MEMO

Topic: Electric Vehicle Charging Requirements
Date: 21/04/2023
Attention: Warren Duarte, Iris Capital

Executive summary

The estimated maximum demand for this project, including Electric Vehicle (EV) charger provisions as outlined in this document, is 1,422 amps for Stage 3, and 1,530 amps for Stage 4. In short, a new 1,000kVA chamber substation is proposed for Stage 3 and a 1,000kVA chamber substation for Stage 4. Stages 3 and 4 will be completely independent developments from a services perspective with dedicated infrastructure within both developments serving their respective needs. This includes the EV infrastructure within both Stage 3 and Stage 4. The EV charging infrastructure envisaged for this project will be in line with Newcastle Council's requirements and NCC 2022. Both of these requirements are outlined and expanded upon within this memo.

Electric Vehicle Infrastructure Overview for Stage 3 and Stage 4: A new high-voltage power feed from the grid will connect to a new transformer within the development, in the form of a new chamber substation. This will in turn provide a new low-voltage connection to a dedicated Main Switch Board (MSB) within the building via a *consumer mains* power feed. Dedicated circuit breakers will be provided within the MSB for the EV charging network. The EV charging network will include several EV distribution boards that will bring power from the MSB out to the physical chargers within the car park. Power cables will be mounted on dedicated cable trays that run through all car park levels to house these power cables.

As per the NCC 2022, a power management system will be incorporated into the system downstream of the MSB that will manage and modulate the power consummated by the EV network. This component will ensure, amongst other things, that the simultaneous power demand of the EV chargers remains within the maximum demand permitted, as agreed with the power supply authority.

From a billing perspective, it is envisaged that each user will have an account with the EV charger operator and a proprietary billing system will is used to charge people for use of the system.

Commentary on NCC 2022 Compliance

NCC 2022 requirements. The 2022 version of the National Construction Code (NCC 2022 Volume 1) Part J9D4 introduces provisions for Electric Vehicle (EV) charging for various building classifications. This only requires electrical infrastructure up to the EV distribution board; the chargers do not actually need to be installed.

Charger average power. The power demand allowed for chargers may be less than the capacity of the charger. The NCC 2022 makes provision for 7 kW chargers but only requires an average of 1.5 kW per charger.

Changer hours of usage. The NCC 2022 specifies the minimum EV charging rate overnight, and hence their maximum power draw may not occur during the time of a 'maximum demand' scenario, used to size transformers for projects. For residential buildings, the NCC 2022 requires this nominated power to be available from 11 pm to 7 am. This power allowance for the EV chargers is not nominated to be added to the 'maximum demand' estimate, which likely occurs during the day. This is left to the discretion of the designers when assessing the transformer sizing.

The number of chargers. The NCC 2022 requires 100% of spaces associated with a class 2 (residential) building to make provision for EV chargers. The number is lower for other classes of buildings.

Electrical reticulation. Note: the rules used for sizing sub-mains and circuit breakers are not the same as those used for estimating maximum demand and sizing transformers. These are separate exercises.

AS/NZ 3000 maximum demand. The AS/NZ 3000 rules for the calculation of maximum demand are flexible and allow for the interpretation and expertise of the Electrical Engineer to be used. It is not mandatory to follow the prescriptive requirements in Table C1 to achieve compliance with AS/NZ 3000.

Project aspirations. The project may aspire to exceed the minimum NCC 2022 requirements, such as actually installing some chargers, making provision for faster chargers, or providing more power to allow a faster average charge.

Mandatory and Optional Requirements

When determining the project requirements for EV charging infrastructure, the key considerations include:

- What are the minimum legislated requirements of the NCC 2022 (and any applicable state/territory and local council requirements, if applicable)
- What are the aspirations of the project in excess of NCC 2022 requirements, including local Council planning conditions

Local Council Requirements

Requirements from Newcastle Council can be found here: Newcastle Development Control Plan 2012, Section 7.03 Traffic, Parking and Access
The council requirements generally align with the NCC 2022, such as accommodating Level 2 slow chargers to 100% of car spaces.
Points in excess of the NCC 2022 include:

- If power distribution routes from the EV distribution board to the future charger location are underground, then provide the buried cable (point 1b)
- If power distribution routes from the EV distribution board to the future charger location are above ground, then provide the cable tray to the charger location (point 1b)
- Faster chargers (Level 2 fast) to shared spaces, which must be at least 1 space or 5% of all car parking spaces (point 2b and 8)
- EV distribution boards to be located to facilitate charger connection with a maximum 50 m cable (point 6)
- DA to include drawings identifying EV distribution boards and cable tray routes (point 7)
- DA to include a report documenting the EV infrastructure (point 8)

It is noted that although the NDCP requests provision for a quantity of chargers, and faster chargers to shared spaces, there is no requirement for the amount of power to be provided, or at what time. On this basis, the NCC 2022 allowance, of an average of 1.5 kW from 11 pm to 7 am for a class 2 building, is still compliant.

This strategy and the above requirements have formed the basis of the concept design.

Types of EV Chargers

To understand the impact of the NCC 2022 requirements, and how this may differ from project aspirations, it's necessary to understand the types of chargers available, and how they are powered. Generally, these are defined in levels, as shown in the below table. The NCC 2022 provisions are based on Level 2 slow chargers. If a faster charger is fitted, it will be able to draw more power to charge the vehicle faster.

	Power	Range added per hour	Charging time	Typical application
Level 1 – single phase (domestic)	2.4-3.7kW	10-20km range / hour	5-16 hours	Home
Level 2 slow – single phase (domestic or public)	7 kW	30-45km range / hour	2-5 hours	Home,work, shopping centres, car parks
Level 2 fast – three-phase (public)	11-22kW	50-130km range / hour	30mins – 2 hours	Urban roadside
Level 3 – fast charge (public)	50kW	250-300km range / hour	20-60 mins	Regional near highways, motorways and key routes
Level 4 – super-fast charge (public)	120kW	400-500km range / hour	20-40 mins	Regional near highways, motorways and key routes
Ultra-fast charge (public)	350kW	1000+ km range / hour	10-15 mins	Highways and motorways

Source: https://www.transport.nsw.gov.au/projects/electric-vehicles/charging-an-electric-vehicle

Load Management System

An electric vehicle load management system is a technology that helps to manage and coordinate the charging of EV's in a way that optimises the use of electricity while avoiding overloading the available power supply. It may use various strategies, such as scheduling charging times based on user preferences, controlling charging rates during peak hours, and even temporarily reducing charging rates.

By controlling when and how fast the EVs are charged, the load management system can help to balance the load between charging stations and reduce the maximum demand from the mains. This may result in a smaller substation or lower LV connection demand.

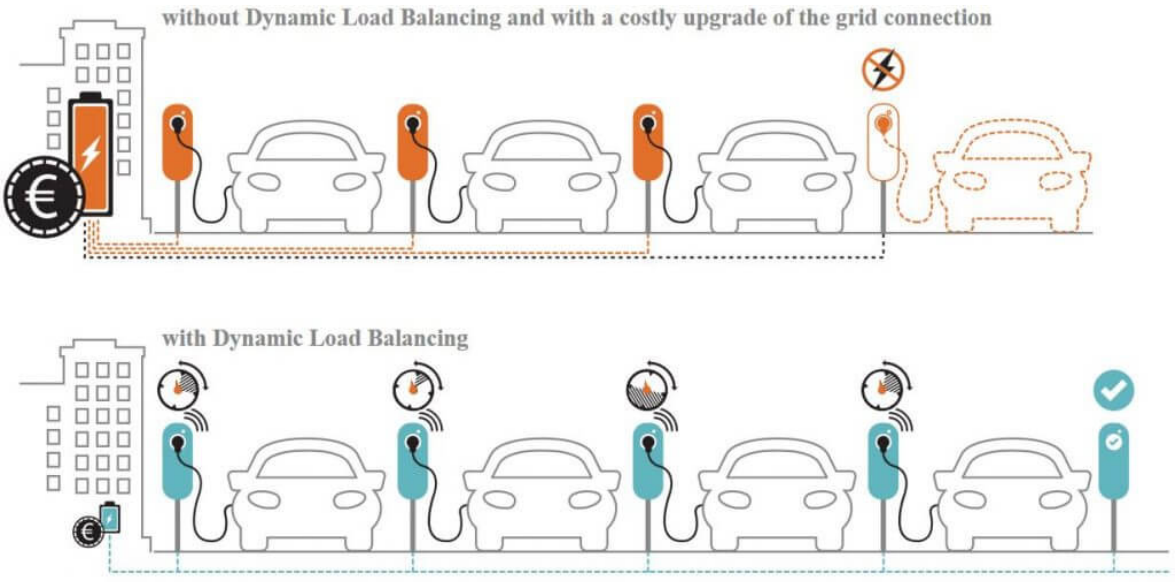


Image source: https://www.jojusolar.co.uk

NCC 2022 Requirements

The intention of NCC 2022 Part J9D4 is to provide the electrical infrastructure to facilitate the future usage of electric vehicle chargers. The scope of the installation stops at the electric vehicle distribution board - it does not actually require the chargers to be installed yet. The infrastructure which will be impacted includes:

- Electrical supply infrastructure (low-voltage mains connection, or substation), if the maximum demand is increased,
- Circuit breakers in the main switchboard, to serve electric vehicle distribution boards,
- Sub-mains cables from a main switchboard to electric vehicle distribution boards,
- Electric vehicle distribution boards

Infrastructure downstream of the electric vehicle distribution board, such as cable trays, power cables, data cables, and chargers, are not required to be installed. It is, however, good practice to provide cable trays, or at least coordinate for their future installation. The NCC 2022 Part J9D4 requirements are based on the quantity of electric vehicle distribution boards which must be provided. A distribution board is required for every 24 electric vehicle car parking spaces on a storey, except that if there are less than 10 electric vehicle car parking spaces on a storey then no distribution board is required.

The building class determines the quantity of car parking spaces that must make provision for EV chargers, and the time and amount of power which must be available. This is summarised below:

Building Class	**Charger Type**	**Car Parking Spaces Covered**	**Average Power Draw per Charger**	**Hours of Operation**
2 *(Residential)*	Level 2 slow: 7 kW, single phase	100 %	1.5 kW	11pm to 7am
3 *(Hotel)*	Level 2 slow: 7 kW, single phase	20 %	6.0 kW	11pm to 7am
5 *(Commercial)*	Level 2 slow: 7 kW, single phase	10 %	1.5 kW	9am to 5pm
6 *(Retail)*	Level 2 slow: 7 kW, single phase	10 %	1.5 kW	9am to 5pm
7b *(Storage)*	Level 2 slow: 7 kW, single phase	20 %	1.5 kW	9am to 5pm
8 *(Process)*	Level 2 slow: 7 kW, single phase	20 %	1.5 kW	9am to 5pm
9 *(Public)*	Level 2 slow: 7 kW, single phase	20 %	1.5 kW	9am to 5pm

Examples:
A class 2 (residential) building with 8 car parking spaces on Ground Floor and 80 car parking spaces on Basement 1 will require:

- *No EV distribution boards on the ground floor, since there are only 8 spaces*
- *4 EV distribution boards on Basement 1*
- *An average 120 kW power supply to the chargers between 11 pm and 7 am*

A class 3 (hotel) building with 28 car parking spaces on Basement 1 and 60 car parking spaces on Basement 2 will require:

- *2 EV distribution boards on Basement 1*
- *3 EV distribution boards on Basement 2*
- *An average 528 kW power supply to the chargers between 11 pm and 7 am*

Project Aspirations

In addition to the minimum NCC 2022 requirements, the project may have aspirations for faster chargers, or a greater average charging speed. These may be installed at the time of initial construction or may be a provision for a future installation.

Some typical project aspirations may include:

- **Faster chargers**. The NCC 2022 is based upon Level 2 slow (7 kW single phase) chargers. It is common to install or make provision for, Level 2 fast (11 kW three-phase) chargers in residential developments.
- **Greater power availability**. In all building classes except for hotels, the NCC 2022 requires an average of only 1.5 kW per charger. If all chargers were operating concurrently then this would allow each 7 kW charger to draw only 21% of its full capacity. The amount of power provided could be expressed either as the average power available to each charger, or the number of chargers that can operate at their full capacity simultaneously.

Electrical Infrastructure

The electrical power drawn by the chargers affects the electrical infrastructure in two distinct ways:

1. the impact on maximum demand, which determines the low-voltage mains connection or substation size, and
2. the electrical reticulation, which includes power distribution, sub mains, and circuit breakers.

The distinction between the electrical load on the reticulation and the maximum demand is critical.

Maximum demand is the estimated peak electrical power demand for the whole development. Many factors affect this, such as occupant schedules, the type of usage of parts of the building, air-conditioning and heating loads, quality of the building facade, and more. While there are many things that consume power, they do not all operate at full capacity all the time, and they often draw power at different times, hence the maximum demand is substantially less than the sum total of all of the connected loads. When considering EV chargers, the maximum demand estimate should consider the actual power draw of the EV chargers, the effect of the load management system, the time at which the EV chargers are used, and the demand of other connected loads (e.g. air-conditioning) at the time of use of EV chargers.

Electrical reticulation, such as power distribution, sub mains, and circuit breakers, are sized according to rules set out in AS/NZ 3000. These rules are not the same as those which are used for maximum demand calculation.

Common Misconceptions

✘ Estimate the *maximum demand without EV chargers*, then add EV chargers on top of that.

In a development without EV chargers, the estimated maximum demand will likely occur during the day, when the air-conditioning load is the highest. For a residential building or hotel, the EV charging may substantially occur overnight, as per NCC 2022 requirements, when the air-conditioning load is lower. In this case, both occasions should be estimated, and the greater of the two would then be the maximum demand.

✘ Calculate the maximum demand based on the full capacity of the chargers.

The load management system can reduce the available power, to limit the effect on the maximum demand. For example, NCC 2022 Part J9D4 makes provision for 7 kW chargers but only requires an average of 1.5 kW per charger for the maximum demand

✘ Follow AS/NZ 3000-2018 Table C1, which requires a percentage of the connected load of the EV chargers based on the number of living units.

The maximum demand must be estimated in accordance with AS/NZ 3000 clause 2.2.2, which allows estimation by calculation, assessment, measurement, or limitation. Appendix C is informative, not normative, and hence compliance with Table C1 is not mandatory. It should also be noted that the current version of AS/NZ 3000 is dated 2018, which is prior to the release of NCC 2022, and hence guidance may have been based on a different projection of the number of EV charger provisions than is now required to

✘ Determine the electrical load used for sizing sub mains and circuit breakers for EV distribution boards, and use that for the maximum demand.

The methodology described in AS/NZ 3000 for sizing electrical reticulation, such as the application of discrimination to determine the rated amps, is not equivalent to the method used to calculate maximum demand. This is because not all power sources peak at the same time.

Sizing Recommendations

✔ Perform maximum demand estimations for several scenarios.

Estimate the maximum demand at the time of occurrence of the *maximum demand without EV chargers*, at the time that the EV chargers are likely to be at full load (or mandated to have load provision according to the NCC 2022), and at any other time at which the overall development maximum demand may occur. At each time, consider the likely load of each of the connected loads, particularly the major loads such as air-conditioning and heating.

✔ Consider what to allow for the peak load for all EV chargers.

The NCC 2022 requires an average of 1.5 kW per EV charger (or 6.0 kW for hotels). If the development has greater aspirations for the average power availability per charger, then consider allowing more power. If the chargers mainly operate overnight, then consider if, in practice, the actual load overnight may be less than the estimated load, and so the load available to the chargers will be greater.

✔ Consider what to allow for the peak draw for each EV charger.

The NCC 2022 bases the EV charger on a Level 2 slow (7 kW, 32 A single phase) charger. If the development would like to make allowance for faster chargers, then size the electrical reticulation accordingly. Note that this does not necessarily affect the maximum demand - the average load allowance per charger may remain low for the purposes of maximum demand calculation, but the reticulation is increased in size for a faster charger to allow more power delivery if that power is available to the individual charger.

Electric Vehicle Infrastructure Description

A new high-voltage power feed from the grid will connect to a new transformer within the development, in the form of a new chamber substation. This will in turn provide a new low-voltage connection to a dedicated Main Switch Board (MSB) within the building via a *consumer mains* power feed. Dedicated circuit breakers will be provided within the MSB for the EV charging network. The EV charging network will include several EV distribution boards that will bring power from the MSB out to the physical chargers within the car park. Power cables will be mounted on dedicated cable trays that run through all car park levels to house these power cables.
As per the NCC 2022, a power management system will be incorporated into the system downstream of the MSB that will manage and modulate the power consummated by the EV network. This component will ensure, amongst other things, that the simultaneous power demand of the EV chargers remains within the maximum demand permitted, as agreed with the power supply authority.
From a billing perspective, it is envisaged that each user will have an account with the EV charger operator and a proprietary billing system will is used to charge people for use of the system.

The specific logic chosen for the power management system will be further developed during the documentation stage of the project. Some examples of different power management systems are outlined below.

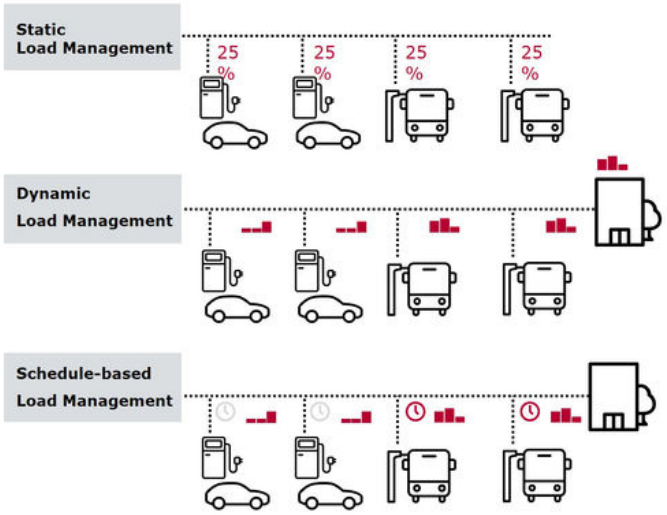
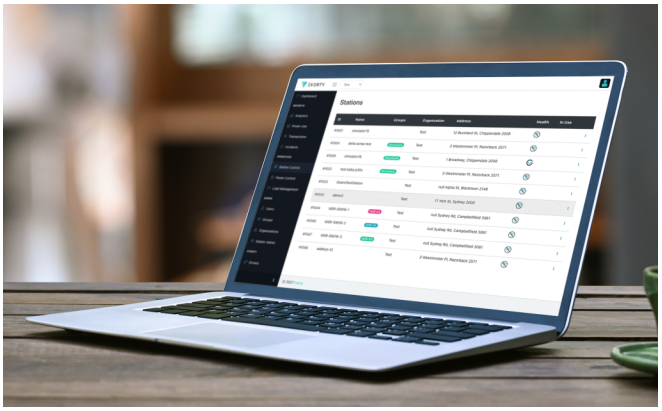


Image source: https://cdn.vector.com/cms/_processed_/6/c/csm_vCharM-Lastmanagement-EN_26799fec9c.jpg

Example of one of the EV charger billing providers in the market. Most are platforms and or phone apps where you can set up accounts and manage billing and usage.



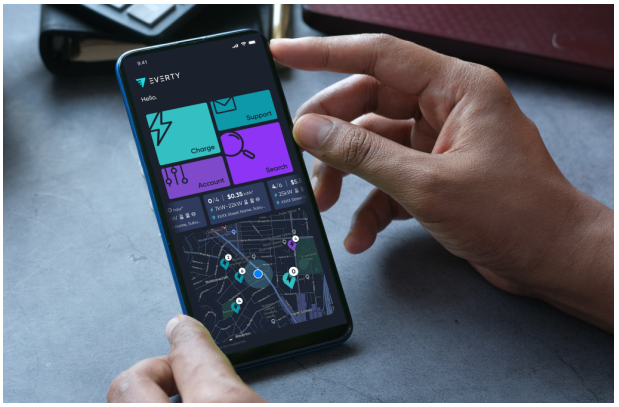


Image source: https://everty.com.au/everty-software/

Any questions please do not hesitate to contact me.

Kind regards,

Steven Cassells NER. RPEQ. CEng. MSc. BEng. MCIBSE. MIEAust.
Engineering Lead | Director

e: steve@neuron.build
w: www.neuron.build
m: 04 01 222 862