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Mr Marc Tutaan
Australian Energy Market Commission

Re: AEMC *Issues Paper* – Energy Market Arrangements for Electric and Natural Gas Vehicles

Dear Marc,

Verdant Vision is pleased to have the opportunity to participate in the *AEMC Review of Energy Market Arrangements for Electric and Natural Gas Vehicles*. We are pleased to provide these extensive comments on the *Issues Paper* and we apologize for missing the deadline as it has taken some time to compile them.

Verdant Vision is Australia's leading provider of independent expertise in electric vehicle readiness, deployment and evaluation. Therefore we see our role in this process as an 'independent reviewer'. We also benefit from having played a significant role in the previous AECOM studies of EV uptake in New South Wales and Victoria. Therefore our objective is to leverage our significant expertise in real-world EV deployments and the global EV industry to provide constructive feedback on the approach taken by AEMC/AECOM (Sections 2 & 3) as necessary. Also note that, as we are not a participant in the energy market or provider of EV products or services, we have provided less comment on Market Arrangements (Sections 4 & 5) as we believe these issues are being well canvassed by the competitive market players as evidenced by submissions to the AEMC thus far. However our submission ends with some very pertinent information relevant to the overall scope and intended outcomes of this AEMC Review, so we draw your attention to that in particular.

Verdant Vision has conducted a detailed review of the *AEMC Issues Paper* and *AECOM's Initial Advice*, and we are providing advice in four key areas listed below. We have some concerns about the approach taken for the *Issues Paper* and believe that this process can benefit from our understanding of global and local EV market developments and drivers.

1. **Estimation of the take-up of BEVs vs. PHEVs**, relating to the inherent differences between PHEV vs. BEV batteries and vehicle products and current actual market trends,

2. **EV Contribution to peak demand and network cost impacts of EVs**, relating to our understanding of diversity in EV charging loads;

3. **The central drivers of the EV and renewable transport market generally**, thereby establishing the right context to appropriately assess the national economic benefit of EVs and the role of energy markets, as a subset of the economy, in enabling those benefits; and

4. **Metering and tariff arrangements for EVs**, relating to an approach that favours rapid uptake of EV technology with careful consideration to cost to each of the relevant parties.

Further detail is provided in the pages below. We stress that our feedback is not intended as a criticism of the AEMC or of AECOM's capabilities or expertise. But we are concerned that this important public policy study is not being framed correctly and, as a matter of public record, we would like our concerns to be noted and reported back to the Ministerial Council of Energy and to the Prime Minister in accordance with their request to identify and address potential barriers to the uptake of electric vehicles in Australia.

Please don't hesitate to contact me to discuss these matters further.

Dr Andrew Simpson
Managing Director – Verdant Vision Pty Ltd

AEMC Review of Energy Market Arrangements for Electric and Natural Gas Vehicles:

Verdant Vision comments on the *AEMC Issues Paper* and *AECOM's Initial Advice*

1. Estimation of the take-up of BEVs vs. PHEVs (*Issues Paper* Section 2)

There are several aspects of the study approach that we feel have led to an underestimation of the take-up of BEVs in favour of PHEVs.

1a) Focusing on electric light-duty vehicles and excluding electric heavy-duty vehicles

The language of Sections 2 and 3 as well as the stated assumptions of AECOM suggest that EVs will only come to market in the light-duty vehicle segment. AECOM writes (p14, *Initial Advice*):
"The estimates of EVs focus on passenger vehicles and light commercial vehicles, which together account for 92% of all vehicles in Australia. Whilst some electric buses and trucks do exist they are very expensive due to the weight to battery ratio, have limited vehicle range and are unlikely to see significant take up in the next 10 to 15 years until battery prices significantly reduce."

A survey of current global EV deployments would reveal that this presumption is not correct. There is now a wide diversity of electric buses and trucks available in the global market. Freight and logistics companies such as FedEx and TNT are leading the deployment of electric trucks, while cities such as Montreal, Seoul and Shenzhen are leading the deployment of electric buses. Locally, organisations such as Adelaide City Council and Crown Coaches are leaders in the space. Industry experts argue[1] that electric vehicles are supremely well-suited to these heavy vehicle applications due to their *"maximum number of revenue miles per charge within a predictable context"*. Finally, in contrast to their earlier statement, AECOM (p89) does note that *"most buses are operated by government who will face increasing pressure to reduce their greenhouse gas emissions"* and that increased take-up of alternatives (natural gas or electric) is possible on this basis. We would argue that take-up of electric buses and trucks is certain, rather than possible, given the current evidence.

The neglect of electric heavy vehicles is a significant gap in this study, not only due to underestimating their take-up and subsequent electricity demand (Sections 2 & 3), but also due to the failure to consider electric heavy vehicles' unique infrastructure requirements which are necessarily quite different from infrastructure for electric light vehicles (Sections 2.1.1 & 2.1.2).

As it was not specified in the *Approach Paper* that electric heavy vehicles would be excluded, we recommend their inclusion in this analysis

1b) The context for battery supply into the EV market, including pricing and other attributes

The *Issues Paper* sections 1 & 2 include a number of contextual assumptions around battery attributes (particularly costs) and how these battery attributes affect electric vehicle product attributes.

Section 2.1 quotes battery cost data that we feel is not reflective of current market conditions. Again, a survey of current literature reveals that BEV battery costs are significantly lower than those presented in the *Issues Paper* – a fact many automotive OEMs would support. The automotive

[1] American Electric Vehicles website, http://www.aevehicles.com/, accessed 28-Feb-12.

batteries in the Nissan Leaf have been stated at US$375/kWh by Nissan executives[2], and the consumer-grade batteries in Tesla Motors' products are available in the global market for ~US$200/kWh[3], which after allowing for an estimated 50% cost mark-up for cell integration into an automotive battery pack, still achieves ~US$300/kWh. Local Australian suppliers of batteries for EV projects are also quoting prices of <AU$400/kWh off-the-shelf[4].

We believe that the discussion of battery attributes in Sections 1 & 2 does not accurately reflect the inherent differences in batteries for BEV vs. PHEV applications, and this is a key factor affecting BEV vs. PHEV supply and uptake. As an employee of the US National Renewable Energy Laboratory, Dr Andrew Simpson helped develop technical goals for EV battery R&D on behalf of the United States Advanced Battery Consortium. This data is often cited as a benchmark for the global battery industry and Table 1 provides a summary of these targets.

Table 1: USABC Goals for Advanced EV Batteries[5]

	PHEV-10 (mi)	PHEV-40 (mi)	BEV-100 (mi)
Available energy (kWh)	3.4	11.6	40
Specific energy (Wh/kg)	57	97	150
Specific power (W/kg)	750	317	300
Power/energy ratio	13.2	3.3	2.0
Cycle life (cycles)	5,000	5,000	1,000
Calendar Life (yrs)	15	15	10
Manufactured cost ($)	1,700	3,400	6,000
Specific cost ($/kWh)	500	293	150

The key point to note is that PHEV vs. BEV batteries have substantially different requirements in terms of energy, power, cycle and calendar life, and cost – generally resulting from the fact that batteries for PHEVs vs. BEVs are quite different in total size and also differ in the style of driving they support (e.g. 10-40mi electric range vs. >100mi). Furthermore, although the target for BEV specific energy (Wh/kg) is the highest, the other requirements such as power/energy ratio, cycle and calendar life and total manufactured cost are significantly more stringent for the PHEV batteries. Therefore it should be understood that PHEV batteries have an inherently higher specific cost ($/kWh) and are also a much greater challenge to bring to market, which largely erodes the perceived cost advantage from having a smaller battery capacity in PHEVs. It is crucial to understand these tradeoffs in order to understand the market trends in battery supply for BEVs vs. PHEVs as well as the relative availability and pricing of BEV vs. PHEV vehicle products (discussed further below).

Section 2.2.1 also indicates that the relative cost of EV batteries is a factor in the relative competitiveness of EVs compared to ICE vehicles (and HEVs), and this issue has similarly been

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[2] Autobloggreen (2010) "Report: Nissan Leaf battery pack costs only £6,000 ($9,000) or $375/kWh!", http://green.autoblog.com/2010/05/05/report-nissan-leaf-battery-pack-costs-only-6-000-9-000-or/, accessed 28-Feb-12.

[3] Autobloggreen (2012) "Battery cost dropping below $200 per kWh soon, says Tesla's Elon Musk", http://green.autoblog.com/2012/02/21/battery-cost-dropping-below-200-per-kwh-soon-says-teslas-elon/, accessed 28-Feb-2012.

[4] EV Works (2012) "Battery Prices", http://www.evworks.com.au/index.php?category=5, accessed 28-Feb-12.

[5] USABC (2012) "Energy Storage System Goals", http://www.uscar.org/guest/article_view.php?articles_id=85, accessed 28-Feb-12.

highlighted through other public consultations such as the Alternative Transport Fuels Strategy[6], however we feel that this issue has been miss-stated. The relative cost of batteries is not directly relevant to consumer uptake of EVs since consumers rarely pay for them (unlike vehicle manufacturers who purchase batteries from their suppliers). The more relevant factor is the relative price of the EVs themselves (discussed further below).

Additionally, Section 2.2.1 does not recognise the powerful positive feedback loop that exists between EV battery costs and EV product prices. The underlying technology and material cost of batteries is already quite low (see above), such that high volume production is essentially all that is needed to achieve the full potential via economies of scale. As EV manufacturing volumes rise to meet the growing market demand, the manufacturing volume of EV batteries also increases, causing both batteries costs and EV product prices to fall. This fall in EV prices increases demand and the process accelerates etc. Therefore it is actually EV production volumes (rather than battery costs) that is currently the greatest driver of EV product prices in the market. We feel it is essential to recognise this powerful economic feedback loop that is currently acting as the primary driver for rapid reduction of EV prices and accelerated EV uptake.

1c) BEV vs. PHEV market appeal and their differences

The EV uptake forecasts and network impacts analyses (Sections 2 & 3) conclude that in Australia there would be a significantly higher uptake of PHEVs vs. BEVs in the near and long term, and that this would temper the impact of EVs on the electricity market (since PHEVs rely on both electricity and petrol). We challenge both of these findings and suggest that they arose through a noticeable (yet probably unintended) bias in the modelling assumptions for PHEVs vs. BEVs[7].

Vehicle Prices, Price Reductions and Supply Constraints

The AECOM model assumes that PHEVs and BEVs will be available in Australia at the same prices and with identical price reduction trajectories and supply constraints. In fact BEVs are available both globally and locally in significantly greater volumes, with a significantly greater range of products, and generally at lower prices than PHEVs. This is particularly true in Australia, and Table 2 presents a summary of the light EV products with confirmed pricing currently available in the US and Australia. We also redraw your attention to Figure 11 in AECOM (2011) that was developed for the original NSW EV uptake study.

There are several reasons for this trend:

- BEV battery requirements are less stringent than PHEV batteries (see above);
- There are significantly more BEV battery suppliers than PHEV battery suppliers;
- BEV batteries have a lower per-unit cost than PHEV batteries (see above), which counters the fact that PHEV batteries are typically smaller than BEV batteries;

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[6] Australian Government (2011) "Strategic Framework for Alternative Fuels", http://www.ret.gov.au/resources/fuels/alternative_transport_fuels/strategy/Pages/AlternativeTransportFuelsStrategy.aspx, accessed 28-Feb-12.

[7] We are also mindful that the author assisted AECOM in the development of models and assumptions for the previous New South Wales and Victorian EV uptake studies, but note that it is at least two years since these assumptions (as well as the overall modelling framework) were defined. Since different trends have clearly emerged in the global and local EV markets, as show here, we suggest that the modelling approach and assumptions need reconsideration before further use.

- BEVs are significantly less complicated and expensive to both engineer and manufacture, since PHEVs effectively have a duplicate powertrain onboard, therefore BEVs have significantly less engineering and manufacturing costs to amortize over the model line;
- The emerging realisation by most vehicle manufacturers that the above statements are true and that BEVs present an easier and more-readily scalable path to market for EVs;
- The tendency for international governments to provide greater consumer incentives for BEVs vs. PHEVs, and which has a trickle-down effect into the EV supply for Australia.

We suggest that this global trend for more supply of less-expensive BEVs vs. PHEVs is likely to accelerate as the battery cost feedback loop (described above) gains momentum and as the level of coverage for EV infrastructure continues to grow.

Table 2: BEV vs. PHEV product availability and pricing in the US and Australia

2012 Models	Manufacturer's Suggested Retail Price (US)	Recommended Retail Price (Australia)
	BEVs	
Ford Transit Connect	$22,035	n/a
Renault Fluence Z.E.	n/a	no pricing yet
Blade Electron	n/a	$47,000
Mitsubishi (i) iMiEV	$29,125	$48,800
Nissan Leaf	$35,200	$51,500
Honda Fit (Jazz) EV	$36,625	n/a
CODA Sedan	$37,250	n/a
Ford Focus EV	$39,200	n/a
Tesla Model S	$57,400	no pricing yet
	PHEVs	
Toyota Plug-In Prius	$32,000	n/a
Chevy/Holden Volt	$39,995	$59,990
Fisker Karma	$95,900	n/a

PHEV Fuel Efficiency

A key assumption in this study is that PHEVs only operate partially on electricity and *"hence PHEVs would have less impact on the electricity market than BEVs."* The AECOM model assumes that PHEVs will operate 50% on electricity during 2012 increasing linearly to 80% by 2035. We offer an alternative approach to these assumptions as they have a corresponding affect on the results of the network impacts analysis.

The parameter that describes the fraction of electric vs. petroleum driving in a PHEV is called the *Utility Factor (UF)*[8]. UF is used throughout the automotive industry to calculate PHEV fuel economy attributes for the purposes of national regulation (such as fuel economy labelling in the US). UF is defined as a function of electric range capability in a PHEV and describes the total fraction of fleet travel distance that would be powered by electricity if the whole fleet was composed of that single PHEV model. UF is derived from national driving statistics such as the US National Household Travel Survey (NHTS). Figure 1 shows the UF curve for the 2001 US NHTS.

[8] J. Gonder & A. Simpson (2007) "Measuring and Reporting Fuel Economy of Plug-In Hybrid Electric Vehicles", Proc. Journal of the World Electric Vehicle Association, vol. 1, pp. 134-141.

The use of this curve is best described with an example. The Chevy Volt has an all-electric range of 40 miles. Therefore the UF curve is used to conclude that a fleet of Chevy Volts would drive approximately 62% of their total miles on electricity. This statistic is backed up by real-world data collected by General Motors[9] indicating that two-thirds of Chevy Volt fleet miles are electrified. Note however that this result is unique to Chevy Volts in the US because this UF curve is derived from US driving behaviours. In Australia, the UF curve for PHEVs is unknown since data of this type is not collected[10] and the Holden Volt is currently the only PHEV product confirmed for our market. However, preliminary analysis of the Holden Volt by the author based on Australian data (up to 80km electric range) suggests that the UF is initially in the range of 70-80%. Therefore we suggest that AECOM's assumptions of 50% UF in 2012 rising to 80% UF in 2035 are too low.

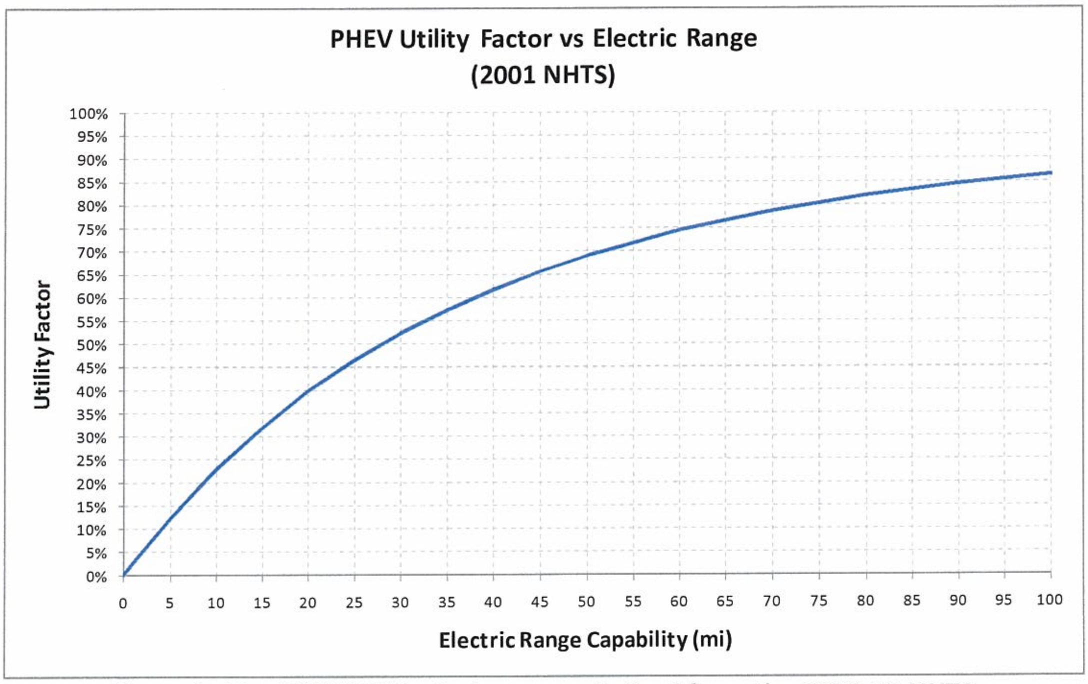

Figure 1: The PHEV Utility Factor curve derived from the 2001 US NHTS.

The net impact of our suggested change is to make PHEVs operate more like BEVs, with a commensurate increase in electricity demand and decrease in petroleum use, operating costs and emissions. Furthermore there is also a psychological dimension to UF that relates to ongoing motorist behaviour change. Anecdotal evidence from both General Motors and the University of California at Davis suggest that PHEV owners seek to *"expand their EV territory"* by modifying their driving and charging behaviours to use less fuel. Public figures such as Jay Leno (who is a Chevy Volt owner) provide examples of this desire amongst PHEV users.

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[9] R. Peterson (2011) "All Charged Up: The Volt Nation", Proc. Plug-In 2011, Raleigh NC, July 18-21.

[10] Note that the UF curve should not be confused with "daily travel distance" statistics that are available in Australia (see the University of South Australia submission on the *Approach Paper* for an example). Daily travel distances describe the probability that a vehicle will drive a certain number of kilometres in a day, whereas Utility Factor describes the fraction of electric travel in a year (since the days with longer distances account for a disproportionate fraction of total fleet kilometres). The UF curve can be calculated from the daily travel curve but they are statistically quite different.

Overall we therefore suggest that the UF of Australian PHEVs is likely to be high initially, and will rise further as new PHEVs come to market with increasing EV range (as a result of improving batteries) and also as PHEV motorists "expand their EV territory". Finally, in the interests of conservatism for this study, it would be better to assume that PHEVs have a higher UF as this will increase their electricity demand leading to a more conservative network impacts analysis.

Consumer Preferences, Range and Infrastructure

The preferred uptake of PHEVs forecast by this study seems to resonate with many Australian stakeholders, as there appears to be a widespread perception (particularly in Federal Government) that BEVs are not well suited to Australian conditions. Stakeholders often cite barriers such as "range anxiety" or the chicken-egg dilemma for EV infrastructure or Australia's geographic sparseness to suggest reasons why BEVs won't compete. Furthermore, the AEMC seems to have adopted this tone by saying in Section 2.1 that *"...the relative competitiveness of EVs will depend upon giving EV users similar levels of comfort and certainty regarding driving range."* However, our real-world experience based on actual BEV deployments both locally and overseas is quite the opposite, and BEVs compete easily with their unique attributes of driving experience, low operating cost and zero tailpipe emissions. Furthermore, Australia has all the makings of a thriving BEV market given our urbanisation, affluence, education, car-dependence, off-street garaging, relative costs of fuel vs. electricity, and renewable energy market.

A particular concern in this study is the use of a homogenous vehicle choice model and the related willingness-to-pay for vehicle range and infrastructure availability amongst other attributes. This effectively translates to "all Australians think the same way" – a one-size-fits-all consumer model which we know is not correct. When AECOM first developed this model in 2009, the homogenous approach was taken since it did not *"require assumptions on the degree of heterogeneity in choice, which would be required if a more sophisticated choice model were developed"*. There was hardly any data available in 2009 to support a heterogeneous uptake model for the ICE, HEV, PHEV and BEV market segments in parallel. Now in 2012, there is a wealth of data from the EV deployments occurring globally, and furthermore it is a well-understood fact that heterogeneous choice is a defining characteristic of the emerging EV market. In other words, EV adopters have different preferences than traditional ICE motorists, which is of course intuitively obvious.

Clear evidence for the heterogeneous choice in the EV market and the relative appeal of BEVs vs. PHEVs is provided in the strategically important US market[11]. During 2011 a total of 10,000 Nissan Leafs were delivered compared to 7,500 Chevy Volts. Furthermore, both the Leaf and the Volt sold more units in 2011 – their first year in the market – than did the (Gen II) Toyota Prius in 2000 (5,500 units). These statistics are significant because the US has less urbanisation, longer typical driving distances and lower fuel prices relative to Australia (all of which would suggest a lesser uptake of BEVs compared to PHEVs, on top of a poor market for EVs generally). Yet BEV supply and uptake in the US continues to outpace PHEV supply and uptake (also see Table 2 above). Clearly these early customers in the US EV market are not subjecting their purchases to the same criteria[12] as a traditional ICE consumer model would predict.

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[11] Green Car Reports (2012) "Electric car sales for 2011: Modest first-year numbers hardly a surprise", http://www.greencarreports.com/news/1071246_electric-car-sales-for-2011-modest-first-year-numbers-hardly-a-surprise, accessed 28-Feb-12.

[12] Note that both the Nissan Leaf and Chevy Volt earn a $7,500 federal tax credit in the US, which arguably has boosted early uptake of EVs generally. However this does not explain the higher uptake of BEVs or the greater supply of BEV products compared to PHEVs anticipated in 2012 (see Table 2).

As a further example, we again refer to AECOM's statement (p89) that *"most buses are operated by government who will face increasing pressure to reduce their greenhouse gas emissions"* and that increased take-up of alternatives (natural gas or electric) is likely on this basis, despite the questionable financial viability noted by AECOM. This again demonstrates heterogeneous choice on the part of heavy vehicle fleet operators.

Therefore we argue that AECOM's homogenous choice model could be unfairly penalising BEVs by effectively forcing BEV consumers to think like ICE consumers do. The calibrating willingness-to-pay values used by AECOM (2011) are somewhat outdated and, given the emerging trends in the EV marketplace, we believe they could and should be recalibrated. We stress that this feedback is not intended as a criticism of the AEMC or AECOM's capabilities or expertise. In fact, we would agree with AECOM that its model is an excellent tool for considering *"the impact of various potential sensitivities around prices (such as electricity price, fuel price, vehicle price) and how these affect take up"* in the automotive market generally. We also accept that AECOM's homogenous choice model is probably well-calibrated to predict EV uptake in the "mainstream" market segment in the present day (2012). However, we believe this model is not valid for forecasting the emergence of an EV market in Australia, and is unlikely to be valid for the mainstream market of the future given that consumer preferences are changing so rapidly.

1d) Summary of forecast BEV take-up

There are several aspects of the study approach that we feel have led to a significant underestimate of the take-up of BEVs in Australia. These include:

- Focusing solely on electric light-duty vehicles and neglecting electric heavy vehicles.
- Misunderstanding of battery costs and their effect on EV product prices as well as the crucial differences between BEV vs. PHEV battery requirements and costs.
- Misunderstanding of BEV vs. PHEV relative attributes and their market appeal, including vehicle price trajectories, supply constraints, fuel use and electric Utility Factor, and heterogeneous consumer preferences in the emerging EV market.

As a final data point, we note there are probably now >200 production-model BEVs operating on Australian roads (including iMiEVs, Leafs, Electrons and Roadsters). In contrast, there are still less than 10 PHEV prototypes – none of which are production models. This trend will continue.

It is essential that BEV take-up is forecast accurately to allow a realistic scenario for the assessment of Australian network impacts (see below), but also to fairly assess the other societal benefits stemming from EVs in Australia for this important public policy study (discussed further below).

2. Overestimating the peak demand and network costs of EVs (*Issues Paper* Section 3)

The AECOM study includes specific assumptions around the lack of diversity in EV charging loads that we believe leads to an overestimate of the peak demand and network cost impacts from EVs. Furthermore, we believe that EV impacts will be less than the scenarios outlined in this study even under scenarios of higher BEV vs. PHEV uptake (see discussion above). Lastly, it is difficult to provide a detailed review of AECOM's methods in this regard as the network impacts analysis has not been documented as thoroughly as the EV uptake analysis from the previous NSW and Victorian studies.

2a) Diversity in EV charging loads and peak load coincidence

Diversity in EV charging loads

AECOM's unmanaged charging scenario assumes that 80% of EVs are charging during existing periods of peak load at Level 1 rates (3.6kW). They also test a sensitivity scenario where 100% of EVs are charged at peak periods at Level 2 rates (7.7kW). While we understand the intent to develop a worst-case estimate, we believe these scenarios are too extreme.

The diversified peak load impact from a fleet of charging EVs is determined by four key factors:

a) The distribution of EV arrival times (which could be to home or the workplace). For the purposes of this study we assume EVs arrive home to plug-in after their last trip for the day.
b) The average daily electrical energy demand per EV (in kWh), which is the product of vehicle electricity consumption (kWh/km) and distance driven (km).
c) The charging rate (in kW), which determines the charging duration as a result of b), and therefore determines the charge load coincidence as a result of a). Note that by definition the peak in diversified charging loads must occur after the peak in EV home arrivals[13].
d) The coincidence of the EV fleet diversified charging load and the existing network peak.

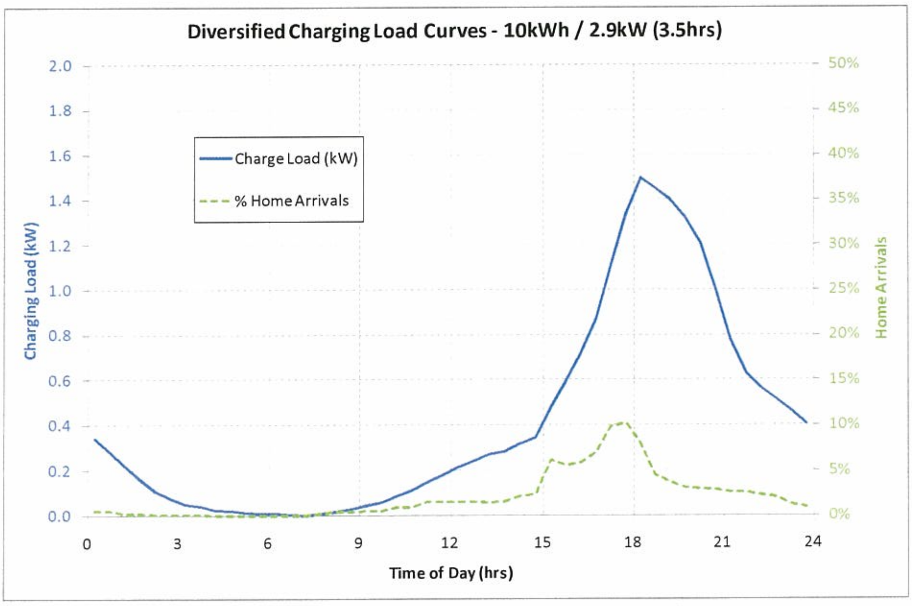

Figure 2: Example of a diversified EV charging load curve

[13] We leave it to the reader to prove why. We illustrate this point with some numerical examples.

Figure 2 provides a numerical example of factors a) – c). This example uses representative data for home arrivals[14] in the Australian urban vehicle fleet over half-hourly intervals. It also assumes that the average electrical energy demand per EV is 10kWh, with a charging rate of 2.9kW, giving an average charging duration of exactly 3.5 hours per EV[15]. Figure 2 shows that the vehicle arrivals (dotted line, right axis) peak at approximately 10% of the fleet arriving home per half-hourly interval during 5:00-6:00pm. However it is not the magnitude of the peak in home arrivals that matters. Instead it is the peak in coincident EV charging load that matters, as shown by the solid line (left axis), which peaks at 1.5kW during 6:00-6:30pm. Since the charging load per EV is 2.9kW, there are 52% of the EVs charging in a coincident manner during this time.

Figure 3 provides a chart of the EV home arrivals data used in Figure 2 and, for relevance, compares it to the profile used in the AEMO 2011 National Transmission Network Development Plan (Scenario EV1). Note that our profile jumps up during 3:00-4:00pm (trips ending after school hours) and then peaks during 5:00-6:00pm (commuter trips), whereas the AEMO profile is primarily for later commuters (peaking 7:00-8:00pm). We consider the use of datasets such as these as being essential to represent the likely diversity in unmanaged EV charging loads. It is not clear whether AECOM used a similar approach from the documentation.

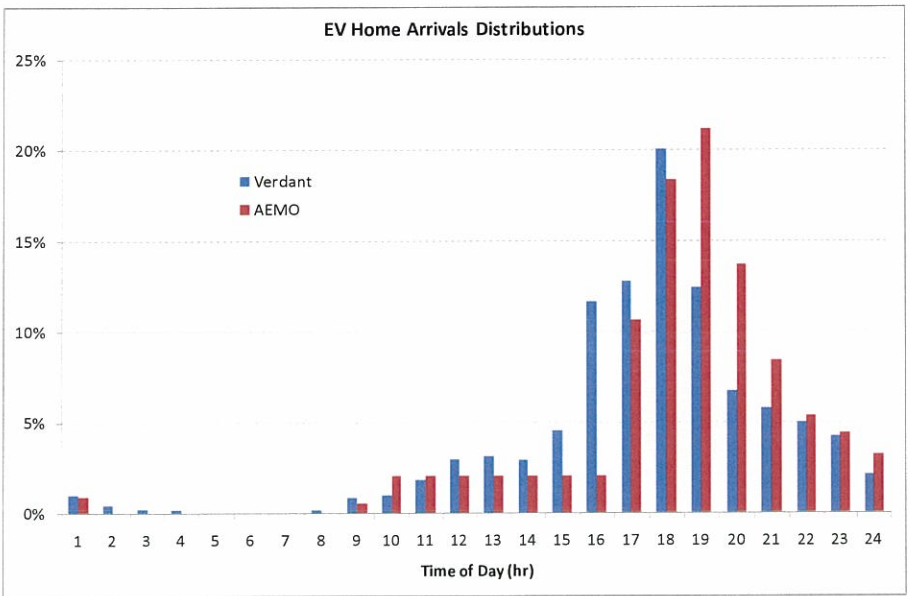

Figure 3: Home arrivals data for EV charging diversity

Figure 4 uses the same home arrival dataset and EV energy demand as Figure 2 to show how the diversified EV charging load varies as a function of charging rate. Figure 4 compares three charging rates: 2.9kW (12A, 3.5hrs), 3.6kW (15A, 2.8hrs) and 7.7kW (32A, 1.3hrs). Note that although 7.7kW is almost triple the rate at 2.9kW, the diversified EV charging load has only increased by 24% from 1.5kW to 1.9kW. The key effect here is coincidence – the faster charging rate reduces the average charge duration, which thereby reduces coincidence in the EV charging, mitigating the increase in diversified peak load. During the peak of the 7.7kW scenario, only 24% of the EVs are charging.

[14] See the University of South Australia submission on the *Approach Paper* as well as AEMO's 2011 National Transmission Network Development Plan (Scenario EV1) for other examples of this type of data.

[15] These assumptions were previously used in AEMO's 2011 National Transmission Network Development Plan.

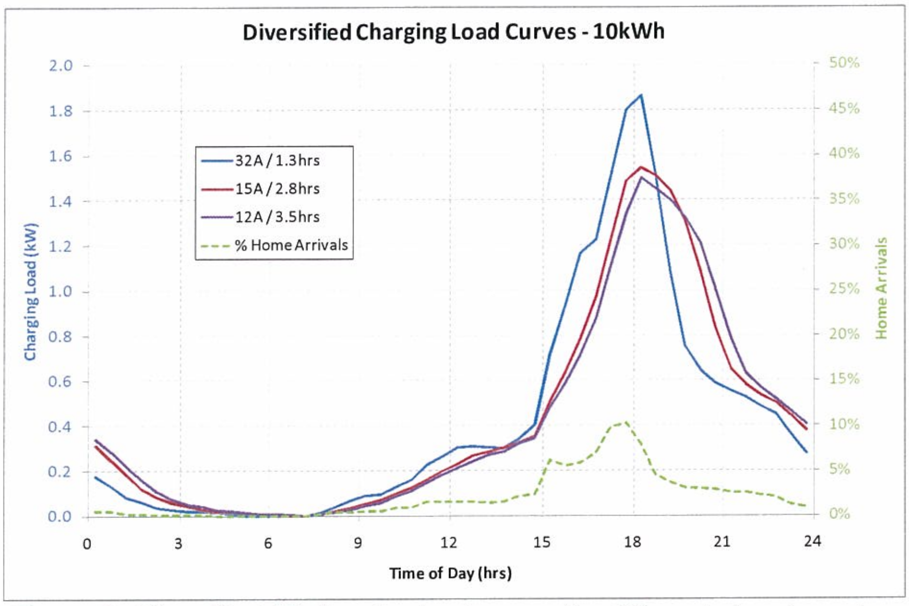

Figure 4: Diversified EV charging load curves for different charging rates

Note also that for significant uptakes of EVs we would expect EV home arrival times to mimic the fleet behaviour at large. Typical daily driving behaviours are well within the capabilities of modern EVs and there is no reason to suspect "niche" behaviour on the part of typical EV motorists. It is certainly possible that small pockets of EV motorists in specific neighbourhoods could exhibit driving behaviours that are much less diverse, but on the large State-wide scale of this study, the EV fleet driving behaviours should approximate the general fleet (otherwise the EVs wouldn't be meeting their primary function of satisfying general transportation demand).

Given the above analysis we believe that AECOM's EV charging scenarios lack the diversity that is inherent in a real-world fleet and are unrealistically extreme. Furthermore a shift to higher charging rates such as in the AECOM's sensitivity scenario should **decrease** the coincidence of EV charging loads, not increase it.

Coincidence between diversified EV charging loads and existing network peaks

The fourth factor d) above deserves further comment. EV charging loads will only add to the existing network peak if they coincide with it, and the effect will be less pronounced if the diversified EV charging load peak doesn't coincide with the existing network peak.

Figure 5 illustrates this effect by showing the maximum demand (MD) days for all of the NEM/SWIS states during 2010-11 and compares them to a diversified EV charging load curve (assuming 15A rate). Note that the maximum demand days (except Tasmania) all demonstrate a summer peak in the afternoon between 12:30-4:30pm, whereas the diversified EV charging loads peak on the shoulder of the MD curves at 6:00-6:30pm. Therefore the full impact of the diversified peak EV charging loads will not be manifested.

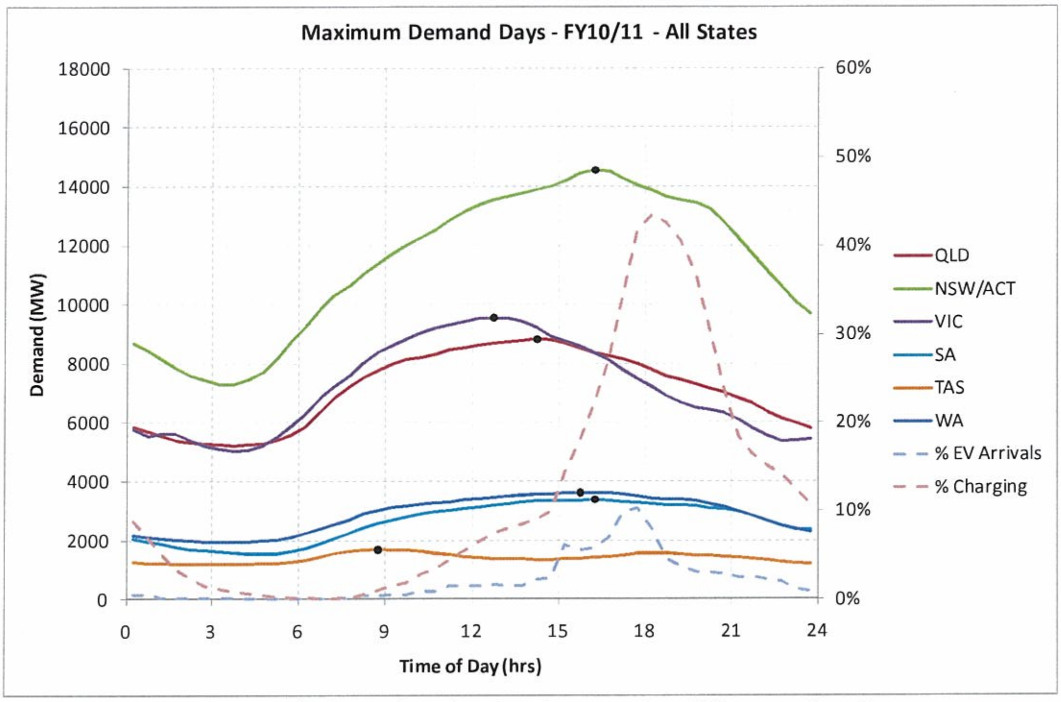

Figure 5: Diversified EV charging load curves for different charging rates

Table 3 outlines the portion of peak diversified EV charging loads that would be added to the existing network peaks in the NEM/SWIS states. Note that the EV load has been expressed on a percentage basis since the size of the EV populations in each state will differ[16]. The portion of EV loads coinciding with the existing network peak is highest in NSW and SA (at 51%) since both states have the latest peak timing of 4:00-4:30pm. In contrast, Victoria receives a much lower portion (17%) since its existing network peak is just after noon. The extent to which coincidence between EV loads and existing network peaks was accounted for by AECOM is not clear from the documentation.

Table 3: Coincidence between diversified peak EV charging loads and existing network peaks

	Maximum Demand (GW)	MD Time	% of peak EV load adding to MD	Extra Peak Demand per EV at 1.5kW diversified (kw)
QLD	8,827	2:15:00 PM	19%	0.29
NSW/ACT	14,553	4:15:00 PM	57%	0.85
VIC	9,551	12:45:00 PM	17%	0.26
SA	3,374	4:15:00 PM	57%	0.85
TAS	1,676	8:45:00 AM	3%	0.04
WA	3,612	3:45:00 PM	46%	0.70

2b) Peak demand impacts and network costs from diversified EV charging loads

AECOM (Table 2 and Table 31) estimates that, under the central take-up scenario with 15A charging and 80% peak load coincidence, EV loads in the NEM in an unmanaged scenario would demand an

[16] A more detailed analysis would also consider how EV fleet attributes and driving and recharging behaviours might differ in each state, but that has not yet been considered here.

additional 649GWh / 737MW_{peak} in 2020 and 8,537GWh / 1,935MW_{peak} in 2030. Based on the cumulative NEM EV uptake figures depicted in AECOM (Figure 2) of approximately 0.4 million and 4.7 million EVs in 2020 and 2030 respectively, we calculate that these energy market impacts equate to 4.4kWh / 1.8kW_{peak} and 5.0kWh / 0.4kW_{peak} per EV in 2020 and 2030 respectively.

Furthermore, AECOM estimates that under the sensitivity scenario (32A charging with 100% peak load coincidence) the demand impact rises to 1,571MW_{peak} in 2020 and 4,127MW_{peak} in 2030 (although there are some inconsistencies in the figures quoted[17]).

We challenge these model results from *Issues Paper* Section 3 based on the diversity in EV charging loads outlined above, and we also contend that unmanaged EV peak demand impacts will be less than the scenarios outlined in Section 3 even under scenarios of higher BEV vs. PHEV uptake (see above). We also find it difficult to explain how the Central scenario results from 2020-2030 can show a 13-fold increase in fleet electricity demand, yet less than 3-fold increase in peak demand.

To explore these issues further Verdant Vision has used its *National EV Scenario Model (NESM)* to predict network impacts from EVs under the AECOM and other scenarios. *NESM* is a comprehensive model of fleet attributes and network impacts that is calibrated using a variety of credible, public Australian data sources[18]. *NESM* does not attempt to predict EV uptake, but rather allows the user to define custom EV scenarios for vehicle sales, uptake and energy demand.

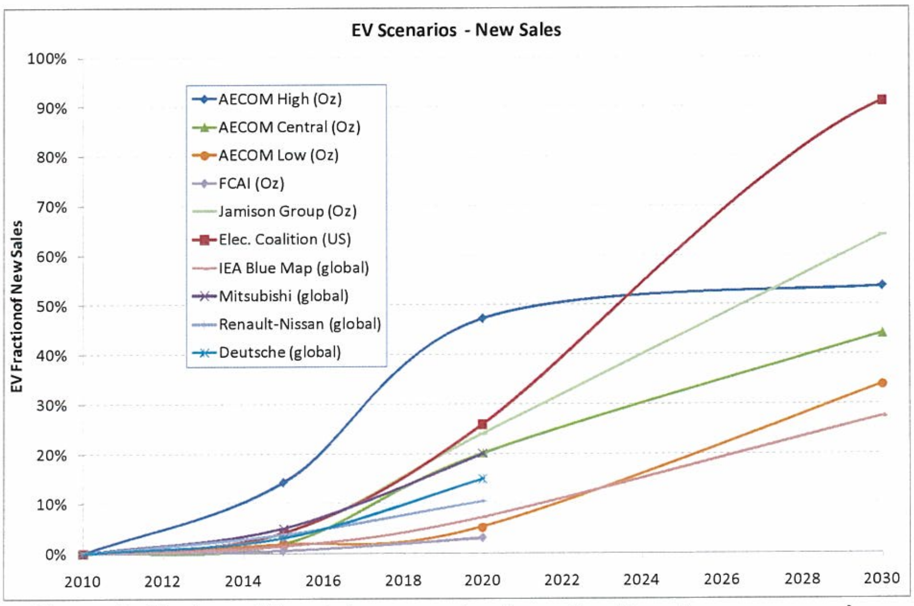

Figure 6: Various EV uptake scenarios from the literature – new sales

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[17] Both the *Issues Paper* and AECOM indicated this equates to a 150% increase in peak load impact, but we have trouble reconciling this figure as the tabulated data indicates a 113% increase in both 2020 and 2030. We also note that 32A / 15A * 100% / 80% = 267% or an increase of 167%. There is also a minor inconsistency between *Issues Paper* Table 3.2 and AECOM Table 2. This is one example of where more detailed documentation of AECOM's methods for Section 3 would be helpful.

[18] Calibration references include the Survey of Motor Vehicle Use (ABS, 2010), Key Automotive Statistics (DIISR, 2010), Carbon Dioxide Emissions from New Australian Vehicles (NTC, 2010), and the Statements of Opportunities from AEMO (2011) and IMO (2011).

Figures 6 and 7 provide examples of the scenarios we can input into *NESM*. Note that we have also included the AECOM Scenarios from this study, and Figures 6 and 7 provide interesting comparisons with scenarios from other literature. The other new sales scenarios (Figure 6) in 2020 tend to lie between the AECOM Low (5%) and Central (20%) scenarios, apart from the very aggressive Electrification Coalition and Jamison Group Scenarios and the quite conservative FCAI Scenario.

Also note that the resulting fleet mixes (Figure 7) in 2020 form distinct clusters around 5% for the more-aggressive scenarios, and around 1.5% for the conservative scenarios. Lastly note that the AECOM High scenario is clearly an outlier that probably exceeds the maximum permissible growth rate of the EV industry (building factories etc.), but it does serve to demonstrate the unbridled EV demand that could occur if there were no constraints on EV supply or infrastructure availability.

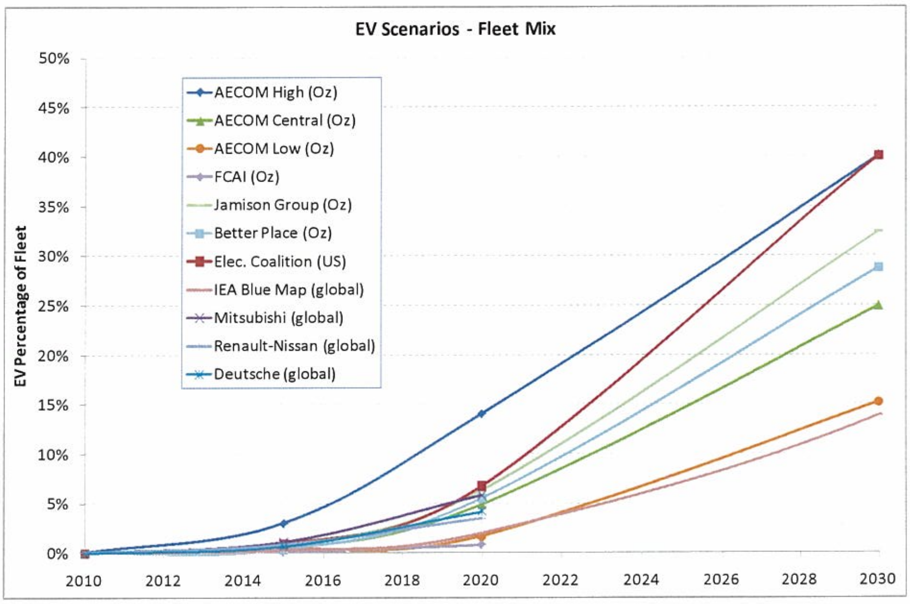

Figure 7: Various EV uptake scenarios from the literature –fleet mix

Using these scenarios, like the AECOM model, *NESM* calculates the peak demand impact and network costs of EV loads on a state-by-state basis with reference to the AEMO/IMO maximum demand forecasts. We also retain AECOM assumptions for network capacity costs for consistency (*Initial Advice* Table 27). However, since there are subtle differences between the vehicle uptake and fleet energy consumption models, we chose to calibrate *NESM* to the AECOM model by using annual EV fleet energy demand (*Initial Advice* Table 17) as the benchmark. In this way, both models are guaranteed to be replacing similar amounts of fleet fuel consumption with electricity, and the differences in modelling EV charge load diversity and network peak impacts can be isolated. However, Verdant Vision has also provided additional scenarios that are calibrated to the cumulative EV uptake in the AECOM results (*Initial Advice* Figure2), but assume that all EVs are BEVs with a commensurate increase in fleet electricity demand.

Table 4 provides a summary of the results from both models for unmanaged charging scenarios. The key calibration parameters are also highlighted in colour for the comparison of the scenario pairs:

- Comparison of the AECOM Central Scenarios with the *NESM* (AECOM Central) Scenarios highlights the impacts of the different approaches to modelling EV charging load diversity. There are two key differences. Firstly, the *NESM* results show an order-of-magnitude lower network impact for the 2020 timeframe (we find the AECOM result difficult to explain), whereas the 2030 results are similar in magnitude. Secondly, comparison of the 15A vs. 32A cases shows that the AECOM model has an exaggerated sensitivity to the increased charging rate (113% increases in network impacts), whereas the *NESM* sensitivity to increased charging rate is far less (increases of 37% and 6% in 2020 and 2030 respectively).

- Comparison of the *NESM* (100% BEV) Scenarios against the AECOM Central Scenarios reveals a surprising result. The forecast network impacts of the 100% BEV Scenarios are generally lower than AECOM, despite the fact that EV fleet energy demands are 130% and 38% higher in 2020 and 2030 respectively.

Table 4: Summary of network impacts in the NEM from the AECOM and *NESM* models

	AECOM Central		NESM (AECOM Central)		NESM (100% BEVs)	
	2020	2030	2020	2030	2020	2030
Number of EVs (approx)	400,000	4,700,000	n/a	n/a	400,000	4,700,000
Energy demand (MWh)	648,800	8,536,700	648,800	8,536,700	1,483,000	11,753,000
Peak demand (MW) - 15A case	737	1935	90	1587	205	2215
Peak demand (MW) - 32A case	1571	4127	123	1686	280	2629
Additional costs ($M) - 15A	3,400	8,900	416	7,411	952	10,347
Additional costs ($M) - 32A	7,200	19,000	573	7,881	1,309	12,320

For both comparisons we conclude that the differences in results are due to the approaches for modelling EV load diversity, and we restate our earlier belief that AECOM's approach is too extreme since it does not properly represent real-world EV driving and unmanaged charging diversity. Furthermore, the implications of this difference are paramount in the national public policy debate, since AECOM's results suggest that unmanaged EV network augmentation by 2020 would be a multi-billion dollar issue, whereas our results suggest the likely total in 2020 is less than a billion dollars.

3. National drivers of the EV and low-carbon transport market generally

The AEMC has stated that it considers its *"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."* The AEMC goes on to say that *"The NEO and NGO are founded on the concept of economic efficiency, with explicit emphasis on the long term interests of consumers."* The AEMC therefore outlines its approach to providing advice to the MCE, and notes that its key principles must ultimately be guided by the NEO and NGO. As the result, the AEMC identifies that one of its key principles is to *"appropriately allocate costs to the party that causes these costs, in as much as is feasible"*. In our view, this particular principle goes to the heart of the matter given the significant EV network augmentation costs forecast by the AECOM study.

In further reference to the NEO and NGO, the AEMC also argues that *"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."* However we consider this to be a very limiting view and we would like to challenge the AEMC's philosophy in this area.

The basis for our challenge relates to the concept of **economic efficiency** and how it is applied to the Australian economy as a whole. As noted by the AEMC, without further energy market reform, the significant EV network augmentation costs forecast by AECOM will be quite difficult to allocate to the appropriate parties. In other words, these costs must otherwise be smeared across the energy market i.e. socialised at the expense of Australian consumers or taxpayers. We feel that since the status quo for EV network augmentation costs is for them to be socialised, it is pertinent to first ask in the course of this review what other national costs or benefits might arise from the uptake of EVs. Lastly, while the AEMC may feel that its terms of reference are bound by the NEO and NGO, we note that the original directive via election commitment from the Prime Minister was not[19]. As a matter of public record, we feel it is essential that all national costs and benefits relating to EVs should be identified through this review prior to any regulatory reform occurring. Otherwise this AEMC review lacks sufficient context and fails to acknowledge the tremendous magnitude of the policy drivers for global EV uptake, the profound, transformative impact that EVs are having in both the transport and stationary energy sectors[20], and the potential total value of EVs to the Australian national economy.

We have used our *National EV Scenario Model (NESM)* in combination with a subset of AECOM's results to estimate the full spectrum of national costs and benefits arising from the uptake of EVs. A shortlist of the key national economic factors includes:

- avoided oil imports (reduced cash exports)
- reduced cost of motoring (consumer savings including reduced tax through fuel excise)
- avoided urban air pollution (reduced health costs of premature mortality and morbidity)
- avoided vehicle GHG emissions (permit value of carbon emissions)
- excess renewable generation enabled by EVs (permit value of carbon emissions)
- energy network impacts (costs of network augmentation)
- local EV and renewables industry development (job creation)
- energy security (avoided cost of energy supply disruption)

Within this list of national economic factors, the external factors include oil imports, urban air pollution, vehicle GHG emissions and excess renewables (as these are all external costs or benefits to the national economy). Energy security is more of a risk to the nation rather than a cost, therefore

[19] J. Gillard (2010) "Emission standards for cars", election commitment of 24 July, Australian Labor Party.
[20] A. Dini (2012) "The Transformative Impact of Plug-in Electric Vehicles on the Energy Sector", Proc. 26th Electric Vehicles Symposium (EVS26), May 6-9, Los Angeles.

we have not priced it, but its critical national significance should not be overlooked[21]. Cleantech industry development will create tremendous value for Australian workers and potential export earnings as well, but we have not devised a method to price this yet. The other factors – reduced cost of motoring, reduced fuel excise and energy network impacts – are internal factors in that they are all paid for by Australian consumers or taxpayers. For example, a saving in the cost of motoring allows that money to be redirected into other consumer spending. Conversely, reduced fuel excise or increased network costs mean higher prices or taxes somewhere in the economy. The key point for these internal factors is that money doesn't flow out of Australia.

For consistency with the AEMC Review, we have modelled a scenario that retains the AECOM Central uptake projections for the number of EVs in the fleet. However, given our discussions above around expected BEV uptake, PHEV utility factor and EV charging load diversity, we have modelled EV loads and network impacts using *NESM* and have assumed a 100% BEV scenario (see Table 4). That is not to say that we think this exact scenario will occur, but we believe it is more likely to approximate the actual development of the Australian EV market over time, and we also note our scenario is still less aggressive than projections by Better Place or The Jamison Group (see Figure 7).

Table 5 presents our estimates for the cumulative national costs and benefits arising from Australian EV uptake to 2030 (undiscounted as per the AECOM methodology for network capacity costs). Compared to previous estimates for the NEM only (e.g. Table 4), these estimates include both the NEM and SWIS (but still exclude the NT and Pilbara, which combined are only 1% of the LDV fleet).

A detailed explanation of our assumptions and costing methodologies is beyond the scope of this submission, but an abbreviated summary is provided here. Oil imports assume a fixed price of AU$100/bbl[22]. Health costs are derived from BTRE (2005)[23] and equate to 22c/L of petroleum fuel combusted in urban areas[24]. ICE vehicle GHG emissions include Scope 1 (tailpipe) only using factors specified in the National Greenhouse Accounts[25] and assuming the current carbon price of $23/t. We have overlooked the current carbon price exemption for light petroleum vehicles as these tailpipe emissions still occur nonetheless. EVs are assumed to recharge with 100% GreenPower since the marginal cost is only ~1c/km and we are not aware of any EV products or services currently deployed in Australia that do NOT use 100% GreenPower (we expect this trend to continue). Excess renewables are those enabled by EV network services, minus the GreenPower required to charge the EV fleet. To underpin renewables we assume a conservative estimate by McDermott (2010)[26] that each EV enables 1kW of renewable generation (producing 3MWh annually at ~1/3 capacity factor)[27]. Reduced cost of motoring uses values from AECOM (2011)[28] but with an additional 1c/km cost for 100% GreenPower. Network impact costs use our methodology as per Table 4 and fuel excise assumes the current value of 38.1c/L. See Footnote 16 for further discussion of *NESM* model calibration references.

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[21] http://www.ret.gov.au/energy/facts/white_paper/Pages/energy_white_paper.aspx
[22] See the US Energy Information Administration's 2011 Annual Energy Outlook (reference case).
[23] BTRE (2005) "Health Impacts of Transport Emissions in Australia: Economic Costs", Working Paper 63, Bureau of Transport and Regional Economics, Canberra.
[24] This externality cost for air pollution of 22c/L is comparable to the AECOM (2011) value of 2.78c/km.
[25] DCCEE (2011) "National Greenhouse Accounts Factors", Canberra.
[26] H. McDermott (2010) "Smart Charging", Proc. Plug-In 2010 Conference & Exposition, San Jose.
[27] Studies at Curtin University (2009) have suggested a much more powerful leveraging effect, with V2G ancillary services from EVs potentially enabling over 15kW / 40MWh of annual renewable generation per EV.
[28] AECOM (2011) "Forecast Uptake and Economic Evaluation of Electric Vehicles in Victoria", Final Report for the Victorian Department of Transport, Melbourne.

Table 5: Cumulative National Costs and Benefits from Australian EV Uptake to 2030 (AECOM Central vehicle populations, NESM model for charging loads assuming 100% BEVs)

	2020	2030	
Number of EVs	448,900	5,274,500	
EV energy demand	1,664	13,189	GWh
Australian Societal Benefits			
Avoided oil imports	$ 3,949	$ 35,157	M
Avoided urban air pollution	$ 1,116	$ 10,504	M
Avoided vehicle GHGs	$ 329	$ 2,933	M
Excess renewables enabled	-$ 26	$ 43	M
TOTAL National Economic Benefit	**$ 5,368**	**$ 48,637**	**M**
Consumer Benefits/Taxpayer Costs			
Avoided cost of motoring	$ 1,526	$ 34,397	M
Network augmentation	-$ 1,204	-$ 13,756	M
Lost fuel excise	-$ 2,395	-$ 21,322	M
Local EV/renewables industry	not priced	not priced	
Energy security	not priced	not priced	
NET Consumer/Taxpayer Benefit	**-$ 2,073**	**-$ 680**	**M**

There are several key points to make based on the results in Table 5.

1. EVs will save billions of dollars of external costs to the Australian national economy ($5.4B in 2020 and $48.6B in 2030), due to the combined value of avoided oil imports, urban air pollution and GHG emissions. This value is dominated by avoided oil imports but the value to urban health is also significant ($1.1B rising to $10.5B).

2. Irrespective of the internal economic factors of motoring costs, network impacts, excise revenues and job creation, EVs are therefore predicted to have an overwhelming net benefit to the national economy. This reinforces the overall positive conclusions drawn by AECOM in their previous economic studies of EV uptake for New South Wales and Victoria.

3. Network costs from unmanaged charging could be significant ($1.2B rising to $13.8B), but these costs are completely offset by the combined value of avoided urban air pollution and GHG emissions. Therefore it would be **economically inefficient** for the national economy to impose cost-reflective network pricing (a disincentive) on these EV users if they were not simultaneously receiving credit for reducing premature deaths from respiratory disease in Australian cities or reducing the hardships of climate change on Australian communities. Of course, these results assume that EV loads are unmanaged and we would also agree in principle with AECOM and others that there are a variety of options available for "smart charging" and that these solutions will mostly alleviate the network impact issues at the level of focus of this Review at least.

4. From the perspective of combined internal economic factors, the total costs of lost fuel excise revenue[29] and network augmentation may cause alarm for Government. But these costs are nearly offset in the long term by the hip-pocket saving for EV motorists, especially Aussie battlers on the urban fringe, and would definitely be overcome if the combined value of new cleantech industry jobs and enhanced national energy security were factored into the analysis. However, this shifting internal revenue stream does highlight a key point – which is that energy market reform for EVs cannot occur in isolation. Rather it must occur as part of broader structural reforms that recognise the profound impact that EVs will have on the governance of both the transport AND energy sectors as they come to market (and come to market they definitely will – Australia cannot stop the global EV tide).

Therefore, the crux of our submission to the AEMC (and to the Ministerial Council on Energy and the Prime Minister) is that we must all recognise that Australian energy markets are only a subset of our national economy and that the impacts of EVs will be much wider and far-reaching than that. Australia stands to gain tremendous national economic benefits from the coordinated uptake of EVs and these benefits will be worth tens of billions of dollars over the next two decades (and substantially more beyond that).

[29] We note that a well-reasoned solution to the EV fuel excise issue has already been identified by the Henry Review and the Australian Automobile Association (amongst others) in the form of Road User Charges (RUC).

4. Metering Arrangements for Electric Vehicles

Metering arrangements for EVs are discussed in the *Issues Paper* and were also canvassed during the workshop in Sydney on 29 February 2012. While we remind the AEMC that Verdant Vision does not represent any commercial interest nor favour any particular business model for electric vehicle sales, recharging or usage, we do believe our 20+ years of combined experience with EV technology and market trends provides sufficient basis to provide some comment on this topic.

As noted above, the national economic benefits of electric vehicles will be substantial and are often greater than many stakeholders realise (without undertaking sufficient analysis). Given the above calculated benefits of EVs, we believe there is a national imperative for Australia to cultivate a thriving local market for EVs as soon as possible. The sooner a broad range of EVs is available in the Australian market, the sooner the local EV supply will reach economies of scale, the sooner EV purchase prices will reduce, the sooner consumer will adopt them, and the sooner their aggregate national benefits will be realised by all Australians. Furthermore, cultivating a wider range of EV products and services with corresponding metering arrangements will promote consumer choice and better-cater to the heterogeneous preferences that consumers clearly exhibit.

Considering this philosophy, we believe that no single metering arrangement can effectively accommodate all models for EV usage. Sub-metering and/or parent-child metering appear to be favoured by many stakeholders and we would agree these are an attractive option for certain EV business models, also recognising that roaming meters are still quite complex and unavailable in the marketplace at present. We are mindful of the view from some stakeholders that EV loads should be managed as part of the 'energy ecosystem' at the point of supply and metered by a single meter, and this is certainly one of the metering arrangements that should be permitted. However, this metering arrangement would only be preferred if tariffs were truly cost-reflective to all consumers at their points of supply, but there is ample evidence that not all tariffs are truly cost-reflective for all consumers at their points of supply and there is ample precedent for 'splitting the bill' at the premise level. The UNSW said it best by noting that current market arrangements reflect the tradeoff between complex and competing objectives of the energy sector in terms of pursuing accessibility and affordability versus economic efficiency.

We strongly refute the default suggestion that EV charging services should be automatically classified as a sale of electricity. There are several commercial models emerging in the Australian EV market that clearly demonstrate this would be an inappropriate classification that would probably only serve to stifle innovation and competition in the emerging EV charging services market.

With regard to the cost of NMI installation and other upgrades at the point of supply to accommodate EV charging, we suspect that the lowest cost approach will be preferred by the market in general. However, we believe consumers should be fully empowered to make choices about the cost of their EV recharging service at their point of supply and that upgrade costs should be negotiated between the stakeholders involved in the EV charging service provision as per the commercial transaction(s) required. Given the diversity of emerging EV business models, it is impossible to presume who those stakeholders will be or how those costs would be shared. The key is to promote a competitive marketplace that does not preclude options such that the market can exhibit its own preferences. Unfortunately, submissions demonstrate that certain metering arrangements are precluded by the current regulations, creating an effective lock-out for those commercial models and depriving EV consumers of choice. The AEMC should rectify this market barrier in metering arrangements as per its mandate for this Review.

While we also appreciate that addition of EV loads to the low-voltage (LV) network may incur additional costs to network infrastructure, we argue that those costs should be weighed against the inherent national benefits of EVs calculated above, and it would be detrimental to the national economy to single out EVs as a load category and allocate these network costs without simultaneously rewarding EVs for their other, greater, national benefits. We also reiterate that EV network impacts are likely to be less-adverse than predicted by AECOM and that the risk of actual adverse network impacts from EVs is still yet to be proven or well-quantified.

Furthermore, there are many other load categories (e.g. air-conditioners) that have not been singled out despite their adverse network impacts. There are also many load categories (e.g. solar PV or off-peak hot water) that benefit from specialised tariffs and metering arrangements. While in theory energy market arrangements should be technology (and load) neutral and fully cost-reflective, there is not much precedent for this. If certain policy decisions are made or commercial negotiations occur that result in EVs attracting a favourable set of market arrangements due to their inherent benefits, it should not be the role of the AEMC to seek to preclude these.

Finally, we believe that in order for the matter of metering to be understood fully, a separate analysis could be undertaken to evaluate the anticipated costs vs. benefits of various EV metering arrangements, with particular attention to the costs for publicly-funded retailers or distributors to accommodate both sub-metering and/or parent-child metering where the EV recharging installation desires its own NMI. However, costs to private market participants should be reconciled through a competitive market environment.

5. Conclusion

This AEMC Review is supposed to *"identify and address potential barriers to the uptake of electric vehicles"*[30], but we have shown that energy market reforms to appropriately allocate network costs to EV users may not only create an unintended disincentive for Australian EV uptake, but would also be a textbook example of **economic inefficiency** in considering the Australian economy as a whole.

Furthermore, energy market reform is only one of the many reforms that must occur to provide a coordinated approach to governing and promoting the successful uptake of EVs in Australia. We are concerned that this AEMC Review is limited by an underlying philosophy that fails to recognise the tremendous magnitude of the policy drivers for global EV uptake and the profound, transformative and simultaneous impacts that EVs are having on both the transport and stationary energy sectors[31]. A better overarching philosophy for this AEMC Review and for the Australian Government would be to recognise the need to **invest in Australia's energy network infrastructure as a strategic priority for both the transport and energy sectors**, and to pave the road to the significantly more valuable national benefits that vehicle electrification will bring.

EVs present a tremendous national opportunity for Australia – and we encourage the AEMC and the Australian Government to think outside the box in order to make the most of it.

Verdant Vision will continue to offer its resources to the AEMC and other stakeholders in this review process and hopes that our comments are considered constructive. We welcome further discussion or query on any of the matters discussed above.

[30] J. Gillard (2010) "Emission standards for cars", election commitment of 24 July, Australian Labor Party.
[31] A. Dini (2012) "The Transformative Impact of Plug-in Electric Vehicles on the Energy Sector", Proc. 26th Electric Vehicles Symposium (EVS26), May 6-9, Los Angeles.