



Electric Vehicle (EV) Charging Infrastructure



PRACTICE NOTE

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Queensland
Government

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Front cover top: Cairns fast charging station

Front cover bottom: Bowen Fast charging station on the Queensland Electric Super Highway.

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Introduction

Purpose of the Practice Note

This Practice Note outlines the principles for planning electric vehicle (EV) charging infrastructure in Priority Development Areas (PDAs) in Queensland, to support the selection of the right type of infrastructure at the right location. It is intended to assist government authorities, town planners, developers and landholders looking at installing EV charging infrastructure. This Practice Note does not replace or override any applicable local planning laws, building codes and Australian standards.

Background

The Electric Vehicle (EV) is an innovative technology that presents a unique opportunity for the State of Queensland to capitalise on the economic, environmental and social benefits of EVs, whilst supporting the transformation of the State's transportation system. To encourage EV uptake among consumers, a network of EV charging infrastructure is required to allow uninhibited long-distance travel.

By following the principles of the State Infrastructure Plan to develop innovative solutions to future needs, installation of a network of EV charging stations can provide a wide range of benefits to Queensland while utilising existing assets and infrastructure.

How to use the Practice Note

This Practice Note explains in Part 1 the principles and general information of how EVs are typically charged and the categories and levels of charging infrastructure.

Part 2 provides a detailed decision making process for the different types of chargers. This considers the various factors which influence the location of EV charging stations.



Figure 1. Fast DC charger at Townsville, James Cook University

Part 1 - Principles and General Information

Need for EV charging infrastructure

A lack of public charging infrastructure is regularly cited as a significant barrier to EV uptake¹. The planning and installation of the right type of EV charging infrastructure at the right location minimises the perceived risk of 'range anxiety' and increases public awareness of EVs.

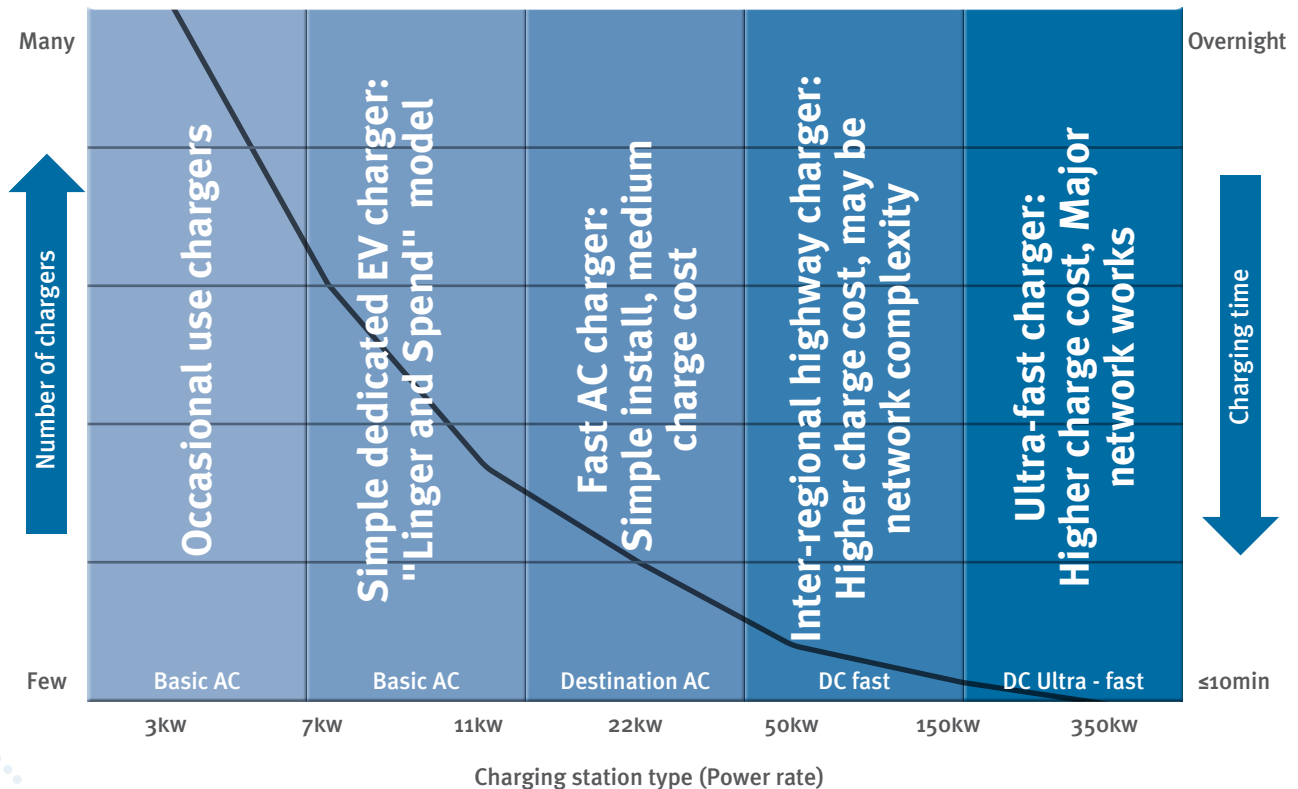
Understanding how EV drivers charge their EVs is important in understanding EV charging infrastructure. A key difference between internal combustion engine (ICE) and plug-in electric vehicles is the way they are refuelled or charged. ICE vehicles are generally refuelled on a 'fill up' basis; that is, when the petrol tank is near empty the driver fills the tank to full. This is because the only place ICE vehicles can be refuelled is at a service station, which requires a specific decision to visit whilst on-route or as the sole reason for the trip.

With battery electric vehicles (BEVs) and plug-in hybrid EVs (PHEVs), drivers tend to regularly 'top up' the battery (often to 80% unless they are preparing for a longer trip when they charge up to 100%) as opposed to irregularly 'filling up'. This is because private owned vehicles are parked most of the time, and the overwhelming majority of vehicle trips, including commuting trips, are short and within battery

range. This provides multiple opportunities for cost effective and convenient charging using either common power points or charging stations. Keeping the EV 'topped up' helps to alleviate the risks of 'range anxiety' by avoiding low battery levels. When required to travel long distances, EVs can 'fill up' at inter-regional fast charging stations whilst on-route.

This charging behaviour leads to a widespread distribution of EV charging points, with every existing accessible standard power socket a potential 'topping up' location. Dedicated public EV chargers, in a wide variety of locations, and a relatively smaller number of fast DC chargers, provide for a complete EV charging ecosystem (see Figure 2). The EV Ecosystem Charging Curve illustrates the relative number of chargers, according to charging type and charging times, (e.g. there are high numbers of slow charging points, whereas relatively few DC ultra-fast chargers are required to achieve a complete EV Ecosystem).

Figure 2. The EV Ecosystem Charging Curve



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

Levels of EV charging explained

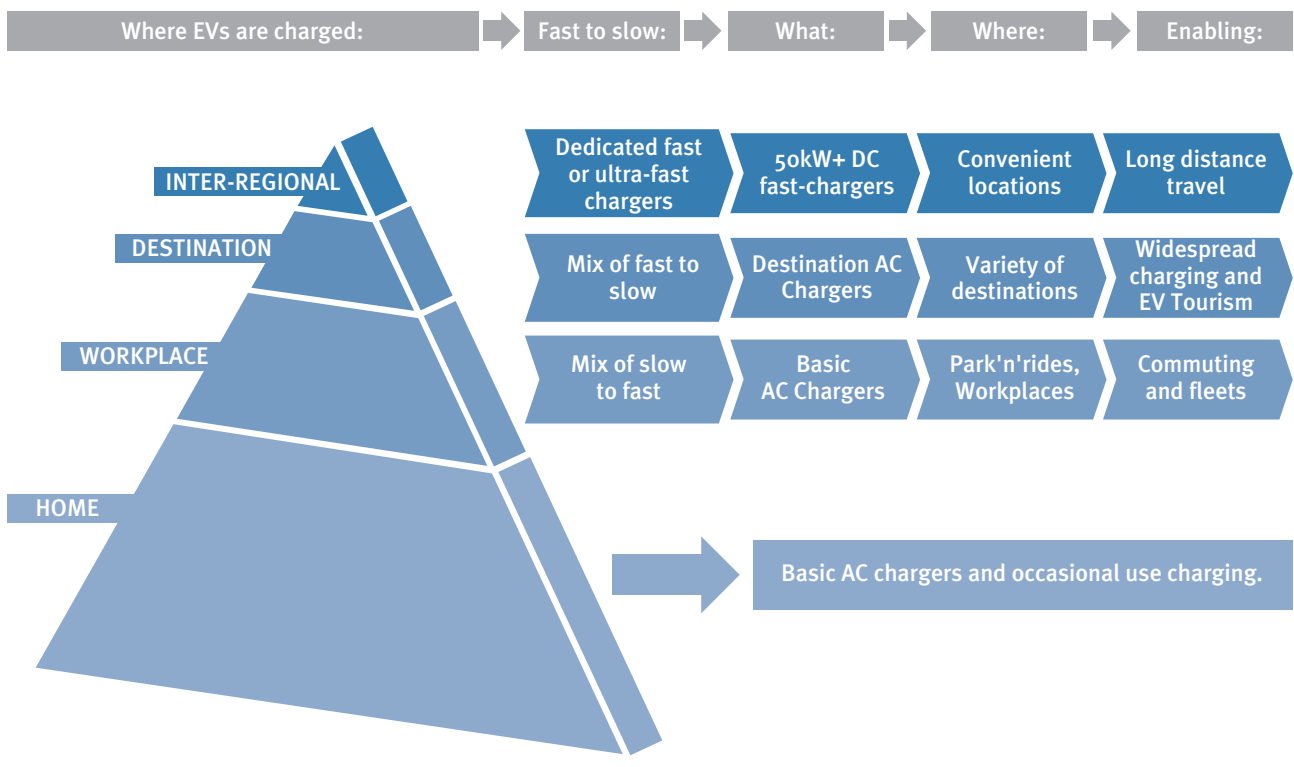
Most EV charging is undertaken at home, principally because this is where it is most convenient to do so². In many overseas regions workplaces are offering EV charging as an additional workplace benefit. Although only 3 to 5% of all EV charging occurs at inter-regional fast charging locations, studies suggest a strong psychological impact of public charging infrastructure on the perceived flexibility of owning an EV, and in turn, how likely a consumer is to purchase an EV^{3,4}.

Figure 3. Hierarchy of EV Charging Infrastructure illustrates the observed general distribution of EV charging across different types of charging infrastructure.

Table 1. provides more information on each category








Figure 3. Hierarchy of EV Charging Infrastructure



- 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
- Sierchula, 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>
- 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>

Table 1. Levels of EV charging

Category	Infrastructure provision	Capital & expected usage cost	Installation difficulty	Operation and management	Example of infrastructure	Typical locations
Occasional Charging (Level 1 / Mode 2) See page 6	Standard power outlet (GPO), and user supplied specific EV charging cable	\$	Straight forward, assuming a standard GPO is within reach of car parking space	Self managed.		Not a recommended solution for existing or new developments as this method is designed only for occasional EV charging.
Basic AC Charging (Level 2 / Mode 3) See page 7	Dedicated AC circuit (15-32A single phase) with hard-wired EVSE (EV supply equipment) AC charger	\$\$	Straight forward installation by a licenced electrician	Can be self-operated or managed by a third party where costs could be recovered		Long dwell time destinations such as homes, apartments, accommodations, and workplaces.
Destination AC Charging (Level 2 / Mode 3) See page 9	Dedicated AC circuit (single phase or three phase, up to 32A) with hard-wired EVSE charger	\$\$\$	Medium difficulty in a public environment - within the scope of property owner to plan and deliver.	Likely to be operated by third party where costs could be recovered		Shorter dwell time destinations such as shopping centres, tourist attractions and public parking areas.
Fast DC Charging (Level 3 / Mode 4) See page 11	Dedicated DC charger for high traffic public areas	\$\$\$\$\$	Difficult, likely to require coordination with electricity networks or masterplan developer, and possibly local government and road transport planning agency.	Likely to be operated by third party where costs are recovered		Inter-regional travel on major transport routes or areas with high demand for fast charging
Ultra-fast DC Charging (Level 3 / Mode 4) See page 14	Dedicated ultra-fast DC charger for strategic public areas	\$\$\$\$\$\$	Difficult, highly likely to require coordination with electricity networks, local government and road transport planning agency	Likely to be operated by third party where costs are recovered		Strategically placed service centre on national highway routes

Plugs and connection hardware

Connector types

The Australian standard covering EV charging plugs/connectors (AS IEC 62196.2:2014) does not mandate a single connector standard, but instead endorses the use of both US and EU standards. As such, EVs and EV chargers currently in Australia have a mixture of connectors. For AC charging there is the SAE J1772 (Type 1) connector type, common to Japan and the US (capable of up to 19kW charging rate and only single-phase compatible); and the IEC 62196 (Type 2), known as the Mennekes connector, which is commonplace across Europe and can deliver up to 43kW charging rate utilising three-phase power.

In terms of DC charging, Japanese manufacturers led the development of the CHAdeMO connector, which can be found in EVs such as the Nissan Leaf and Mitsubishi Outlander PHEV. Although this standard was also initially rolled out in the U.S., American manufacturers have now shifted towards the CCS Combo 1 Type 1 connector, which is essentially the same in appearance as the AC J1772 (Type 1), however, has an additional two pins to carry the DC charge. Similarly, the E.U. has adopted the CCS Combo 2 Type 2 connector, which is essentially the Mennekes connector, but again, with two additional pins to carry the DC charge.

Most Australian distributors of major auto manufacturers who produce EVs are in agreement that the current Australian standard should be updated to ensure all electric and hybrid electric vehicles imported to Australia in the future are Type 2 compliant.

The installation of electric vehicle charging infrastructure throughout Queensland should prioritise Type 2 Mennekes / CCS Combo 2 given this is most compatible with our electrical infrastructure and would guarantee the fastest DC and Level 2 AC charging combination. Compatibility for existing vehicles is possible through the use of cable adapters for AC charging (it's possible to convert from J1772 to Mennekes, but not the reverse); and in the case of DC charging, stations can be configured to be equipped with an additional CHAdeMO cable to suit Japanese vehicles. With the inclusion of a standard power point at destination charging stations, any electric motorbike, mobility vehicle or bicycle will also be able to charge, in addition to providing another charging option any type of EV.



Figure 4. Type 2 Mennekes connector

Charging hardware layout

Placement of the charging hardware in relation to the parking bay is also an important consideration that is often neglected until installation. As with the connector types, car manufacturers have not been consistent with the location of the charging port, which varies between the front and rear and both sides of the vehicle.

DC fast-chargers carry high amounts of current and therefore the charging cables are thick and heavy, resulting in relatively short cable lengths. This results in a need to place the charging unit in the correct position to cater to all EVs that would charge from that cable. AC chargers often have longer cables which can reach to all sides of a parked car, in which case placement of the charger is less critical.

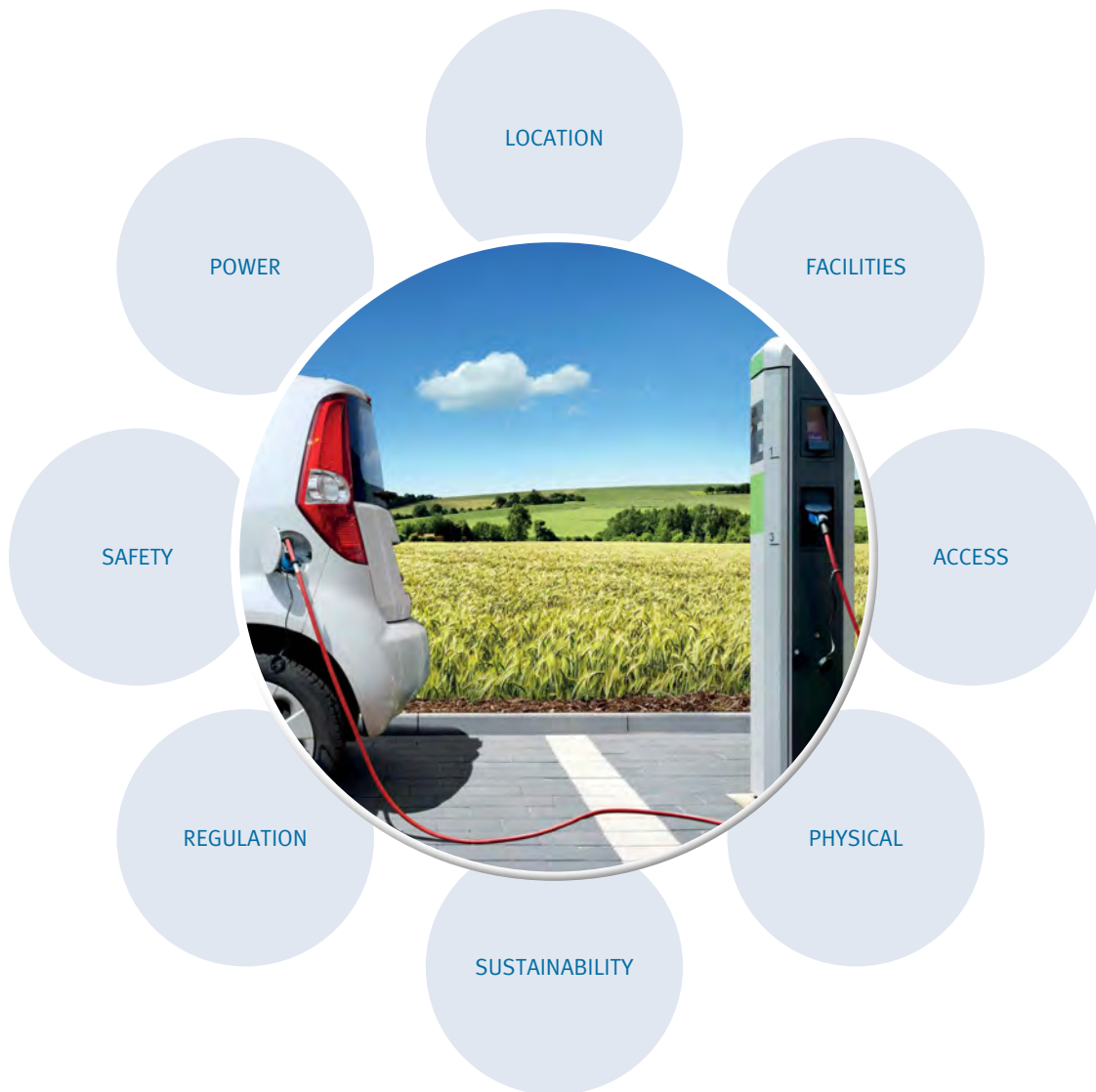
In general terms, if the charging cable can reach both sides of the front of the carparking space, then it should be able to cater for all EVs parking in that space (assuming the vehicle can also reverse in to the space). All charging bays should be standard perpendicular carpark spaces (not angled, parallel, or reverse-in only) with space beyond the front of the bay (or to the side) for the charging hardware to be mounted on a wall or to the ground.

Part 2 - Site decision making process

Site Selection Criteria

The process of selecting a suitable location for an EV charging station is based on a series of key factors, presented in the Figure 5 below. These are described in each of the following chapters according to the charging category type.

Figure 5. Key location selection criteria for EV charging stations



Occasional Charging

Although EV users can charge their vehicle from a standard power outlet (using their own manufacturer-supplied EVSE cable), these are designated for occasional use only. This is not a recommended practice for regular EV charging and therefore not a solution for EV charging at homes, apartments, or any public location.

Basic AC Charging

Likely locations

Long dwell time destinations such as homes, apartments, workplaces, tourist attractions, retail centres, cinemas, beach, council car park, multi-residential buildings, entertainment and restaurant precincts.

Background

Basic AC chargers⁶ can be installed in public or private areas and are the minimum recommended solution for EV charging. Widespread roll out of cost effective AC chargers throughout Queensland will improve the viability of EV uptake, increase EV awareness, and reduce range anxiety.

Basic AC chargers require an EVSE charging unit to be installed on a dedicated circuit by a licensed electrician, in accordance with AS/NZS 3000:2018. Developments can be future proofed by wiring dedicated AC circuits to parking spaces during construction and terminating with a standard

GPO which can be readily replaced with a dedicated EVSE charger at a later date.

Basic AC Charging Characteristics:

- » Power: 2.4 - 7 kW (240V, 10-32A, single phase) - "Level 2"
- » Approx. charging rates⁷: Adds 10 - 45 km range per hour
- » Typical parking / charging time: Min. 2 hours to overnight.
- » Max. electricity consumption per charge: 10 - 35 kWh
- » Charging Mode 3 (IEC 61851-1)

Site Selection

To determine the optimum number and type of chargers the following factors should be considered: type of charging station/destination; likely visit duration; hours of access; need for metering, pricing, and communication requirements.

Criteria	Description	Check
Location	To determine if a location is suitable for a Basic AC charger, consideration should be given to the type of destination and its visitors, and availability of other EV charging points.	
Facilities	Charging locations should have safe, easy access to high levels of amenity including restrooms and refreshments (eateries, cafes, restaurants). Proximity to a location of significance which showcases Queensland's diverse range of destinations, or allows users a choice of nearby recreation facilities such as parks, pools, walks or tourist areas are ideal candidates for destination chargers.	
Power	In order to minimise capital expenditure, it is preferable for the proposed car spaces to have simple access to the host's electricity supply. If running multiple chargers an electrician may need to check that there is sufficient capacity. Placement of Basic AC charger within a property is usually dictated by the proximity to the main switchboard, to reduce cable runs and hence installation costs.	
Safety	Charging points should be located such that cables do not form a hazard for pedestrians or other vehicles whilst plugged in and not in use. If in a public location, bays should be able to meet the Crime Prevention through Environmental Design (CPTED) principles, and have adequate lighting for the safety and security of EV drivers as well as the vehicles and hardware. The location of the hardware should consider the risk of vehicle impact and proximity to hazards such as dangerous fuels: Australian Standards (AS 1940, AS 4897, AS 60079.10) and the Queensland Work Health and Safety Act 2011 specify the minimum proximity of electrical charging hardware from hazards such as dangerous goods and fuels.	
Access	The charging station should be easily visible (inclusive of signage, parking bays and charging equipment) and accessible for users to find. A prominent location has the additional effect of creating awareness amongst the general public of the existence of EV charging infrastructure. Though prominence is important, the location should not be in a premium, high-demand parking area that would encourage non-EVs to occupy the charging bay, or attract high parking fees. Accessibility in terms of limitations to non-paying patrons, and out-of-hours restrictions also need to be considered.	
Sustainability	Ideally the charging stations would be coupled with distributed renewable energy, such as solar PV, or with low cost and renewable electricity tariffs.	
Physical	As it is preferable to utilise existing carparks, the physical characteristics (such as: available space for the charging hardware; potential trenching implications; gradient; turning circles; canopies; surface drainage; flood risk etc) need to be considered. The footprint of an AC charger is minimal and can be mounted on a nearby wall or on a bollard.	
Regulation	Installing chargers to an existing car park is ancillary to the purpose of the car park and therefore would not instigate any need for planning development applications.	

⁶ Alternating Current (AC) chargers use common existing AC power connection points which have restricted charging rates due to circuit limitations. Fast AC can be achieved using three phase power connections.

⁷ Dependent on the vehicle, battery state of charge, supply voltage, circuit loadings etc.

Operational costs

For Basic AC chargers in public locations, hosts may choose to recover the cost of the electricity from charging through direct methods, such as having the chargers metered by a third party, or by indirect methods as explained below.

Indirect cost recovery

The low upfront cost of destination charging infrastructure, paired with the electricity consumption charges, can be offset by consumers spending money at the location. Many businesses will offer EV charging as means of attracting the EV tourist/EV demographic, by providing a competitive edge within the marketplace.

At locations where high usage is forecast, there are a number of available mechanisms for hosts to recover the cost of electricity consumed by free EV chargers. For example:

- » In exchange for conducting business at that destination, EV visitors can be provided with a free AC charge, under a 'linger-and-spend' model.
- » At a retail, tourist or food/drink location the costs could be offset by a 'loyalty rewards system' with a spend X, receive free charging model (e.g. spend \$20 receive 2 hours EV charge).
- » At a managed car parking location, appropriate 'parking control' such as car parking fees or time restrictions could offset or manage the electricity consumption.

Analysis shows that customer spending is related to time spent or dwell time at a location⁸. A US study showed that the installation of EV chargers at a Californian shopping centre, increased visitor dwell time at the location⁹. Therefore, there are clear economic benefits to site hosts of longer customer 'linger' or dwell time, in addition to the increased green credentials. This works best where there is a captured market, where the parking and spend opportunities are linked and there is little to no leakage opportunities to other locations. Where there is likely to be significant leakage then a rewards system or parking controls may be necessary.

Presently 'loyalty rewards' and fuel discount schemes operate with fuel distribution and supermarket chains. EV 'loyalty rewards systems' are more likely to be operated by a property owner (i.e. shopping centre) or by a local government on behalf of local retailers.



Figure 6. Destination chargers in a large shopping centre carpark



Figure 7. Basic AC Charger

⁸ The average dwell time at a typical Australian shopping centre is 59 minutes, and analysis shows that customers spend an additional \$0.76 per minute for each additional minute spent in the location - Bailey, Matthew. 2013. Consumer Profiles and Behaviour in Australian Shopping Centres, Retail Property Insights Vol.20, No.1, 2013

⁹ A study in the US indicated that after the installation of EV chargers at a Californian shopping centre, visitors spent an additional 50 minutes at the location above the normal dwell time <https://www.chargepoint.com/files/casestudies/cs-retail.pdf>

Destination AC Charging

Likely locations

Tourist attraction with short dwell time, tourist information centre, retail centre, council car park, council pool, fast food location, service station with dwell facilities. Multi-residential or workplaces with fleet vehicles are also suitable locations, where they may be installed to complement a larger number of slower chargers.

Background

Destination AC chargers are an ideal public charging option for locations where visitors can partake in an activity whilst also charging their EV. These chargers are ideally on three phase power with metering and require installation on a dedicated circuit by a licensed electrician.

Destination AC Charging Characteristics:

- » Power: 11 - 22 kW (415V, 16-32A, three phase) - "Level 2"
- » Approx. charging rates: Adds 50 - 130 km range per hour
- » Typical parking / charging time: 30 minutes to 2 hours
- » Max. electricity consumption per charge: 8 - 32 kWh
- » Charging Mode 3 (IEC 61851-1)

Site Selection

To determine the optimum number and type of chargers the following factors should be considered: type of charging station/destination; likely visit duration; hours of access; need for metering, pricing, and communication requirements.

Criteria	Description	Check
Location	To determine if a location is suitable for a destination AC charger, consideration should be given to the type of destination and its visitors, distances from other attractions, and availability of other EV charging points. Placement of the charger within a property is usually dictated by the proximity to the main switchboard, to reduce cable runs and hence installation costs.	
Facilities	Charging locations should have safe, easy access to high levels of amenity including restrooms and refreshments (eateries, cafes, restaurants, retail, recreation tourism attractions). Proximity to a location of significance which showcases Queensland's diverse range of destinations, or allows users a choice of nearby recreation facilities such as parks, pools, walks or tourist areas are ideal candidates for destination chargers.	
Power	In order to minimise capital expenditure, it is preferable for the proposed car spaces to have simple access to the host's electricity supply. High powered destination chargers can draw a significant amount of power, so a review of the property's electrical infrastructure is required prior to installation. Network impact of destination charging is unlikely.	
Safety	Charging points should be located such that cables do not form a hazard for pedestrians or other vehicles whilst plugged in and not in use. Destination charging is likely to be in demand over extended hours, similar to the location. If in a public location, bays should be able to meet the Crime Prevention through Environmental Design (CPTED) principles, and have adequate lighting for the safety and security of EV drivers as well as the vehicles and hardware. The location of the hardware should consider the risk of vehicle impact and proximity to hazards such as dangerous fuels: Australian Standards (AS 1940, AS 4897, AS 60079.10) and the Queensland Work Health and Safety Act 2011 specify the minimum proximity of electrical charging hardware from hazards such as dangerous goods and fuels.	
Access	The charging station (inclusive of signage, parking bays and charging equipment) should be easily visible and accessible for users to find. A prominent location has the additional effect of creating awareness amongst the general public of the existence of EV charging infrastructure. Though prominence is important, the location should not be in a premium, high-demand parking area that would encourage non-EVs to occupy the charging bay, or attract high parking fees. Accessibility in terms of limitations to non-paying patrons, and out-of-hours restrictions also need to be considered.	
Sustainability	Ideally the charging stations would be coupled with distributed renewable energy, such as solar PV, or with low cost and renewable electricity tariffs.	
Physical	As it is preferable to utilise existing carparks, the physical characteristics (such as: available space for the charging hardware; potential trenching implications; gradient; turning circles; canopies; surface drainage; flood risk etc) need to be considered. The footprint of an AC charger is minimal and can be mounted on a nearby wall or on a bollard.	
Regulation	Installing chargers to an existing car park is ancillary to the purpose of the car park and therefore would not instigate any need for planning development applications.	

¹⁰ Dependent on the vehicle, battery state of charge, supply voltage, circuit loadings etc.

Operational costs

For Destination AC chargers, hosts may choose to recover the cost of the electricity from charging through direct methods such as having the chargers metered by a third party. Indirect methods could also be used though the electricity consumption will be higher than with slower chargers. A mix of basic and destination chargers may also be installed in a location with different methods of cost recovery.

Indirect cost recovery

The upfront cost of destination charging infrastructure, paired with the moderate electricity consumption charges, are usually offset by consumers spending money at the location. Many businesses will offer EV charging as means of attracting the EV tourist/EV demographic, by providing a competitive edge within the marketplace.

Analysis shows that customer spending is related to time spent, or dwell time, at a location¹¹. A US study showed that the installation of EV chargers at a Californian shopping centre, increased visitor dwell time at the location¹². Therefore, there are clear economic benefits to site hosts of longer customer 'linger' or dwell time, in addition to the increased green credentials. This works best where there is a captured market, where the parking and spend opportunities

are linked and there is little to no leakage opportunities to other locations. Where there is likely to be significant leakage then a rewards system or parking controls may be necessary.

At locations where high usage is forecast, there are a number of available mechanisms for hosts to recover the cost of electricity consumed by free EV chargers. For example:

- » In exchange for conducting business at that destination, EV visitors can be provided with a free AC charge, under a 'linger-and-spend' model.
- » At a retail, tourist or food/drink location the costs of Level 2 (fast) charging could be offset by a 'loyalty rewards system' with a spend X, receive free charging model (e.g. spend \$60 receive 1-2 hours EV charge).
- » At a managed car parking location, appropriate 'parking control' such as car parking fees or time restrictions could offset or manage the electricity consumption.

Presently 'loyalty rewards' and fuel discount schemes operate with fuel distribution and supermarket chains. EV 'loyalty rewards systems' are more likely to be operated by a property owner (ie shopping centre) or by a local government on behalf of local retailers.



Figure 8. Dual socket public destination chargers.

¹¹ The average dwell time at a typical Australian shopping centre is 59 minutes, and analysis shows that customers spend an additional \$0.76 per minute for each additional minute spent in the location - Bailey, Matthew. 2013. Consumer Profiles and Behaviour in Australian Shopping Centres, Retail Property Insights Vol.20, No.1, 2013

¹² A study in the US indicated that after the installation of EV chargers at a Californian shopping centre, visitors spent an additional 50 minutes at the location above the normal dwell time <https://www.chargepoint.com/files/casestudies/cs-retail.pdf>

Fast DC charging

Likely locations

A fast charging station is best placed on major inter-regional transport routes, at key locations within inner cities, or near major airports where there is high daily EV traffic.

Background

Fast charging stations are required in key strategic locations along major routes or in areas of high demand to provide easily accessible, fast charging facilities for EV drivers, with direct access to amenities to ensure charging time can be coupled with other activity. The implementation of DC fast chargers¹³ at these locations will allow rapid charging of the EV battery for minimum travel disruption.

The deployment of an inter-regional network is best undertaken in a planned manner by state and local government in conjunction with the local electricity network provider.

Fast Charging Characteristics:

- » Power: 50 kW - 150 kW (415V, three phase) - "Level 3"
- » Approx. charging rates¹⁴: From 100 to over 300 km range per hour*
- » Typical parking / charging time: 20 minutes to 1 hour*
- » Max. electricity consumption per charge: 15 - 90 kWh*
- » Charging Mode 4 (IEC 61851-1)

*Dependent on make and model.

Site Selection

Geographic distance between inter-regional charging stations and ease of accessibility from the major transport route is a key priority for locating an inter-regional station. Distances between regional stations should be minimised (ideally 70km but no more than 200km) as to provide EV drivers choices in their trip planning.

A proposed fast charging site, and all surrounding sites, should be evaluated to determine if there will be any likely changes in future use which may affect the sites suitability and the demand for parking. This could be in the form of a nearby future retail development site which could impact car parking demand in the vicinity.

Fast chargers may be located in areas where there are significant levels of EV ownership without access to overnight EV charging, or where high demand daily users (fleet vehicles, taxis, ridesharing and share cars) require regular access to fast charging. These fast chargers are likely to be at car parking or other facilities in the inner city (including university and health precincts) or near major airports.

Fast charging facilities should consider means of rationing demand to ensure access is prioritised to high demand users - the rationing of demand may be through high user charges or restricted access.

Inter-regional charging stations as part of the Queensland Electric Super Highway will generally operate as a separately metered business on local government or state controlled reserve or freehold land, or as part of a service station.



Figure 9. Toowoomba fast charging station on the Queensland Electric Super Highway

¹³ Direct Current (DC) chargers require a high-powered grid connection to deliver direct current to the EV battery at a high rate. DC chargers could be complemented with AC chargers at key locations.

¹⁴ Dependent on the vehicle, battery state of charge, supply voltage, circuit loadings etc.

Criteria	Description	Check
Location	To determine if a location is suitable for a Fast DC charger, consideration should be given to the distance from other Fast chargers on the route or in an area. Placement of Fast charger within a property requires careful planning, and is usually dictated by the proximity to the main switchboard, to reduce cable runs and hence installation costs.	
Facilities	A requirement of inter-regional charging is to ensure users have a comfortable, enjoyable and pleasant experience. Charging locations should have safe, easy access to high levels of amenity including restrooms and refreshments (eateries, cafes, restaurants). Ideally an inter-regional station should have proximity to a location of significance which showcases Queensland's diverse range of destinations, or allows users a choice of nearby recreation facilities such as parks, pools, walks or tourist areas.	
Power	To minimise capital expenditure, it is critical for an inter-regional station (which features powerful DC chargers) to optimise the location according to the capacity of the surrounding electrical infrastructure. Some sites may have multiple DC chargers, or be in combination with several AC chargers. Therefore, the site needs to consider electricity network capacity and should be located adjacent to an existing high power transformer with sufficient capacity, or as part of a wider development that requires new transformer capacity.	
Safety	The design and layout of the road access to and from highway charging stations needs to be considered in terms of the safety and efficiency of the road network. The location and design of the charging bays also needs to be considered in terms of pedestrian safety for disembarking and accessing nearby facilities. If part of a larger development, charging bays should be located in areas that allow drivers to access a full range of services at the facility. Charging points should be located such that cables do not form a hazard for pedestrians or other vehicles whilst plugged in and not in use. Charging bays should be able to meet the Crime Prevention through Environmental Design (CPTED) principles, and have adequate lighting for the safety and security of EV drivers as well as the vehicles and hardware. The location of the hardware should consider the risk of vehicle impact and proximity to hazards such as dangerous fuels: Australian Standards (AS 1940, AS 4897, AS 60079.10) and the Queensland Work Health and Safety Act 2011 specify the minimum proximity of electrical charging hardware from hazards such as dangerous goods and fuels.	
Access	The charging station (inclusive of signage, parking bays and charging equipment) should be easily visible and accessible for users to find. A prominent location has the additional effect of creating awareness amongst the general public of the existence of EV charging infrastructure. Though prominence is important, the location should not be in a premium, high-demand parking area that would encourage non-EVs to occupy the charging bay, or attract high parking fees. Accessibility in terms of limitations to non-paying patrons, and out-of-hours restrictions also need to be considered.	
Sustainability	Ideally the charging stations would be linked with low cost and renewable electricity tariffs. Distributed renewable energy, such as solar PV, will not match the energy demand profile of fast chargers. Batteries may provide support to better match local renewable distribution to charging demand as well as reducing peak demand tariff costs.	
Physical	As it is preferable to utilise existing carparks, the physical characteristics (such as: available space for the charging hardware; potential trenching implications; gradient; turning circles; canopies; surface drainage; flood risk etc) need to be considered. The footprint of an DC charger is approximately 750mm x 350mm, and often a switchboard cabinet is also required in the vicinity of the chargers.	
Regulation	Installing chargers to an existing car park is ancillary to the purpose of the car park and therefore would not instigate any need for planning development applications, however this should be reviewed in cases of a new dedicated carpark for EV charging. Planning considerations for any new development and associated uses would need to be considered based on the land use zoning of the site.	

Capital and Operational costs

Fast charging stations require a significant capital investment in addition to the operational costs, and almost all stations will incorporate payment mechanisms into the charging hardware to cover the ongoing cost of the electricity consumed. EV users can operate charging stations through a smartphone app, cloud-based accounts, or credit card. There are several after-market software management systems which can manage the data collection, payment mechanisms and user interface of the EV charging hardware. It is recommended that inter-operability

and ease-of-use for EV drivers is considered when selecting the interface system.

Although the upfront cost of fast-charging infrastructure is high, several locations in Queensland have already installed DC chargers as means of attracting the EV demographic, by providing a competitive edge within the marketplace.



Figure 10. Cairns fast charging station on the Queensland Electric Super Highway

Ultra-fast DC Charging

Likely locations

Carefully selected, strategically located, travel service centres on highly trafficked major national highways.

Background

EV technology is rapidly evolving with higher capacity batteries and charging technology to enable longer driving range. EV infrastructure is also evolving to enable significantly reduced charging times. As longer-range EVs become more affordable, 'ultra-fast' charging is expected to allow EVs to add 300km of range within five to ten minutes.

Longer range electric freight vehicles may be heavy users of ultra-fast charging, though the electrification pathway of freight is still unclear. Hybrid electric technologies with hydrogen fuel cells or bio-fuels may limit the need for on-route ultra-fast charging.

Ultra-Fast Charging Characteristics:¹⁵

- » Power: 150 - 350 kW
- » Typical parking / charging time: 5 - 20 min
- » Max. electricity consumption per charge: 20 - 100 kWh

Site Selection

Ultra-fast chargers will require a significant investment in the local electrical network, and therefore extensive planning is necessary. It is envisaged that the best place for these chargers is at highly trafficked highway service centres where users will value the convenience offered by the short charging times. While EV adoption rates are relatively low, it is estimated that only a small number of ultra-fast chargers will be necessary to complement the other charging categories.

The national highway network should be assessed for potential sites for deployment of the ultra-fast chargers.

Capital and Operational costs

Ultra-fast charging stations will require a significant planning process and capital investment. EV users will be expected to pay a premium price for the use of these chargers.



Figure 11. Artist impression of an ultra fast charging facility (source: electrek.com)

¹⁵ Estimated only.

Criteria	Description	Check
Location	Placement of an ultra-fast charger within a highway network requires careful planning of traffic volumes, fatigue management, electrical infrastructure, and other charging stations.	
Facilities	A requirement of inter-regional charging is to ensure users have a comfortable, enjoyable and pleasant experience. Charging locations should have safe, easy access to amenity including restrooms and refreshments (eateries, cafes) preferably 24 hours per day.	
Power	The site will need an extensive review of the serving electrical network, and should be located adjacent to an existing high power transformer with sufficient capacity, or as part of a wider development that requires a new transformer to be installed.	
Safety	<p>The design and layout of the road access to and from highway charging stations needs to be considered in terms of the safety and efficiency of the road network including fatigue management.</p> <p>The location and design of the charging bays also needs to be considered in terms of pedestrian safety for disembarking and accessing nearby facilities. If part of a larger development, charging bays should be located in areas that allow drivers to access a full range of services at the facility.</p> <p>Charging points should be located such that cables do not form a hazard for pedestrians or other vehicles whilst plugged in and not in use.</p> <p>Charging bays should be able to meet the Crime Prevention through Environmental Design (CPTED) principles, and have adequate lighting for the safety and security of EV drivers as well as the vehicles and hardware.</p> <p>The location of the hardware should consider the risk of vehicle impact and proximity to hazards such as dangerous fuels: Australian Standards (AS 1940, AS 4897, AS 60079.10) and the Queensland Work Health and Safety Act 2011 specify the minimum proximity of electrical charging hardware from hazards such as dangerous goods and fuels.</p>	
Access	The charging station (inclusive of signage, parking bays and charging equipment) should be easily visible and accessible for users to find. A prominent location has the additional effect of creating awareness amongst the public of the existence of EV charging infrastructure. Though prominence is important, the location should not be in a premium, high-demand parking area that would encourage non-EVs to occupy the charging bay, or attract high parking fees. Accessibility in terms of limitations to non-paying patrons, and out-of-hours restrictions also need to be considered.	
Sustainability	In regional locations, ultra-fast charging stations would be ideally located near higher capacity transmission network infrastructure and/or near large scale grid renewable energy to ensure adequate and secure supply of electricity. Ideally ultra-fast charging would be linked to renewable electricity tariffs.	
Physical	As it is preferable to utilise existing carparks, the physical characteristics (such as: available space for the charging hardware; potential trenching implications; gradient; turning circles; canopies; surface drainage; flood risk etc) need to be considered. The footprint of an DC charger is approximately 750mm x 350mm, and often a switchboard cabinet is also required in the vicinity of the chargers.	
Regulation	Installing chargers to an existing car park is ancillary to the purpose of the car park and therefore would not instigate any need for planning development applications, however this should be reviewed in cases of a new dedicated carpark for EV charging. Planning considerations for any new development and associated uses would need to be considered based on the land use zoning of the site.	

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