EV Charging Stations Research (Australia)

In this paper, I'll discuss about the 'Type of connector used & the existing hardware layout', 'EV charging station site decision process' & its 'Operational costs & indirect cost recovery method' produced by the 'Economic Development Queensland' (state of Queensland), Department of State Development, Manufacturing, Infrastructure and Planning, Australia. I will first discuss about the connector types used across Australia and their uses.

The shift from internal combustion engines (ICE) to low carbon emission vehicles is occurring at a fast rate across the globe. By 2040, EVs will comprise 54% of worldwide new vehicle deals. As the greener and more expense proficient option in contrast to fossil-fuelled cars as EV bring forth a crucial reduction of greenhouse gas emissions when charged through renewable energy.

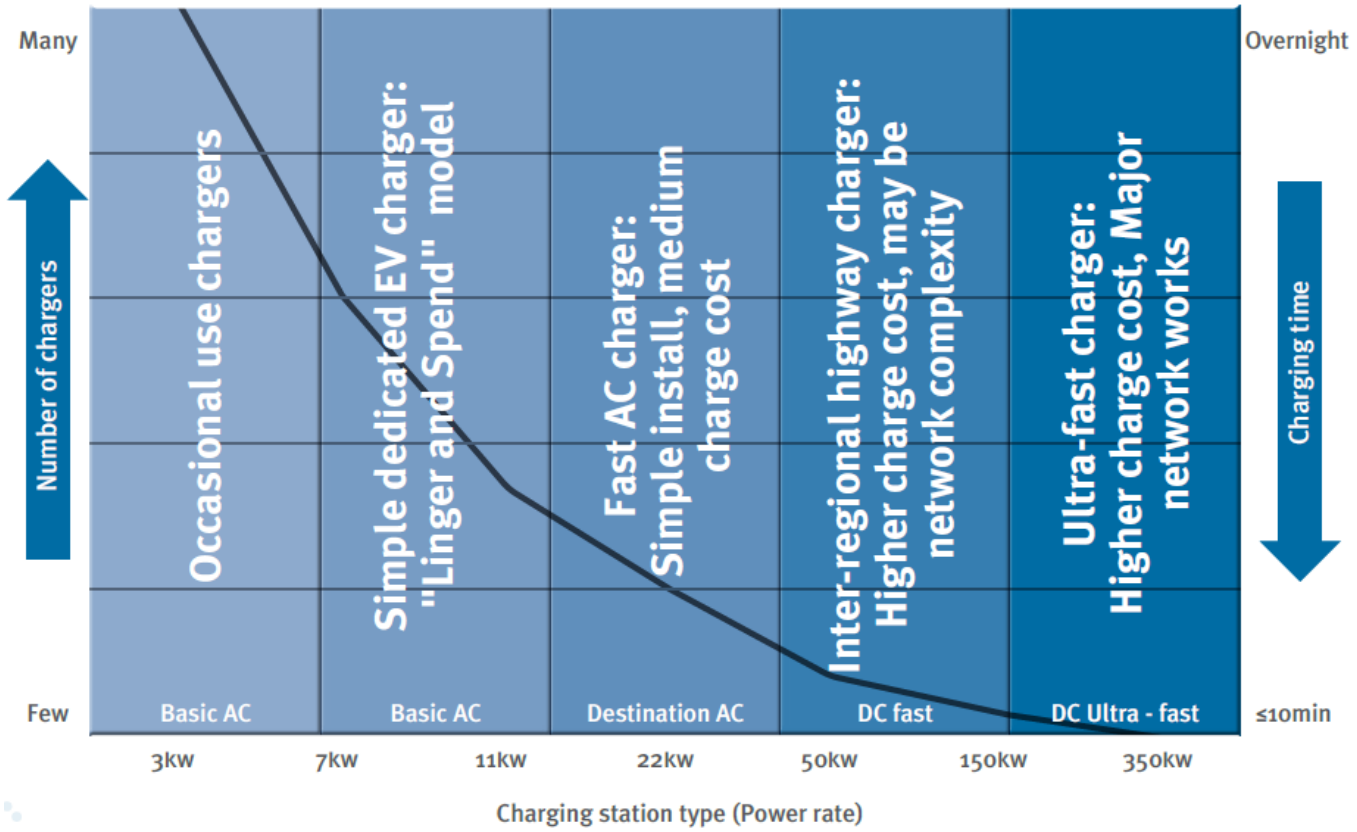

Fig.1. Effect on Charging time with respect to number of chargers & charging station type

Type of Connector used & Layout of the charging Hardware

The Australian standard covering EV charging plugs/connectors (AS IEC 62196.2:2014) doesn't command a single connector standard, yet rather supports the utilization of the two US and EU principles. In that capacity, EVs and EV chargers as of now in Australia have a combination of connectors. For AC charging there is the SAE J1772 (Type 1) connector type, normal to Japan and the US (equipped for up to 19kW charging rate and just single-phase viable); and the IEC 62196 (Type 2), known as the Mennekes connector, which is typical across Europe and can convey up to 43kW charging rate using three-phase power. As far as **DC charging**, Japanese manufacturers drove the development of the CHAdeMO connector, which can be found in EVs, for example, the Nissan Leaf and Mitsubishi Outlander PHEV. Albeit this standard was likewise at first carried out in the U.S., American manufacturers have now moved towards the CCS Combo 1 Type 1 connector, which is basically a similar in appearance as the AC J1772 (Type 1), however, has two extra pins to convey the DC charge. Additionally, the E.U. has embraced the CCS Combo 2 Type 2 connector, which is basically the Mennekes connector, yet once more, with two extra pins to convey the DC charge. Most Australian distributors of significant car manufacturers who produce EVs are in understanding that the ongoing Australian standard ought to be updated to guarantee all electric and hybrid electric vehicles imported to Australia in the future are Type 2 compliant.

The establishment of electric vehicle charging foundation all through Queensland ought to focus on Type 2 Mennekes/CCS Combo 2 given this is generally viable with Australia's electrical framework and would ensure the quickest DC and Level 2 AC charging blend. Compatibility for existing vehicles is conceivable using cable connectors for AC charging (it's feasible to change over from J1772 to Mennekes, yet not the reverse); and in that frame of mind of DC charging, stations can be designed to be furnished with an extra CHAdeMO cable to suit Japanese vehicles. With the consideration of a standard power point at destination charging stations, any electric motorbike, versatility vehicle or bike can likewise charge, as well as giving another charging choice any sort of EV.

Arrangement of the charging equipment as comparable to the parking inlet is likewise a significant thought that is frequently disregarded until establishment. Similarly, as with the connector types, vehicle manufacturers have not been reliable with the area of the charging port, which fluctuates between the front and back and the two sides of the vehicle. DC fast chargers convey high measures of current and hence the charging cables are thick and weighty, bringing about generally short cable lengths. This outcomes in a need to put the charging unit in the right position to take special care of all EVs that would charge from that cable. AC chargers frequently have longer cabled which can reach to all sides of a parked vehicle, in which case placement of the charger is less critical. In general terms, on the off chance that the charging cable can reach at the two sides of the front of the carparking space, then, at that point, it ought to have the option to cater for all EVs parking in that space (expecting the vehicle can likewise reverse into the space). All charging bays ought to be standard perpendicular carpark spaces (not angled, parallel, or reverse-in only) with space past the front of the bay (or to the side) for the charging equipment to be mounted on a wall or to the ground. Now, according to the research conducted for different types of connectors used with respect to the EV charging hardware, we will discuss the site decision making process of EV charging stations in Australia:

EV Charging Station site decision making process

The method involved with choosing a reasonable location for an EV charging station depends on a progression of key variables: **Location, Facilities, Access, Physical, Sustainability, Regulation, Safety & Power.**

Infrequent Charging

Despite the fact that EV users can charge their vehicle from a standard power outlet (utilizing their own manufacturer provided EVSE cable), these are assigned for infrequent utilize as it were. This is certainly not a suggested practice for normal EV charging and accordingly not an answer for EV charging at homes, condos, or any public area.

Basic AC Charging

Fundamental AC chargers can be introduced out in the public or private regions and are the base suggested solution for EV charging. Wholesale carry out of cost-efficient AC chargers all through Australia will enhance the suitability of EV assimilation, increment EV recognition, and diminish range concern. Fundamental AC chargers require an EVSE charging unit which needs to be installed on an assigned circuit by an authorized electrical technician, in accordance with **AS/NZS 3000:2018**. Developments can be future proofed by wiring dedicated AC circuits to parking spots during development and ending with a standard GPO which can be promptly supplanted with a committed EVSE charger sometime in the not-too-distant future. The basic AC Charging Characteristics are:

1. The Power output can be in a range of 2.4 - 7 kW (240V, 10-32A, single phase) & considered as "Level 2".
2. The trip adds up to 10 - 45 km range per hour according to approximate charging rates set by the station.
3. The charging time can vary from minutes to 2 hours to an overnight charge.
4. There’s a consumption of 10 - 35 kWh of maximum electricity per charge.
5. Charging Mode 3 (IEC 61851-1) is used in this type of configuration.

Characteristics used for selecting site:

- To decide whether an area is reasonable for a Basic AC charger, thought ought to be given to the kind of destination, people visiting the area & accessibility of other EV charging points.

- Charging areas ought to have safe, simple admittance to elevated degrees of convenience including bathrooms, cafes, diners, parks, pools, malls, or tourist areas which are ideal possibility for destination chargers.

- To limit capital consumption, it is ideal for the proposed vehicle spaces to have straightforward admittance to the host's power supply which lessens cable runs and henceforth establishment costs.

- Charging points ought to be located to such an extent that cables don't shape a danger for users or different vehicles while connected and not being used. In a public location, the designated space should be able to meet the Crime Prevention through Environmental Design (CPTED) principles with proper lighting for the safety and security of EV drivers.

- The charging station ought to be effectively noticeable including the signpost, parking area, and charging stations which should be available for the EV users with less demand in parking fees & out-of-hour restrictions.

- In an ideal manner, the charging stations would be combined with distributed renewable energy or with minimal expense and renewable electricity tariffs, for example, solar powered vehicle.

- Introducing chargers to an existing car park is auxiliary to the motivation behind the vehicle parking and accordingly wouldn't prompt any requirement for arranging development applications.

Destination AC Charging

Destination AC chargers are an ideal public charging choice for areas where visitors can participate in an activity while likewise charging their EV. These chargers are ideally on three phase power with metering and require establishment on a committed circuit by an authorized electrical technician. The Destination AC Charging Characteristics are:

1. The Power output can be in a range of 11 - 22 kW (415V, 16-32A, three phase) & considered as "Level 2".
2. The trip adds up to 50 - 130 km range per hour according to approximate charging rates set by the station.
3. The charging time can vary from 30 minutes to 2 hours to an overnight charge.
4. There’s a consumption of 8 - 32 kWh of maximum electricity per charge.
5. Charging Mode 3 (IEC 61851-1) is used in this type of configuration.

Characteristics used for selecting site:

- To decide whether an area is reasonable for a destination AC charger, thought ought to be given to the type of destination and its visitors, distances from different attractions, and accessibility of other EV charging points. Position of the charger inside a property is typically directed by the vicinity to the fundamental switchboard, to lessen cable runs and subsequently establishment costs.

- Charging areas ought to have safe, simple admittance to elevated degrees of convenience including bathrooms and refreshments eateries, cafes, restaurants, retail, recreation tourism attractions). Vicinity to an area of importance which grandstands Australia's different scope of destinations, or permits users a decision of neighbouring entertainment facilities, for example, parks, pools, strolls, or tourist regions are ideal contender for destination chargers.

- To minimize capital expenditure, it is best for the proposed vehicle spaces to have basic admittance to the host's power. Powerful destination chargers can draw a lot of power, so a review of the property's electrical framework is expected preceding establishment. Network impact of destination charging is unlikely.

- Charging points ought to be located with the end goal that cables don't shape a danger for pedestrians or different vehicles while connected and not being used. Destination charging is probably going to be in demand over extended hours, like the area. On the off chance that in a public area, bays ought to have the option to meet the Crime Prevention through Environmental Design (CPTED) standards and have sufficient lighting for the wellbeing and security of EV drivers as well as the vehicles and equipment. The area of the equipment ought to consider the risk of vehicle impact and proximity to perils like hazardous fuels: Australian Standards (AS 1940,

AS 4897, AS 60079.10) and the Queensland Work Health and Safety Act 2011 determine the base proximity of electrical charging equipment from hazards like dangerous products and fuels.

- The charging station (comprehensive of signage, parking bays and charging gear) ought to be effectively noticeable and available for users to find. A conspicuous area has the additional impact of making awareness among the general public of the presence of EV charging framework. However unmistakable quality is significant, the area ought not be in premium, high-demand parking region that would urge non-EVs to possess the charging bay or draw in high parking expenses. Accessibility regarding impediments to non-paying patrons, and out-of-hours limitations likewise should be thought of.

- Preferably the charging stations would be combined with distributed renewable energy, for example, solar based PV, or with minimal expense and renewable electricity tariffs. As it is desirable to use existing carparks, the physical attributes, (for example, accessible space for the charging equipment; potential trenching implications; gradient; turning circles; shelters; surface seepage; flood risk and so on) should be thought of. The footprint of an AC charger is negligible and can be mounted on a nearby wall or on a bollard. Introducing chargers to an existing car park is subordinate to the motivation behind the car park and consequently wouldn't prompt any requirement for arranging development applications.

Fast DC charging

Fast charging stations are expected in key strategic areas along significant routes or in areas of high demand to give effectively accessible, fast charging facilities for EV drivers, with direct admittance to conveniences to guarantee charging time can be combined with other activity. The implementation of DC fast chargers at these areas will permit rapid charging of the EV battery for least travel interruption. he deployment of an inter-regional network is best embraced in a planned manner by state and local government in conjunction related to the local electricity network supplier. Distances between regional stations ought to be minimized (preferably 70km but no more than 200km) as to give EV drivers choices in their trip planning. Inter-regional charging stations as a part of the Queensland Electric Super Highway (QESH) will generally operate as a separately metered business on local government or state-controlled reserve or freehold land, or as a component of a service station. The Fast DC Charging Characteristics are:

1. The Power output can be in a range of 50 - 150 kW (415V, three phase) & considered as "Level 3".
2. The trip adds up to 100 - 300 km range per hour according to approximate charging rates set by the station.
3. The charging time can vary from 20 minutes to 1 hour.
4. There’s a consumption of 15 - 90 kWh of maximum electricity per charge.
5. Charging Mode 4 (IEC 61851-1) is used in this type of configuration.

Characteristics used for selecting site:

- To decide whether an area is reasonable for a Fast DC charger, thought ought to be given to the distance from other Fast chargers on the route or in a region. Position of Fast charger inside a property requires cautious planning and is generally directed by the proximity to the fundamental switchboard, to lessen cable runs and consequently establishment costs.

- A prerequisite of inter-regional charging is to guarantee users have a comfortable, enjoyable, and wonderful experience. Charging areas ought to have safe, simple admittance to elevated degrees of convenience including bathrooms and refreshments (eateries, cafes, restaurants). Ideally an inter-regional station ought to have proximity to an area of importance which grandstands Queensland's different scope of destinations or permits users a choice of neighbouring recreation facilities like parks, pools, strolls, or tourist areas.

- To minimize capital expenditure, it is essential for an inter-regional station (which includes powerful DC chargers) to optimize the area as per the capacity of the encompassing electrical framework. A few sites might have multiple DC chargers or be in mix with several AC chargers. Thusly, the site needs to consider electricity network capacity and ought to be found nearby an existing high-power transformer with adequate capacity, or as a feature of a more extensive development that requires new transformer capacity.

- The design and layout of the road admittance to and from highway charging stations should be viewed as far as the safety and efficiency of the road network. The area and design of the charging bays likewise should be viewed as far as pedestrian security for disembarking and accessing nearby facilities. If part of a larger development, charging bays ought to be situated in regions that permit drivers to get to a full scope of services at the facility. Charging points ought to be found to such an extent that cables don't shape a hazard for pedestrians or different vehicles while connected and not being used. It should follow the same CPTED principles & Australian standards for safety.

- The charging station (comprehensive of signage, parking bays and charging gear) ought to be effectively noticeable and available for users to find. A conspicuous area has the additional impact of making awareness among the general public of the presence of EV charging framework. However unmistakable quality is significant, the area ought not be in premium, high-demand parking region that would urge non-EVs to possess the charging bay or draw in high parking expenses. Accessibility regarding impediments to non-paying patrons, and out-of-hours limitations likewise should be thought of.

- Ideally the charging stations would be connected with minimal expense and renewable electricity tariffs. Distributed renewable energy, for example, solar oriented PV, won't match the energy demand profile of fast chargers. Batteries might offer support to all the more likely match local renewable distribution to charging demand as well as lessening peak demand tariff costs.

- As it is desirable to use existing carparks, the physical attributes, (for example, accessible space for the charging equipment; potential trenching implications; gradient; turning circles; shelters; surface seepage; flood risk and so on) should be thought of. The footprint of a DC charger is roughly 750mm x 350mm, and frequently a switchboard cabinet is likewise required nearby the chargers.

- Introducing chargers to an existing car park is subordinate to the motivation behind the car park and consequently wouldn't prompt any requirement for arranging development applications, however this ought to be reviewed in instances of a new dedicated carpark for EV charging. Planning considerations for any new development and related uses would need to be viewed based on the land use zoning of the site.

Operational cost & cost recovery

For Basic AC chargers in public areas, hosts might decide to recuperate the expense of the power from charging through direct strategies, for example, having the chargers metered by a third party, or by some indirect techniques. The low forthright expense of destination charging foundation, matched with the power utilization charges, can be counterbalanced by spending money at the area. Numerous business organizations will offer EV charging as method for drawing in the EV tourist/EV demographic, by giving a competitive edge inside the marketplace. At those areas where high utilization is forecast, there are various accessible systems for hosts to recuperate the expense of power consumed by free EV chargers.

For Destination AC chargers, hosts might choose to recuperate the expense of the electricity from charging through direct methods, for example, having the chargers metered by a third party. Indirect methods could likewise be utilized however the power utilization will be higher than with more slow chargers. A blend of basic and destination chargers may likewise be introduced in an area with various methods for cost recuperation.

Locations where high utilization is forecast, there are various accessible mechanisms for hosts to recuperate the expense of power electricity by free EV chargers. For instance:
1. In exchange for conducting business at that destination, EV visitors can be furnished with a free AC charge, under a 'linger-and-spend' model.
2. At a retail, tourist or food/drink location, the expenses of Level 2 (fast) charging could be balanced by a 'loyalty rewards system' with a spend X, get free charging model (for example spend $60 & get 1-2 hours EV charge).
3. At a managed vehicle parking area, suitable 'parking control, for example, vehicle parking charges or time restrictions could counterbalance or deal with the power utilization.

Fast charging stations require a significant capital investment notwithstanding the operational expenses, and mostly all stations will incorporate payment mechanisms into the charging equipment to cover the ongoing expense of the power consumed. EV users can operate charging stations through a cell phone application, cloud-based accounts, or credit card. There are several aftermarket software management systems which can manage the data collection, payment mechanisms and user interface of the EV charging equipment. It is suggested that inter-operability and ease-of-use for EV drivers is thought about while choosing the interaction system. Albeit the upfront expense of fast-charging framework is high, several areas in Queensland have proactively introduced DC chargers as method for drawing the EV demographic, by providing a competitive edge within the marketplace.

Investigation shows that customer spending is connected with time spent or stay time at an area. A US study showed that the establishment of EV chargers at a Californian shopping centre, expanded guest stay time by an additional 50 minutes at the location. Consequently, there are clear financial advantages to site hosts of longer customer 'wait' or dwell time, notwithstanding the expanded green credentials. This works best where there is a captured market, where the parking and spend opportunities are connected and there is next to zero spillage opportunities to different areas. Where there is probably going to be critical spillage then a rewards system or parking controls might be vital. The average stay time at a typical Australian shopping centre is 59 minutes, and analysis shows that customers spend an extra $0.76 per minute for each extra minute spent in that area.

Future innovation plan for Australian EV Charging stations

As a component of their 2020-21 financial plan, Australia reported it will finance BEV (Battery Electric Vehicle) fast-charging stations across key cities and regions, allot $40 million for charging infrastructure support and hold a two-year EV trial for a government fleet. Where Australia truly stands out is at the state level. States have set their own initiatives, strategies, and impetuses to help progress transition numbers even without national standards to utilize as a guide. The lack of national policies or guidelines around the EV market stands apart as Australia's greatest chance to impel an EV transition. An official EV policy with impetuses for making the transition will highlight the significance of EVs to inhabitants and encourage prior adoption. States might have made a move; however, it is in the national government's hands to accelerate the transition to EV with firm regulatory standards. There are just about 10 EVs for each public charge point and by 2030 there will be an expected 20 EVs for each 1,000 individuals with an accessibility of 30 EV models.

Queensland’s ambitious 10-year plan

Queensland's Department of Transport and Main Roads (TMR) as of late delivered Creating Better Connections for Queenslanders, an ambitious 10-year initiative to get ready for the 2032 Olympics and 2023 FIFA Women's World Cup alongside changing customer expectations and industry dynamics. TMR intends to harness Industry 4.0 and the application of sustainability and resilience standards to empower mobility for Queenslanders and visitors. Australia's mobility specialists as of late given input and feedback on TMR's objectives. In doing as such, they identified five strategic focus regions that would add to a safe, reliable, and sustainable mobility landscape. Technology and great data rehearse have the capacity to empower better journey results more than ever. Incorporating Big Data to connect disparate systems and make an all-encompassing perspective across networks can open a profound comprehension of network performance that ranges historic, real-time, and future viewpoints. A solid data establishment will be essential to mobility as a service (MaaS), which TMR perceives as a feature of the bundle of choices to further develop mobility for Queenslanders.

TMR must strategize for the planned events (infrastructure changes, major sporting events, etc) while likewise tending to the unique pressures brought about by natural disasters and severe climate. Every event, planned or unplanned, is special and will require a painstakingly planned reaction informed by data. A pledge to green the fleet by 2030 is invigorating yet there is no time to waste. Fleet transition attainability review and planning is the essential initial step of the electrification journey to boost capital and develop viable pilots, testing, and program optimization plans. Past buses, rideshare and taxi vehicles, ships and trains can likewise be transitioned as EV and hydrogen vehicle technology evolves.

An ideal EV environment will guarantee long haul success. This incorporates a mix of policy, financial initiatives, and public and private partnerships to convey a critical amount of empowering infrastructure for the adoption of green fleets. Government fleets can be the early adopters of electric fleets to demonstrate Queensland's obligation to sustainability. The charging facilities for municipal vehicles can be imparted to the public, which expands the usage of the chargers as well as advances the perceivability of the investment in sustainable mobility.

Developments like EV and associated and autonomous vehicles bring welcome change, yet additionally new pressures on infrastructure by making road use more appealing and wiping out jurisdictions primary source of road funding (traditional fuel taxes). This is as well as existing disputes for road space from expanded ride sharing and freight connected with online shopping. Dispute around parking is ascending too. Integrated ways to deal with policy, planning and digital advancement are expected to address the accelerating change in road utilization and curb side management.

REFERENCES

1. Overcoming Barriers to Deployment of Plug-in Electric Vehicles. Transportation Research Board and National Research Council. Washington, DC: The National Academies Press, 2015. doi:10.17226/21725

2. Overcoming Barriers to Deployment of Plug-in Electric Vehicles. Transportation Research Board and National Research Council. Washington, DC: The National Academies Press, 2015. doi:10.17226/21725

3. Sierzchula, W., Bakker, S., Maat, K. & van Wee, B., 2014. The influence of financial incentives and other socio-economic factors on electric vehicle adoption, Energy Policy 68, 183-194. http://dx.doi.org/10.1016/j.enpol.2014.01.043

4. Nilsson, M. & Nykvist, B., 2016. Governing the electric vehicle transition - Near term interventions to support a green energy economy, Applied Energy. http://dx.doi.org/10.1016/j.apenergy.2016.03.056

5. https://electricvehiclecouncil.com.au/wp-content/uploads/2020/08/EVC-State-of-EVs-2020-report.pdf

6. https://www.abs.gov.au/statistics/industry/tourism-and-transport/motor-vehicle-census-australia/latest-release

7. https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf

8. https://electricvehiclecouncil.com.au/about-ev/evs-available/

9. https://www.energy.vic.gov.au/renewable-energy/zero-emissions-vehicles

10. https://electricvehiclecouncil.com.au/wp-content/uploads/2020/08/EVC-State-of-EVs-2020-report.pdf

11. https://www.environment.act.gov.au/__data/assets/pdf_file/0012/1188498/2018-21-ACTs-transition-to-zero-emissions-vehicles-Action-Plan-ACCESS.pdf

12. https://www.publications.qld.gov.au/dataset/the-future-is-electric-queensland-s-electric-vehicle-strategy/resource/7e352dc9-9afa-47ed-acce-2052cecfec8a

13. https://www.wa.gov.au/sites/default/files/2020-11/State_Electric_Vehicle_Strategy_for_Western_Australia_0.pdf

14. https://www.environment.gov.au/system/files/resources/f52d7587-8103-49a3-aeb6-651885fa6095/files/summary-australias-2030-emissions-reduction-target.pdf