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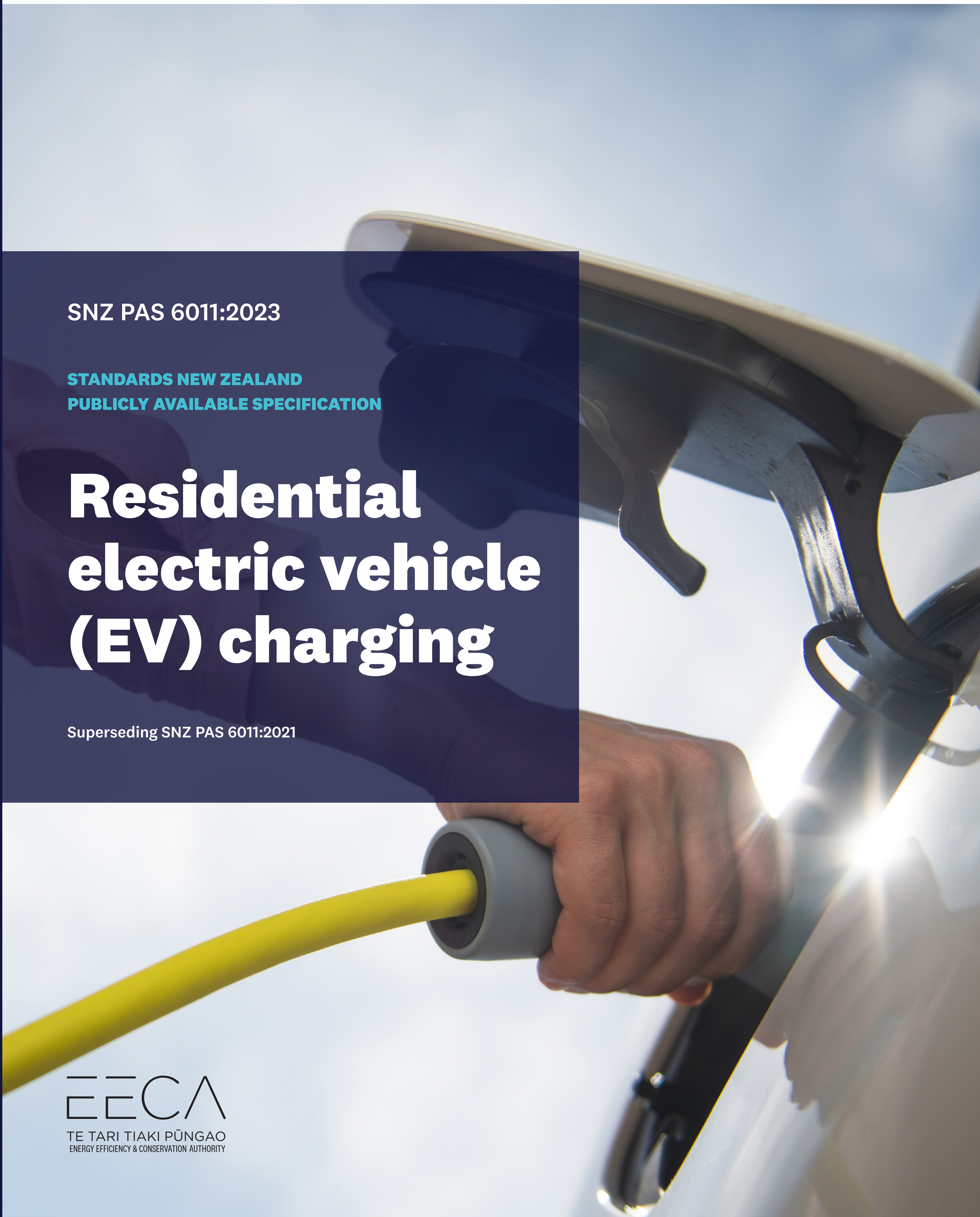

SNZ PAS 6011:2023

STANDARDS NEW ZEALAND
PUBLICLY AVAILABLE SPECIFICATION

Residential electric vehicle (EV) charging

Superseding SNZ PAS 6011:2021

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

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TECHNICAL ADVISORY GROUP REPRESENTATION

This publicly available specification was prepared by the P6011 Residential Electric Vehicle (EV) Charging Technical Advisory Group (TAG). Membership of the TAG was appointed by the New Zealand Standards Executive under the Standards and Accreditation Act 2015.

The TAG consisted of representatives of the following nominating organisations:

ChargeNet NZ Ltd
Drive Electric Organisation
Electricity Authority
Electricity Engineers' Association
Electricity Networks Association
Energy Efficiency and Conservation Authority (EECA)
Imported Motor Vehicle Association
Motor Industry Association of NZ
Motor Trade Association
Waka Kotahi – NZ Transport Agency
WorkSafe New Zealand – Energy Safety

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Superseding SNZ PAS 6011:2021

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REFERENCED DOCUMENTS

Reference is made in this document to the following standards and other publications.

New Zealand standards

SNZ PAS 6010:2023	Commercial electric vehicle (EV) charging
SNZ PAS 6013 (forthcoming)	On-journey electric vehicle (EV) charging

Joint Australian/New Zealand standards

AS/NZS 3112:2017	Approval and test specification – Plugs and socket-outlets

British standards

BSI PAS 1878:2021	Energy smart appliances. System functionality and architecture. Specification

International standards

IEC 60529:1989	Degrees of protection provided by enclosures (IP code)
IEC 62196:----	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles
Part 3:2022	Dimensional compatibility requirements for DC and AC/DC pin and contact-tube vehicle couplers
IEC 62262:2002	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
ISO 15118:----	Road vehicles – Vehicle to grid communication interface
Part 3:2015	Physical and data link layer requirements
SAE J1772_201710	SAE electric vehicle and plug-in hybrid electric vehicle conductive charge coupler

Other publications

Climate Change Commission He Pou a Rangi. *2023 Draft advice to inform the strategic direction of the Government's second emissions reduction plan*. Wellington: Climate Change Commission, 2023. Retrieved June 2023 from https://www.climatecommission.govt.nz/public/Advice-to-govt-docs/ERP2/draft-erp2/CCC4940_Draft-ERP-Advice-2023-P02-V02-web.pdf

Fagan, M., Megas, K., Scarfone, K., and Smith, M. NISTIR 8259A *IoT device cybersecurity capability core baseline*. Gaithersburg, Maryland: National Institute of Standards and Technology (NISTIR), U.S. Department of Commerce, 2020. Retrieved April 2023, from https://nvlpubs.nist.gov/nistpubs/ir/2020/NIST.IR.8259a.pdf

Institution of Engineering and Technology. *Code of practice for electric vehicle charging equipment installation.* 4th ed. London: The IET, 2020.

Institution of Engineering and Technology. *Designer's guide to energy efficient electrical installations*. London: The IET, 2016.

New Zealand legislation

Electricity (Safety) Regulations 2010

Electricity Industry Act 2010

Electricity Industry Participation Code 2010

Websites

www.climatecommission.govt.nz

www.eeca.govt.nz

www.journeys.nzta.govt.nz

www.legislation.govt.nz

www.openchargealliance.org

www.worksafe.govt.nz

LATEST REVISIONS

Users of this specification should ensure that their copies of the above-mentioned New Zealand standards are the latest revisions. Amendments to referenced New Zealand and joint Australian/New Zealand standards can be found on www.standards.govt.nz.

REVIEW

Suggestions for improving this specification are welcome. Send them to The National Manager, Standards New Zealand, PO Box 1473, Wellington 6140.

FOREWORD

New Zealand is experiencing a seismic shift in transport technology.

Due to climate change, every major manufacturer that supplies vehicles to New Zealand is being forced to transition from selling only fossil-fuelled vehicles to including cleaner alternatives in their range. New Zealand can use renewable electricity for non-commercial transport, so we are an ideal market for global suppliers of new and used electric vehicles (EVs). As a result, the supply of low-emission vehicles to New Zealand is rapidly increasing. As the uptake of EVs increases, so does the demand for electricity

This document, SNZ PAS 6011:2023 *Residential electric vehicle (EV) charging*, has been prepared as a guidance document and published as a publicly available specification (PAS).

PAS is an ISO-recognised category for a document that is not a national standard but is produced by a national standards body to respond to a particular market need. A PAS represents consensus in an organisation or industry, or consensus of experts in a specific working group.

SNZ PAS 6011:2023 has been prepared by representatives from the motor vehicle industry, electrical engineering and transport sectors, and energy retailers and central government regulators. It collates advice for New Zealand consumers on how to install an EV charging station in a residential setting, or at a residential home. It also provides guidance on how to charge an EV safely and cost- effectively at home. Use this guideline if you are a New Zealand consumer who is thinking about buying an EV or has already joined the fast-growing fleet of EV owners. It will help you focus on the important considerations related to charging your EV, such as when and where best to charge, and how to maximise the benefits from your EV – now and in the future.

This guideline will also help you understand the different charging systems available in New Zealand, and technology that will be introduced in the future. This includes smart EV charging and its relationship with demand flexibility.

SNZ PAS 6011 can also inform your decisions about other electricity-reliant items in your home. It explains how pieces of the smart-home-energy jigsaw fit together, and how your choice of EV and EV charging station can complement and enhance them.

In 5.7, you will find a handy reference tool to help you consider your EV charging station options. To thoroughly explore your options, we recommend you read the other sections of the guideline first. This will give you the knowledge you need to make informed choices, based on your personal requirements, and understand the trade-offs of those choices.

If you are an equipment installer, refer to the appropriate guidelines on the WorkSafe New Zealand – Energy Safety website before you install an EV charging station in a residential setting.

NOTE –

(1) This guideline does not apply to commercial, or public EV charging stations, but there will be some crossover for employees who charge a company-owned vehicle at their home overnight. For more information on employees charging at home refer to SNZ PAS 6010:2023 *Commercial electric vehicle (EV) charging*.

(2) This guideline highly recommends that a ‘registered electrician’ undertakes all prescribed electrical work referred to within this publication.

Changes to this version

In 2021 we published SNZ PAS 6011:2021 *Electric vehicle (EV) charging for residential use*. With publicly available specifications (PASs) providing a quick solution, and market snapshot in such a rapidly evolving industry, it has become necessary to revise the original publication.

Installing an EV charging station at home is less complex than installing them in a commercial environment, which is why it is differentiated from SNZ PAS 6010:2023 *Commercial electric vehicle (EV) charging*. Yet there are several new terms and concepts that may be foreign to homeowners considering purchasing an EV and this has therefore warranted further explanation.

To date over 4000 downloads of our EV PAS guidelines have occurred, kindly sponsored by the Energy Efficiency and Conservation Authority (EECA). These PASs have offered invaluable guidance for those establishing a safe, efficient charging system based on good practice, designed by subject matter experts.

Key changes to this 2023 revision pertain to the following:

- Referenced documents have been updated and layout modified.
- The revised publication now consists of five sections rather than the previous three. This was done to improve the narrative flow, and to expand on the preliminary considerations the homeowner should consider before purchasing an EV (section 3) and enhancements to general information about EV technology (section 4).
- Definitions and abbreviations have been updated.
- Section 3 focuses on assessing existing electrical load capacity, EV charging station locations and the futureproofing of your EV investment through smart charging technology.
- Section 4 explains the different types of EVs, the limitations of current technology and introduces the concept of demand response and demand flexibility. Information has been updated on electric vehicle supply equipment (EVSE) and the types of common plug and socket configurations (connectors) car manufacturers use – depending on which part of the world the vehicle was manufactured in.
- Information on charging rates for EVs has been updated, and the difference between the different types of EV charging stations available has been expanded upon.
- Section 5 is now the technical specification and is primarily aimed at equipment suppliers and installers. It includes enhanced installation protocols, analysis of electricity capacity, and electrical safety and maintenance regimes. Greater clarity has been provided on grid connectivity and communication requirements, as well as cybersecurity. Lastly, this section contains a handy installation checklist and EV charging station reference tool.

Publicly Available Specification

Residential electric vehicle (EV) charging

1 GENERAL

1.1 Scope

1.1.1 Inclusions

This publicly available specification (PAS) gives consumers guidance on good practice for charging their electric vehicle (EV) at their residence. It also includes information on efficiency and smart EV charging.

1.2 Exclusions

This PAS does not apply to commercial charging stations that are installed on business premises. Refer to SNZ PAS 6010 for guidance on commercial applications.

1.3 Overview

There are five sections in this PAS.

(a) Section 1 explains the terminology used in this document;

(b) Section 2 introduces the evolution of EV technology, how it is impacting on the energy sector, and size of the market;

(c) Section 3 provides key preliminary (including budgetary) factors for the homeowner to consider before purchasing an EV;

(d) Section 4 provides an overview of EV technology to guide homeowners, as well as suppliers of electric vehicle supply equipment (EVSE) and associated equipment and services, who want to use good practice for smart EV charging;

(e) Section 5 sets out prescriptive technical requirements for complying with this PAS, including installation considerations for homeowners and EVSE installers in the form of an installation checklist.

1.4 Objectives

This PAS is intended to provide consumers with all the relevant information they need for charging EVs. It also provides links to more detailed information published elsewhere.

1.5 Interpretation

In this PAS, the word ‘shall’ refers to requirements that are essential for complying with this specification. The word ‘should’ refers to recommended practices.

1.6 Defined terms

The following definitions apply in this PAS:

Adaptor (EV adaptor)	An accessory that incorporates a plug portion and a socket-outlet portion for converting a vehicle connection or EVSE socket outlet
Adaptor (socket-outlet adaptor)	An accessory that incorporates a plug portion and one or more socket-outlet portions for converting an installation socket outlet
Alternating current (AC)	An electric current that reverses direction at regular intervals
Ampere (amp)	Unit of electric current
Battery electric vehicle (BEV)	An EV that draws its entire motive source from a battery. The battery is charged by connecting to an external electricity source. The battery is also charged when travelling downhill and braking, as the motor recovers energy and returns it to the battery
Battery management system (BMS)	Any electronic system that manages a rechargeable battery (cell or battery pack). This can include protecting the battery from operating outside its safe operating parameters, monitoring the state of the battery, calculating and reporting secondary data, controlling the environment, and authenticating and balancing the system
Battery pack	An energy storage device that contains an array of batteries. Their configuration depends on the manufacturer. They are normally connected with cell electronics, power-supply circuits and an overcurrent shut-off device. They include electrical interconnections that interface with other external systems, such as a BMS
CHAdeMO	An abbreviated reference to a particular rapid charging system standard (CHArge de Move) for up to 50 kW in New Zealand. It is also used for DC charging of primarily Japanese vehicles
Charger	When utilising AC charging, the only charger is aboard the vehicle. All other components are not chargers but are known as electric vehicle supply equipment (EVSE), charging stations, or IC-CPD. See Mode 4 definition
Charging	Re-energising an EV's battery or batteries with electricity
Charging station	Any location where electric vehicle supply equipment (EVSE) is permanently located and an EV can be plugged in and charged. Locations include home, work, or publicly accessible locations, such as fuel stations and shopping precincts

Combined charging system (CCS)	CCS Type 2: Also known as IEC 62196-3 Combo, CCS Type 2 is primarily used in European vehicles and supports both AC and DC charging. An EV may be supplied with the corresponding socket that fits either the AC or DC plug of the CCS. CCS Type 2 connectors also include an optional feature called 'Plug & Charge', which allows for secure and seamless authentication and billing without the need for additional cards or apps. For more information see Figure 3
Connector	A device that is inserted into the charging socket of an EV. EV charging plugs and sockets vary depending on the vehicle brand, charging level, and country where they are manufactured
DC charging	The DC current is delivered directly to the battery and the on-board charging station is bypassed. Mode 4 DC charging stations are fast, rapid, or ultra-rapid/high-powered and can deliver up to 1000 V DC. Given the high power involved in this mode, DC charging has greater communication and other features NOTE – See Table 1 for more information.
Dedicated short-range communications (DSRC)	One-way or two-way short-range to medium-range wireless communication channels that are specifically designed for automotive use, and the corresponding set of protocols and standards
Direct current (DC)	An electric current of constant direction. This distinguishes it from alternating current (AC)
Electric vehicle (EV)	A vehicle (includes BEV and PHEV) that plugs into an external electricity source and stores energy that can be used later to power an electric motor for vehicle propulsion
Electric vehicle supply equipment (EVSE)	EV supply equipment, or a combination of equipment, providing dedicated functions to supply electric energy from a fixed electrical installation or electricity supply network to an EV for the purpose of charging
Electricity distribution business (EDB)	A company that distributes electricity to electricity retailers (which then sell the electricity to consumers)
Energy load	The ratio of maximum demand of an installation to the rated capacity of that installation
Energy utilisation factor	The ratio of the time that a piece of equipment is in use to the total time that it could be in use. It is often averaged over time – such that the ratio becomes the amount of energy used divided by the maximum possible to be used

EVRoam	A database of New Zealand's EV charging infrastructure. The database is administered by Waka Kotahi – NZ Transport Agency
Flexibility provider	A third-party commercial agent who acts as an intermediary between the EV and the electricity retailer and/or network. The flexibility provider is responsible for supplying EV charging stations with operating instructions. They also participate in the electricity market as load aggregators with supply and demand energy bids
Fuel cell electric vehicle (FCEV)	A vehicle that uses a fuel cell to generate electric power via an energy converter in the form of a fuel cell. The fuel cell transforms gas directly into electricity to power an electric motor
Hybrid electric vehicle (HEV)	A vehicle that integrates a small battery and an electric motor to enhance the efficiency of the engine. The battery's charge is maintained by an internal combustion engine (ICE) and cannot be charged by plugging into an electrical supply. HEVs offer greater fuel economy than traditional ICEs
Incentives	Normally government initiatives. In the case of EVs, incentives are usually intended to encourage consumers to change their purchasing behaviour away from fossil-fuelled vehicles over a relatively short period. Incentives can be grants, tax exemptions, or other initiatives that would, for example, help a government meet its international climate change obligations
In-cord control and protection device (IC-CPD)	An assembly for supplying electric vehicles in charging Mode 2, which performs control functions and safety functions
Internal combustion engine (ICE)	The liquid-fuelled, or gaseous-fuelled powered engine used in cars, SUVs, and trucks. ICEs generate power by igniting an air–fuel mixture. ICEs can produce harmful emissions like hydrocarbons, oxides of nitrogen (NO_x), carbon monoxide (CO), and carbon dioxide (CO_2)
Kilowatt hour (kWh)	A unit of energy equivalent to the energy transferred or expended in one hour by one kilowatt of power. EV battery size is measured in kilowatt hours. It is an EV equivalent to the litres of fuel used by an ICE
Load factor	In electrical engineering the load factor is defined as the average load divided by the peak load in a specified time period. It is used to determine the overall cost per unit generated (in other words, the higher the load factor, the lower the cost per unit will be)

Load profile A load profile is a graph that shows your energy usage on a daily or seasonal basis (as energy consumption can vary significantly from season to season). You can also look at the entire year to understand your energy usage over that time. By understanding this graph, you'll be able to see how your electricity usage varies over the course of a day (for example, you probably use more electricity in the evening when you're home compared to during the day when you're at work). It also can help identify times when you could reduce your electricity consumption to potentially save money on your electricity bill

Load management The process of balancing electricity supply and demand on an electrical network or the grid. It involves monitoring and adjusting the generation and consumption of electricity so that the electricity supply remains stable, reliable, and cost effective

Modes There are three ways that EVs can be charged in New Zealand: Modes 2, 3, and 4. Mode 1 relates to basic charging requirements for e-bikes and e-scooters and is outside the scope of this guideline

Mode 2 A method of charging by the connection of an electric vehicle to a standard AC socket-outlet through an AC EVSE with a control pilot function and system for personal protection against electric shock. The charging speed for an IC-CPD is limited by the rating of the plug connecting the IC-CPD to the socket outlet in the wall

Mode 3 This mode uses either single-phase or three-phase power via a fixed, dedicated circuit. The electronics on/off control function is contained in a box mounted on the wall. As with Mode 2, AC power is sent to the EV on-board EV charger that disconnects power to the vehicle once the EV is fully charged. User safety is the same as in Mode 2, although configurations can be a tethered cable or a dedicated socket outlet. Mode 3 uses dedicated circuitry and components, so there are more options available. In 'single phase', these range from 3.0 kW to 7.4 kW; in 'three phase', these range from 11.0 kW to 22.0 kW

Mode 4 The only charging mode that provides remote charging with a DC output. The DC current is delivered directly to the battery, bypassing the EV on-board EV charging system. Mode 4 DC charging can deliver up to 1000 V DC with a maximum current of 500 A.

Mode 4 involves greater communication and other features than Mode 3. Mode 4 EV charging stations are often characterised as moderate to ultra-rapid or high-powered, with ranges that vary between 25.0 kW and 475.0 kW

NOTE – See Table 1 for more information.

Open charge-point protocol (OCPP)	An application protocol for communication between EV charging stations and a central management system. It is also known as a charging station network that is like cell phones and cell-phone networks. This publication acknowledges version 1.6 and above (see www.openchargealliance.org)
Person conducting a business or undertaking (PCBU)	This is a WorkSafe New Zealand term used in legislation to describe types of modern working arrangements that we commonly refer to as 'businesses'
Phase balancing	A manual process that ensures each incoming phase conductor carries about the same amount of electricity demand at any time. This minimises electrical capacity requirements
Plug-in hybrid electric vehicle (PHEV)	A vehicle that is configured like an HEV, but with a larger capacity battery pack, that can be charged with EVSE. A PHEV can make short journeys energy efficient with zero tailpipe emissions
Portable power analyser	An instrument that measures and quantifies the rate of power flow in an electrical system. Power flow is expressed in joules per second (J/s) or kilowatts per hour (kW/h). The analyser can provide for real-time recording and monitoring of electrical parameters anywhere in an electrical installation for the conduct of energy-improvement studies, as well as for the detection of problems related to the quality of supply and consumption
Power	Rate of generating, conveying or consuming work or energy, including electricity (electrical energy)
Range	The distance an EV can travel on pure electric power before the battery needs recharging
Range anxiety	Fear of running out of battery charge before reaching a charging station
Regenerative braking (regen)	An energy-recovery system used in most EVs that can help charge the battery while the vehicle is slowing down. Typically, power flows both ways between the electric motor and the battery. This enables the electric motor to act as a generator, reversing power flow and returning energy to the battery. Regen helps extend the range, while also helping to slow the vehicle in a similar way to engine braking in an ICE-powered vehicle

Registered electrician	The term 'registered electrician' refers to a person who is required to carry out prescribed electrical work. To comply with the requirements of the Electrical Workers Registration Board, that person shall hold a current practising licence and be able to present that licence upon request, if the work is undertaken for payment or reward
Residual current device (RCD)	A current-sensitive, life-saving protection device intended to protect circuits. It is designed to switch off power when electricity flows down an unintended path (leakage, for example, when a person touched a live wire or live metallic objects)
Residual direct-current detecting device (RDC-DD)	An RDC-DD is intended to remove, or start removing, the power supply to an EV when a smooth, residual direct current (leakage) is detected, that is equal to or above 6 mA. This device was chosen to prevent impairing the correct operation of an upstream RCD
SAE J1772	The North American standard for EV electrical connectors that are commonly referred to as 'Type 1'. The standard covers the general physical, electrical, functional, and performance requirements for charging EVs and PHEVs
Standard low voltage	Refer to definitions in the Electricity (Safety) Regulations 2010
State of charge (SoC)	The level of charge of an electric battery relative to its capacity. The units of SoC are percentage points: 0% equals empty; 100% equals full
Supplier declaration of conformity (SDoC)	A declaration required by a supplier (manufacturer or importer) for them to sell, or offer for sale, a medium-risk article in New Zealand. It contains a description of the article and a statement that the article complies with the required standard or other safety assurance
Supply lead	An assembly consisting of flexible cable or cord, fitted with a plug and/or a vehicle connector, that is used to establish the connection between the EV and the EV charging station
System standards	For the purposes of this publication, 'system standards' refers to those technical standards (including protocols) which enable communication, and therefore the transference of data to and from the electricity network, via a flexibility provider (where applicable) and charging station, to the EV onboard charging system. These system standards may be amended from time to time
Tesla supercharger	A bespoke charging system (see Figure 4) that can only be used with Tesla's vehicles

Time of use (ToU)	The rate charged to an EV customer, based not only on the total electricity they use but also on the time of day they use the energy. Utility rates for electricity supply vary according to time. Some hours are peak-use hours, and have a higher rate, and some are low-use hours with a lower rate
Type 1 plug (type of connector)	A single-phase plug that allows for charging power levels up to 7.4 kW (230 V, 32 A). Also known as a J1772
Type 2 plug (type of connector)	A three-phase plug that commonly charges power levels up to 22 kW. At some public charging stations, the plug can charge power levels up to 43 kW (400 V, 63 A, AC). Most public charging stations are equipped with Type 2 plugs on tethered leads. All Mode 3 charging cables have a 'Mennekes' plug (Type 2) that can be used with this type of socket on the EV
Utility	For the purposes of this guideline, a 'utility' is a publicly available service that provides electricity or gas
Vehicle-to-grid (V2G)	A charging station that facilitates energy flow to and from an EV, allowing the EV to act as a rechargeable energy source. When hooked up to a V2G charging station, an EV can be used as a power boost back into either the grid network or a private residence (in which case, it can be a cheaper power source when electricity prices are high). This technology will eventually be able to power homes (V2H) during power outages
Vehicle-to-infrastructure (V2I)	A communication model that uses dedicated short-range communication (DSRC) frequencies to transfer data from a vehicle to the components that support a country's highway system
Zero emission vehicle (ZEV)	A vehicle that emits no tailpipe emissions from its on-board power source. Harmful emissions to health and the environment include particulates (soot), hydrocarbons, carbon monoxide, ozone, lead, and various oxides of nitrogen

1.7 Abbreviations

The following abbreviations are used in this PAS:

A	Ampere or ‘amp’
AC	Alternating current
BEV	Battery electric vehicle
BMS	Battery management system
CCS	Combined charging system
CHAdeMO	CHArge de MOve
CoC	Certificate of compliance
DC	Direct current
DF	Demand flexibility
DR	Demand response
DSRC	Dedicated short-range communications
EA	Electricity Authority
EDB	Electricity distribution business
EPOD	Electrical portable outlet device
EREV	Extended-range electric vehicle
ESR	Electricity (Safety) Regulations 2010
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FCEV	Fuel cell electric vehicle
HEV	Hybrid electric vehicle
Hz	Hertz
IC-CPD	In-cord control and protection device
ICE	Internal combustion engine
IK07	A degree of protection against mechanical damage (see IEC 62262)
IPX4	A degree of protection against the ingress of water or solid particles (see IEC 60529)
kW	Kilowatt
kWh	Kilowatt hour

MEN	Multiple earthed neutral system
OCPP	Open charge point protocol
PCBU	Person conducting a business or undertaking
PE	Protection earth conductor
PEV	Pure electric vehicle
PEW	Prescribed electrical work
PHEV	Plug-in hybrid electric vehicle
PSOA	Portable socket-outlet assemblies
PV	Photovoltaic
RCD	Residual current device
RDC-DD	Residual direct-current detecting device
RFID	Radio frequency identification tag
RPM	Revolutions per minute
SDoC	Supplier declaration of conformity
SoC	State of charge
TOU	Time of use
V	Nominal voltage
V2G	Vehicle-to-grid
V2H	Vehicle-to-home
V2I	Vehicle-to-infrastructure
ZEV	Zero-emission vehicle

2 THINKING ABOUT AN EV

2.1 Transformative change

EVs are an evolving technology that will force New Zealand's energy landscape to change. This change will affect everyone – electricity-network operators, electrical trades, fleet lease operators, government regulators and policymakers, commuters, and consumers.

Transport is one of New Zealand's most cost-effective ways to reduce emissions and air pollution. Therefore, EVs and other efficient and low-emission vehicles are set to make a major contribution to New Zealand's ability to meet its climate change targets.

When consumers change from a vehicle that uses fossil fuel to one that uses electricity, they have to think differently about owning, running and refuelling their vehicle. An EV stores electrical energy in a rechargeable battery; it uses this electricity to provide motive power. The vehicle is charged with electricity from an external source, such as a dedicated EV charging station at home or work, or a public charging station. However, most EV charging will be done at home by the owners of private vehicles and employees who have a company vehicle.

2.2 Potential of the EV market

The Climate Change Commission's data (2023 draft report, Table 2.3: *2030 benchmarks for action to meet the second emissions budget*) suggest that by 2030, up to 550,000 light passenger and light commercial EVs will be operating on New Zealand roads.

Consumers want to minimise charging time, especially when they are using charging services on a journey or at their destination. The size of EV batteries is expected to continue to increase, which will improve range. The capacity of home EV charging stations also needs to increase, as 'trickle charging' might not be suitable for higher-capacity batteries that provide better range.

2.3 Current snapshot of the EV market

By March 2023, New Zealand had just under 50,000 battery electric vehicles (BEVs) registered. Registrations have increased significantly since 2021, as several government and industry initiatives have made it easier to buy an EV (see below). The reduced running costs and carbon emissions associated with this trend have been clear.

The government's clean car discount programme has given EV purchasers a significant rebate and continues to showcase the value of EVs to New Zealand.

Investment in public charging infrastructure has also meant that, by the end of 2021, on average, public EV charging was available every 75 km on 96% of the state highway network. This investment continues to increase as the government looks to make public EV charging as easy as possible. To assist further, the Waka Kotahi EVRoam app has made it much simpler for EV owners to locate EV charging stations, which can help them plan their journeys.

As New Zealand motorists and businesses see the effects of climate change around them, many are choosing to decarbonise their transport to reduce their costs and impact on the climate. The shift to EVs is starting to happen at pace, so policymakers are working on the practicalities of managing the increased demand for electricity from EV charging and building a demand-flexible electricity grid that can maximise the potential of this technology to reduce carbon emissions.

2.4 EVRoam

EVRoam is a live database of EV charging infrastructure in New Zealand. It collects real-time information (such as whether the charging point is operational or offline) from every safe, monitored public charging point and makes it freely available to EV drivers. EVRoam maximises the profile of available charging infrastructure by pushing the data to dozens of apps and maps.

You can use the Waka Kotahi – NZ Transport Agency's journey planner to find a map of EV charging stations in New Zealand or find EV charging stations for a particular route.

3 PRELIMINARY CONSIDERATIONS BEFORE BUYING AN EV

3.1 General

If you are thinking about getting an EV, there are several things to factor into your budget, in addition to the cost of buying or leasing the EV. These factors mainly relate to your existing electrical installation and how you intend to position and use EVSE (electric vehicle supply equipment). Most people expect to use their EV every day, so they need a charging point at home that they can conveniently activate at any time.

3.2 Existing electrical capacity

Once you have chosen an EV model, make sure the EV charging station comes with the plug mode you need.

Engage a registered electrician to determine what charging type will suit your needs and situation. They will check the capacity of your existing electrical installation and satisfy themselves that it can accommodate the charging circuitry needed for your EV charging equipment.

This may require installing load-monitoring equipment for a given period to determine when peak demand occurs. Make sure you ask for a quotation for any electrical remedial work, including installation of any new circuit and associated EVSE.

3.3 EV charging station locations

3.3.1 General considerations

Consider these points when planning where to locate an EV charging station:

(a) For a single-dwelling installation, ensure the charging station is located next to where the EV will be parked and as close as practicable to the side of the EV with the power inlet (some EVs have power inlets on both sides). This will minimise the risk of tripping over and reduce the strain on cables. Position the charging station so that it is easy for you to move around the EV and still be able to easily open the vehicle's doors;

(b) For a multi-dwelling installation, ensure charging stations are located in the optimal position to charge more than one EV at the same time. Consider installing protective barriers around the charging station, particularly if they are free standing; and

(c) For all installations, position the charging station so that there is adequate space for ventilation and cooling.

3.3.2 Explosive atmospheres

Ideally, EVSE will be installed in a garage or covered location. However, the EVSE should not be installed in locations with potentially explosive atmosphere conditions (such as locations where fuel vapour or other flammable or combustible gases could be present). If EVSE is needed in the vicinity of potentially explosive conditions, it, and any EV connected to it, shall be located outside the defined hazardous zone. If in doubt, seek professional advice to ensure you safely manage this risk of fire or explosion.

3.4 Introducing smart EV charging

3.4.1 What is it?

Smart EV charging means that your EV charging station has built-in communication capability and can vary charging based on external signals. It allows you to safely and cost-effectively ensure your EV is ready for use the next time you need it.

If every New Zealander owned an EV and we all plugged them in at the same time (such as when we got home from work), we would need to invest much more in the electricity network to meet this additional demand. That would result in higher electricity costs for everyone. Smart EV charging allows you to increase or decrease your charging level, often to take advantage of lower-cost off-peak electricity.

Smart charging also allows EVs, charging stations, charging operators, and electricity-network operators to share data and control to optimise the use of electrical resources and thereby reduce costs.

NOTE – Through smart charging, the charging station(s) can monitor, manage, and restrict the use of charging devices to optimise energy consumption and enable vehicle-to-grid (V2G) or bidirectional charging without inconveniencing the vehicle owner or user.

3.4.2 Choosing a smart EV charging station is a future-proof investment

In the near future, New Zealand's electricity network will include demand-response (DR) programmes. DR means an electricity account holder is paid to not use electricity. For example, if you are going on holiday and do not need to charge your EV at home while you are away, you can make this 'demand' available to the grid using an app on your smartphone.

DR enables electricity distributors to manage demand across their network and plan for maintenance shutdowns. By choosing a smart EV charging station, you can participate in DR programmes and reduce your electricity costs, when it suits your lifestyle.

Smart EV charging and communication can also help you to balance your electricity consumption and further reduce your costs. For example, you can draw on the electricity in your EV battery when prices are high, and recharge the battery when prices are low.

Later in this publication we explore interoperability, which looks at connectivity – how your EV and smart EV charging station can be core parts of a connected, demand-flexible, energy-efficient electricity network.

Buying a smart EV charging station is a logical and energy-efficient choice. Wall-mounted EV charging stations offer an efficient and cost-effective option that will ensure your home is ready to capitalise on DR payments and your EV is charged at the most cost-effective and convenient time.

Different smart EV charging stations have different features and capabilities. Select an EV charging station that will meet your specific needs now and in the future.

4 EV TECHNOLOGY

4.1 Types of EV

4.1.1 Battery electric vehicles (BEVs)

A BEV is charged by the power supplying the battery. The battery is charged by connecting to an external electricity source. The battery is also charged when travelling downhill and braking, as the motor recovers energy and returns it to the battery.

4.1.2 Plug-in hybrid vehicles (PHEVs)

A PHEV has an electric motor and an internal combustion engine (ICE) and can be charged by plugged into a charging station. The electric motor is powered by batteries and the ICE is powered by petrol or diesel. The main way the batteries charge is through a connection to an external electricity source. A PHEV can make short journeys energy efficient, with zero tailpipe emissions, but can also be used for long journeys.

4.1.3 Hybrid electric vehicles (HEVs)

An HEV has an electric motor and an ICE. The battery's charge is maintained by the ICE and cannot be charged by plugging into an electrical supply. HEVs do not use the type of EV charging stations described in this guideline. HEVs offer greater fuel economy than traditional ICEs but can travel only short distances when using electric power only.

4.1.4 Fuel-cell electric vehicles (FCEVs)

FCEVs combine gas (such as hydrogen and oxygen), in a fuel cell to produce electricity to power an electric motor. These vehicles are not able to be recharged using an external electricity source and, therefore, would not use the EV charging stations discussed in this publication.

4.2 Limitations and risks of current EV technology

EVs themselves can limit the charge rate. For example, some older models can only charge up to 3.6 kW, whereas newer EVs can accept charge up to 11 kW.

Even if your EV is connected to a 22 kW EV charging station, it will charge only as fast as the on-board management system allows. If other vehicles are connected to the EV charging station at the same time, this could further limit its output capacity and charge rate.

4.3 Demand response and demand flexibility

Demand response (DR) is a payment for reducing your demand. It refers to the remote control that a flexibility provider has over the charging load of your EV. The flexibility provider may use this control when demand on the network exceeds the available supply, creating a need to 'shed' load at certain times (such as morning and evening peaks during the winter). DR already exists in many New Zealand homes, where ripple control signals are used to turn electric hot-water cylinders on or off.

DR is an element of demand flexibility (DF). DF enables your home to function as an energy ecosystem – your home devices can communicate with each other (this is known as interoperability) when you have a home energy-management system fitted. DF also enables your home devices to communicate with external signals. For example, it can enable your smart EV charging station to reduce or stop charging based on a signal (such as a price signal) from an electricity provider.

Selecting a smart EV charging station is a first step towards achieving DF at your home so that you can use the least amount of electricity for the lowest cost. DF creates new ways for EV owners to get more value from their EV. A smart EV charging station can instantly – and automatically – react to pricing signals and minimise charging costs. In future, smart EV charging will create the option to use the battery in your EV to power your home or business, or to sell electricity back to the grid.

Smart EV charging is also the first building block of a 'smart home', where all devices that consume, generate, or store electricity are linked into a network. This will minimise consumer costs by using DF to make sure that homes only use electricity when it is available at the right time and at the right price.

During peak periods, demand on the electrical grid is very high (normally from 7am to 11am and 5pm to 9pm weekdays, particularly in the winter months). Charging your EV during peak times could increase demand on the grid. However, smart EV charging and load management enable optimal energy usage and the grid to operate more sustainably and cost-effectively (see Figure 1), by using existing available capacity at low grid-usage times.

Combining solar panels with a smart EV charging station can be a good way to optimise solar energy and reduce your overall energy costs, and you might not need a home energy-management system.

With a smart EV charging station, you can create a charging profile. This is a schedule of time periods and maximum charge power or current values for charging your EV. The smart EV charging station ensures that the values in the schedule are adhered to. You can instruct your smart EV charging station to charge your EV during specific hours, such as when your solar panels are generating excess electricity. This ensures that you make the most of the solar energy you are generating, rather than relying on the grid to charge your vehicle, when energy may be more expensive or less renewable.

NOTE – Programme your EV or EV charging station to charge during off-peak times. During such times, when retailers expect there will be lower demand on the electricity grid, they might offer cheaper power.

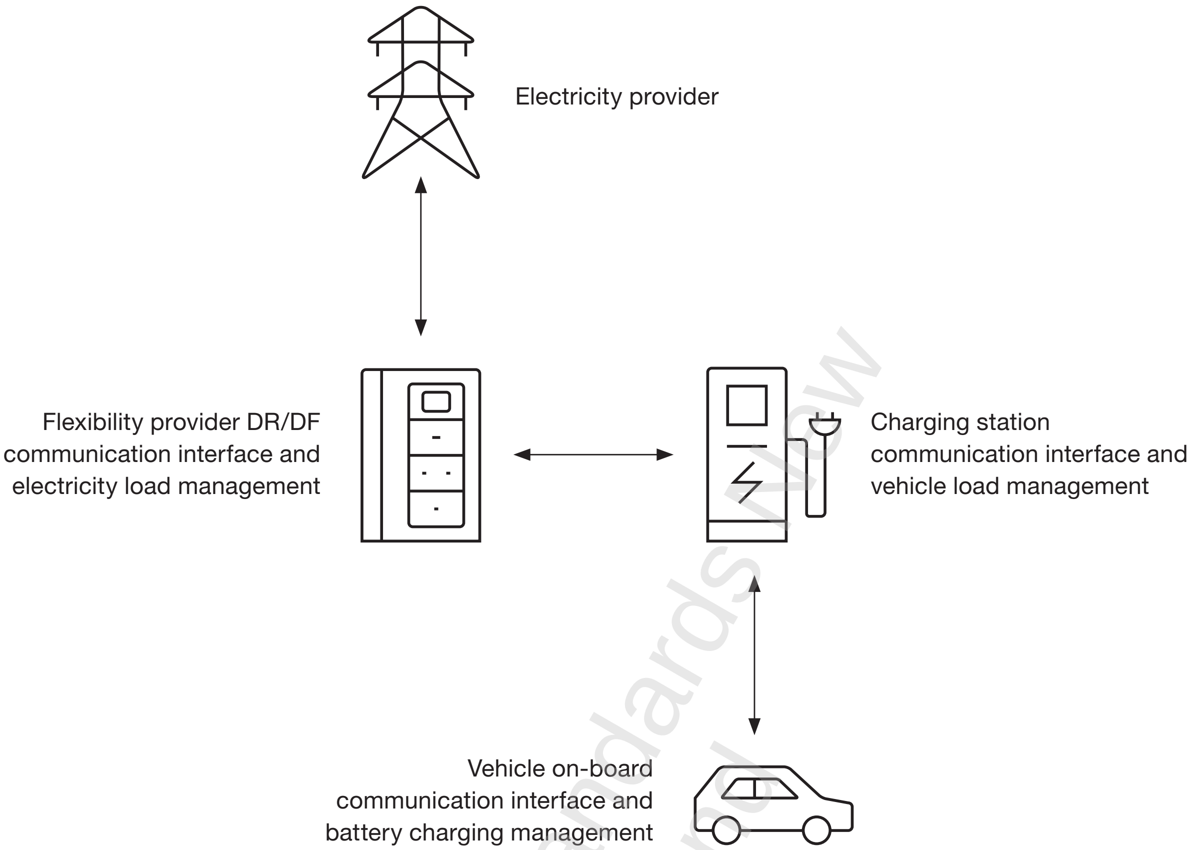


Figure 1 – Demand response and demand flexibility involve two-way communication

4.4 EV charging stations

An EV charging station is a device that provides electrical energy to charge an EV. There are three categories:

(a) An AC EV charging station, or 'on-board EV charging station', is built in and converts power from an AC to a DC supply to charge the battery;

(b) A DC EV charging station is generally mounted in public places, as part of the electricity infrastructure. It converts the grid AC to DC and connects to an EV's DC charging port with a permanently connected (tethered) cable and bypasses the on-board charging equipment; and

(c) An in-cord control and protection device (IC-CPD) is an assembly for supplying electric vehicles in charging Mode 2, which performs control functions and safety functions.

Collectively, these devices and their respective components are referred to as electric vehicle supply equipment (EVSE). Figure 2 summarises EV charging components, and Figure 3 shows a range of plug connections.

NOTE – Charging stations provide a range of connectors that conform to various international standards. Common DC rapid multi-standard EV charging stations are equipped with two or three supply standards, such as combined charging system (CCS), CHArge de MOve (CHAdeMO), and AC fast connectors.

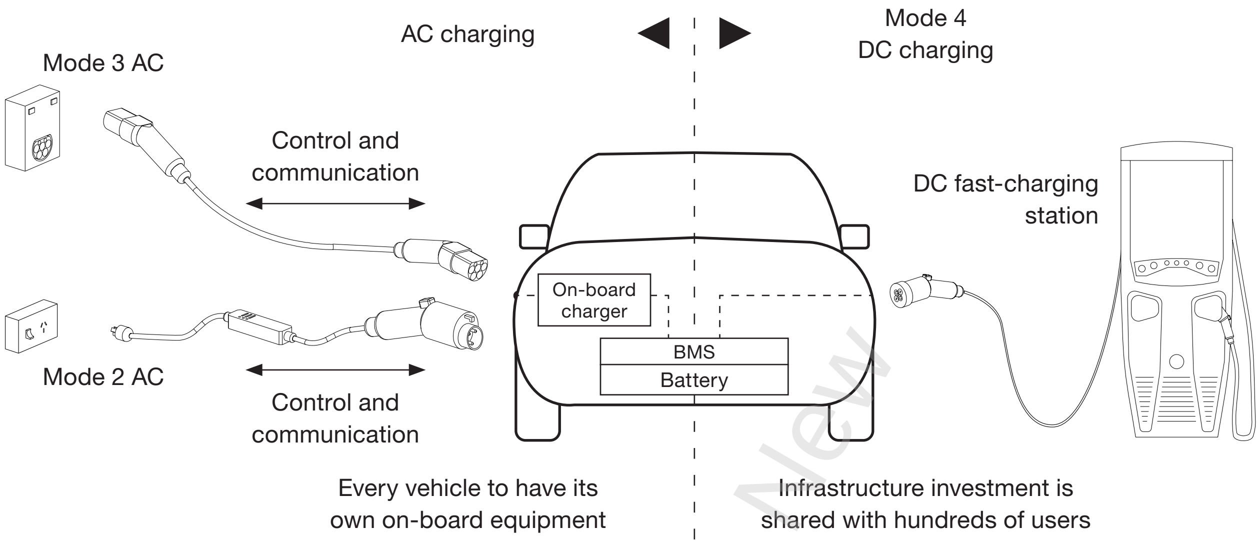


Figure 2 – Electric vehicle supply equipment

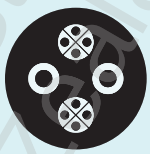
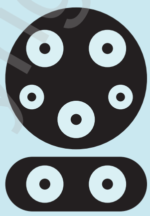
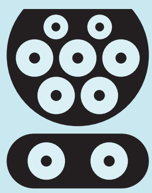
Charging system	Connector types	Key manufacturers
CHAdeMO		Nissan Mitsubishi Toyota Subaru
CCS	 Combo 1: J1772 (USA)  Combo 2: Mennekes (NZ, Australia, Korea and Europe)	Audi BMW Ford GM Hyundai Jaguar Kia Mercedes-Benz MG Porsche Renault Tesla Volkswagen

Figure 3 – Charging stations accommodate a range of plug connections

4.5 Types of EV charging station

4.5.1 Bidirectional EV charging station

A bidirectional EV charging station is a two-way device that allows an EV's on-board battery to be charged and discharged. In most cases this is done via DC charging.

V2G charging is a two-way flow of energy to and from the EV. Under the V2G concept, driving is just one of the various services it can provide as it can also be used to help balance the network. This means that, if the electricity network is short of power (for example, when a power station suddenly drops offline), an EV could provide power to the grid and help balance the network. However, under conventional use, the only time an EV battery is discharged is when it is used to drive the vehicle.

NOTE – V2G capability makes an EV an extremely flexible asset. As well as providing mobility, it can be used for smart charging, to reduce the demand for electricity and export it. Currently, only a limited number of vehicles support the V2G protocol needed for bidirectional charging, but more vehicles will have this function in the future.

When customers are contemplating vehicle-to-house (V2H) or V2G bidirectional capability, they should engage with the owner of the electricity network that connects to their premises at an early stage to determine:

(a) They understand the connection requirements (consult the owner of the electricity network);

(b) If they offer flexibility services that could generate an additional income stream (consult the owner of the electricity network and electricity retailer); and

(c) If the metering arrangements need to be upgraded (consult the electricity retailer).

If customers generate an electricity flow from a premises to a network, they become a participant in the electricity market, according to section 7 of the Electricity Industry Act 2010. These customers shall:

(d) Comply with your local electrical distribution business (EDB) connection and operations standards, which could include New Zealand standard compliance requirements;

(e) Find out about any limitations on what can flow from their premises to the network. Network owners may specify maximum export capacities, and voltage and frequency threshold settings that the inverter shall comply with; and

(f) Apply to the owner of their electricity network for consent to connect the generation and ensure that they comply with the requirements of Part 6 of the Electricity Industry Participation Code 2010.

4.5.2 Bespoke EV charging stations

Bespoke EV charging stations are custom made or made to individual specifications (for example, for testing purposes, buses, and certain vehicle manufactures (see Figure 4).

Figure 4 – An example of a bespoke EV charging station

4.5.3 In-vehicle charging equipment

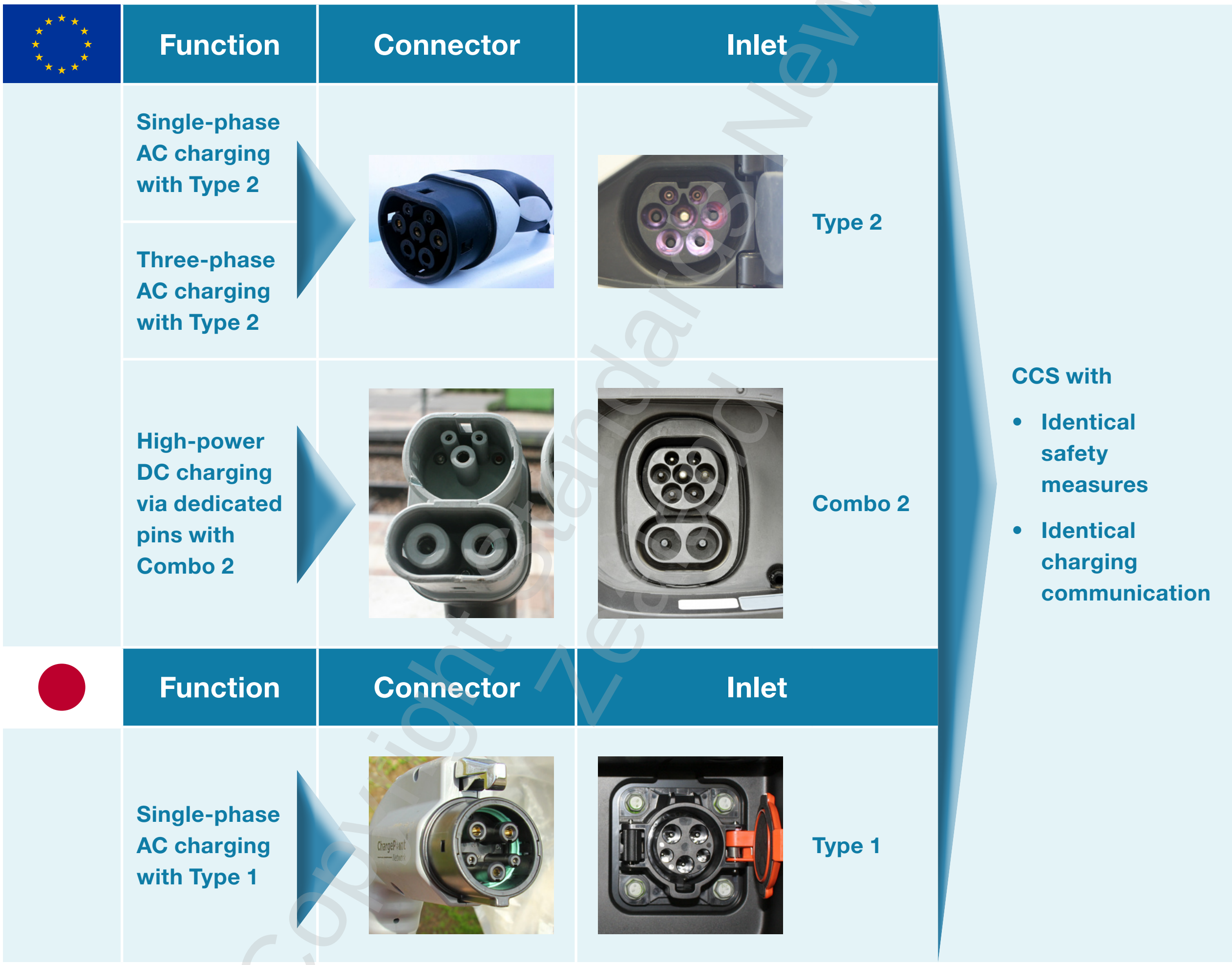
Some EV suppliers provide an assembly that is compatible with the vehicle (see Figure 5). This assembly is referred to as an in-cord control and protection device (IC-CPD). The IC-CPD provides electrical safety, communicates with the EV's on-board charger unit, provides AC power to that unit, and monitors the electricity supply. An IC-CPD allows you to connect and charge your EV virtually everywhere.

Figure 5 – An example of an in-cord control and protection device

4.5.4 Types of plugs, cable connections

There are three types of plugs, cable connections, and operating modes for EV charging stations (see Figure 6a and Figure 6b).

New cars sold in New Zealand and imported from Europe have Type 2 plugs, whereas second-hand vehicles from Japan and earlier models from the UK have Type 1 standard (J1772) plugs. The standard DC plug used by Japanese vehicle manufacturers is CHAdeMO, while the standard plug used by European and US vehicle manufacturers is CCS.



NOTE – CCS plug types have identical safety measures and charging communication.

Figure 6a – CCS plug types and configurations

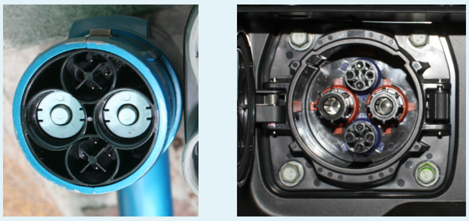


Figure 6b – CHAdeMO plug and inlet configuration

4.5.5 Electricity charge rates and durations

Smart EV charging can potentially be used to achieve several other purposes including:

(a) Reducing a household's demand for electricity at peak times, so that wiring at the premises does not need to be upgraded;

(b) Respond to demand management signals and using DR to defer charging;

(c) Minimising a household's exposure to high retail electricity by responding to high price periods and shifting charging; and

(d) Reducing demand on the network at times when it is constrained.

As EV charging stations have a high demand for electricity, they could have a significant impact on our ongoing electricity supply and charges. However, the controllable nature of EV charging stations means that the impact on a customer's premises – or even the electricity charges – can be minimised.

To make an informed choice, engage early with the retailer and the owner of the electricity network so that you understand the options and their costs and benefits. Over time, the retailer may start to offer payments or reduced costs if your EV charging station reduces electricity demand at peak times, as this will help them meet electricity-supply constraints and minimise their costs.

4.5.6 Recommended types of EV charging station

Always choose a manufacturer that complies with the EV charging standards we observe in New Zealand (see Table 1) and WorkSafe regulations and guidelines.

The type of EV charging station you need (see Figure 7a) will depend on the electricity supply and capacity, and how you intend to use the EV charging station.

AC destination	DC destination
3 kW – 22 kW (Mode 3)	**11 kW – 50 kW (Mode 4)**
3 – 20 hours	**1 – 3 hours**
	
• Office/workplace • Parking structures • Multi-family housing • Hotel and hospitality • Overnight fleet • Supplement at DC charging sites for PHEVs	• Public retail • Hotel and hospitality • Parking structures • Vehicle dealerships

Figure 7a – Types of EV charging stations

4.5.7 Single phase versus multi-phase charging

It is worth understanding the difference in charging speeds made possible by multi-phase capable charging stations as opposed to those restricted to single-phase charging. This is often expressed in terms of three speeds of charging, slow, moderate, and fast:

(a) Mode 3 AC slow charging (single phase): This relates to single phase 3.0 kW to 7.4 kW EV charging stations (see Figure 7b). They are suitable for overnight charging at home or at a business location;

(b) Mode 3 AC moderate charging (multi-phase): This relates to multi-phase 11 kW to 22 kW EV charging stations (see Figure 7b). They are suitable for charging at offices and workplaces, and hotels and hospitality locations; and charging fleet vehicles overnight;

(c) Mode 4 DC fast charging (multi-phase): This relates to multi-phase 25 kW to 50.0 kW EV charging stations (see Figure 7c), which are suitable for charging at offices and workplaces, hotels and hospital locations, car parks, vehicle dealerships and retail centres. They are also suitable for charging fleets (vehicle share) and when 1.5-to-3-hour charging times are acceptable.

4.5.8 EV charging station communication capability

EV charging stations can be connected to a local household control system through an ethernet system, 4G (or later) platform, or wi-fi. Their communication capability will affect their ability to be independently controlled.

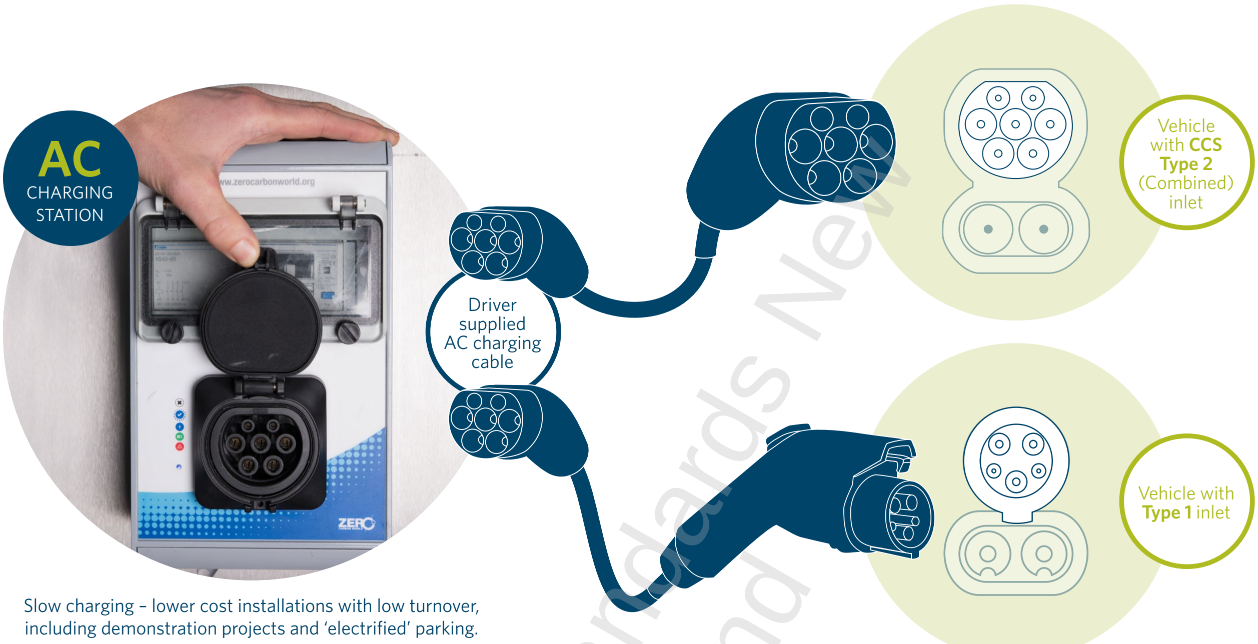


Figure 7b – Mode 3 charging connections

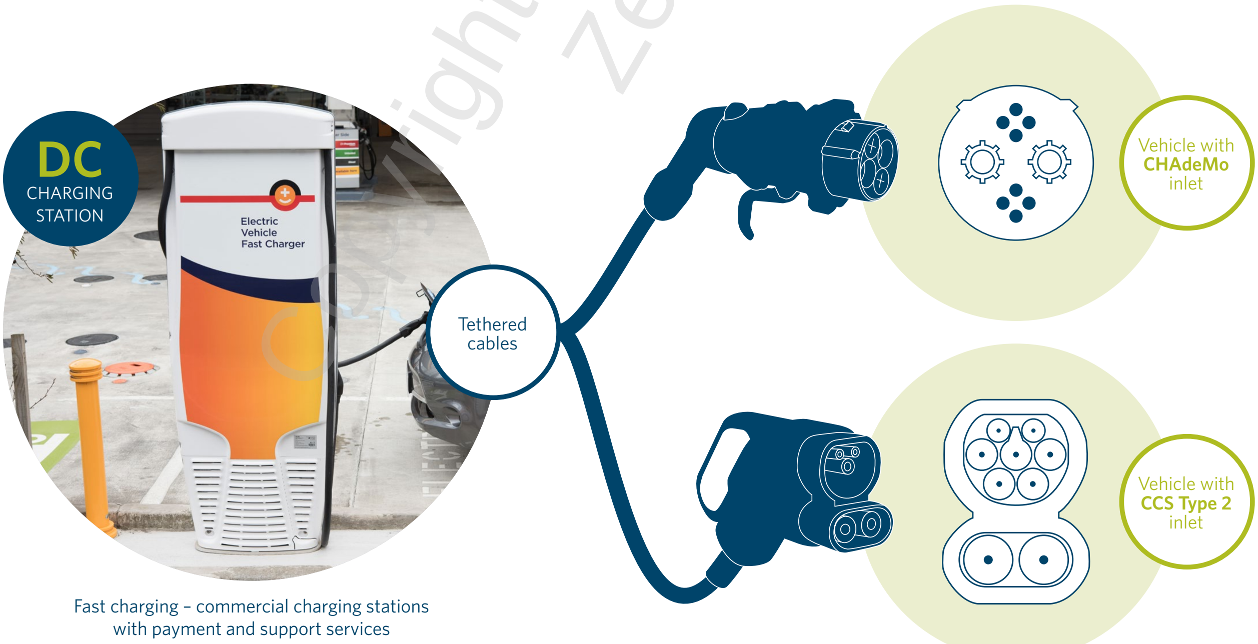


Figure 7c – Mode 4 charging connections

4.6 Battery technology

4.6.1 Battery capacity and charging times

Battery size (capacity) determines the amount of charge needed to fill the battery. Other factors, listed in 4.6.2, determine the rate of charge.

PHEVs typically have smaller battery packs because they have more than one energy source. The battery range of some PHEVs is as little as 30 km. On the other hand, BEVs are completely reliant on the battery for motive power, so need a much larger battery. Most new BEVs have a battery range of 100 km to 300 km, and some makes and models have a range that exceeds 400 km.

4.6.2 Factors that affect the rate of charge

The time needed to completely charge an EV depends on these factors, in order of influence:

(a) Battery capacity (measured in kilowatt hours);

(b) Ambient temperature of the battery;

(c) Utility or grid constraints that limit the current available to the charging station;

(d) Ambient temperature of the charging station;

(e) Charging type;

(f) Charging profile over time, managed by the vehicle's battery management system (BMS);

(g) Capacity of the on-board EV charging station; and

(h) Maximum available capacity (kilowatt rating) of the charging station.

The amount of charge already in the battery also affects the speed at which a battery can recharge. The closer it is to empty, the faster the electricity can flow. When a battery is charged to 80%, the charging rate typically starts to taper off. Therefore, if an EV driver is paying by the minute at a fast-charge station, it can be costly to charge over 80%, so they could choose not to completely fill up (see Figure 8).

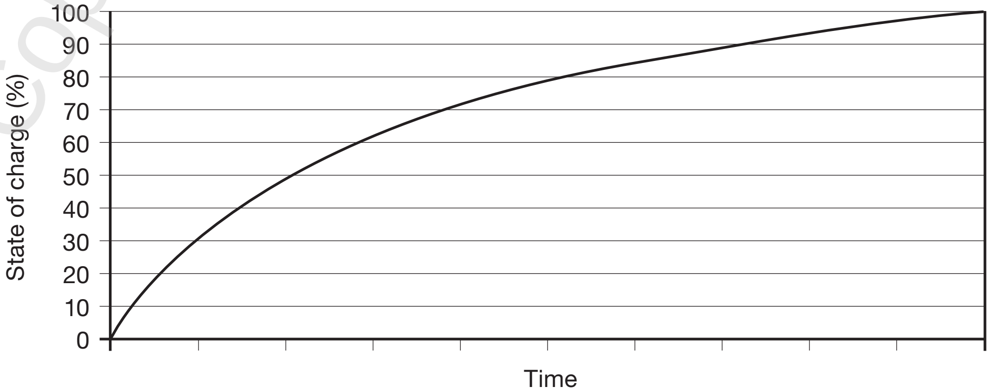


Figure 8 – Typical charging rate

EV charging stations fall into two categories: those that provide an AC charge and those that provide a DC charge. The difference is where the AC power is converted – inside or outside the EV.

DC EV charging stations convert the AC input in the EV charging station itself. This means that the converted electrical energy feeds directly into the EV battery. This negates the need for your EV's on-board EV charging station to convert it. This results in quicker charging times (see Table 1) and an extended vehicle range.

DC EV charging stations have substantially more charging capacity than AC EV charging stations and are more efficient at charging EVs. However, Mode 4 EV charging stations are expensive, and they need multi-phase AC input which few residential properties have. As such, they are primarily suited for charging EVs in public or commercial applications.

Table 1 – Typical charging times for Mode 3 and 4 EV charging stations

EV charging station type (charge rate)	Features and application	Input AC voltage (V)	Mode	Output capability (kW)	Range added per hour (km)	Charge time (hours)
Single phase (very slow)	**Home use** Provides a very slow trickle rate of charge Typically designed for overnight charging Uses a Mode 2 single-phase IC-CPD type power supply Has cable-incorporated a residual current function	230	2	1.5 (6 A)	~9	~50.0
				1.8 (8 A)	~11	~42.0
				3.7 (16 A)	~22	~20.1
Single phase (slow)	**Home use** Provides AC power via the on-board EV charging station Uses a slow rate of charge Typically designed for overnight charging Has control and protection functions to guarantee user safety (such as verifying the protective earth connection and the connection between the EVSE and the EV) Uses a tethered cable or dedicated socket outlet	230	3	3.0	~18	~25.0
				3.7	~22	~20.0
				7.4	~44	~10.0
Multi-phase (moderate)	**Commercial use** Has the same features as single phase Typically designed for commercial settings and electrified parking infrastructure, where auxiliary power is provided adjacent to parking bays (such as a service station) Can be used in residential settings where multiphase power is available	400	3	11	~65	~7.0
				22	~131	~3.5

EV charging station type (charge rate)	Features and application	Input AC voltage (V)	Mode	Output capability (kW)	Range added per hour (km)	Charge time (hours)
Fast	**Public use** Incorporates an off-board EV charging station with a DC output. The DC current is delivered directly to the battery, bypassing the on-board EV charging station Can deliver up to 1000 V DC with a maximum current of 500 A Has further enhanced communication and safety features than Mode 3, such as the connecting cable being permanently tethered to the charging station, due to the high-power level	400	4	25	~149	~3.0
				50	~298	~1.5[a]
Rapid				75	~446	~1.0[a]
				125		~0.6[a]
				150		~0.5[a]
Ultra-rapid or high-powered				175	~450	~0.43[a]
				350	~451	~0.22[a]
				475	~471	~0.17[a]

[a] Charge times are for charging the battery to 80%.

NOTE –

(1) The information in this table is based on New Zealand's EV market, an average battery capacity of 76 kWh, and an average energy consumption rate while driving of 16.8 kWh/100 km. Rates will vary according to manufacturers' specifications.

(2) Only some EVs will accept higher delivery speeds from ultra-rapid or high-powered EV charging stations. Check with your EV supplier first.

4.6.3 Factors that affect battery range

The distance that an EV can travel before requiring a recharge will be reduced by these factors:

(a) Aggressive driving, including driving at high speed;

(b) Low tyre pressure that can cause excessive use of power;

(c) Long mountain climbs;

(d) Non-stop high speeds (for example, on a highway);

(e) Strong headwinds and wet weather;

(f) Extra weight (for example, added passengers and luggage);

(g) Loss in battery capacity (as a battery ages, its maximum charge reduces);

(h) Objects that affect the EV's aerodynamics (for example, a fully loaded roof rack, bike rack or trailer);

(i) High use of the air conditioner or heating;

(j) Cold temperatures;

(k) Battery temperature.

4.6.4 Ways to extend battery range

To increase the distance that an EV can travel before requiring a recharge:

(a) Drive smoothly at lower speeds;

(b) Maximise regenerative braking;

(c) Travel light;

(d) Use the heater and air conditioning sparingly.

5 TECHNICAL SPECIFICATION REQUIREMENTS

5.1 Charging equipment

5.1.1 General requirements

This section outlines the approach for a single residential dwelling or a complex of dwellings that each have individual connections to the electricity network (see Figure 9).

For residential complexes that have shared facilities and a common network connection, see SNZ PAS 6010.

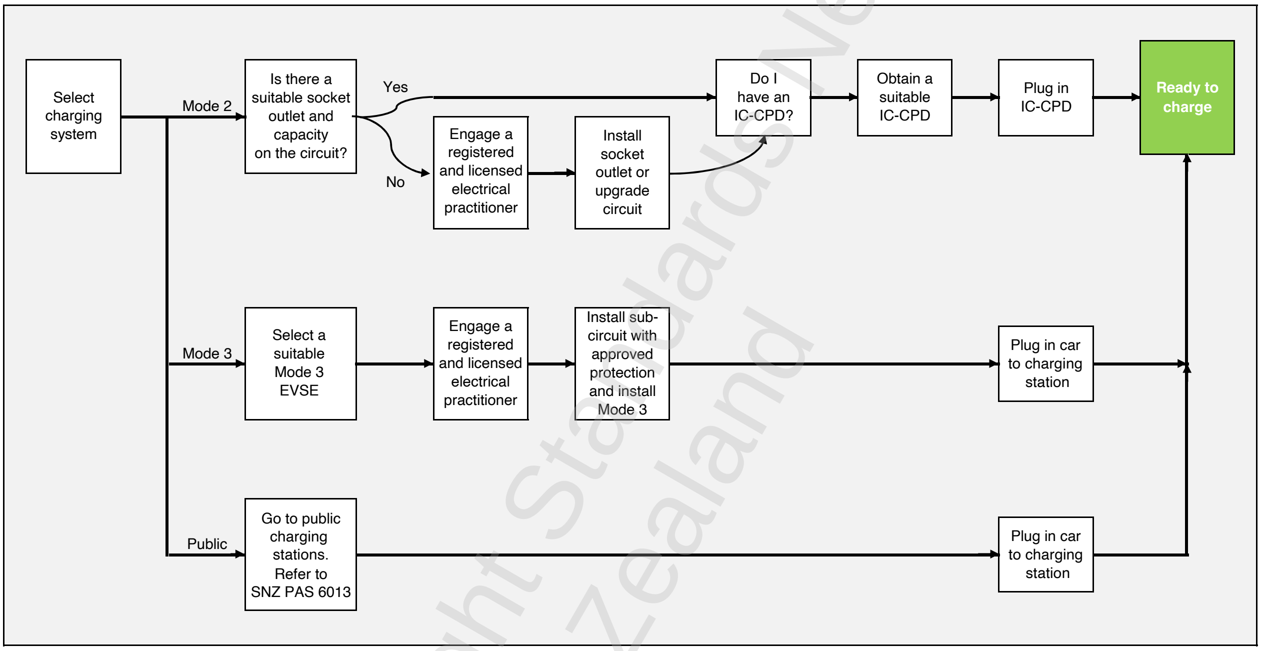


Figure 9 – Installation protocol for charging equipment

5.1.2 Prerequisites

Always use a registered electrician to install and analyse the capacity of any EV charging equipment. Make sure that the installer is:

(a) Competent (trained and experienced) to perform the task required, has equipment knowledge and able to work within their limits; and

(b) Familiar with all local electrical regulations and the manufacturer's instructions in the installation manual.

Ensure that any electrical work meets the distribution network's Electricity Network Connection Standard.

5.1.3 Charging modes in New Zealand

Residential charging primarily uses Mode 2 or Mode 3.

This PAS recommends that (unless a temperature-sensing plug is used) Mode 2 domestic outlets should conform with AS/NZS 3112, which requires 10 A rating (for 8 A maximum continuous charging), 15 A (12 A maximum continuous charging), 20 A (for 16 A maximum continuous charging), or BS 13 A socket marked 'EV' (for 10.4 A maximum continuous charging).

Mode 3 charging allows faster AC charging than Mode 2. It is a good option for EVs that have medium or large battery capacity (greater than 24 kWh) or that need to be charged quicker than overnight (such as in 8 to 10 hours).

Some EVs imported from the UK come with an EV charging station cable that has a UK standard plug. You may fit a UK standard approved outlet (provided it is protected by a type B RCD), and you use it only to charge your EV.

5.1.4 Analysing load to accommodate an EV charging station

Always employ a registered electrician to analyse the capacity of your current electrical load, including incoming supply. They will advise you on what type of charging equipment you need, as well as carry out the installation of EV charging equipment.

Mode 2 charging uses a power outlet on an existing sub-circuit. Even with an 8 A IC-CPD, check what other loads are likely to be running on that sub-circuit to avoid tripping the sub-circuit overload protection (circuit breaker or fuse). If more than one socket outlet is available and the sockets are on different sub-circuits, charge the EV using the sub-circuit that is likely to have the least load.

Some IC-CPDs have an extra-low power option of 6 A that can be used when the sub-circuit has limited capacity to charge an EV.

5.1.5 Mode 3 charging equipment

Mode 3 charging can use a single-phase or three-phase supply depending on the property, the electrical supply to the property, and the vehicle. Check each of these factors before choosing a charging device.

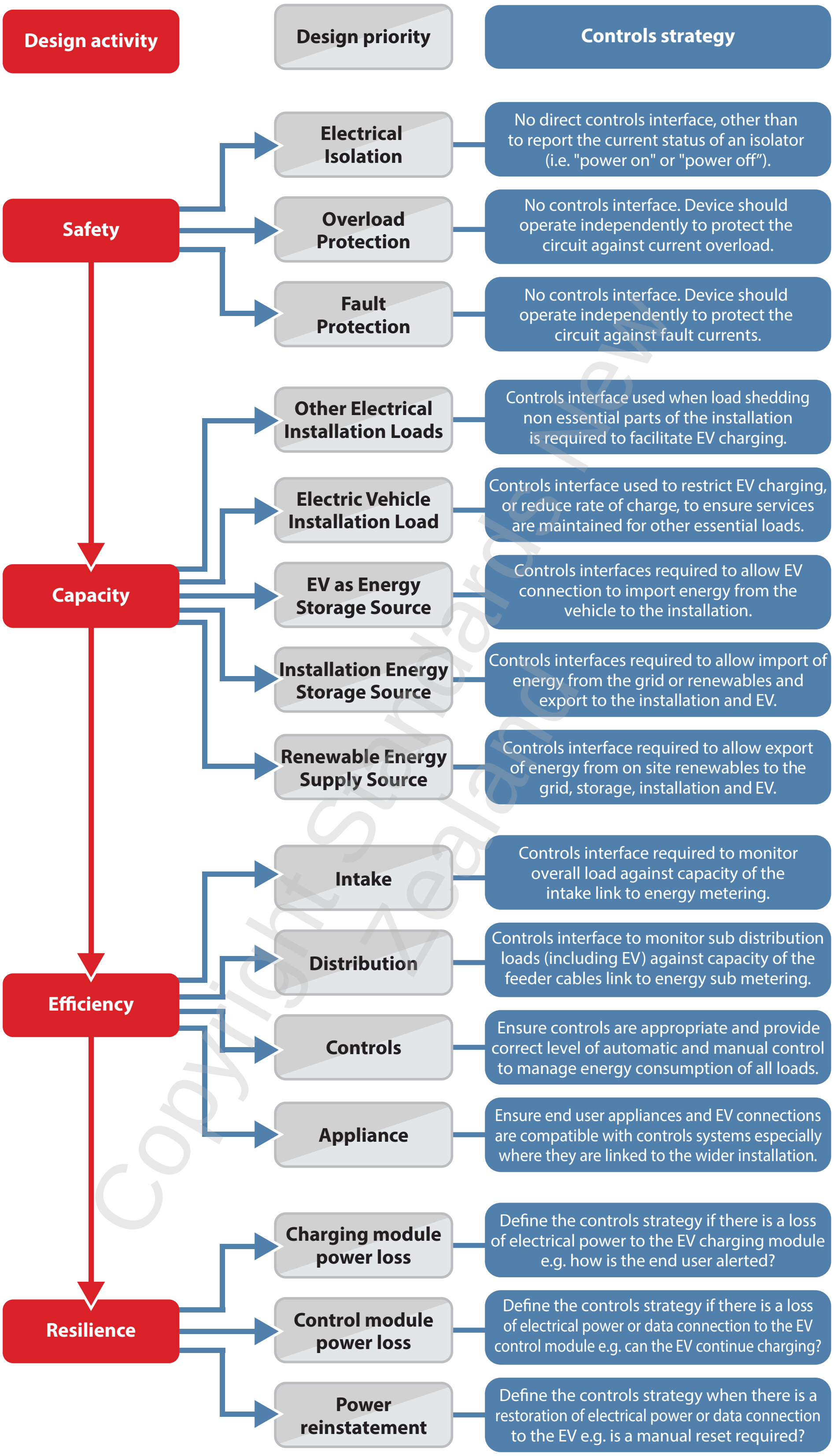
The most common load ratings of Mode 3 charging equipment are 16 A or 32 A. However, when you run a new, dedicated sub-circuit to charge your EV, the cable should be rated for 32 A, even if you install a 16 A Mode 3 EV charging station. This will ensure the installation's fixed wiring is futureproofed.

5.1.6 Electrical design hierarchy and the influence of controls

According to the Institute of Engineering and Technology's *Designer's guide to energy efficient electrical installations*, safety, capacity, efficiency, and resilience are key activities in an electrical-installation design hierarchy.

For each activity, key design priorities will influence how the EV and its EV charging system are integrated with the electrical and data installations.

For each design priority, carefully consider the controls interface. Figure 10 highlights some of the main considerations and interfaces but is not an exhaustive list.



NOTE – 'Controls strategy' means how the EV is expected to interface with other energy-management systems, such as V2H, V2I and V2G (via an aggregator).

Figure 10 – Considerations for designing an installation

5.1.7 Analysis of electricity capacity

When connecting Mode 3 charging to an existing installation, a registered electrician should size the cables that supply the charging equipment, as well as check the capacity of the upstream supply and the installation's sub-mains and mains.

Capacity shall be checked against the installation's existing demand and the proposed increased demand from the charging equipment. Capacity in the sub-mains and mains should include volt drop as well thermal rating. If more capacity is needed, you will need to apply to the electricity distribution business (EDB) for increased capacity and upgrade the installation's mains and or sub-mains.

When assessing the existing demand on the mains or sub-mains, you should measure and calculate the load. Your electricity retailer may have some load data if the installation has a smart meter.

Some suppliers of Mode 3 charging equipment have an option that measures the load on the mains or sub-mains and adjusts the EV charging rate to keep demand below the rating of the main or sub-mains. This reduces the amount of additional load that EV charging places on the installation so that the maximum demand is less than it would be without load management. In many cases, this negates the need to increase the capacity of the electrical supply line to the property.

When the installation is multi-phase, the Mode 3 EV charging station – if single phase – should usually be connected to the least-loaded phase to reduce the peak demand on the mains or sub-mains. If your household has photovoltaics (PV) and your EV is mostly parked at home during the day, you could benefit financially by connecting the EV charging to the same phase as the PV.

If there is no load-management system in place, when determining the supply capacity you need for a new installation, add the load for the charging equipment to other loads you propose to use the installation for.

NOTE – With low-powered Mode 2 charging there is normally enough power in the sub-mains and mains to accommodate EV charging. However, you should undertake the same capacity checks as Mode 3 charging when using Mode 2 to charge multiple EVs at the same time.

5.2 Typical locations for EV supply equipment

EVSE locations vary depending on the circumstances, but Figures 11, 12, 13, and 14 illustrate some typical locations. Table 2 gives more guidance on EVSE positioning.

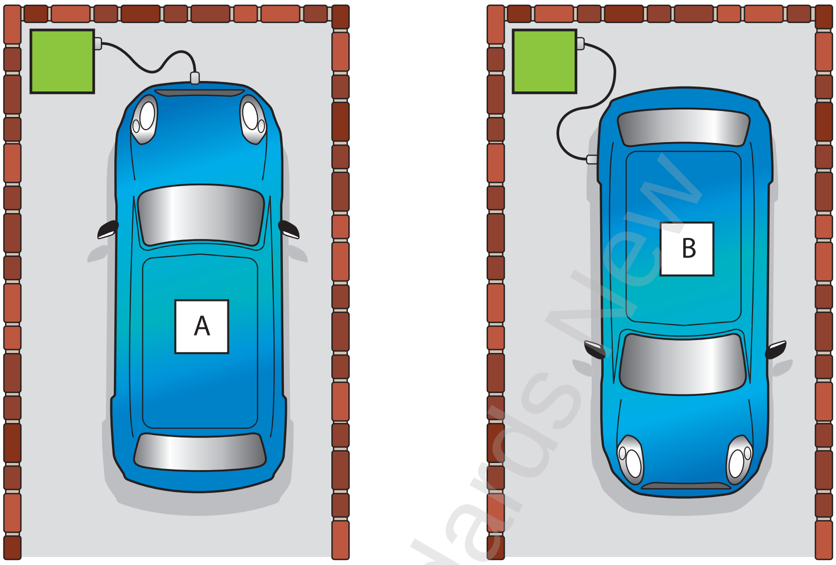


Figure 11 – Positioning EVSE in an internal or detached garage

Figure 12 – Positioning EVSE in a car port or off-street parking location

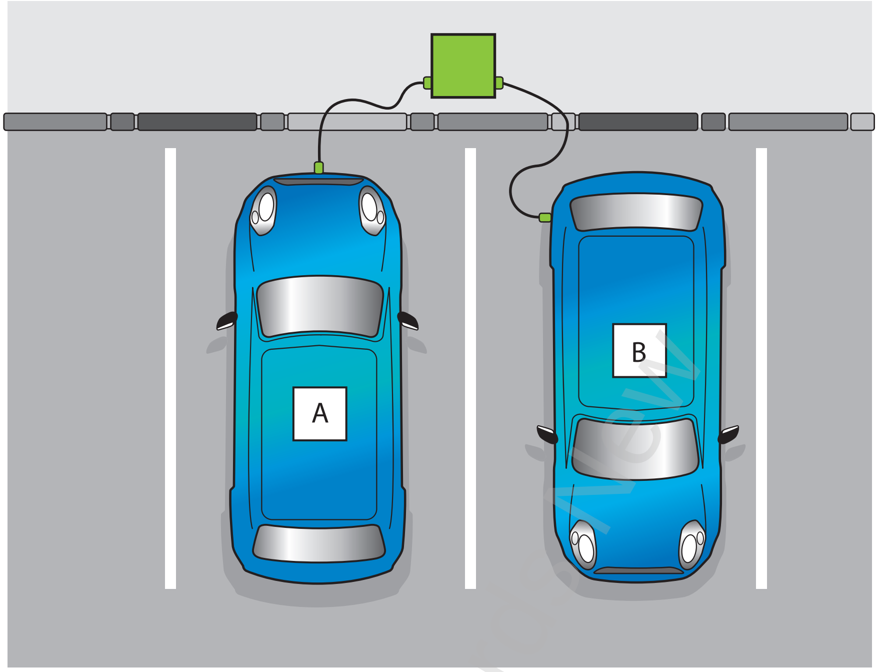


Figure 13 – Positioning EVSE in apartment parking or other multi-car dwelling

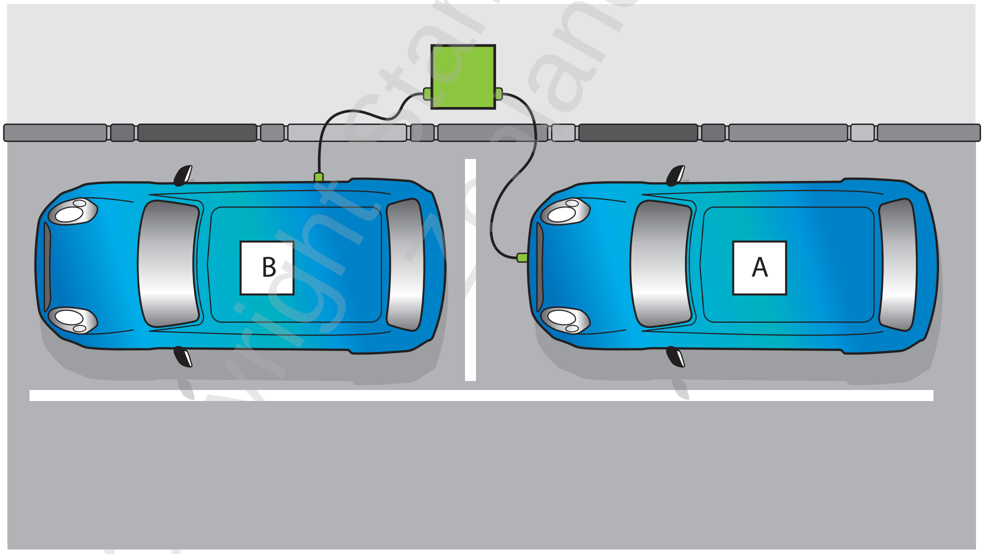


Figure 14 – Positioning EVSE for on-street charging for private dwellings

5.3 Electrical safety requirements

5.3.1 Safety principles for charging EVs

These principles are intended to provide an acceptable level of safety when charging equipment is connected to an electricity supply in New Zealand. The principles are consistent with New Zealand's arrangements for electricity-supply configuration and earthing.

Therefore, it is important that all equipment and fittings are correctly installed and maintained, and in good condition every time they are used.

All charging stations should include a fail-safe earth-continuity monitoring system that interrupts the supply if the earthing connection to the vehicle becomes ineffective. It is strongly recommended that earth continuity is verified by a registered electrician.

5.3.2 Additional safety considerations

If you feel a tingle when touching metal appliances or taps, have flickering lights or a lower output than normal, or find appliances are not working properly, this could indicate a broken or high-resistance neutral connection. Promptly arrange for a registered electrician to investigate the situation. If an EV is plugged into a socket outlet or charger, make sure that no one touches or comes close to its chassis until it has been checked and declared safe

5.3.3 Compliance testing requirements

In New Zealand, before an EV charging station can be connected to an electricity supply, the installer shall issue a certificate of compliance (CoC) to verify it has been correctly installed. Similarly, before a charging station is put into service, the installer shall issue an electrical safety certificate attesting that it is safe to use. These certificates may sometimes be combined into the same document.

5.3.4 Maintenance regimes

Each installation should be periodically verified. Any maintenance required should be carried out according to the manufacturer's instructions. This includes testing the electrical and mechanical safety of the output cable and connector, due to wear and tear. Owners of EV charging stations or devices are advised to engage a registered electrician to do such work.

5.3.5 Unsafe practices

This guideline considers the following practices to be unsafe when electricity is being supplied to an EV or an EVSE is being used:

(a) Using an EV adaptor that is not specifically supplied by the vehicle manufacturer or the EVSE manufacturer;

(b) Using a socket-outlet adaptor;

(c) Cascading two or more supply leads;

(d) Using an extension lead;

(e) Using portable socket outlets, including electrical portable outlet devices (such as multiboxes);

(f) Using a single socket outlet to supply more than one vehicle at a time;

(g) Using EVSE that is not labelled by the manufacturer as being compatible with a 230 V, 50 Hz supply;

(h) Using a charging station for public charging without an appropriate test tag; and

(i) Supplying electricity from an IC-CPD or charging station to anything other than an EV.

If a charging station or EVSE is found to be unsafe or is involved in an electric-shock event, it should be immediately taken out of service and not used or returned to service until it is verified as safe.

5.3.6 Finished installation

Once your new charging installation is installed you should ensure that you registered electrician provides you with a Certificate of Compliance and an Electrical Safety Certificate.

5.4 Grid connectivity and communication requirements

5.4.1 Electricity delivery prices

Lower-cost pricing plans may be available if the EV charging station can be remotely controlled or set to operate during specific time periods.

Electricity retailers can provide information on pricing plans. Different retailers offer different pricing plans, so there could be pricing plans that improve the average purchase price of electricity for your premises that will benefit you in the long term. However, some pricing plans could require changes to the metering or internal wiring configuration of your premises. If a retailer does not offer you a suitable pricing plan, consult other competing retailers.

Before buying an EV charging station, you should investigate its communication capability as well as the retailer's capability to manage and communicate with it locally and remotely. The EV charging station's capability may have specific benefits immediately and in the future.

To obtain EV charging for the lowest long-term cost, seek advice from your electricity retailer and the owner of your electricity network before you install the EV charging station.

5.4.2 Communication protocols

Demand response (DR) can be used to manage the charging load of EVs connected to the grid. This reduces the cost to the consumer, electricity network, electricity retailer, and electricity generator.

To enable DR, the EV charging station needs the technical capability to communicate with an external device (such as a smart house system or a utility's control centre). There are various methods and protocols for this communication, such as Modbus RTU, Modbus TCP/IP or BACnet. The choice of communication method and protocol depends on factors such as what type of EV charging station is used, what type of communication infrastructure is available, and what requirements the DR programme has.

The charging station should have OCPP 1.6 or above installed to enable communication with DR suppliers.

NOTE – Network or retailer pricing-plan options may be tied to communication capability, or pricing incentives, or the customer has local control.

5.4.3 Data capture and smart metering

EVSE should include the capability to measure the quantity of electricity in real time. either through an absolute meter register or an accumulation meter register. The measurement does not need to comply with strict accuracy standards but should be within a range of ± 3%.

5.4.4 Smart-charging requirements

Smart charging shall:

(a) Support open charge-point protocol (OCPP) 1.6 or above;

(b) Support these OCPP profiles:

  (i) Core

  (ii) Firmware management, and

  (iii) Smart charging; and

(c) Be able to connect to any OCPP server, not just the manufacturer's or reseller's.

5.4.5 Charge-point requirements

The charge point shall be able to:

(a) Receive and process information;

(b) React to information it receives, by adjusting the charging or discharging rate; and

(c) Monitor and record energy consumption in half-hourly intervals and transmit this at least once a day.

5.4.6 Data communication protocol

The charge point shall be accessible remotely, through a data communication protocol and communication technology, by using OCPP version 1.6 or above, or equivalent.

5.5 Cybersecurity and data capture

5.5.1 Appropriate security measures

Charging stations shall incorporate appropriate security measures to ensure that their functions are resilient to cyberattacks. This ensures that any communications are secure, authenticated and encrypted to prevent interception by a third party.

Charging stations shall include the capability for the remote software updates described in NISTIR 8259A *IoT device cybersecurity capability core baseline* (see Fagan et al. in the 'Other publications' section).

5.5.2 Other considerations

It should be noted that the NISTIR 8259A baseline is not the only set of cybersecurity capabilities that exist. The baseline represents a coordinated effort to produce a definition of common capabilities, not an exhaustive list. Therefore, an implementing organisation may define capabilities that better suit their needs. Using these additional capabilities to support Internet of Things (IoT) device cybersecurity risk management is encouraged and, to that end, all actors involved might wish to consider ISO 15118-3, or BSI PAS 1878, or both.

5.6 Installation checklist

The checklist set out in Table 2 is designed to help EV owners and equipment installers ensure that they have considered all electrical safety measures. It is not exhaustive.

Include a copy of this checklist with the electrical CoC and electrical safety certificate in the event the ownership of the current property where the EVSE is located changes hands.

Table 2 – Residential checklist

ITEM CHECK		Yes	No	N/A
		(tick box where appropriate)		
Homeowner				
1	Have you, the homeowner, discussed with the installer which model EV you will be purchasing and what type of EV charging station and plug configuration is to be used?	☐	☐	☐
2	Check any requirements to provide information about the EV installation to your network and/or energy provider.	☐	☐	☐
3	Have you and the installer followed the recommended EV charging station installation protocol identified in Figure 9 of this document?	☐	☐	☐
4	Have you agreed with the installer's recommendations to proceed with the prescribed electrical work, as outlined in the quotation, and signed it off?	☐	☐	☐
5	Have you received a CoC from the installer including an electrical safety certificate (this maybe combined)?	☐	☐	☐
Installer				
6	Have you, the installer, clearly identified any explosive substances that could affect the installation and discussed with the owner how such risks will be mitigated?	☐	☐	☐
7	Does your pre-work survey of the existing installation include an assessment of:			
	(a) The rating and condition of existing electrical equipment?	☐	☐	☐
	(b) The suitability of additional electrical load?	☐	☐	☐
	(c) Earthing and bonding arrangements?	☐	☐	☐

		Yes	No	N/A
8	Did your pre-work tests of the existing installation include:			
	(a) Earth continuity, polarity, and insulation tests?	☐	☐	☐
	(b) Earth-loop impedance tests?	☐	☐	☐
	(c) Tests regarding the operation of residual current devices (RCDs) and checks that the correct protection devices have been used?	☐	☐	☐
9	Have you, the installer, notified the owner of any constraints or difficulties related to the proposed installation, including:			
	(a) The outcome and test results of items 2 and 3 above?	☐	☐	☐
	(b) Any electrical remedial work, including the installation of new circuity and any associated EVSE?	☐	☐	☐
10	Before commencing work, have you, the installer, reviewed the installation instructions provided by the owner or charging equipment manufacturer, and agreed with the owner on the most appropriate permanent location of the EVSE, including any dedicated electrical socket outlets?	☐	☐	☐
11	Has the charging equipment been installed in an optimal location with respect to the intended vehicle parking position?	☐	☐	☐
12	Has the EVSE been installed in a location to minimise the likelihood of vehicle impact damage?	☐	☐	☐
13	Were protective barriers required to be installed?	☐	☐	☐
14	Are the main operating controls and any socket-outlets between 0.75 m and 1.2 m above the ground, and displays between 1.2 m and 1.4 m above ground?	☐	☐	☐
15	Is there sufficient space around the charging equipment to open all doors and covers?	☐	☐	☐
16	Is there sufficient space around the charging equipment for ventilation and cooling purposes?	☐	☐	☐
17	Have all trip hazards been considered and, where possible, avoided?	☐	☐	☐
18	Following completion of the installation, did you go through the correct charging operation, any associated safety considerations, and equipment instructions with the owner?	☐	☐	☐
19	Following completion of any prescribed electrical work, did you provide the owner with a certificate of compliance (CoC), including an electrical safety certificate (this maybe combined)?	☐	☐	☐
20	Does the installation comply with the distribution network's Electricity Network Connection Standard?	☐	☐	☐
21	Has the owner been instructed on the need to test operation of the associated RCDs and the recommended interval between tests?	☐	☐	☐

5.7 EV charging station reference tool

All EV charging stations have pros and cons. The model you choose will depend on your personal preferences, but Table 3 will help you decide.

Table 3 – Overall ratings for EV charging stations

Rating	Mode 2	Mode 3	Mode 4
Cost	1★	2★	3★
Safety	3★	4★	5★
Charge time	1★	2★/3★	4★/5★/6★
Reasons for rating	Basic level of features when plugged into undedicated circuit socket outlets. Least expensive option If you prefer charging overnight, or charging time is not a serious consideration then this is a good option.	Good level of features combined with moderate (single phase) to good (multi-phase) charging performance. Suitable for commercial use that needs shorter charging times. Likely to be the most commonly used and available units.	High level of features combined with outstanding performance. Very expensive, so primarily limited to public charging stations and only certain EVs have Mode 4 charging capability.

Explanation of ratings

Cost

1★ $700 – $1200

2★ $2,000 – $4,000

3★ $45,000 – $60,000

Safety

3★ **Mode 2** has basic control pilot on/off features, with restricted charging current functionality

4★ **Mode 3** has enhanced functions over Mode 2. Permanently tethered connecting cables are an option. If there is no proper mechanical connection with the vehicle inlet, then electricity will not flow. It has controlled charging current, RCD protection against electric shock and continuous monitoring of earth continuity. It also automatically disconnects the supply if the earthing connection becomes ineffective

5★ **Mode 4** has again more enhanced vehicle communication and other features over that of Mode 3. It also includes permanently tethered cables connected to the charging station, capable of varying charging currents up to 500 A

Charge times

1★ 20 – 50 hours (230 V)

2★ 10 – 25 hours (230 V)

3★ 3.5 – 7 hours (400 V)

4★ 1.5 – 3 hours (400 V)

5★ 0.5 – 1 hour (400 V)

6★ 10 – 26 minutes (400 V)

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