Government of **Western Australia**
Department of **Water and Environmental Regulation**

We're working for Western Australia.

A guide to
electric vehicles

www.wa.gov.au

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Introduction and background

The Government of Western Australia has committed to working with all sectors of the economy to achieve net zero emissions by 2050 for a prosperous and resilient low carbon future. The Western Australian Climate Policy outlines its action around six key themes including "Lower-carbon transport".[1]

Globally, electric vehicle (EV) uptake is on the rise. This recent decade has witnessed about 10 million electric cars on the road with a 41% increase of EV registrations in 2020. A further acceleration in uptake is expected as EV prices reach parity with conventional vehicles. Governments around the world are supporting the transition to EVs as a fundamental action in achieving their emission reduction goals.[2] The EV market also presents a significant opportunity for industry in Western Australia. With some of the world's largest reserves for all the critical battery minerals, Western Australia is already capturing economic and employment benefits, and has the skills, infrastructure and standards to become a key player in the global battery value chain.[3]

As part of its commitment to a low-carbon future, the Western Australian Government developed a State Electric Vehicle Strategy for Western Australia in 2020, accompanied by a $21 million investment. This strategy sets out a roadmap to a cleaner, more efficient and sustainable transport future. In addition to EV uptake, the strategy focuses on the development of charging infrastructure; standards, guidelines, and planning approval requirements; and industry development.

The charging infrastructure program outlined in the Electric Vehicle Strategy will deliver Australia's longest electric vehicle fast charging network. This will provide electric vehicle owners with confidence that they can access fast charging stations along major travel routes, as well as tourism locations across Western Australia. The network will reach north from Perth to Kununurra, south to Esperance, and east to Kalgoorlie. The Strategy also targets a minimum 25 per cent EV acquisition for the government fleet within eligible fleet segments by 2025-26.[4]

Efforts are being made to raise EV awareness so that the introduction of this technology can be accelerated and provide environmental, health and economic benefits within Western Australia. While the State EV Strategy also covers fuel cell EVs (FCEVs), this brochure focuses on battery EVs (BEVs) and plug-in hybrids (PHEVs) because of their market readiness.

Environment Minister **Amber-Jade Sanderson** with a Nissan Leaf AZEO

Purpose of the document

The purpose of this brochure is to provide practical information for fleet managers about features and benefits of EVs particularly in the context of WA to support their adoption.

1 www.wa.gov.au/sites/default/files/2020-12/Western_Australian_Climate_Policy.pdf
2 www.iea.org/reports/global-ev-outlook-2021?mode=overview
3 www.wa.gov.au/government/publications/western-australias-future-battery-industry-strategy
4 www.wa.gov.au/sites/default/files/2020-11/State_Electric_Vehicle_Strategy_for_Western_Australia_0.pdf

The global drive towards zero emissions transport

With global commitments to address climate change and limit the rise in global temperatures to 1.5°C, zero emissions vehicles are becoming a critical part of a lower-carbon society.

Transport contributes 16% of Western Australia's greenhouse gas emissions. Transport emissions continue to increase and are now 45% higher than in 2005[5]. Petrol and diesel internal combustion engine (ICE) vehicles also produce nitrogen oxide (NOx) and particulate matter emissions that cause adverse health impacts. A recent study showed that in Australia, of those surveyed, 36% said that they had become more interested in air quality issues, versus 7% who said they had become less interested since the start of COVID-19[6].

On average, Western Australians drive about 11,400 kilometres every year, each generating over 3 tonnes of carbon dioxide (CO_2)[7].

The global drive towards zero-emissions transport

Many countries have now set dates for the phase out of ICE vehicle sales. End dates range from 2025 in Norway (which already has EV share of new car sales above 50%).

5 Australian Government Department of Industry, Science, Energy and Resources, 2021, National Greenhouse Gas Accounts 2019, www.industry.gov.au/data-and-publications/national-greenhouse-accounts-2019/state-and-territory-greenhouse-gas-inventories-2019-emissions
6 Source: 5th Annual Global Mobility Study by Vision Mobility, CuriosityCX and LEK Consulting
7 rac.com.au/about-rac/advocating-change/sustainability/vehicle-emissions

Country	Key policy measures and targets
Canada (EV30@30 signatory)	**Target:** 825,000 ZEV passenger LDV stock by 2025, 2.7 million by 2030 and 14 million by 2040.
China (EV30@30 signatory)	**Target:** 20% share of passenger NEV sales by 2025. **Ambition**: 70% of passenger vehicles electrified (of which 40% NEVs) in 2025 and 100% in 2035 (of which 50% NEVs and 95% of those are BEVs).
European Union	**Target:** 13 million passenger ZEV stock by 2025 (based on CO_2 emissions standard for LDVs)
France (EV30@30 signatory)	**Target:** 1.8 million passenger PHEV and 3 million passenger BEV and FCEV stock and 500,000 light commercial BEV and FCEV stock by 2028.
Germany (EV30@30 signatory)	**Ambition:** 7-10 million passenger electric LDV stock by 2030.
India (EV30@30 signatory)	**Target:** 2 million passenger EV stock and 13 million electric motorcycle stock by 2030. **Ambition:** 30% share of EVs in passenger LDV sales in 2030.
Italy	**Target:** 6 million passenger electric LDV stock (including 4 million BEVs) by 2030.
Japan (EV30@30 signatory)	**Target:** 20-30% shares of BEVs and PHEVs, 30-40% share of HEVs and 3% of FCEVs in passenger LDV sales by 2030.
Malaysia	**Ambition:** 100% (electrified, CNG, LPG or biofuel-fuelled vehicle) stock for all private transport by 2030 and 40% in public transport (across all modes).
New Zealand	**Target:** 100% sales of urban buses to be ZEVs by 2025 and 100% stock by 2035.
Norway (EV 30@30 signatory)	**Target:** 100% ZEV sales in passenger LDVs by 2025.
Singapore	**Target:** phase out passenger ICE vehicles by 2040.
Sweden (EV 30@30 signatory)	**Proposal:** ban on new petrol or diesel cars sales after 2030.
United Kingdom (EV30@30 signatory)	**Ambition:** phase out petrol and diesel passenger LDV sales by 2030. All sales of passenger LDVs to be BEVs or FCEVs by 2035.
United States	**Target:** 3.3 million ZEVs in LDV stock in eight US states combined by 2025. (California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island and Vermont.)

*Led by the Clean Energy Ministerial, the EV30@30 campaign redefines the ambition of the CEM's Electric Vehicles Initiative (EVI), setting the objective to reach a 30% sales share for EVs by 2030. (http://www.cleanenergyministerial.org/campaign-clean-energy-ministerial/ev3030-campaign)

EV launch commitments by vehicle manufacturers

With the success of new electric vehicle OEMs, such as Tesla, incumbent vehicle manufacturers, who deal with long product to market lead times, have had to react. Many have now made electrification announcements and set targets to phase out production of ICE vehicles. Many billions of dollars are being spent globally to develop new technologies for BEVs, as well as PHEVs and FCEVs. This global shift will have significant implications on Australia's transportation future.

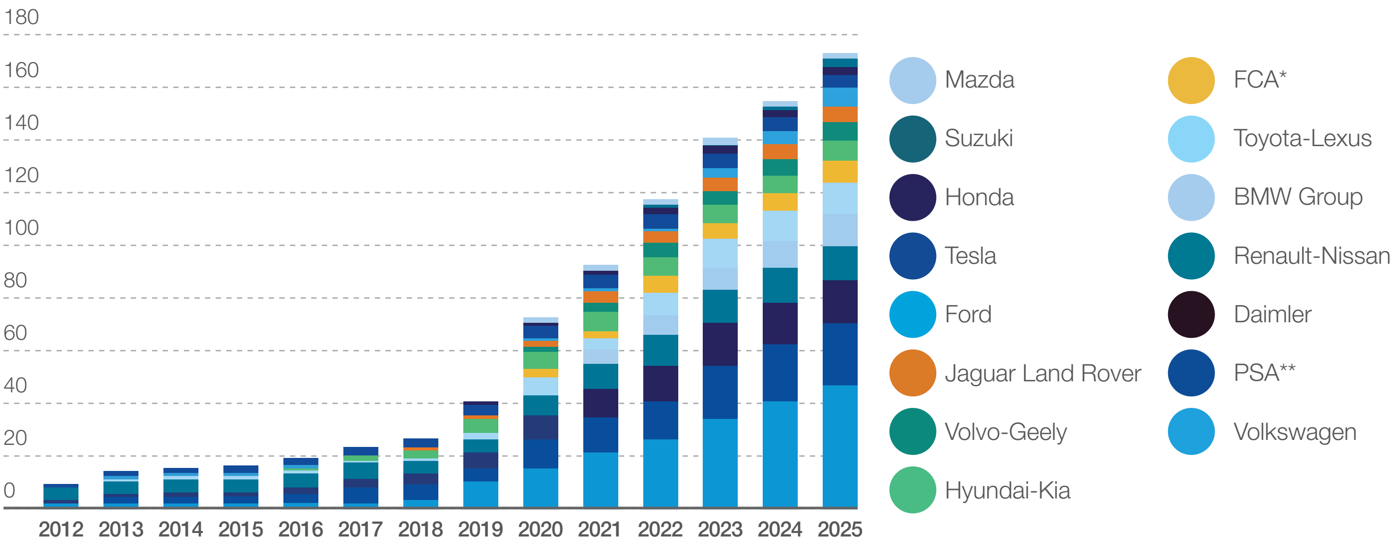
Almost all OEMs have made electrification announcements including future goals to cease production of ICE vehicles.

- **Volvo** announced that every new car they launch from 2019 onwards will have an electric motor.[7] By 2030, Volvo will only sell fully electric cars.[8]
- **Ford** announced US$ 22 billion investment in EVs through 2026. They also target to use 100% locally sourced renewable electricity for all manufacturing plants by 2035.[9]
- **Hyundai** aims for eco-friendly vehicles to comprise 25% of its total sales by 2025.[10]
- **Honda** announced its commitment to strive for carbon neutrality by 2050. To reach the zero environmental impact objective by 2050, their target is to increase EVs sales ratio to 40% by 2030, to 80% by 2035, and to 100% by 2040.[11]
- **Toyota** aims to sell more than 5.5 million electrified vehicles including more than 1 million ZEVs by 2030.[12]
- **General Motors** committed to bring 30 new EVs by 2025 with a $35 billion investment in EV and AV product development between 2020 and 2025.[13] GM's net zero commitment: General Motors plans to become carbon neutral in its global products and operations by 2040. [14]
- **BMW** has a goal to reduce emissions by 200 million tonnes with 50% sales from fully electric models by 2030.[15]

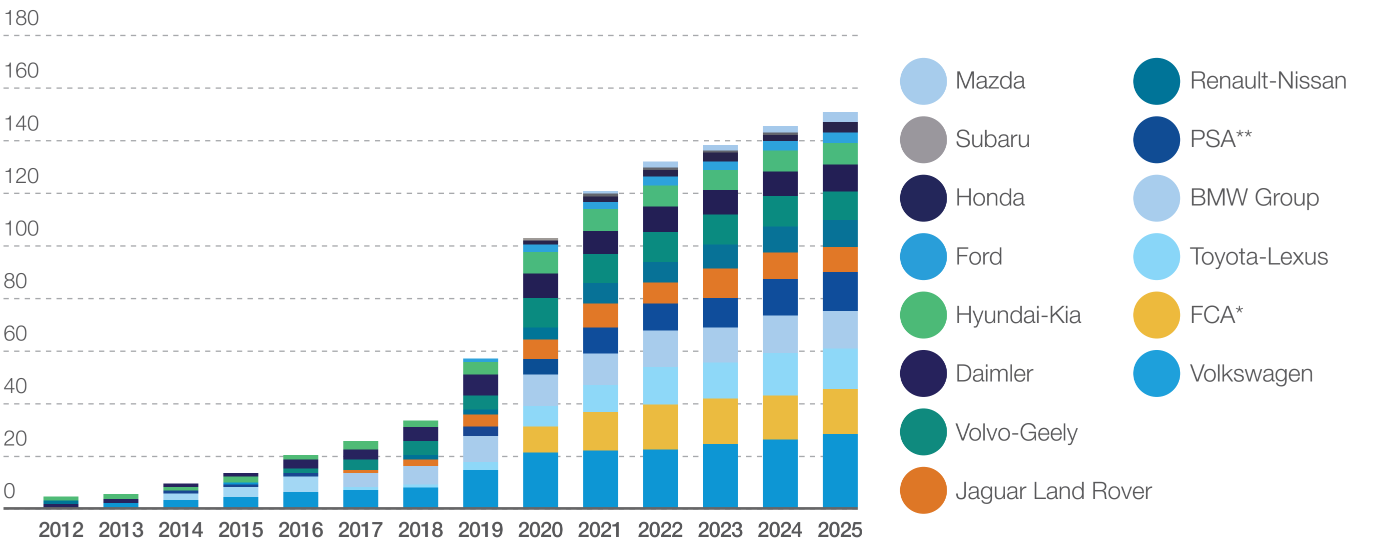
7 group.volvocars.com/company/innovation/electrification
8 www.media.volvocars.com/global/en-gb/media/pressreleases/277409/volvo-cars-to-be-fully-electric-by-2030
9 media.ford.com/content/fordmedia/feu/en/news/2021/03/31/building-a-better-world--ford-announces-steps-towards-carbon-neu.html
10 www.hyundai.news/eu/articles/press-releases/hyundai-and-canoo-to-co-develop-all-electric-platform.html
11 global.honda/newsroom/news/2021/c210423eng.html
12 www.toyota-europe.com/world-of-toyota/feel/environment/environmental-challenge-2050/2030-global-mid-term-targets
13 www.gm.com/electric-vehicles.html
14 media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html
15 www.bmwgroup.com/en/company/news.html#ace-1312289094

The following table shows the exponential growth in choice of BEV and PHEV models and provides insight into the European market proving to be representative of other key markets.

Total number of new BEV models by year in Europe[16]

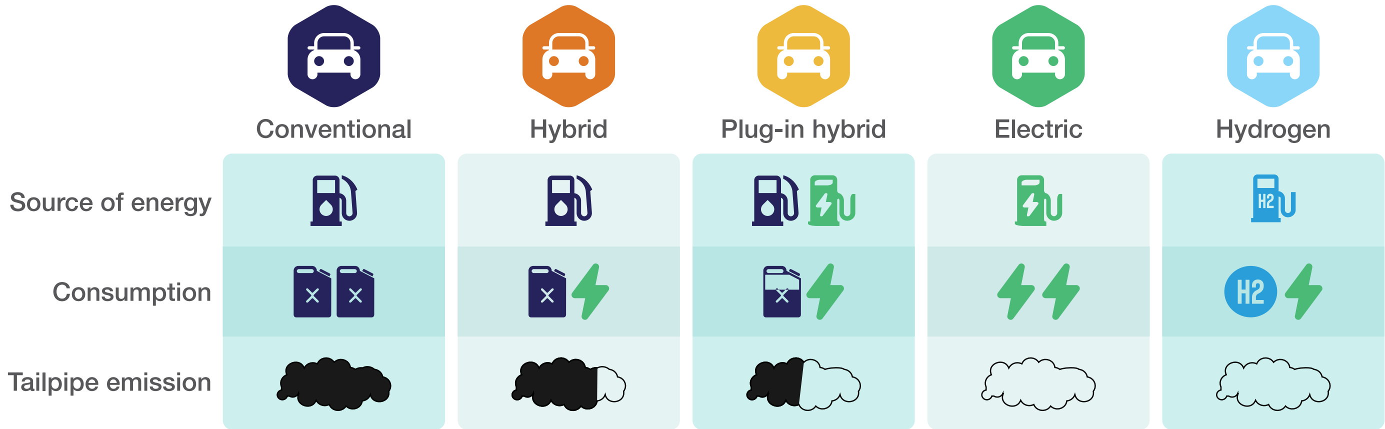


Total number of new PHEV models by year in Europe[17]

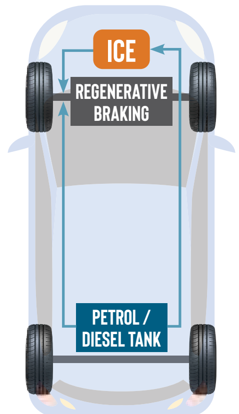
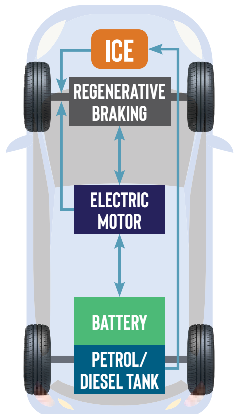
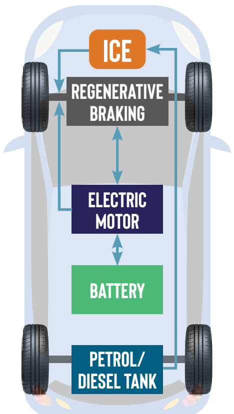
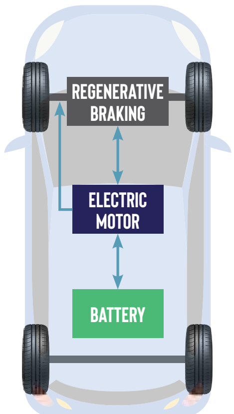
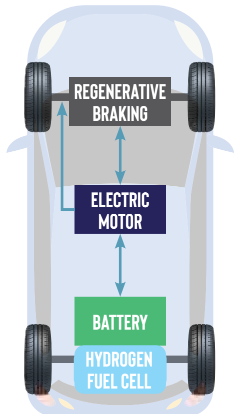


* Fiat Chrysler Automobiles ** Peugeot Societe Anonyme Group
16,17 www.transportenvironment.org/sites/te/files/publications/2019_07_TE_electric_cars_report_final.pdf

An introduction to electric vehicles



Comparison of tailpipe emissions of conventional vehicles (ICE), hybrid (HEV), plug-in hybrid (PHEV), Electric (BEV), and Hydrogen (FCEV)[18]

ICE	HEV	PHEV	BEV	FCEV
				
Opportunities to utilise biofuels such as E10, B5 and B10 to reduce particulates (20-30%[19]), GHG emissions reduction (1.5-5%).	Strong transitional option with broadening availability in the passenger segment.	Electric range of 40-50 km may reduce emissions and be more practical in some instances in the coming few years. If regularly driven more than 50 km the emissions benefit reduces significantly.	Can be zero carbon emissions and zero NOx if charged with renewable energy. Most practical zero emissions option in the next 10 years.	Can be zero carbon emissions and zero NOx. Technology is expensive over the coming decade. May work sooner in heavy vehicle applications.

18 www.wa.gov.au/sites/default/files/2020-11/State_Electric_Vehicle_Strategy_for_Western_Australia_0.pdf
19 CSIRO 2008

Electric vehicle availability

There are now 31 EV models (BEV and PHEV)[20] ranging in price from $41,000 - $260,000 available in Australia, with another 13 models coming in 2021-22.[21]

Globally, about 370 EV models are available as of 2020 (235 BEV models and 133 PHEV models).[22] Companies have made announcements to introduce 200 new EV models over the next five years.[23]

The following tables present EVs under $100,000 currently available in the Australian market. Vehicle pricing is subject to change and also may vary under fleet contracts. State Government entities should note that not all models in the tables listed below are available for lease through State Fleet, Department of Finance.

Battery Electric Vehicles available now in the Australian market under $100,000

Make	Model	Segment	ANCAP rating (stars)	CO_2 (g/km tailpipe)	Range (km)**	Entry Price (AUD)	Battery Size (Kwh)
BMW	i3	Small passenger	5	0	310	$71,990	33
Hyundai	Ioniq	Small passenger	5	0	311	$49,970	38.3
Hyundai	KONA	Small SUV	5	0	484	$62,000	64
Kia	Niro	Small SUV	5*	0	450	$62,490	64
Mazda	MX30	Small SUV	5	0	224	$70,559	35.5
Mercedes	EQA	Small SUV	5	0	426	$76,800	80
MG	ZS EV	Small SUV	5	0	262	$40,990	44
MINI	Electric	Small passenger	5	0	233	$55,650	32.6
Nissan	Leaf	Small passenger	5	0	270	$49,990	40
Renault	Kangoo ZE	Light commercial van <= 2.5t	4	0	214	$50,290	33
Tesla	Model 3	Medium passenger	5	0	415	$59,900	70

*Estimated: Not yet released at time of publishing

**WLTP or WLTP-converted vehicle range (ideal)

20 electricvehiclecouncil.com.au/about-ev/evs-available/
22 www.iea.org/reports/global-ev-outlook-2021/trends-and-developments-in-electric-vehicle-markets
21 myelectriccar.com.au/evs-in-australia/
23 www.iea.org/reports/global-ev-outlook-2020

PHEVs available now in the Australian market under $100,000

Make	Model	Segment	ANCAP rating (stars)	CO_2 (g/km tailpipe)	Range (km)**	Entry Price (AUD)	Battery Size (Kwh)
BMW	330e	Medium passenger	5	48	59	$84,900	12.4
Hyundai	Ioniq	Small passenger	5	26	63	$47,950	8.9
Kia	Niro	Small SUV	5*	29	58	$49,990	8.9
Mercedes Benz	A250e	Small passenger	5	34	61	$64,800	15.6
Mercedes Benz	C300e	Medium passenger	5	46	43	$84,472	13.5
Mercedes Benz	GLC-300e	Medium SUV	5	46	43	$93,800	13.5
MG	HS	Medium SUV	5^^	39	52	$43,000^	16.6
Mini	Countryman	Small SUV	5	54	61	$67,818	9.6
Mitsubishi	Outlander	Medium SUV	5	43	54	$47,990	13.8
Volvo	XC40 Recharge	Small SUV	5	50	44	$66,990	10.7
Volvo	XC60 T8 Polestar	Medium SUV	5	50	44	$95,333	10.4

Evaluating electric vehicles for your fleet

The following tables provide information to evaluate vehicles for your own fleet. Key considerations will be the range of the vehicle in your driving environment, the time it will take to charge, purchase price and the total cost of ownership (TCO) per km against alternative choices.

Other factors that will impact on the TCO will be how long you hold the vehicle for (longer is generally better with EVs) and how many kilometres you travel each year (those that drive further achieve a better payback).

Notes on the tables below:

Electric range is based on standard testing conditions. Range will vary by over 20% depending on driving conditions, for example highway or city and whether you use air-conditioning.

The time to charge is based on the time to fill battery to full from empty. This is assuming an average charging efficiency of 88%.

For more information on available cars in Australia, visit fleets.chargetogether.org and consider signing up to Australia's first online free electric vehicle transition platform - BetterFleet.

Costs in the tables below are intended as a guide only and State Government entities wishing to lease an EV through State Fleet, Department of Finance, should refer to the on-line e-decision aid for total operating costs relevant for State Fleet vehicles.

Small passenger vehicles

Type of vehicle	Model	Operational costs	Electric range	Time to charge	Purchase price	TCO/ km*	CO_2/km^
Small passenger PHEV	Hyundai IONIQ Premium	Annual $948 Including: Servicing $305 Tyres $188 Fuel $162 Electricity $293	City 59 km Highway 47 km WLTP 63 km NEDC 75 km	AC household power point 2.3 kW 4 hrs AC wall charger 7.4 kW 2:15 hrs DC fast charger Not supported	$47,950	$0.64	Tailpipe - 26g Well-to-Wheel - 83g
Small passenger BEV	Hyundai IONIQ Elite	Annual $778 Including: Servicing $280 Tyres $188 Electricity $310	City 293 km Highway 233 km WLTP 311 km NEDC 373 km	AC household power point 2.3 kW 17.75 hrs AC wall charger 7.4 kW 05:30 hrs DC fast charger 50 kW 1.5hrs	$49,970	$0.63	Tailpipe - 0g Well-to-wheel - 103g
Small passenger BEV	Nissan LEAF	Annual $839 Including: Servicing $277 Tyres $188 Electricity $374	City 255 km Highway 202km WLTP 270 km NEDC 324 km	AC household power point 2.3 kW 17:23 hrs AC wall charger 7.4 kW 06:06 hrs DC fast charger 50 kW 48 min	$49,970	$0.64	Tailpipe - 0g Well-to-wheel - 150g
Small passenger ICE	Hyundai i30 Elite	Annual $2,253 Including: Servicing $299 Tyres $188 Fuel $1,766	N/A	N/A	$30,220	$0.50	Tailpipe - 176g Well-to-wheel - 216g

The Western Australian Department of Finance's 2020 Hyundai Electric Ioniq is the department's most utilised pool vehicle being booked 65% more than the average pool vehicle. It is charged using a 22 kW wall-charger installed at the department's main office building.

Western Power's 10 PHEV Outlanders cost 40% less to maintain and service compared with its diesel Outlanders. The running cost of the PHEV Outlanders is $0.03 per km compared with $0.07 per km for the diesel Outlanders

Medium passenger vehicles

Type of vehicle	Model	Operational costs	Electric range	Time to charge	Purchase price	TCO/ km*	CO_2/km^
Medium passenger BEV	Tesla Model 3 Standard Range	Annual $590 Including: Servicing $90 Tyres $188 Electricity $312	City 391.51 km Highway 311 km WLTP 415 km NEDC 510 km	AC household power point 2.3 kW - 22 hrs AC wall charger 7.4 kW 4.6 hrs DC fast charger 50 kW 1:55 hrs	$59,990	$0.74	Tailpipe - 0g Well-to-wheel - 116g
Medium passenger ICE	Toyota Camry SL Sports	Annual $2,495 Including: Servicing $176 Tyres $188 Fuel $2,131	N/A	N/A	$45,290	$0.74	Tailpipe - 197g Well-to-wheel - 239g

* Tesla does not require annual servicing.Estimate is based on periodic replacement of parts as recommended.

Small SUVs

Type of vehicle	Model	Operational costs	Electric range	Time to charge	Purchase price	TCO/ km*	CO_2/km
Small SUV BEV	Hyundai Kona Electric	Annual $722 Including: Servicing $165 Tyres $188 Electricity $369	City 424 km Highway 336 km WLTP 449 km NEDC 561 km	AC household power point 2.3 kW 19hrs AC wall charger 7.4 kW 4:50hrs DC fast charger 50 kW 1hr	$62,000	$0.76	Tailpipe - 0g Well-to-wheel - 115g
Small SUV BEV	MG ZS EV Essence	Annual $819 Including: Servicing $192 Tyres $188 Electricity $439	City 248 km Highway 197 km WLTP 263 km NEDC 328 km	AC household power point 2.3 kW 19:18 hrs AC wall charger 7.4 kW 06:42 hrs DC fast charger 50 kW 54 min	$40,990	$0.58	Tailpipe - 0g Well-to-wheel - 143g
Small SUV ICE	Hyundai Kona Elite	Annual $2,227 Including: Servicing $319 Tyres $188 Fuel $1,719	N/A	N/A	$30,600	$0.55	Tailpipe - 153g Well-to-wheel - 179g

Medium SUVs

Type of vehicle	Model	Operational costs	Electric range	Time to charge	Purchase price	TCO/ km*	CO_2/km^
SUV medium 4X4 PHEV	Mitsubishi Outlander	Annual $1,664 Including: Servicing $359 Tyres $188 Fuel $557 Electricity $560	City 50.94 km Highway 40.47km WLTP 54 km NEDC 67 km	AC household power point 2.3 kW 06:00 hrs AC wall charger 7.4 kW 2.1hrs DC fast charger 50 kW 0.4 hrs	$47,990	$0.65	Tailpipe - 43g Well-to-wheel - 142g
SUV medium petrol	Mitsubishi Outlander	Annual $2,345 Including: Servicing $479 Tyres $188 Fuel $1,678	N/A	N/A	$34,690	$0.63	Tailpipe - 166g Well-to-wheel - 198g

*TCO/km based on a 5 year term, 14K per year annual distance. This figure is based on assumptions as provided at https://fleets.chargetogether.org/assumptions/. Every fleet's operating condition is different so you should refer to your own operating history when calculating these figures.

WLTP - The WLTP is a global harmonized standard for determining the levels of pollutants, CO_2 emissions and fuel consumption of traditional and hybrid cars, as well as the range of fully electric vehicles.

NEDC - The New European Driving Cycle is a driving cycle designed to assess the emission levels of car engines and fuel economy in passenger cars.

^ Well to wheel includes emissions from electricity used to charge EV/PHEV. Actual emissions will vary depending on renewable energy % and for PHEVs the % of time driving on fuel vs electric. Data sourced from https://www.greenvehicleguide.gov.au/Vehicle/QuickCompareVehicles and based on combined cycle and full lifecycle values.

Sustainability of EVs

Lifecycle emissions

Although BEVs do not produce tailpipe emissions,[26] there are greenhouse gas (GHG) emissions associated with the production of the vehicles and the generation of electricity to charge the vehicles. However, when considered over the whole life cycle, EVs have lower GHG emissions than ICE vehicles.[27] EV emissions can be reduced further by using clean renewable energy in battery production and vehicle charging.

- A 100% BEV deployment can result in 63%-65% emissions reduction over the lifetime usage.[28]
- An average BEV charged using power from WA's SWIS produces 30% less GHGs than an average ICE in Australia.[29]
- There are no operational GHG emissions if the BEVs are charged by electricity generated by renewable energy, or if FCEVs are powered by renewable hydrogen.

Noxious tailpipe emissions

The transport sector is a major contributor to poor air quality because of noxious emissions generated during vehicle operation. The major pollutants (i.e., NOx, SOx, COx, HCs, VOCs, PM) associated with fuel combustion in vehicles are known to cause respiratory illness, cardiovascular diseases, and cancer.[30]

Unlike conventional ICE vehicles, EVs create no noxious tailpipe emissions, contributing to cleaner air and better health.

Recycling of batteries

The recycling of batteries is an essential part of EV end-of-life management, not only for environmental and safety reasons but also for the security of resource supply. The global EV battery recycling market is expected to exhibit 19% compound annual growth rate between 2019-25 with the total value of about US$ 3 billion by 2025. Companies around the world are extracting valuable materials from batteries by recycling. For example, Li-cycle, a Canadian company, is already recycling with a current capacity of 10,000 tonnes of Li-ion batteries per year achieving 95% recovery of battery grade materials.[33,34] The State Government is assessing opportunities for the development of a local battery recycling industry in Western Australia.

26 www.epa.gov/greenvehicles/explaining-electric-plug-hybrid-electric-vehicles
27 www.transportenvironment.org/sites/te/files/downloads/T%26E%E2%80%99s%20EV%20life%20cycle%20analysis%20LCA.pdf
28 www.mdpi.com/2071-1050/11/16/4328/htm
29 www.climateworksaustralia.org/resource/the-state-of-electric-vehicles-in-australia-second-report/
30 www.eea.europa.eu/publications/explaining-road-transport-emissions
31 link.springer.com/chapter/10.1007/978-3-319-69950-9_12
32 www.marketresearchfuture.com/reports/electric-vehicle-battery-recycling-market-8326
33 li-cycle.com/
34 spectrum.ieee.org/energy/batteries-storage/lithiumion-battery-recycling-finally-takes-off-in-north-america-and-europe

Plug types and applications

There are specific chargers made for home, work or public charging, with options available for faster and more convenient charging.

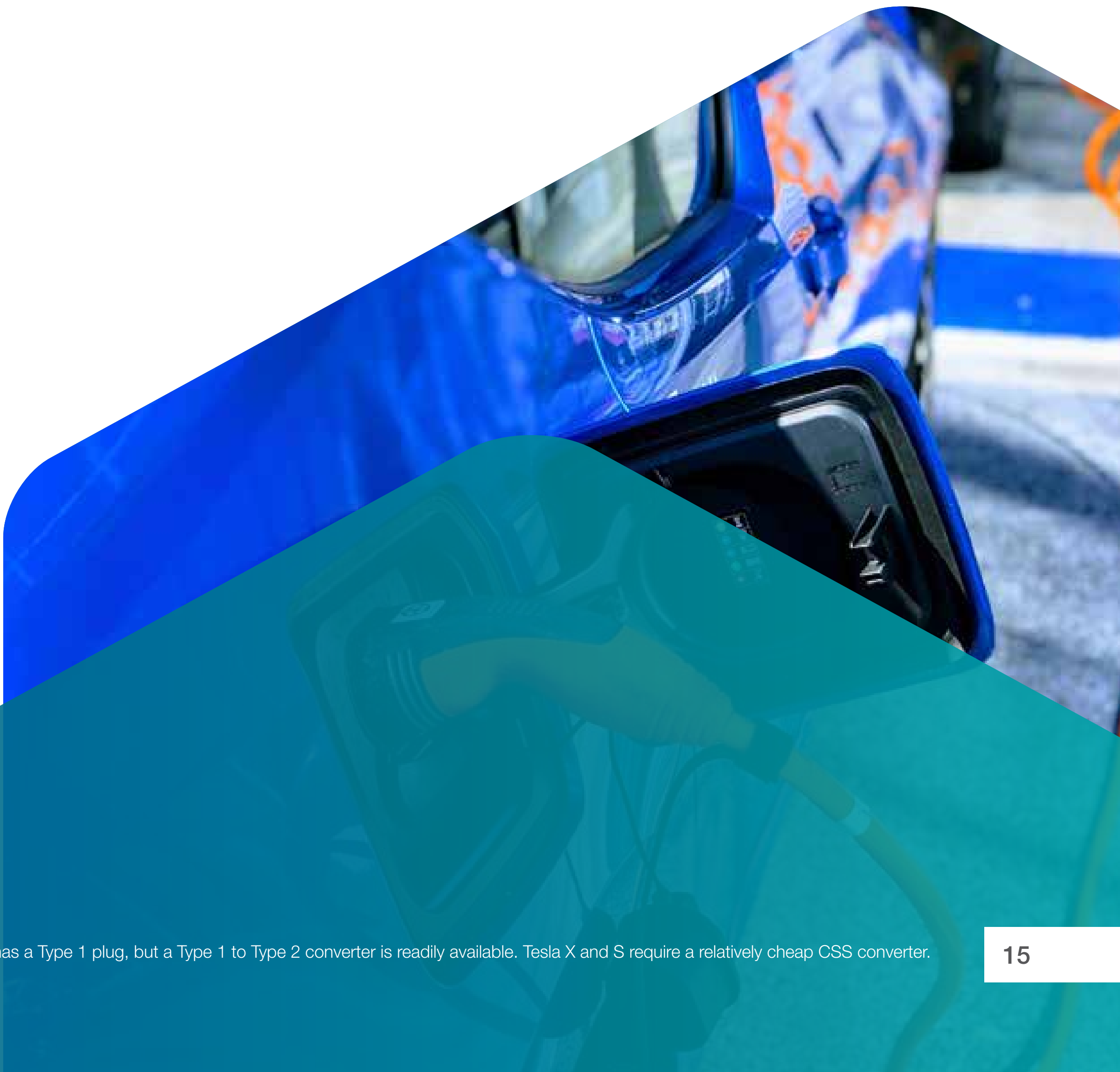
Many fleet applications install 7.4 kW chargers; however, some are starting to consider 22 kW (AC) charge stations. Although some vehicles cannot charge at this speed yet, they can be similar in cost to 7.4 kW chargers once installed and they are more 'future proof' for advancements in electric vehicle maximum charge rates. At this stage in the market it may be advantageous to install one charger per vehicle, until organisations become more comfortable with electric vehicles.

The Federal Chamber of Automotive Industries (FCAI) created a de facto standard in Australia when it endorsed the Type 2 (Mennekes) plug for AC charging and both the CCS and ChaDeMo for DC charging. For AC charging, the 'Type 2' connector is currently used by all EV manufacturers and is now the standard for EVs in Australia.

For DC charging, there are two plug types:

1. CHAdeMO: used internationally by Japanese manufacturers Mitsubishi, Nissan and Toyota. In Western Australia, 20.3% of EVs have CHAdeMO plugs, including the Nissan Leaf.
2. Combined Charging System (CCS): allows AC and DC charging using the same plug. This plug is mandated in Europe and is becoming the standard in all 220-240V 3-phase countries (except China). In Western Australia, about 80% of EVs have CCS plugs or adapters to enable charging using CCS plugs.

Most Australian EVs[35] are supplied with Type 2 (Mennekes), and either ChaDeMo or CCS sockets. There are also adaptor cables available, for example to convert Type 1 to Type 2 inlets.



35 The Mitsubishi Outlander PHEV has a Type 1 plug, but a Type 1 to Type 2 converter is readily available. Tesla X and S require a relatively cheap CSS converter.

Charger speeds, types, applications and potential costs*[36]

Common Name	Power Level	Charge Type	Power	Time to charge 100km of range	Application	Cost Per Station[37]	Apperance	Typical location
Slow charging	Level 1	Wall socket	2.3 kW	8 hrs or more	Home charging	Installation only		Any location with a normal power point: apartments, houses, buildings
	Level 2	AC charger	3.5 kW	5 hr 43 min	Dedicated or scheduled charging	$2,000 - $10,000	 Type 2 (Mennekes)	Houses, buildings and parking lots.
AC fast charging			7.4 kW	2 hr 42 min	Heavy duty dedicated or scheduled charging			
			22.1 kW	54 min	Multi-purpose charging, opportunity charging	$5,000 - $20,000		
DC fast charging or rapid charging	Level 3	DC wall charger	25 kW					Public roads, petrol stations and parking lots
Tesla super-charging		DC charger	50 kW	24 min	Public journey enablement, Heavy duty opportunity charging	$75,000 - $400,000	 Combined Charging System (CCS)	
			100 kW	12 min				
			120 kW	10 min				
Ultra-fast charging			< 350 kW	less than 10 min			 "Charge de Move" (CHAdeMO)	
*For vehicle with driving energy efficiency of 20 kWh/100 km								

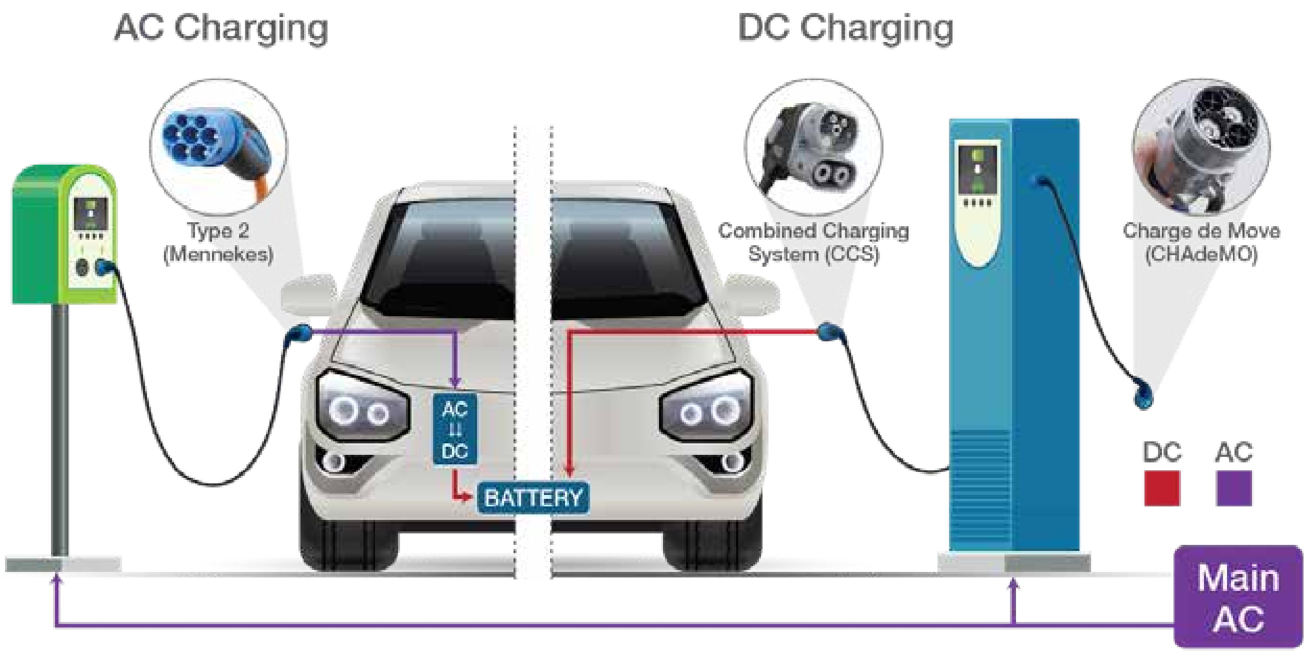
*Costs can be highly variable and will reduce on a per unit basis with scale.

36 Costs include hardware, software, civil and electrical works
37 DC fast chargers commonly come in dual-port configurations. Costs shown here are for the complete charger

AC charging vs DC

There is a fundamental difference between AC and DC chargers that enables DC chargers to deliver higher power and thus shorter charge times. Ultimately, the battery of an electric vehicle must be charged with a direct current (DC) power source. This is shown by the red arrows in the diagram below.

DC charging vs AC charging



Charging infrastructure

This section will outline how each component of the charging station contributes to the overall cost of a charging station installation. When installing charging stations you will need to consider the charger itself, electrical, civil, site works and connectivity.

Key cost components of installing charging infrastructure

Item	Component
Electric vehicle supply equipment (EVSE)	• The charger unit, connectors, pole mount
Electrical	• Cable, conduits, distribution board • Metering (Class 1) • Transformer* • Labour
Civil	• Trenching, tunnelling, boring • Repairing • Labour
Site works	• Signs, bollards • Road markings • Labour
Connectivity	• 4G/5G; Ethernet Cable (fibre / copper), WiFi • Software installation

It is important to note that the charging infrastructure cost estimates in this brochure are indicative only and current only at the date of publication. Each location will require a site inspection for an accurate installation cost estimate before the roll out of the EVSE solution. Civil and electrical costs are derived from case studies and industry analysis. Electricity network connection fees can vary by an order of magnitude if network augmentation or upgrade is required.

The ChargeTogether website provides information on charging infrastructure suppliers in Western Australia and further detail on the installation process. Visit fleets.chargetogether.org

Cost for components of electric vehicle supply equipment

Component	Description	Cost
Type: AC or DC	DC chargers are inherently more expensive than AC chargers because of the additional hardware, called a rectifier, required to convert the current from AC to DC. The purpose of this design is to deliver a higher power to the vehicle, so DC chargers are heavier duty, with thicker, heavier and stiffer connectors which all add to the cost.	AC cost range: $1,500 to $10,900 DC cost range: $20,000 to $35,000+
Power output	EVSE with higher power delivery does so by utilising a higher amperage current. Most AC EVSE delivers power at either 16 A or 32 A, with a 3-phase supply facilitating higher power at the same amperage. Commercial-grade chargers are equipped for both 16 A and 32 A.	3-phase power delivery incurs a 5% increase in charger unit cost
Number of ports	Some EVSE are available in single and double port versions (i.e. capable of charging two vehicles). While the double port version is more expensive, on a per-port basis, it is cheaper than installing two single-port versions.	Double port versions can cost 17% more than single port versions. However, on a per-port basis, a double port version costs 42% less than a single port version.
Mount type: Wall or pedestal	Pedestal-mounted EVSE is generally more expensive than wall-mounted EVSE for several reasons: • The pedestal mount itself has a material cost • For pedestal-mounted EVSE, the electrical circuit must pass underground. The civil work involves trenching/ tunnelling and repairing	Overall costs for pedestal designs are between 20% and 30% more expensive.

Charging and demand management

The energy delivery of EV charging consists of two components:

- The rate at which charging happens, or charge level. Measured in kilowatts (kW)
- The amount of energy required to charge the battery. Measured in kilowatt-hours (kWh).

As a business introduces more electric vehicles, the level of charging (kW) is increased and may lead to some additional site infrastructure requirements. This can be managed to a degree through smart charging (systems optimising energy consumption between vehicles and other loads as well as time of day), solar installations or local battery storage.

Installing smart-enabled or capable chargers now can reduce future costs by enabling participation in future grid services or use of charging control to assist reduction in overall electricity costs.

Innovations are also occurring in vehicle to home and vehicle to grid which may enable your fleets to further reduce power bills and provide some local reliability services to your facilities. In addition, some EVs are equipped with vehicle to load functionality and are able to charge electric devices such as power tools and laptop computers.

The benefits of connectivity

Having chargers with an internet connection provides a number of benefits. Firstly, this allows for more dynamic demand management, potentially lowering power bills. It also allows for more sophisticated billing and can simplify monitoring for maintenance, as well as being able to facilitate driver or vehicle identification, which can assist in cost apportionment.

Charging at home

Home charging for fleets can require a process to recoup costs for employees. There are several key benefits of home charging, including:

- Reducing the need for public charging
- Taking advantage of the lower household electricity costs at night
- Ensuring that all electric vehicles are fully charged for the next day
- Reducing the demand for fleet facility infrastructure investments

Typically, at home, people can install a 3.5 or 7.4 kW charger; however, it is also possible to charge from a standard 2.3 kW wall plug.

Cost reimbursement

Reimbursements for infrastructure and electricity costs for home-based charging of fleet EVs can be considered as follows:

1. Infrastructure

If the fleet decides to allow for home charging, then policy guidelines should be considered in relation to home charging infrastructure and the associated labour, electrical upgrades, charger installation and network service fees.

2. Electricity

When fleet vehicles are charged at home, there may be a need to track and reimburse electrical expenditures. Electricity consumption from EV charging can be measured in a variety of ways:

Odometer readings: a corporate cost per km could be established, which is seen as a fair reflection of the average cost per km. This would be the simplest way to manage the issue, given that employees may also charge at public charging stations.

Telematics devices: Making use of fleet vehicle telematics enables the company to track energy consumption by vehicle rather than charger. Setting up charging reports by location guarantees that the amount of electricity consumed at home can be tracked.

Smart or networking-based charging stations: Smart charging stations that are networked have the capacity to track electricity usage and provide reimbursement. Some networks enable for company accounts, allowing for use reports to be delivered directly to the company administrator. Additional capabilities such as access control and charge management may be available with networked stations.

Monitoring through digital meters: Electricity meters are commonly used to assess energy consumption for invoicing and/or monitoring purposes. The meter must be dedicated to the EV charging circuit or integrated with a smart home monitoring system in order to track only the EV load. However, there are some restrictions to this approach. If the charger is ever used by non-fleet vehicles, or if the meter is not connected to a dedicated EV-only circuit, consumption data for the fleet vehicle will not be accurate.

The correct electricity rate must be applied to the energy consumed for proper reimbursement. This may include varying time-of-use tariffs.

Public charging

Existing chargers:

22 kW or less | 50 kW | 75 kW | 120 kW or higher

Metropolitan	Existing
22 kW or less	90
50 kW	6
120 kW or higher	1
Total	97

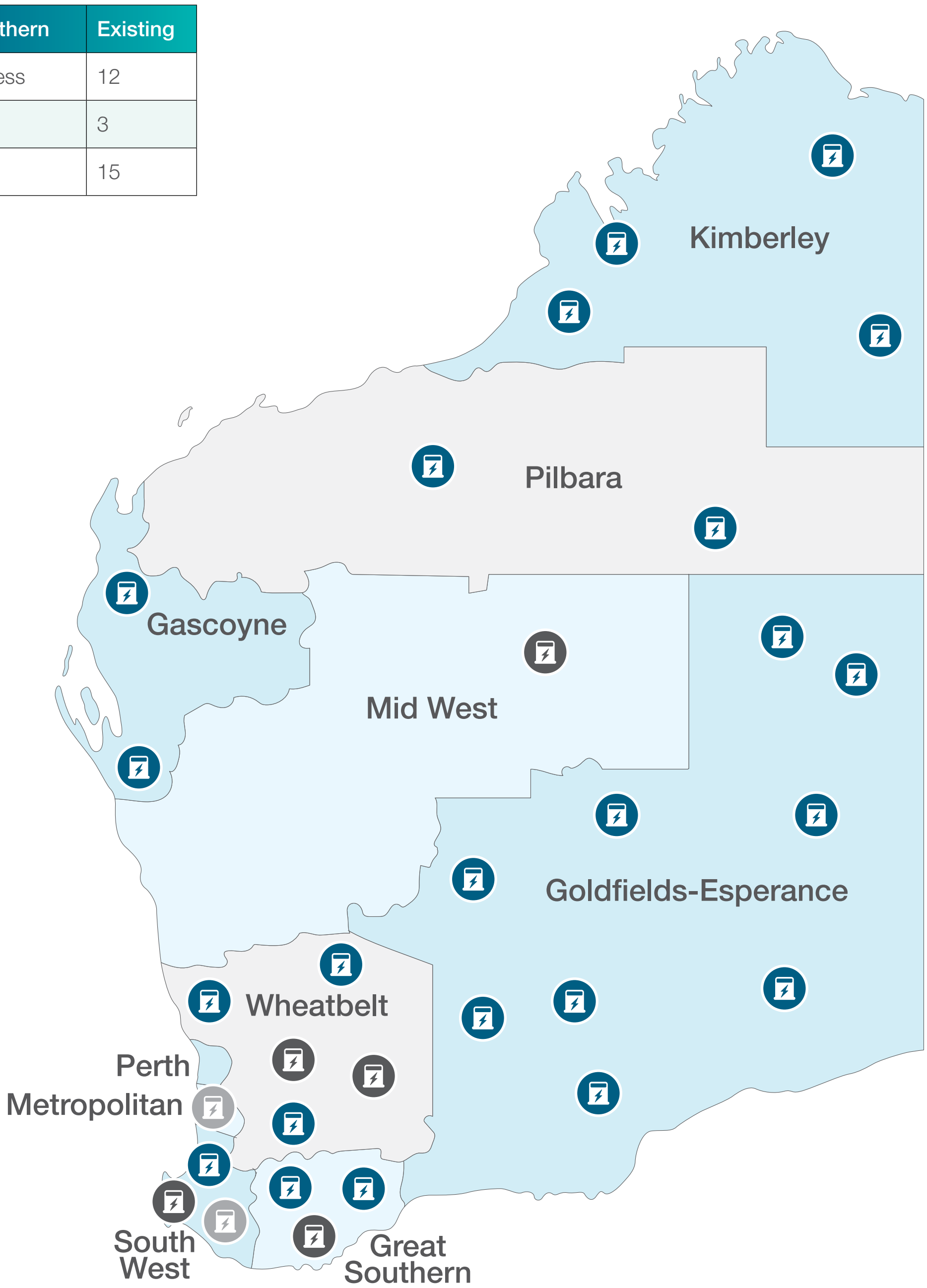
South West	Existing
22 kW or less	39
50 kW	12
120 kW or higher	8
Total	59

Wheatbelt	Existing
22 kW	15
50 kW	2
Total	17

Goldfields-Esperance	Existing
22 kW or less	16
Total	16

Gascoyne	Existing
22 kW or lower	9
Total	9

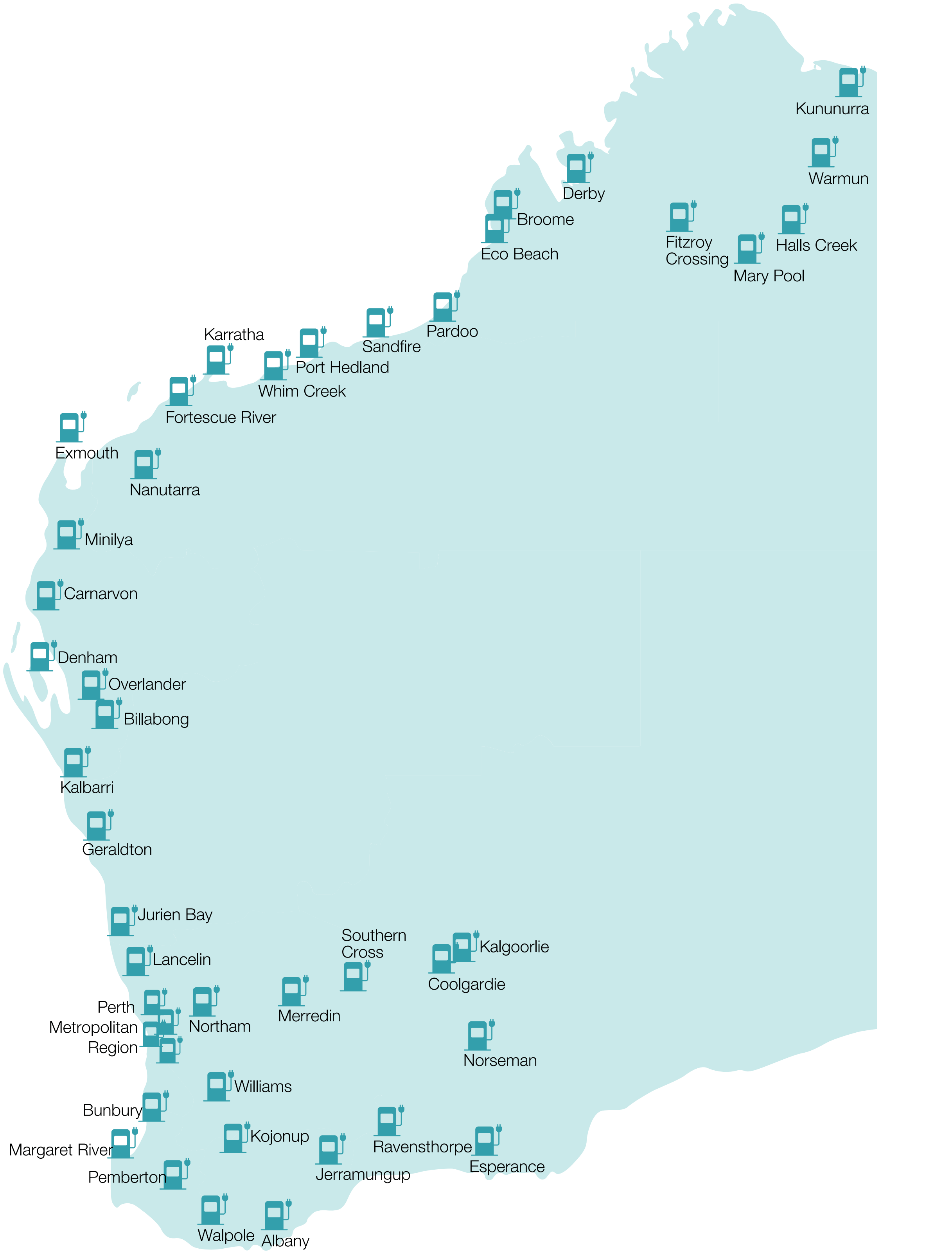
Great Southern	Existing
22 kW or less	12
50 kW	3
Total	15



For all available charging stations, refer to **plugshare.com**

Western Australia electric vehicle charger map

Intended charging station locations as part of the Western Australian Government's electric vehicle fast charging network.



Maintenance and roadside assistance

The low complexity of electric vehicles results in only a small number of moving parts throughout the entire vehicle. In the powertrain this is represented by the stator/rotor, which is zero contact and does not wear out in a meaningful way, and the motor bearings. Cooling circuits are largely sealed or lubricated for life, with software updates, brake fluid, wiper fluid, wiper blades, tyre and wheel alignment and care, air-conditioning servicing and the cabin air filter being the only maintenance items typically requiring attention.

Major service issues such as motor bearing failure and battery degradation are generally not issues that arise in the operational life of electric vehicles, though are known to occur on occasion and are warranty-covered items. Given the relatively recent introduction of these technologies to fleets, vehicle manufacturers often offer extended warranty on these drivetrain components for peace of mind. Overall, the cost of maintaining an EV is less than that of an ICE.

Roadside assistance is provided by some EV manufacturers, as well as companies such as the Royal Automobile Club WA.

Heavy vehicles

Many fleets include heavy vehicles. Examples of heavy fleets include garbage trucks, tipper trucks or delivery trucks. Because heavy vehicles often consume a large amount of fuel, moving to zero emissions alternatives can have significant environmental benefits, and although the purchase prices are much higher, could have a positive payback because of lower operating costs.

It is important to note that the range of heavy vehicles can be lower than passenger vehicles because of the heavy loads, so it is particularly important to understand the performance requirements of the vehicles and to independently verify that the manufacturer's specifications will be fit for purpose in your own specific operating environment.

List of abbreviations

Abbreviation	Definition
BEV	Battery electric vehicle
COx	Oxide of carbon
EV	Electric vehicle - including BEV, PHEV and FCEV
EVSE	Electric vehicle supply equipment
FCEV	Fuel cell electric vehicle
GHG	Greenhouse gas
HC	Hydrocarbon
HEV	Hybrid electric vehicle
ICE	Internal combustion engine
NOx	Oxide of nitrogen
OEM	Original equipment manufacturer
PHEV	Plug-in hybrid electric vehicle
PM	Particulate matter
SOx	Oxide of sulphur
SWIS	South West Interconnected System
VOC	Volatile organic compound
ZEV	Zero emission vehicle

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If you lease a vehicle through State Fleet, Department of Finance, and would like more information on leasing an EV, please contact the State Fleet team at state.fleet@finance.wa.gov.au

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