CHARGEFOX

Fast Charging Site Selection Guide

Advice for developers, governments, and utilities

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Disclaimer: The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein

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Introduction

Founded in 2018, Chargefox set out with a mission to create a cleaner future for all Australians. Our 22-station ultra-rapid charging network will allow electric vehicle (EV) travel between Adelaide, Melbourne, Sydney and Brisbane, with additional stations in Western Australia and Tasmania. As part of our commitment to clean energy, all these stations are powered by 100% renewable energy.

The ultra-rapid network is Australia's largest open, ultra-rapid network of charging stations for EVs. The project is funded from a combination of sources including investment from The Australian Mobility Clubs (NRMA, RACV, RACQ, RAC, RAA and RACT), Wilson Transformers and the founder of Carsales, Greg Roebuck, and grants from Australian Renewable Energy Agency (ARENA) and the Victorian Government.

These ultra-rapid charging stations will be open to all EVs and charging time will be fast, with up to 400km of range delivered in 15 minutes. The chargers will be capable of power output of at least 150kW and up to 350kW, which will be the fastest of any charger currently available in Australia.

The purpose of this document is to provide guidance on site selection for governments, utilities and other groups interested in developing new EV charging sites.

Scope and further reading

This guide aims to complement (rather than replicate) existing Australian resources on site selection and is aimed at those delivering charging projects. As such it focuses on practical and technical issues. The guide will discuss planning and scouting, concept designs incorporating renewables integration and smarter controls, and site configurations. Real examples from our project are provided along the way.

The following publications are also useful sources of further information on charger site selection.

Queensland Government (2018). Electric vehicle (EV) charging infrastructure – practice note.

This document provides a good background on the different levels of EV charging, including both AC and DC, and different plug types. It includes advice on appropriate locations and key issues for different types of sites.

Central NSW Joint Organisation (2020). Electric vehicle (EV) charging toolkit.
https://www.centralnswjo.com/

This website sets out the necessary steps involved in installing electric vehicle chargers including considerations such as site selection, charging infrastructure, required approvals, the installation process and signage. Though it has been aimed at projects based in Central NSW, it is broadly applicable.

Ndevr Environmental (2020). Charging the regions: local government EV charging network study.

http://www.cvga.org.au/uploads/9/8/3/8/9838558/81670_ctr_outcomes_va.3_public__1_.pdf

Aimed at local governments in Victoria, this document provides, among other things, advice on identifying appropriate charging sites based on case studies and stakeholder consultation.

Planning and scouting

Network planning

Fast DC charging sites generally fall into two categories, being urban (or neighbourhood) chargers and highway (or intercity) chargers. The ultra-rapid project is the latter. Highway chargers are designed to facilitate longer, less frequent EV journeys and their presence is an important factor in many people's decision to purchase an EV. They should use the fastest chargers (150 kW or more) and be located close to major routes.

The ultra-rapid network is designed to cater to current and future EVs which have battery capacities providing between about 250 and 550 km of range (Figure 1). Therefore, we aimed for approximately 200 km as a maximum spacing between connected sites. This guided high-level network planning prior to commencing scouting for specific places to build.

The completed network has between 105 and 212 km spacings (Figure 2). This allows a large range of EVs to comfortably make trips spanning multiple sites without worry of running out of charge. Many modern EVs may only need to stop at every second or third site.

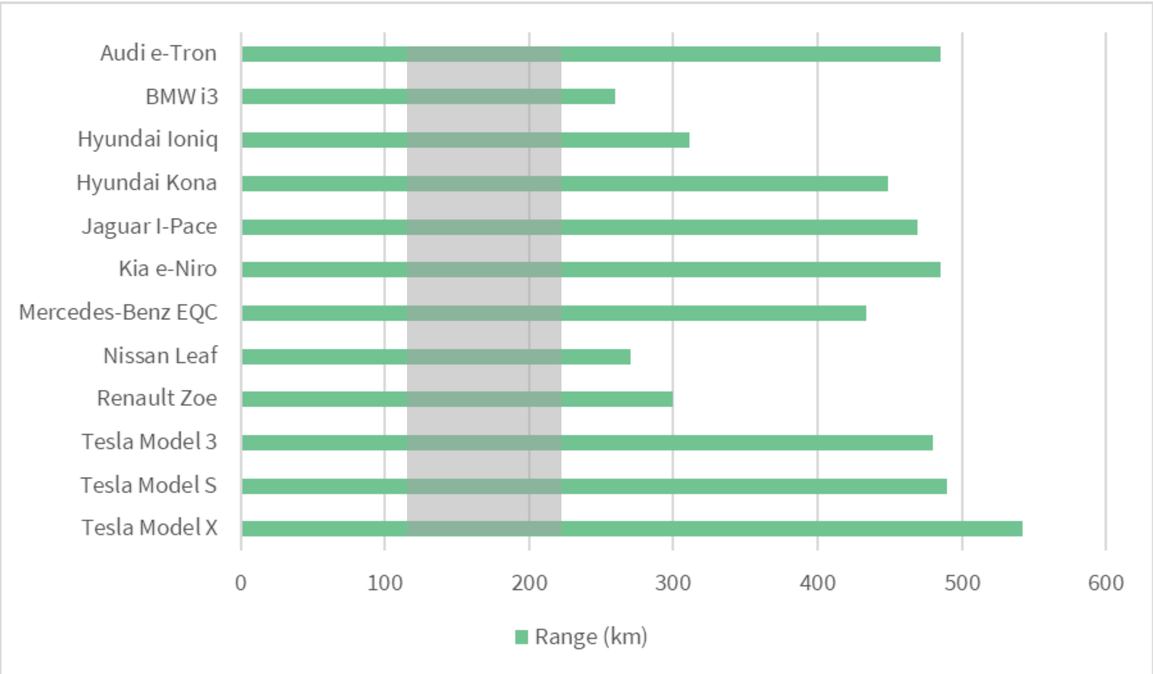

Figure 1: Maximum range of selected EVs available in Australia (source: https://www.carsguide.com.au/urban/hacks/12-best-evs-available-in-australia-78872) with range of ultra-rapid charger spacings shown in grey.

Figure 2: Chargefox ultra-rapid network showing distance in kilometres between each site.

Scouting for sites

With a general location known, scouting for sites can commence. Preceding a visit to the area, a range of information can be obtained from desktop study including:

- Businesses and other premises that may be suitable sites, such as service stations, retail centres and visitor attractions;
- Public toilets, parks, visitor centres and other amenities; and
- Medium voltage power lines and substations.

There is a limit to what can be discovered from desktop study and all of it must be confirmed in person. When scouting a location, potential sites should be assessed using a checklist based on customer needs (refer to other site selection guides for further information).

From an engineering point of view, there are several key items that will drive technical and economic feasibility:

- Method of electrical connection;
- Switchboard space and capacity for connections and metering;
- Space for installing electrical hardware;
- Distance of cable runs; and
- Local rules for electrical installations.

Based on this, the ideal site is one with existing low-voltage capacity at a site main switchboard, where the site main switchboard is located close to an area where hardware cabinets can be installed, and which likewise is located near car parking spaces that the landholder is willing to turn into EV charging bays. However there are many other options available.

Ideal site example: Chargefox Toombul

Our ultra-rapid station at Toombul is connected to existing capacity at the retail centre main switchboard. The charging bays are on a different level to the main switchboard, but still close by, so the cable runs to the hardware and the chargers are relatively short.

The chargers are installed on the suspended slab of an upper-level carpark, which meant that cables were installed in covered cable trays rather than via underground conduits.

The charger heads were able to fit within the existing parking bays without modification.

These aspects of the site made building the station relatively quick and cost-effective.

Figure 3: Chargefox Toombul.

Engineering concept design

Every site has different challenges and opportunities to be accommodated in the engineering design, as each is nearly always constrained by existing conditions. In particular, the capacity of existing infrastructure or the cost of upgrading infrastructure is a major determinant of site feasibility. A further concern is the cost of electricity, both in terms of consumption and maximum demand charges. Finally, one of the aims of the ultra-rapid project was to power the chargers with 100% renewable energy, which is preferably achieved using on-site generation.

On-site generation is preferable mostly because it is cheaper; in most places in Australia solar power will provide local power cheaper than what can be purchased from the grid. On-site generation can also provide capacity benefits, albeit 'soft-capacity' that can't be relied on all the time, but solar output broadly matches charger use, and so usually makes a contribution to improving capacity constraints

Existing infrastructure

The electrical connection options for a site will fall into four general categories:

- Existing low-voltage connection at the property's switchboard – this is the least costly option and has the shortest lead time;
- Building a new high-voltage connection to the distribution network – this can be costly and take a long time, but can provide a large dedicated connection to accommodate future expansion. It also means purchasing an asset that is then owned by the network, though there is often a rebate;
- Existing low-voltage connection supplemented by a large battery – this can be a good option where the existing connection capacity is too small on its own. Batteries can be expensive (though this is rapidly changing) and have the benefit of remaining the property

of the charging site developer. Batteries can also unlock additional value streams by trading with the energy market; and

- Installing a dynamic connection arrangement which uses what capacity is available at an existing network asset at any given point in time – this is cost-effective, though requires a collaborative approach with the network service provider.

Chargefox adopted all four of these options in building the ultra-rapid network.

Dynamic connection example: Chargefox Gundagai

For our charging station at Gundagai, we worked with the network service provider Essential Energy to design a dynamic connection arrangement. We installed monitoring devices into the Chargefox switchboard and programmed them to monitor capacity at Essential Energy's substation. The system controls the power that the chargers are allowed to deliver when a customer plugs in their car (Figure 4).

This solution, an Australian first, makes efficient use of an existing network asset, which is more cost-effective for both Chargefox and Essential Energy because it avoids the need for augmentation. In future, solutions such as this deployed across Australia's electricity networks could help put downward pressure on prices and make electricity more affordable for everyone.

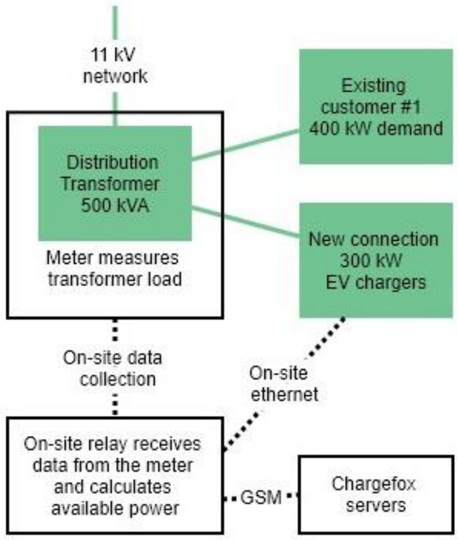

Figure 4: Dynamic connection schematic design.

Maximum demand

Electricity costs for an operating site will normally be comprised of fixed (daily) charges, per-unit charges for electricity consumption and per-unit charges for maximum demand. The load profile for ultra-rapid EV charging tends to be very "peaky" due to intermittent use and high power requirements – theoretically up to 350 kW, and often above 100kW, at a single charger. This can lead to high maximum demand costs reflective of the impact on network capacity.

The impact of maximum demand charges on the economics of a charging station can be mitigated a number of ways, including:

- Considering diversity and setting a maximum power value that the site can draw at any one time;
- Installing a battery to supply times of high demand; and
- Installing behind an existing meter at a site where EV charger demand is unlikely to impact overall maximum demand, along with a commensurate commercial arrangement with the bill payer.

Integrating renewables

The average daily load profile of DC charging stations peaks during the middle of the day and is lowest overnight (Figure 5). This corresponds well with solar output, meaning that solar power can be a practical and cost-effective inclusion at an EV charging site. Similarly, installing EV charging at a site that already has solar power can be a good way to better utilise that existing facility.

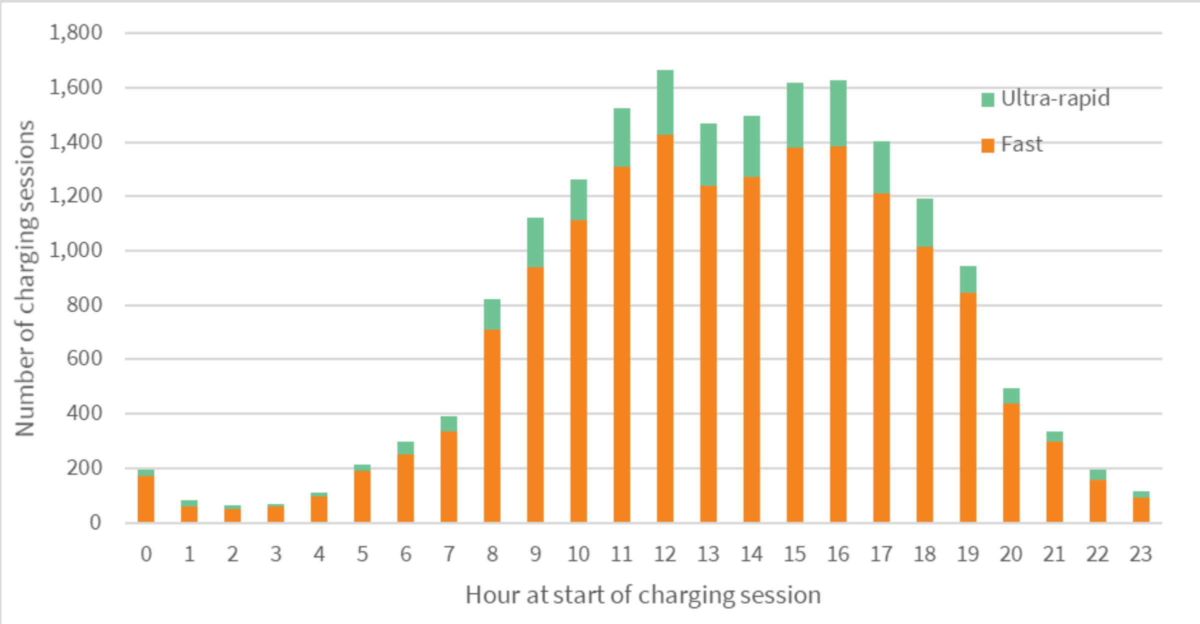

Figure 5: Count of charging sessions by hour at the start of the charging session, for all public fast and ultra-rapid chargers across the Chargefox network. An average charging session is around 30 minutes.

Across the Chargefox ultra-rapid network we have integrated renewables a number of ways, including:

- Installing solar behind our own meter;
- Installing the charging station behind the site meter where there is solar installed – this can be of commercial benefit to both parties;
- As above, but also installing a battery to obtain additional mutual benefits; and
- Connecting the charging station to a solar embedded network.

Renewables integration example: Chargefox Euroa

Our charging station at Euroa is located at a highway service centre comprising a petrol station with a handful of food and beverage tenancies. An on-site solar power system was installed behind the main site meter, which includes the house light and power but not the tenancies. This meant that much of the solar generation was being exported.

We expanded the site main switchboard to accommodate our chargers, but not to the point where the connection could power our chargers on its own. We also installed our own solar system and a battery.

With the combination of the switchboard connection and the battery, we established sufficient power supply for the chargers. Because they are behind the main site meter, the charging station and the battery are able to account for more of the solar generation, so net export is reduced and the economics of the solar are improved. In addition, our commercial agreement means that the property owner is better off overall.

Figure 6: Chargefox Euroa (source: Safety Drones Australia).

Charging station configuration

EV manufacturers position the charging port in different places around the car (Figure 7). In addition, parking spaces come in different configurations, including perpendicular, parallel or angle parking, and are governed by different traffic rules. Some cars are low the ground and can't park with the nose over a wheelstop. Charger manufacturers do not design their cables to reach a certain minimum distance. Furthermore, the accessibility of EV charging for people with mobility-related disabilities is not well understood, which is particularly challenging as EV charging facilities are typically self-service.

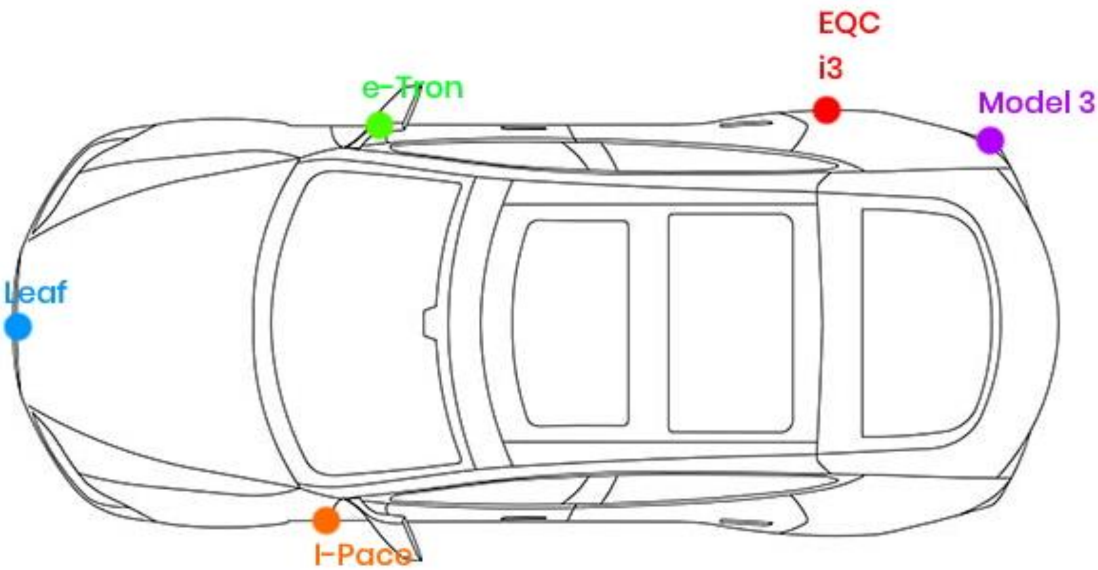

Figure 7: Charging port location for a sample of EV available in Australia.

As a result, practically every configuration for EV charging bays will have its challenges. The ultra-rapid network has adopted a range of different configurations, often dictated by the existing conditions of the site. Over time, as our network is used by a larger range of cars and drivers, the network will serve as a real-life trial of the various layouts and drive continual improvement.

This section details the different configurations we are using and some of the implications of each.

Chargefox Barnawartha North

Perpendicular bays with charger heads centred at the end of the bay, except for one charger head located on a line shared with a PWD bay. Drivers can drive in nose or tail first (Figure 8).

As a greenfield site, we were free to decide on the best configuration for this site. As such we were able to provide a PWD charging bay. The one charger that is located on the line, rather than in the centre of the bay, also provides greater convenience for EVs with charging ports located near the rear-view mirrors.

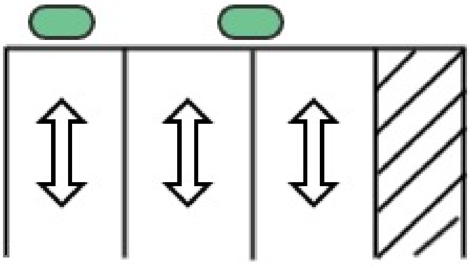

Figure 8: Chargefox Barnawartha North parking configuration.

Chargefox Airport West

Perpendicular bays with a combination of charger heads centred at the end of the bay, except for one at the side of the bay. Drivers can drive in nose or tail first (Figure 9).

At Airport West the chargers are installed in an existing carpark where there was no scope to change the layout or cater for disabled drivers. Due to space constraints, one charger head was positioned at the side of one bay. This combination provides extra flexibility for different cars.

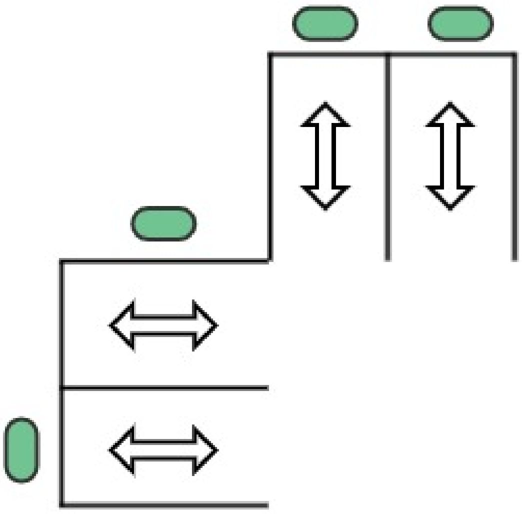

Figure 9: Chargefox Airport West parking configuration.

Figure 10: Chargefox Airport West.

Chargefox Murray Bridge

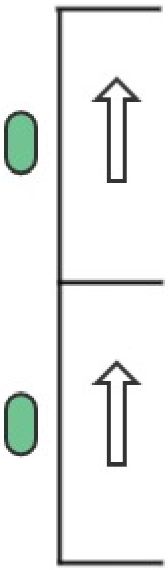

Figure 11: Chargefox Murray Bridge parking configuration.

Parallel on-street parking with charger heads centred at the side of the bay. Drivers may only enter in the direction of traffic flow (Figure 11).

This is likely to be our most challenging site in terms of configuration, as vehicles with the charging port located on the driver's side of the vehicle may need to pull the cable to reach.

In order to mitigate this, we have used longer than standard parking bays. This gives drivers space to move their car so it is easier to get the cable to the port.

Initially we hoped to include one PWD space, however this was not possible as the extra space would have obstructed the adjacent footpath (Figure 12).

Figure 12: Chargefox Murray Bridge.