Determining maximum demand for an apartment complex with EV chargers

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ELECTRIC VEHICLE COUNCIL

Interested in how to determine maximum demand for an EV charger installation in an apartment complex?
Here's what you need to know.

Disclaimer: The Electric Vehicle Council (EVC) is not your local electrical regulator. Therefore, this guidance should be considered in combination with input from your relevant electrical regulator or licensed electrical inspector. It is not to be interpreted as legal guidance. If in doubt, please contact the relevant electrical regulator in your region for clarification.

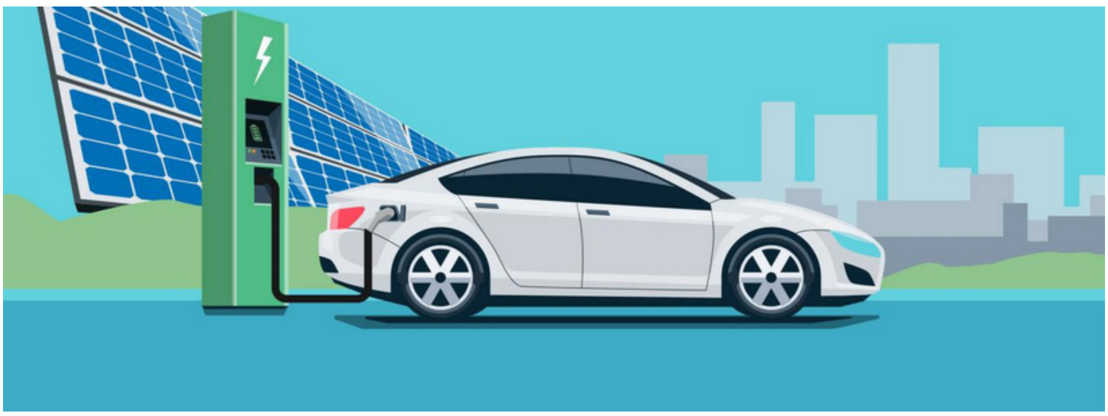
What is the maximum demand?

Maximum demand is the expected peak load in an electrical system. It is determined at the time of design or modification to the electrical installation, in order to inform the required capacity of upstream electrical equipment, in accordance with section 2.2.2 of AS/NZS 3000:2018 (Australian/ New Zealand Wiring Rules).

If an incorrect determination of maximum demand is obtained, there will be negative consequences. The installation will be more expensive than necessary if the maximum demand is overestimated. The circuit breakers will trip, or fuses will blow, if the maximum demand is underestimated. Getting it right is important.

The standard presents four methods to determine maximum demand as part of the installation.

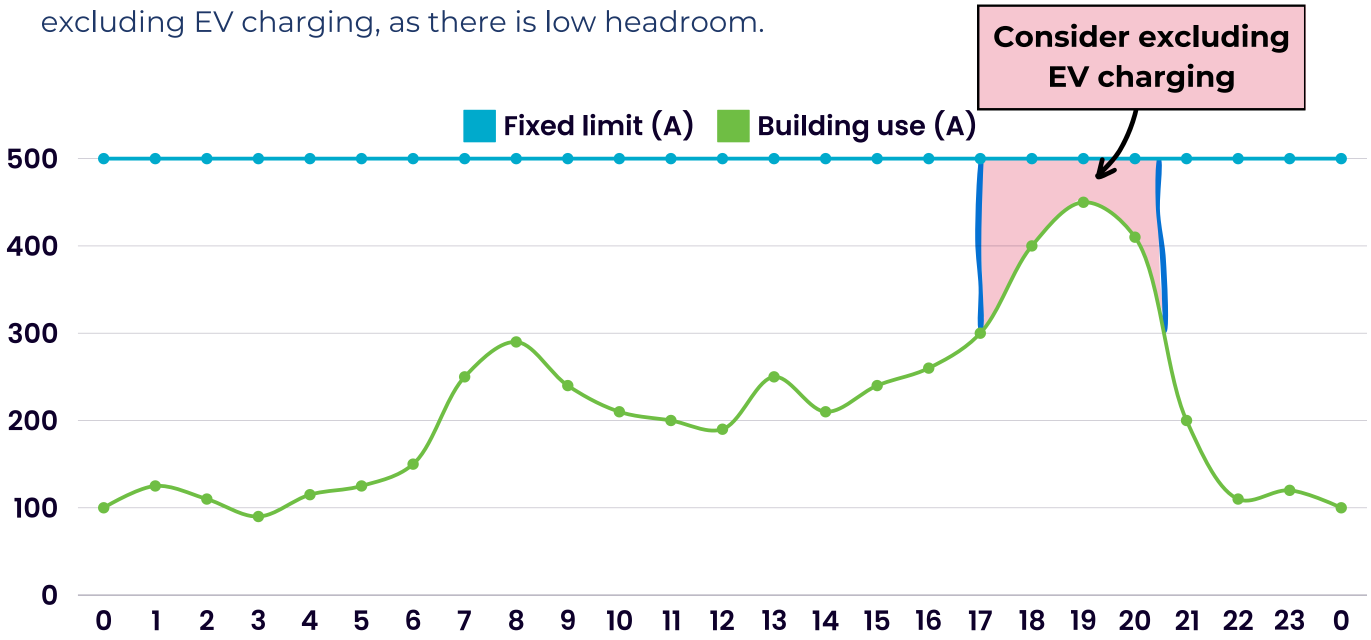
The methods most relevant to installing EV chargers in apartment complexes are (a) calculation and (b) assessment, backed up by (d) limitation. Method (a) calculation, is relevant to domestic installations and is covered in that guideline, it is good for applications where use of EV chargers at full capacity at anytime is required. Method (c) measurement, can be used for any installation once complete and functioning as intended.



Headroom

The dynamic limit of an electrical installation's connection capacity is the difference between the fixed supply connection capacity defined by the incoming circuit breaker, and the balance of building use of each phase that varies over time and is not 'orchestrated' or controlled. It is this headroom or spare capacity that we can target for EV charging.

In the graph below of a building's daily energy use, the two blue lines represent the dynamic limit at two points in time. The shaded area represents a period to consider excluding EV charging, as there is low headroom.



Method (b): Assessment

There are many ways to carry out an assessment of an electrical installation. One way is to draw up a table of all loads present, including their nameplate rating, normal condition current draw, power factor and when the loads will be drawing, to add up the overall draw at any one time. For large installations with many loads, this would be time consuming.

AS/NZS 3000:2018 clause 2.2.2 states that "The maximum demand may be assessed where - (i) the electrical equipment operates under conditions of fluctuating or intermittent loading, or a definite duty cycle;". Applying control to electrical equipment in your installation, such as a load management system, can ensure a definite duty cycle.

The underpinning assumption is that the implementation of a suitable load management system in the context of an apartment complex can ensure that EV charging is actively prevented from contributing to building-level maximum demand.

In this guideline, we treat a 'suitable load management system' as comprising of two aspects:

- 'primary load management', which is the part of the system that operates all the time, and which defines the user experience, and
- 'back-up load management', which only comes into play if the primary system fails to perform correctly, but which guarantees that the EV load will not compromise the rest of the building electrical supply.

Primary Load Management

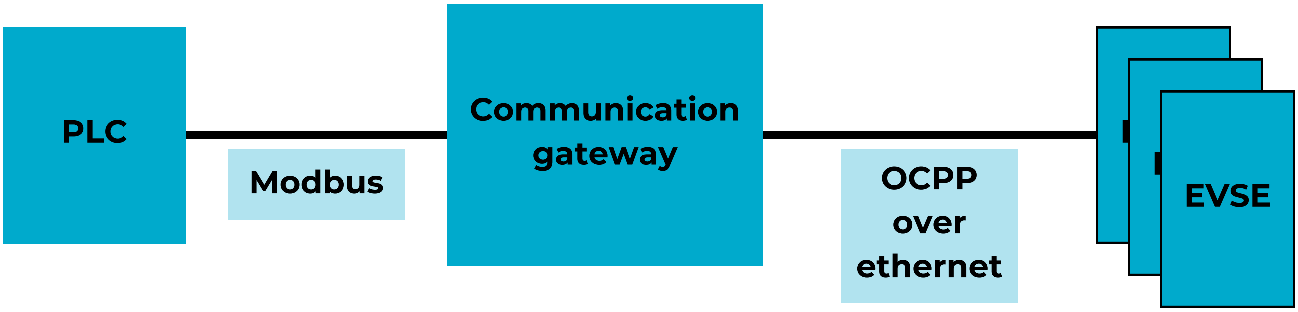
There are many architectures one could use to make sure EV infrastructure stays under desired load limits, this is not an exhaustive list of approaches in use today, and this is an evolving space - more approaches to load management will emerge over time.

Timeclocks -

Usings timeclocks or timer relays to bring in contactors that feed certain circuits at certain times is an effective and cheap but crude method of control. While generally reliable, if timers are reprogrammed at a future date, run times could undesirably overlap, creating higher than expected loads. Using the approach in the context of an apartment complex will support regular top-up charging, but will generally not support full recharging of individual vehicles overnight.

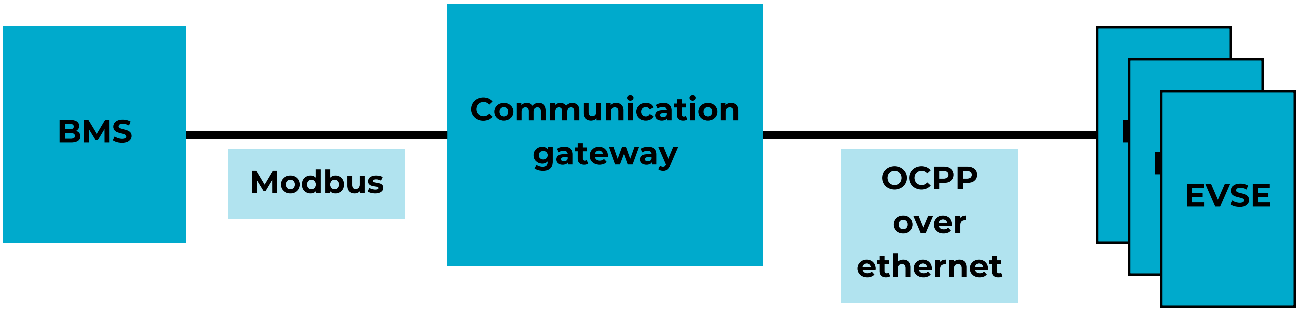
PLC -

Some EVSE coordination systems comprise of a communication gateway connected via a building automation network, such as Modbus, to a control system such as a Programmable Logic Controller. The EVSE are connected via ethernet on the OCPP (open charge point protocol). This architecture can use communication to the EVSE to ramp charging up and down rather than switching chargers on and off.



Building management system -

A building management system (BMS) is connected to the internet and could - in addition to providing local smart control - take input from external sources such as energy networks, energy retailers and individual driver preferences to orchestrate charging based on a range of competing priorities.

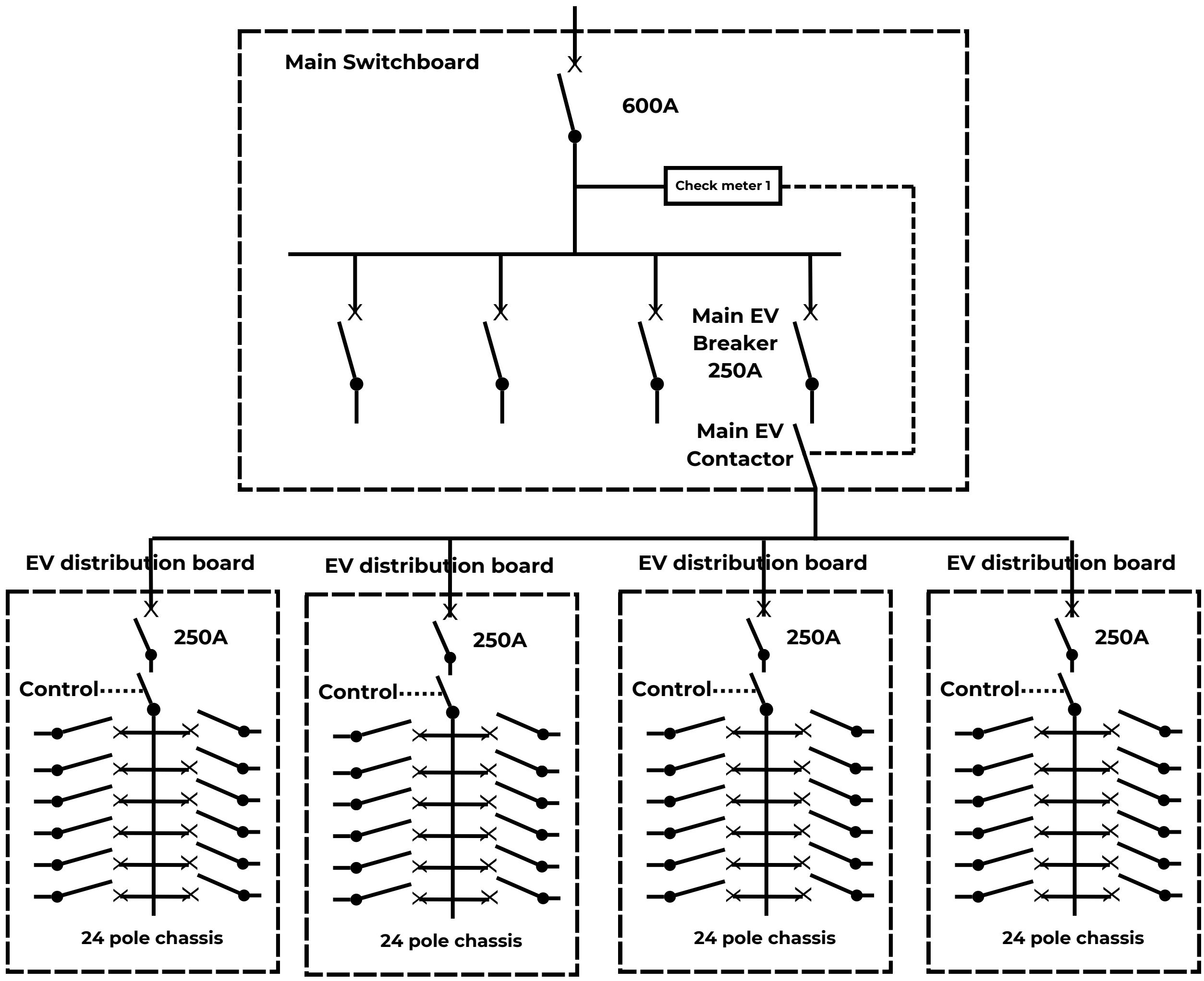


Software-based load management -
Systems requiring authentication, billing and/or reporting will typically use software-based solutions, with the underlying hardware being either local or cloud based. These systems routinely provide primary load management of EV charging, while also performing the billing and authentication functions.

Regardless of the choice of primary load management approach, any control solution implemented can be expected to be subject to adjustment over time as EV uptake scales, which may compromise the intended outcome - hence the recommendation for 'backup load management' in addition.

Backup Load Management example
This example is illustrative, intended to help lay out the principles - specific implementations will vary widely.

Consider an apartment building with a 600A main supply, and four EV distribution boards, each with a 250A circuit breaker as the main isolator, each equipped to serve up to 24 individual EV chargers.



The 'primary load control solution' depicted is timer based control in the distribution boards, but for the purposes of considering the 'back-up' system, this is irrelevant. It could just as easily be a cloud based software solution or a BMS undertaking the active control of the EV chargers on a day to day basis.

There is a 600A circuit breaker protecting the consumer mains, which is the fixed limit in the building - exceed that, and the building loses supply. For this example, we assume that the historical data for the building demonstrates that maximum actual usage of the building is 500A per phase, and only ever occurs between about 4 and 10pm, on hot days when air-conditioning equipment is in full use. At other times of the day, building demand is never more than 300A per phase. This means that outside of the peak demand period, up to 250A of EV load can be presented, without coming too close to the 600A limit at the consumer mains. This data informs the setup of the primary load management system - what we're exploring in this section is what happens if the primary system fails.

There are 4 x 250A EV distribution boards connected. One possible failure of the primary load control system is that more than 250A three phase of EV charging load is presented, perhaps because someone adjusted the timers. In the case that >250A of total EV charging load is presented at any time, the 'Main EV breaker' will trip, in accordance with its trip characteristics. This element is the maximum demand determination by limitation.

Another possible failure mode is that baseline building usage changes significantly in future, leading to there being an occasion after 10pm where the expected 250A of capacity available for EV charging is not actually available. Check meter 1 is in place to open the main EV contactor on sensing current at close to 600A to avoid tripping the 600A main circuit breaker. This should never occur - because the primary load management system should prevent it - but in the event that it does, it's far better to switch off the EV charging than to lose supply to the building. This meter would have a hysteresis setting, such that the main EV contactor is not re-closed until the meter senses base building load is below 300A.

This type of 'meter and contactor' arrangement can be used to demonstrate that the EV load will not contribute to maximum demand exceeding 600A, at the point of supply, under the assessment method for maximum demand determination. Importantly, any load shedding within the building caused by this arrangement will be limited to the EV charging - it will not compromise supply to the dwellings or essential services in the building.

Method (c): Measurement

When using the measurement method for an apartment complex, smart meter interval data of at least a year should be obtained. This will show the maximum current draw in all seasons and most conditions. For most of Australia, peak demand will likely be seen in the Summer months, but for other areas like Tasmania, peak demand may appear in the Winter months. The measurement method by nature does not allow for future additions of load or changes in conditions, such as very hot days, unless that load is controlled.

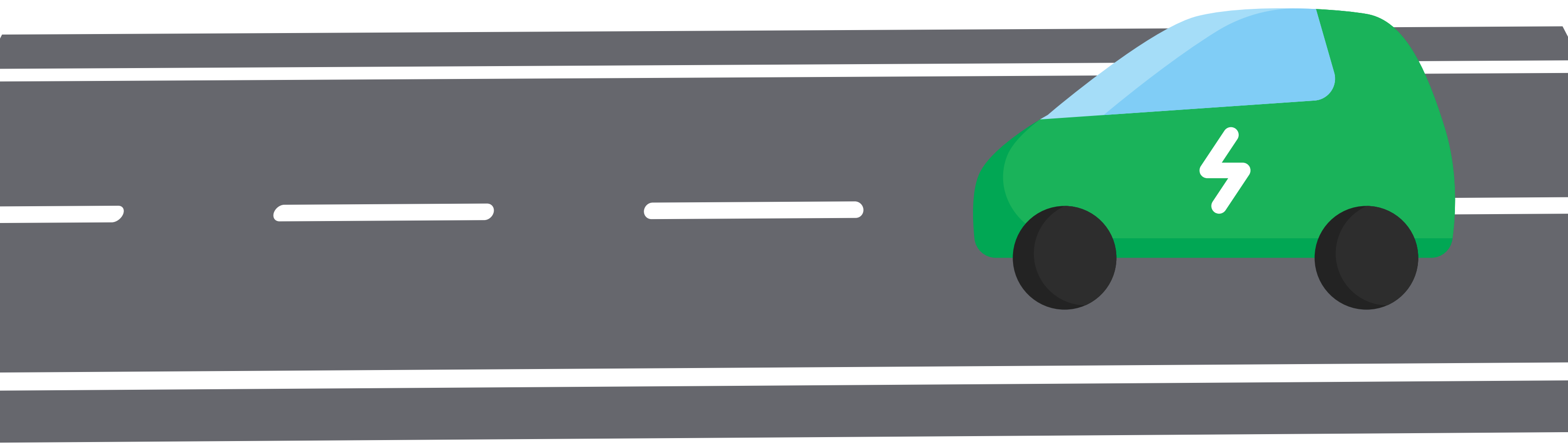
The measurement method is useful for building retrofits that require EV charging to be available at any time - for example, a shared charging facility intended to be available on demand. The maximum demand can be determined by adding the peak load current over the previous years of data log, to the full load current of the EVSE proposed for installation. If that number is lower than the size of the supply, a connection upgrade can typically be avoided.

Example of application of measurement method
An apartment building with a supply sized at 500A measures the historical usage in the building, and finds that the historical peak usage is 300A.

After surveying the residents, the owners corporation decides that they want to install a pair of 25kW DC chargers in a shared area, accessible to the residents at any time. This equipment has a combined, total full-load current of 100A.

The combination of the 300A determined via the measurement method, with the addition of the full load current of the new EV charging equipment, totals 400A.

A full calculation of everything on the whole site downstream of the existing 500A connection is not required to make the decision around the suitability of the existing supply being sufficient to support the new load, which will contribute at most an additional 100A.



Method (d): Limitation

The limitation method uses circuit breakers and is discussed in more detail in the ‘Determining maximum demand for a domestic EV charger installation’ guideline.

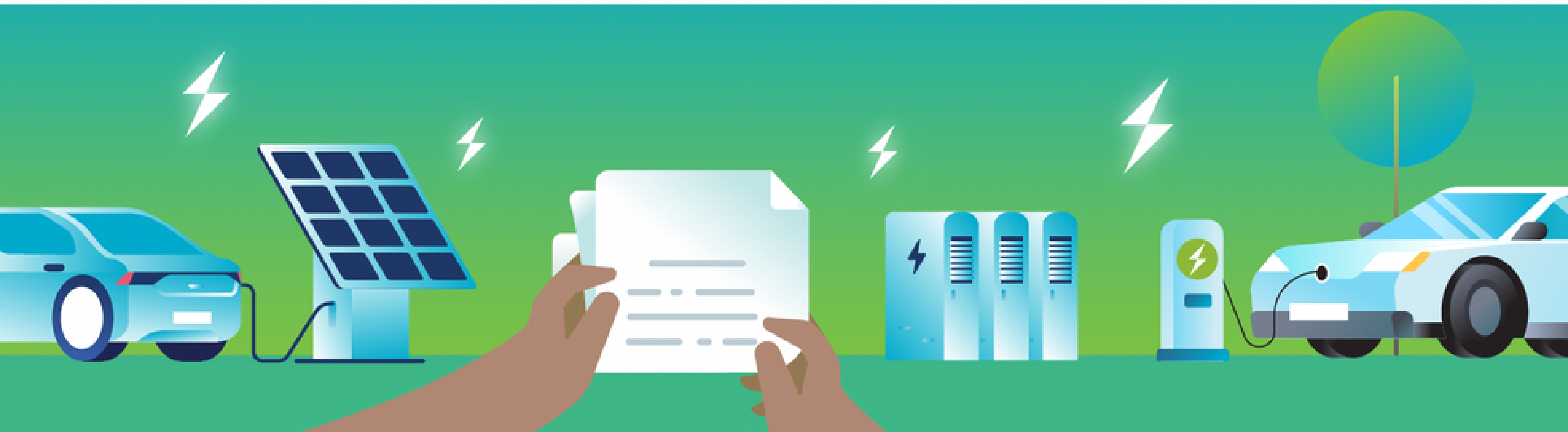
In the setting of a domestic home, the usage of the limitation method for maximum demand determination when installing a typical EVSE is reasonable, because the likelihood of nuisance tripping is low, and the consumer will be easily able to resolve the nuisance trip without calling in a service provider.

In the backup load management example, there is a 600A circuit breaker in place limiting the building maximum demand. There is also a 250A circuit breaker limiting the EV sub-main.

If one of these breakers trips on overload, it is not likely that the consumer will be able to easily resolve the nuisance trip without help. In the case of the 600A breaker, supply to many dwellings, and to shared services, will be compromised.

For this reason, in a more complex building, it's not reasonable to rely solely on limitation to manage maximum demand when adding EV charging equipment.

In this guideline we have discussed the concepts of headroom, methods; assessment, measurement and limitation for determining maximum demand and how they can be most effectively employed in an apartment complex. Please turn over for a comparison of the methods.



Comparison between the methods

	A - Calculation	B - Assessment	C - Measurement	D - Limitation
Charging Availability	Charging always available	**System** load managed	Variable	**Self** load managed
Upstream installation implications	Can be high	Low	Moderate	Very low
Use cases	Cases where 100% availability is worth higher cost	Apartments and workplaces	Retrofit of charging, using available capacity	Standalone domestic
Consumer education	Not required	Required	Required	Required
Trade-offs	Higher cost installations	Limited availability	Limited ability to scale	Limited availability
Grid implications	Possible increase to network peak demand	Increase network utilisation	It depends!	Increase network utilisation

Next steps

If you'd like to discuss these matters further with the EVC, or enquire about becoming a member, please reach out to us at office@evc.org.au.