# SECCCA Electric Vehicle Charging Roadmap Future Scan

**Prepared for the South East Councils Climate Change Alliance**

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Institute for Sensible Transport

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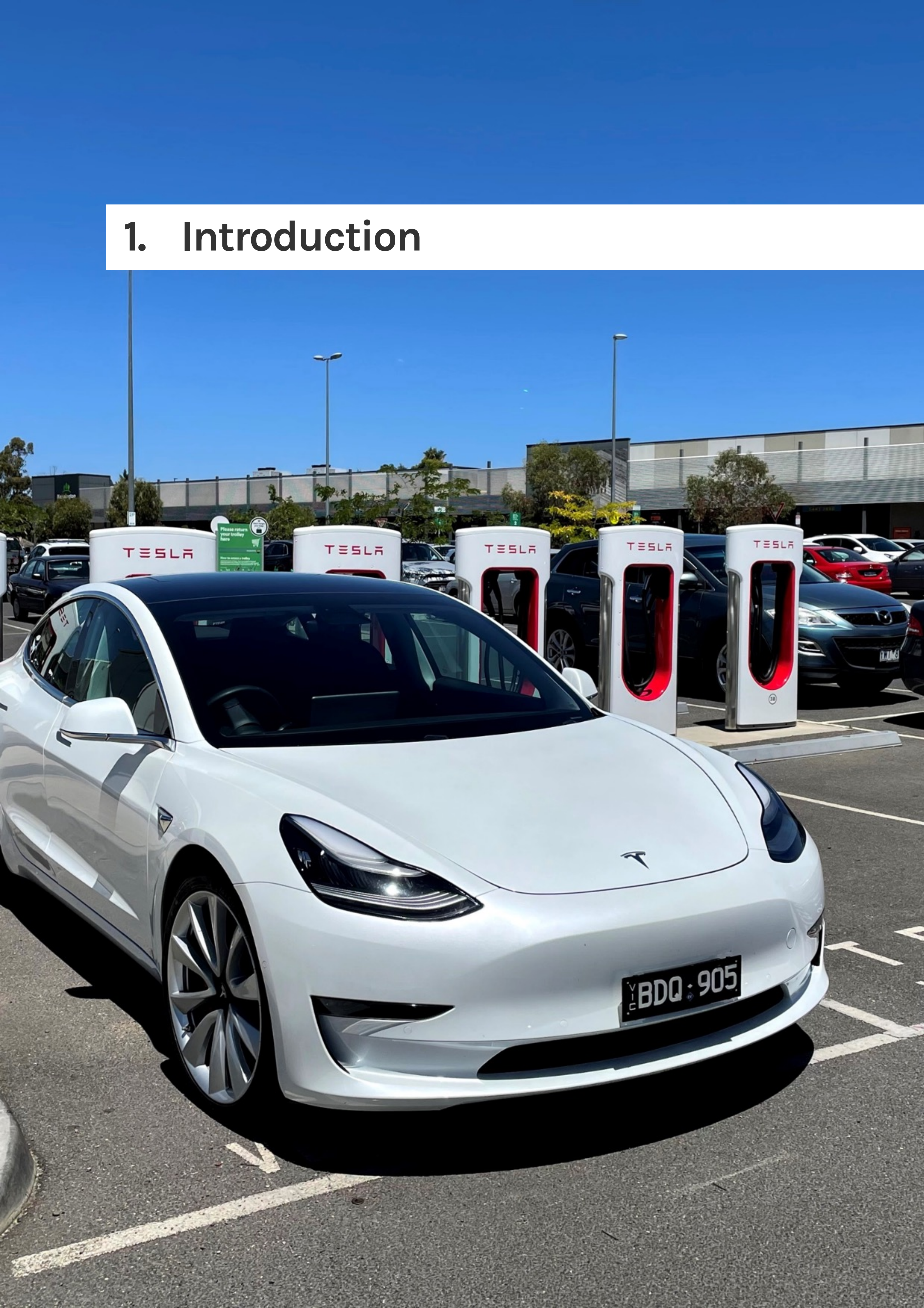

**South East Councils Climate Change Alliance (SECCCA) has commissioned the development of an electric vehicle (EV) charging roadmap, policy guidance and a snapshot of future trends. This project is intended to help lower transport emissions by enabling a shift from internal combustion engine (ICE) vehicles to EVs. This report is focused on the future trends for EVs and charging.**

## 1.1 Brief background

SECCCA has a vision for the south east of Melbourne to be a thriving and productive region that has a safe and sustainable climate. There are several important reasons for the commissioning of this project:

- SECCCA has declared a climate emergency and have recognised that 25% of emissions are transport related.
- Community sentiment on EVs is evolving rapidly, and some member councils have begun to receive requests from residents for public EV charging.
- EV charging equipment suppliers have approached councils seeking to install chargers on public land and clearer policy guidance is required to consistently manage these requests. The role of local government in facilitating this must be clarified.
- A stronger understanding is required on where future charging infrastructure should be placed, using a data-led approach.
- A clear, robust plan for publicly available charging infrastructure will provide a strong foundation for SECCCA members to apply for funding to have chargers installed in their LGAs.

## 1.2 What this project involves – in brief

In essence, SECCCA require three key deliverables to achieve the objectives of this project, as illustrated in Figure 1. This report is focused on the third component, the *Future Scan.*

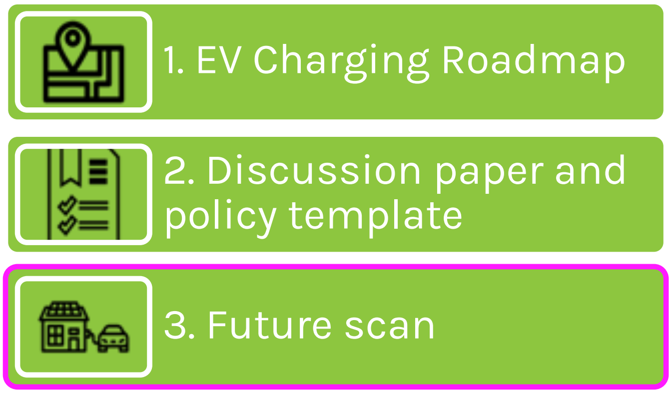


**Figure 1 Key project components**

This future scan looks at emerging market trends and the implications of these trends for SECCCA members and the Roadmap. This report explains why these trends are important and the implications they are likely to have on:

a) EV adoption and

b) the SECCCA EV Charging Roadmap.

Figure 2 provides a map of the SECCCA region and its member councils. As each member council is at a different stage of their EV journey, five of the nine SECCCA member councils are participating in this project (Cardinia, Casey, Frankston, Kingston, Mornington Peninsula).

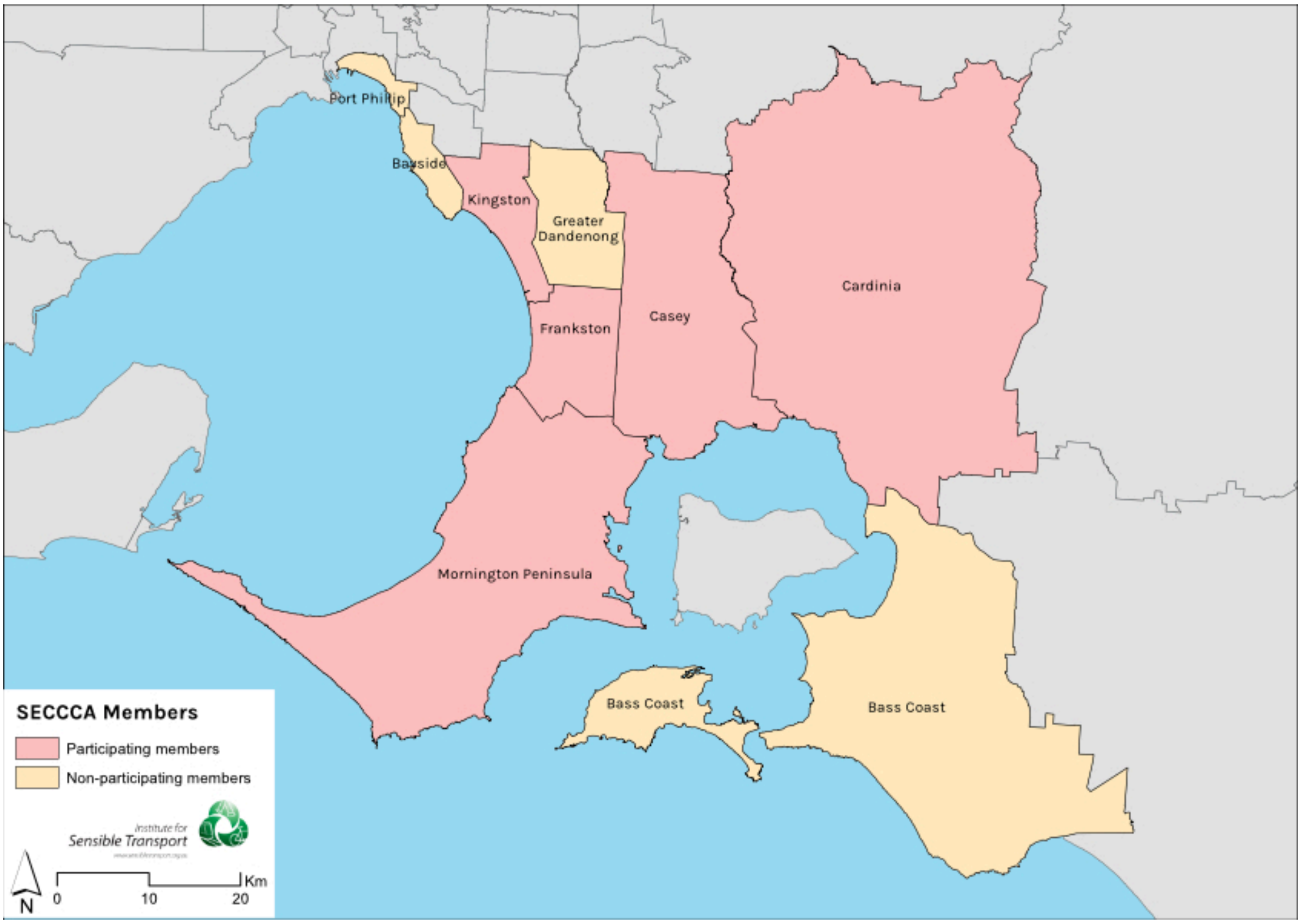


Figure 2 SECCCA region

# 2. Emerging technology and trends

**The EV industry has undergone a rapid transformation over the past 5 – 10 years, and this is expected to continue. Advances in battery technology, new charging capabilities, and innovations in vehicle types are all likely to influence the way in which people charge EVs. Moreover, the increasing role of renewable energy supplying the grid bolster the environmental benefits of EVs. Ten years ago there were few EVs on the market, most were very expensive and battery range was a fraction of what it is today. The EV market today provides more vehicle options, with greater range, and at lower cost than just a few years ago. This section provides an overview of some of the key trends and emerging technologies likely to impact the market in coming years.**

## 2.1 Underlying trends

The following underlying trends have been identified of relevance to the development of the SECCCA EV Charging Roadmap:

- Continuation of trend to cheaper batteries, longer life, faster charging and greater energy density, leading to cars with increased range batteries.
- High voltage EVs, with batteries capable of faster charging (affordable/without damage)
- Market differentiation:
  - short range cheaper 'urban' cars (100-200 km)
  - medium range (400-500km)
  - long range (600km+)

  The EVs available over the next couple of years and beyond will be designed for different use cases and user groups and different charging needs.
- EV chargers will become cheaper with volume. By 2025 expect 'dumb' chargers[1] costing around $200; 'smart' chargers at ~ $300 and bi-directional chargers costing ~$1,000.
- The cost of retrofitting (i.e. installing a charger once a building is already established) will generally be high. The cost of installing where supply is designed at the time of construction will be low. Installations associated with new construction will be the norm for residential due to the capital cost advantage. This has already begun (see https://www.smh.com.au/property/news/apartments-racing-to-retrofit-electric-vehicle-chargers-even-with-only-one-user-20211217-p59ig8.html).

## 2.2 Economic drivers

The following identifies some of the pertinent economic drivers influencing the adoption of EVs:

- EV prices drop below equivalent model ICE prices around 2025, driving a huge increase in volume, which reduces the price of EVs further.
- Capacity of *'batteries on wheels'* grows (see Section 2.3) so strongly it challenges the role of stationary batteries (e.g. Tesla Powerwall). This can happen even without bi-directional charging but bi-directional charging makes the case against stationary batteries even stronger.
- Public fast charging will always be more expensive than slower charging but will provide an important role where the EV is passing through and requires additional charge to reach their final destination.
- Mass production brings down the cost of charging equipment.
- Grids will incentivise charging during periods of renewables surplus (sunny and windy days for generation) and available grid capacity (periods of low demand). During day time solar peaks, feed in tariffs may go negative – that is, you pay to send surplus solar to the grid. This provides an important economic incentive to charge during these periods.
- Strong pressure in long term toward managed charging (see Section 2.3) at home or at work but with a degree of grid control.

[1] A 'dumb' charger is a non-networked charger that is isolated from the cloud and remote connectivity/control.

- Bi-directional charging with increase the value of connection to the grid, by allowing the user to sell electricity back to the grid at selected times.
- Well considered basic infrastructure for civil work, electricity supply should have a relatively long life. For charging equipment planners, assume a lifetime of five years for financial planning due to rate of change of technology plus wear and tear.

## 2.3 Bi-directional charging

Bi-directional charging describes the capability of an EV to not just accept charge going into its battery but also for electricity to flow out of the vehicle's battery, to another load (e.g. a house, another EV etc). This is widely considered one of the most important innovations expected to occur over the next few years. Some EVs already on the market have this capability (e.g. Nissan Leaf, Hyundai IONIC 5). This enables people owning such vehicles to provide power to one's own home in the evening, soaking up solar during the day and enhance grid stability. Ultimately, this increases the *value proposition* EVs offer the consumer.

CHARIN, the body dedicated to the interoperability of the Combined Charging System (CCS) has developed the graphic shown in Figure 3. This provides an overview of the spectrum of grid integration. In Australia, we are barely on the first step of this pathway with regulations in place in some states (e.g. South Australia) and early trials of demand management in others (Victoria, Tasmania and the Australian Capital Territory).

The Combined Charging System (CCS) 2 is the European standard of CCS and is also used in Australia. CCS refers to a combined plug for AC and DC charging and the communication protocol that applies. CCS2 ISO15118-20 is the international standard that outlines the digitial communications protocol that an EV and charging station should use to recharge the EVs high voltage battery. CCS2 ISO15118-20 is in draft form and expected to be released in 2022.

The DC communications protocol for CCS is different from and not compatible with the CHAdeMO DC communications protocols. The standard is being updated to permit bi-directional charging. While the proposed date for this is 2025, some Original Equipment Manufacturers (OEMs) have announced an early implementation.

The CHAdeMO communications protocol has supported bi-directional charging since 2014. It has been available on all Japanese models produced since shortly after it was published. A number of manufacturers make suitable bi-directional chargers for sale in North America, Europe and Asia. There are several bi-directional CHAdeMO charging devices currently being assessed for approval in Australia.

Bi-directional charging is also possible with AC connections such as the Type 2 connector now adopted as standard for Australia. No manufacturer has enabled this for cars sold in Australia and as yet there are no published standards or approved devices on the market.

Figure 3 shows that bi-directional charging is only one part of grid integration. The other technological component is *networked managed charging*. This is where a network manager can program when vehicles are charged, to reduce the burden on the grid that might otherwise occur. Together with a regulatory framework and economic incentives, they contribute to full grid integration. Grid integration and bi-directional charging are two distinct, albeit complementary elements.

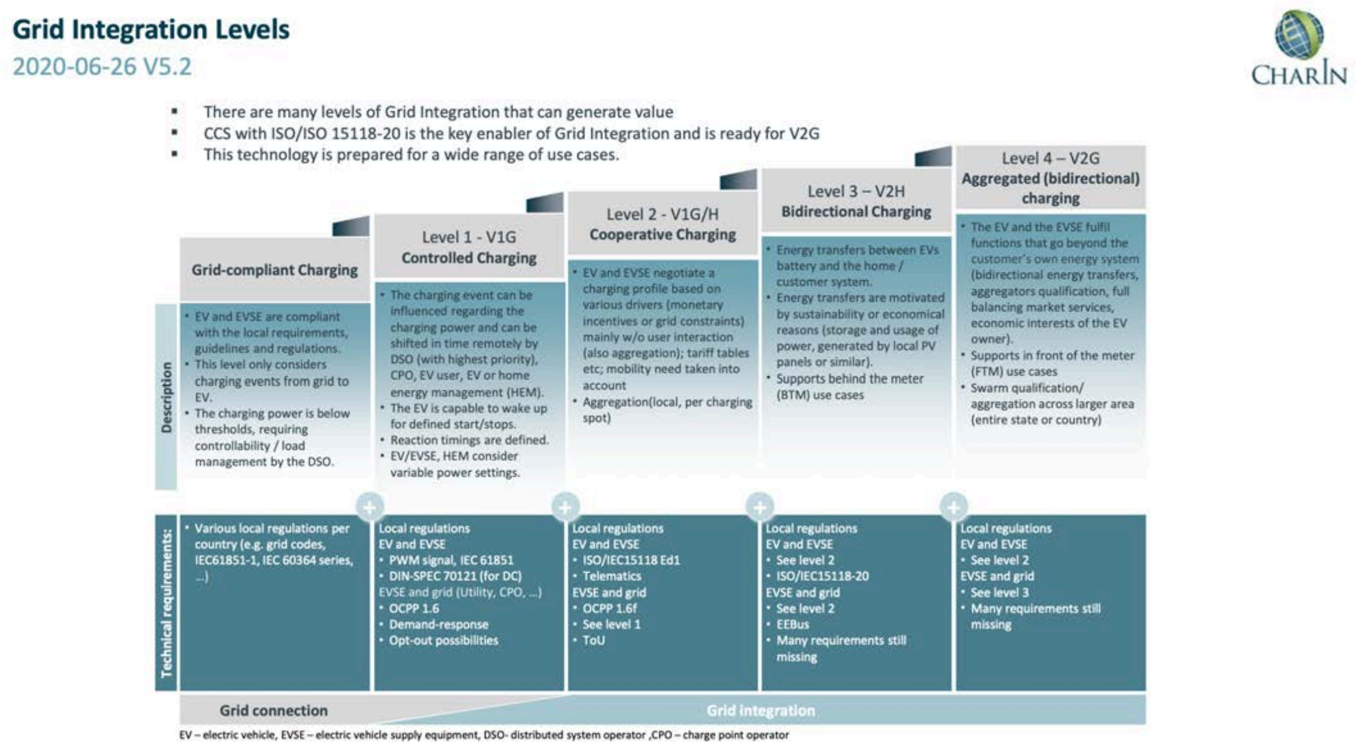


**Figure 3 Grid integration levels**

Source: CHARIN

### 2.3.1 Vehicle to Load

This is available now with some recently arrived models (e.g. Hyundai IONIC 5 and the new Nissan Leaf). This has little to do with grid integration, but provides useful power off the grid on construction sites, camping or in emergencies when power has failed. It is effectively a small-scale alternative to the grid.

Vehicle to Load (V2L) is expected to become a standard feature of most if not all EVs in the future. In essence, it enables a user to plug a device into a standard 240V plug. There are several applications for this capability, including work tools, car fridge etc. Figure 4 provides an image of the new Ford F-150 Lightning, that will have up to 10 power sockets available, enabling tradespeople to use their vehicle to power tools and other appliances.

**Figure 4 Vehicle to Load capabilities of the Ford F-150 Lightning**

While V2L is not expected to have major implications for the SECCCA EV Charging Roadmap in itself, it is expected to increase EV adoption, which will have flow on impacts in terms of potential demand for EV charging.

### 2.3.2 Vehicle to Home

Vehicle to Home (V2H) describes the ability of some EVs to use the vehicle's battery to supply the electricity to power a home.

V2H is expected to have a major impact on the type of charging equipment EV owners use to charge their battery while at home. Currently, around 80% of EV owners use a standard power point to charge their EV. Once V2H becomes standard, some in the industry expect this to change dramatically, with around 70% of EV owners electing to install a charger that offers V2H capabilities.

### 2.3.3 Vehicle to Grid

Vehicle to Grid (V2G) describes the capability of a vehicle to supply energy from its battery into the electricity grid. Once CCS 2 becomes the standard, it is expected that many models of EV will provide V2G capabilities.

Vehicle to Grid is important because:

- It increases the resilience of the grid by enabling connected cars to support the grid during times of high demand
- Has the potential for vehicle owners to sell electricity back to the grid.

There are no chargers that offer V2G capabilities currently, but this is expected to become a standard function from 2025. Some in the Australian EV charging industry expect that V2G will be utilised in home chargers rather than public chargers, although the medium sized Dutch city of Utrecht is planning a large-scale trial of V2G utilising EVs and public charging infrastructure.[2]

**Regulatory considerations from new charging capabilities**

The transition from Vehicle to Load, to Vehicle to Home, to Vehicle to Grid is primarily regulatory and about safety. At each step, additional risks and equipment interactions occur. At each step additional players must agree on how their side of the interaction will respond to the different states that can arise so that they do not interfere with or cause damage to the other side of the interaction. It is this important regulatory aspect that takes time, particularly as each side has different priorities.

## 2.4 Wireless chargers

Wireless charging involves the delivery of electricity into the vehicle's battery via a pad that connects wirelessly to the vehicle. There are no cars currently in Australia that offer this capability. This is likely to change significantly in coming years, and some within the industry predict that in 10 years, wireless home charging will become the default, and is likely to integrate bidirectional charging capability.

In recent years, there have been some important developments regarding wireless charging, including:

- Increased efficiency of transfer of energy, even with relatively wide gaps between the pad and the car.
- Increased tolerance of position so the car and pad do not have to be as accurately aligned.
- Enabled wireless bi-directional charging.

The advantages of wireless charging include:

- Enabling taxis on a rank, emergency vehicles on stand-by or delivery vehicles in an unloading bay, to connect and move away quickly but continuing to charge while waiting. This is impractical with a cable.
- Enabling on street charging without the visual clutter, trip hazard or risk of damage to cables and connectors.
- No detachable parts, which reduces wear and tear and potentially lowers maintenance cost.
- Automatic connection – you do not have to (remember to) plug in. This is particularly important for fleets, bi-directional charging, and autonomous vehicles.
- Greatly assisting disabled users.
- Easier for the home user to avoid plugs and cables.

The disadvantages of wireless charging include:

- Minor electricity loss compared to cable charging, though this is improving significantly.

[2] https://chargedevs.com/newswire/utrecht-plans-to-be-a-bidirectional-city-turning-its-evs-into-a-giant-battery/

- More expensive equipment, at least currently. The costs are expected to reduce significantly over the next decade.
- Compatibility issues between chargers and certain vehicles. Those within the industry expect this to reduce over time.
- Anxiety by some about 'radiation' (not factual, but this can still have an impact on adoption).

In terms of implications for SECCCA, the prospect of wireless charging does not impact on the EV charging roadmap. Should wireless charging capability become standard in EVs available in Australia, it may be necessary for SECCCA to re-assess its charging offer. There is currently no suggestion that the potential for wireless charging replaces the need for cable charging in the short to medium term future.

## 2.5 Ultra-fast chargers

Ultra-fast chargers, capable of 350kW charging have begun to be installed across Australia, including via Commonwealth funding (and 600kW chargers are currently under development). While there are only one or two cars on the market that can accept this rate of change, the general trend for newer EVs is to accept higher rates of charge. For instance, the Tesla Model 3 accepts a maximum charge rate of 120kW while the yet to be released Model Y will have a charge rate of 250kW. Most vehicles cannot sustain their peak charge rate for more than a small part of the total charge cycle, with average charging rates typically about two thirds of the peak rate, tapering to very low rates at a high state of charge.

It is expected more cars will be capable of accepting 250kW + peak charge rates in the future. This will be driven by the changeover to 800V DC EV architecture (EVs currently operate on 400V DC architecture) that will allow more energy with less current. With liquid cooled cables, charging rates up to 600kW have been proposed.

While much more expensive than 50kW or 100kW chargers, ultra fast chargers are very useful for commercial applications, and for passing through motorists, where time considerations are paramount. Given the substantially higher costs of ultra-fast chargers, there may be more benefit in providing a much larger number of 50kW DC chargers, helping to densify the charging network. EV drivers soon find they benefit from a 15 minute break every two hours.

**Figure 5 Ultra fast charging, Airport West, Melbourne**

As part of the EV charging roadmap, one ultra fast charger site has been recommended, at the twin BP petrol stations in Baxter on the Peninsula Freeway.

## 2.6 Solar roofs

One development that has recently emerged on the market overseas are EVs with an integrated solar roof. These are expected to add around 20km of range on a sunny day in summer. Advances in solar technology, such as the use of Perovskite, which can increase the efficiency of photovoltaics, may enable solar roofs to more effectively charge the EV battery.

There are limited some use cases in which a solar roof might provide utility to the owner. When an EV is parked for multiple days with little or no use, without access to a charger (e.g. while camping), a solar roof can be advantageous.

The new Hyundai IONIC 5 comes with an option for a solar roof, pictured in Figure 6. Some within the EV industry believe that solar roofs are more of a gimmick than a technology offering a practical capability, and believe the additional cost would be better spent by the owner on additional solar panels on one's home.

**Figure 6 Solar roof on the Hyundai IONIC 5**
Source: Hyundai

As the cost of photovoltaic cells continues to reduce, it is likely more EVs will offer solar roofs. There are no immediate implications of this technology for the EV charging roadmap and there is no prospect of this technology replacing cable-based charging.

## 2.7 Managed charging

There are two main types of managed charging; network managed charging and home owner managed charging, as described below.

### 2.7.1 Networked managed charging

. As introduced in Section 2.1, *networked managed charging* is where the agencies managing the electricity grid are able monitor and manage EV charging, to ensure the grid is not overburdened. Electricity distributors can turn on and off segments of the network to moderate demands on the grid. Without such management, there is little to prevent large numbers of EVs arriving home at approximately the same time, beginning their charging session. In summer, this may be exacerbated by running other high load appliances like air conditioners.

The charging of EVs while at home is highly discretionary. It generally does not matter if the charging begins at 5:30pm to 2:30am, as long as there is sufficient charge in the battery at the time the owner requires the vehicle. Networked managed charging is likely to be necessary to ensure the demands on the grid does not exceed the capabilities of the network.

### 2.7.2 Home owner/local business etc managed charging

Home owners, local businesses, councils and other institutions are able to program when their EVs are charged through the use of a *smart charger*. While there is a wide spectrum of capabilities covered under the broad term *'smart charger'*, their defining characteristic is the ability for the charging to be turned on/off/adjusted remotely. These chargers are generally more expensive to install, but enable the owner to lower their charging costs (e.g. by taking advantage of off peak tariffs) and to maximise the use of their solar power. Smart charging is already available, but is expected to become standard in the coming years.

Site owners can also manage charging of one or more vehicles on their site to avoid exceeding their site's electrical supply capacity.

As the SECCCA Roadmap is focused on public charging, there are limited implications for managed charging on the future SECCCA public network. This is because EVs will be unlikely to connect to this proposed network overnight or for extended periods during the day, limiting the applicability to the SECCCA network.

The 2021 Commonwealth government's release of funding for 50,000 homes to receive a subsidised EV smart charger is expected to significantly increase smart chargers in Australia. Some within the industry expect smart chargers to be mandated in coming years, to protect the grid. Those not wishing to install smart chargers may be limited in the amount of electricity their charger can draw, to limit pressure on the electricity network.

## 2.8 Regulations on solar exports

It is plausible that Victoria may introduce regulations for solar inverters in coming years, to be controllable in response to grid issued instructions. The South Australian government has recently introduced such regulations, that govern how much energy can be exported in the next five minute interval, from full capacity down to zero. This will also be extended to how much EV chargers can demand, or for bi-directional chargers and batteries, how much they can export to the grid.

A practical implication of such regulatory changes can be seen in the case of shopping centres/super markets with solar. When they have surplus energy, there may be certain times they are unable to export it to the grid. If they were to make it available to EV chargers in their car parks, electricity used to charge EVs would count towards their *renewable energy generation credits*. If they were simply to shut down their solar, they would lose this benefit. By making this electricity available to their customers in the form of free or very low-cost EV charging, they would be able to make money. The implication of this possibility for the SECCCA roadmap is that shopping centre owners may have an incentive to provide charging opportunities beyond what they would have provided in the absence of such a regulatory tool. Such sites should be considered important potential locations for charging infrastructure.

## 2.9 E-bikes and e-cargo bikes.

It is a little-known fact that around 95% of all EVs are actually *e-bikes*.[3] Given that around 50% of all trips in Melbourne are under 5km, and some 30% are under 3km, there is considerable capacity for e-bikes and other forms of e-micro mobility to meet a greater portion of trips within the SECCCA region.

While the benefits of micro mobility may appear obvious to some, it is worth briefly summarising these benefits explicitly:

- Reduced emissions. Transport is one of Australia's fastest growing sources of greenhouse gas emissions and a major source of Victoria's emissions. As highlighted in Figure 7, electric micro mobility, even when powered by Victorian grid electricity, is only 1/40 as carbon intensive as a regular motor vehicle's emissions.

### Frankston's e-bike share trial

Frankston City Council and Neuron have introduced an e-bike share program, operating in the municipality, with 150 bikes.

[3]https://www.sciencedirect.com/org/science/article/pii/S0144164722002550

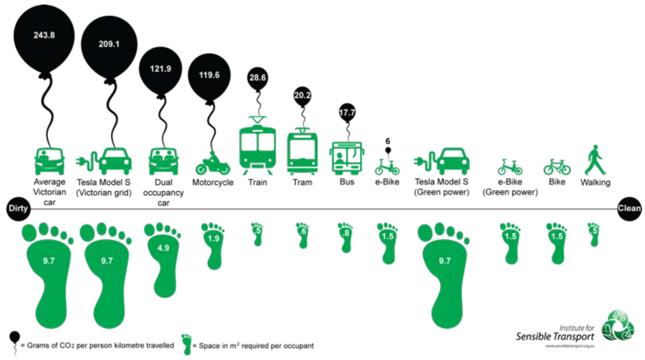


**Figure 7 Emissions and space intensity, various modes**

- Congestion. Micro mobility consumes about 1/6 of the road volume of a standard motor vehicle. As Melbourne increases its density, and the SECCCA region is home to more jobs, using scarce road space more efficiently will become increasingly important.
- Health. Micro mobility usually involves some physical activity on the part of the rider. Studies have shown that people using an e-bike for instance gain around 70% of the physical activity benefits of those riding a regular bike.
- Enhanced transport choice. Micro mobility, especially when shared, creates affordable opportunities for enhancing accessibility and transport choice.

Key to enhancing opportunities for electric micro mobility will be the development of a network of protected bicycle lanes and paths. These vehicles will charge at home or work and do not require a publicly available charging network like cars. In summary, improving opportunities for using micro mobility can help to lower emissions, reduce congestion, enhance health and increase transport choice.

## 2.10 Mobility as a Service (MaaS)

Mobility as a Service (MaaS) has grown over the last decade, to include ride sourcing services (like Uber), as well as shared micro mobility, such as bike share. The defining feature of MaaS is that it offers *access* to transport, without the need to *own* the vehicle. One of the reasons this is considered useful is because motor vehicles are only used 4% of the time, and given that vehicles are usually the second most expensive item most people will ever buy, MaaS has the potential to lower transport costs without reducing access.

Autonomous (or driverless) vehicles have attracted major investment over recent years, and the technology has improved.

While many of the challenges associated with operating a vehicle without the aid of a driver have been overcome, their use in cities is still considered at least 5 – 10 years away, and it is not inevitable that autonomous vehicles will have a dominant role in urban transport. Thus, there are no major implications that driverless vehicles are likely to have on the EV charging roadmap between now and 2030.

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