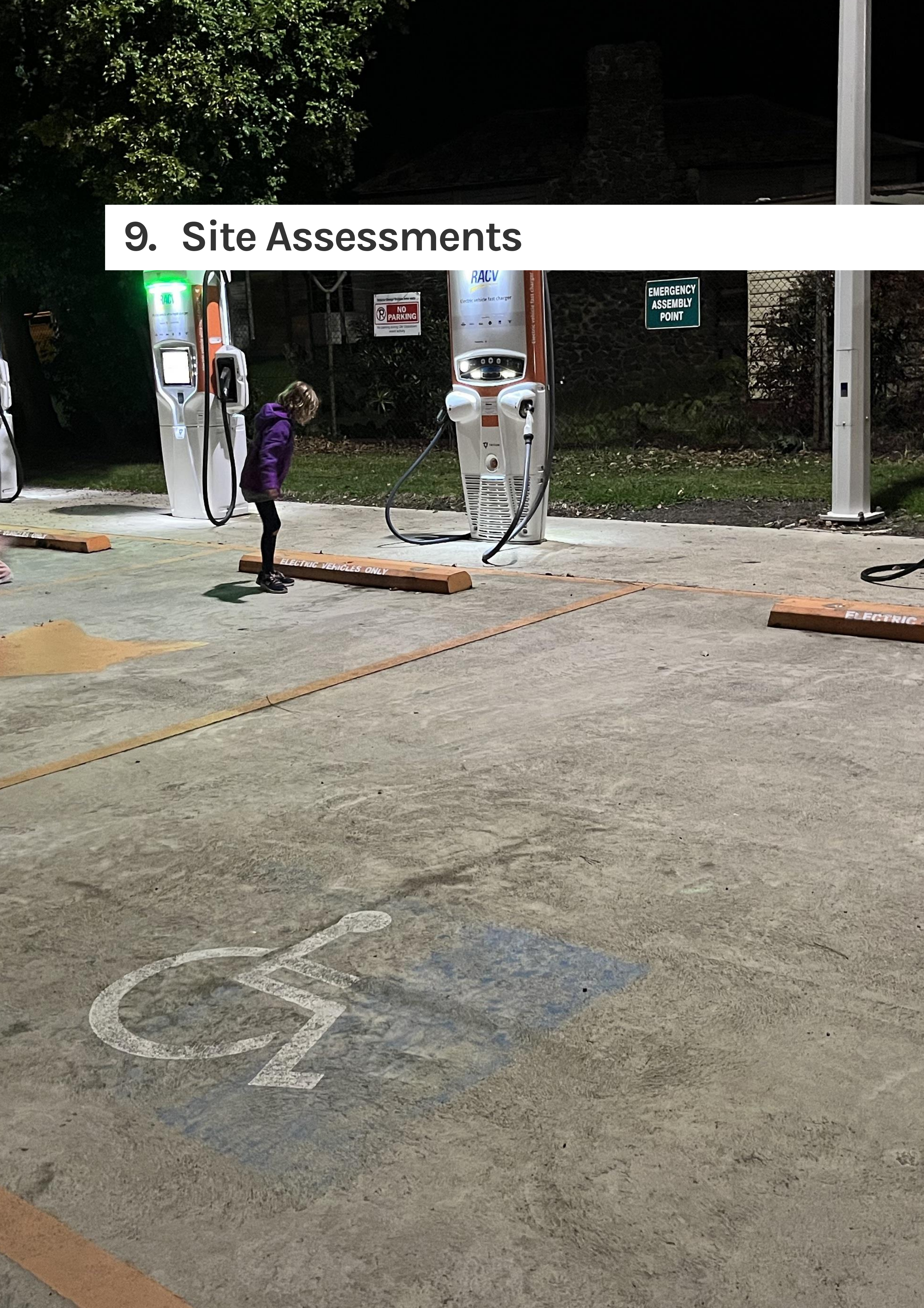
Appendix 1:
Electric Vehicle Charging Plan – Additional information

9. Site Assessments



As part of this project, 20 Council owned car parks were assessed for their capacity to provide electric vehicle charging stations. Council, Institute for Sensible Transport, and electrical specialist Bryce Gaton assessed each site together on the 13th and 14th of July 2022. These sites were selected by Council for assessment on the basis that they were the largest Council-owned car parking assets, there was internal interest in assessing them, and some have existing electrical infrastructure that could be used. This section outlines the findings from the site assessment. Each car park has its own sub-section with electricity capacity, potential demand, and constraints all assessed.

Estimated demand is drawn from our analysis outlined earlier in this document. When referring to ports required, these are estimated as 50kW DC charging ports. Amenity, electrical capacity, and other considerations are taken from the on-site assessment. An 80 amp three phase capacity is required per 50kW charging port

9.1 Summary

In order to meet the forecast demand for EV charging outlined earlier in this report, electricity capacity upgrades are required at all of the assessed Council car parks. One car park, the Windsor Street Paid car park, requires immediate safety upgrades at the on-site switchboard building.

Figure 37 shows the car parks assessed. The numbered order reflects the layout of the car park sections in this section of the report.

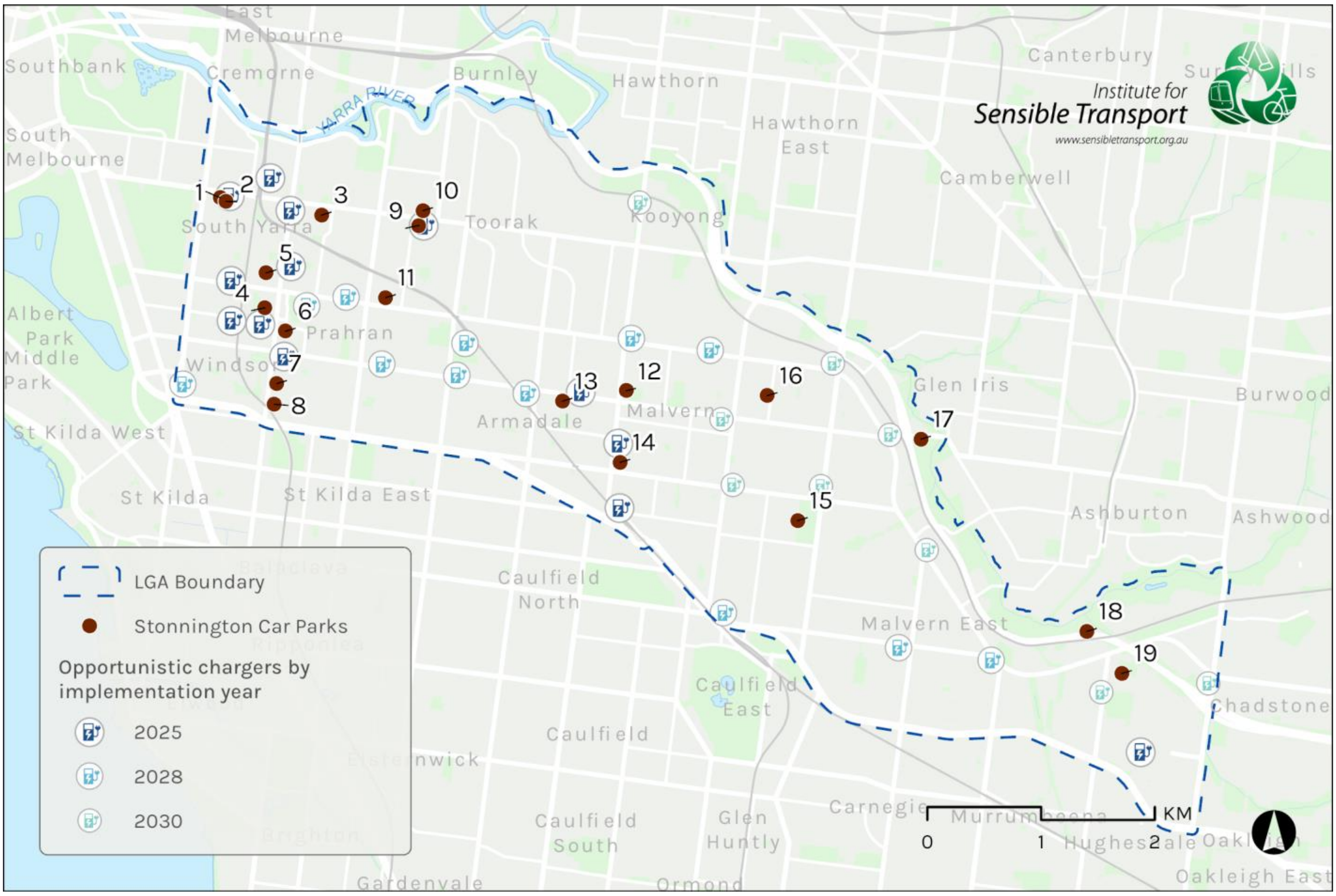


Figure 37 Stonnington managed car parks assessed for EV charging

Table 18 Site visit summary

No.	Carpark	Ports required	Electrical capacity	Other considerations
1	Caroline Street South Car Park	4	High	Near sub-station. Need to check with Citipower.
2	Powell Street Car Park	4	Low	Power supplies to both ends of carpark.
3	Surrey Road North Car Park	4		Power supply on opposite side of road to car park.
4	Prahran Square Car Park	6	High	Two existing 22kW AC chargers.
5	Elizabeth Street Multi Deck Car Park	6		Two charging areas near each switchboard an option.
6	King St (Little Chapel Street) Multi Deck Car Park	6		Existing capacity in switchboards constrained.
7	James Street Reserve Car Park	6	Low	Potential street adjacent spaces off James Street.
8	Windsor Station paid carpark (28 Chapel St)	6	High	Switchboard building requires complete rebuild. The current facility has a catastrophic risk of electrical explosion and should be addressed ASAP.
9	Carters Avenue Car Park	4		Power supply poles (overhead supply) on opposite side of road.
10	Jackson Street Car Park	4		Busy car park. Switchboard located in current construction site next door.
11	May Road Car Park 2	4		No on-site power supply. Power supply (overhead) is on opposite side of May St to car park.
12	Malvern Town Hall Car park	4	Unknown	Need to check with Citipower but likely a good DC charging site adjacent to Glenferrie Road.
13	William Street Car Park, Armadale	4	Low	No easy options. No logical layout and hard to access the council carpark.
14	Drysdale Street Car Park	4	High	Site switchboard on lower level next to walkway through to shops.
15	Central Park Carpark	4	High	Medians between parking bays could be used for charging.
16	Edgar Street Car Park No 2 (constructed section)	Low	Unknown	Need to check plans for swimming pool service building. Likely several AC charging ports.
17	T. H. King (Glen Iris Wetlands) carpark	Low	Low	Some EV drivers may be uncomfortable in this car park. Feels very isolated/out of sight from main road.
18	Malvern Valley Golf Course	Low	Low	Difficult site to provide power and low demand.
19	Phoenix Park Library	Low	Low	Main SB well loaded. Main SB and DBs all at maximum with few to no spare slots for additional breakers.

Table 19 provides a breakdown of the estimated ports required by 2030 for each activity centre, based on our demand analysis outlined earlier in this report, and the number of ports that are able to be installed at nearby Council-owned car parks assessed by the project team. Where no Council car park exists, or the car park wasn't assessed, an N/A is given in the capable ports column.

Table 19 Required and capable charging ports by activity centre

Site	Ports required by 2030	Council car park	Existing or planned ports
Chadstone SC	6	No	?
Chapel Street AC - Greville Village and Princes Gardens	6	Prahran Square	2
Chapel Street AC - Jam Factory District and Market District	6	Elizabeth Street Multideck	0
Chapel Street AC - Forest Hill	6	No	0
Chapel Street AC - Windsor Village	6	Windsor Paid	0
Glenferrie Road - Malvern Central	4	No	?
Chapel Street AC - Toorak Road Central	4	Surrey Road North	0
Glenferrie Road, Malvern	4	Drysdale Multideck	0
Chapel Street AC - Toorak Road West	4	Caroline Street South and Powell Street	0
Toorak Village	4	Jackson Street and Carters Ave	0
Chapel Street AC - Greville Village	4	Prahran Square	2
Chapel Street AC - Market District	4	Elizabeth Street Multideck	0
Malvern Village	4	No	0
High Street, Armadale	4	William Street	0
Hawksburn SC	4	May Road 2	0
Waverley Road NAC	4	No	0
Prahran East Village	4	Aberdeen Road (not assessed)	0
High Street and Orrong Road	4	No	0
East Malvern Village	4	No	0
Punt Road, Windsor	4	No	0
East Malvern Terminus	4	No	0
Malvern Hill Village	4	No	0
Beatty Avenue, Toorak	4	No	0

Site	Ports required by 2030	Council car park	Existing or planned ports
High Street and Toroonga Road	4	No	0
Glen Iris Village	4	Essex Street car park (not assessed)	0
Warrigal Road, East Malvern	4	Peverill Street (not assessed)	0
Central Park Village	4	Central Park	0
Darling Village	4	No	0
Wattletree Village	4	No	0
Malvern Road - Burke Road NAC	4	Kyarra Park Tennis Club (not assessed)	0
Kooyong Village	4	No	0
Malvern Valley Shopping Strip	2	Percy Treyaud (not assessed)	0

9.2 Costings

Drawing on costs from previous EVSE installations and discussions with EVSE industry leaders, we have put together high-level figures to help guide Council's decision-making. Table 20 provides the base figures we used to provide high-level costs required for each of the identified sites.

Table 20 High level EVSE costs

Item	Cost
50kW DC charging unit	$40,000
Civil works	$10,000 per site + $1,000 per charging port
Electricity grid upgrades	$16,000 per charging port

N.B. These figures are estimates only and final costs may differ substantially based on site specifics.

Fast charging units (50kW) are currently available for approximately $40,000 including GST.

When undertaking civil works associated with EVSE installations, there are a number of fixed costs that will remain the same regardless of the number of ports installed. Because of this, we have used a base charge per site and an additional $1,000 per charging port for the additional conduit and installation work required.

Based on previous EVSE fast charging installations, it costs an average of $20,000 per 100 amps of extra electricity capacity. We have scaled this down to $16,000 as a DC charger requires 80 amps per 50kW.

These costs are indicative only and could change significantly based on the individual characteristics of each site. Where additional grid capacity already exists, this would bring the installation costs down substantially.

Other options exist to work within the available grid capacity, such as using a load balancing charging unit. For example, a dual port 50kW charging unit could spread the 50kW across the two charging ports. If both plugs are in use, then only a maximum of 25kW could be fed to the EVs.

At present, the Distribution Network Service Provider (DNSP) process for requesting a new EVSE connection are opaque and complex. An application, including a fee, is required before being able to know whether the installation is possible or what upgrades are required. In addition, there is no iterative process for working with the DNSP to find the best solution for the area, only resubmitting the application based on feedback from the first application. Working with the State Government, EVSE industry, and other local governments to establish a working group with DNSPs is recommended.

The costings shown in Table 20 provide a breakdown of the likely costs for each component of an EVSE installation. A total with and without the grid upgrades is provided as not all sites will require upgrades.

As such, we estimate that the proposed EV charging network in Stonnington would cost between $6.2 and $8.5 million to deliver 144 50kW DC charging ports.

Table 21 Cost estimate by site

Activity Centre	Ports	Maximum energy capacity requirements (amps)	Grid upgrade costs (indicative)	Civil works	Charging units	Total	Total minus grid upgrades
Chadstone SC	6	480	$96,000	$16,000	$240,000	$352,000	$256,000
Chapel Street AC - Greville Village and Princes Gardens	6	480	$96,000	$16,000	$240,000	$352,000	$256,000
Chapel Street AC - Jam Factory District and Market District	6	480	$96,000	$16,000	$240,000	$352,000	$256,000
Chapel Street AC - Forest Hill	6	480	$96,000	$16,000	$240,000	$352,000	$256,000
Chapel Street AC - Windsor Village	6	480	$96,000	$16,000	$240,000	$352,000	$256,000
Glenferrie Road - Malvern Central	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Chapel Street AC - Toorak Road Central	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Glenferrie Road, Malvern	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Chapel Street AC - Toorak Road West	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Toorak Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
High Street, Armadale	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Chapel Street AC - Greville Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Chapel Street AC - Market District	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Malvern Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
High Street, Armadale	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Hawksburn SC	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Waverley Road NAC	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Prahran East Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
High Street and Orrong Road	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
East Malvern Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Hawksburn SC	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Punt Road, Windsor	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
East Malvern Terminus	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Malvern Hill Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Beatty Avenue, Toorak	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
High Street and Toroonga Road	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Glen Iris Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Warrigal Road, East Malvern	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Central Park Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Darling Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000

Activity Centre	Ports	Maximum energy capacity requirements (amps)	Grid upgrade costs (indicative)	Civil works	Charging units	Total	Total minus grid upgrades
Wattletree Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Malvern Road - Burke Road NAC	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Kooyong Village	4	320	$64,000	$14,000	$160,000	$238,000	$174,000
Malvern Valley Shopping Strip	2	160	$32,000	$12,000	$80,000	$124,000	$92,000
Total	**144**	**11,520**	**$2,304,000**	**$484,000**	**$5,760,000**	**$8,548,000**	**$6,244,000**

9.3 Individual site findings

The project team visited the following council managed car parks to assess their potential as a future EV charging location.

9.3.1 Caroline Street South Car Park

Address: 36-28 Caroline Street South Yarra

Figure 38 Caroline Street South Car Park

9.3.1.1 Estimated demand

The Caroline Street South Car Park is located within the Chapel Street Activity Centre - Toorak Road West. This Activity Centre is recommended to have chargers installed by 2025. A total of 4 chargers are estimated to be required. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.1.2 Electricity Capacity

High Voltage substation is located on-site, however, it is relatively old with no indication of its capacity or existing loading. Street lighting is provided from street cable – no metering on site. It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.1.3 Issues

Would need a metered LV supply to the site. Discussion with CitiPower needed regarding cost. Will need to be discussed with CitiPower regarding additional load capacity of HV sub (high cost to upgrade).

9.3.1.4 Other considerations

Due to the proximity of the electrical substation, this site is preferred over Powell Street.

9.3.2 Powell Street Car Park

Address: 57 Powell Street, South Yarra

Figure 39 Powell Street Car Park

9.3.2.1 Estimated demand

Powell Street Car Park is also located within the Chapel Street Activity Centre - Toorak Road West. A total of 4 chargers are recommended be available in this activity centre by 2025. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.2.2 Electricity Capacity

One power supply on same side of road as car park. Suggest siting any EVSEs near that position (yellow circle). It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.2.3 Other considerations

Less well used site: would make a good site for EV charging as less contentious re reserving spaces that may not be used much in the short term. Well positioned for longer time EV charging – close to shopping and public transport (tram and train). Power supplies to both ends of carpark. (blue circles) Fewer apartments close by, but are still within a short walk.

9.3.3 Surrey Road North Car Park

Address: 135 Surrey Road North, South Yarra

Figure 40 Surrey Road North Car Park

9.3.3.1 Estimated demand

This site falls to the east of the Chapel Street AC - Toorak Road Central activity centre. A total of 4 charging ports are recommended by 2025. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.3.2 Electricity Capacity

Power lines are located across the road from the car park (blue circle). See red circle for suggested EVSE parking positions. See yellow circle for suggested EVSE positions. Power supply may be constrained based on a visual analysis of the power lines and the surrounding buildings that draw power from them. Council will need to discuss with CitiPower the cost to install a metered supply of required capacity at this location. It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.3.3 Other considerations

No switchboard in carpark only lighting. Carpark is used by library visitors and slightly less overused than other carparks so a good candidate.

One-way road access. Lots of small lots being supplied by the overhead supply.

9.3.4 Prahran Square Car Park

Address: 30-40 Izett Street, Prahran

Figure 41 Prahran Square Car Park

9.3.4.1 Estimated demand

This car park is located within the Chapel Street Activity Centre - Greville Village and Princes Gardens. We have estimated that 6 50 kW DC charging ports are required by 2026. Two 22kW chargers are already installed in this car park and are well-used. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.4.2 Electricity Capacity

2 x 22kW (3 phase) existing EVSEs on first level near entrance, on separate 40A circuit breakers. Appears to be allowance in DB for a third 22kW charger but it is a 32-amp breaker and would need to be changed to 40-amp. Many 10A outlets scattered around carpark levels (Placed on every second support pillar). Suggest 4 x EVSE positions on lower level next to lower-level DB. (There is a suitable 4 car area). It is recommended that those four positions be 50kW DC chargers, with an estimate cost of $174,000 to $238,000.

9.3.4.3 Other considerations

No obvious provision for conduit from first level DB to an EVSE site for 3rd EVSE (of any type) near the existing 2 x 22kW chargers. This third charger could be load managed at the DB or main board – at more expense though. Lower level 4 spot provision would encourage movement away from main entrance to lower level.

9.3.5 Elizabeth Street Multideck

Address: 9 Elizabeth Street, South Yarra

Figure 42 Elizabeth Street Multideck

9.3.5.1 Estimated demand

This car park is located within the Chapel Street Activity Centre - Jam Factory District and Market District. A total of 6 50 kW DC charging ports are estimated to be required by 2027. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.5.2 Electricity Capacity

Two sub-boards on ground floor: DB1 and DB2. DB1 in far NW corner. DB2 in room next to entrance. (blue dashed line ovals) Many spare circuit breaker slots in both boards. Both boards appear to have enough spare electrical capacity for at least 1 x 32A (7kW) EVSE. DB upgrades are required to install the chargers forecast to be required by 2030. We estimate that it would cost $256,000 to $352,000 to provide six 50 kW DC charging ports at this location.

9.3.5.3 Other considerations

Area beside DB1 would be best area for EVSEs as would encourage use of positions further from entrance/reduce congestion. Suggest eastern wall by DB1 as this area is fully protected from weather. (Northern wall has some rain ingress). It is recommended not to place EVSEs on top (exposed) deck as EVSEs would need higher Ingress Protection ratings and would deteriorate faster due to the weather exposure. Entranceway parking confusingly laid out. Blue dashed lines in the figure above indicate DB locations, with yellow circles indicating potential EVSE locations and red circles the parking bays for EV charging.

9.3.6 King Street Multideck

Figure 43 King Street Multideck

9.3.6.1 Estimated demand

This site is located within the Chapel Street Activity Centre - Greville Village and Princes Gardens. A total of 6 50kW DC charging ports are estimated to be required by 2026. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.6.2 Electricity Capacity

Overall supply is only 100A for this car park. DBs capacity constrained by both 100A overall max/DB breakers on main board (DB1 = 40A, DB2 = 32A, DB3 = 63A, DB4=63A, lift 63A). EVSEs could only go onto level 2 upwards. Street also appears to have supply constraints. We estimate that it would cost $256,000 to $352,000 to provide six 50 kW DC charging ports at this location.

9.3.6.3 Other considerations

Older (tighter) 4 level multideck carpark. Lower levels set aside for specified parking already. Office unattended/fully automated. Main SB in office with DBs on each level. Consolidating all EVSEs to the same location would provide a more legible experience for EV drivers and would maintain low costs as part of any DB upgrade and conduiting to the parking bays.

9.3.7 James Street Reserve

Address: 8 Lincoln Place, Windsor

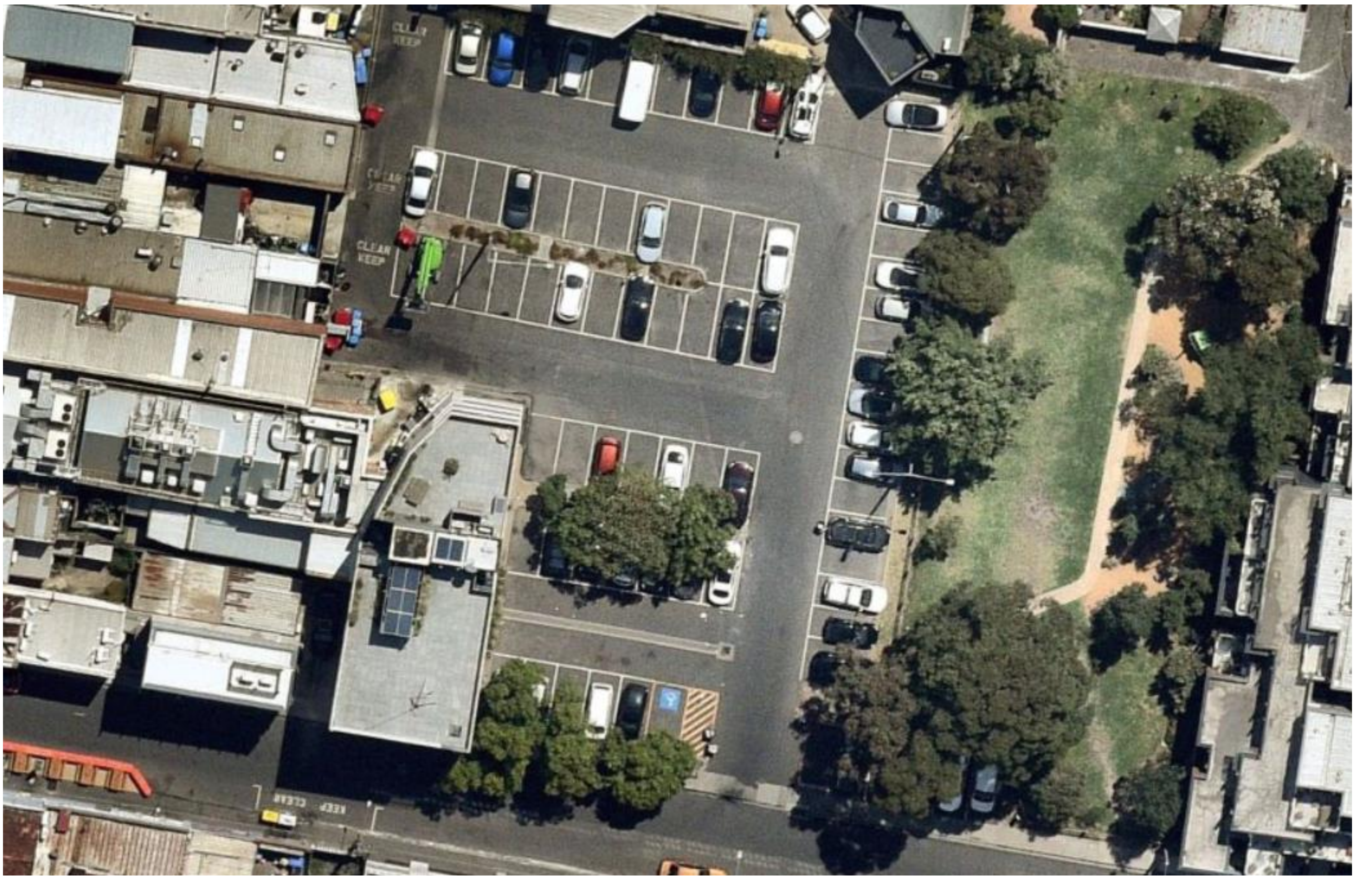


Figure 44 James Street Reserve

9.3.7.1 Estimated demand

James Street Reserve is located within the Chapel Street Activity Centre – Windsor Village. A total of 6 50kW DC charging ports are required by 2030. This site is also likely to provide charging capabilities for the surrounding residents, many of whom do not have access to off-street parking to charge their EV at home.

9.3.7.2 Electricity Capacity

No grid electrical connection to be found. Lighting from street supply only (no meter). Parking counter appears to be supplied from solar, not grid. Front row by street a possible AC EVSE row or single DC position but would need the establishment of a supply. Area likely to be supply constrained: old, thin overhead street cabling. We estimate that it would cost $256,000 to $352,000 to provide six 50 kW DC charging ports at this location.

9.3.7.3 Other considerations

Potentially street adjacent spaces off James St. Has lighting and a carpark space counter so there is likely to be an existing supply. High potential for ICEing: a busy carpark where there could be pushback regarding reserving sites which would in the first instance be little utilised.

9.3.8 Windsor Station Paid

Address: 28 Chapel Street, Windsor

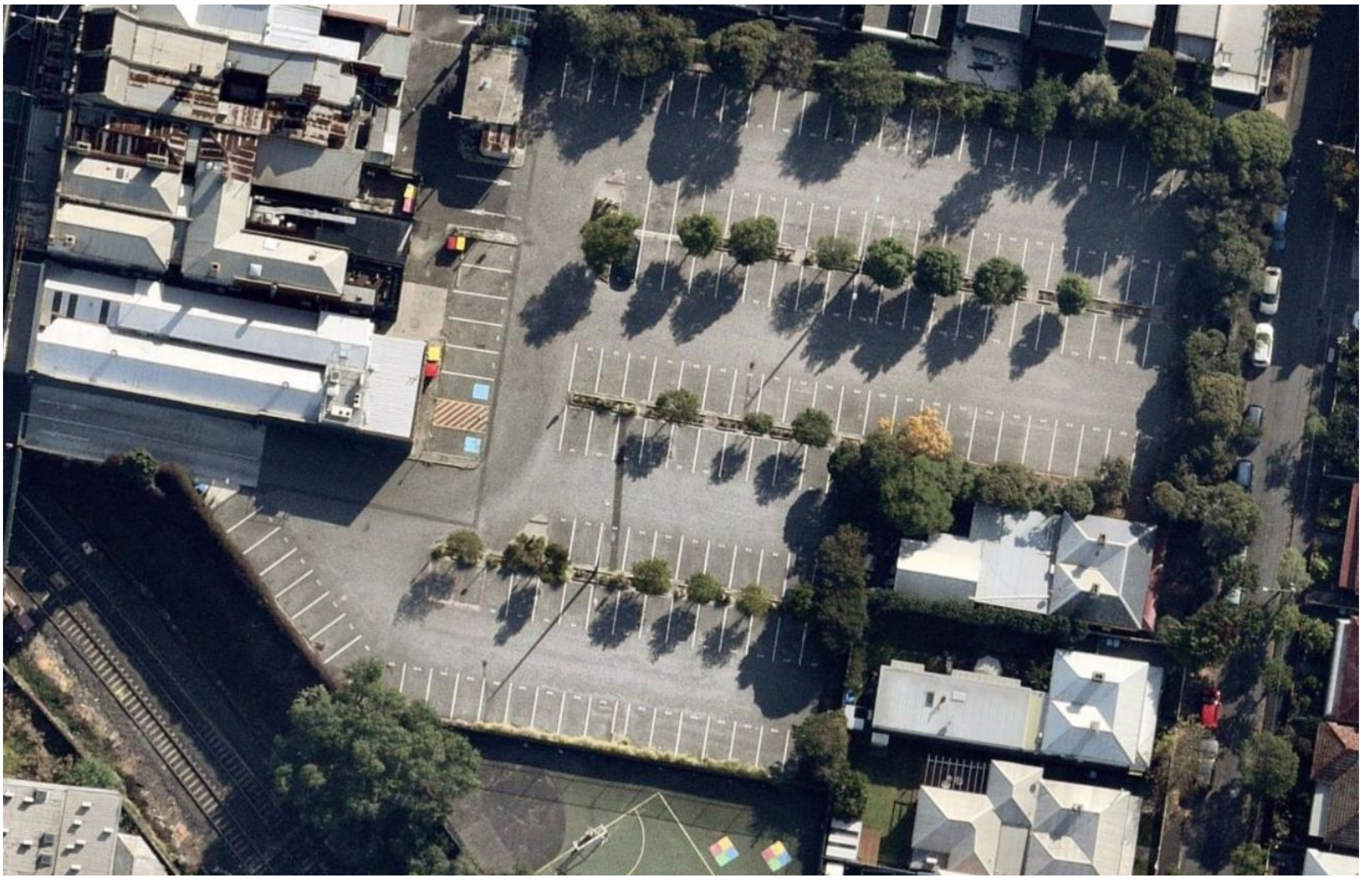


Figure 45 Windsor Station Paid

9.3.8.1 Estimated demand

James Street Reserve is located within the Chapel Street Activity Centre – Windsor Village. A total of 6 charging ports are required by 2030. This site is also likely to provide fast charging for through traffic along Dandenong Road.

9.3.8.2 Electricity Capacity

Has an HV substation and attached LV metered supply room on-site. LV supply room **VERY** dangerous. Appears to have old open electrical busbars, exposed 3 phase knife switches. Too dangerous to enter and test without full arc protection gear and (preferably) HV substation turned off. LV room roof is full of holes (especially over the exposed electrical busbars etc) and water was running over the floor/out the door. No foundations to brick walls of LV switch room. (Appears that car park was lowered at some time, exposing the edges of concrete floor. Soil now washing away from under edges of floor that brick walls rest on). HV substation also appears to be very old/dilapidated. Any changes to the electrical supply here will necessitate rebuild of LV room and likely the HV room as well. We estimate that it would cost $256,000 to $352,000 to provide six 50 kW DC charging ports at this location. Rebuilding the substation is likely to require additional costs but is required in any case to remove the existing dangerous conditions in the substation.

9.3.8.3 Other considerations

There is high potential for fast charging at this location due to its proximity to Chapel Street and Dandenong Road.

9.3.9 Carters Avenue Car Park

Address: 2 Carters Avenue, Toorak

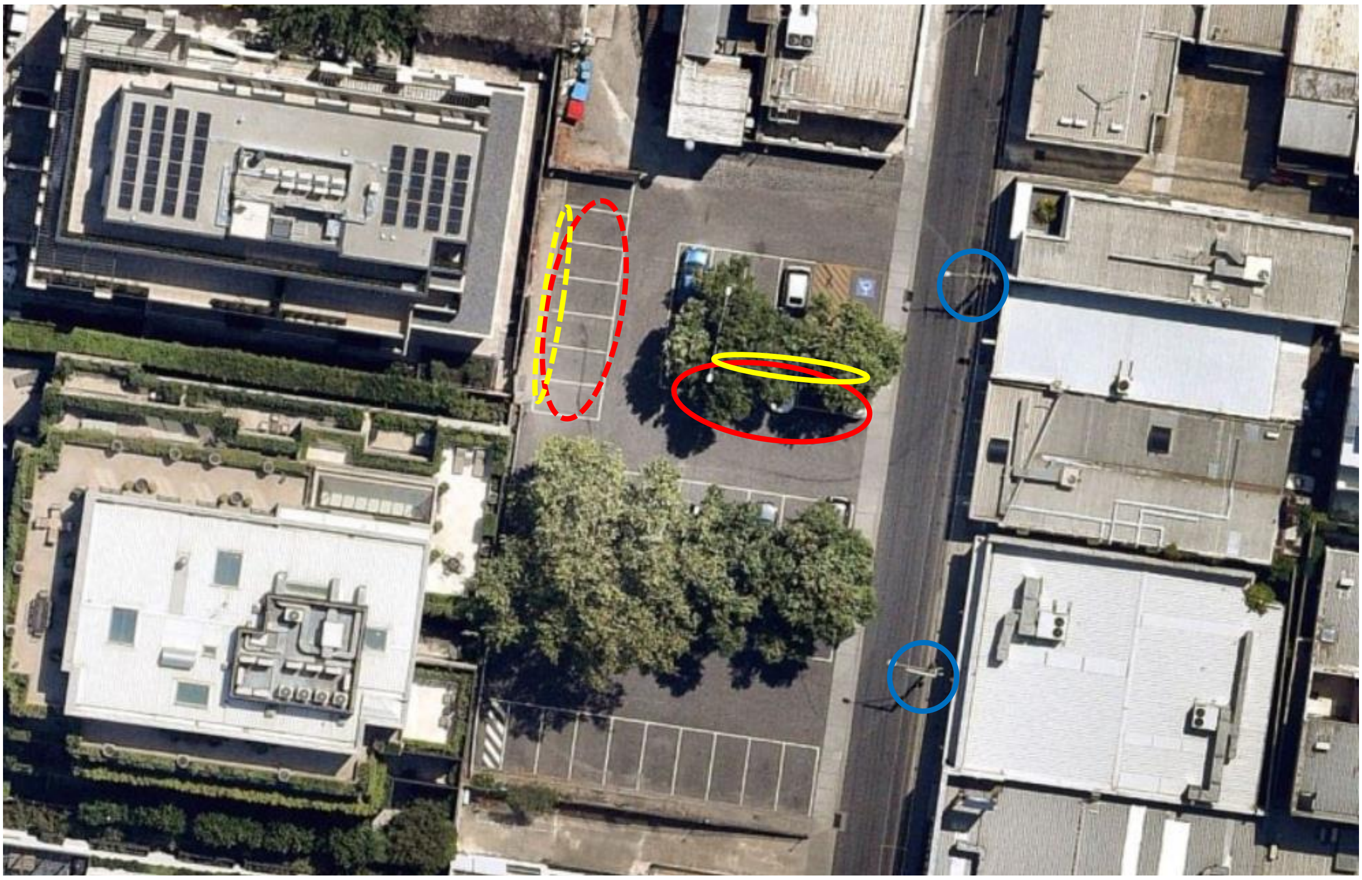


Figure 46 Carters Avenue Car Park

9.3.9.1 Estimated demand

This site is located within the Toorak Village Activity Centre. A total of 4 50 kW DC charging ports are required by 2030.

9.3.9.2 Electricity Capacity

Power supply poles (overhead supply) on opposite side of road. (Blue circles). It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.9.3 Other considerations

AC EVSEs in yellow circled position would need good protection: the poles protecting the trees at this site are heavily damaged. Installing EVSEs in yellow circled position would cause damage to the root systems of the existing trees. Potential for alternative position with less possibility for EVSE damage and no root damage to occur – but would incur additional cost to extend to this position. (red and yellow dashed circles).

9.3.10 Jackson Street Car Park

Address: 18-22 Jackson Street, Toorak

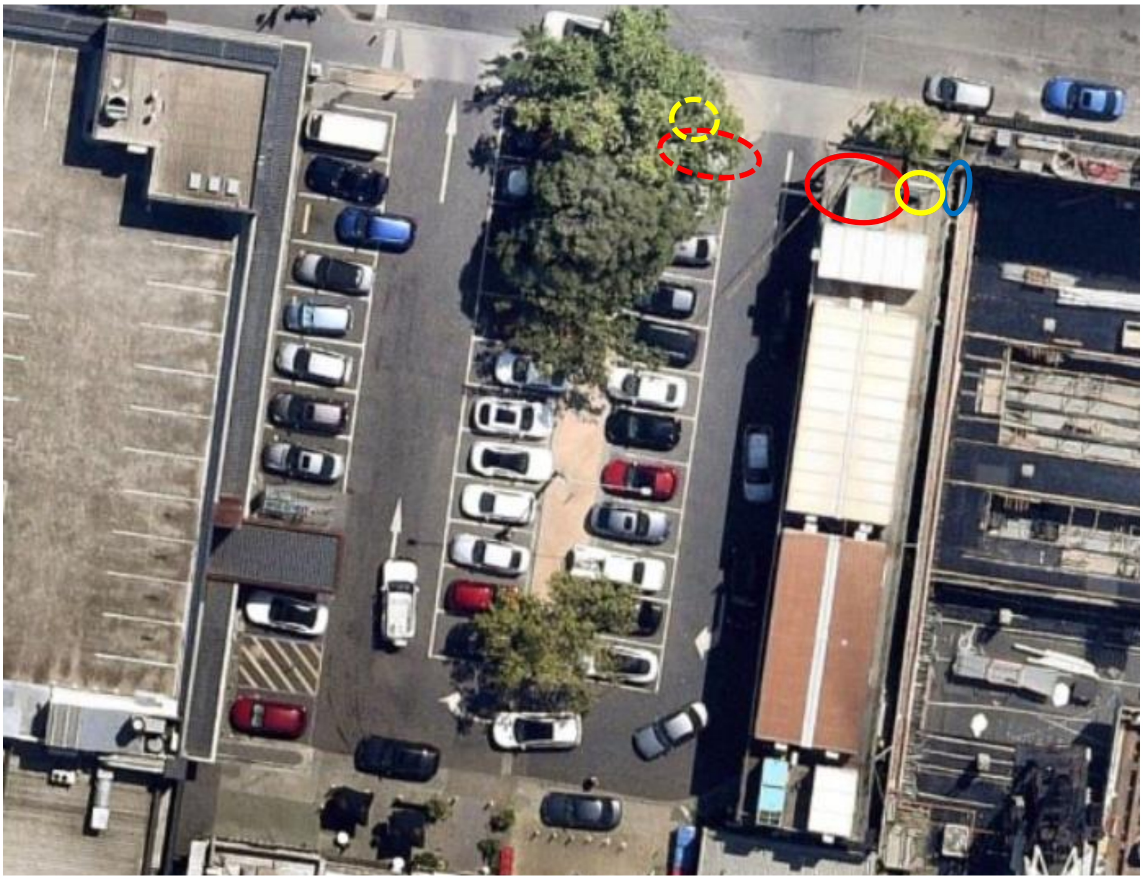


Figure 47 Jackson Street Car Park

9.3.10.1 Estimated demand

This site is located within the Toorak Village Activity Centre. We have estimated that 4 50 kW DC charging ports are required in this area by 2030.

9.3.10.2 Electricity Capacity

Unable to properly access the switch board due to construction works at the adjoining building. A secondary inspection will need to be undertaken once access is returned to the switchboard to investigate what services are drawing on that switchboard. Only minor upgrade works (trenching and conduits) likely required to support a 50kW DC charger at 80A 3 phase if the current supply cables are sized for a 100A service fuse - as stated in the board drawings. To provide for all chargers required, it is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.10.3 Other considerations

High potential for ICEing (deliberately parking an ICE vehicle in an EV charging bay to prevent use) AC EV parking positions. Very busy site – may be push back for taking up multiple positions for AC charging.

9.3.11 May Road Car Park 2

Address: 28 May Road Toorak

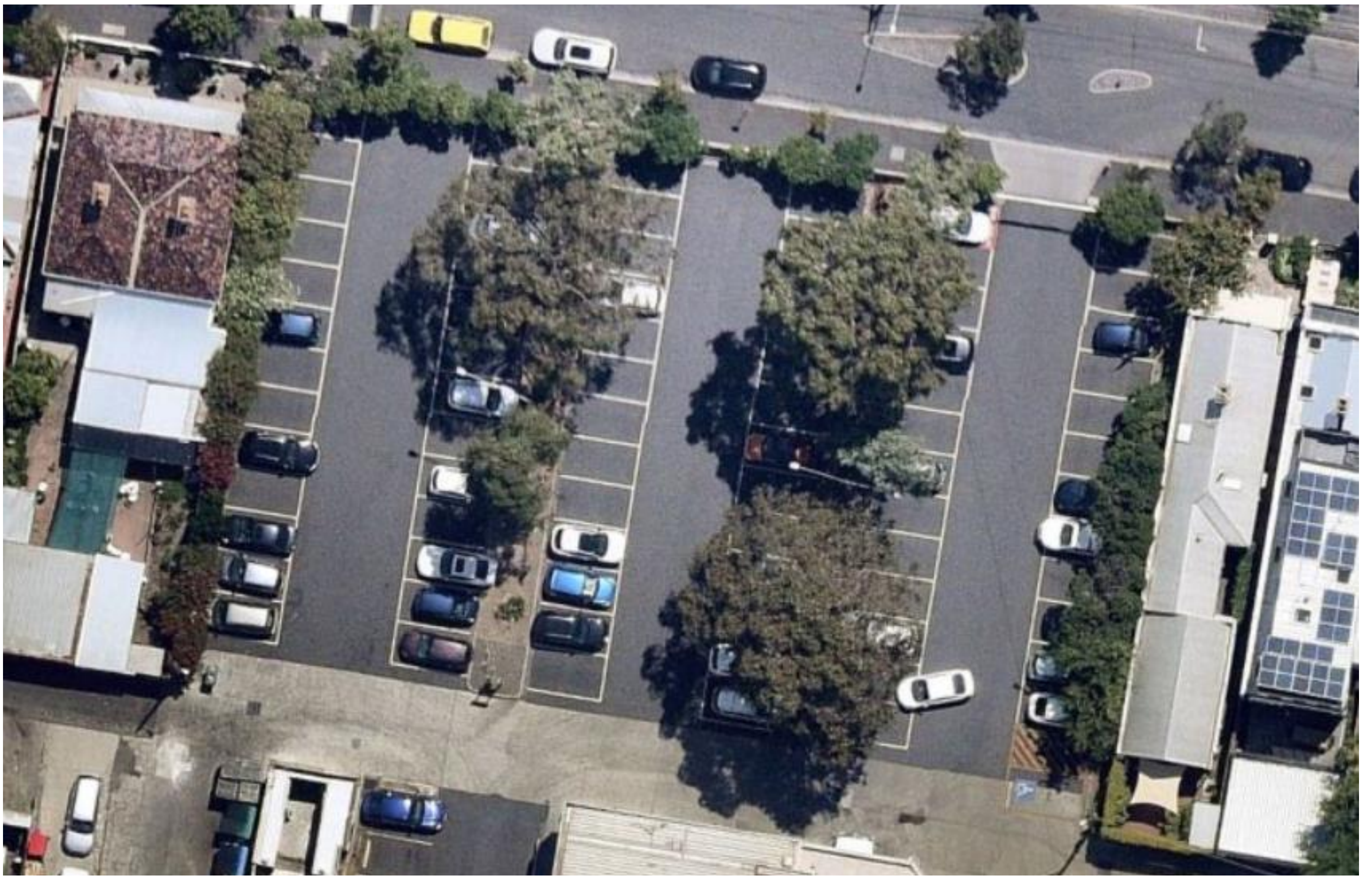


Figure 48 May Road Car Park 2

9.3.11.1 Estimated demand

This car park services the Hawksburn Shopping Centre. We have estimated that 4 50kW DC charging ports are required at this site by 2030.

9.3.11.2 Electricity Capacity

No on-site power supply. Power supply (overhead) is on opposite side of May St to car park. Nearest pole is relatively close to suggested eastern end of the car park site. Not an obvious car park to find and access for people unfamiliar with the area (e.g. PlugShare users). It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.11.3 Other considerations

Nil.

9.3.12 Malvern Town Hall

Address: 290 Glenferrie Road, Malvern

Figure 49 Malvern Town Hall Car Park

9.3.12.1 Estimated demand

This site is located close to the Glenferrie Road Malvern and High Street Armadale Activity Centres. It is also close to Council's offices and a police station. We have estimated that 4 50 kW DC charging ports are required for each activity centre by 2030.

9.3.12.2Electricity Capacity

Site for DC charger (red circle) is very close to power pole (blue circle). It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site. With limited trenching and a high-level assessment that electricity capacity is available, we estimate this site to come in at the lower end of the estimate cost.

9.3.12.3 Other considerations

Very good site for DC charging as it is located close to amenities and shopping. Best spots would be the three spots (red circled) with DC EVSE in middle spot so cars can access it from either side/queue for access next to it. The central disabled spot is a second preference (dashed red circle) with DC EVSE in garden bed at end. (Losing only 1 spot but requiring moving the disabled spot to the other side of the cross-hatched area) – but it would entail greater cost in site works to bring electricity supply to it.

9.3.13 William Street Car Park

Address: William Street, Armadale

Figure 50 William Street Car Park

9.3.13.1 Estimated demand

This car park is located within the High Street, Armadale activity centre. We have estimated that 4 charging ports are required within this activity centre by 2030.

9.3.13.2 Electricity Capacity

No power supplies to either of the council areas. (Stuart St or William St). Stuart St has no lighting, William St lighting fed from street (i.e. no metering). It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.13.3 Other considerations

No easy options. No logical layout (Council owned site preferred for charging in yellow circle) and hard to access the council carpark. Due to the fragmented land ownership of these car parks, Council should consider entering into a consolidation process with the various landowners. This could provide improved quality of the car park, including surface and lighting and EV charging.

9.3.14 Drysdale Street Car Park

Address: 9-15 Drysdale Street, Malvern

Figure 51 Drysdale Street Car Park

9.3.14.1 Estimated demand

This site is located within the Glenferrie Road, Malvern activity centre. We have estimated that 4 50 kW DC charging ports are required in this area by 2030.

9.3.14.2Electricity Capacity

Possibly good supply capacity for reasonable number of 7kW EVSEs or even a 50kW DC. To provide for the four 50kW DC chargers forecast to be needed at this site, it is estimated to cost $174,000 to $238,000.

9.3.14.3Other considerations

Site Switchboard on lower level next to walkway through to shops (dashed yellow circle), attached to southern side of HV substation. Height constrained for access by larger EVs/EV trucks. Possible EV charging bays in red circle.

9.3.15 Central Park

Address: 25 Kingston Street, Malvern East

Figure 52 Central Park

9.3.15.1 Estimated demand

This site is located near the Central Park Village activity centre. It is estimated that 4 charging ports are required by 2030.

9.3.15.2Electricity Capacity

Power supply pole in sizeable dividing strip – ideal for pit, meter board and EVSE. Will need supply authority to agree to supply onto dividing strip. Will need supply authority to agree to supply onto dividing strip. It is estimated to cost $174,000 to $238,000 for four 50kW DC chargers at this site.

9.3.15.3Other considerations

This site has relatively high amenity, with a local park and toilet facilities. A local shopping strip is located at the other end of the park. The park itself is also a popular attraction on the weekend. The street itself has ample on-street parking. The ease of installation and high amenity make this site attractive for EV charging facilities.

9.3.16 Edgar Street No. 2

Address: 19 Edgar Street, Glen Iris

Figure 53 Edgar Street Car Park 2

9.3.16.1 Estimated demand

This site is located adjacent to the Harold Holt Swim Centre. Demand has not been assessed for this site as it sits outside of an activity centre.

9.3.16.2Electricity Capacity

Unable to access switchboard as site is still being constructed and yet to be handed over to council. The DNSP may require separate supply if car park is a separate lot. In that case – dashed coloured circled positions apply.

9.3.16.3Other considerations

Most housing in this area has off-street parking, but there are a number of blocks of older flats nearby that could perhaps justify one. If separate supply required, then could look at a 50kW DC charger. Should EV charging at this site be desired, then an analysis of the average length of stay at the swim centre should be undertaken. Charging speeds should provide a meaningful charge (50% or more) within the average duration of stay. On the initial assessment, while demand may not be high for this location, installation appears to be relatively straightforward compared to other locations visited. For instance, two 50kW DC chargers would cost $92,000 to $124,000 at this location.

9.3.17 T H King (Glen Iris Wetlands)

Address: 1650 High Street, Glen Iris

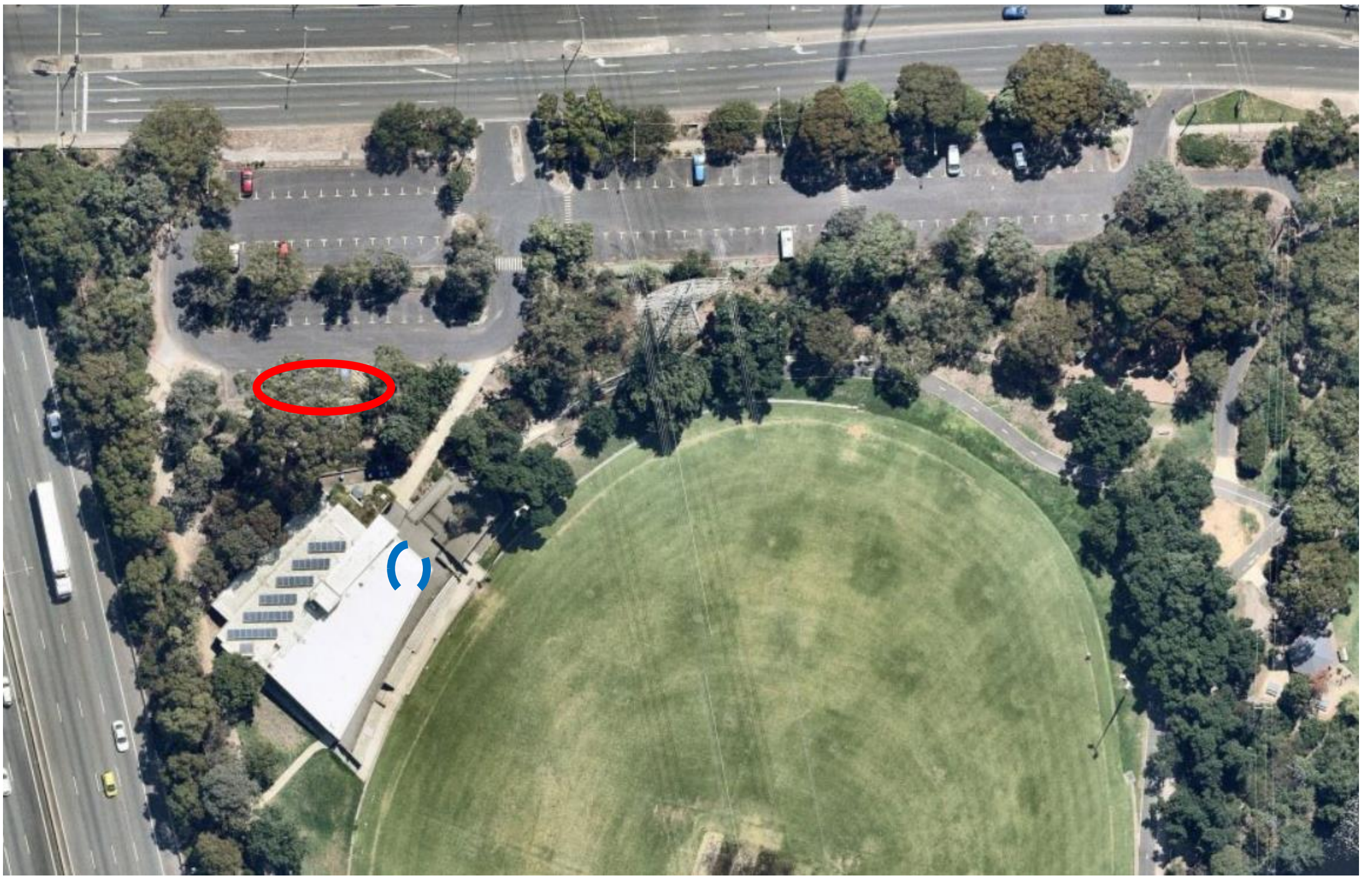


Figure 54 T H King Car Park

9.3.17.1 Estimated demand

This site is located adjacent to the T H King Oval and Glen Iris Wetlands. Demand has not been assessed for this site as it sits outside of an activity centre.

9.3.17.2 Electricity Capacity

Small main SB capacity (125A) given likely load of building when in use (especially at night with oval lighting on). Minimal room in SB for additional breakers. Long and potentially difficult trenching and conduits required to supply even nearest potential EVSE spot. Tiny solar system – no real potential for additional capacity for 'green' powered EVSEs here. For instance, two 50kW DC chargers would cost $92,000 to $124,000 at this location but with the extra civil works required, this site would be at the high end of the estimate range.

9.3.17.3 Other considerations

Just off Monash Freeway but cannot access outbound from Melbourne back onto freeway at this point. Some EV drivers may be uncomfortable in this car park as it is very isolated and out of sight from main road.

9.3.18 Malvern Valley Golf Course

Address: 1-3 Golfers Drive, Malvern East

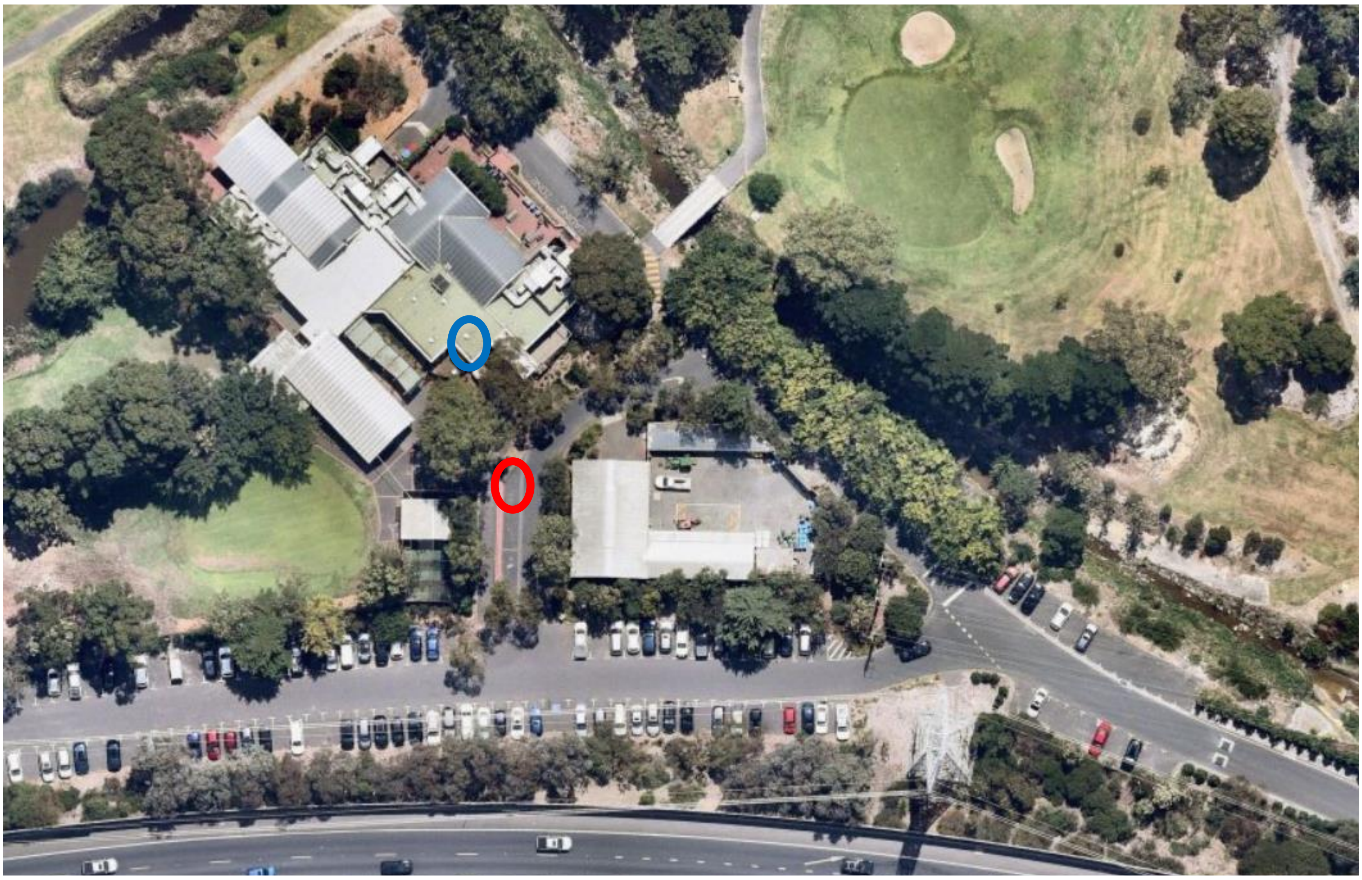


Figure 55 Malvern Valley Golf Course

9.3.18.1 Estimated demand

This site is located adjacent to the Malvern Valley Golf Course. Demand has not been assessed for this site as it sits outside of an activity centre.

9.3.18.2 Electricity Capacity

No easy access from switchboard to any potential EVSE positions. No room in the switchboard. No capacity likely from supply to service more than one or two 7kW chargers (at most). Supply to anything beyond 1 x 15A outlet is likely to be constrained without a major upgrade.

9.3.18.3 Other considerations

EV chargers won't provide amenity to others beyond users of the golf course, limiting the overall potential for the chargers. Given length of a golf game: a single 15A outlet to the nearest parallel park position to the Pro Shop would probably suffice if demand was demonstrated.

9.3.19 Phoenix Park Library

Address: 30-36 Rob Roy Road, Malvern East

Figure 56 Phoenix Park Library

9.3.19.1 Estimated demand

This site is located adjacent to the Phoenix Park, Library, and Primary School. Demand has not been assessed for this site as it sits outside of an activity centre.

9.3.19.2Electricity Capacity

Main SB well loaded. Main SB and DBs all at maximum with few to no spare slots for additional breakers. Will need major SB and supply upgrades to install any EVSEs here. Would be costly to trench across concrete path and road surface to install cabling to any EVSEs. Would need major supply upgrade to install DC, estimated at up to $124,000 for 2 50kW DC chargers.

9.3.19.3 Other considerations

Least congested is strip carpark on Rob Roy Rd. (red circled EVSE positions shown). Bigger carpark to south is heavily congested at school drop-off/pick-up times

10. Appendix 1 EV Charging Case Studies

This section provides a series of case studies on EV charging, from other local government areas, in Australia and abroad.

Councils and other agencies are beginning to recognise the need to provide publicly available charging infrastructure. While some 95-98% of charging is typically done at the vehicle owner's home or workplace, there will be situations in which publicly available chargers will be required. This includes people away from their home charger and those without the capacity to park their car off street. This section focuses on what other councils are doing to help overcome the barrier to EV ownership caused by a lack of charging infrastructure.

A number of countries have begun developing charging networks at the national level, with a host of smaller, city scale programs having been implemented over recent years. The International Energy Agency have identified that while the very early adopters of EVs generally have their own private parking bay (off street parking), as the market broadens, there will be an increasing need to supply publicly available charging locations (International Energy Agency 2018). This view was confirmed in stakeholder consultation conducted as part of this project with the EV charging industry.

10.1 London boroughs

Transport for London require that 20% of all parking places in new developments must include an EV charging point. Importantly, EVs are viewed through the lens of London's aspiration for a lower level of car use, and their Transport Strategy includes restrictions in the development of new car parks.

In London, Local Authorities (LAs) are essential to the development of EV charging infrastructure, as they are most commonly the responsible authority managing on-street car parking (as is the case in Australia). London Boroughs have benefited from Central Government funds such as the *Go Ultra Low Cities Scheme* which provides information to assist people shift towards low emissions transport.

Electric vehicles are also exempt from the London *Congestion Charge*, which is currently $A28.17 per day.

A zoomed in map of London charging locations is shown in Figure 57. There are many fast chargers in central London, usually in larger, off-street car parks.

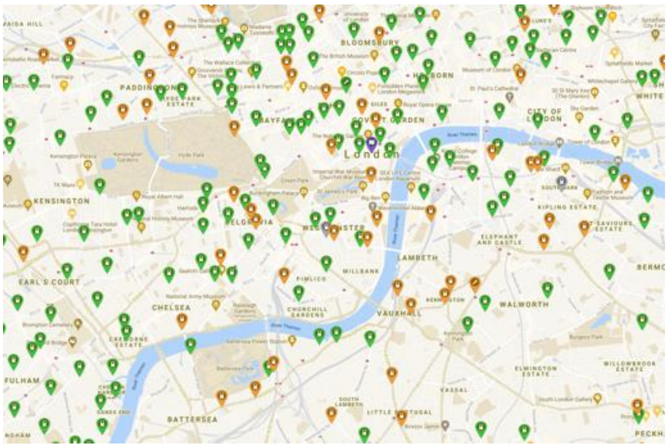


Figure 57 EV charging locations, inner London
Source: Plugshare

One of the many kerbside EV charging bays located in London is shown in Figure 58.

Figure 58 Kerbside EV charging, London
Source: Plugshare

The regulation of time limits and fees is somewhat more complicated for EVs than for ICE vehicles, because EVs consume both *space* and *energy* and it is important to apply a price to both. Figure 59 illustrates how Southwick Council in London communicates its regulation of EV charging. As with all policies, it must strike a balance between something that is both *fair* and *easily comprehensible.*

The regulation of time limits and fees is somewhat more complicated for EVs than for ICE vehicles, because EVs consume both *space* and *energy* and it is important to apply a price to both.

Figure 59 Regulating the use of kerbside EV charging in central London

Source: Plugshare

As the public charging network develops, applications for on-street charger permits have naturally become harder to obtain. This has resulted in greater development in the commercial marketplace, with more commercial services being offered to help communities build their own charging infrastructure. Supported by the On-Street Residential Charging Scheme, residents can gain help to analyse proposed locations, and gain finance to build chargers in their neighbourhood. Another commercial service that has been offered is mobile charging whereby a power van (i.e. Charge Fairy) delivers a charge to the customer's car. Residents with a driveway and charger are also providing an Airbnb type rental for EV-charging.

10.1.1.1 Hackney Council, London

The previous *Air Quality Action Plan* that ran between 2015-2019, has successfully implemented emissions-based parking across the majority of Hackney, and transitioned 12.3% of the council's total fleet to EVs. With Hackney declaring a Climate Emergency in 2019, the management of air quality issues will be in the updated *Air Quality Action Plan* 2020-2025. Hackney Council has adopted the following key priorities adopted to support the use of EVs:

- Assess potential impact of installing Ultra-Low Emission Vehicle (ULEV) infrastructure (e.g. EV charging points, rapid EV charging points)
- Increase uptake of EVs and ensure charging infrastructure is commensurate with growth in the Borough's Fleet.
- Assess the air quality benefits of the actions in *Rebuilding a Greener Hackney: Emergency Transport Plan*, the *Transport Strategy 2015 - 2025* and the *Local Implementation Plan 2019 – 2022*.

Due to the improvements in vehicle emission standards and the uptake of EVs, the Ultra-Low Emission Zone (ULEZ) will be expanded to encompass the whole of Hackney borough from October 2021. The ULEZ is implemented by Transport for London and is in operation at all times with the only exception of Christmas Day. £12.50 is charged daily for vehicles that do not meet ULEZ emission standards when they enter the zone.

Hackney is currently in partnership with the surrounding London Boroughs to expand the EV charging network on local residential streets.

Hackney has worked with external stakeholders to create a borough-wide network called *Source London*. For residential houses, it aims to provide a fast EV charge point no more than 500m from the residents' address.

There are currently 64 lamp column chargers, 22 free standing fast chargers and 11 free standing rapid charge points located in Hackney with a total of 296 chargers expected to be installed by the end of 2021[16].

[16] https://news.hackney.gov.uk/3000-electric-vehicle-chargers-in-hackney-by-2030/

Hackney Ultra Low Emission Vehicle (ULEV) Streets

Hackney City Council have launched two zones in the City Fringe that, during peak hours, will be restricted to walking, cycling, and low emissions vehicles only (vehicles that emit less than 75g/km of CO2). Petrol, diesel, and older hybrid vehicles will not be permitted on the streets during these hours.

ULEV streets will be in operation Monday to Friday, 7-10 am and 4-7 pm. Petrol, diesel, or older hybrid vehicles which aren't registered for an exemption aren't permitted to enter the streets during the operating times. These vehicles will be identified by camera and issued with a penalty charge notice.

Box 9 Ultra low emission zones

Source: https://hackney.gov.uk/ulev-streets

Source London is one of the EV providers in Hackney. They charge a flat fee for annual membership and offer a Pay-As-You-Go option.

It is envisaged that, in the long-term, Hackney aims to charge for parking in all EV charging points during Controlled Parking Zone (CPZ) hours, to discourage local car journeys.

Hackney was the first borough to install publicly accessible on-street rapid EV charging points for residents. Hackney currently have three 50kW rapid EV chargers. The following charges apply:

- Initial registration fee: £20, thereafter £20 annually
- Connection fee per charging session: £1.80 incl. VAT
- Usage fee: £0.30p incl. VAT per kilowatt-hour.

Residents and local businesses who own an EV will require a parking permit to park in their home zone area. The cost of a permit with no local emissions is £10 for 12 months, compared to £214 for vehicles emitting 226gCO_2/km or above.

In terms of improving the emissions performance of Hackney's organisational fleet, the Council was awarded £380,000 from the Mayor of London's Air Quality Fund (MAQF) to assist with the greening of the fleet. To support this, Hackney Council (2015) will:

- Undertake a review of the potential and cost-effectiveness of equipping Hackney with one of the lowest emission Council fleets in London
- Identify realistic targets to reduce the size of the Council's fleet and increase the proportion of cycle freight, electric vehicles, and hybrid vehicles for the vehicles with highest utilisation
- Review the use of parking permits for private vehicles and essential car usage across the Council
- Ensure there is sufficient provision to charge EVs at all Council buildings and key destinations
- Explore opportunities to pilot and introduce hydrogen-powered vehicles into the fleet
- Continue the progress of the Council's *Workplace Travel Plan* and increase sustainable travel options for staff e.g., through a bike hire scheme.

10.1.1.2 London Borough of Hounslow

Much of the housing stock in Hounslow, London lacks off-street parking. In order to overcome the barrier that this might present would-be owners of EVs, the Borough of Hounslow began a trial of retrofitting EV charge points on lamp posts. An excerpt from Hounslow's communication to residents regarding EV charging is shown below.

Charging points for residents without off-street parking

Hounslow are committed to providing EV charge points for residents who own an EV or are considering buying one but do not have off-street parking available. As the majority of electric / hybrid owners usually charge their cars overnight on a driveway, the Borough recognise that residents without off-street parking might be put-off purchasing an electric or hybrid vehicle because they do not have access to nearby charge points.

Eligibility requirements

In order to be eligible for the scheme residents need to:

- demonstrate they already own an EV or plug in hybrid or have committed to purchasing one
- have no off-street parking on their property

Applicants make a financial contribution of £500 towards the cost of the charge cable.

Box 10 EV Charging for residents without off-street parking

Source: London Borough of Hounslow. See https://www.hounslow.gov.uk/xfp/form/331

Hounslow have partnered up with Shell subsidiary *Ubitricity* to install streetlamps with energy efficient LEDs (see Figure 60). While this firm does not currently operate in Australia, it is investigating options for establishing a presence in Australian cities.

Fees for the energy used is determined by the supplier and the amount consumed and is billed to the user of the smart cable.

As of 2020, EV charge points outnumber petrol stations in Hounslow two to one.

Figure 60 Lamp post charging, London

Source: https://www.ubitricity.co.uk

10.1.1.3 Westminster City Council, London

In Westminster there are over 1000 on-street 3kw or 7kw charging points. There are dedicated charging bays where you can charge for up to 4 hours from 8.30am to 6.30pm every day, as well as points fitted into lamp posts, alongside existing resident or pay-to-park bays. Figure 61 provides an indication of the different charging opportunities in Westminster.

In terms of the operators of the charging points, this is done by a number of third-party providers, including *Source London*, *Chargemaster*, *PodPoint, ESB (for taxis only)* and *Ubitricity*.

In an initiative launched in May 2021, Westminster City Council and Ubitricity partnered to repurpose EV charging bollards into a power supply for market stallholders at Tachbrook Street Market[17]. Such evolving technology demonstrates the possibilities for EV charging infrastructure to be multifunctional.

[17] https://www.ubitricity.com/westminster-installs-ubitricity-charge-points-to-solve-power-supply-for-street-markets/

Overall, London has benefitted from a range of factors that work to encourage the use of EVs over ICE vehicles: The *Congestion Charge* helps to improve the cost competitiveness of EVs over ICE vehicles; the ULEZ enhances the accessibility of EVs over ICE vehicles; and, the proliferation of publicly available charging locations gives drivers the confidence they need regarding battery recharge. Finally, the progress London has made regarding EVs could not have come about without strong leadership and funding availability and policy support from Transport for London.

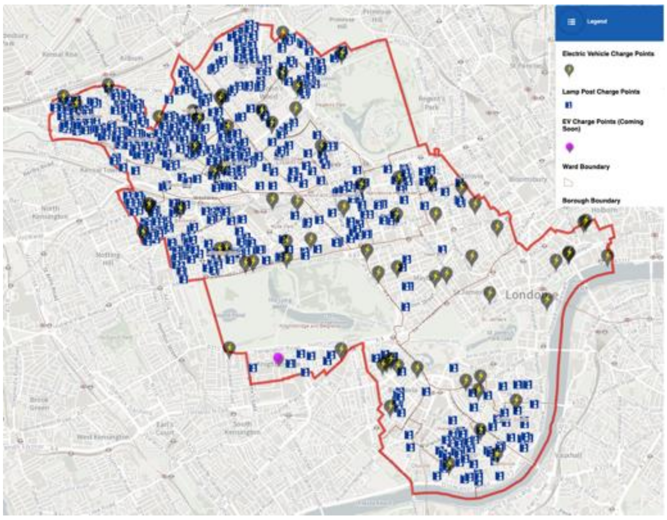


Figure 61 Westminster EV charging

Source: https://tinyurl.com/36cp9ta8

10.2 Norway

It is well recognised that Norway leads the world on EV policy. It has the highest take up of EVs. In November 2021, sales data shows that 73.8% of all new vehicles sold were EVs[18]. The Norwegian government has set a goal for all cars sold by 2025 to be zero-emission vehicles and have implemented the following policies to encourage the take up of EVs (Lorentzen 2017, Norsk ElbilForening 2020):

- No purchase/import tax (1990)
- Exemption from 25% VAT on purchase (2001)
- Low annual road tax (1996), road tax was replaced by motor insurance tax in 2018
- No motor insurance tax (2018)
- No charges on toll roads or ferries (1997/2009 - 2017)
- '50% rule' so fee for ferries, tolls and public parking is 50% cheaper for EVs compared to ICE vehicles
- Free municipal parking (1999-2019)
- Access to bus lanes (2005), amended to only allow EVs carrying two or more people on specific corridors during peak periods (2017)
- 50% reduced company car tax (2000)
- Exemption from 25% VAT on leasing (2015).

Data from the Norwegian EV consumer survey shows that almost all charging is done at home and fast chargers are only used 13 – 16 times per year, on average (Institute for Transport Economics 2016).

The Norwegian Centre for Transport Research also notes that Norway has some suitable characteristics for EVs, including:

- Clean, low cost electricity – 98% hydroelectric
- High taxes on vehicles and fuels since the 1960s
- No vehicle manufacturers
- >75% can park on own property
- Strong electrical grids, as electricity is used for heating.

10.2.1.1 Pricing comparison

Three models of a popular car (VW Golf) are presented in Figure 62 to demonstrate the impact of the various financial incentives in place in Norway. This demonstrates that when taxes are applied to the ICE models, the EV becomes the cheapest of the three options.

[18] https://ofv.no/bilsalget/bilsalget-i-november-2021

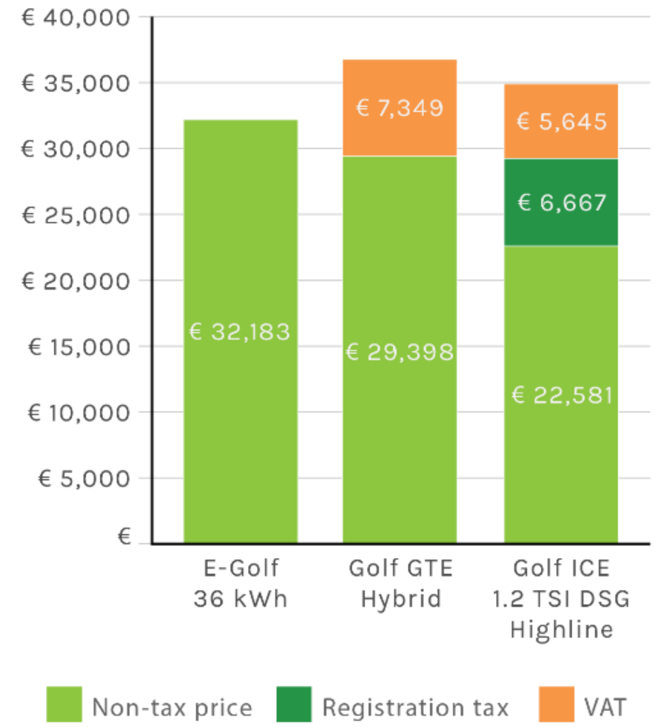


Figure 62 Golf price comparison, Norway

Source: Beate Inger Hovi, Norwegian Centre for Transport Research

The financial benefits for EVs is amplified when considering the annual cost of ownership of an EV, compared to an equivalent model ICE car, as demonstrated in Figure 63.

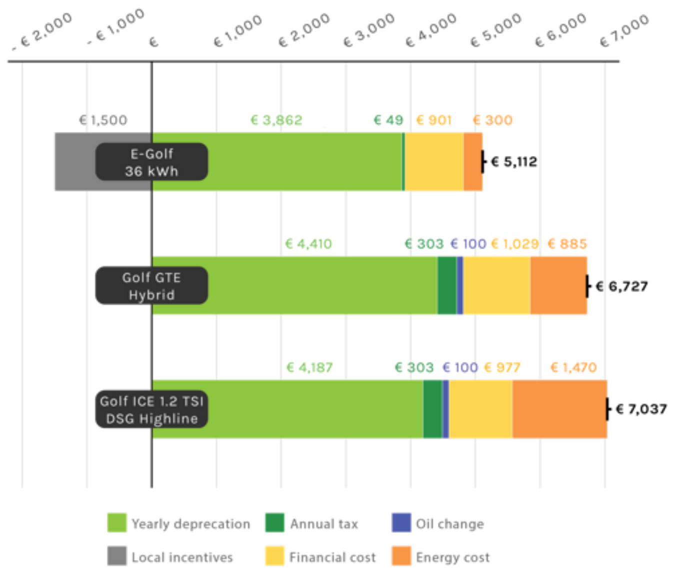


Figure 63 Annual cost of ownership, Norway

Source: Beate Inger Hovi, Norwegian Centre for Transport Research

The local incentives shown in Figure 63 above include access to bus lanes, reduced ferry rates, free parking, and free toll roads. As adoption of EVs in Norway continues to increase, it is expected that many of these local incentives will be reduced, and some already have been.

A national fast charge support program which has been in operation since 2011 provides two 50kW chargers per 50km on all main roads. Municipalities/provinces offer regional support for charging.

The widespread take up of EVs has led the private sector to begin offering a large EV fast charging network. For instance, the convenience store chain *CircleK* now provide a network of EV chargers, including 350kW ultra-fast chargers at its chain of convenience stores linked to petrol stations and motorways. One of the learning experiences has been to avoid placing only one or two chargers in isolation, for public, mid-point chargers. These chargers are avoided by customers as it is seen as a risk to drive to one that is occupied. CircleK now only provides banks of at least six chargers. In 2020, there were almost 17,000 charging stations in the country, with over 3,300 of those being fast chargers[19].

In terms of the different types of chargers available in Norway (and other European countries), Table 22 provides a summary of the type, the time it takes to charge and the costs of the charger itself. As highlighted in other areas of this report, the faster the charge rate, the higher the capital costs for installation.

Table 22 Charging types in Norway

TYPE	POWER OUTPUT	KILOMETRES PER 10 MINUTES OF CHARGE	TYPICAL LOCATIONS	COST FOR A SINGLE CHARGING POINT*
AC Mode 2 Home	up to 11kW	1-2	Home	< Euro (EUR) 800
AC Mode 2 Commercial	up to 19.4kW	3.2	Private, Workplace, and Public	<EUR 2,000
AC Mode 3 Fast Charging	22kW or 43kW	21	Public, Private	EUR 1,000-4,000
DC fast charging (standard)	20-50kW	64	Public, Private	EUR 20,000
DC high power fast charging	100-400kW	90	Public	EUR 40,000-60,000

[19] https://www.visitnorway.com/plan-your-trip/getting-around/by-car/electric-cars/

Source: Spöttle et al (2018)

*Note: this is only the purchase cost of the charger itself, not the installation, grid connection or operational costs.

In terms of the location of fast charges, the overwhelming majority are located on major transport corridors. Figure 64 shows one new ultra-fast charging station launched by *CircleK* off a motorway.

Figure 64 350kW ultra fast charger, Norway

Source: CircleK

10.2.1.2 Charging initiatives in Oslo

Oslo is at the centre of Norway's transition towards EVs. As indicated earlier, there are a range of incentives designed to encourage residents to adopt EVs, and charging is one of them. According to the Vice Mayor for Environment and Transport in Oslo, Lan Marie Nguyen Berg, there was initially a ratio of one charger for every four EVs. Due to the increased take up of EVs, there is now one charger for every 10 EVs. To respond to this imbalance, Oslo is ramping up the provision of EV charging infrastructure.

The City of Oslo through the Agency for Urban Environment allocated €540,000 per year for four years to establish 400 chargers in 2008-11 (URBACT 2015). Oslo determined that a lack of charging infrastructure is a major barrier for increasing EVs.

Oslo currently has over 1,300 charging points with a goal of increasing this by 600 chargers per year between 2018 and 2021. The city will install at least 400 new semi-fast chargers, 200 regular chargers, and 6 fast chargers in addition to subsidising 8,000 charging points in apartment buildings due to a high public demand (Nguyen Berg 2018).

The following process was used to determine where these charges will be installed:

1. Collaboration with the EV Association of Norway.
2. Oslo residents were surveyed via local paper receiving feedback from both current EV owners and potential customers.
3. Field research to note and map where EVs were currently parked and if they had charging opportunities.
4. Determine where established sources of electricity exist.

Oslo also created a subsidy program for apartments, stores, private companies, and shopping malls in the event the city could not act due to site jurisdiction. The subsidies could be up to €1200 per charging point to cover the purchase and installation cost of a charging point (URBACT 2015). This allowed for 350 additional charging points to be implemented from 2008-2015.

As of March 2019, fees have been introduced in public stations to improve turnover of spaces. The fee is based on *time spent charging*, not *kWh usage*. The question of whether to charge based on time spent in space or electricity consumption is a common issue for cities installing publicly accessible EV charging. In 2020, a hike in fees announced by European electric fast charging network Ionity[20], drew a backlash from the Norwegian EV association. The previously fixed rate of A$12.90 was replaced by a price-per-kWh rate of A$1.37/kWh. The new pricing structure favoured subscription services to the different car manufacturers for a discounted rate[21].

[20] https://ionity.eu/_Resources/Persistent/a/7/c/7/a7c7ce ce094e15da7bfc2864a74e62b51c8d829a/_20200116_IONITY_PRICING_EN_.pdf

[21] https://thedriven.io/2020/01/20/norway-horrified-as-new-rates-make-ev-charging-prices-higher-than-petrol/

The cost of using EV chargers: Applying fees for time, energy consumption or both?

One consideration for Stonnington relates to what is more valuable; *space* or *electricity*? Not all EVs can accept kwh at the same rate, and therefore a time-based charge may favour high end vehicles. For fast chargers, it is appropriate to charge for both *space* and *electricity* usage. A time charge pays for the equipment, and an energy fee pays for the electricity used.

For chargers delivering 7kW or less, the cost of electricity dominates and the cost of the charger is negligible. However, a time charge encourages turnover, and can be set at a level that recovers energy cost too, as charge rates do not vary as much between vehicles. Ideally, both time charge and energy charge should vary over the day to reflect relative demand and costs, as per the Oslo time example below.

Depending on location, the fees for charging at Oslo municipality owned chargers are A$2.33 or $1.55 per hour from 9am to 8pm and for the rest of the day it is A$0.82 per hour. Fees have been kept low because a majority of EV users charge at home or at work, whereas public charging stations are typically used for short charges. In 2017, one critique regarding the payment came from the EV Association, which advocated for fees based on kWh and not time because fast chargers consume more power. Nonetheless they support fees to encourage commercial development of charging stations and believe the city needs to radically increase the number of charging stations since there is currently only one public charger for every ten EVs (not counting home chargers).

Since 2015, the Norwegian EV Association has provided a universal charging tag to all their members. This tag can be registered with many of the charging operators for easier access and payments. According to an 2017 member survey, the tag is the most important service provided by the association (Lorentzen 2017).

10.2.1.3 Taxis

Taxis typically drive between 10 and 25 times more than the typical private car (Davies and Fishman 2018). As such, the City of Oslo has partnered with the taxi industry via the creation of moderate and fast charging stations that are dedicated to taxis. Other examples of private enterprise participating in EV charging projects include a real estate firm (Aspelin Ramm), creating a parking garage with 102 charging points where parking is free for EVs in the evening and overnight. Two chargers are DC fast chargers and the remaining are AC slow chargers.

10.2.1.4 City of Oslo – organisational fleet

As Stonnington have a strong ambition to lower transport emissions, it is useful to explore what the City of Oslo has done to help its transition to EVs within its organisational fleet. Oslo's current goal is to reduce by 95% the city's emissions by 2030, from 2009 levels. To help achieve this, Oslo conducted a purchasing agreement of 1,000 EVs. The program costs €6.2 million and provides interest-free loans to its various agencies to make the switch.

What Oslo, and Norway generally, have been able to demonstrate is that with a range of financial and convenience incentives in place, people are willing to make the transition to EVs.

What Oslo, and Norway generally, have been able to demonstrate is that with a range of financial and convenience incentives in place, people are willing to make the transition to EVs. By providing access to bus lanes and high occupancy vehicle lanes, free access to toll roads, lower cost parking and purpose price incentives, people choose EVs. The fact that EVs now outstrip ICE vehicles in Norway is proof that that given the right mix of carrots (for EVs) and sticks, such as high cost of petrol (for ICE vehicles), EVs have become a compelling value proposition.

10.3 Vancouver, Canada

The City of Vancouver has committed to encourage a shift in the fleet mix in favour of EVs. The framework used to guide Vancouver's EV-related initiatives is captured in the *EV Ecosystem Strategy* (City of Vancouver 2016). There are three primary goals of the Strategy:

1. *Accessibility*: Improve access to charging infrastructure.
2. *Affordability*: Reduce the barrier presented by upfront cost.
3. *Economic opportunity*: Develop a market large enough to support the private sector to operate charging infrastructure.

While Vancouver may use different terminology, a similar spectrum of strategic approaches were applied in Norway.

The *EV Ecosystem Strategy* takes place over five years and has been allocated $3M to cover:

- $2M for fast charging infrastructure
- $500,000 for Level 2 expansion in recreation centres or parks
- $500,000 for a multi-family building/workplace retrofit program.

The City of Vancouver (City of Vancouver 2018) ran a *Curbside [sic] Electric Vehicle Pilot Program* which residential and non-residential property owners can participate. Only 15 stations were budgeted for in the pilot program. One of the conditions of participation was that the applicant could not have access to an off-street parking location. Pilot project users were prohibited from the resale of electricity and from charging a fee. An additional five stations were included under the pilot project for non-residential applicants, at kerbside locations (City of Vancouver 2018). The pilot program was concluded in 2019, and in 2020, the *Climate Emergency Action Plan* was adopted with a goal to cut carbon emissions in half by 2030. A target of 50% of the km driven on Vancouver's roads to be by zero emission vehicles, aligns the action plan of the *EV Ecosystem Strategy*. The action plan included developing the private and public charging networks (City of Vancouver 2020). A schematic of the action plan is shown in Figure 65.

Figure 65 How We Move from the City of Vancouver Climate Emergency Action Plan
Source: City of Vancouver Climate Emergency Action Plan Summary

10.3.1 Fees

Vancouver chose to implement a fee structure intended to offer a user-friendly experience for payment and is cost competitive with the fuel costs of an ICE vehicle. Fees were introduced in November 2018 for nine charging stations that needed greater turnover (City of Vancouver 2018). Fees were based on a duration model and not per kW usage. Fees were in effect from 9am to 6pm and evening or overnight rates were free. Fees start at $2-per hour for Level 2 chargers, and $0.26 per minute for a DC fast charger (City of Vancouver n.d.), with highest rates in areas with stronger demand and more expensive general parking. The cost of charging an EV in these areas reflects the higher value space.

10.3.2 Private sector involvement

Vancouver envisions the private sector taking a greater role in investment and operating charging infrastructure in the medium term (2 – 5 years). As previously mentioned, Vancouver supports this market change through building regulation changes and mandating EV charging stations for every parking stall in new multi-family residential units (City of Vancouver 2016). The City will also partner with organisations that are ideal sites for fast charging stations but are not on City owned land. By providing financial support to ensure the uptake of charging infrastructure, the network and partnerships can increase. To encourage greater participation from residents to switch to EVs, owners or building managers who meet eligibility requirements can apply to have City-owned EV chargers installed in their buildings for use by tenants. This program is paid by council with part funding from BC Hydro, a government owned power provider. Vancouver council will pay up to $93,000 for the infrastructure, including the cost of the chargers, and applicants are required to contribute $2,000 (City of Vancouver n.d.).

10.4 Seattle, USA

The City of Seattle, under its *Drive Clean Seattle* implementation plan includes the goal of having 30% of cars being EV by 2030 (City of Seattle 2019). Under the Plan, charging infrastructure must also integrate any paid parking and fee collection into a single transaction. The charging station owner must also pay for any lost meter revenue in the event no EV is being charged. Private owner stations are responsible for construction and maintenance costs, whereas publicly owned infrastructure construction costs will be covered by the City, excluding maintenance and repair. Each infrastructure owner must also have general liability insurance.

The Seattle Department of Transportation concluded the *Electric Vehicle Charging in the Public Right-of-Way (EVCROW) Pilot Program*[22] in 2019. The purpose for the program was to establish guidelines for EV charging on non-residential streets within Urban Centres and Urban Villages and commercial streets outside of Urban Centres and Urban Villages. The Permit Pilot was the first step in a multi-step process to develop right-of-way charging policies city-wide. Seattle kerb space policies prioritise space for EVs for short-term and shared-use as opposed to long-term vehicle storage on right-of-way in commercial and mixed-use areas. The data acquired from this program was evaluated and presented in *the EVCROW Evaluation Report* (Seattle Department of Transportation 2019) with some notable points brought up in the discussion:

- Some EV drivers use EVCROW stations as their primary charging point, thus making EVCROW solutions an alternative to at-home charging.
- Off-street spaces should be utilised for EV charging and Right of Way space for public and active transport. Prioritising Right of Way charging where off-street charging isn't available should only be adopted where off-street EV charging is not able to provide adequate support.
- Sites for EVCROW should not conflict with existing Right of Way demands, and the priority should still be on walking, biking, and public transport.
- Expansion of EVCROW should identify the desired use-case and design with the end-user in mind. A Right of Way equity toolkit can help implement strategies in areas of high displacement risks.
- There is concern that installing Right of Way EV charging station will remove parking for residents and exacerbate gentrification and displacement in disadvantaged communities.
- Permit structure, requirements and application process needs to be simplified.

Seattle City Light will construct and maintain 20 DC fast chargers and have a fee structure that is set at US$0.33/kWh between 7am – 7pm from Monday to Saturday, with a cheaper rate applies for all other times; payment is possible through an app, an RFID card, by phone, or by credit card (Seattle City Light n.d.). A residential charging pilot project to assist in the installation of 200 EV chargers in homes also took place in 2017.

22 http://www.seattle.gov/Documents/Departments/SDOT/NewMobilityProgram/EVCROW_Program.pdf

Figure 66 Two DC Fast Chargers owned by Seattle City Light on the 2500 block of 16th Avenue S

Source: EVCROW Evaluation Report

Seattle aims to begin public-private partnerships with EV industry partnerships for the purpose of improving charging infrastructure throughout the city as well as electric shared transport options (City of Seattle 2019).

10.4.1.1 Planning codes

In 2019, Seattle City Council passed an EV readiness ordinance requiring all new developments that include off street parking to provide power outlets for EV charging (U.S. Department of Energy 2021). Seattle is far from the only US city with a requirement to install EV chargers. In San Francisco, for instance, 10% of parking spaces in new construction must have level 2 chargers.

It is now a requirement in Seattle that 20% of the parking bays in multi-dwelling developments must be equipped with wire conduits to facilitate the installation of EV chargers

10.4.1.2 EV Fleet

Seattle has undergone a significant fleet transformation since 2010 when they were provided federal funding to begin investment in EVs. Through the Green Fleet Program, the municipal fleet comprises more than 500 petrol/electric hybrid vehicles and 300 EVs. Approximately 80% of the light-duty fleet is fully electrified with plans to retrofit vehicles that cannot yet be electrified, i.e. Class 8 trucks are outfitted with auxiliary battery power to eliminate emissions from idling (U.S. Department of Energy 2021). The transition towards an EV fleet has resulted in a 40% reduction in operating costs compared to ICE vehicles as well as 98% reduction in greenhouse gas emissions due to the fleets' powering via green energy (Seattle Office of Sustainability & Environment 2017).

10.5 Adelaide: Case Study

Focus area: Public charging infrastructure

The City of Adelaide is one of Australia's most advanced local governments in terms of the number of public charging facilities it has installed. The City of Adelaide is heavily involved in the off-street car parking market, operating a number of multi-deck car parks generating revenue for Council (UPARK). It is partly as a consequence of this historical fact, coupled with the Council's interest in lowering transport emissions that have motivated the City of Adelaide to provide EV charging facilities.

There are currently around 30 charging bays located in their off street car parks, provided by the City of Adelaide. These are AC chargers.

In addition, the City of Adelaide has four charging bays (plugs) from two Tritium 50kW DC units. There are also four Schneider 22kW AC 3 Phase chargers co-located with the fast chargers. The fee for the use of fast chargers is 35 cents per kWh, compared to 25 centres per kWh for the AC chargers.

The 22kW AC chargers require the vehicle owner to bring their own cable with a Type 2 (Mennekes) plug, whereas the fast chargers have their cable fixed to the charger.

Ease of payment was an important consideration for the City of Adelaide. When they developed their

RFQ, suppliers were required to offer Paywave, in addition to App-based payment, to maximise the ease with which people were able to use the EV chargers. While limited data is currently available regarding usage rates, it was implied during a phone call the author had with the City manager that usage rates are currently low, though increasing over time. Figure 67 captures the Tesla Super Charger station in the centre of Adelaide (installed independent of the City of Adelaide).

The use of the 22kW AC chargers requires payment for on-street parking, in addition to the electricity consumption. Time limits apply, to ensure access is maximised. Initially, the City of Adelaide did not provide clear signage that the bays were only to be used by EVs. As a consequence, there were instances of ICE vehicles parking in EV only bays. They have since improved signage to minimise incursions.

Figure 67 Tesla Super chargers, central Adelaide

Figure 68 shows an example from Adelaide of the information provided to the public regarding the use of EV charging bays.

Figure 68 Information on EV charging in the City of Adelaide

The network tariff increases as the consumption spikes, though it is possible with the system Adelaide has deployed to throttle down in high demand times. The City of Adelaide is currently working with the Department of Energy and Mining to develop a trial using smart chargers that will capitalise on the excess renewable energy in the middle of the day. This program will use Schneider 7kW AC wall box chargers.

10.5.1.1 Key lessons learnt

- BYO cable reduce the risk of trip hazards, copper theft and plug crash/vandalism rates (though Moreland City Council provide cables and have not experienced vandalism, as described in Section 10.6).

- Streamlining the connection types to only CCS 2 in the future will simplify the use and operation of the EV chargers
- 'Nose to Kerb' is best for on street bays. Angle parking can cause a problem for 5m cables.
- Parallel bays are not considered acceptable to risk managers as the user may need to stand on the traffic side of the car to plug/unplug cable. Additionally, cyclists may be placed at risk, with cables and charging port doors. Given that most of the EV market is designed for countries driving on the right-hand side of the road (i.e. Europe and North America), for countries that drive on the left-hand side, such as Australia, the charging port on the car faces the street rather than the kerb.

All electricity supplied to the chargers is sourced from renewable means. The City of Adelaide are set to strategically review their EV charger program in 2022, in light of changing EV ownership, the commercial sectors' activity in this space and the impact of wholesale electricity price changes.

10.6 Moreland City Council: Case Study

Focus area: Public charging infrastructure

Moreland City Council are considered one of the most advanced municipalities in Melbourne with regards to the deployment of publicly available EV charging infrastructure.

Moreland's EV charging program began eight years ago, when Council participated in the Victorian Government's Electric Vehicle Trial. The trial included the launch of Victoria's first EV fast charge station as well as the first trial of a plug-in electric car share service. On-going expansion of the network means that Moreland currently manages one of the largest charging networks owned and operated by council in Australia. The overarching objective of Moreland's EV charging program is to decrease emissions of the organisation's fleet and increase the uptake of EVs among the community.

10.6.1 The charging network

Moreland Council runs a network of sixteen EV chargers. Eleven are for public use, capable of charging fourteen cars simultaneously. For of these chargers are 50kW DC 'fast' chargers. Five chargers are reserved for Council only use, and these are capable of charging nine cars simultaneously. Council owns 28 EVs, making up almost half of Council's car fleet. There are 2 – 3 EVs in Council's EV fleet per charger bay reserved for Council,

The Moreland Brunswick EV Hub, composed of two 50kW DC fast chargers and two slow charging bays was the busiest on the Chargefox network in early 2021. Figure 69 shows both the 7kW AC chargers (to the left), and the faster, DC chargers (on the right). The time limit varies at the EV Charging Hub depending on whether it is a DC (fast) or AC (slow) charger (see Figure 69).

Figure 69 EVs charging at the Brunswick EV Hub

Table 23 provides a summary of the slow and fast chargers at the Brunswick EV Hub in Moreland.

Table 23 Brunswick EV Hub User Statistics

	Slow (AC) Charger	Fast (DC) Charger
No. of charging sessions per day	5	9
Duration of stay	65 min	40 min
Cables provided?	Yes	Yes
Cost per kWh for the user	Free	Free
Time limit	3 hrs	1 hr
Average energy consumed per charge (kWh)	6	21

There are a number of possible reasons for the popularity of the Brunswick EV Hub. Electricity is provided for free, the site is on a key transport route (Sydney Road), near a busy shopping centre (Barkly Square), and is located in a built-up area where residents tend not to have off-street parking. As well as this, the hub is surrounded by a diverse set of destinations including numerous cafes, an activity centre and a wide variety of businesses (see Figure 70).

One of the reasons for the popularity of the Brunswick EV Hub, apart from the fact it is free, is the location. It is very close to a large variety of shops, cafes and other services.

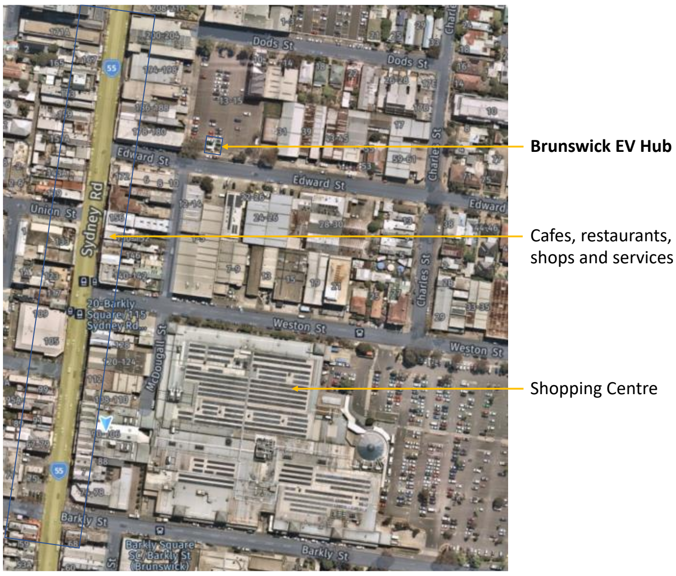


Figure 70 Brunswick EV Hub is surrounded by popular destinations

It is important to recognise that not all chargers in Moreland are busy. Two of the slower (AC) chargers were used less than once per day during the assessment period. These are located next to aquatic centres, which were closed during COVID-19 lockdowns. These chargers are seeing usage increase with the aquatic centres reopened. The busiest AC chargers are those located near fast chargers.

Moreland's charging network contains a range of chargers and all have performed well. Key charger models are the Schneider EV Link (AC charger), Keba AG (AC charger) and Tritium (DC charger).

Some 37% of all charging sessions at Moreland public chargers are by vehicles registered to a Moreland address. This may be due to commuters working in Moreland, or the chargers are attracting visitors to the area. Further research is needed to quantify the economic benefit to the local area of EV owners waiting for their vehicle to charge.

Some 37% of vehicles using Moreland chargers are registered to a Moreland address.

10.6.2 What makes a successful charging network?

The chargers provided by Moreland Council are all 'tethered' – a charging cable is locked to the charger, so that users do not need to bring their own cable. Council considers this provide a better user experience, and Council has not experienced theft or vandalism of these cables. Moreland has not received reports of 'ICEing', where an ICE (Internal Combustion Engine) parks in an EV-only charging bay. Overstays are an issue, however, where EVs stay parked longer than permitted. Moreland have installed remote sensing technology that alerts compliance staff to EVs that have remained in the bay longer than the time permitted.

All electricity provided at Moreland EV chargers is zero-carbon, sourced from the Crowlands Wind Farm under the Melbourne Renewable Energy Project (MREP). This fact is advertised on Moreland's chargers, and has been highlighted as something very important to the community.

10.6.3 What's next?

The charging network will continue to grow. Moreland's Sustainable Buildings Policy (link) requires that EV chargers be installed on suitable Council sites when Council carries out a significant construction or refurbishment project. Work is also on-going to incorporate a requirement for EV infrastructure within the Moreland Planning Scheme.

Moreland is keeping a keen eye on new business models in the EV charging space, where commercial organisations offer to install and maintain chargers in exchange for long-term leases. Moreland will continue to assess whether these offerings can successfully complement the existing charging network.

Moreland is also keen to explore whether car share providers could start to offer EVs. Barriers include insurance limits on car-share vehicles, and matching charging infrastructure to the needs of these vehicles. It is however an area that offers significant potential environmental benefits.

10.7 Summary

The case studies highlighted in this section have illustrated that many cities have maturing programs in place to overcome the barrier to EVs related to charging. Cities are beginning to extend their networks of on-street charging (both fast and slow chargers) and establish planning controls to ensure newly constructed buildings have charging infrastructure included in their design.

While cities like Oslo, London and Seattle are more advanced than all Australian cities in relation to the development of their EV charging network, some Australian regions have begun to develop a publicly available network of chargers. Adelaide City Council and Moreland City Council are among the most advanced. It is important to note that utilisation rates are still relatively low. Stonnington should not expect publicly available chargers to have a very high initial utilisation rate. As highlighted earlier, this demonstrates the multiple factors that influence EV adoption, whereby the provision of EV charging infrastructure is an example of a factor. The key implications from the Australian case studies presented in this section are:

- Charge a fair price
- Require users to bring their own cable to reduce vandalism
- Offer easy payment options (e.g. tap and go)
- Be conscious of safety factors when determining which bays to use
- Lead by example: Ensure EVs are used by the most prominent members of Council.

11. Appendix 2 Transport and Population Background Analysis

This section provides an analysis of existing travel patterns, transport network and population features within the study area. This was used to inform the development of suitable charging locations and appropriate charging speeds for this project.

11.1 Analysis of travel patterns and land use

11.1.1 Journey to work data, both from a trip origin and destination perspective.

The ABS Census is the most comprehensive dataset on trips in Australia. While all households participate in the census, only data related to journeys to work are collected. The mode share for journeys to work in the LGA of Stonnington, is shown in Figure 71. The car is the dominant mode of transport, followed by the train, with 1 in 4 people reporting travelling from home to work via train. Walking and commuting by tram were next, at 8 and 7 per cent, respectively. Only 1 per cent journeyed to work by bus.

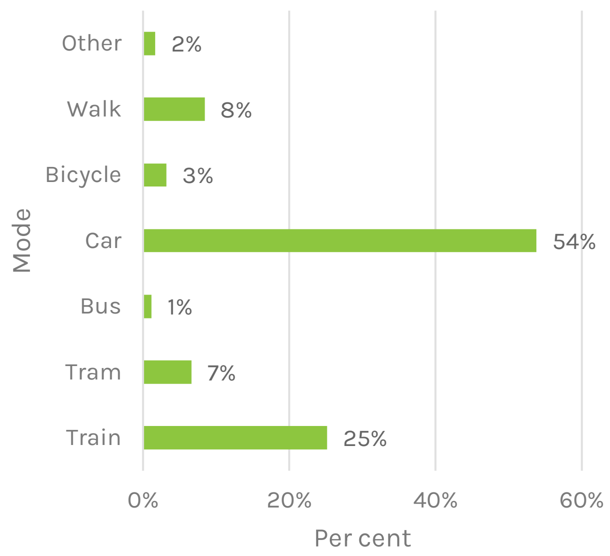


Figure 71 Journey to Work mode share by origin, 2016

Source: ABS Census 2016

Census data can also be integrated to reveal journey to work mode share by destination. Figure 72 shows journey to work mode share as a destination in Stonnington. The car is the dominant mode of journey to work at 70 per cent.

The proportion of the population commuting by car was more than four times the proportion of the population commuting by train at 15 per cent. Walking and the tram were next at 7 per cent and 4 per cent, respectively. The bus and bicycle were amongst the least reported mode of travel for journey to work.

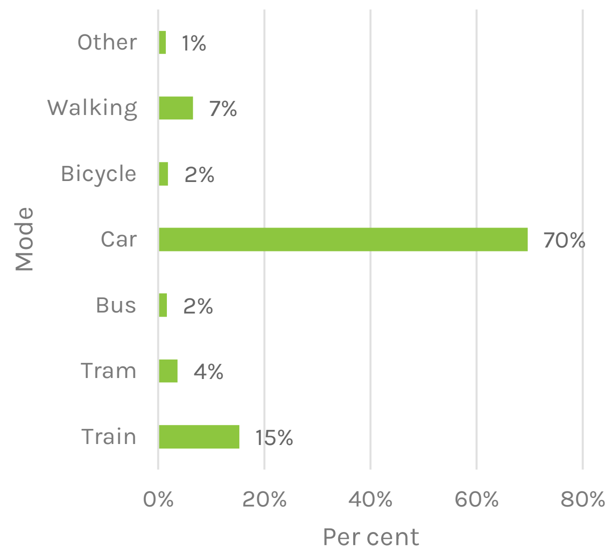


Figure 72 Journey to Work mode share by destination, 2016

Source: ABS Census 2016

ABS Census data indicates that for most workers, they drive to work. A consequence of this travel pattern is that most workers will have their cars with them at work, and may benefit from charging infrastructure at places of employment.

11.1.2 Victorian Integrated Survey of Travel and Activity (VISTA) data

The Victorian Integrated Survey of Travel Activity is a travel diary, covering all trips, by purpose and by mode. Figure 73 shows the average number of trips completed by day, with approximately 2,000 more trips completed on an average weekday than a Saturday or Sunday. Analysis of the VISTA data in Figure 74 shows that for all trip purposes, more than half are by car on any day of the week, with more passengers arriving by car on a weekend at 28% than on an average weekday, at 17%. Walking is the next most common mode at 22% on a weekday and 23% on a weekend. There are more trips completed by train, tram, bus and bicycle on an average weekday, with three times as many trips by train and tram reported on an average weekday as an average weekend.

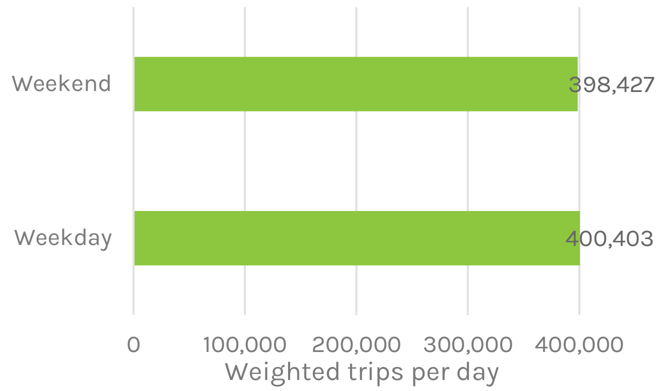


Figure 73 Average trips completed by day

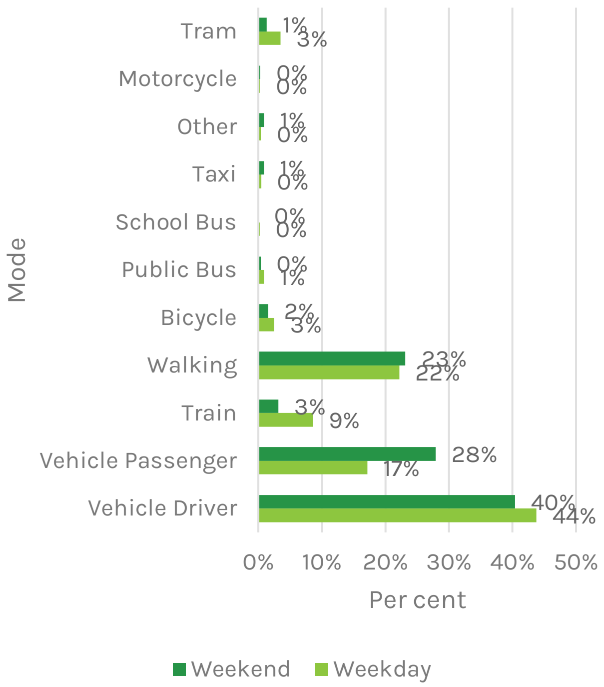


Figure 74 Mode for all trip purposes

Source: VISTA

A comparison of trip purpose is shown in Figure 75. More than one in five journeys are work related on weekdays, compared to weekends where work trips expectedly drop off, making up 5% of total trips on an average weekend. Similarly, more trips for education are made on weekdays at 7%, compared to 1% of weekends. On an average weekday, shopping was the next most common trip purpose at 17%, followed by social and recreational purposes at 14% and 9% respectively. Trip purposes reflected similarly on weekends, except for journeys made for shopping, socialising and pick-ups or drop-offs. For these purposes, approximately twice as many trips are made on weekends than on weekdays

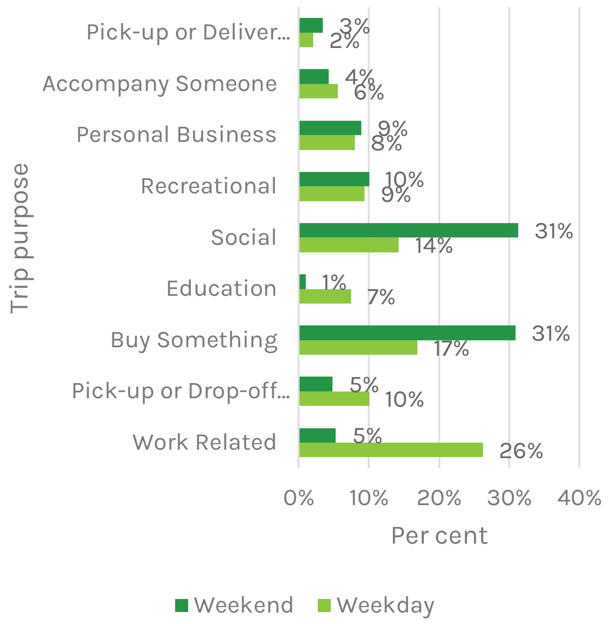


Figure 75 Journeys by purpose

Source: VISTA

11.1.3 Vehicle ownership and vehicle type, based on ABS Motor Vehicle Census data.

The Census provides the number of motor vehicles per dwelling, which can be segmented by dwelling structure. Table 24 shows the average number of vehicles per dwelling, based on dwellings structure, for each suburb in Stonnington at the 2016 Census. For all dwellings, there are 1.3 cars per dwelling across Stonnington. There is variation between suburbs, with there being between 1 vehicles per dwelling in South Yarra and 1.7 vehicles per dwelling in Kooyong, Malvern East, and Glen Iris.

However, these numbers vary depending on dwelling structure within each LGA. Separated housing have more vehicles per dwelling, typically closer to 2, in most suburbs. Semi-detached dwellings typically have around 1.5. Flats typically have fewer vehicles, with several contexts having less than one per dwelling. All up, an average of 27.4% of flats (of any size) have zero vehicles, while an average of 54% of flats have only one car.

This has important implications for placing on-street charging infrastructure in residential neighbourhoods. Separated dwellings are, in almost all circumstances, able to install charging equipment themselves, however, those in multi-unit developments (i.e., flats) and semi-detached housing can face barriers. However, due to lower car ownership rates, the amount of chargers per dwelling may be lower than could be necessary for separated dwellings.

Table 24 Average vehicles per dwelling, by dwelling structure, by suburb, 2016

	South Yarra	Prahran	Windsor	Toorak	Armadale	Kooyong	Malvern	Malvern East	Glen Iris	Stonnington
Separate house	1.7	1.4	1.4	2.2	1.8	2.2	1.9	2.0	2.1	**2.0**
Semi-detached, row or terrace house, townhouse etc. with one storey	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	**1.3**
Semi-detached, row or terrace house, townhouse etc. with two or more storeys	1.5	1.5	1.4	1.7	1.5	1.5	1.8	1.6	1.6	**1.6**
Flat or apartment in a one or two storey block	1.1	1.0	1.0	1.4	1.1	1.4	1.1	1.0	1.1	**1.1**
Flat or apartment in a three storey block	0.9	0.9	1.0	1.1	1.0	1.3	1.1	0.9	1.2	**1.0**
Flat or apartment in a four or more storey block	0.8	0.8	0.7	1.3	1.0	N/A	1.1	0.5	1.2	**0.8**
Flat or apartment attached to a house	0.0	N/A	N/A	2.0	N/A	N/A	N/A	N/A	N/A	**1.1**
House or flat attached to a shop, office, etc.	0.8	1.2	2.0	N/A	0.8	N/A	1.1	0.8	2.0	**0.9**
Average for all dwellings	**1.0**	**1.1**	**1.1**	**1.6**	**1.3**	**1.7**	**1.6**	**1.7**	**1.7**	**1.3**

Source: ABS Census