Achieving "*Electric Vehicle ready*" in the built environment – discussion paper and recommendations

September 2019

1. Policy context

Australia is undergoing a technological, social and economic transformation around items that have been considered part of our cultural bedrock such as:

- Housing – where medium and high-density apartment living is growing faster than single family discrete residences.

- Transport – where electric vehicles (EVs), ride sharing and potentially autonomous vehicles are set to displace internal combustion engine vehicles and reduce individual car ownership.

- Energy – where renewable energy is displacing fossil fuels and distributed energy resources are growing to supplement centralized generation and transmission systems.

These changes are driven by many factors. Alternatives are increasingly competitive with the total cost of existing practices. Individual preferences are shifting. And interest in solutions to the challenge of climate change is growing. Responses to these changes are also multifaceted and that may challenge many entrenched practices, market offerings and statutory controls.

Australian governments are increasingly interested in the potential of electric vehicles (including plug in hybrid, fuel cell, and battery electric). The Commonwealth Government has committed to develop a national Electric Vehicle Strategy which will deliver 10 million tonnes of greenhouse gas abatement by 2030. While the Federal Coalition expressed concern about the costs of aggressive EV targets during the recent election campaign, their policy states:

> *"The strategy will build on grants from ARENA, finance from CEFC, and the work of the COAG Transport and Infrastructure Council to coordinate action across governments, industry and community in both urban and regional areas. This work will include consultation on whether mandating an electric vehicle plug type could improve the consistency of public charging."*

State Governments are also engaged.

New South Wales has established an EV plan of its own, including co-investment in charging points and investigation of how to make buildings EV ready.

Queensland's Electric Vehicle Strategy envisages charging infrastructure investment and strategic coordination in the regions.

Tasmania has established an Electric Vehicle Working Group as part of its climate response strategy.

Victoria is supporting charging infrastructure deployment and an independent review of emissions targets commissioned by the Victorian Government recommended deep reductions and highlighted electric vehicle uptake as a critical contributor.

The politics of climate change can be fraught, particularly at the Federal level. The growth of electric vehicles raises attractive prospects for increased opportunity, cleaner air and lower emissions, but can also inspire fear of change, concern about costs or worry about equity. Policy proposals in this area need to be framed astutely and designed well to navigate these sensitivities.

One critical area for activity relates to charging infrastructure for EVs. Provision of electrical power to cars, unlike petrol, liquefied petroleum gas or diesel, is not controlled via a standalone controlled distribution network. Refueling is liberated and can potentially be done in any location with electrical power. While special-purpose charging stations, parking garages and workplaces are likely to play important roles with residential charging an important opportunity. This paper makes a number of recommendations to increase the "EV readiness" of new dwellings.

2. Objectives of the discussion paper

To develop a set of recommendations for Government/regulators and standards makers to assist in the development of regulatory frameworks to ensure that new domestic dwellings are "Electric Vehicle ready".

3. Ai Group / Electrical Vehicle Council EV forum

Awareness of electric vehicles (EV) in Australia is increasing and the market is approaching a tipping point as the choice of models increases and unit prices fall. In response, much of the focus on EV by policy makers relates to market uptake, public charging infrastructure, service/support and grid issues.

However, an overlooked problem is that regulatory frameworks have yet to respond to technical infrastructure requirements to meet growing demand for EVs – inaction which may result in very *costly* retrofits for EV owners in the future. In particular, little attention is being

given to the technical infrastructure needs of the built environment in both residential and commercial premises to facilitate integration, charging and energy management.

Ai Group, in partnership with the Electric Vehicle Council, held a forum on 12 April 2019 in Melbourne. This forum informed industry participants on the state of play of policy development in Australia and most importantly placed a spotlight on gaps in the regulatory framework, comprised primarily of Australian Standards and the National Construction Code (NCC), that need to be addressed as the market for EVs accelerates. An EV Working Group was formed to develop recommendations on issues raised at the forum.

4. Working Group

To capture the ideas from the forum and to further flesh out concepts Ai Group formed an EV Working Group (WG) to develop a set of recommendations for policy makers. The WG included the following stakeholders:

- Supplier/manufacturer of charging equipment
- Supplier/manufacturer of electric vehicles
- Installer of electric vehicle charging equipment
- Regulator of electrical safety (Energy Safe Victoria)
- User of electric vehicles
- Apartment consumer advocates and asset owner of built structures
- Developer of built structures
- Distribution network service provider
- Energy retailer

Observers

- Worksafe New Zealand
- Standards Australia

These recommendations are a collective view held by the WG but do not necessarily reflect the position of any one stakeholder or sector.

5. Built environment

In Australia, our dwellings are typically built with an expectation that they will see at least 40 years of use, before potentially being replaced by different structures. In most cases, new dwellings constructed today are required to be provisioned with car parking spaces dedicated to the dwelling as part of a planning process, in order to ensure that our residential streets are not overcrowded with parked cars. Strata (apartment building) is the fastest growing form of residential property ownership in Australia. Over half the new dwellings to be

built in our metropolitan areas over the next decades will be strata titled. In Sydney city alone that apartment growth now exceeds 80% of all new housing developments.

The scale and speed of the transition currently underway towards electric cars is highly uncertain. The Australian Energy Market Operator has begun to incorporate EVs into its long range forecasts of electricity demand. They project EVs to be one third of the passenger vehicle fleet being plug-in electric by 2040, which translates to near 100% of the passenger vehicle fleet being electric by 2060, the nominal 40 year design life of today's built dwellings. Policy makers and stakeholders should prepare for this kind of scenario, while also being aware that development may be considerably faster – or slower.

For electric car drivers with off street parking, the most convenient way to recharge their vehicles is typically at home, overnight. Depending on the evolution of the electricity system this may have added individual and systemic benefits – or costs. Load on the system and wholesale electricity prices are currently lowest overnight, so overnight charging may improve network and generation asset utilisation and lower costs for everyone. On the other hand, higher penetration of rooftop and large scale solar is likely to increase supply and lower wholesale prices in daylight hours. Care will be needed to drive the best value for all.

Based on the above, there will be a need over the next 40 years to retrofit significant amounts of electric vehicle charging infrastructure to existing building stock. The experience to date has found this to be complex in the Australian market, especially in the context of apartment complexes. To reduce the costs associated with these retrofits, this paper has been compiled to help guide planners in specifying electric vehicle charging readiness strategies for new construction, in order that the cost and complexity of retrofitting EV charging equipment in future be reduced.

6. Recommendations

R1 - Government forms a technical infrastructure group comprised of key stakeholders to develop a road map to address gaps in standards and building regulation with the objective that new builds be "EV ready". This should include building policy makers/regulators, the Australian Building Codes Board (ABCB) and Standards Australia (SA).

Rationale

This multi-stakeholder committee would bring industry, unions, government and researchers together to:

- develop a national EV roadmap;
- broader EV supply chain roadmap; and
- identify priority actions.

This group would maintain oversight of roadmap implementation through the bodies responsible for actioning policy initiatives.

R2 - Standalone domestic dwellings - For new standalone and semi-detached domestic dwellings with off-street parking, at least one (1) dedicated circuit to support the future installation of an EV charger shall be included as part of the electrical installation.

2.1 Regulatory instruments

- National Construction Code 2022
- AS/NZS 3000 Electrical wiring rules

2.2 Rationale

A large proportion of Australia's housing is provided in single dwellings in urban and lower density sub-urban settings. Many provide parking spaces within the block (on title). The provision of recharge at the home has numerous benefits, including convenience, simplified regulatory requirements and billing methods.

Optimising the home occupier's ability to take up EVs requires quite simple provision, and this could be legislated.

An overarching legislative requirement per-property would remove own-to-rent discretion in making this available; rental properties are approximately 30% of total housing.

In these cases, the electric vehicle driver will be well served by a 7kW (32A single phase) AC charger, which is capable of delivering 30 - 40km of range into an electric passenger vehicle per hour plugged in. This style of charger is available with a wide range of optional features from a large number of manufacturers, can be installed by any qualified electrical contractor, and can be mounted either in the garage or external to the house near the driveway.

Enabling the installation of the EV charger in future will be best served by running an electrical circuit capable of supporting a 32A single phase load from the load-center in the house (the box full of circuit breakers), to the location on the property where the car will likely be parked. The EV charger does not need to be installed at the time of new home construction unless the builder / new owner wish it to be, but the presence of the circuit will make it much easier to install an EV charger in future, and it will be cheaper and easier to install the circuit for it at time of construction rather than later on. This model has already proven successful in California, which is around 5 years ahead of Australia in EV uptake.

2.3 Technical considerations

- Standalone domestic dwellings shall incorporate a 32A single phase circuit, protected by a suitable circuit breaker and RCD or combination thereof, in accordance with AS/NZS3000 requirements for electric vehicle chargers.

- This circuit shall run from the load-center to a location on the property where a car would typically be parked, for example in the garage or on a wall adjacent to a driveway.

- This circuit shall be safely terminated, for example in an isolator, socket outlet or junction box.

R3 - The provision of dedicated distribution boards in new multi-residential car parks for connection of future EV charging equipment

3.1 Regulatory instruments

- National Construction Code 2022
- AS/NZS 3000 Wiring rules

3.2 Rationale

The specific requirement from a construction standpoint would be to include sufficient distribution boards in the car parking areas such that there is a spare 32 A circuit available for every car parking space in the structure. These distribution boards will need to be ~~fed by~~ supplied from the main switchboard at the site. Each board would be capable of supplying up to half of the EV chargers connected to it at full power, or all of them at half power. The actual load being presented would be handled by the load management system described further down.

In order to fairly share the costs of installation, cable tray should be installed at the time of construction to enable the easy future installation of the cabling from the distribution board to the EV chargers. Unlike with the domestic home, there is no need to put the final circuit cabling in at time of construction, but there is a requirement to provision for where it will go. Failure to do this will mean that the first installation of an EV charger will require the installation of cable tray which will be shared by future EV charger installations – it will be more equitable to put it in at the outset, as it will ultimately be shared by and deliver benefit to the bulk of residents.

From a practical standpoint, it is to be expected that there will be one or more distribution boards per floor of a car park. This will enable much simpler future installation than attempting to pull individual cables between floors to serve new EV charging installations.

3.3 Technical considerations

- A typical distribution board for this duty would have capacity for either 24 or 48 outgoing circuits, each sufficient to supply 1 x 7kW EV charger.

- This board would incorporate either a 125A or 250A three phase main switch respectively, protected by a suitable circuit breaker at the main switchboard.

- This board should have an energy meter installed to enable measurement of total energy supply to electric vehicles as an aggregated load, independent from the load management system described below. This energy meter should have communications capability to enable it to be remotely read.

- The connection to this board from the main switchboard at the site should be part of the initial installation.

- This distribution board would not be required to be populated with miniature circuit breakers at time of installation. Procurement and installation of miniature circuit breakers to feed the final circuit to the EV charger would be done at the same time as the procurement and installation of the EV charger itself. This measure is intended to:

    - Ensure technical compatibility.
    - Limit up front cost.
    - Provide freedom for selection of a range of different power levels of EV charger.
    - Provide sufficient cable tray to support the future installation of a single-phase sub-circuit to each car parking space from the distribution board.

R4 - Multi-residential - That a load management system is installed to support EV charging

4.1 Regulatory instruments

- National Construction Code 2022
- Relevant standards

4.2 Rationale

In multi-residential apartment complexes, infrastructure to support peak power capacity at the site is typically designed to approximately 3kW per apartment, plus common property load. This is sufficient to support peak electrical demand requirements, generally

associated with either cooling on very hot days or heating on very cold days, coinciding with evening meal preparation.

The addition of EV charging as described above will bring an additional 7kW load to each car parking space. It has to be assumed that large numbers of residents will arrive in the car park at the same time of day (5-6pm), at which time the building will already be operating at peak electrical capacity on some days. In the absence of a system designed to intelligently manage these new loads, the peak power capacity in the building would need to be significantly increased to accommodate this additional load, which would be prohibitively expensive in capital outlay and ongoing peak demand charges from the energy retailer supporting the site.

Modelling of apartment complex energy use data (provided by Distribution Network Service Providers (DNSPs)) by the working group has shown that providing a system to intelligently manage these loads is implemented, typical apartment complex sites have the capacity to deliver sufficient energy overnight to easily support the daily usage of two electric vehicles per dwelling, without breaching the 3kW/apartment capacity level, even during the highest demand periods on record.

There is also likely to be a substantial market for demand response to deliver improved outcomes in the wholesale and network segments of the electricity system. Load management systems can potentially facilitate participation in demand response, allowing shifting of charging behavior to maximise value.

With this in mind, a load management solution which can scale to include new electric vehicle chargers as they are added is a required element of preparing a multi-residential building for the cost-effective future installation of electric vehicle chargers. Overall costs will be higher and fairness lower if a load management system is not installed at the outset.

There are a range of architectures and technologies which can be utilized to achieve effective load management, so the technical considerations here comprise a system capability specification, rather than a prescriptive technical specification as used in section 3.3.

4.3 Technical considerations

The electric vehicle load management solution shall have the capacity to:

- Read real-time current (A) and energy (kWh) data from multiple points, including the electric vehicle chargers under management and energy meters at other locations in the building to be determined by the system designer.

- Determine, based on known building parameters and real time current and energy data collected, the appropriate behavior for each EV charger, with the goals of:

- mitigating collective impact of electric vehicle charging equipment on building peak demand;
- avoiding overloading of any elements of the electrical reticulation system in the building;
- ensuring to the extent possible that every electric vehicle connected is fully recharged overnight;
- facilitating participation in demand response arrangements.

- Enact this behavior on the electric vehicle chargers under management.

- Monitor the behavior of the electric vehicle chargers under management, to ensure that the system is performing as intended.

- Maintain, in an appropriate accessible data structure, the cumulative energy used by each EV charger, for potential use in other systems and for reporting to the body corporate.

- Scale to include additional EV chargers as they are added at the site over time, up to the total number of car parking spaces in the premises.

R5 - Multi-residential - That a mechanism to enable appropriate cost allocation for energy used in charging electric vehicles is included in multi-residential buildings.

5.1 Regulatory instrument

Owner's corporation rules.

5.2 Rationale

In multi-residential buildings, the energy meter upstream of the load-center in the dwelling is typically located on the same floor as the dwelling, and it's not practical to run the supply to the EV charger from there. One of the consequences of this is that the energy is being supplied to the EV chargers from general building power, rather than residents individually metered supplies, which means that an appropriate cost allocation needs to be made to the resident using the energy, outside of (and in addition to) the electricity bill for their home. It will certainly not be perceived as fair if residents with electric vehicles are getting electricity paid for out of owner's corporation fees shared equally by everyone, while most residents paying said fees are driving petrol powered vehicles.

As with load management, there are a range of approaches that can be taken with regard to cost management, and the issue of which solution is the best is far from settled. This is an area where it is somewhat more difficult to directly take learnings from other markets, as the structures and rules governing billing for electricity vary considerably across jurisdictions.

The simplest method for cost allocation will be to incorporate a fixed annual fee into the body corporate fees for any resident with an EV charger in their parking space, along similar lines to AGL's '$1 per day all you can eat' electric vehicle charging offer. This has the benefit ~~the~~ that no special arrangements need to be made around energy metering or contestability of the bill; the resident is not paying per kilowatt-hour as they would on an energy bill but is rather paying for access to a service provided by the body corporate. Ensuring that the cost is being effectively passed through in aggregate (i.e. the total cost of electricity delivered to EVs is approximately equal to the total contributions from all EV drivers) would require reviewing energy consumption which is addressed in the technical considerations below.

A more granular approach would involve separately metering each EV charger, and billing individual users for energy consumption. While the data on energy consumption will typically be available via the load management system, it is less clear as to whether this data will be considered in future to be 'revenue-grade'. There are many rules to comply with in Australia when it comes to certifying an energy meter to NMI (National Measurement Institute) standards for use as part of a billing system, where billing is on a per-kWh basis. This said, it is in-practice possible for an invoice to be generated using energy consumption data from individual EV chargers on a network, and it is certainly possible to install revenue grade meters upstream of each individual EV charger if this is required, potentially as a component of an embedded network managed by an appropriate embedded network operator.

Finally, there are several proponents of 'software as a service' solutions whereby the EV charger connects via a cellular network to a cloud-based service, billing is managed with the user (in this case, the resident), and the received monies are remitted to the site operator (in this case, the body corporate). This approach is functionally comparable to an embedded network, but is substantially less regulated at this stage in the Australian market than embedded networks.

Given that there are a wide range of possible architectures, and a lack of clear regulation in this space, the technical considerations here focus on enabling a minimum viable solution, without either ruling out or requiring other capabilities.

5.3 Technical considerations

- In order to enable the body corporate to appropriately allocate costs associated with supply of energy to electric vehicles on site, the load management system shall maintain in an appropriate data structure the cumulative energy used by each EV charger.

- This data structure shall be readily accessible by the body corporate.

- Note that this does not necessarily imply direct billing per kWh, which may in future require trade certified metering and associated processes. This data could potentially be used by the body corporate as an input into determining an appropriate annual service fee for all EV drivers, or some other approach mutually acceptable to the body corporate and residents.