMO and its purpose is to ensure adequate generation capacity exists to meet expected demand in a given time period. In basic terms, the Reserve Capacity Mechanism obliges retailers (or parties purchasing power in the WEM) to either secure adequate capacity bilaterally (from generators) or from the IMO to ensure that the SWIS generation capacity requirements are met.

A.2.2 Bilateral contracts

Bilateral trades of energy and capacity occur between Market Participants and the IMO has no interest in how these trades are formed. However, Market Participants are required to submit bilateral schedule data pertaining to bilateral energy transactions to the IMO each day so that the transactions can be scheduled.

A.2.3 Short Term Energy Market

The STEM is a daily forward market for energy that allows Market Participants to trade around their bilateral energy position, producing a net contract position. The combined net bilateral position and STEM position of a Market Participant describes its net contract position.

A.2.4 Balancing

Balancing refers to the settlement process to address the cost of the difference between the net contract position of Market Participants and their actual supply and consumption levels, allowing for dispatch instructions issued by System Management.

A.2.5 Ancillary Services

Ancillary Services are services required to support the energy market but which are not traded as part of the energy market and are procured by System Management.

A.2.6 WEM mechanisms operating together

These market mechanisms are designed to operate together. Most energy is traded outside the IMO administered market via bilateral contracts between Market Customers and Market Generators. These bilateral contracts can have energy and capacity components. Market Customers and Market Generators can modify their bilateral energy position through trading in the STEM. Finally, buying or selling energy via the Balancing process is the last resort in the circumstances where actual energy supplied or consumed differs from that contracted in the day-ahead mechanisms. Further, System Management is required to secure ancillary services, the costs of these services are passed on to those participating in the market.

A.3 Market Evolution Program

The Market Evolution Program was designed to improve aspects of the WEM. The Market Rules Evolution Plan was endorsed by Market Participants on the Market Advisory Committee (MAC). Key changes will include:

- more cost reflective balancing pricing and opportunities to provide competition for balancing services;
- a greater ability to use more accurate information in the operation of the STEM;
- a more “real time” targeted reserve capacity refund system;

- more opportunities for competition in the provision of Ancillary Services; and
- a more adaptable IT system supporting the current WEM.

In April 2011, the IMO board approved the new Balancing and Load Following Ancillary Services market arrangements. These new arrangements will enable greater competition in the provision of balancing by creating a half hour ahead market for balancing energy and a market for load following ancillary services. Rule drafting and system development is now underway with the aim of the new rules coming into operation in April 2012.

A.4 Retail pricing in Western Australia

In Western Australia, all residential electricity customers remain on standing offer contracts.[141] Also, the prices that customers pay are significantly lower than the actual cost of providing these services as the Western Australian government provides a tax payer funded community service obligation (CSO) payment to the retailers to fund the difference between the actual cost of supplying energy in the SWIS and the price paid by consumers.

In addition to the CSO payment provided by the WA government, customers in the SWIS also pay a contribution, namely, the Tariff Equalisation Contribution (TEC). The TEC is used to fund the difference between the costs of supplying electricity in the SWIS and the cost of supplying electricity outside the SWIS.

141 Australian Energy Market Commission, *Future Possible Retail Electricity Price Movements: 1 July 2010 to 30 June 2013*, final report, AEMC, 30 November 2010, Sydney