STANDARDS
NEW ZEALAND
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SNZ PAS 6010:2023

STANDARDS NEW ZEALAND
PUBLICLY AVAILABLE SPECIFICATION

Commercial electric vehicle (EV) charging

Superseding SNZ PAS 6010:2021

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

SNZ PAS 6010:2023

TECHNICAL ADVISORY GROUP REPRESENTATION

This publicly available specification was prepared by the P6010 Commercial 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
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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NOTES

CONTENTS

Figure

REFERENCED DOCUMENTS

Reference is made in this document to the following standards and other publications. When a version date is not quoted, use the version referenced in the relevant regulation.

New Zealand standards

SNZ PAS 6011:2023	Residential electric vehicle (EV) charging

Joint Australian/New Zealand standards

AS/NZS 3000:2018	Electrical installations (known as the Australian/ New Zealand wiring rules)
AS/NZS 61439:----	Low-voltage switchgear and controlgear assemblies
Part 1:2016	General rules
Part 2:2016	Power switchgear and controlgear assemblies
Part 3:2016	Distribution boards intended to be operated by ordinary persons (DBO)

International standards

BSI PAS 1878:2021	Energy smart appliances. System functionality and architecture. Specification
BSI PAS 1899:2022	Electric vehicles. Accessible charging. Specification
ETSI EN 303 645	Cyber; Cyber security for consumer Internet of Things: Baseline requirements v2.1.1
IEC 60529:1989	Degrees of protection provided by enclosures (IP Code)
IEC 61851:----	Electric vehicle conductive charging system
Part 1:2017	General requirements
Part 23:2014	DC electric vehicle charging station
Part 24:2014	Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging
IEC 61980-1:2020	Electric vehicle wireless power transfer systems
IEC 62196:----	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles
Part 1:2022	General requirements
Part 2:2022	Dimensional compatibility and interchangeability requirements for AC pin and contact-tube accessories
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)

IEC 62752:2016	In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD)
IEC 62955:2018	Residual direct-current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles
ISO 15118:----	Road vehicles – Vehicle to grid communication interface
Part 1:2019	General information and use-case definition
Part 2:2014	Network and application protocol requirements
Part 3:2015	Physical and data link layer requirements
Part 4:2018	Network and application protocol conformance test
Part 5:2018	Physical layer and data link layer conformance test
Part 8:2018	Physical layer and data link layer requirements for wireless communication
OCPP 2.0.1	Open charge-point protocol
SAE J1772_201710	SAE electric vehicle and plug-in hybrid electric vehicle conductive charge coupler
UL 2202	Standard for safety for electric vehicle (EV) charging system equipment (2018 revision)
UL 2251	Standard for safety for plugs, receptacles and couplers for electric vehicles

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

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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 Act 1992

Electricity Industry Act 2010

Electricity Industry Participation Code 2010

Electricity (Safety) Regulations 2010

Land Transport Rule: Traffic Control Devices 2004 (Rule 54002)

Resource Management Act 1991

Websites

www.legislation.govt.nz

www.nzta.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 will be welcomed. They should be sent to the National Manager, Standards New Zealand, PO Box 1473, Wellington 6140.

FOREWORD

This document, SNZ PAS 6010:2023, *Commercial electric vehicle (EV) charging*, has been prepared as a guidance document and published as a publicly available specification (PAS).

The International Organization for Standardization (ISO) recognises PAS as documents that are not national standards, but which are produced by national standards bodies in response to particular market needs. A PAS represents consensus in an organisation or industry, or consensus of experts in a specific working group.

SNZ PAS 6010:2023 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 commercial enterprise.

This guideline covers plug-in-type EVs. The Energy Efficiency and Conservation Authority (EECA) can use this guideline to determine the selection criteria for energy-efficient commercial charging stations under its funding programmes.

Use this guideline if you are a New Zealand business owner thinking about buying an EV for your fleet or if you provide EV supply equipment (EVSE) or associated EV charging services. It will help you understand the types of charging infrastructure that suit New Zealand workplaces and commercial premises. It explains how to optimise EV charging systems to ensure EVs are safely and efficiently charged at commercial premises.

This guideline also explains what businesses and suppliers need to know about how to specify and select commercial charging stations to install in New Zealand. Table A1 (see Appendix A) provides a pre-purchase assessment checklist, which is designed to guide organisations transitioning from traditional fossil-fuelled vehicles to EVs.

SNZ PAS 6010 can also inform decisions about the future needs of New Zealand's infrastructure to meet EV charging requirements and how to modify the electricity system to facilitate smart charging.

NOTE – It is recommended that a 'registered electrician' undertake all prescribed electrical work referred to within this publication.

Changes for commercial fleet transport

New Zealand is experiencing a seismic shift in transport technology.

Owing to climate change, every manufacturer that supplies vehicles to New Zealand is being encouraged to transition from selling only fossil-fuelled vehicles to including cleaner alternatives in their range. 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, and New Zealand's network of charging infrastructure is already developing.

Despite EVs being a relatively new and evolving technology, they are changing the energy landscape in New Zealand. This change affects everyone: electricity-network operators, electrical trades, government regulators and policymakers, commuters, and consumers.

Transport is one of the most cost-effective ways to reduce emissions and air pollution in New Zealand. Renewable electricity is one of several options that will help decarbonise New Zealand's heavy-duty and commercial fleet. EVs and other efficient and low-emission vehicles will therefore help New Zealand meet its climate change targets.

Electricity can be used as a low-carbon energy source to drive an electric motor by directly charging a battery pack in the vehicle. Battery electric vehicles (BEVs) use electricity stored in a battery pack in the vehicle to power an electric motor and turn the wheels. Although BEVs produce no tailpipe emissions, they do produce greenhouse gas emissions if the electricity used to charge them does not come from renewable sources. When the battery pack is depleted, it is recharged from the electricity grid via a charging station. The charging station can be located at a private business premises, or anywhere there is vehicle access. The charging speed depends on the rate of charge the vehicle can accept and the power of the charging station.

Public charging and commercial buildings

Currently, charging stations at public and commercial premises account for a small share of the country's charging needs; however, they are critical for giving long-distance or high-usage vehicles fast charging. They also complement charging already completed at homes.

The technology available for charging stations to charge faster is developing quickly. In the future, urban and non-urban areas will need different solutions based on the volume of public and commercial charging and home-based charging required.

Charging stations at commercial premises are often specific to certain locations, vehicles, and consumers. For example, private EV owners in an apartment building will have different needs to a business fleet with charging stations at the workplace. Likewise, urban public buses and heavy-duty trucks, which have large batteries and high electricity consumption, will need another infrastructure solution.

As battery technology and energy density evolve, electricity may increasingly be used to power medium and heavy vehicles. New Zealand's charging infrastructure should be designed to anticipate this change.

In general, giving the public access to charging stations at commercial premises will help increase EV ownership because, by making increased access visible, business fleets and private car owners will have more confidence to invest in EVs. As a result, the availability of charging infrastructure is likely to increase.

Changes to this version

In 2021 we published SNZ PAS 6010, *Electric vehicle (EV) chargers for commercial applications*. With publicly available specifications (PAS) 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 a commercial location is more complex than installing one at home, which is why it is differentiated from SNZ PAS 6011, *Residential electric vehicle (EV) charging*.

To date, there have been more than 4000 downloads of our EV guidelines, sponsored by the Energy Efficiency and Conservation Authority (EECA). These PAS offer guidance in establishing a safe, efficient charging system based on good practice and designed by subject matter experts.

Key changes to this 2023 revision pertain to the following:

- Given the need to provide greater clarity around end-user terms universally applied to EV charging equipment, the TAG agreed that a change of title for this PAS was warranted. The new title for this 2023 revision is *Commercial electric vehicle (EV) charging*. Referenced documents have been updated and the layout modified;
- The foreword has been updated to reflect the evolving EV market, the shift in transport technology, and the important role that public-facing commercial enterprise can play in the provision of smart charging infrastructure;
- The revised publication is now four sections (previously five). This was done because the original public charging 'on-journey 'component was creating confusion about requirements for smaller commercial enterprise and was not focused on destination charging. A separate 'on-journey' PAS with information on publicly available EV charging is currently under development.
- Definitions and abbreviations have been updated;
- Section 2 has been updated to include a snapshot of the market to March 2023. Also:
  - The clauses on EV plug connector types have been updated to reflect current manufacturer requirements
  - There is a greater focus on demand-response and demand-flexibility and how they relate to EVs
  - There are new clauses on 'load management' and 'grid-connectivity and communication protocols', with a minimum specification set for EV charging stations, defining efficiency, connectivity, and cybersecurity requirements;
- Section 3 now includes more guidance for installation procedures and compliance requirements, including identifying unsafe work practices.

Publicly Available Specification

Commercial electric vehicle (EV) charging

1 GENERAL

1.1 Scope

1.1.1 Inclusions

This publicly available specification (PAS) gives guidance on good practice for commercial electric vehicle (EV) charging stations. It applies to equipment fed with standard low voltage from the electricity network, and references:

(a) WorkSafe New Zealand safety requirements and Waka Kotahi – NZ Transport Agency guidance;

(b) Advice on how to efficiently transmit electricity from the grid to an EV through a charging station in a commercial setting and the types of charging stations available to optimise this efficiency.

1.1.2 Exclusions

This PAS does not apply to residential charging stations that are installed for individual EV owners on a non-commercial basis. See SNZ PAS 6011 for guidance on residential use.

1.2 Overview

There are four sections in this PAS.

(a) Section 1 explains the terminology.

(b) Section 2 gives an overview of EV technology to guide public-facing businesses and suppliers of electric vehicle supply equipment (EVSE) and associated equipment and services that want to use good practice for public and commercial EV charging.

(c) Section 3 sets out the prescriptive technical requirements to comply with this PAS, including installation considerations for property owners and EVSE installers.

(d) Appendix A is an EVSE pre-purchase assessment tool (a checklist) for business owners or senior managers responsible for managing a vehicle fleet. It provides a logical pathway and checklist to help organisations transition to EVs.

1.3 Objectives

This PAS is intended to guide public-facing businesses and suppliers of EVSE and associated equipment and services that want to use good practice for public and commercial EV charging. It is designed to be a document that contains all relevant general information about EV charging, with references to more detailed information.

Installing an EV charging station at a commercial location is more complex than installing one at a home. This guideline condenses available information on the types ➤

and design of charging stations, as well as the permit and other general points. It also includes aspects not addressed in current guidance, namely efficiency, smart charging, and interoperability.

1.4 Interpretation

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

The PAS uses the term ‘informative’ to define how to use the appendix that it refers to. An ‘informative’ appendix gives additional information for guidance. It does not contain requirements.

1.5 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
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 system 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 safety features NOTE – See Table 1 for more information.
Dedicated short-range communications (DSRC)	One- or two-way short- 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	Electrical energy
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 in to 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- or gaseous-fuelled 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 (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 the 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 at night 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	The method of charging by connecting an EV 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 in-cord control and protection device (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- 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 charger that disconnects power to the vehicle once it 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 charging system. Mode 4 DC charging can deliver up to 1000 V DC, with a maximum current of 500A. Mode 4 involves greater communication and other features than Mode 3. Mode 4 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. The latest is version 2.0.1
Person conducting a business or undertaking (PCBU)	'Person conducting a business or undertaking' 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 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 that 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
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 on-board charging system. These system standards may be amended from time to time

Tesla supercharger	A bespoke charging system (see Figure 5) 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
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

1.6 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
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

1.7 Thinking about an EV

1.7.1 General

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 could make a major contribution to New Zealand's ability to meet its climate change targets.

Organisations that change from vehicles that use a fossil fuel to ones that use electricity will have to think differently about owning, running, and refuelling their vehicles.

An EV stores electrical energy in a rechargeable battery and uses this electricity to provide motive power. The vehicle is charged with electricity from an external source, such as a dedicated charging station at home, work or a public charging station.

1.7.2 Smart charging

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

Smart charging allows multiple charging stations to work together to make best use of a limited electricity supply, take advantage of lower-cost, off-peak electricity, and respond to requests from a building or the grid to temporarily reduce the charging rate.

In a commercial premises, if a fleet of vehicles is plugged in at the same time (for example, at the end of the business day), smart charging shares the available power between the vehicles. As each vehicle finishes charging, its share of the power is redistributed among the remaining vehicles until they are charging at their maximum rate. This means the whole fleet can be charged and ready for use the next day without the need for significant infrastructure (such as increased charging capacity) that would simultaneously charge every vehicle at its maximum rate.

The same philosophy and technology can be applied to reduce the combined load of charging stations on the national grid. This could reduce, or eliminate, the significant investment that electricity distribution businesses (EDBs) would otherwise need to make in, for example, larger local network transformers to increase grid capacity, which will avoid New Zealanders incurring higher electricity costs.

Choosing smart charging is a future-proofed investment and, in the near future, New Zealand's electricity-supply system will include demand-response (DR) programmes. Under DR, an electricity account holder will be paid to not use electricity. For example, if you parked your commercial EV overnight and did not need it until the following morning, you could make that 'demand' available to the grid. You'd do that by using an app on your smartphone or programming your charging station to respond to a signal from your electricity supplier.

DR will enable electricity distributors to manage demand across their network and plan for maintenance shutdowns. By choosing a smart EV charging station, you will be able to participate in DR programmes and reduce your electricity costs, when it suits your business needs.

Smart charging and communication can also help you balance your electricity consumption and further reduce 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' (how your EV and smart charging station can be core parts of a connected, demand-flexible, energy-efficient electricity system).

Once you have purchased a smart EV charging station, ensure that you have it installed by a registered electrician, who will ensure that all installation safety and network connections standards are met.

2 ELECTRIC VEHICLE TECHNOLOGY

2.1 Snapshot of the EV market

In March 2023, New Zealand had just under 50,000 BEVs registered. Registrations have increased significantly since 2021, as several government and industry initiatives have made it easier to buy an EV. 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 75km on 96% of the state highway network. This investment continues to increase, as the government is looking to make public EV charging as easy as possible. The Waka Kotahi EVRoam app has made it much simpler for EV owners to locate public charging stations, which helps 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 costs and their 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 the need to build a demand-flexible electricity grid that can maximise the potential of this technology to reduce carbon emissions.

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 the range of EVs. The capacity for home charging also needs to increase, as 'trickle charging' will not necessarily be suitable for higher-capacity batteries that provide an improved range.

2.3 Limitations and risks of current EV technology

EVs themselves can limit the charge rate. For example, an older model might only charge up to 3.6 kW, whereas a newer model could accept charge up to 11 kW.

Even though you can connect a 22-kW charging station to an EV, it will charge only as fast as the car allows. If other vehicles are connected to the charging station at the same time, this could further limit its output capacity and charge rate.

2.4 Demand response and demand flexibility

Demand response (DR) 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, which creates 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.

Demand flexibility (DF) refers to the ability of a smart charging station to reduce or stop charging based on a signal (such as a price signal) from an electricity provider.

DF creates new ways for EV owners to get more value from their EV. Their smart charging station can instantly react to pricing signals and minimise charging costs. In the future, smart charging will allow you 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 to 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.

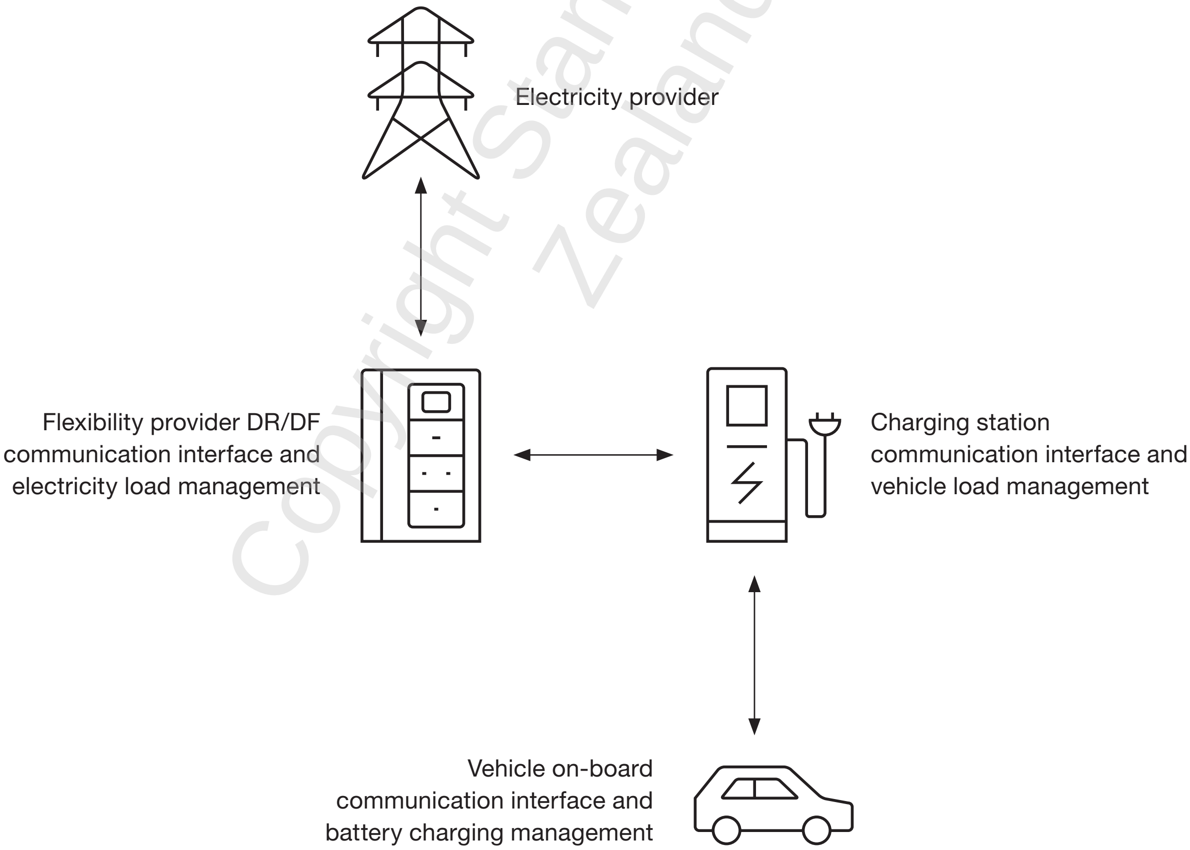


Figure 1 – Demand response and demand flexibility involve two-way communication

2.5 Ways to charge an EV

Charging stations are devices that let electrical energy flow through them to enter an EV.

On-board charging systems are built into EVs. They convert power from an AC source to a DC supply, which in turn charges the battery.

DC charging stations are generally mounted in public places (or are accessible 24 hours a day on commercial premises) as part of the electricity infrastructure. They convert the grid AC to DC and use their own permanently connected (tethered) cable to connect to an EV's DC charging port.

An in-cord control and protection device (IC-CPD) can also control the flow of AC electricity to the on-board charging system.

Collectively, these devices, their respective components, and any other electrical products related to supplying electricity to an EV, including wires and 'normal' electrical products, are referred to as electric vehicle supply equipment (EVSE). See Figure 2, which summarises EV charging components, and Figure 3, which shows a range of plug connections.

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

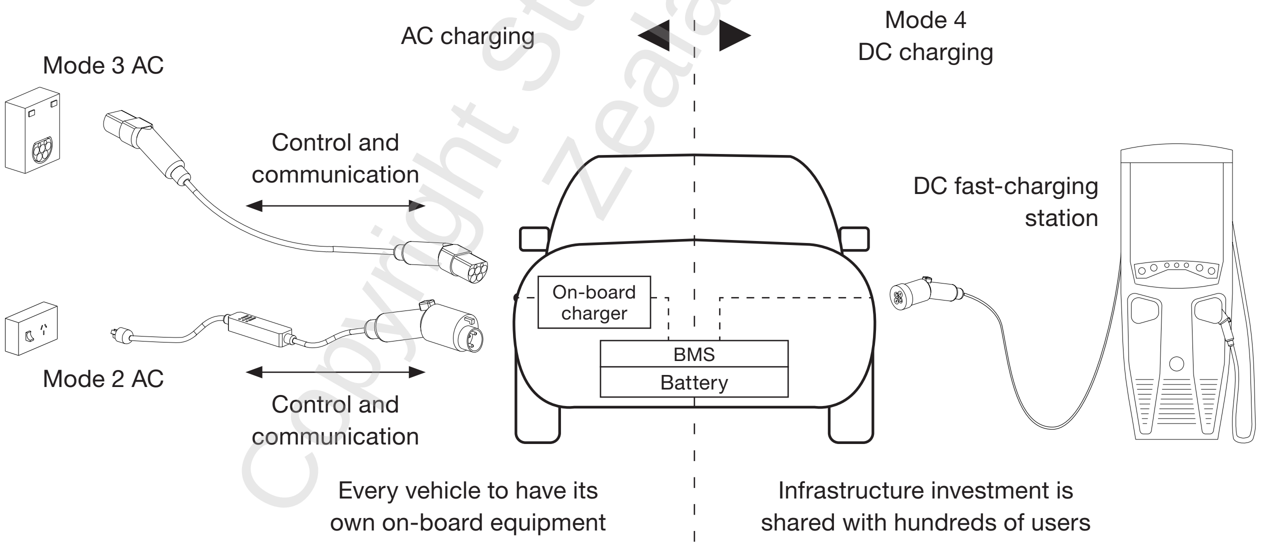


Figure 2 – Electric vehicle supply equipment

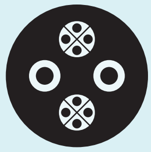
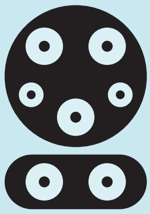
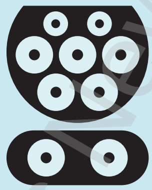
Charging system	Connector types	Key manufacturers
CHAdeMO		Nissan Mitsubishi Toyota Subaru
CCS	 Combo 1: J1772 (USA)  Combo 2: Mennekes (NZ, Australia, Korea and Europe)	Audi BMW Ford GM Hyundai Jaguar Kia Mercedes-Benz MG Porsche Renault Tesla Volkswagen

Figure 3 – DC charging stations accommodate a range of plugs

2.6 Load management

2.6.1 General

Managing load is especially important when EV charging stations are added as they can cause demand to fluctuate significantly. For larger (kW capacity) EV charging stations, this fluctuation can be challenging for the internal wiring in installations and the electricity supply system.

Connecting charging stations to an electrical installation can have a high initial cost as well as ongoing network and retailer costs. Load management can help minimise these costs by controlling the charge rate or the timing of active charging. This is made possible by implementing strategies to manage peak load and balance the electrical installation's load with the available network capacity.

To get the maximum financial and operational benefits from an EV charging station, it is essential to consider how to manage peak load at an early stage of the installation process. This involves consulting the network operator and electricity retailer to understand the load management options available and their associated costs and benefits. It is also important to consult flexibility providers to explore alternative solutions for flexibly managing load. Flexibility providers can help identify the most suitable strategies and technologies to manage load for the specific requirements of an electrical installation.

By implementing a strategy to manage load, you can minimise the charging station's ongoing operating costs and reduce the cost of increasing the electrical installation's network connection capacity. This can result in lower electricity bills, better energy efficiency, and improved charging capacity.

Managing load at EV charging stations can be achieved by controlling the charge rate for an individual charging station or all of the charging stations. However, load management will increase EV charging times, so there is a trade-off between cost and charging time.

Although load management can be manually controlled, an automated system is highly recommended. Various commercial systems are available, starting from relatively low-cost systems. When selecting a load management system, consider getting professional advice on what other loads you can control in an electrical installation (such as heating, cooling, and lighting) to reduce overall operating costs.

It is also important to consider phase balancing for the network load of a charging station to optimise how available electrical capacity is used within the electricity network and the customer's electrical installation.

2.6.2 Usage cases for load management with local networks

There are four types of load management. They can be mixed so as to operate together or individually.

Managing peak demand of the EV charging station or its installation: This type of load management can reduce the initial and ongoing connection cost by constraining the peak demand that is placed on the electricity network. Demand can be managed for extended periods when the installation or EV charging station is fully utilised, while at other times there can be no load management so as to allow unconstrained charging.

Managing peak demand of the electricity network that the EV charging station, or its installation, is connected to: This type of load management will temporarily reduce the demand on the overall network. Demand can be managed for extended periods, usually during peak periods on weekdays. For this type of load management, the EV charging station shall be able to receive and react to an external signal from the owner of the electricity network.

Managing the purchase price of electricity: This type of load management involves reducing the charging demand of the charging station when the electricity price is high and increasing the charging demand when the electricity price is low. To achieve this, you need a contract with your electricity retailer that incentivises flexibility in electricity demand and use. When the electricity price is high, this method will decrease the amount of available charging time but means there could be no load management at other times, which would allow for unconstrained charging.

Contracting ancillary-service reserve load to the electricity market: This type of load management requires a specific contract with the system operator that involves turning off charging stations very quickly under their instruction. This method suits larger charging stations and should be discussed with the system operator on a case-by-case basis.

2.6.3 Designing load management

Load management is a tool to manage the demand for electricity at EV charging stations, but it should be implemented carefully. You will need to consider its potential impact on charging times and users' experience. Professional advice will help ensure that your load management system is tailored to the specific requirements of the network and your EV fleet and electrical installation, and that it achieves the desired outcomes efficiently and cost effectively.

Also consider the attributes of individual charging stations and ensure they are compatible with your load management system.

It is recommended that you:

(a) Assess the impact that load management can have on delays to charging your EV fleet;

(b) Seek professional advice when selecting which type(s) of load management and load management platform to use and the attributes required of individual charging stations; and

(c) Investigate connection and flexibility options with your local network, and pricing and flexibility options with your electricity retailer.

2.6.4 Selling electricity to customers from a commercial EV charging station

When customers are to pay for EV charging, the person that operates the EV charging station should ensure that the equipment has the facility to limit the rate and time of charge in return for a pre-set credit.

Several commercial solutions allow customers to pay for EV charging. However, charging stations have certain attributes that are critical to enabling them to operate. Potential EV charging operators should determine which payment method to use before they decide which EV charging station to buy.

NOTE – The person that operates an EV charging station and sells electricity to customers may be a retailer as defined in the Electricity Industry Act 2010, even though that person purchases electricity from another retailer. If you are considering selling electricity to customers, it is a good idea to discuss your requirements with the Electricity Authority.

2.7 Grid connectivity and communication requirements

2.7.1 Communication protocols with flexibility providers

An EV charging station should have the technical capability to communicate with an external device (such as a building management system) and give this device the 'read' and 'write' parameters it needs to operate. It should also have the capability to monitor charging status and fault conditions (see Figure 4).

This PAS does not define which communication method and protocol to use. However, Modbus RTU, Modbus TCP/IP, and BACnet are commonly used.

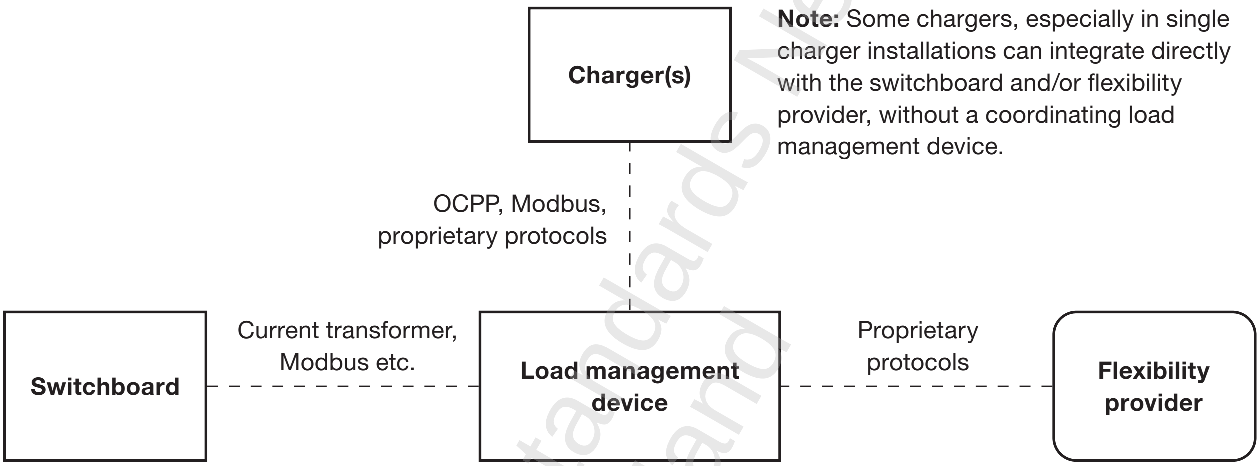


Figure 4 – Load management and flexibility provider interface

This PAS also does not define what level of access should be available to specific users, but this is important to consider in order to meet the requirements of the payment platforms.

2.7.2 Load management protocols

Building load management allows many charging stations to be installed at the same location without a costly upgrade. This prevents overcommitting the electricity supply to the EV charging installation or the building. To achieve this, the charging station should have the capacity to coordinate with other charging stations in the same installation or the building management system.

The EV charging station should support the open charge-point protocol (OCPP) smart charging profile. When the building needs to overcommit the electricity supply, the EV charging station or load management system should support the electricity supply or building management system to control the input.

When a cloud-based load management system is used, take extra care to ensure that an internet outage does not prevent the building management system from reducing the EV charging load. You could need a local connection between the EV charging station and the building management system or electricity meter.

When you buy or install an EV charging station, you do not need the technical capability for load management or communication to be enabled or active. However, this capability should be fitted and available so that you can activate it without having to make significant changes to the EV charging station.

2.7.3 Open access and interoperable payment for EV charging

In New Zealand, people currently need to become a member and have an account with a charging provider to use public EV charging stations. Sometimes, members are issued with a radio frequency identification (RFID) tag, which is a plastic disc with a unique identifier chip that is linked to the member's account. This forms the basis for a relationship between EV charging providers and users for accessing, authorising, and settling payments for EV charging services.

It is important that EV owners find EV charging services convenient and easy to access, use, and pay for. As the update of EVs increases, and public charging infrastructure continues to be rolled out, there is potential for various EV charging payment methods to be used by different charging providers. These methods could limit access to charging and not achieve the needs of the broader market.

Although EV charging providers are not required to offer specific payment options, ensuring customers have open and interoperable access to, and use of, public EV charging stations will help grow the market and ensure that as many EV owners as possible use the charging stations. For example, an interoperable payment method allows a member of one EV charging provider to use a charging service run by another EV charging provider by, for example, network roaming. Other ways of providing open access or interoperable payment include the capacity to take credit or debit card payments at the charging station. These options help overcome any lack of interoperability between public charging stations and ensure that people can charge their EV at any public charging location.

The simplest and cheapest payment method in New Zealand that most members of the public have access to is the EFTPOS system. This PAS recommends that all public charging systems incorporate payment methods that allow payment immediately after charging (whether a hold on the card is taken or not) through the EFTPOS or credit card networks, including Apple and Android pay and other major banks 'tap to pay' methods. Any other payment methods – for example, through the use of RFID or otherwise, including current payment methods – can limit interoperability and the ability of anyone to easily use EV charging infrastructure.

Owners and operators of EV charging stations are advised to use the most up-to-date, secure, interoperable and open payment technologies available for New Zealand EV infrastructure.

2.7.4 Requirements for grid-tied communication devices

An EV charging station's control system should allow the unit to be safely switched on and off using a remote connectivity system.

2.7.5 Vehicle-to-infrastructure (V2I) and communication

In the context of commercial applications, charging stations should have the capability to connect with local grid-interoperable control systems through Ethernet, cellular connection, or wi-fi, or a combination of these methods. In future, this communication capability could allow charging stations to independently manage electrical demand, which would add value for customers and the electricity industry.

NOTE – Before purchasing an EV charging station, check your electrical network operator's communication requirements.

2.7.6 Data capture and smart metering

The Electricity Industry Participation Code 2010 sets out specific requirements for handling meter readings accurately. Specifically, retailers of installations shall provide metering at the installation's point of connection to a network and capture data from the meter to invoice customers.

If an installation has a vehicle-to-grid (V2G) charging station installed, the installation owner is a participant under the Electricity Industry Act 2010. Under the Act, they shall consult the owner of their electricity network before they connect the charging station as there could be requirements to meet. They shall also consult the retailer of the charging station because the retailer is responsible for upgrading the installation's metering.

An EV charging station with an internal meter will, in the future, be able to be read remotely, without the charging station needing significant changes. This could present a purchase-cost advantage to a customer.

2.7.7 Minimum specifications for charging stations

New Zealand recognises international standards on EV charging (IEC, ISO, ISO/IEC and ITU). Government regulators aim to bring in minimum specifications as soon as possible (specifically, IEC 61851, *Electric vehicle conductive charging systems* and IEC 61980-1, *Electric vehicle wireless power transfer systems*). WorkSafe's *Electric vehicle: Charging safety guidelines* references IEC 61851-1, IEC 61851-23, and UL 2251 in relation to charging stations.

In New Zealand, minimum specifications are used for most household appliances sold (such as TVs, refrigerators, and washing machines) to ensure we do not use low-quality, low-efficiency technology. Minimum specifications ensure New Zealand consumers can choose from a suitable range of models and know that the technology will meet their needs and minimise their running costs.

Commercial enterprises are advised to choose an EV charging station that meets the minimum efficiency, connectivity, and cybersecurity specifications set out here.

Efficiency: Most residential Mode 3 charging equipment is largely a switch and up to 99% efficient at transferring electricity from the charging outlet to the AC/DC converter in the EV. Consumers are encouraged to look for such equipment that has been tested to ensure it is at least equal to this efficiency level.

The efficiency of Mode 4 DC charging stations varies significantly. Businesses are encouraged to look for such equipment that has been tested to ensure efficiency is not less than 90%.

Connectivity: Government agencies are trialling the use of open communications protocols on electricity networks to ensure that DF devices (this includes charging stations) are easily incorporated into New Zealand's electricity system. Open communication protocols ensure that all DF technologies can communicate with external sources (such as electricity suppliers with price signals), DF providers (entities that will exist in the future and aggregate demand from multiple homes and make this demand available to the network when supply is constrained), and other devices in a smart home. Open communication protocols are a prerequisite for a fully flexible electricity demand system. They will ensure that consumers are not locked in to proprietary technology solutions that restrict switching to another DF provider.

OpenADR and IEEE 2030.5 are the most common global open communication standards. It is anticipated that New Zealand will adopt these standards once the trial has concluded. It is important that charging stations have appropriate communication standards installed in the device (such as OCPP v1.6 and above) and that the unit can communicate using protocols such as OpenADR and IEEE 2030.5.

If a charging station is merely compatible with these standards, it can restrict user choice. When you are buying a charging station, ask your supplier if it can communicate using these open communication protocols so that you will be able to participate in a DF marketplace.

Cybersecurity: Charging stations shall, as outlined below, have appropriate security measures incorporated to ensure their functions are resilient to a cyberattack. This involves making sure that any communications are securely exchanged with an appropriate level of authentication and encryption that prevents unauthorised interception by a third party.

The charging station shall include the following remote software-update capability, described in NISTIR 8259A *IoT device cybersecurity capability core baseline* (see Fagan et al in the 'Other publications' section):

(a) The charging station should align with requirements in UK PAS 1878:2021 and ISO 15118-3;

(b) The charging station should align with the cyber security standard ETSI EN 303 645; and

(c) The charging station should log security events, to help monitor the security of the charging system.

2.8 Cybersecurity and data capture

2.8.1 Appropriate security measures

Charging stations shall incorporate appropriate security measures to ensure that their functions are resilient to cyberattacks. This will ensure that any communications are secure and appropriately authenticated and encrypted to prevent them being intercepted by a third party.

NOTE – Charging stations shall include the capability for remote software updates described in NISTIR 8259A (see Fagan et al in the 'Other publications' section).

2.8.2 Other considerations

It should be noted that the NISTIR 8259A baseline is not the only set of capabilities. 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 could consider ISO 15118-3 or BSI PAS 1878, or both.

2.9 Types of EV charging

2.9.1 Smart charging

Smart charging is a system where EVs, charging stations, charging operators, and electricity network operators share data and control to optimise the use of resources and 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 V2G or bidirectional charging without inconveniencing the vehicle owner or user.

2.9.2 Bidirectional charging

Bidirectional charging is a two-way system, allowing an EV's on-board battery to be charged and discharged. In most cases this is done through 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 various services it can provide – it can also be used to help balance the network. This means that if the electricity system is short of power (for example, when a power station suddenly drops offline), an EV could provide power to the grid to 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 a flexible asset. As well as providing mobility, it can be used for smart charging (to reduce the demand for electricity and to export electricity). 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-infrastructure (V2I) or V2G bidirectional capability, they should engage with the owner of the electricity network that connects to their premises and their electricity retailer at an early stage to determine:

(a) If installation complies with the distribution network's Electricity Network Connection Standard (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 should:

(d) Seek advice, as they shall comply with the distributor's connection and operations standards, which may 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 as well as 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.

2.9.3 Bespoke charging stations

Bespoke charging stations are custom made or made to individual specifications (for example, for testing purposes, buses, and certain vehicle manufactures [see Figure 5]).

Figure 5 – An example of a bespoke EV charging station

2.9.4 In-vehicle charging equipment

Some EV suppliers provide an assembly that is compatible with the vehicle (see Figure 6). 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 charging 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 6 – An example of an in-cord control and protection device

2.9.5 Types of plugs, cable connections, and operating modes

There are three types of plugs, cable connections, and operating modes for charging station (see Figure 7a and Figure 7b).

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 (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.

	Function	Connector	Inlet	
	Single-phase AC charging with Type 2 Three-phase AC charging with Type 2		 Type 2	
	High-power DC charging via dedicated pins with Combo 2		 Combo 2	
	Function	**Connector**	**Inlet**	
	Single-phase AC charging with Type 1		 Type 1	

CCS with
- Identical safety measures
- Identical charging communication

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

Figure 7a – CCS plug types and configurations

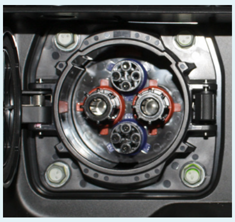


Figure 7b – CHAdeMO plug and inlet configuration

2.9.6 Recommended types of EV charging

Always choose a manufacturer that complies with the EV charging standards observed in New Zealand (see 2.7.7).

The type of charging station you need will depend on the electricity supply and capacity, and how you intend to use it. See Figure 8a.

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 8a – Types of charging stations

2.9.7 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 8b). 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 8b). 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 8c), 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.

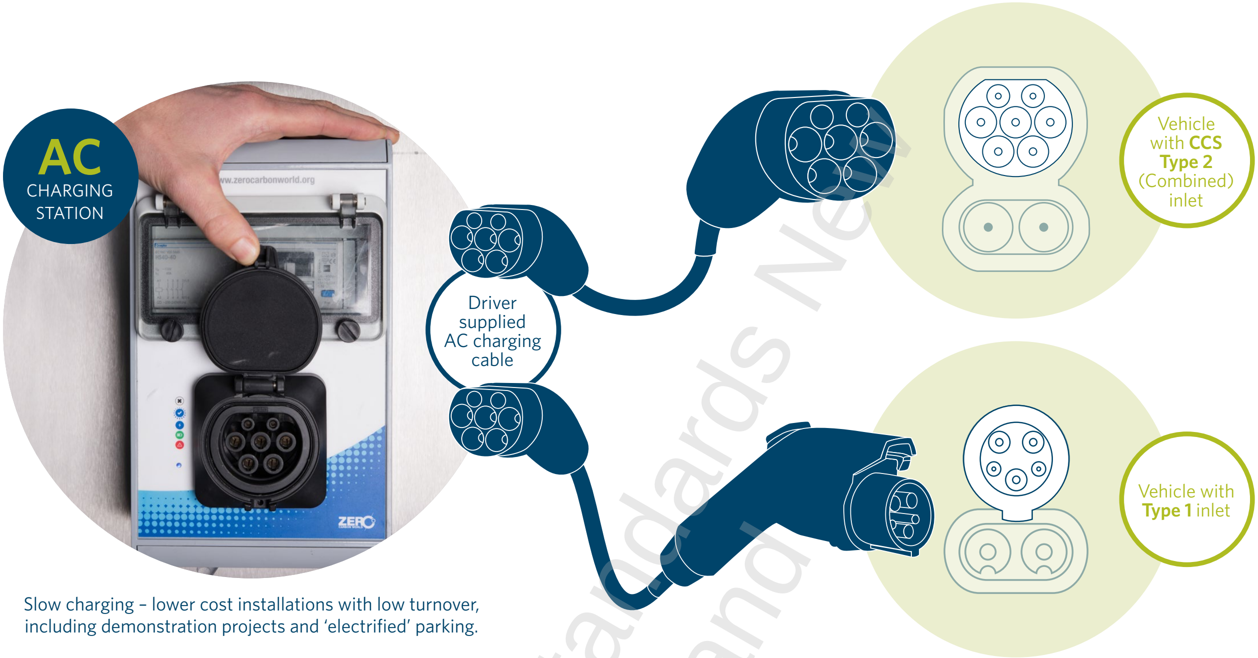


Figure 8b – Mode 3 charging connections

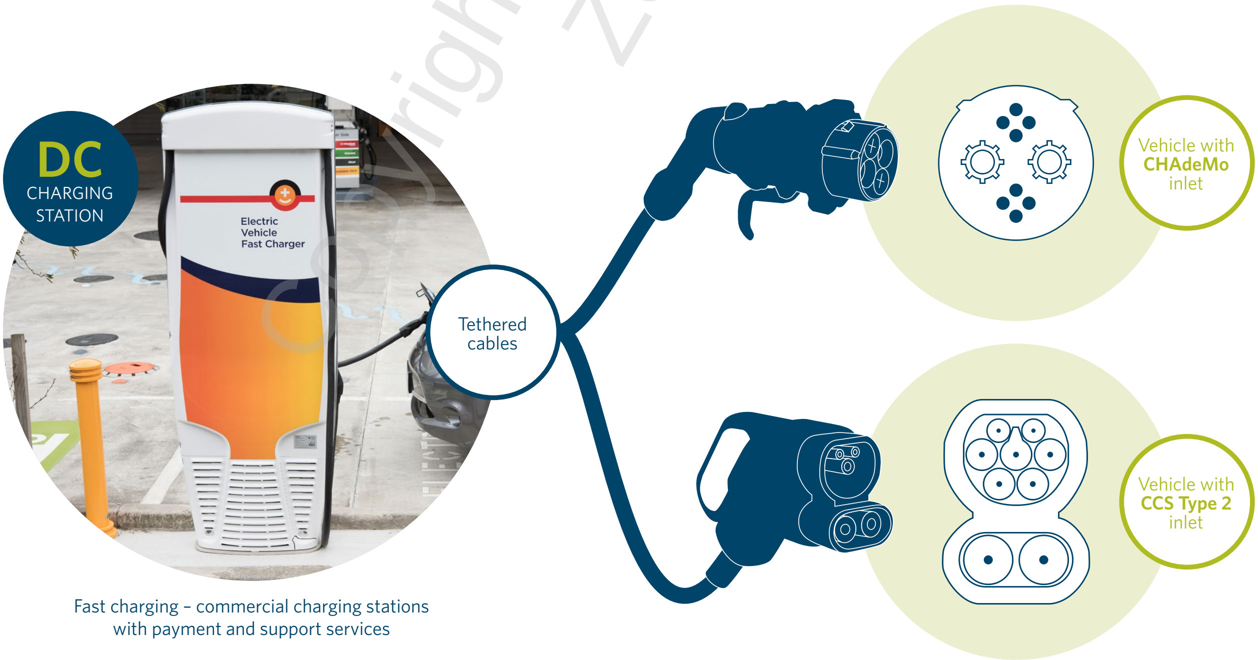


Figure 8c – Mode 4 charging connections

2.10 Battery technology

2.10.1 Battery capacity and charging times

Battery size (capacity) determines the amount of charge needed to fill the battery; other factors (see 2.10.2) 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 50 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.

2.10.2 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) Charging type;

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

(f) Capacity of the on-board charging unit; and

(g) 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 9).

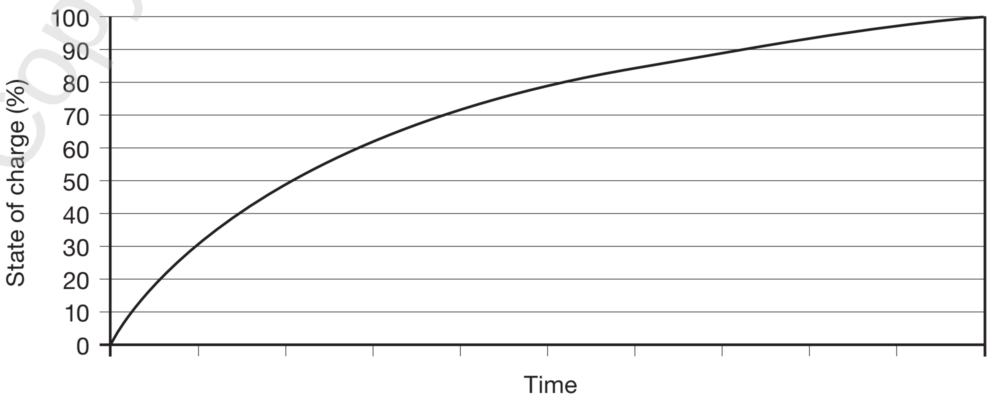


Figure 9 – Typical charging rate

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

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

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

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 (slow)	Provides AC power through the on-board charging unit 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)	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 multi-phase power is available	400	3	11	~65	~7.0
				22	~131	~3.5
Multi-phase (fast)	Incorporates remote charging with a DC output. The DC current is delivered directly to the battery, bypassing the on-board charging unit Can deliver up to 1000 V DC, with a maximum current of 500 A Has enhanced communication and safety features, 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]
Multi-phase (rapid)				75	~446	~1.0[a]
				125		~0.6[a]
				150		~0.5[a]
Multi-phase (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 Table 1 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 manufacturer's specifications.

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

2.10.3 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.

2.10.4 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.

3 TECHNICAL SPECIFICATION REQUIREMENTS

3.1 Charging equipment

3.1.1 General requirements

Section 3 outlines the approach for installing Mode 3 and 4 EV charging equipment for commercial applications (see Figure 10). This guidance extends to large residential complexes with shared facilities and a common connection to the network.

3.1.2 Prerequisites

Always use a registered electrician – as determined under Part 10 of the Electricity Act 1992 – to install and analyse the capacity of any Mode 3 and 4 EV charging stations. Make sure that the installer is:

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

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

The owner of the charging station is responsible for making sure that the installer has the correct practising licence and obeys local rules, the installation instructions, and the charging station manufacturer's specifications.

There are two ways to evaluate capacity:

(c) Pre-determine a location and identify the electrical capacity that can be delivered to it, then select the type and number of charging stations that will suit that situation; or

(d) Determine the type and number of charging stations you need, then look for locations that have sufficient capacity for them. Engage your local electricity network early in your search process, as it can take time to determine available capacity. The network may also be able to suggest other site areas or options.

3.1.3 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 an EV charging system and the EV itself are integrated into the electrical and data installations.

For each design priority, carefully consider the controls interface. Figure 11 highlights some of the main considerations and interfaces but is not an exhaustive list.

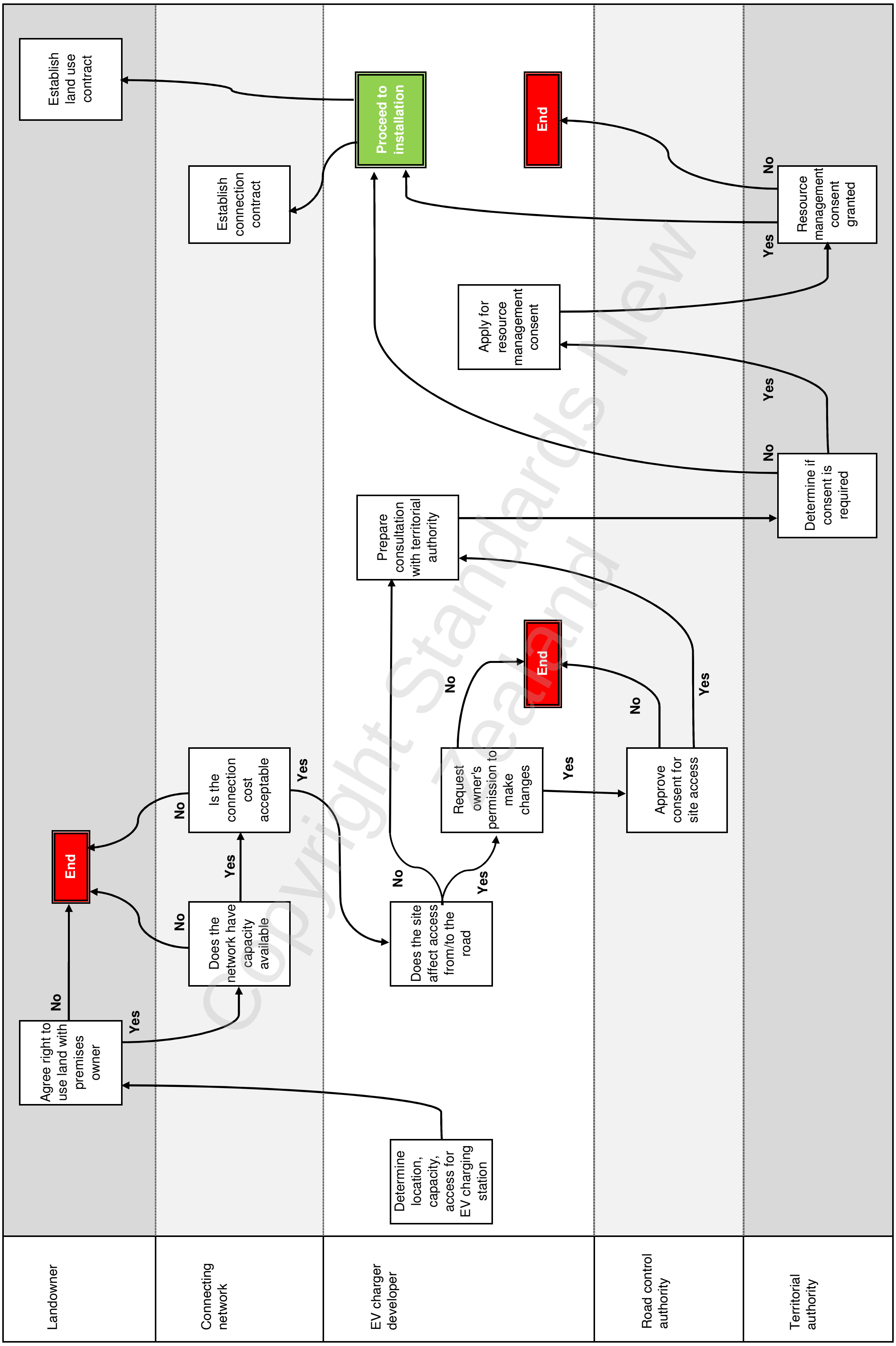
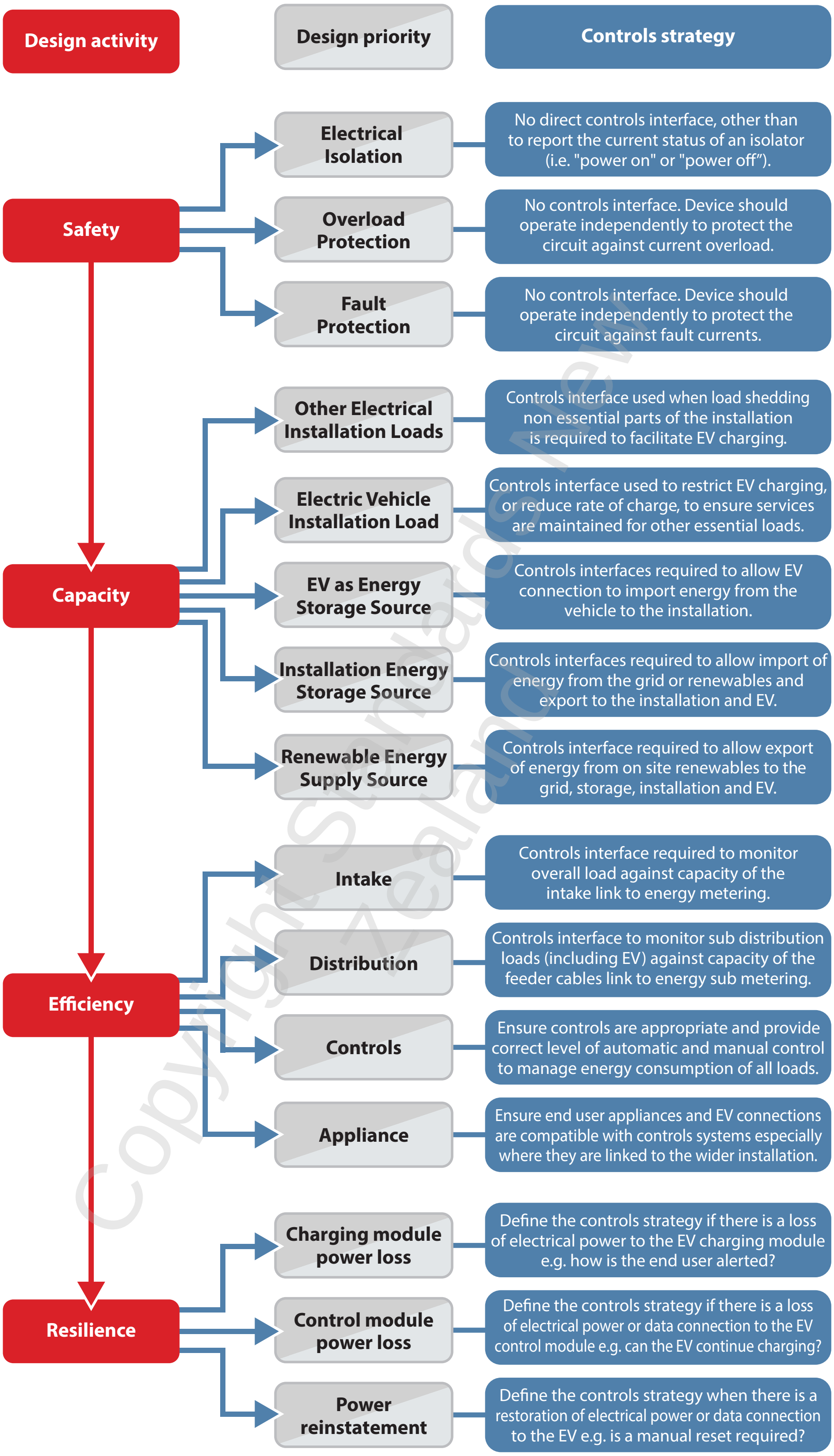


Figure 10 – Installation protocol for charging equipment



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

Figure 11 – Considerations for designing an installation

3.1.4 Analysis of load to accommodate electric charging

To calculate the load where the charging installation is multi-phase, you need to consider the phase balance. AC charging equipment will generally be a single-phase load, as most EVs have only single-phase on-board charging units

You also need to consider ancillary load, which could include:

(a) Lighting;

(b) The communication system;

(c) Motorised access gates; and

(d) Car grooming facilities.

NOTE – Consider the electrical supply network from an existing installation or the distribution network.

3.1.5 Analysis of electricity capacity

When one or more electrical devices share a grid connection that has a maximum capacity, the total power demand of the devices that use the grid connection shall not exceed that capacity, because protection systems will disconnect the device(s).

EV charging stations can be connected to:

(a) An existing electrical installation;

(b) A new electrical installation; or

(c) An electricity distribution network.

When you are planning and assessing a proposed EV charging installation, it is worth considering this guidance:

(d) Obtain current electrical as-built drawings (internal to the installation) to help you understand the existing electrical infrastructure and its capacity limitations;

(e) Recognise a commercial building's load factor, relative to seasonal and production variances;

(f) Verify the capacity of the upstream supply and clarify the constraints in the installation to the connection point to the distribution network. Check this capacity against the installation's existing demand, the increased demand posed by the charging equipment, and the potential for developing the site in future. You can obtain the revenue meter demand profile from your electricity retailer as half-hour data;

(g) Use a digital 'portable power analyser' to monitor and record the load profile for the installation, or relevant parts of it;

(h) Apply to the distribution company if you need more capacity from the connection point. This will incur a cost and there could be additional costs internal to the installation for the change in capacity;

(i) If the distribution network supplies electricity directly to the charging station, apply to the network for increased capacity. If you plan to install ultra-fast, or multiple rapid charging stations you could need a dedicated distribution transformer and would then need a high-voltage supply near the charging station; and

(j) If deferred charging is not a problem for your EV fleet, consider using load management and phase balancing to reduce the need for extra capacity at the installation connection point and within the installation (see 2.6).

3.1.6 Mode 3 – AC charging equipment

For commercial applications, Mode 3 charging stations (see Figure 12) are classified as multi-phase (400 V).

Mode 3 charging shall be on a separate sub-circuit with protection from overload and earth leakage (Type B RCD or Type A RCD with RDC-DD). The sub-circuit wiring needs to be sized to accommodate the Mode 3 charging capacity. The electrician shall calculate the breaker value depending on the conductor parameters, length of the cable, EV charging station rating, and environmental conditions.

Type 2 charging is technically capable of accommodating one, two, or three phases. However, charging equipment is either single phase or three phase. Where EVs has a single-phase on-board charging unit, it is common to use a single-phase, or a three-phase charging station wired for single phase.

It is common to use a single- or three-phase Type 2 charging station that is wired single phase. When wiring multiple single-phase AC charging stations (this includes three-phase versions that are configured for single phase), it is usual practice to spread the charging stations across all available phases in a multi-phase installation in order to improve phase balancing.

NOTE – Do not be overly concerned with the make and model of AC charging equipment or Type 1 versus Type 2 charging connectors. EVs and associated equipment are still evolving. In many situations, installing the supply cable is the most expensive part and therefore the main asset. Future-proofing the investment is often more about the size of cable ducting.

Figure 12 – Mode 3 (AC) 22 kW three-phase charging station

3.1.7 Responsibilities of owners and operators of Mode 3 and 4 charging stations

If you own or operate Mode 3 or 4 charging stations (see Figure 13), you shall fulfil these responsibilities:

(a) Operate and maintain the charge station with all necessary protective devices, according to the manufacturer's instructions;

(b) Write an emergency plan that tells people what to do in an emergency;

(c) Prepare the site where the charge station will be installed, according to the manufacturer's instructions;

(d) Make sure there is enough space around the charging station for maintenance work to be carried out; and

(e) Appoint someone to be responsible for operating the charging equipment safely and coordinating all work.

NOTE – DC charging stations are normally supplied multi-phase owing to the high-power requirements, although lower-power DC charging stations (typically around 25 kW) are available in single-phase configuration. The single-phase configuration would normally be used in locations where multiple phases are not available.

Figure 13 – Mode 4 (DC) 24 kW pedestal charging stations

3.2 Electrical safety requirements

3.2.1 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.

3.2.2 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 that 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 charging station, make sure that no one touches or comes close to its chassis until it has been checked and declared safe.

3.2.3 Compliance certification

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.

3.2.4 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 to check for wear and tear. Owners of EV charging stations or devices are advised to engage a registered electrician to do such work.

3.2.5 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 a multi-box);

(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.

APPENDIX A – EVSE PRE-PURCHASE ASSESSMENT

(Informative)

If you own or manage a fleet of vehicles, you could be considering making the transition from fossil-fuelled vehicles to EVs. It can be hard to know where to start with this process. Table A1 is a checklist to help. It is not exhaustive; you can add to it.

NOTE – To reduce unnecessary complexity, we have deliberately excluded from this checklist electrical installation procedures relating to commercial charging stations. Service providers who specialise in carrying out such installations are already familiar with WorkSafe and the regulatory requirements for carrying out this type of prescribed electrical work.

Table A1 – EVSE pre-purchase checklist

	PRELIMINARY ASSESSMENT	Yes	No	N/A
		(tick box where appropriate)		
1	**Define our needs: What are our primary needs and how do we support our staff to successfully make this transition?**	☐	☐	☐
1.1	Do we know how big our current fleet is and do we have a clear understanding of our annual running and servicing costs?	☐	☐	☐
1.2	Do we know what type of light fleet vehicles we need?	☐	☐	☐
1.3	Do we know what type of heavy fleet vehicles (if any) we need?	☐	☐	☐
1.4	Do we know what type of special vehicles (if any) we need?	☐	☐	☐
1.5	Do we know what sort of mileage the vehicles we intend to replace do on any given day?	☐	☐	☐
1.6	Given the nature of our business, where we are physically located and the sort of mileage we do – plus the known typical charge times for EVs (see Table 1) – is staff time better spent charging vehicles throughout the day, or overnight?	☐	☐	☐
	NOTE – This question is designed to help organisations to consider operational efficiencies as well as assist in determining whether investing in the installation of charging stations at employees' residences makes more commercial sense. Questions 1.7 to 1.9 below expand on this.			
1.7	Do our staff, for whom the intended replacement vehicles are, primarily work from our office facilities and thus require EV charging on our business premises throughout the working week or overnight, or at all times?	☐	☐	☐
1.8	Are our staff, for whom the intended replacement vehicles are, primarily home based and thus would require EV charging at their private residences? (This may also include public charging throughout the working week.)	☐	☐	☐

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		Yes	No	N/A
1.9	Because of the nature of our business, we have company-owned EVs but expect staff to charge their vehicles (overnight) at their private residence. We have therefore opted to provide, install, and maintain (at company expense) an appropriate EV smart charging station in their home for that specific purpose.	☐	☐	☐

NOTE – This option should be undertaken in accordance with the WorkSafe addendum to *Electric vehicle charging safety guidelines*. It requires mutual agreement between both parties regarding such things as the terms and conditions of use and who will pay for the electricity.

		Yes	No	N/A
2	**Determine site suitability: Are our business premises suitable for on-site EV charging and what factors do we need to consider?**	☐	☐	☐
2.1	Do we own the business premises and therefore understand our legal obligations?	☐	☐	☐
2.2	Do we have sub-tenants (on our electrical supply) who could be affected by additional electrical load (potential brown-out) required for our new EV charging station, and have we discussed our intentions with them?	☐	☐	☐
2.3	Because we lease our business premises, have we notified the landlord (and any other associated tenants) of our intention to add EV charging facilities to our business operations? (This is particularly the case if the landlord is responsible for the primary source of electrical power entering the building, and it could potentially affect other tenants.)	☐	☐	☐
2.4	Do we intend to make our EV charging facilities publicly available for our customers free of charge?	☐	☐	☐
2.5	Do we expect to monetise the public use of our EV charging station(s)?	☐	☐	☐
2.6	Because we are intending to make our EV charging facilities publicly available, we will now follow the requirements laid out in Section 3 in this PAS.	☐	☐	☐
2.7	Have we engaged a registered electrician to provide a proper electrical assessment of our load and the current carrying capacity of our supply cables (given the type of EVs we intend to purchase and the way in which those vehicles will be charged – that is, whether overnight, throughout office hours, or other)?	☐	☐	☐
2.8	As a result of the assessment in question 2.7 above, do we need to increase our electrical capacity and obtain a quotation for doing so?	☐	☐	☐
2.9	Do we have the budget to undertake any electrical remedial work resulting from questions 2.7 and 2.8 and have we agreed with the installer on the terms and an appropriate time frame before we purchase our EVs and associated charging station(s)?	☐	☐	☐

		Yes	No	N/A
3	**Equipment determination:** **Now that we know with confidence what our maximum demand is, the nature of our electrical supply (multi-phase) and the current carrying capacity of our supply cables, the next step is to determine what type of charging equipment is appropriate?**	☐	☐	☐
3.1	We have reviewed Table 1 as guidance on typical charge rates for a given size and type of EV charging station (Mode 3 or Mode 4), considered our time-in-use, the nature in which the units will be used (private or public), the level of communication required between the electricity network and our units. Then, having analysed the respective costs (relative to our on-site capacity), we now have a clear understanding of which type of charging station(s) are most appropriate for our needs.	☐	☐	☐
	NOTE – If you still don't know which type of charging equipment is appropriate, re-read Section 2 of this PAS.			
3.2	Having identified the charging station(s) and considered the individual cost, we have agreed to purchase these units through the installation company.	☐	☐	☐
3.3	Having identified the charging station(s) and considered the individual cost, we have agreed to lease these units through the installation company.	☐	☐	☐
3.4	Having identified the charging station(s) and considered the individual cost, we have opted to purchase these units directly from an EVSE supplier (under a separate agreement) and simply provide them to the installer on site.	☐	☐	☐
4	**Optimised performance:** **How do we best optimise energy use and electricity charges?**	☐	☐	☐
4.1	Have we discussed with our installer how to manage our electrical load most effectively?	☐	☐	☐
	NOTE – This may require phase balancing or a reconfiguration of sub-circuits or a re-prioritisation of equipment (such as air conditioning or refrigeration) controlled through a building management system to load shed at various times. Load management can reduce the cost of a lot of charging stations in one place by reducing peak demand charges, avoiding a capacity upgrade, or both.			
4.2	Have we:			
	(a) Checked with the local electricity network that we comply with the *Electricity Network Connection Standard* and are now electrically connected to their network;	☐	☐	☐
	(b) Told our electricity retailer that we intend to install a commercial EV charging station(s), and the nature in which these will be operated (privately or publicly)?	☐	☐	☐
	NOTE – (1) It may be necessary for the local electricity network to upgrade the transformer or conductors in your street or on your premises. Are there costs involved and who will pay for this? (2) Be aware that the change in electricity consumption can affect network connection pricing, demand charging, or time of use pricing. Remember that charging at night or using a load management system could reduce your overall operating cost. This could warrant a company policy change specifically for your fleet of EVs.			

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