Deloitte.

Zero Emission Vehicle Charge Rollout

ACT Government

October 2021

Deloitte Access Economics

Contents

Acronym	Definition
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AM	Latin ante meridiem, translating to "before midday", before the sun has crossed the meridian line
ARENA	Australian Renewable Energy Agency
AV	Automated Vehicle
BEVS	Battery Electric Vehicles
BITRE	Bureau of Infrastructure and Transport Research Economics
DER	Distributed Energy Resources
EV	Electric Vehicle
EOI	Expression of Interest
FCEVS	Fuel Cell Electric Vehicles
FY	Financial Year
GHG	Greenhouse Gases
ICE	Internal Combustion Engine
KWh	Kilowatt Hour
Level 2 (or AC) charger	Level 2 (or Alternating Current) charging is the most commonly used level for daily EV charging. Level 2 charging equipment is typically installed in places where charging can take place over a longer period of time or overnight (i.e., home, workplaces, or shopping centres)
Level 3 (or DC) charger	Level 3 EV chargers provide rapid charging rates and can be up to 50 times faster than level 2 EV chargers. They are designed so that people can quickly recharge their electric vehicle in a matter of minutes using direct current (DC) technology.
MaaS	Mobility as a Service
MVA	Mega-Voltage-Ampere
NSW	New South Wales
OECD	Organisation for Economic Cooperation and Development
PHEVS	Plug-In Hybrids
PM	Post meridiem or "after midday", after the sun has crossed the meridian line
RFT	Request for Tender
SA	Statistical Area
SA2	Statistical Area Two
SA3	Statistical Area Three
SOC	State of Charge
VAT	Value-added Tax
VCCE	Deloitte ZEV Vehicle Charger Consumer Environment
VKT	Vehicle Kilometres Travelled
WA	Western Australia
ZEV	Zero Emissions Vehicle

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Executive summary

Purpose of this report

The Australian Capital Territory (ACT) Government has made a commitment to release a 'Zero Emission Vehicles' (ZEV) *Public Charging Masterplan* (the Masterplan) for the rollout of charging infrastructure in the ACT, including $1.2 million for the delivery of the first 50 publicly accessible charging stations by 2022[1]. The Masterplan will include information relating to the locations of these 50 new public chargers.

The ACT Government has engaged Deloitte to undertake the supporting analysis and modelling to identify and validate the locations of these chargers in the Masterplan. This report has three key objectives:

1. Understand **current and future demand** for public charging infrastructure in the ACT.

2. Determine the **supply requirements** for the number of public chargers required to meet demand.

3. Identify, evaluate and **prioritise suitable locations** for the installation of public charging infrastructure in the ACT.

Background

The transport sector is evolving and is being led by a combination of technological developments and the broader objectives of policy makers, governments, corporations and communities, to reduce greenhouse gas (GHG) emissions. Approximately 60% of the ACT's total greenhouse gas emissions currently come from transport, making it the highest emitting sector in the Territory.[2]

ZEVs emit no tailpipe emissions or harmful particulates lowering air and noise pollution, leading to improved public health and urban amenity. However, the adoption of ZEVs represents a major step change from Internal Combustion Engine (ICE) vehicles and therefore has further implications on travel behaviour, electricity networks and road network operations.

The demand for ZEVs in Australia has not kept pace with many other advanced economies around the world. The Australian ZEV share of new sales is predicted to reach 8 per cent by 2025 and 27 per cent by 2030.[3] In comparison, due to a significant subsidisation program Norway had over 60 per cent of new vehicle sales being ZEVs in 2021. [4] To support accelerated ZEV uptake, many countries have introduced incremental incentives over the past two decades.

In June 2021, there were 266,127 total passenger vehicles registered across the ACT, with 265,100 (99.6%) ICE and 1,027 (0.4%) ZEVs. As the anticipated level of uptake of ZEVs in Australia to 2030 and beyond is uncertain, an understanding of the potential impacts to travel behaviour and energy use will be essential for future planning.

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[1] ACT Government 2020, *Budget 2020-21*, <https://www.treasury.act.gov.au/budget/budget-2020-21/budget-papers>.

[2] ACT Government, 'Zero Emissions Vehicles', *Environment, Planning and Sustainable Development Directorate – Environment* (June 2021) <https://www.environment.act.gov.au/cc/zero-emissions-vehicles>.

[3] *Bureau of Infrastructure and Transport Research Economics* (June 2021)

[4] BITRE 2019

The Deloitte ZEV Vehicle Charger Consumer Environment (VCCE) framework incorporates four key areas across the *end-to-end* lifecycle for ZEVs including vehicle, charger, consumer and environment. The Deloitte VCCE framework is designed to be an iterative measurement process to monitor the dynamic market factors within a jurisdiction to allow agile policy decisions for the emerging ZEV market.

Some considerations within the VCCE framework influencing ZEV uptake include:

- **Limited number and availability of public charging infrastructure** is a key concern and needs to be addressed to support the ZEV market. However, there is a 'chicken and egg' dilemma in terms of the relationship between ZEV demand and the availability charging stations. As ZEVs are an infrastructure dependent vehicle, the number of readily available public charging facilities will encourage ZEV uptake.
- **High purchase cost is a barrier to entry** for consumers who are unable to afford new ZEVs compared to more affordable ICE vehicles. Without incentives or subsidies, many may not be willing to purchase a new ZEV.
- **Reluctance to invest** by infrastructure providers in expensive infrastructure projects without the security of a well-established ZEV market or supportive policy environment.

Scenarios modelled in this analysis

To better understand the demand and supply requirements for ZEV uptake to 2030 and beyond, three core scenarios have been modelled. Each of these includes a list of key 'drivers' and factors that would impact the rate of ZEV demand and uptake. An overview of each of the three core scenarios is set out below:

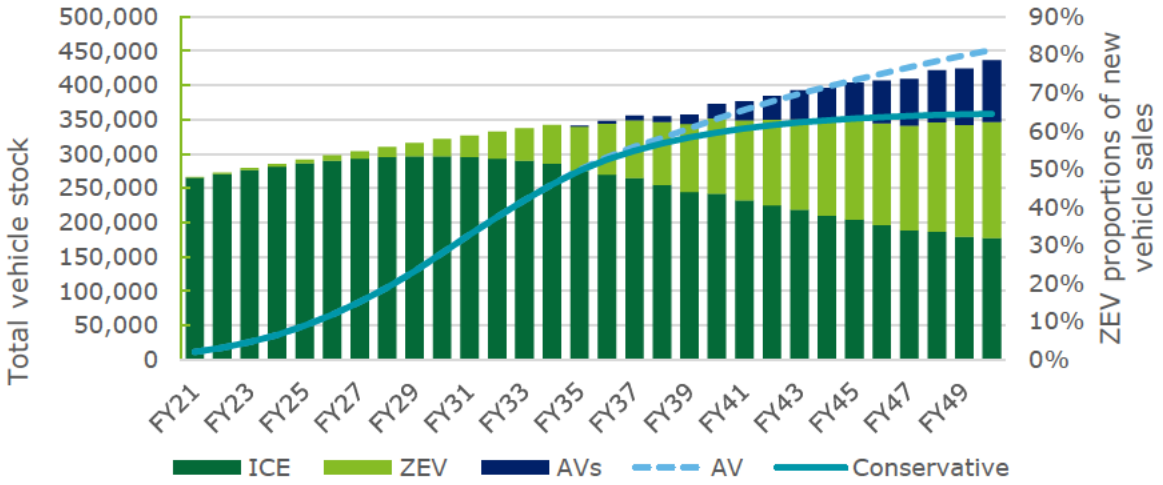
- **Conservative:** This scenario is characterised by a 'do minimal' policy approach to ZEV uptake in the ACT. This scenario assumes ZEV uptake increases as price parity with ICE vehicles is achieved. This scenario also assumes organic improvements in battery technology and changes in the policy environment.
- **Pessimistic**: This scenario represents a less optimistic view of the future, relative to the Conservative scenario. In this scenario, ZEVs fail to reach upfront cost parity with ICE vehicles and charging infrastructure availability does not improve on current day levels.
- **Optimistic:** This scenario represents a more optimistic view of the future – ambitious decarbonisation - relative to the Conservative scenario. In this scenario, ZEV uptake is assumed to increase significantly, reaching and surpassing price parity with ICE vehicles.

Each of the above scenarios describe different potential future states, including trends in society, technology and policy. They each outline the possible drivers and behavioural considerations that are assumed to impact ZEV uptake and the need for public charging infrastructure in ACT. These scenarios are not predictions about what will happen – they hypothesise what could happen and are designed to frame and inform strategic decisions and planning discussions.

Automated Vehicles

An additional Automated Vehicles (AV) scenario was also modelled to understand the potential impact of AVs on future outcomes for the uptake of ZEVs, with the assumption that AVs will be more readily available from 2035 onwards.

Figure i – Autonomous vehicles scenario, FY21-FY50



Source: Deloitte analysis

Similar to the current slow uptake of ZEVs, AVs are likely to be expensive in early years as a result of consumer apprehension to use vehicles with limited to no driver assistance.

As AVs become more accessible, the potential change on travel behaviour may be profound, with increased propensity to share vehicles and a possible reduction in private vehicle ownership, impacting the frequency of trips and the number of vehicles in the total fleet. This would lead to an increase in current trip projections as a result of additional trips being undertaken.

Analysis methodology

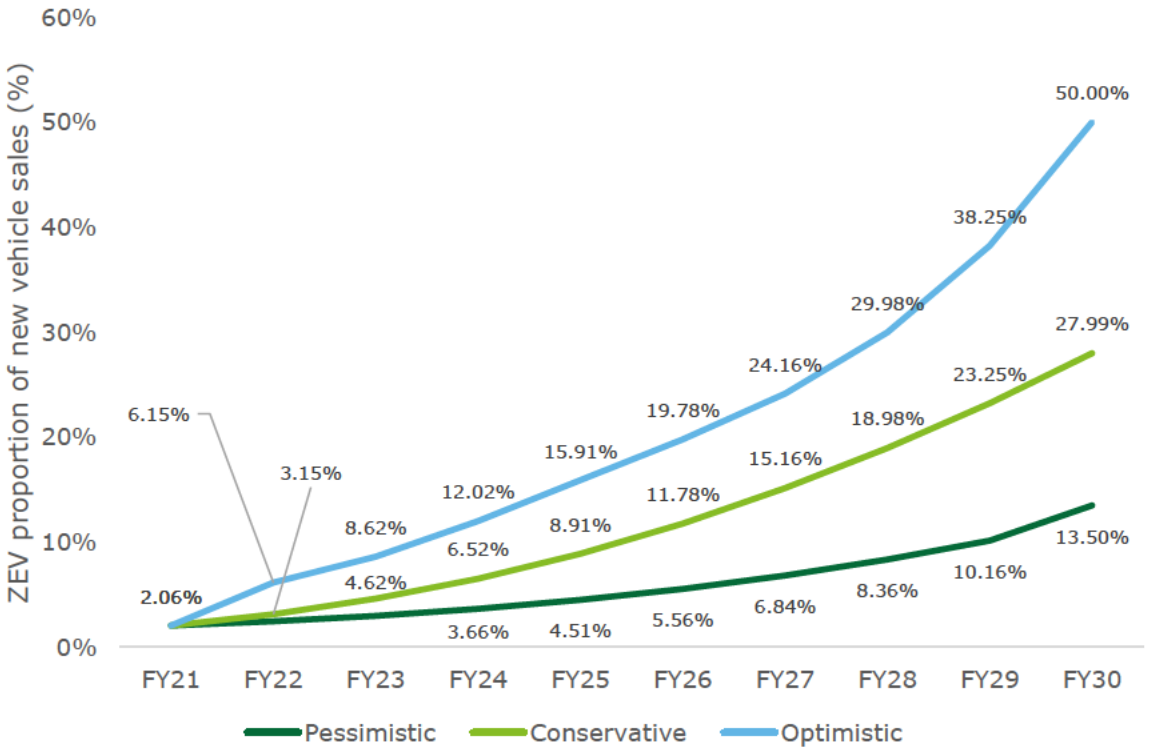
Deloitte has developed a three-stage methodology to forecast anticipated ZEV uptake, energy consumption and priority locations for potential charger locations, outlined in the figure below. Understanding the number of ZEVs likely to be registered within the ACT provides the necessary insights to inform the number and placement of public charging locations.

Demand

A variety of factors including demographic and existing vehicle ownership across the ACT has been taken into consideration in modelling the future uptake of ZEVs. The geographic spread of ZEV uptake considers current ZEV registrations as an indicator of future uptake, in addition to future sales based on an assumption that there may be a faster rate of uptake among higher income groups.

The ZEV proportions of new vehicle sales forms a key indicator in determining the total proportion of ZEVs for passenger vehicles. ZEV proportions of new vehicle sales to FY 2030 across the three scenarios are shown in Figure iii.

Figure iii – ZEV proportions of new vehicle sales to FY 2030



Source: Deloitte analysis

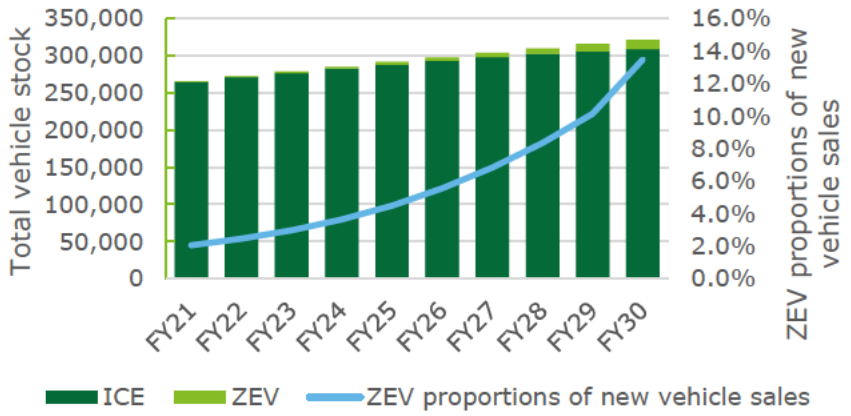
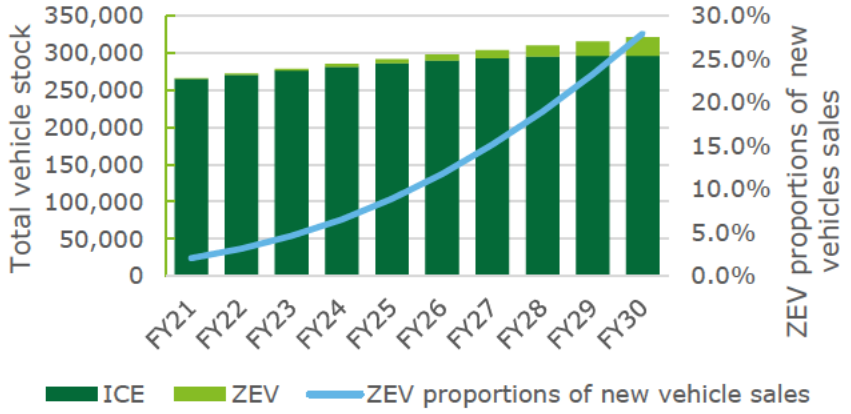
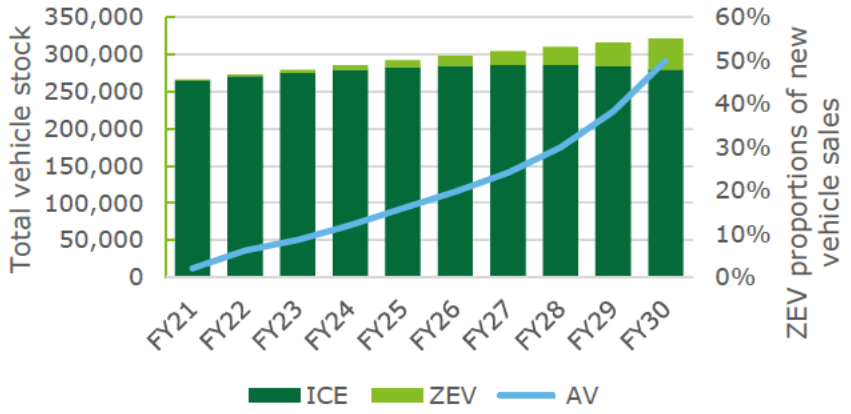
The vehicle stock model used in the scenario analysis is consistent with ACT Treasury. Estimates for total passenger vehicle registrations by type and percentage of ZEV new sales are provided in Table i and Table ii below show the forecast number of ZEVs throughout the ACT – based on the ZEV proportion of new vehicles sales for scenarios and segmentation of income classes by SA2 (outlined in Figure iv).

Table i – Scenario outputs ZEV registrations, financial year

Year	FY2021	FY2025	FY2030
Pessimistic			
ZEV proportion of new vehicle sales	2.1%	4.5%	13.5%
ZEV uptake (total % of fleet)	851 (0.3%)	3,399 (1.2%)	12,106 (3.8%)
ICE number (total % of fleet)	265,100 (99.7%)	288,220 (98.8%)	309,210 (96.2%)
Conservative			
ZEV proportion of new vehicle sales	2.1%	8.9%	28%
ZEV uptake (total % of fleet)	851 (0.3%)	5,369 (1.8%)	24,911 (7.8%)
ICE number (total % of fleet)	265,100 (99.7%)	286,250 (98.2%)	296,404 (92.2%)
Optimistic			
ZEV proportion of new vehicle sales	2.1%	15.9%	50%
ZEV uptake (total % of fleet)	851 (0.4%)	9,287 (3.2%)	41,944 (13.1%)
ICE number (total % of fleet)	265,100 (99.7%)	282,332 (96.8%)	279,371 (86.9%)

Source: Deloitte analysis

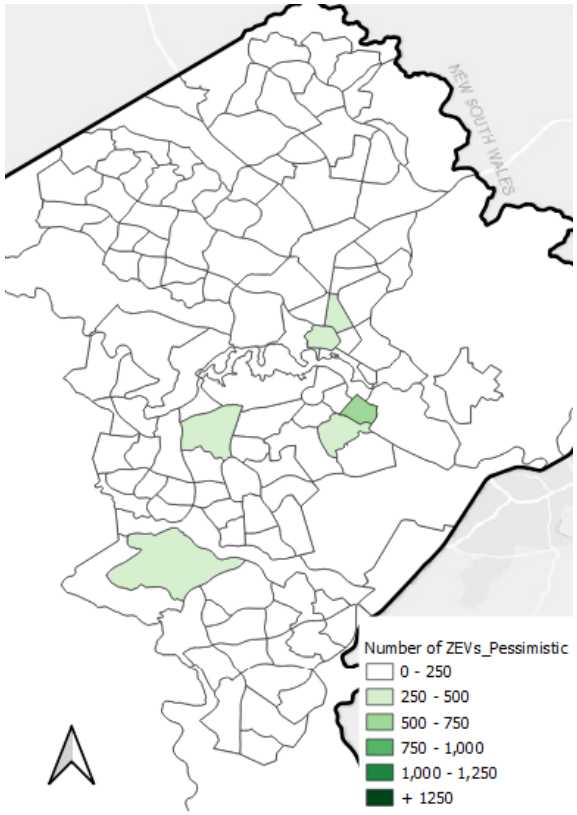
Table ii – Summary of scenario results to FY2030

Scenario	Forecasts
Pessimistic	
Conservative	
Optimistic	

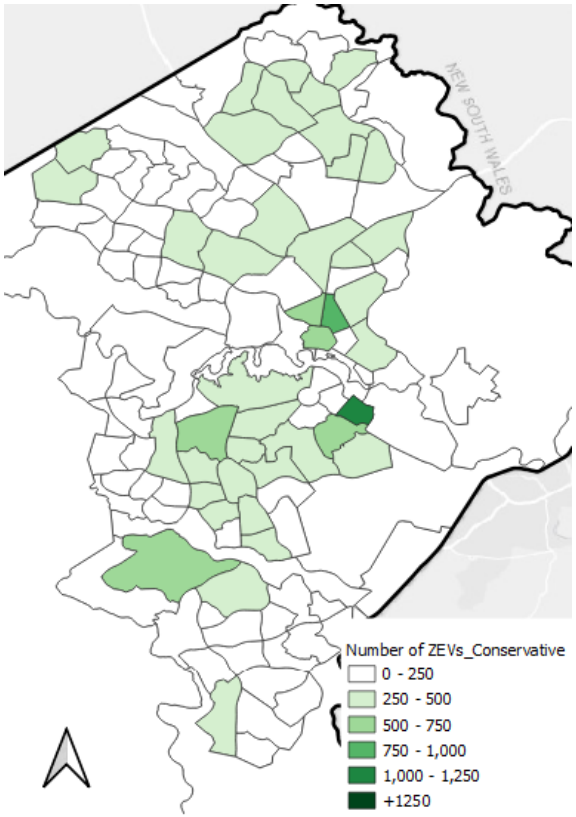
Source: Deloitte Analysis

Figure iv – Heatmap showing forecast of total number of ZEVs by SA2 for each scenario at FY2030

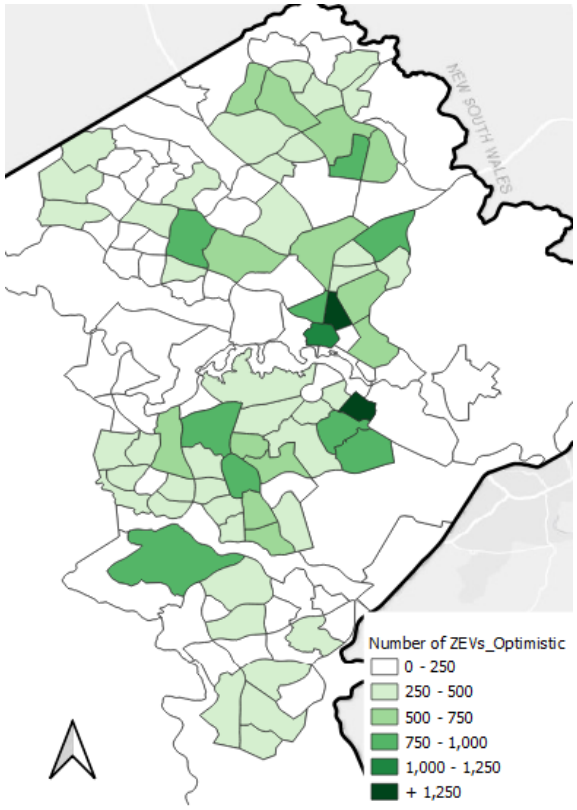
Pessimistic



Conservative



Optimistic



Source: Deloitte analysis

Supply

The modelling approach to understand the charging requirements and the number of chargers required comprise the following three key elements:

1. Determine the **total ZEV kWh per year** on the basis of annual projections sourced from the demand model.
2. Estimate **charging requirements** on the basis of anticipated charging patterns and travel behaviours.
3. This information is used to determine the **number of Level 2 and Level 3 public chargers required to meet demand.**

Shortlisting SA2 locations

The approach to determine a prioritised list of potential locations for public charging is described below. This analysis has adopted the 'conservative scenario' due to the higher likelihood of probability.

1. **The 'long list'** consists of an assessment of **all 131 SA2 locations** across the ACT against four key ZEV criteria. This involves an assessment of the outputs from the scenarios, dwelling composition, and evaluation of available distribution capacity. The scoring of the long list seeks to identify key SA2s which align closely to respective metrics.
2. **The 'short list'** consists of the top 25 SA2s with the highest composite score across the four key ZEV criteria. To evaluate the long list (131 SA2s) of potential locations for public chargers, a quantitative and qualitative assessment was undertaken.
3. Analysis of all 131 SA2 locations across the ACT against the four key ZEV criteria, which include (each of these four criteria are discussed in turn in the sub-sections below):
    - Origin-Destination trips in 2030 (Quantitative)
    - ZEV demand uptake 2021 and 2030 (Quantitative)
    - Dwelling Composition (Quantitative)
    - Distributed Energy Resources (DER) Available Capacity.
      Due to data limitations this is a qualitative assessment at the substation level.
4. Identification of the **top 25 SA2 locations** under **each of the four key ZEV criteria**, with locations being ranked from highest to lowest (e.g., in terms of number of trips, vehicles, people, or distribution capacity).
5. Allocation of a corresponding score (a total of 524) to each SA2 location under each of the four key ZEV considerations.
6. Aggregation of scores for each of the long-listed locations under the four key ZEV considerations, resulting in an **'overall composite score' for each SA2 location** and an overall long list of the top 40 SA2 locations.

Table iii below outlines the short list of 'Top 10' SA2 locations throughout the ACT, by the four key ZEV criteria.

Table iii: Short list of 'Top 10' SA2 locations by the four key ZEV criteria

Rank	SA3	SA2	C1. O/D trips (2030) (trips)		C2. ZEV uptake (2030) (vehicles)	C3. Dwelling type (dwellings)	Distribution capacity (2030) Qualitative
			O	D			Six = High One = Low
1	North Canberra	Braddon	8,960	8,439	879	3,675	Five
2	North Canberra	Civic	47,788	44,759	621	2,388	Five
3	South Canberra	Kingston (ACT)	7,646	6,890	1,124	3,682	Five
4	Belconnen	Belconnen	7,112	7,973	466	3,552	Two
5	Woden Valley	Phillip	7,067	7,837	497	2,193	Three - Five
6	South Canberra	Griffith (ACT)	4,124	4,129	549	1,865	Five
7	North Canberra	Turner	3,450	3,044	500	1,958	Five
8	Belconnen	Bruce	3,696	7,917	298	2,212	Two
9	North Canberra	Lyneham	3,750	3,418	356	1,497	Five
10	North Canberra	Campbell	3,696	3,714	366	985	Five

Source: Deloitte Analysis

Sequence of locations requiring public charging to 2030

Travel behaviour considerations differ depending on people living in urban or regional environments, which in turn influences charging demands. Key charging behaviours to inform the number of public chargers required will vary by individual, and include the following:

- **Time:** The duration of charging and time people would be willing to charge in public varies by individual.
- **State of Charge (SOC):** The SOC represents a key variable in the duration an individual would charge, to ensure sufficient range is provided to align with their travel needs.
- **Frequency of charging:** The number of times people would charge their ZEV also depends on the individual's preferences. The ideal scenario would be to maximise the range available to a certain SOC (i.e., 20%) to then charge the requisite amount needed rather than the maximum amount.
- **Charger utilisation:** The number of times a charger is used during the day provides the power output needed to support the charging needs across the network.

Key inputs for determining the number of public chargers include the assumed utilisation of network chargers, the duration of charging by the consumer, and the assumed initial battery capacity of vehicles. The required charging infrastructure by scenario to FY2030 are provided in the table and figure below.

Table iv – Charging infrastructure requirements per scenario by Level 2 and 3 by FY2030

	FY2021	FY2025	FY2030
Existing			
Level 2	9	NA	NA
Level 3	4[5]	NA	NA
Total	13	NA	NA
Pessimistic			
Total public charging kWh	1,040,964	4,892,855	21,246,286
Level 2	12	56	245
Level 3	2	8	36
Total	14	65	281
Conservative			
Total public charging kWh	1,040,964	7,729,070	43,719,951
Level 2	12	89	504
Level 3	2	13	74
Total	14	102	578
Optimistic			
Total public charging kWh	1,040,964	13,369,891	73,612,962
Level 2	12	154	849
Level 3	2	23	74
Total	14	177	973

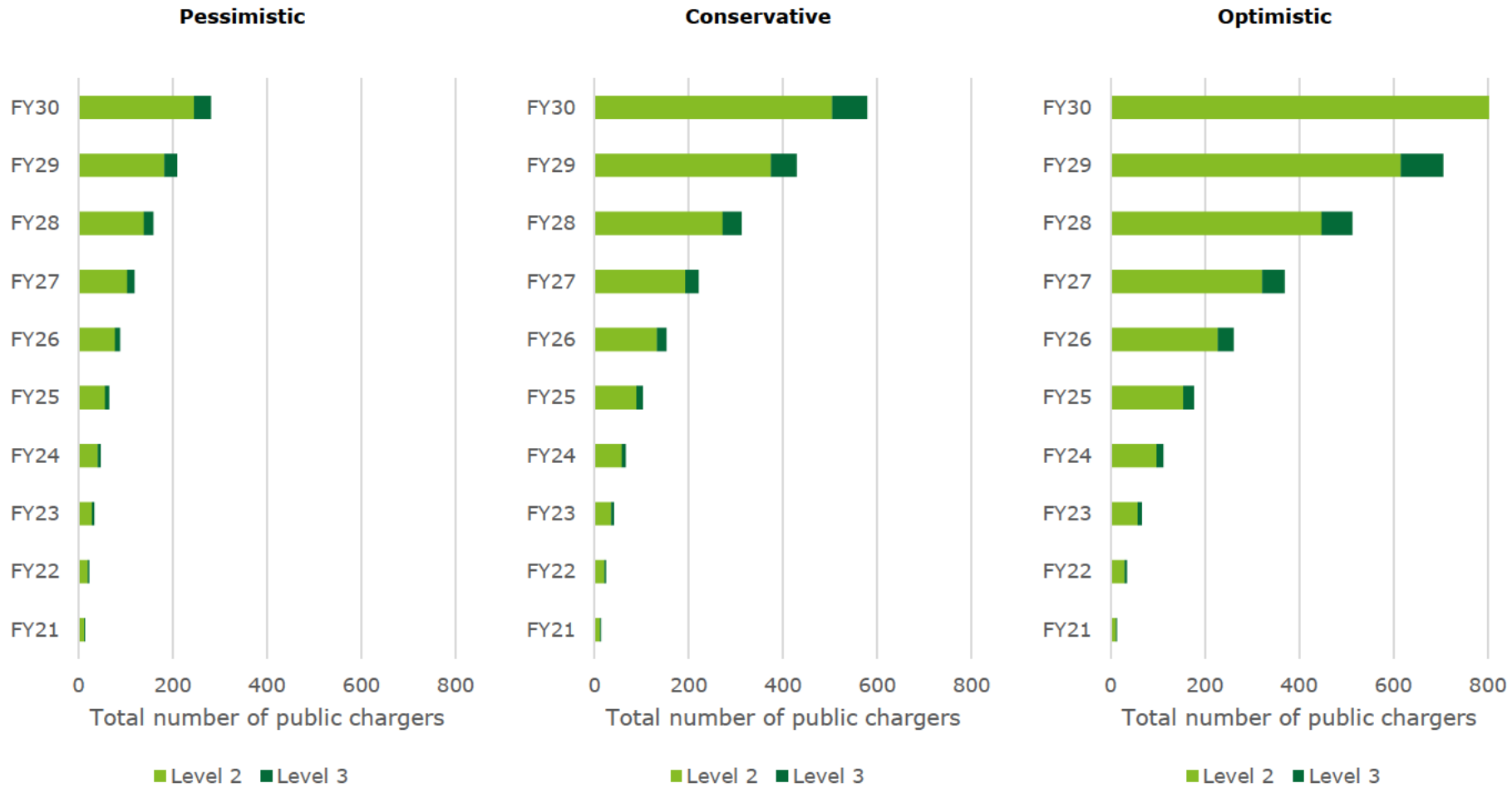
Source: Deloitte analysis

The projected number of public chargers required across the Pessimistic, Conservative and Optimistic scenarios are provided in Figure v. Demand for the first 50 chargers is expected to be exceeded in the years as follows:

- Pessimistic scenario: FY25 (66 chargers)
- Conservative scenario: FY24 (66 chargers)
- Optimistic scenario: FY23 (65 chargers).

[5] ARENA announced in June 2021 the approval for 8 new charging stations with the ability to serve two charge points of 50kW. Confirmation on timing of construction and operation will need to be determined.

Figure v – Public charging infrastructure requirements per scenario by Level 2 and 3 by FY2030



Source: Deloitte analysis

The number of chargers required across each SA2 has been mapped and sequenced to 2030 for each of the Pessimistic, Conservative and Optimistic scenarios. Movement from the Pessimistic through to the Conservative and Optimistic scenarios sees a greater number of chargers required, in terms of both concentration and distribution across the ACT. The need for chargers in Civic is heavily concentrated across all three scenarios. Specifically:

Under the Pessimistic scenario:

- The need for chargers will be largely concentrated in Civic; and
- There will be some need for chargers spanning from the North to South-most portions of the ACT.

Under the Conservative scenario:

- In Civic, the need for chargers will continue to increase in concentration, where the number of chargers required doubles;
- In the South-East regions of the ACT, a need for chargers emerges;
- In Greenway, Barton, Canberra Airport, Kingston, Braddon, and Belconnen, the number of chargers needed notably increases; and
- In the Central to Southern regions of the ACT, a need for chargers emerges in Wanniassa, Monash, Isabella Plains, Calwell, Conder and Banks.

Under the Optimistic scenario:

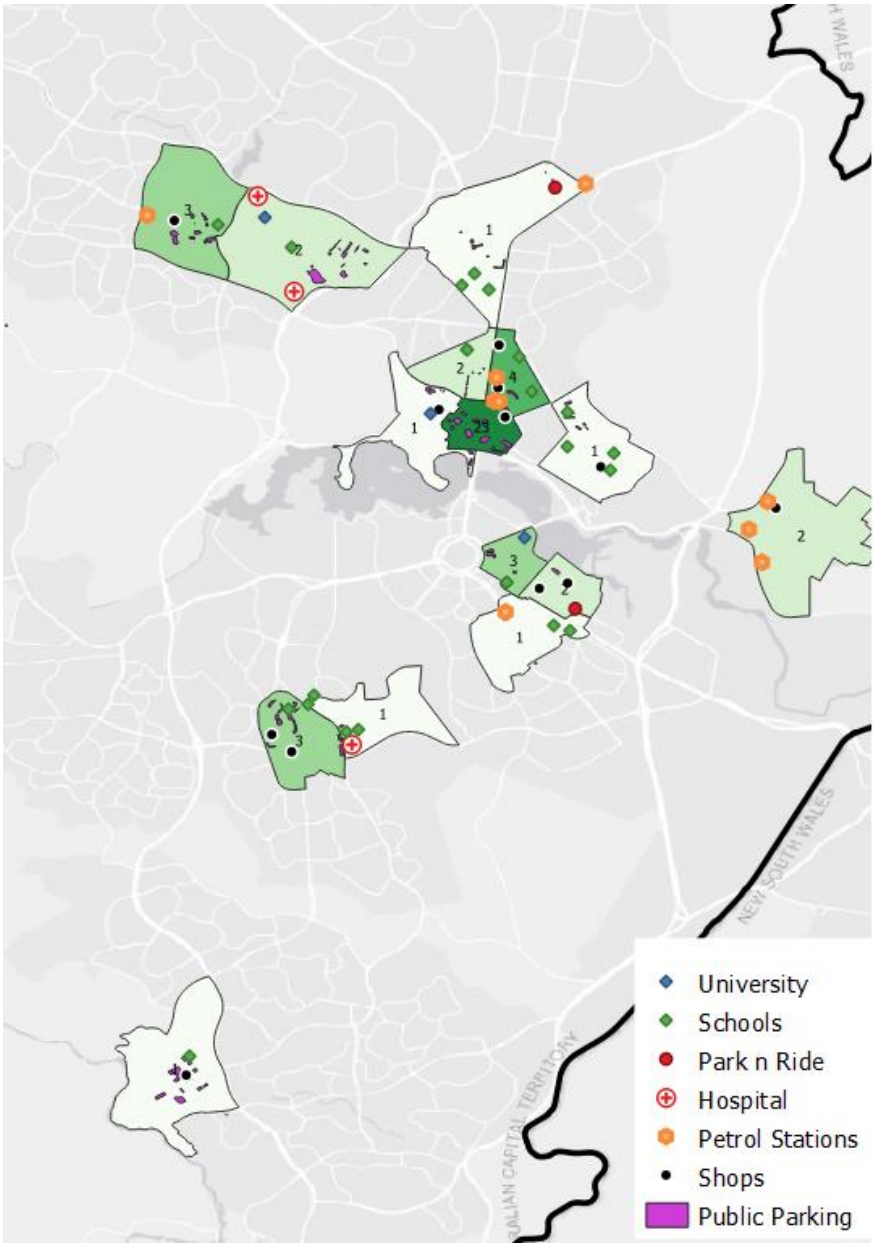
- In Civic, the need for chargers continues to increase in concentration; and
- SA2s exhibiting a need for chargers in the Conservative scenario will require a higher number of chargers – particularly Gungahlin, Franklin, Garran and Greenway

The suitability of the charging types will depend on the specific locations. For the purposes of analysis, the potential charging locations considered are detailed below.

- Institution uses (universities and schools)
- Park ‘n’ Ride
- Hospital
- Petrol Station
- Shopping Centre
- Public Parking.

An overview of these potential charging locations in the SA2s relevant for the first 50 chargers under the Conservative scenario is provided in Figure vi. Figure 7.6

Figure vi – Potential destination charger locations for the first 50 chargers under the Conservative scenario



Source: Deloitte analysis

1 Introduction

1.1 Purpose of this report

The ACT Government has an objective to reduce transport emissions through the encouragement of the uptake of ZEVs. The ACT's *Transition to Zero Emissions Vehicles Action Plan 2018–21* outlines the ACT Government's actions for encouraging the rapid uptake of electric cars, motorbikes and bicycles. This plan commits the ACT Government to 11 key actions in increasing the uptake of electric vehicles. This project will support a greater total number of ZEVs in the ACT and the establishment of a self-sustaining ZEV industry, through the delivery of a public ZEV charging network which increases the visibility of ZEVs in the ACT, and the removal of barriers to ZEV uptake (e.g., range anxiety or the lack of access to chargers).

As part of the *ACT Budget 2020-21*, the ACT Government has committed to commence work on a ZEV Public Charging Masterplan (the Masterplan) for the rollout of charging infrastructure, including $1.2 million for the delivery of the first 50 publicly accessible charging stations by 2022. The Masterplan will additionally detail the locations of the 50 new public chargers. Additionally, strategic planning is being undertaken to determine the location of future ZEV charging infrastructure on the basis of forecasted ZEV uptake and demand to 2030.

The ACT Government has engaged Deloitte to deliver analysis and modelling to inform the Masterplan and other policy development to support the transition to ZEVs in the ACT. This report has three overriding objectives:

1. **Determine the demand for charging in the ACT**

- Forecast the number of ZEV registrations to 2030 under several alternative uptake scenarios.
- Develop ZEV driving and charging profiles of ZEV users to inform what ZEV ownership will look like at different points in time throughout the ACT.

2. **Investigate potential constraints for charging infrastructure**

- Energy requirements from the grid to allow for energy planning and efficient choice of charging locations.
- Commercial constraints for charging locations (e.g., potential utilisation rates).

3. **Outline a methodology to refine and determine likely priority locations in the ACT**

- To optimise charger usage and encourage ZEV uptake, determine where the chargers should be placed and the timing of the rollout, on the basis of geographical information, physical constraints of potential charger sites, population spread, and the distribution of ZEV uptake.

1.2 Background

The transport sector is evolving, with this evolution being led by a combination of significant technological developments and broader goals of governments, corporations, communities and individuals to reduce emissions. This combination of forces has created both opportunities and challenges for the transport sector in the ACT with more than 1,000 battery electric and plug-in hybrid cars currently registered in the ACT.

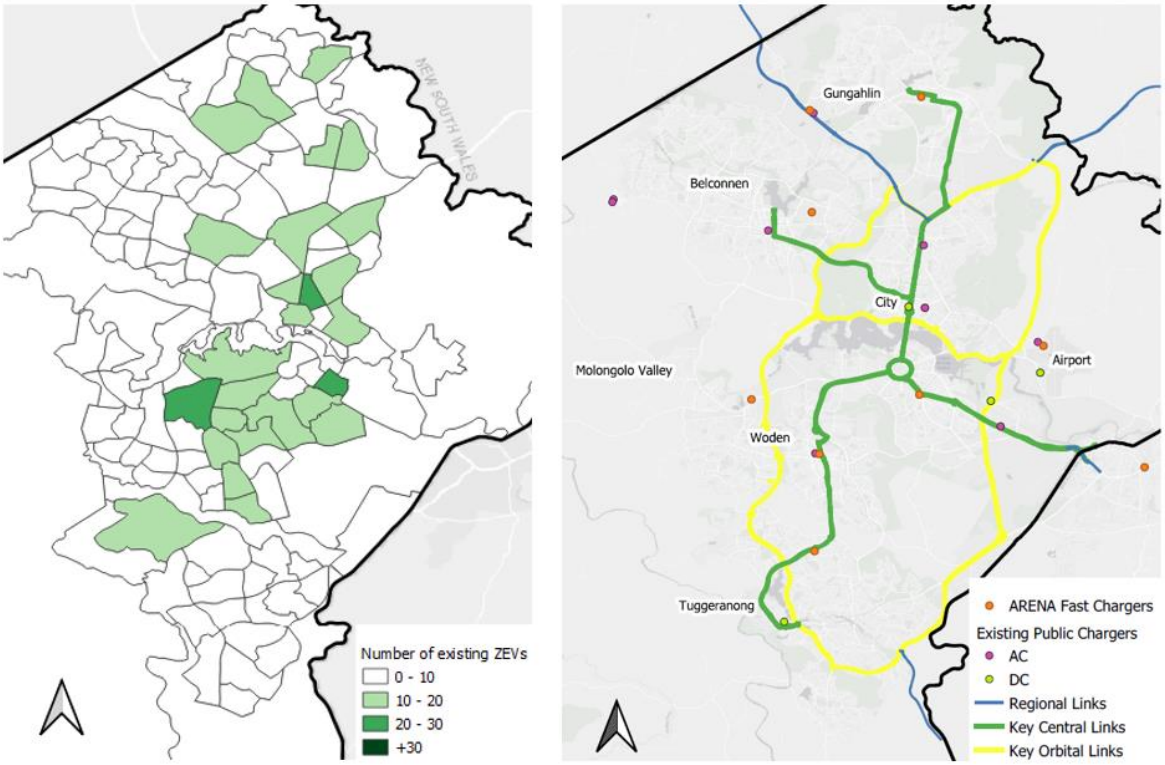
The ACT has Australia's most generous financial incentives for the purchase and registration of passenger ZEVs. They include:

- **Stamp duty exemption**: ZEVs that are purchased for the first time are eligible for a full stamp duty exemption.

- **2 years free registration**: Available between 24 May 2021 and 30 June 2024 for new or used ZEVs registered in the ACT. Second-hand ZEVs imported into Australia from overseas will also be eligible.
- **20% discount on registration costs**: All eligible ZEVs registered in the ACT currently not eligible for the full 2-year waive.
- **Sustainable household scheme**: The ACT Government has committed to providing households with interest free loans of up to $15,000 to assist in the upfront costs of investing in ZEVs, including second-hand ZEVs and home ZEV charging infrastructure.

In the short-term, as the relative prices of ZEVs become increasingly attractive, there will be greater incentives for the public to purchase ZEV vehicles. This combination of forces has created both opportunities and challenges for the transport sector in the ACT with more than 300 ZEVs currently registered across the ACT, as shown in Figure 1.1.

Figure 1.1 ACT cumulative ZEV registrations through June 2021 (left) and currently available public chargers (right)



Source: ACT motor vehicle registrations, ACT Transport Strategy and Plugshare

In Figure 1.1, chargers are categorised as 'fast charging' (DC) or 'slow charging' (AC) depending on the power output of the charger. On 30 July 2031, the first funding round of the Australian Renewable Energy Agency (ARENA) *Future Fuels Fund* of $24.55 million was announced, with over 400 public fast chargers nationwide and 8 within the ACT region[6].

Accessibility to charging infrastructure, however, will be vital in encouraging the adoption of ZEVs for many households. Poor access to charging infrastructure will result in a number of consequences across the ACT and may not allow ZEVs to fully realise their potential as a safe,

[6] 'Future Fuels Fund revved up to provide EV charging nationally', *Australian Renewable Energy Agency* (30 July 2021) < https://arena.gov.au/news/future-fuels-fund-revved-up-to-provide-ev-charging-nationally/>

efficient and accessible transport option which improves the economy and sustainability of the ACT.

1.3 Types of vehicles

Conventional vehicles with ICEs comprise the majority of passenger fleets due to a range of factors. These include vehicle cost, limited model availability, and the low number of existing public chargers. A comparative illustration of available vehicle types is shown in Figure 1.2.

Figure 1.2 Illustration of vehicle types

Criteria	Conventional	Hybrid	Plug-in Hybrid	Electric
Sources of Energy				
Consumption	Fuel only	Fuel + Battery	Fuel + Battery	Battery
Tailpipe emissions				

Source: RAC, Low and zero emission vehicles

The main types of ZEVs and inclusions within the demand model are provided in Table 1.1 below.

Table 1-1 Description of main types of EVs

Type	Description	ZEV
Battery electric vehicles (BEVS)	Powered solely by electric batteries charged from the grid	Yes
Fuel cell electric vehicles (FCEVs)	Powered by hydrogen gas	Yes
Plug-in Hybrids (PHEVS)	Powered interchangeably between electricity and gasoline (or both together)	No

Source: Factors affecting electric vehicle uptake, School of Built Environment

Key characteristics for ZEVs are:

- Any vehicle that is fully or partially driven by an electric motor and can be plugged in to charge
- Uses one or more electric motors powered by a battery pack to accelerate and drive
- Does not use petroleum fuels or emit greenhouse gas emissions from the tailpipe.

1.4 ZEV models in Australia

There are currently 28 ZEV models available for sale in Australia, with an additional 15 ZEV models anticipated by the end of 2021[7]. The limited range of ZEVs available domestically compared to international markets may be attributed to ZEV manufacturers overlooking the Australian market due to a lack of support measures or suitable consumer incentives[8]. Additional contributing factors include the smaller scale of the Australian market and right-hand drive of vehicles.

Larger battery sizes are additionally cost prohibitive with ZEVs typically close to $150,000 in price, with the starting price of majority being above $50,000 – therefore increasing barriers to ZEV uptake. Ongoing improvements to battery technology over time, however, is expected to result in continual reductions to vehicle price and an increase in ZEV sales.

A non-exhaustive list of current model specifications is detailed in Table 1-2.

Table 1-2 – Short list of vehicle models price and specifications as of April 2021

Model Type	Model Year	Price	Battery Capacity (kWh)	Range	Efficiency (kWh/100km)
Mercedes-Benz EQS	2021	$200,000	108	<770km	16
Porsche Taycan	2021	$190,400	79	450km	20
Audi e-tron GT	2021	$170,000	93	<487km	20
BMW iX	2021	$160,000	110	460km	21
Mercedes-Benz EQC 400	2020	$141,400	80	417km	21
BMW iX3	2021	$130,000	80	460km	18
Jaguar I-Pace EV400	2020	$128,248	90	470km	20
Tesla Model 3	2020	$62,900	50	440km	15
Kia Niro EV	2020	$62,590	53	455km	16
Hyundai Kona EV	2019	$62,000	64	484km	15
Hyundai Ioniq 5	2020	$60,000	58	<485km	16
Mazda MX-30 EV	2022	$60,000	36	200km	17
Mini Cooper SE Electric	2020	$54,800	33	233km	17
Renault Kangoo Maxi ZE	2018	$50,290	33	200km	12
Nissan Leaf	2019	$49,990	40	385km	17
Hyundai Ioniq Electric	2020	$48,970	38	455km	14
MG ZS EV	2021	$43,990	43	263km	19

Source: Royal Automobile Club of Western Australia, 'Electric cars available in Australia in 2021' (April 2021) <https://rac.com.au/car-motoring/info/electric-cars-australia

A survey of 3,800 participants had 58% of respondents identify the high purchase costs as the major barrier to purchasing a ZEV within the ACT region[9]. With battery size a leading indicator for vehicle prices and longer ranges, for the foreseeable future consumers will be more price sensitive while the supporting infrastructure for ZEVs (i.e., home/public charging stations) are developed.

[7] Royal Automobile Club of Western Australia, 'Electric cars available in Australia in 2021' (April 2021) <https://rac.com.au/car-motoring/info/electric-cars-australia>.

[8] Hamish Fitzsimmons, 'EV policies focus on the destination not the journey', *Australian Energy Council* (24 June 2021) < https://www.energycouncil.com.au/analysis/ev-policies-focus-on-the-destination-not-the-journey/>.

[9] Electric Vehicles in the ACT, University of Canberra (2020)

2 Current State

This chapter examines relevant case studies of ZEV uptake around the world. These case studies provide a high-level overview of examples of international success – and the strategies used – in the widespread adoption of ZEVs.

It is noted that the ACT is a unique jurisdiction in its own right and the jurisdictions considered below are not necessarily directly comparable. The following insights do, however, present valuable lessons which can be leveraged to inform decision-making.

2.1 International Case studies

2.1.1 Comparative review: Norway

Norway has been the most successful country in achieving ZEV market penetration, with policy support being the main driver of ZEV adoption. It is the first country where the sale of electric cars had overtaken those powered by petrol, diesel and hybrid engines in 2020.

Table 2-1 provides a snapshot of Norway including the extent of ZEV uptake across the country, existing charging infrastructure, and national targets.

Table 2-1 – Case Study: Norway

Norway (2021)	Description
Current population	5.5 million
# of registered ZEVs	464,000
ZEV market share	54%
# of ZEV chargers	16,000
Charging stations per population (100,000)	1:291
National targets	Ban of sales of fossil-fuelled cars by 2025

Source: Electrive (July 2021)

The Norwegian Government has invested heavily in financial incentives and EV charging infrastructure. Relevant policies, incentives and critical success factors attributable to the Norwegian Government are summarised as follows:

At the national level:

- No purchase/import tax or Value-added Tax (VAT)[10]: Drivers are exempt from both purchase tax and a 25% VAT on purchase when buying or leasing a new or pre-owned EV.
- No road traffic insurance tax: EV owners are exempt from paying annual road traffic insurance tax.

[10] VAT is analogous to Goods & Services Tax (GST) in Australia

At the local government level:

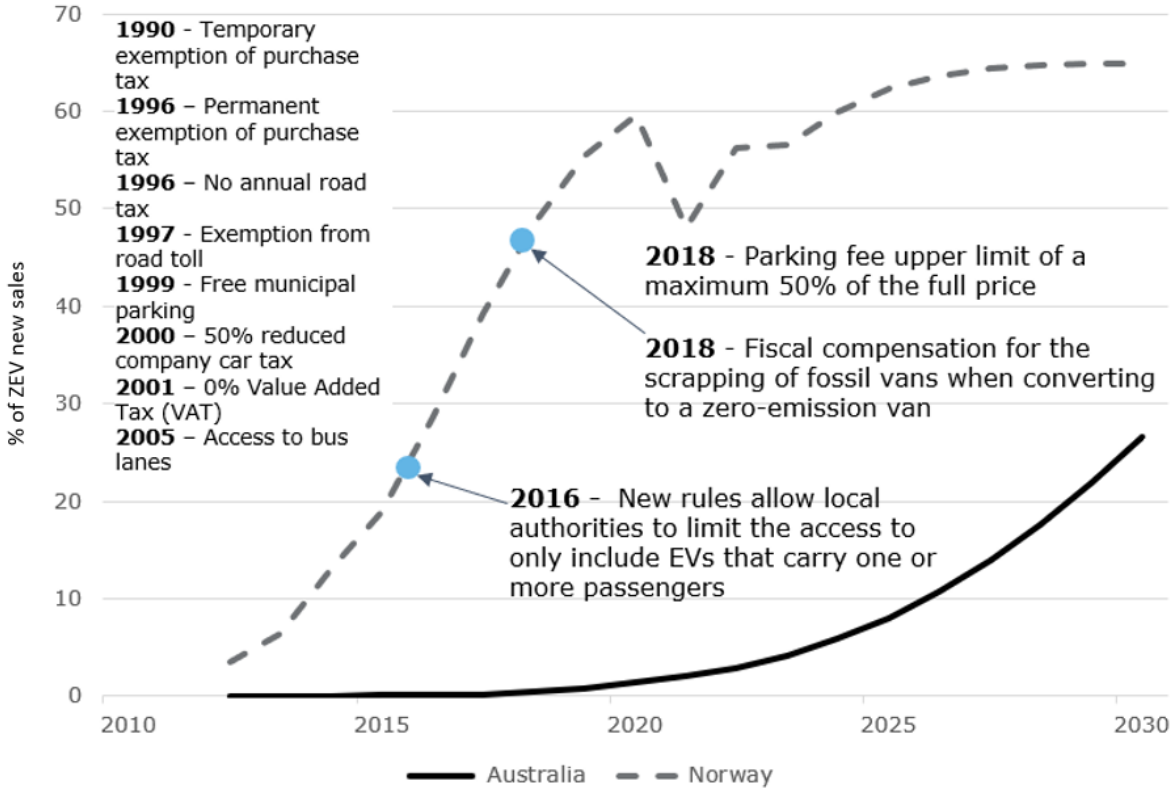
- Half price tolls: Charge of a maximum of 50% of standard toll prices on roads and ferries for EV owners.
- Half price parking: Charge of a maximum of 50% of the cost of standard parking for EV owners.
- Use of bus and taxi lanes: Access to bus and taxi lanes by EV owners.

Critical success factors:

- Funding of national, regional or local initiatives created by counties and municipalities: Funding of organisations such as Enova, and the creation of a framework for both the public and private sector to work within.
- Significant investment in charging infrastructure: Development of charging stations along major highways and investment in a national charging grid. For example, The Norwegian government has established fast-charging stations on every 50km on all main roads.
- Demographics – Comfort, safety and design: New standards have also been set in terms of range and speed.

The range of incentives introduced over time in Norway and the corresponding ZEV proportion of new sales is provided in Figure 2.1.

Figure 2.1 – Jurisdiction analysis on Norway's policy implementation with ZEV uptake



Source: BITRE (2020), Deloitte Analysis

2.1.2 Comparative review: Beijing, China

Rapid uptake of ZEVs across Beijing can be attributed to high levels of government support including the implementation of policies that promote investment in infrastructural support and incentivise of buyers. More broadly, China accounts for nearly half of global EV sales.

Table 2-2 provides a snapshot of Beijing including the extent of ZEV uptake across the city, existing charging infrastructure, and broader national targets.

Table 2-2 – Case Study: Beijing, China

Beijing, China (2021)	Description
Current population	20.9 million
# of registered ZEVs	188,000
ZEV market share	4.4%
# of ZEV chargers	205,100
Charging stations per population (100,000)	1:981
National targets	• *Ban on sale of ICE vehicles:* End sales of conventional vehicles by 2030 • *Zero emissions vehicle mandate*: Each Chinese vehicle manufacturer and importer is required to make or import at least 12% EVs (2020). Companies that fail to achieve the required percentages may purchase credits from companies that over-comply.

Source: He, Jin, 'How China put nearly 5 million new energy vehicles on the road in one decade', *The International Council on Clean Transportation* (28 January 2021) < https://theicct.org/blog/staff/china-new-energy-vehicles-jan2021>.

Government policy initiatives, incentives and critical success factors attributable to the Chinese Government are summarised as follows:

At the Central Government level:

- 20% ZEV passenger car share by 2025
- Exemption of ZEVs from consumption and sales taxes
- Waiving 50% of vehicle registration fees for ZEVs.

At the provincial and local government level:

- Subsidies for manufacturers of longer-range ZEVs
- Free and preferential parking for ZEVs
- Provision of grants for technological innovation and subsidies for manufacturers of ZEVs.

Critical success factors:

- Leadership and political commitment: High level of support from the government through incentive packages and regulatory legislative action. This has resulted in the increasing popularity of ZEVs among the public and changing consumer preferences.
- Focussed and flexible policy: Rollout of subsidies and incentives in Beijing to encourage initial interest in ZEVs, and imposition of restrictions on foreign car sellers to collaborate with local manufacturers created a strong domestic market, leading to a rapid uptake of ZEVs. Promotion

of policies to create a self-sufficient market will be shortly rolled out (e.g., reduction in subsidies).

- Involvement of a wide range of stakeholders to change consumer preference and behaviour: In the development of targeted policies, technological inputs from private and government-owned car and battery manufacturers have been incorporated, in addition to inputs from academic institutions studying the performance, acceptance and infrastructural requirements of ZEVs.

2.1.3 Comparison of international incentives

A summary of the range of policies that have been introduced across leading jurisdictions in terms of ZEV uptake is presented in Table 2-3. Policy options range from consumer incentives, infrastructure deployment, building codes, zoning and parking concessions.

Table 2-3 – Jurisdiction analysis on policy implementation

Policy	ACT, Australia	Oslo, Norway	Amsterdam, Netherlands	Los Angeles, USA	San Francisco, USA	London, England	Paris, France	Stockholm, Sweden	Beijing, China
Building code changes	✓								
Fuel efficiency standards			✓						
Direct vehicle incentive (i.e., interest free loans or tax concessions)									
Stamp duty/Registration discounts			✓						✓
Incentives for home and multi-dwelling chargers									
Exemption from road toll									
Zero emission zones									
Access to HOV and bus lanes		✓	✓		✓				
Free municipal charged parking									
Subsidies for companies		✓				✓	✓		
Owners of ICE vehicles are charged additional taxes			✓		✓	✓		✓	✓
Compensation for scrapping of ICE vehicles		✓			✓		✓		✓

Source: Deloitte analysis

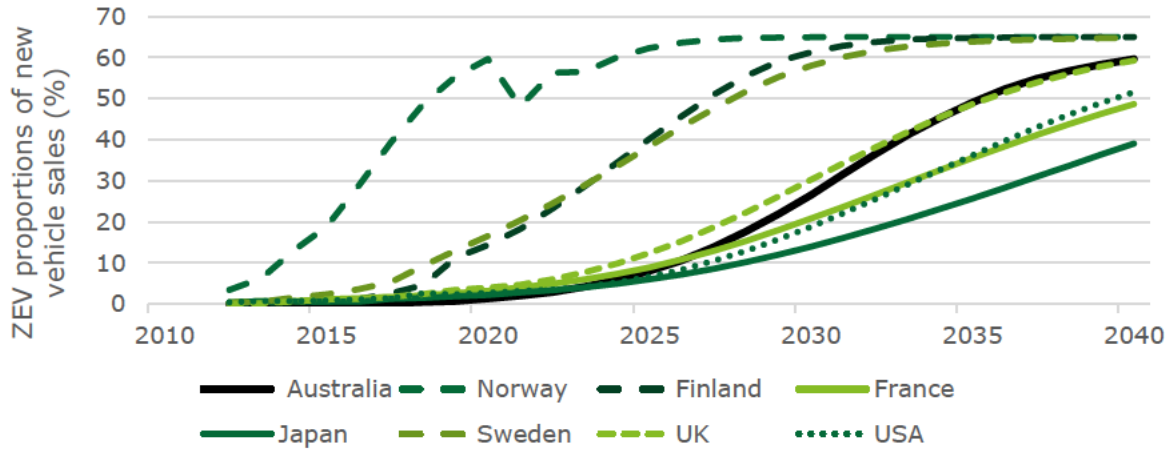
2.1.4 Comparison of major ZEV metrics

The introduction of Government subsidies to accelerate ZEV uptake varies depending on region. A number of jurisdictions have implemented a range of mechanisms to increase ZEV uptake. These include additional public charging infrastructure, discounts on upfront and operational costs and travel concessions to attract new users.

- ZEV proportion of new sales
- ZEVs per million population
- Public chargers per million population
- ZEVs per public charger.

A summary of a key metric – the ZEV proportion of new vehicle sales – across a number of jurisdictions is shown in Figure 2.2.

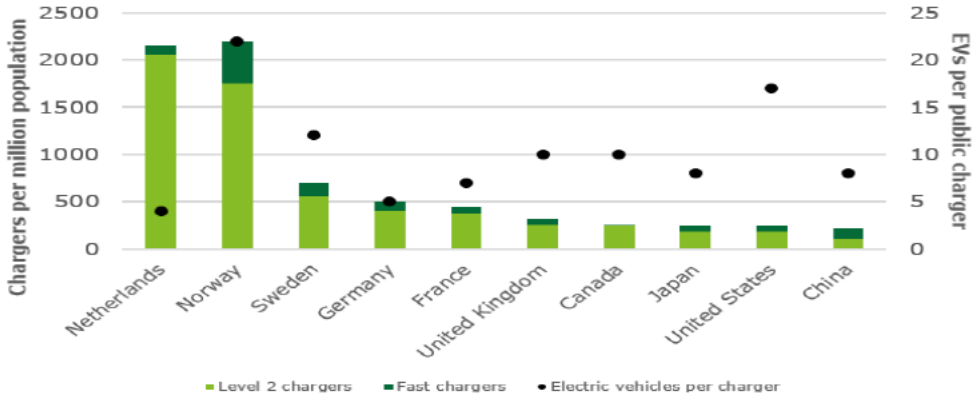
Figure 2.2 – ZEV uptake across leading adopters across the world



Source: BITRE

In 2021, there are 30 chargers per million population in the ACT and 79 ZEVs per public charger. These metrics provide a benchmark to gauge the ACT's current activities relative to leading nations as shown in Figure 2.3.

Figure 2.3 – Public charger per million population and ZEVs per public charger



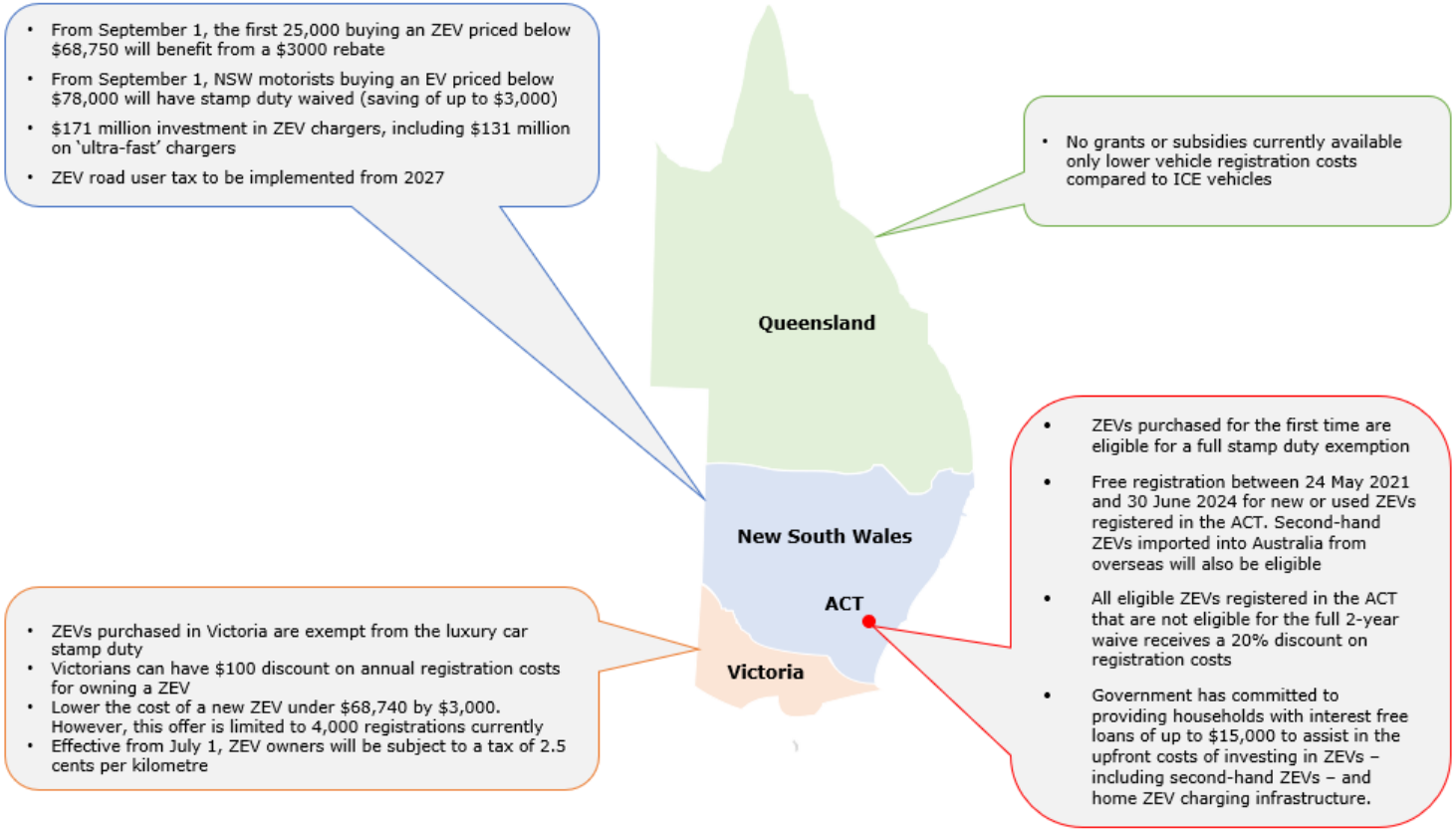
Source: Driving a green future: A retrospective review of China's electric vehicle development and outlook for the future, International Council on Clean Transportation (January 2021

2.2 Domestic overview

2.2.1 Existing ZEV policies

State and Territory Governments are introducing a greater range of ZEV incentives to lower price differences between ZEVs and ICE vehicles as a means of encouraging ZEV uptake. A summary of current incentives across a select number of Government bodies is illustrated in Figure 2.4.

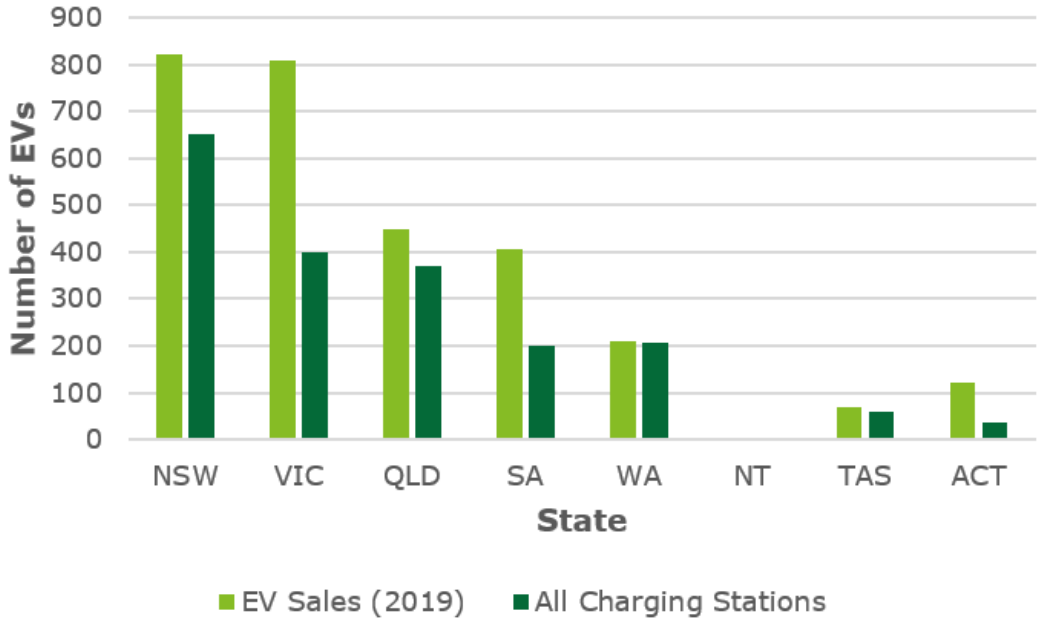
Figure 2.4 – Current ZEV incentives available across eastern Australia



Source: Various State and Territory Government websites

The three largest Australian states by population are the three states with the highest number of charging stations and ZEV sales, as shown in Figure 2.5. This indicates population is a key factor for consideration in the rollout of charging infrastructure.

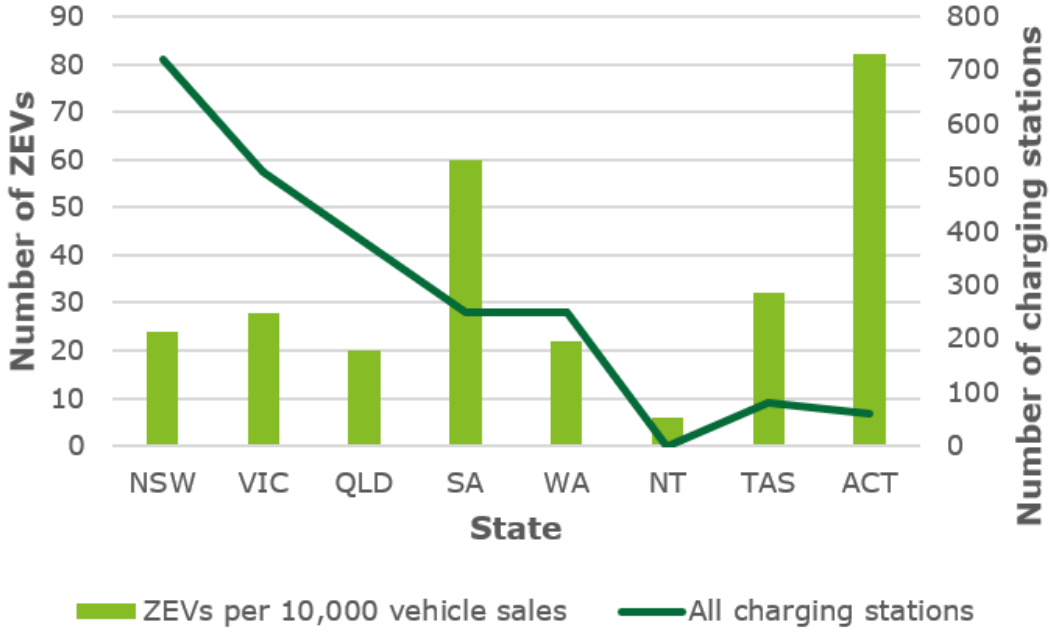
Figure 2.5 – Number of public charging stations per total ZEV sales in 2019



Source: Factors Affecting Electric Vehicle Uptake

While the ACT has a smaller population relative to larger Australian states, the ACT Government has been proactive in its introduction of incentives. The indicator of ZEVs per 10,000 vehicle sales demonstrates the effectiveness of ACT's initiatives with respect to other jurisdictions as shown in Figure 2.6.

Figure 2.6 – Number of ZEVs per 10,000 vehicle sales and total number of available public charging station (right)

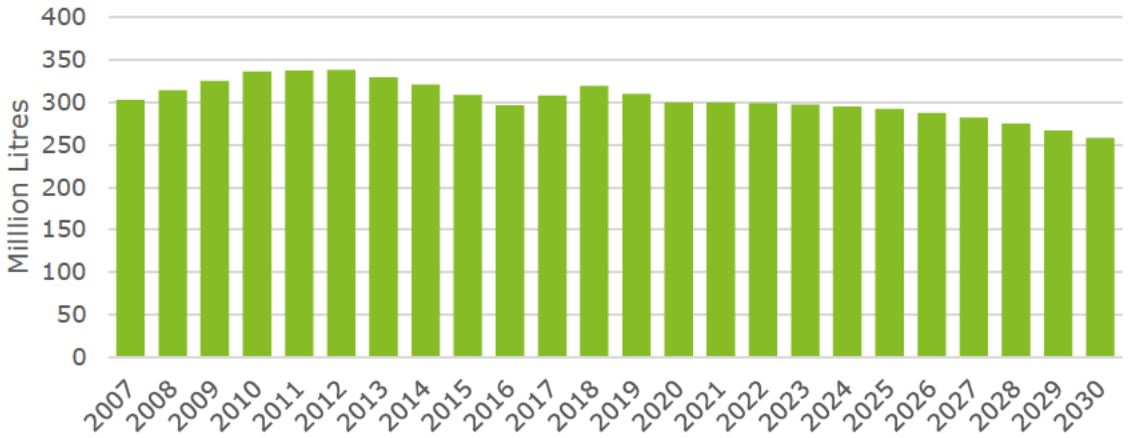


Source: Factors Affecting Electric Vehicle Uptake

2.3 ACT ZEV revenue implications

The introduction of ZEVs into the market will have direct financial consequences on existing business model structures. Currently, ICE vehicles have a number of potential revenue sources including fuel excise, registrations and associated taxes. The emergence of ZEV uptake will reduce revenue typically received from ICE vehicles, limiting available funding for allocation to community assets such as operations and the maintenance of roads. A 14% decline in demand of total fuel consumption to 2030 as shown in Figure 2.7 demonstrates flow-on effects on revenue contributions.

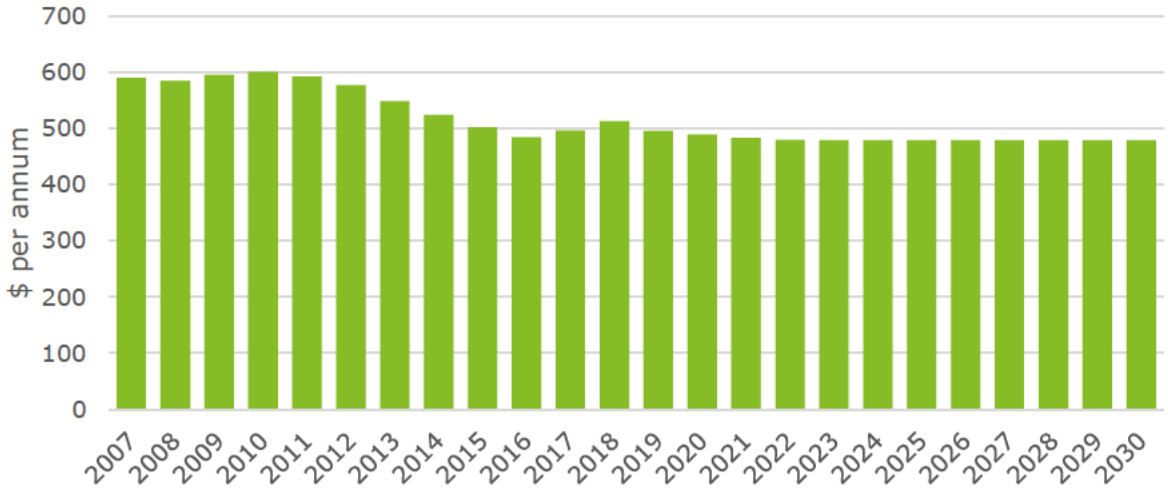
Figure 2.7 ACT total fuel consumption (million litres)



Source: ACT Treasury Stock model

In June 2021, the NSW Government announced the abolition of stamp duty on ZEVs. This is part of a $500 million investment for ZEVs to have more than half of all new car sales by 2031. The caveat to this announcement were the future intentions to introduce road-user tax within six years to fund road and infrastructure spending to compensate for loss of revenue from fuel excise. From the ACT Treasury stock model, projected fuel excise per annum is projected to have minimal variation to 2030 as shown in Figure 2.8.

Figure 2.8 ACT annual fuel excise ($ per annum)



Source: ACT Treasury Stock model

The current fuel excise revenue forecasts have not considered variations on potential ZEV uptake and the potential implications on funding to support the delivery of, for example, charging infrastructure. Future opportunities to offset revenue losses should be considered.

3 Demand Scenarios

Three core ZEV uptake scenarios have been developed in conjunction with the ACT Government through a series of workshops. This has enabled a clearer understanding of the demand for ZEV uptake over the medium to long term to be achieved. Each scenario has been modelled to reflect core assumptions based on key drivers and factors likely to impact the rate of ZEV uptake.

The Deloitte ZEV VCCE framework incorporates four key areas across the end-to-end lifecycle for ZEVs including vehicle, charger, consumer, and environment. The VCCE framework has been developed for the ZEV market to provide strategic guidance for policymakers. The below sections outline each scenario and key assumptions considered in this analysis.

3.1 Pessimistic

This scenario represents a less optimistic view of the future, relative to the base case. In this scenario, ZEVs fail to reach upfront cost parity with ICE vehicles and the availability of charging infrastructure does not improve on current day levels. A description of the Pessimistic scenario is detailed in Table 3-1 below.

Table 3-1 ZEV VCCE approach – Pessimistic

Element	Area	Description
Vehicle	Battery technology and lifecycle	Vehicles below $30,000 will have battery sizes around 25kWh with limited range capabilities
	Model availability	Only high price range ZEV manufacturers / companies enter Australian market – limited range around price parity
Charger	Charger reliability	There is a low proportion of suitable public chargers serving the needs of the community.
	Charger availability	Charging network infrastructure availability is limited, resulting in range anxiety
Consumer	Price costs	Price parity is not achieved by 2030, with limited affordability of ZEVs by low to middle income brackets
	Fuel efficiency standards	Limited fuel efficiency standards are imposed to discourage the use of ICE vehicles
	Environmental awareness	Population have limited awareness to impacts on transport emissions leading to minimal increase in ZEV uptake
Environment	Investment and Funding	Lack of ongoing coordination between State and Federal Government to provide necessary sequential charging infrastructure rollout
	Policies and subsidies	Policy support for ZEVs is inconsistent, meaning Australia does not receive the model variety and benefits the rest of the world sees
	Petrol prices	Minimal variation to current petrol prices is leading to minor increase in ZEV sales due to lower operational costs

Source: Deloitte analysis

3.2 Conservative

This scenario is characterised by a 'do minimal' policy approach to ZEV uptake in the ACT. This scenario assumes that ZEV uptake increases as price parity with ICE vehicles is achieved. It also assumes the occurrence of organic improvements in battery technology and changes in the policy environment. A description of the Conservative scenario is provided in Table 3-2.

Table 3-2 ZEV VCCE – Conservative Scenario

Element	Area	Problem
Vehicle	Battery technology and lifecycle	Vehicles below $30,000 will have battery sizes around 50kWh to enable greater range capabilities.
	Model availability	Combination of middle to high price range ZEV manufacturers / companies entering the Australian market
Charger	Charger reliability	There is a medium proportion of suitable public chargers serving the needs of the community.
	Charger availability	Charging network infrastructure availability is fair, enabling range anxiety for ZEV drivers to be reduced for frequented destinations
Consumer	Price costs	ZEV uptake increases as ZEVs reach price parity with ICE vehicles in 2027
	Fuel efficiency standards	Moderate fuel efficiency standards are imposed to discourage the use of ICE vehicles
	Environmental awareness	Population has a heightened awareness of the social and environmental benefits leading to a moderate increase in ZEV uptake
Environment	Investment and Funding:	Minimal support from the Federal Government means that, compared to other OECD countries, Australia is still behind the ZEV uptake curve
	Policies and subsidies	Adopting current initiatives such as stamp duty exemption, 2 years free registration, 20% discount on registration costs and sustainable house scheme
	Petrol prices	Moderate increase petrol prices are leading to an increase in ZEV sales due to lower operational costs

Source: Deloitte analysis

3.3 Optimistic

This scenario represents a more optimistic view of the future – ambitious decarbonisation - relative to the base case. In this scenario, ZEV uptake is assumed to increase significantly, in addition to reaching and surpassing price parity with ICE vehicles. A description of the Optimistic scenario is provided in Table 3-3.

Table 3-3 ZEV VCCE – Optimistic Scenario

Element	Area	Problem
Vehicle	Battery technology and lifecycle	Vehicles below $30,000 will have battery sizes above 75kWh to enable greater range capabilities.
	Model availability	Mass market ZEV manufacturers / companies enter Australian market and increasing model availability
Charger	Charger reliability	There is a high proportion of suitable public chargers serving the needs of the community.
	Charger availability	Charging network infrastructure availability is high, significantly decreasing range anxiety across the majority/all ODs
Consumer	Price costs	ZEV uptake increases significantly as they reach and surpass price parity with ICE vehicles in 2025
	Fuel efficiency standards	Strong fuel efficiency standards are imposed to discourage the use of ICE vehicle
	Environmental awareness	Population is motivated to switch to ZEVs due to the environmental impacts leading to an exponential increase in ZEV uptake
Environment	Investment and Funding:	ACT has implemented a broad/credible range of policies to encourage ZEV uptake. Subsidies can be wound back, as the ZEV environment has passed beyond the need for support
	Policies and subsidies	• Strong government incentives for international car manufacturers to enter Australia (i.e., lower import tax) • Introduction of more attractive Government incentives such as free vehicle registrations, grants and exemption of stamp duty next 5-10 years
	Petrol prices	Major increase in petrol prices is leading to higher ZEV sales due to lower operational costs

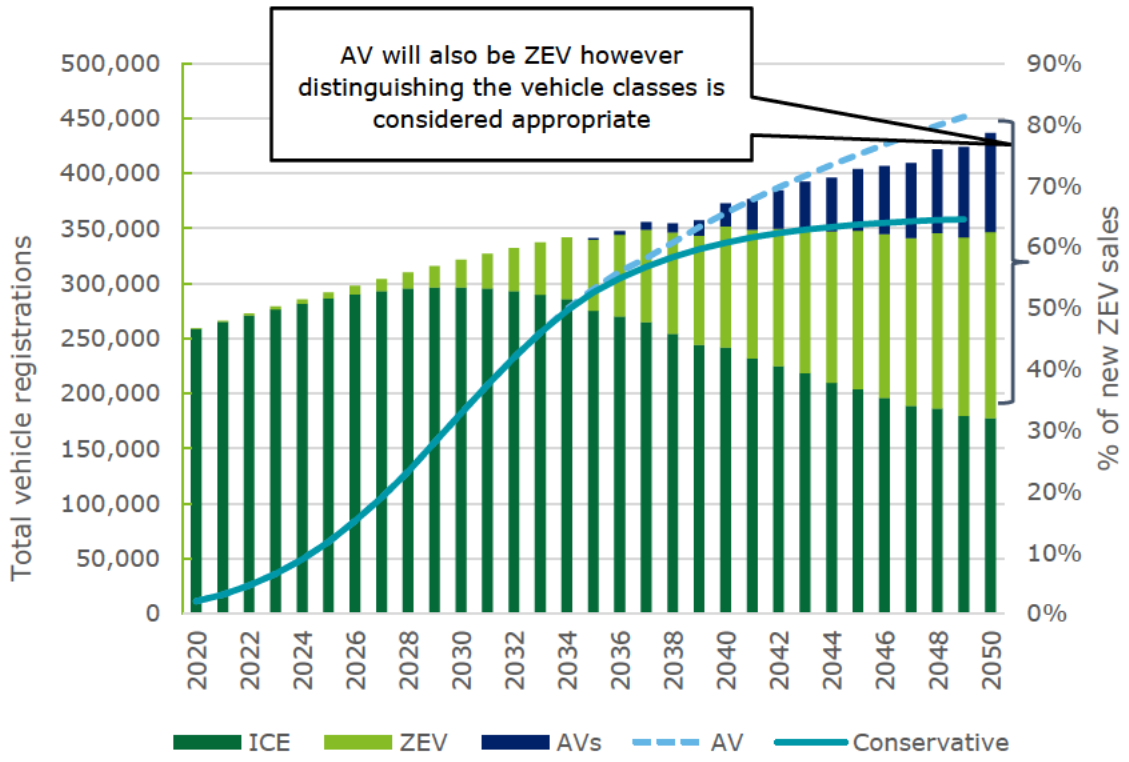
Source: Deloitte analysis

3.4 Automated Vehicles

The introduction of Automated Vehicles (AVs) as a likely future outcome will be an important consideration for the planning and delivery phases of ZEV charging infrastructure. This is due to the potential impact of AVs on future outcomes for the uptake of ZEVs. However, due to the uncertainty of timing with AVs, this scenario has been considered separately.

The projected uptake rates for the AV scenario are shown in Figure 3.1.

Figure 3.1 Autonomous Vehicles total vehicle registrations and ZEV proportion of new vehicle sales, FY50



Source: Deloitte analysis

While AVs and ZEVs have been grouped as ZEVs, for the purposes of this analysis, they have been distinguished. Similar to the current slow uptake of ZEVs, AVs are anticipated to be expensive in the early years and subject to consumer apprehension regarding the use of vehicles with limited to no driver assistance.

AVs are assumed to be readily available from 2035, where it will predominately be ZEVs that will accelerate growth of new ZEV sales. Due to changing ownership patterns, this is likely to result in an overall reduction in private fleet numbers.

A range of potential infrastructure and policy initiatives to consider include the incentivisation of ownership models, technology choices, and uptake rates aimed to maximise the benefits for AVs. Government investment in infrastructure to support necessary data systems will require coordination with vehicle manufacturers to understand infrastructure requirements.

AV scenario planning considers four potential use cases. These include:

- **Car Ownership & Urban Sprawl:** People are comfortable living away from metropolitan areas and are accepting of longer commutes. Public transport patronage decreases, car ownership increases, and road network congestion increases from current levels
- **Car Ownership & Urban Development:** Peoples' living patterns are clustered around activity centres with more precincts developed. Intensification of land use along defined public transport corridors with congestion reduced as people have less reliance on commutes.
- **Mobility as a Service (MaaS) & Urban Sprawl:** People will commute on a needs basis with variable travel times and costs via an app. Shared use trip increases with higher Vehicle Kilometre Travelled (VKT) leading to increased congestion and emissions.
- **MaaS & Urban Development:** People have a preference for shared trips with public transport less desirable, unless when replacing expensive low frequency service. This adoption will likely result in a sub-optimal network with more vehicle users.

At this stage, the business models for AVs are yet to established with various considerations to the impacts on land use planning and place of residence. Within a fully autonomous environment, the potential change on travel behaviour may be quite profound with people able be more productive by working in the vehicle instead of the idle time currently experienced while driving.

The frequency of trips and how vehicles are managed are also key considerations. With parked vehicles representing a significant component of use, the opportunity for vehicle owners to 'lease' their vehicle for trips for people can be a potential new alternative and revenue source for individuals. This would lead to an increase in current trip projections based on the additional new trips being added.

6 Shortlisting SA2 locations

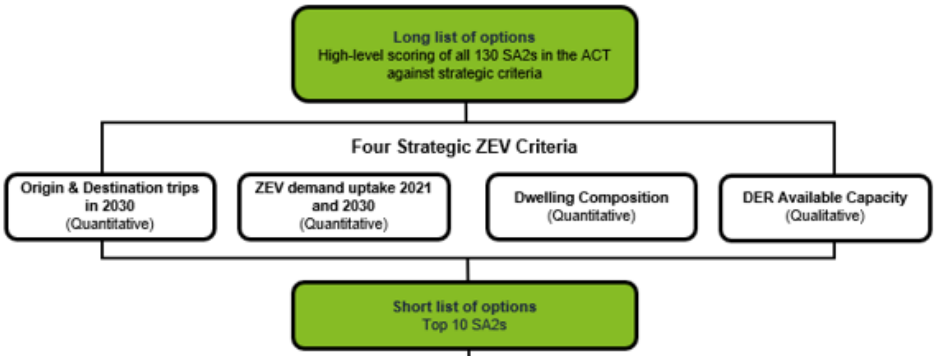
The findings presented in Chapters 4 and 5 provide an overview of the demand and supply requirements for charging infrastructure across the act. This chapter takes this analysis one step further to refine the final list of potential charging locations and determine a sequential rollout based on constraints and uptake, in order to maximise the benefits of the ACT Government's investment in public charging facilities.

This includes the application of a series of assessments frameworks to test the performance of various locations against both strategic and risk-based criteria. While each scenario varies in scale, the analysis has been applied to the modelling results for the 'conservative scenario' based on the higher likelihood of probability. Depending on changes to policy and ZEV uptake each year, an ongoing monitoring and evaluation of charging locations can continuously be applied to this approach.

1. **The 'long list'** consists of an assessment of **all 131 SA2 locations** across the ACT against four key ZEV criteria. This involves an assessment of the outputs from the scenarios, dwelling composition, and evaluation of available distribution capacity. The scoring of the long list seeks to identify key SA2s which align closely to respective metrics.
2. **The 'short list'** consists of the 'Top 25' SA2s with the highest composite score across the four key ZEV criteria.

An overview of the model structure, key assumptions and steps to determine the charger locations is depicted in Figure 6.1.

Figure 6.1 Deloitte's approach to the long and short list



Source: Deloitte

6.1 Analysing the long list of SA2 locations

To evaluate the long list (131 SA2s) of potential locations for public chargers, a quantitative and qualitative assessment was undertaken. The methodology for the development of the long list of locations is outlined as follows:

1. **Analysis of all 131 SA2 locations across the ACT against the four key ZEV criteria, which include** (each of these four criteria are discussed in turn in the sub-sections below):

- Origin-Destination trips in 2030 (Quantitative)
- ZEV demand uptake 2021 and 2030 (Quantitative)
- Dwelling Composition (Quantitative)

- DER Available Capacity.
  Due to data limitations this is a qualitative assessment at the substation level.

2. Allocation of a corresponding score (a total of 524) to each SA2 location under each of the four key ZEV considerations.
3. Identification of the 'T**op 30' SA2 locations** under **each of the four key ZEV criteria**, with locations being ranked from highest to lowest (e.g., in terms of number of trips, vehicles, people, or distribution capacity). They are provided in Sections 6.1.1 to 6.1.4 below.
4. Aggregation of scores for each of the long-listed locations under the four key ZEV considerations, resulting in an **'overall composite score' for each SA2 location** and an overall long list of the top 40 SA2 locations.

6.1.1 Origin and Destination trips

There are a number of common SA2's for major Origin and Destinations that highlight key nodes such as Civic, with the highest rank for both Origin and Destination in 2030. These are provided in Table 6-1 and are ordered from the highest to lowest number of trips.

Table 6-1 – Conservative Scenario - Top 30 ZEV Origin and Destination trips (2030)

#	Origin		Destination	
	SA2	**# trips**	**SA2**	**# trips**
1	Civic	47,788	Civic	44,759
2	Braddon	8,960	Braddon	8,439
3	Barton	7,775	Barton	8,101
4	Kingston (ACT)	7,646	Belconnen	7,973
5	Belconnen	7,112	Bruce	7,917
6	Phillip	7,067	Phillip	7,837
7	Garran	4,957	Kingston (ACT)	6,890
8	Hume	4,895	Acton	6,545
9	Griffith (ACT)	4,124	Garran	4,991
10	Watson	4,002	Hume	4,932
11	Lyneham	3,750	Griffith (ACT)	4,129
12	Bruce	3,696	Campbell	3,714
13	Campbell	3,696	Watson	3,662
14	Turner	3,450	Canberra Airport	3,591
15	Canberra Airport	3,427	Lyneham	3,418
16	Acton	3,249	Reid	3,352
17	Gungahlin	3,068	Deakin	3,170
18	Deakin	3,057	Turner	3,044
19	Dickson	2,865	Greenway	3,040

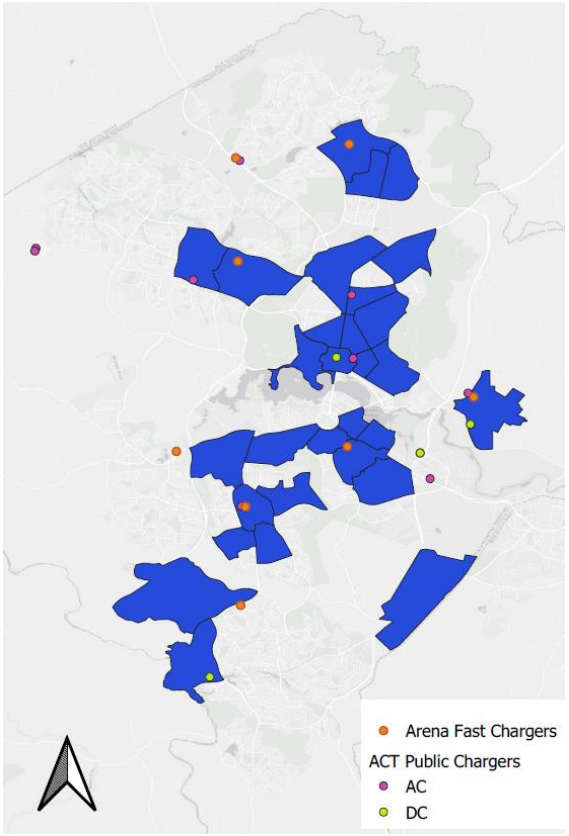
#	Origin		Destination	
	SA2	**# trips**	**SA2**	**# trips**
20	Greenway	2,767	Dickson	3,038
21	Curtin	2,596	Gungahlin	2,936
22	Mawson	2,544	Curtin	2,332
23	Narrabundah	2,485	Narrabundah	2,244
24	Kambah	2,227	Mawson	2,166
25	Forrest	2,196	Forrest	2,146
26	Ainslie	2,061	Harrison	2,082
27	Franklin	1,991	Kambah	1,924
28	Harrison	1,986	Franklin	1,802
29	Downer	1,668	Pearce	1,776
30	Casey	1,589	Ainslie	1,730

Source: ACT Transport Model

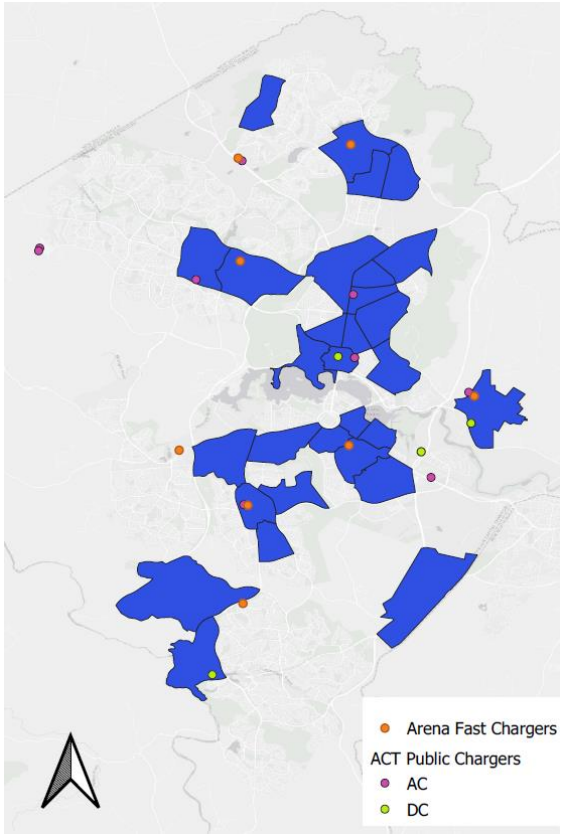
The top 30 Origin and Destination Trips to 2030 under the Conservative scenario are provided in Figure 6.2.

Figure 6.2 Conservative Scenario – Top 30 Origin and Destination Trips (2030)

Origin 2030



Destination 2030



Source: Deloitte analysis

6.1.2 ZEV uptake

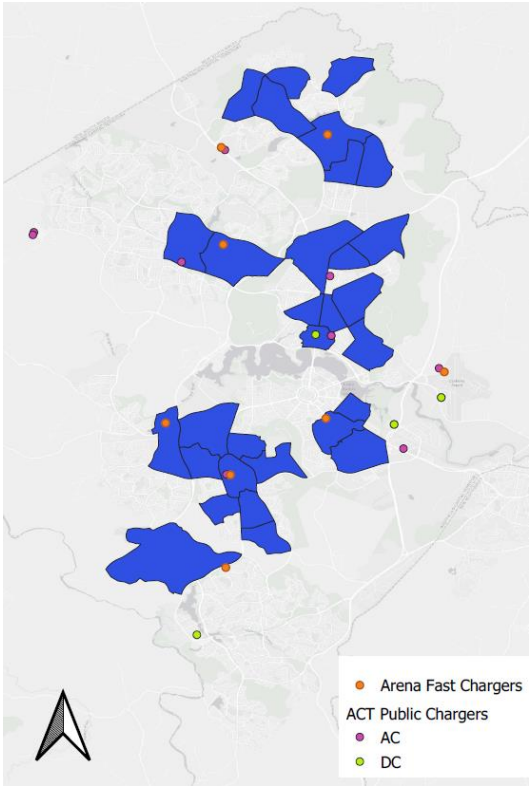
The anticipated ZEV uptake by SA2 provided in Table 6-2 gives insight into key growth areas under the Conservative scenario, and is ordered from highest to lowest number of ZEV vehicles. This is also represented visually in Figure 6.3.

Table 6-2 – 2030 Conservative Scenario – ZEV Demand Uptake

Rank	SA2	ZEV (2030)	#	SA2	ZEV (2030)
1	Kingston (ACT)	1,124	**16**	Campbell	366
2	Braddon	879	**17**	Farrer	357
3	Civic	621	**18**	Lyneham	356
4	Curtin	569	**19**	Ainslie	353
5	Griffith (ACT)	549	**20**	Hughes	334
6	Kambah	536	**21**	Mawson	330
7	Turner	500	**22**	Weston	329
8	Phillip	497	**23**	Gungahlin	329
9	Watson	488	**24**	Casey	303
10	Franklin	470	**25**	Bruce	298
11	Belconnen	466	**26**	Downer	294
12	Narrabundah	453	**27**	Pearce	293
13	Garran	420	**28**	Lyons (ACT)	293
14	Harrison	389	**29**	Bonner	287
15	Ngunnawal	377	**30**	Moncrieff	282

Source: Deloitte analysis

Figure 6.3 2030 top 30 SA2 scoring assessed for ZEV demand uptake (Conservative)



Source: Deloitte analysis

6.1.3 Dwelling type

Home charging comprises the majority of charging needs for people with access to dedicated charging. However, residents in non-detached housing such as apartments and townhouses will have limited access to such charging infrastructure. The top 30 SA2 locations within areas with a high proportion of non-detached housing composition is ordered from highest to lowest number of people in Table 6-3, and visually represented in Figure 6.4.

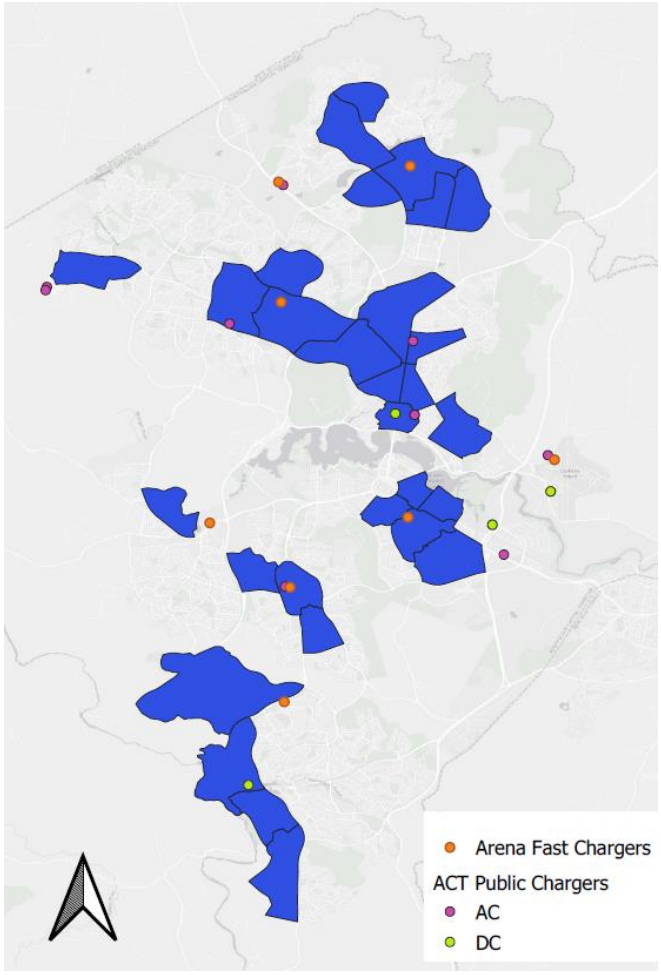
Table 6-3 2030 Top 30 SA2 with Apartment residents (Number of dwellings)

Rank	SA2	Number of Dwellings (2030)	Rank	SA2	Number of Dwellings (2030)
1	Kingston (ACT)	3682	**16**	Coombs	915
2	Braddon	3675	**17**	Lawson	878
3	Belconnen	3552	**18**	Dickson	832
4	Civic	2388	**19**	Mawson	806
5	Bruce	2212	**20**	Ngunnawal	720
6	Phillip	2193	**21**	Gordon (ACT)	719
7	Turner	1958	**22**	O'Connor (ACT)	717

8	Griffith (ACT)	1865	**23**	Palmerston	672
9	Greenway	1619	**24**	Narrabundah	650
10	Gungahlin	1520	**25**	Holt	649
11	Lyneham	1497	**26**	Bonython	610
12	Franklin	1429	**27**	Kambah	610
13	Harrison	1136	**28**	Lyons (ACT)	599
14	Barton	1084	**29**	Forrest	545
15	Campbell	985	**30**	Moncrieff	537

Source: Deloitte analysis

Figure 6.4 2030 top 30 SA2 scoring assessed for non-detached dwelling type (Conservative)



Source: Deloitte analysis

6.1.4 Available distribution capacity

Current data on distribution capacity (criteria four) is only available at the substation level, which has a broad alignment to SA3. As a consequence, broad geographical areas may be flagged has having (in)sufficient distributional capacity but may not have (in)sufficient capacity at the SA2 level. This is noted as a limitation in this analysis.

The combined capacity of renewable electricity generation capacity in the ACT now exceeds 220 megawatts (MW).[14] The opportunity to leverage these renewable sources for storage capacity can assist the network's ability to accommodate public charging. Table 6-4 provides estimates of available rooftop solar capacity by property type (MW) for the ACT.

Table 6-4 ACT Potential Rooftop Solar PV (MW), by property type

Capacity by property type	Residential	Industrial	Commercial	Mixed	Total
MW	3,198	46,447	153,538	13,908	217,091

Source: Solar PV zone potential, National Map

The power metric adopted across network level is typically Mega-Voltage-Ampere (MVA) which is equivalent to MegaWatt (MW). However, for the purposes of this analysis, MVA is the adopted metric based on the uncertainty of the power factor across the network.

Table 6-5 is in relation to the available capacity able to service energy demands across the network at the Zone Substation level (Asset Code). This identifies areas that either have substantial surplus capacity or are severely constrained moving ahead, as detailed below.

Table 6-5 Substation available capacity to 2029, MVA

#	SA3	Asset Code	Year								
			21	22	23	24	25	26	27	28	29
1	Tuggeranong	EV_TZS	43	44	44	44	45	45	46	46	47
2	Canberra East	EV_ELZS	37	37	38	37	38	38	38	39	39
3	South Canberra	EV_TPZS	31	31	31	33	34	33	34	34	35
4	Tuggeranong	EV_GZS	17	17	18	17	17	16	15	16	15
5	Canberra East	ES_763	13	12	11	13	13	13	13	13	13
6	Canberra East	EV_CEZS	1	-1	-2	-6	-6	-6	-6	-6	-6
7	Belconnen	EV_LZS	0	-1	-2	-3	-3	-3	-3	-3	-3
8	Canberra East	ES_883	3	3	3	3	3	3	3	3	3
9	Belconnen	EV_BZS	5	5	-2	-5	-7	-7	-7	-7	-7
10	Urrriarra-Namadgi	EV_WAZS	0	0	0	0	0	0	0	0	0

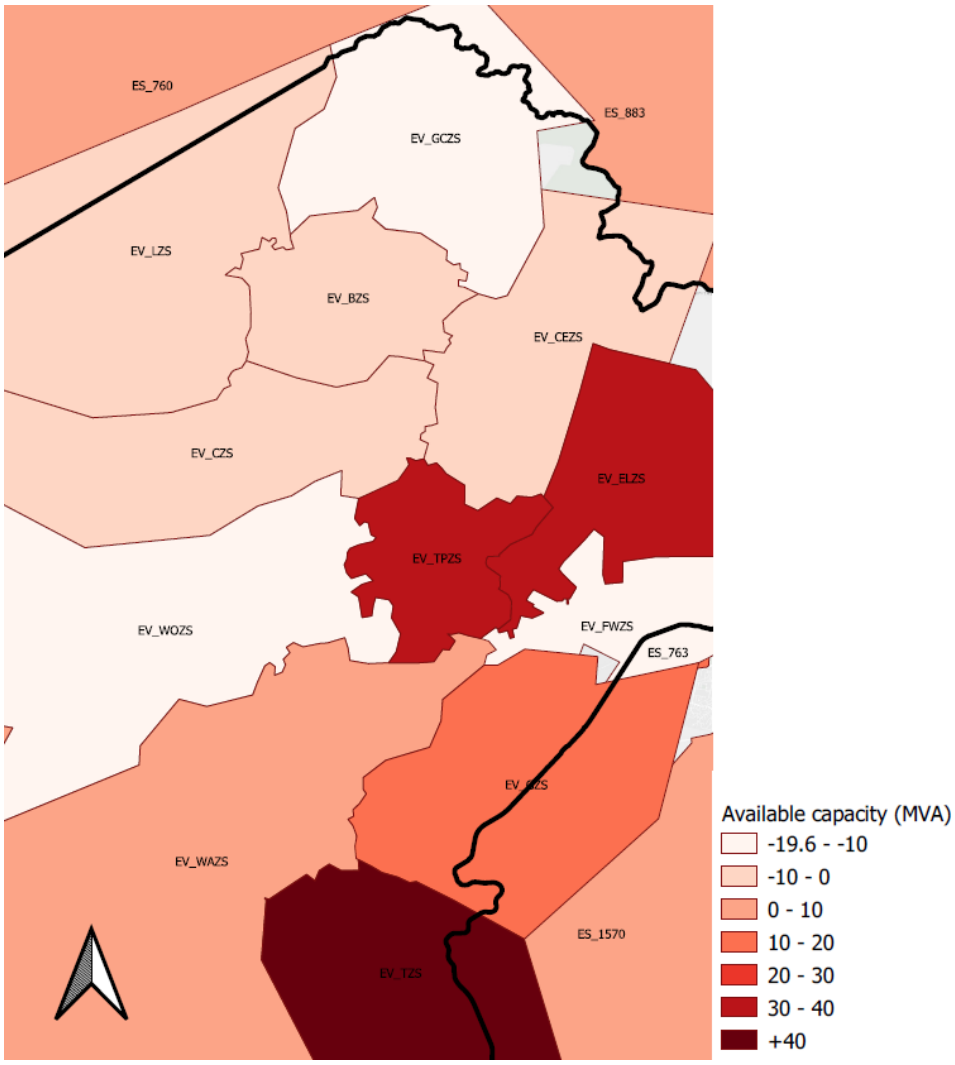
[14] ACT Government, Cleaner Energy

#	SA3	Asset Code	Year								
			21	22	23	24	25	26	27	28	29
11	Urrriarra-Namadgi	EV_WOZS	0	-1	-7	-10	-12	-12	-12	-12	-12
12	Canberra East	EV_FWZS	-10	-11	-11	-11	-10	-10	-10	-10	-10
13	Gungahlin	EV_GCZS	-6	-12	-15	-17	-20	-20	-20	-20	-20

Source: Australian Government, National Map

In Figure 6.5 below, the dark shaded colours indicate a period when zones that have sufficient spare capacity (available capacity is around or above zero), while the lighter shade colours (where available capacity is below zero) indicate periods where zones face capacity-related constraints – where investment will be needed to ensure reliability is maintained.

Figure 6.5 2029 Available Distribution Capacity (MVA)



Source: Australian Government, National Map

Across the ACT energy grid network, a number of areas appear to have surplus and shortfall capacity up to 2029. Based on the ZEV uptake analysis, regions including Gungahlin and Belconnen have shortfalls which require consideration for future investments, in terms of upgrading capacity.

6.2 The short list of SA2 locations

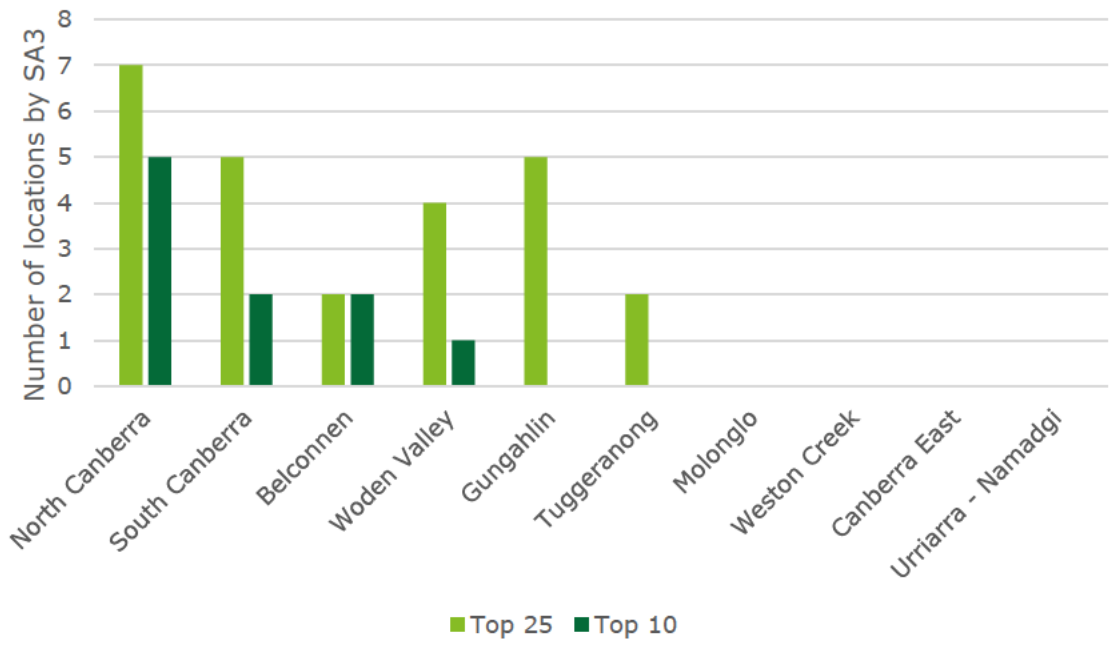
Table 6-6 below provides an overview of the scores of the top 25 SAs by three of the four key ZEV criteria. Due to data limitations, this is a qualitative assessment at the substation level. The short list consists of the top 10 SAs, which will be subject to a location assessment in Section 6.3.

Current data on the distribution capacity (criteria four) is only available at the substation level, which has a broad alignment to SA3 (as discussed in Section 6.1.4). As a consequence, broad geographical areas may be flagged as having (in)sufficient distributional capacity however may not have (in)sufficient capacity at the SA2 level. This is noted as a limitation of this analysis.

From the results presented in Table 6-6, it can be seen that the SA3 level 'North Canberra' accounts for 50% of the locations of the T**op 10 SA3 location short list**. This is followed by 'South Canberra' and 'Belconnen' at 20% and 'Woden Valley' at 10%.

Looking the broader list of the T**op 25 SA3 locations**, 'North Canberra' accounts for almost 30% of locations, and 'South Canberra' and 'Gungahlin' accounts for 20% of locations. 'Woden Valley' at 15%, and 'Belconnen' and 'Tuggeranong' at 5%. The SA3s of 'Molonglo', 'Weston Creek', 'Canberra East', and 'Urriarra – Namadgi' do not appear in the top 25 by this assessment criteria (Figure 6.6).

Figure 6.6: Number of SA3 locations in the short list assessment



Source: Deloitte Analysis

The long list of the top 131 SA2 locations are provided in Appendix C.

Table 6-6 – Short list scoring of potential charging locations by SA2

Rank	SA3	SA2	C1. O/D trips (2030)		C2. ZEV uptake (2030)	C3. Dwelling type (2030)	Distribution capacity (2030)
			O	D			Qualitative *6 = High* *1 = Low*
1	North Canberra	Braddon	130	130	130	130	5
2	North Canberra	Civic	131	131	129	128	5
3	South Canberra	Kingston (ACT)	125	128	131	131	5
4	Belconnen	Belconnen	128	127	121	129	2
5	Woden Valley	Phillip	126	126	124	126	3 - 5
6	South Canberra	Griffith (ACT)	121	123	127	124	5
7	North Canberra	Turner	114	118	125	125	5
8	Belconnen	Bruce	127	120	107	127	2
9	North Canberra	Lyneham	117	121	114	121	5
10	North Canberra	Campbell	120	119	116	117	5

Rank	SA3	SA2	C1. O/D trips (2030)		C2. ZEV uptake (2030)	C3. Dwelling type (2030)	Distribution capacity (2030)
			O	D			Qualitative *6 = High* *1 = Low*
11	South Canberra	Barton	129	129	88	118	5
12	Woden Valley	Garran	123	125	119	96	3 - 5
13	Gungahlin	Gungahlin	111	115	109	122	1
14	Gungahlin	Franklin	104	105	122	120	1
15	Gungahlin	Harrison	106	104	118	119	1
16	South Canberra	Narrabundah	109	109	120	108	5
17	Tuggeranong	Kambah	105	108	126	105	4 - 6
18	Woden Valley	Mawson	108	110	111	113	3 - 5
19	Woden Valley	Curtin	110	111	128	86	3 - 5
20	Gungahlin	Ngunnawal	99	101	117	112	1
21	North Canberra	Dickson	112	113	82	114	5

Rank	SA3	SA2	C1. O/D trips (2030)		C2. ZEV uptake (2030)	C3. Dwelling type (2030)	Distribution capacity (2030)
			O	D			Qualitative *6 = High* *1 = Low*
22	Gungahlin	Casey	98	102	108	101	1
23	Tuggeranong	Greenway	113	112	60	123	4 - 6
24	South Canberra	Deakin	115	114	94	84	5
25	North Canberra	Ainslie	102	106	113	81	5

Source: Deloitte analysis

*Due to insufficient data distribution capacity has been subject to a qualitative assessment at the substation level.

7 Sequence of locations requiring public charging to 2030

7.1 Overview

This section presents:

- The location of the first 50 public chargers to be delivered in the ACT
- The distribution of likely demand for public chargers to 2030.

Section 7.2 presents the number of chargers required across the ACT. While Section 7.3 presents the number of chargers required across each SA2 to 2030 for each of the Pessimistic, Conservative and Optimistic scenarios. The need for chargers has been mapped and sequenced to show the 2021, 2025 and 2030 states.

Section 7.4 presents the potential charging location types across the ACT, which comprise the variety of land uses that will provide the first 50 chargers. The potential charging location types included in this analysis are:

- Universities
- School
- Park 'n' Ride
- Hospital
- Petrol Station
- Shopping centre
- Public Parking.

An evaluation framework intended to provide a guideline to align with the actual ACT ZEV uptake based on the evolving needs of the charging network over time is provided in Section 7.5. The considerations for the charging station rollout will also need to consider the breakdown in Level 2 and Level 3 chargers.

7.2 Charging infrastructure across the ACT

Travel behaviour considerations differ depending on people living in urban or regional environments, which in turn influences charging demands. Key charging behaviours to inform the number of public chargers required will vary by individual, and include the following:

- **Time:** The duration of charging and time people would be willing to charge in public varies by individual.
- **State of Charge (SOC):** The SOC represents a key variable in the duration an individual would charge, to ensure sufficient range is provided to align with their travel needs.
- **Frequency of charging:** The number of times people would charge their ZEV also depends on the individual's preferences. The ideal scenario would be to maximise the range available to a certain SOC (i.e., 20%) to then charge the requisite amount needed rather than the maximum amount.

- **Charger utilisation:** The number of times a charger is used during the day provides the power output needed to support the charging needs across the network.

A description of the charging types considered for modelling the number of chargers is based on the charger utilisation and power output. These are provided in Table 7-1.

Table 7-1 – Summary of purposes for the modelled charge types

Type of charger	Description	Level	Power	% across network
Destination Charging	Slow charge, when the battery is close to full or the charger can supply a small amount of power.	2	22kW	80%
Fast Charging	Station has a larger charging capacity that enables longer journeys by adding as much range as possible in the shorter time period.	3	50kW	20%

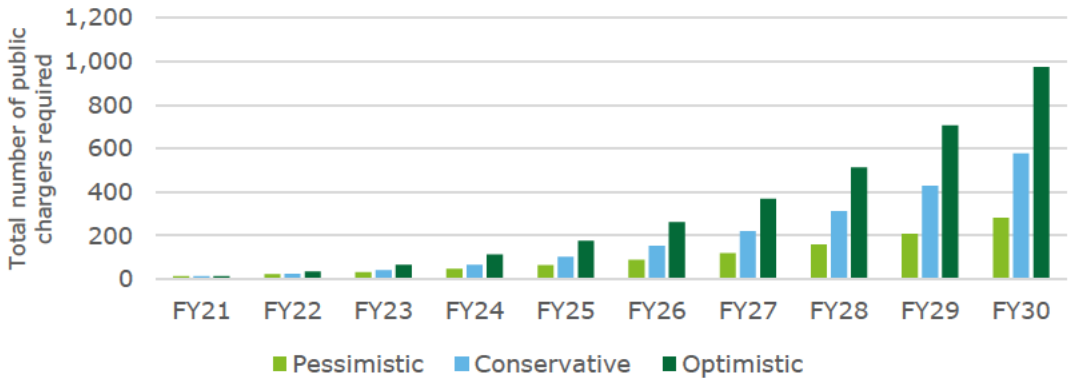
Source: Deloitte analysis

The projected number of public chargers required across the Pessimistic, Conservative and Optimistic scenarios are provided in Figure 7.1. Demand for the first 50 chargers is expected to be exceeded in the years as follows:

- Pessimistic scenario: FY25 (66 chargers)
- Conservative scenario: FY24 (66 chargers)
- Optimistic scenario: FY23 (65 chargers).

It can be seen from Figure 7.1 that under each of the three core scenarios, demand for chargers is fairly uniform between FY23 and FY25. However, after this point, the need for new chargers under each scenario differs substantially.

Figure 7.1 Projected number of public chargers required by scenario to FY2030



Source: Deloitte analysis

By 2030, Level 3 fast chargers in ACT will need to increase to 30-120 chargers, while public Level 2 chargers will need to increase in the range of 250-850 chargers. A summary of the public charging infrastructure requirements currently meeting demands and to FY2030 is provided in Table 7-2.

Table 7-2 – Charging infrastructure requirements per scenario by Level 2 and 3 by FY2030

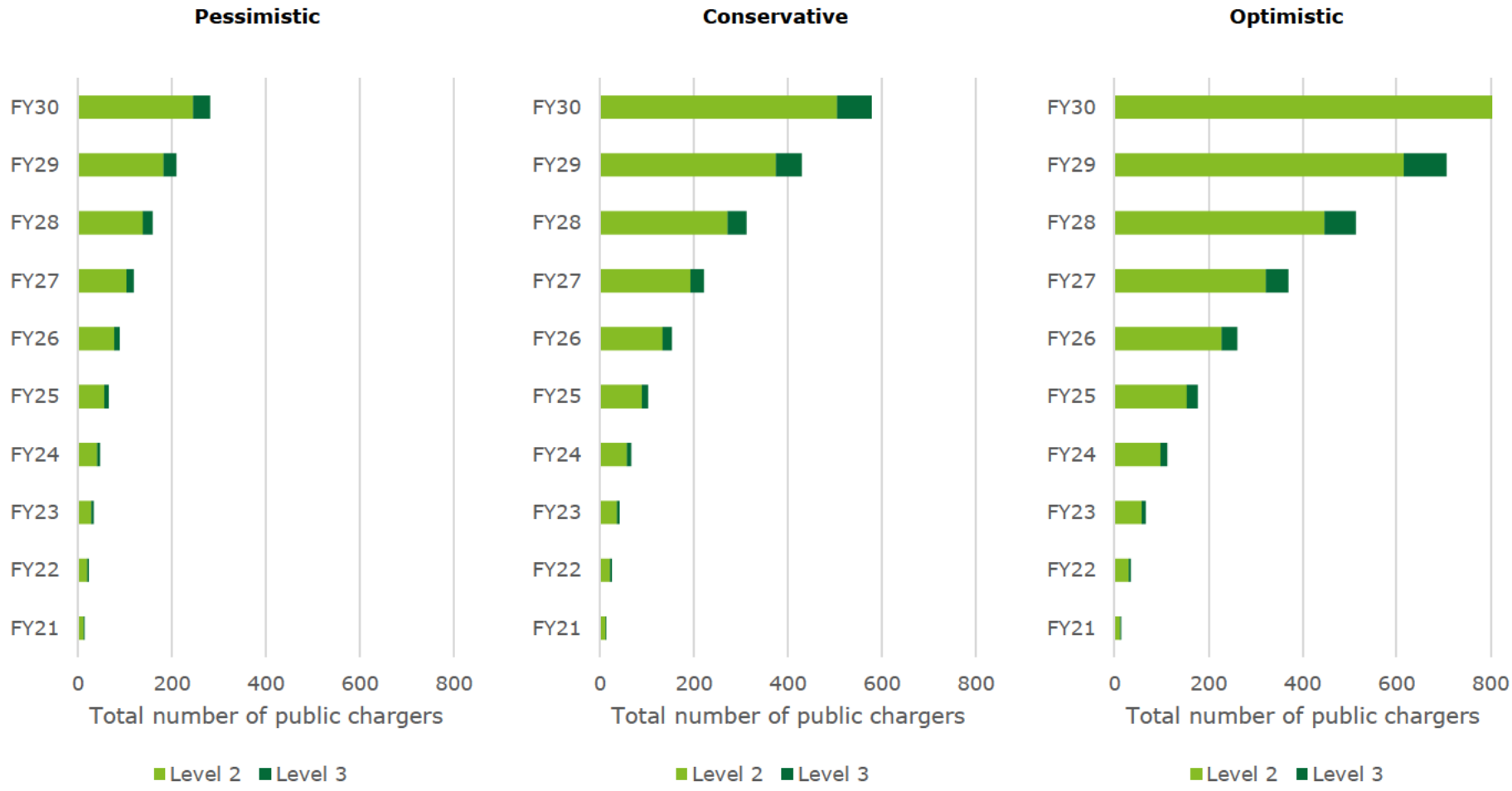
	FY2021	FY2025	FY2030
Existing			
Level 2	9	NA	NA
Level 3	4[15]	NA	NA
Total	13	NA	NA
Pessimistic			
Total public charging kWh	1,040,964	4,892,855	21,246,286
Level 2	12	56	245
Level 3	2	8	36
Total	14	65	281
Conservative			
Total public charging kWh	1,040,964	7,729,070	43,719,951
Level 2	12	89	504
Level 3	2	13	74
Total	14	102	578
Optimistic			
Total public charging kWh	1,040,964	13,369,891	73,612,962
Level 2	12	154	849
Level 3	2	23	74
Total	14	177	973

Source: Deloitte analysis

The anticipated uptake of ZEVs across each scenario has been considered in forecasting the number of Level 2 and 3 public chargers required to FY2030. This is shown in Figure 7.2.

[15] ARENA announced in June 2021 the approval for 8 new charging stations with the ability to serve two charge points of 50kW. Confirmation on timing of construction and operation will need to be determined.

Figure 7.2 – Number of Level 2 and 3 public chargers modelled for each scenario to FY2030



Source: Deloitte analysis

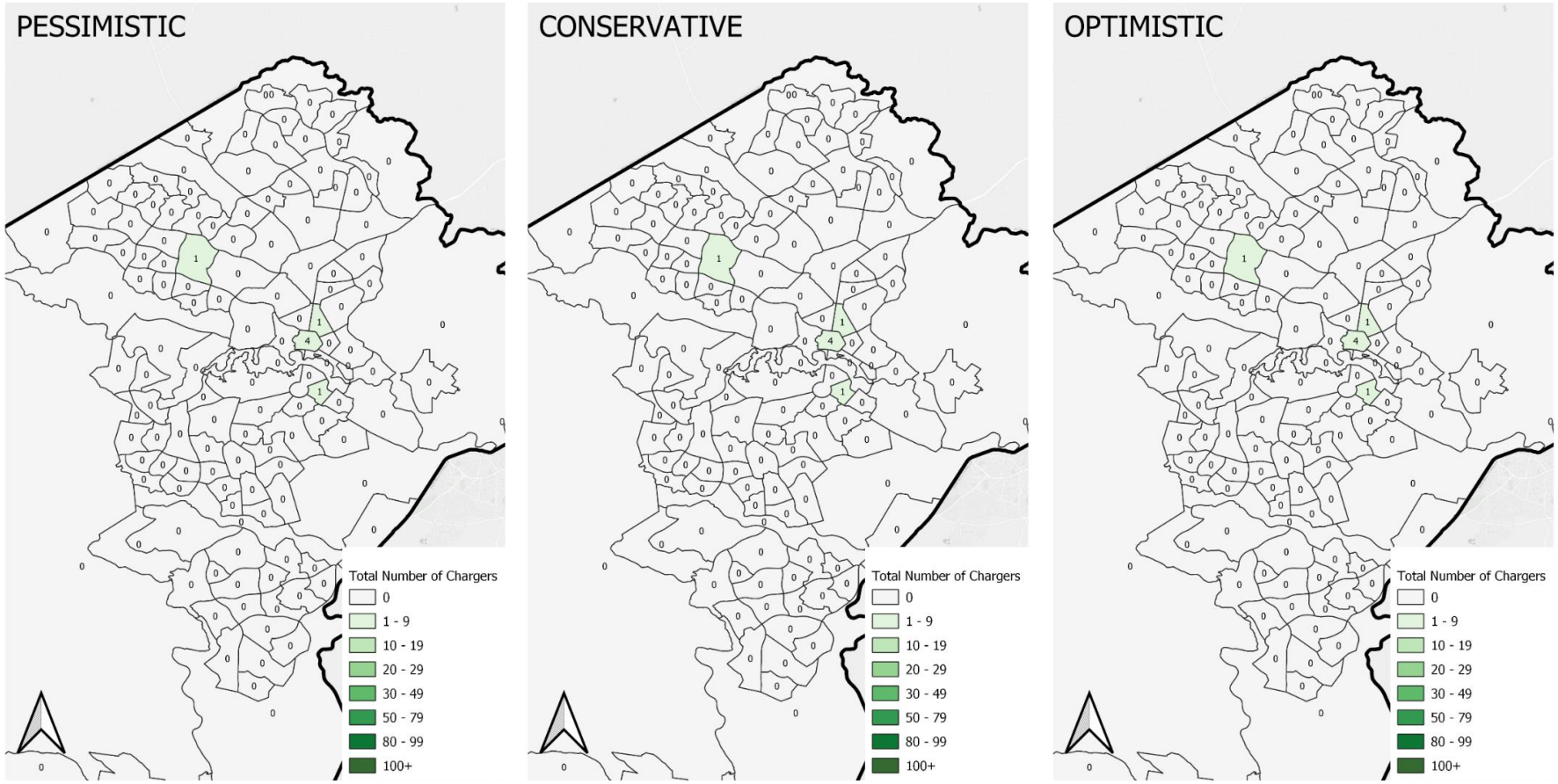
7.3 Mapping and sequencing of the need of chargers

The number of chargers required across each SA2 has been mapped and sequenced to 2030 for each of the Pessimistic, Conservative and Optimistic scenarios. Section 7.3.1 to 0 provides an overview of FY21, FY25 and FY30 and provides an indication of key SA2s which will require chargers in the respective year.

7.3.1 2021

The number of public chargers needed across the ACT under each scenario in 2021 is illustrated in Figure 7.3 below. This will be the same across all three scenarios: Pessimistic, Conservative and Optimistic. More than half of the chargers required will stem from Civic SA2, with the remaining from Belconnen, Barton and Braddon.

Figure 7.3 – Number of public chargers needed in the ACT per scenario (2021)



Source: Deloitte analysis

The underlying data for the figure above has been provided in Table 7-3.

Table 7-3 – Number of chargers needed in the ACT per scenario (2021)

SA3	SA2	Number of chargers needed
Pessimistic		
Belconnen	Belconnen	1
North Canberra	Braddon	1
North Canberra	Civic	4
South Canberra	Barton	1
	Total	**7**
Conservative		
Belconnen	Belconnen	1
North Canberra	Braddon	1
North Canberra	Civic	4
South Canberra	Barton	1
	Total	**7**
Optimistic		
Belconnen	Belconnen	1
North Canberra	Braddon	1
North Canberra	Civic	4
South Canberra	Barton	1
	Total	**7**

Source: Deloitte analysis

7.3.2 2025

The number of chargers needed across the ACT under each scenario in 2025 is illustrated in Figure 7.4 below. Movement from the Pessimistic through to the Conservative and Optimistic scenarios sees a greater number of chargers required, in terms of both concentration and distribution across the ACT.

Under the Pessimistic scenario:

- The need for chargers will be largely concentrated in Civic;
- There will be some need for chargers just south of the central regions of the ACT, particularly in Barton, Phillip and Kingston;
- The northern parts of the ACT will exhibit some need for chargers, particularly in Gunghalin, Franklin and Harrison; and
- Very few SA2s in the southern parts of the ACT will require chargers, with only one being needed in Greenway.

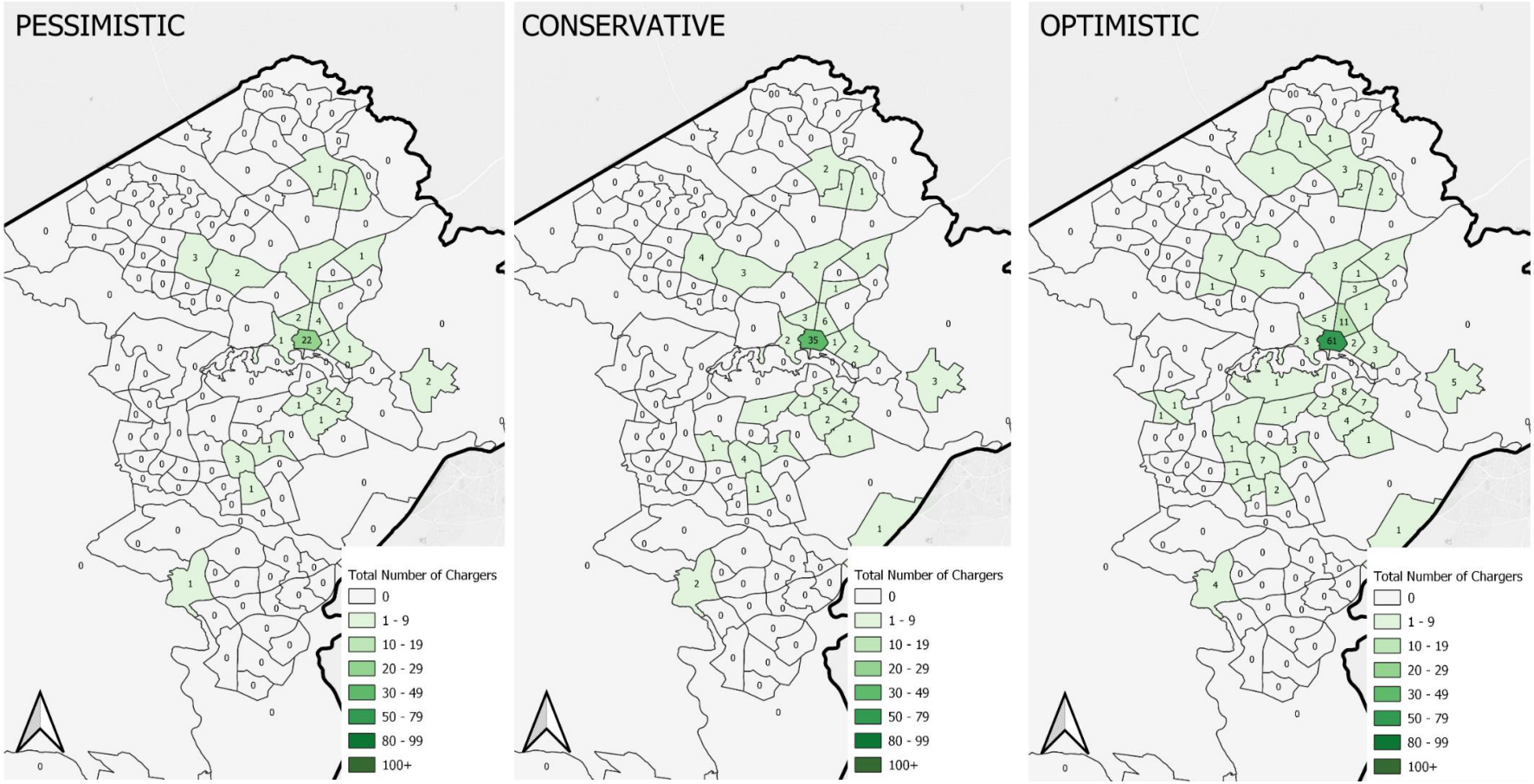
Under the Conservative scenario:

- SA2s exhibiting a need for chargers in the Pessimistic scenario will require a higher number of chargers;
- In Civic, the need for chargers will continue to increase in concentration; and
- In additional SA2s just south of the central regions of the ACT, such as Deakin, Lyons and Narrabundah, a need for chargers emerges.

Under the Optimistic scenario:

- SA2s exhibiting a need for chargers in the Pessimistic and Conservative scenarios will require a higher number of chargers;
- In Civic and Braddon, the need for chargers will continue to increase in concentration;
- In the Northern portion of the ACT, there is an emerging need for chargers in Nicholls, Ngunnawal and Casey; and
- In the Central Western regions of the ACT, there is an emerging need for chargers in Coombs, Curtin and Yarralumla.

Figure 7.4 – Number of chargers needed in the ACT per scenario (2025)



Source: Deloitte analysis

The underlying data for the figure above has been provided in Table 7-4.

Table 7-4 – Number of chargers needed in the ACT per scenario (2025)

SA3	SA2	Number of chargers needed
Pessimistic		
Belconnen	Belconnen	3
Belconnen	Bruce	2
Canberra East	Canberra Airport	2
Gungahlin	Franklin	1
Gungahlin	Gungahlin	1
Gungahlin	Harrison	1
North Canberra	Acton	1
North Canberra	Braddon	4
North Canberra	Civic	22
North Canberra	Dickson	1
North Canberra	Lyneham	1
North Canberra	Turner	2
North Canberra	Watson	1
North Canberra	Campbell	1
North Canberra	Reid	1
South Canberra	Forrest	1
South Canberra	Griffith (ACT)	1
South Canberra	Barton	3
South Canberra	Kingston (ACT)	2
Tuggeranong	Greenway	1
Woden Valley	Garran	1
Woden Valley	Mawson	1
Woden Valley	Phillip	3
Total		**57**
Conservative		
Belconnen	Belconnen	4
Belconnen	Bruce	3
Canberra East	Hume	1
Canberra East	Canberra Airport	3
Gungahlin	Franklin	1
Gungahlin	Gungahlin	2
Gungahlin	Harrison	1
North Canberra	Acton	2
North Canberra	Braddon	6
North Canberra	Civic	35
North Canberra	Dickson	1

SA3	SA2	Number of chargers needed
North Canberra	Lyneham	2
North Canberra	Turner	3
North Canberra	Watson	1
North Canberra	Campbell	2
North Canberra	Reid	1
South Canberra	Deakin	1
South Canberra	Forrest	1
South Canberra	Griffith (ACT)	2
South Canberra	Narrabundah	1
South Canberra	Barton	5
South Canberra	Kingston (ACT)	4
Tuggeranong	Greenway	2
Woden Valley	Garran	2
Woden Valley	Lyons (ACT)	1
Woden Valley	Mawson	1
Woden Valley	Phillip	4
Total		**92**
Optimistic		
Belconnen	Belconnen	7
Belconnen	Bruce	5
Belconnen	Lawson	1
Belconnen	Macquarie	1
Canberra East	Hume	1
Canberra East	Canberra Airport	5
Gungahlin	Amaroo	1
Gungahlin	Casey	1
Gungahlin	Franklin	2
Gungahlin	Gungahlin	3
Gungahlin	Harrison	2
Gungahlin	Ngunnawal	1
Gungahlin	Nicholls	1
North Canberra	Acton	3
North Canberra	Ainslie	1
North Canberra	Braddon	11
North Canberra	Civic	61
North Canberra	Dickson	3
North Canberra	Downer	1
North Canberra	Lyneham	3

SA3	SA2	Number of chargers needed
North Canberra	Turner	5
North Canberra	Watson	2
North Canberra	Campbell	3
North Canberra	Reid	2
South Canberra	Deakin	1
South Canberra	Forrest	2
South Canberra	Griffith (ACT)	4
South Canberra	Narrabundah	1
South Canberra	Yarralumla	1
South Canberra	Barton	8
South Canberra	Kingston (ACT)	7
Tuggeranong	Greenway	4
Woden Valley	Chifley	1
Woden Valley	Curtin	1
Woden Valley	Garran	3
Woden Valley	Lyons (ACT)	1
Woden Valley	Mawson	2
Woden Valley	Pearce	1
Woden Valley	Phillip	7
Molonglo	Coombs	1
Molonglo	Wright	1
	Total	**172**

Source: Deloitte analysis

7.3.3 2030

- The number of chargers needed across the ACT under each scenario in 2030 is illustrated in In Civic, the need for chargers continues to increase in concentration; and
- SA2s exhibiting a need for chargers in the Conservative scenario will require a higher number of chargers – particularly Gungahlin, Franklin, Garran and Greenway.

Figure 7.5 below. Movement from the Pessimistic through to the Conservative and Optimistic scenarios sees a greater number of chargers required, in terms of both concentration and distribution across the ACT. The need for chargers in Civic is heavily concentrated across all three scenarios. Specifically:

Under the Pessimistic scenario:

- The need for chargers will be largely concentrated in Civic; and
- There will be some need for chargers spanning from the North to South-most portions of the ACT.

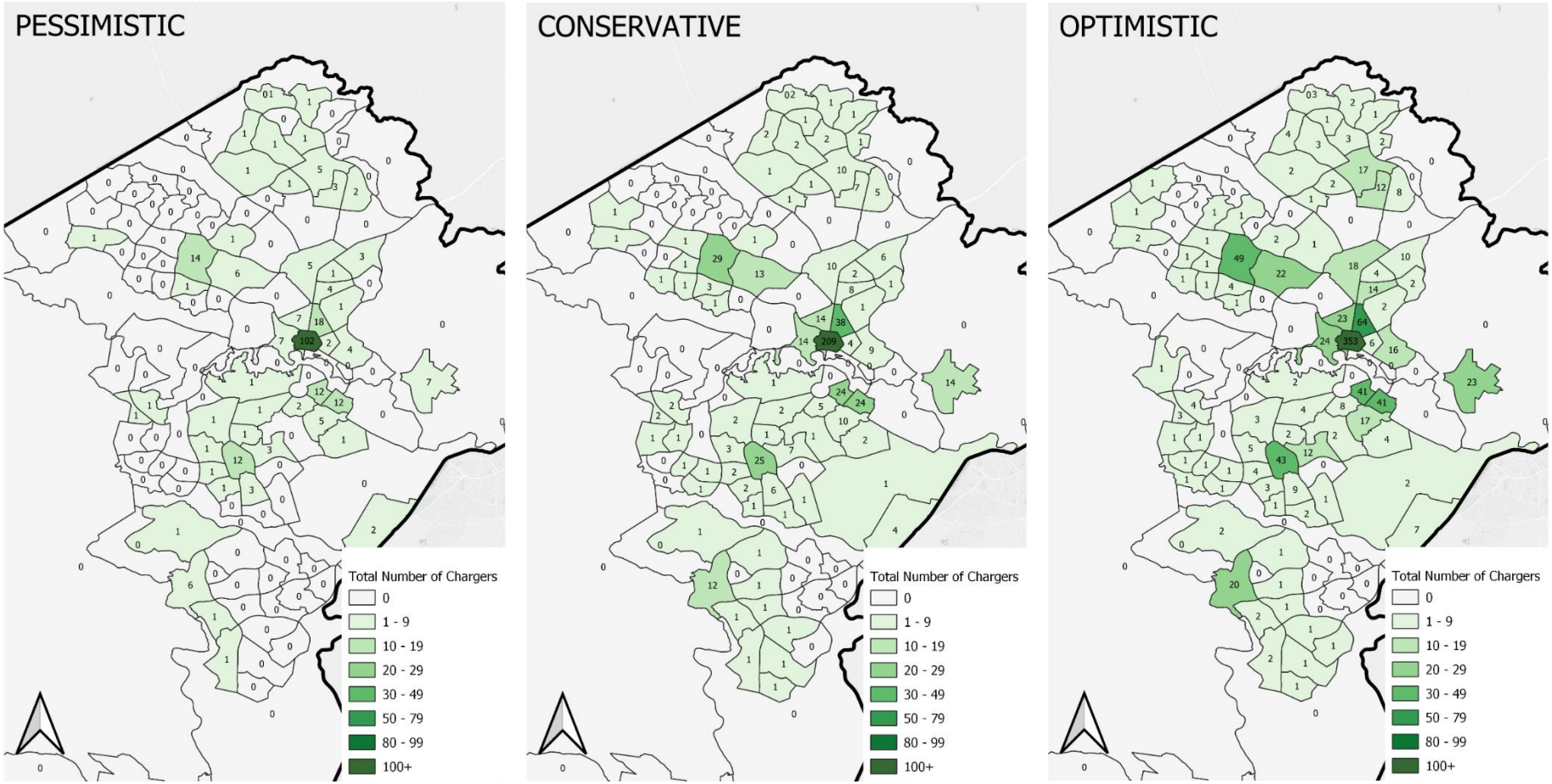
Under the Conservative scenario:

- In Civic, the need for chargers will continue to increase in concentration, where the number of chargers required doubles;
- In the South-East regions of the ACT, a need for chargers emerges;
- In Greenway, Barton, Canberra Airport, Kingston, Braddon, and Belconnen, the number of chargers needed notably increases; and
- In the Central to Southern regions of the ACT, a need for chargers emerges in Wanniassa, Monash, Isabella Plains, Calwell, Conder and Banks.

Under the Optimistic scenario:

- In Civic, the need for chargers continues to increase in concentration; and
- SA2s exhibiting a need for chargers in the Conservative scenario will require a higher number of chargers – particularly Gungahlin, Franklin, Garran and Greenway.

Figure 7.5 – Number of chargers needed in the ACT per scenario (2030)



Source: Deloitte analysis

The underlying data for the figure above has been provided in Table 7-5.

Table 7-5 – Number of chargers needed in the ACT per scenario (2030)

SA3	SA2	Number of chargers needed
Pessimistic		
Belconnen	Belconnen	14
Belconnen	Bruce	6
Belconnen	Holt	1
Belconnen	Lawson	1
Belconnen	Macquarie	1
Canberra East	Hume	2
Canberra East	Canberra Airport	7
Gungahlin	Amaroo	1
Gungahlin	Casey	1
Gungahlin	Franklin	3
Gungahlin	Gungahlin	5
Gungahlin	Harrison	2
Gungahlin	Ngunnawal	1
Gungahlin	Nicholls	1
Gungahlin	Palmerston	1
Gungahlin	Jacka	1
Gungahlin	Taylor	1
North Canberra	Acton	7
North Canberra	Ainslie	1
North Canberra	Braddon	18
North Canberra	Civic	102
North Canberra	Dickson	4
North Canberra	Downer	1
North Canberra	Lyneham	5
North Canberra	Turner	7
North Canberra	Watson	3
North Canberra	Campbell	4
North Canberra	Reid	2
South Canberra	Deakin	1
South Canberra	Forrest	2
South Canberra	Griffith (ACT)	5
South Canberra	Narrabundah	1
South Canberra	Yarralumla	1
South Canberra	Barton	12
South Canberra	Kingston (ACT)	12
Tuggeranong	Bonython	1

SA3	SA2	Number of chargers needed
Tuggeranong	Gordon (ACT)	1
Tuggeranong	Greenway	6
Tuggeranong	Kambah	1
Woden Valley	Chifley	1
Woden Valley	Curtin	1
Woden Valley	Garran	3
Woden Valley	Hughes	1
Woden Valley	Lyons (ACT)	1
Woden Valley	Mawson	3
Woden Valley	Pearce	1
Woden Valley	Phillip	12
Molonglo	Coombs	1
Molonglo	Wright	1
Total		**271**
Conservative		
Belconnen	Belconnen	29
Belconnen	Bruce	13
Belconnen	Cook	1
Belconnen	Florey	1
Belconnen	Hawker	1
Belconnen	Holt	1
Belconnen	Lawson	1
Belconnen	Macgregor (ACT)	1
Belconnen	Macquarie	3
Belconnen	Page	1
Belconnen	Weetangera	1
Canberra East	Hume	4
Canberra East	Canberra East	1
Canberra East	Canberra Airport	14
Gungahlin	Amaroo	2
Gungahlin	Bonner	1
Gungahlin	Casey	2
Gungahlin	Crace	1
Gungahlin	Forde	1
Gungahlin	Franklin	7
Gungahlin	Gungahlin	10
Gungahlin	Harrison	5
Gungahlin	Ngunnawal	2

SA3	SA2	Number of chargers needed
Gungahlin	Nicholls	1
Gungahlin	Palmerston	1
Gungahlin	Jacka	1
Gungahlin	Moncrieff	1
Gungahlin	Taylor	2
North Canberra	Acton	14
North Canberra	Ainslie	1
North Canberra	Braddon	38
North Canberra	Civic	209
North Canberra	Dickson	8
North Canberra	Downer	2
North Canberra	Hackett	1
North Canberra	Lyneham	10
North Canberra	Turner	14
North Canberra	Watson	6
North Canberra	Campbell	9
North Canberra	Reid	4
South Canberra	Deakin	2
South Canberra	Forrest	5
South Canberra	Griffith (ACT)	10
South Canberra	Narrabundah	2
South Canberra	Red Hill (ACT)	1
South Canberra	Yarralumla	1
South Canberra	Barton	24
South Canberra	Kingston (ACT)	24
Tuggeranong	Banks	1
Tuggeranong	Bonython	1
Tuggeranong	Calwell	1
Tuggeranong	Conder	1
Tuggeranong	Gordon (ACT)	1
Tuggeranong	Greenway	12
Tuggeranong	Isabella Plains	1
Tuggeranong	Kambah	1
Tuggeranong	Monash	1
Tuggeranong	Wanniassa	1
Weston Creek	Duffy	1
Weston Creek	Fisher	1
Weston Creek	Holder	1

SA3	SA2	Number of chargers needed
Weston Creek	Stirling	1
Weston Creek	Waramanga	1
Woden Valley	Chifley	2
Woden Valley	Curtin	2
Woden Valley	Farrer	1
Woden Valley	Garran	7
Woden Valley	Hughes	1
Woden Valley	Isaacs	1
Woden Valley	Lyons (ACT)	3
Woden Valley	Mawson	6
Woden Valley	Pearce	2
Woden Valley	Phillip	25
Woden Valley	Torrens	1
Molonglo	Coombs	2
Molonglo	Wright	2
Total		**575**
Optimistic		
Belconnen	Belconnen	49
Belconnen	Bruce	22
Belconnen	Cook	1
Belconnen	Dunlop	1
Belconnen	Evatt	1
Belconnen	Florey	1
Belconnen	Hawker	1
Belconnen	Holt	2
Belconnen	Kaleen	1
Belconnen	Lawson	2
Belconnen	Macgregor (ACT)	1
Belconnen	Macquarie	4
Belconnen	Melba	1
Belconnen	Page	1
Belconnen	Scullin	1
Belconnen	Weetangera	1
Canberra East	Hume	7
Canberra East	Canberra East	2
Canberra East	Canberra Airport	23
Gungahlin	Amaroo	3
Gungahlin	Bonner	1

SA3	SA2	Number of chargers needed
Gungahlin	Casey	4
Gungahlin	Crace	1
Gungahlin	Forde	2
Gungahlin	Franklin	12
Gungahlin	Gungahlin	17
Gungahlin	Harrison	8
Gungahlin	Ngunnawal	3
Gungahlin	Nicholls	2
Gungahlin	Palmerston	2
Gungahlin	Jacka	2
Gungahlin	Moncrieff	1
Gungahlin	Taylor	3
North Canberra	Acton	24
North Canberra	Ainslie	2
North Canberra	Braddon	64
North Canberra	Civic	353
North Canberra	Dickson	14
North Canberra	Downer	4
North Canberra	Hackett	2
North Canberra	Lyneham	18
North Canberra	Turner	23
North Canberra	Watson	10
North Canberra	Campbell	16
North Canberra	Reid	6
South Canberra	Deakin	4
South Canberra	Forrest	8
South Canberra	Griffith (ACT)	17
South Canberra	Narrabundah	4
South Canberra	Red Hill (ACT)	2
South Canberra	Yarralumla	2
South Canberra	Barton	41
South Canberra	Kingston (ACT)	41
Tuggeranong	Banks	1
Tuggeranong	Bonython	2
Tuggeranong	Calwell	1
Tuggeranong	Conder	1
Tuggeranong	Gordon (ACT)	2
Tuggeranong	Greenway	20

SA3	SA2	Number of chargers needed
Tuggeranong	Isabella Plains	1
Tuggeranong	Kambah	2
Tuggeranong	Monash	1
Tuggeranong	Theodore	1
Tuggeranong	Wanniassa	1
Weston Creek	Chapman	1
Weston Creek	Duffy	1
Weston Creek	Fisher	1
Weston Creek	Holder	1
Weston Creek	Rivett	1
Weston Creek	Stirling	1
Weston Creek	Waramanga	1
Woden Valley	Chifley	4
Woden Valley	Curtin	3
Woden Valley	Farrer	2
Woden Valley	Garran	12
Woden Valley	Hughes	2
Woden Valley	Isaacs	1
Woden Valley	Lyons (ACT)	5
Woden Valley	Mawson	9
Woden Valley	Pearce	3
Woden Valley	Phillip	43
Woden Valley	Torrens	1
Molonglo	Coombs	4
Molonglo	Denman Prospect	1
Molonglo	Wright	3
Total		**971**

Source: Deloitte analysis

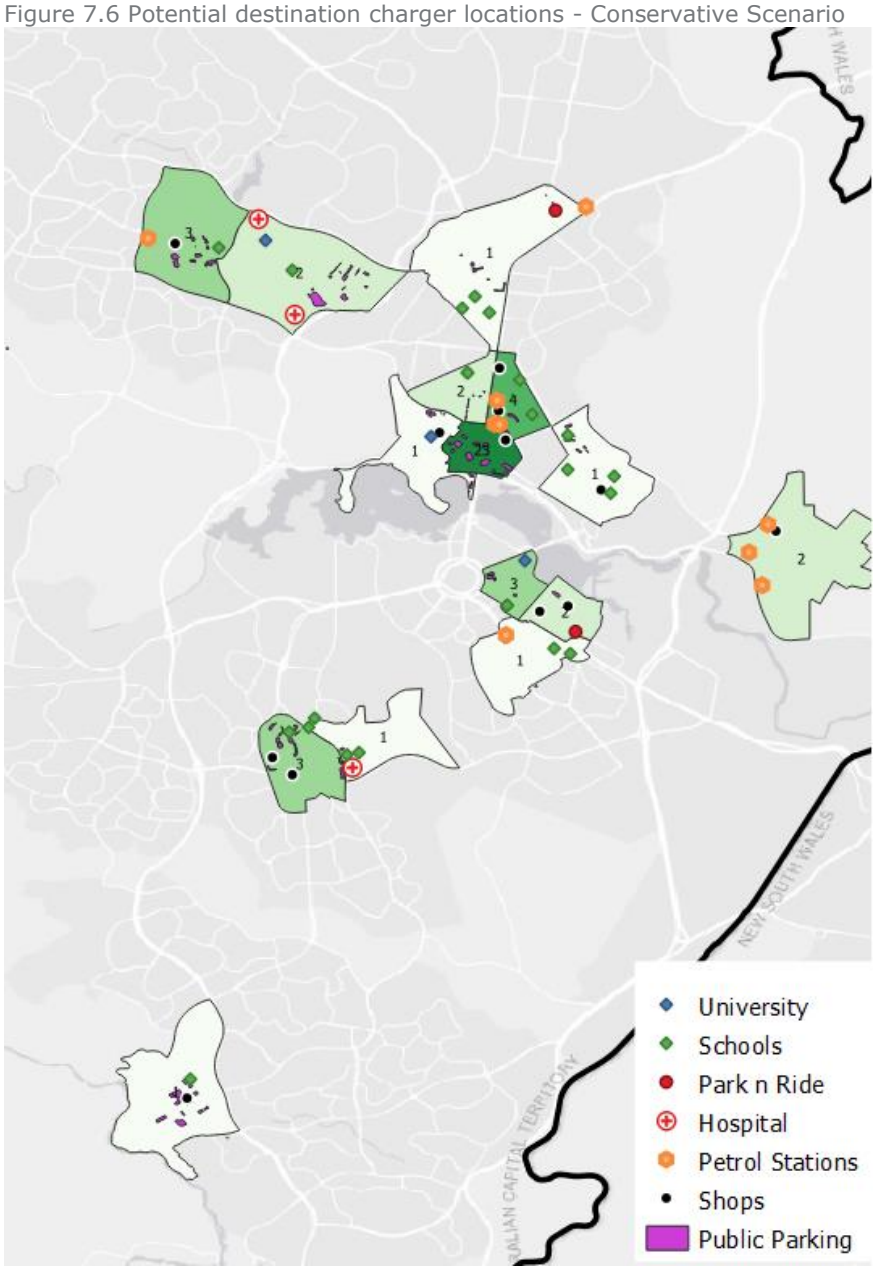
7.4 Potential charging locations types

The suitability of the charging types will depend on the specific locations. For the purposes of analysis, the potential charging locations considered are detailed below.

- Institution uses (universities and schools)
- Park 'n' Ride
- Hospital
- Petrol Station
- Shopping Centre
- Public Parking.

An overview of these potential charging locations in the SA2s relevant for the first 50 chargers under the Conservative scenario is provided in Figure 7.6.

Figure 7.6 Potential destination charger locations - Conservative Scenario



7.5 Procurement evaluation framework

The uptake of ZEVs across the ACT is still in the early stages based on the overall fleet percentage with ICE vehicles. A potential framework has been developed to assist the ACT Government across three-time horizons that align closely with the scenarios outlined earlier in the report is detailed below.

Table 7-6 Potential charging rollout framework

No	Stage	Horizon	ZEV uptake	Outcomes
1	**Expansion** Build out the network	Near-term (2021-2025)	Low (0-20%)	Increase coverage across the public charging network between existing and potential locations

No	Stage	Horizon	ZEV uptake	Outcomes
2	**Densification** Increase number of chargers at each location	Mid-term (2025-2030)	Medium (20-30%)	Increase number of chargers at each location
3	**Consolidation** Decrease distance between stations	Long-term (>2030)	High (>30%)	Decrease the distance between charging stations

This framework is intended to provide a guideline to align with the actual ACT ZEV uptake based on the evolving needs of the charging network over time. In accordance with ZEV uptake progression will require different approaches to ensure sustainable and equitable rollout is implemented. The suitability of the charging types will depend on the specific locations. For the purposes of analysis, the potential charging locations considered are detailed below:

- Institution uses (universities and schools)
- Park 'n' Ride
- Hospital
- Petrol Station
- Shopping Centre
- Public Parking.

The considerations for the charging station rollout will need to consider the breakdown in Level 2 and Level 3 chargers. The suitability for charging will also depend on likely dwell times, charger output, technical specifications and installation costs to determine the affordability and suitability of a site. For the subsequent phase of procurement, these considerations would be evaluated by the market. A high-level overview of potential considerations is detailed below.

Table 7-7 High-level overview of charger specifications and considerations

Charger types	AC (Level 2)	DC (Level 3)
Charging Location	• Retail centres • Airports • Off-street parking • Institution uses (universities and schools)	• Alongside major highways • Petrol stations • Public parking • Transport hubs • Inner city rapid charge points
Average dwell time	+60 min	5-20 min
Technical specifications[16]	• Dedicated circuitry • 3.3- 22kW • 240V, 16-32A, Single phase or three phases • Hardwired	• Dedicated circuitry • 22kW up to 50kW • 200- 600V, up to 1000A • Hardwired
Installation Costs[17]	• Hardware costs $3,000 • Installation costs $7,000	• Hardware costs $40,000-$100,000 • Installation costs $15,000-$60,000
Installation considerations	Medium difficulty. One or two should not require too much planning, more than two may require site plan and potential electrical upgrades	High difficulty Electrical upgrades may be necessary and consultation with the network provider is recommended for consultation and site plan/scope of work.

Further development of the procurement process will be required to understand and specify the requirements. A broad outline of the likely next steps includes:

- **Commercial model development -** Undertake analysis to identify potential commercial models for delivery of the 50 EV charging stations in ACT.
- **Market sounding -** Engage with potential market participants to test the preferred commercial model and identify any barriers to entry and conditions for success.
- **EOI and RFT process -** Provide commercial advice and procurement support to undertake a market process and assist with negotiations with bidder(s).

The procurement process will inform the delivery and packaging arrangement most suitable to the market risk appetite. From an individual site selection, the need to assess a broad range of criteria from characteristics of land uses and the travel/consumer behaviour will be essential to ensure appropriate sites are considered. Liaising with relevant stakeholders with available data (i.e., Evo Energy) can streamline the assessment. Potential location evaluation criteria are detailed below.

[16] 'How much does it cost to set up an EV Charging Station?' *EVSE* (6 October 2021) < https://evse.com.au/blog/evchargercost/>

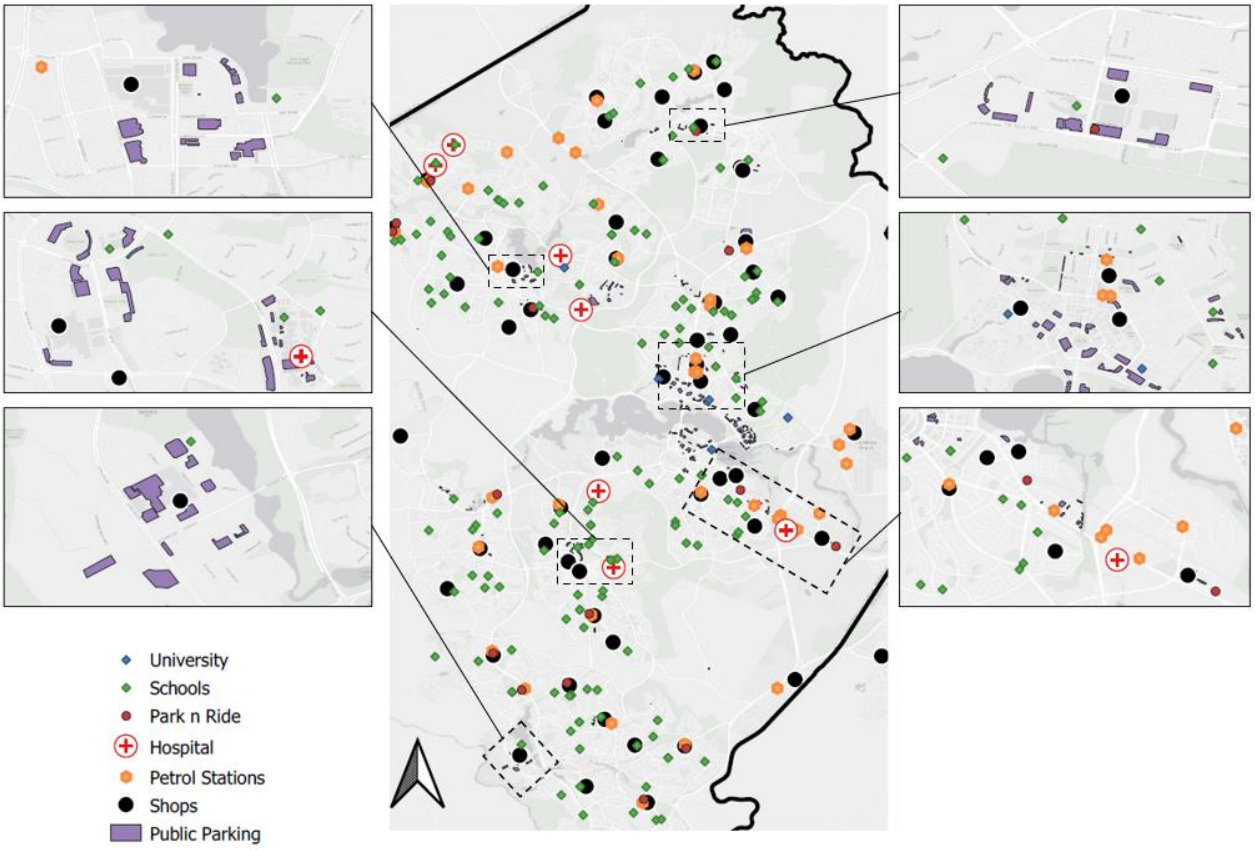
[17] Ibid

Table 7-8 Potential location evaluation criteria

No.	Criteria	Description	Unit					
1	Traffic Volumes	Peak hour traffic flow in 2031	vph	0-1000	1000-2000	2000-3000	3000-4000	>4000
2	Population density for non-detached	Percentage of non-detached dwellings	%	0-20%	20-40%	40-60%	60-80%	+80%
3	Proximity to nearest electric charging stations	Distance to ZEV public chargers	km	<1	1-2	2-3	3-4	>4
4	OD trips	Number of anticipated OD trips	trips	<500	500-1000	1000-1500	1500-2000	>2000
5	Proximity to nearest transport hub/station	Walking distance to nearest transport hub/station	m	>2000	1500-2000	1000-1500	500-1000	<500
6	Proximity distance to nearest hospital	Walking distance to nearest hospital	m	>2000	1500-2000	1000-1500	500-1000	<500
7	Proximity to nearest school or university	Walking distance to nearest school or university	m	>2000	1500-2000	1000-1500	500-1000	<500
8	Parking spaces available	Number of current and future spaces available	spaces	<10	10-20	20-30	30-40	>50
9	Anticipated dwell time	Period of duration a user will stay at a location	min	0-5	5-15	15-30	30-60	>60
10	Available electricity capacity	The charging station can service current and future charging needs	kW	<10	10-20	20-30	40-50	>50

Identifying the types of characteristics of possible locations for charging station infrastructure will support the suitability of sites. A summary of the potential charging location types is illustrated below.

Figure 7.7 List of potential locations



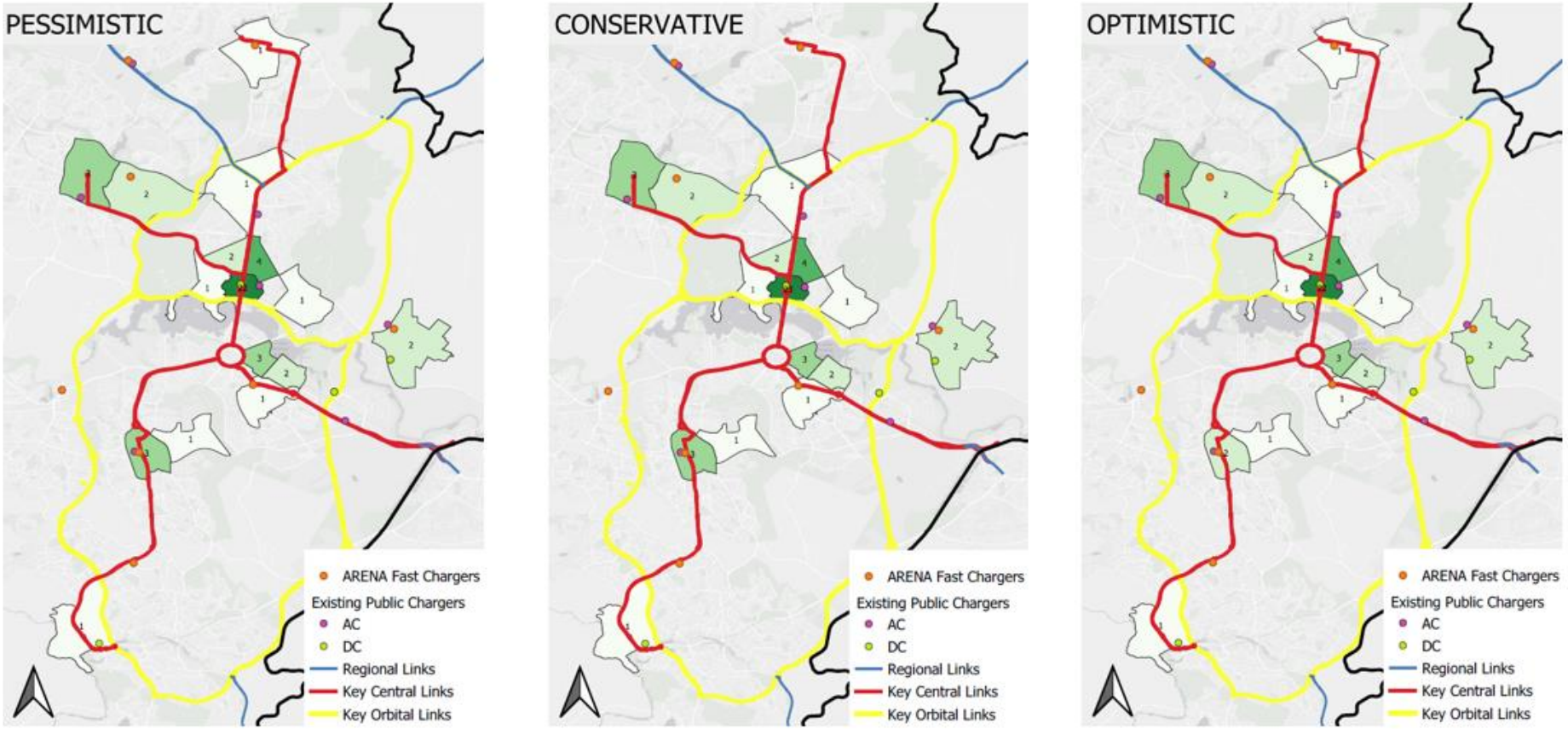
The long-list of charging locations has used a combination of open-source data[18] and manual inputs from aerial imagery. The upcoming procurement for the ACT Government aims to deliver a total of 50 chargers. The short-listing process will be undertaken based on the identified SA2s that account for the top 50 chargers. The time to reach a minimum of 50 chargers across the network varies corresponding to the three respective scenarios. The financial year the total number of chargers reaches 50 is detailed below.

- **Pessimistic -** FY2025
- **Conservative -** FY2024
- **Optimistic –** FY2023

A summary of the potential charging location types under each scenario for the first 50 chargers is shown below.

[18] Open street maps from QGIS

Figure 7.8 Top 50 chargers by scenario



7.5.1 Level 2 chargers

The number of level 2 chargers across the scenarios is provided in Section 7.2. Due to the modelling approach used to calculate the number of chargers required per SA2 the figures presented in this table has been presented to the fist decimal place for accuracy. However, it would be appropriate to round these figures up.

The table below shows that Civic accounts for around 43% required charging infrastructure, with Braddon accounting for another 7%. Barton and Belconnen and Phillip account for a further 6%, 5%, 5% respectively. These five SA2s together account for two thirds of the required charging infrastructure.

Table 7-9 – Level 2 chargers

SA3	SA2	FY25	FY24	FY23
		Pessimistic	Conservative	Optimistic
North Canberra	Civic	19.6	19.7	19.4
North Canberra	Braddon	3.4	3.5	3.4
South Canberra	Barton	2.5	2.6	2.6
Belconnen	Belconnen	2.4	2.4	2.3
Woden Valley	Phillip	2.2	2.2	2.1
South Canberra	Kingston (ACT)	2.1	2.1	2.1
Belconnen	Bruce	1.5	1.6	1.7
North Canberra	Turner	1.5	1.5	1.6
Canberra East	Canberra Airport	1.5	1.5	1.5
Tuggeranong	Greenway	1.2	1.2	1.2
South Canberra	Griffith (ACT)	1.1	1.2	1.2
North Canberra	Campbell	1.1	1.2	1.2
North Canberra	Lyneham	1.0	1.1	1.2
North Canberra	Acton	1.0	1.0	1.0
Woden Valley	Garran	0.9	0.9	1.0
Gungahlin	Gungahlin	0.8	0.8	0.8
North Canberra	Dickson	0.8	0.8	0.8

SA3	SA2	FY25	FY24	FY23
		Pessimistic	Conservative	Optimistic
North Canberra	Watson	0.7	0.7	0.8
Total		**45.4**	**46.2**	**45.9**

Source: Deloitte analysis

7.5.2 Level 3 chargers

The number of level 3 chargers across the scenarios is provided in Section 7.2. Due to the modelling approach used to calculate the number of chargers required per SA2 the figures presented in this table has been presented to the fist decimal place for accuracy. However, it would be appropriate to round these figures up.

As outlined in the below table, Civic accounts for around 43% required charging infrastructure, with Braddon accounting for another 7%. Barton and Belconnen and Phillip account for a further 6%, 6%, 4% respectively. These five SA2s together account for two thirds of the required charging infrastructure.

Table 7-10 – Level 3 chargers

SA3	SA2	FY25	FY24	FY23
		Pessimistic	Conservative	Optimistic
North Canberra	Civic	2.9	2.9	2.8
North Canberra	Braddon	0.5	0.5	0.5
South Canberra	Barton	0.4	0.4	0.4
Belconnen	Belconnen	0.4	0.3	0.3
Woden Valley	Phillip	0.3	0.3	0.3
South Canberra	Kingston (ACT)	0.3	0.3	0.3
Belconnen	Bruce	0.2	0.2	0.2
North Canberra	Turner	0.2	0.2	0.2
Canberra East	Canberra Airport	0.2	0.2	0.2
Tuggeranong	Greenway	0.2	0.2	0.2
South Canberra	Griffith (ACT)	0.2	0.2	0.2
North Canberra	Campbell	0.2	0.2	0.2
North Canberra	Lyneham	0.2	0.2	0.2
North Canberra	Acton	0.2	0.2	0.1

SA3	SA2	FY25	FY24	FY23
		Pessimistic	Conservative	Optimistic
Woden Valley	Garran	0.1	0.1	0.1
Gungahlin	Gungahlin	0.1	0.1	0.1
North Canberra	Dickson	0.1	0.1	0.1
North Canberra	Watson	0.1	0.1	0.1
Total		**6.7**	**6.8**	**6.7**

Source: Deloitte analysis

7.5.3 Total chargers

The total number of chargers across the scenarios is provided in Section 7.3. Due to the modelling approach used to calculate the number of chargers required per SA2 the figures presented in this table has been presented to the fist decimal place for accuracy. However, it would be appropriate to round these figures up.

Similarly, in this scenario, Civic also accounts for around 43% required charging infrastructure, with Braddon accounting for another 7%. Barton and Belconnen and Phillip account for a further 6%, 5%, 5% respectively. These five SA2s together account for two thirds of the required charging infrastructure.

Table 7-11 – First 50 chargers (Level 2 and 3) required by SA2

SA3	SA2	FY25	FY24	FY23
		Pessimistic	Conservative	Optimistic
North Canberra	Civic	22.4	22.6	22.3
North Canberra	Braddon	3.9	4.0	3.9
South Canberra	Barton	2.9	3.0	3.0
Belconnen	Belconnen	2.7	2.7	2.6
Woden Valley	Phillip	2.5	2.5	2.4
South Canberra	Kingston (ACT)	2.4	2.4	2.4
Belconnen	Bruce	1.7	1.8	1.9
North Canberra	Turner	1.7	1.8	1.8
Canberra East	Canberra Airport	1.7	1.7	1.7
Tuggeranong	Greenway	1.4	1.4	1.4

SA3	SA2	FY25	FY24	FY23
		Pessimistic	Conservative	Optimistic
South Canberra	Griffith (ACT)	1.3	1.4	1.4
North Canberra	Campbell	1.3	1.3	1.4
North Canberra	Lyneham	1.2	1.3	1.3
North Canberra	Acton	1.2	1.2	1.2
Woden Valley	Garran	1.0	1.1	1.1
Gungahlin	Gungahlin	1.0	1.0	0.9
North Canberra	Dickson	0.9	0.9	0.9
North Canberra	Watson	0.8	0.8	0.9
Total		**52.1**	**52.9**	**52.6**

Source: Deloitte analysis

Limitation of our work

This report is prepared solely for the internal use of the ACT Government. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose inform Canberra's Charging Masterplan and also inform policy development to support the transition to zero emissions vehicles in the ACT as per the *Territory Short Form Contract* dated 01/06/2021. You should not refer to or use our name or the advice for any other purpose.

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Appendix C Long list of SA2's

Table C.1 – Long list of 131 SA2s in the ACT by the four key ZEV criteria

		Criteria 1	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Rank	**SA2**	**Origin (trips) - FY30**	**Destination (trips) - FY30**	**ZEV vehicles - FY30**	**Dwelling (# of non/semi-detached) - FY30**	**Distribution Capacity - FY30*** Six = High One = Low
1	Braddon	8,960	8,439	879	3,675	Five
2	Civic	47,788	44,759	621	2,388	Five
3	Kingston (ACT)	7,646	6,890	1,124	3,682	Five
4	Belconnen	7,112	7,973	466	3,552	Two
5	Phillip	7,067	7,837	497	2,193	Three - Five
6	Griffith (ACT)	4,124	4,129	549	1,865	Five
7	Turner	3,450	3,044	500	1,958	Five
8	Bruce	3,696	7,917	298	2,212	Two
9	Lyneham	3,750	3,418	356	1,497	Five
10	Campbell	3,696	3,714	366	985	Five
11	Barton	7,775	8,101	240	1,084	Five
12	Garran	4,957	4,991	420	440	Three - Five
13	Gungahlin	3,068	2,936	329	1,520	One
14	Franklin	1,991	1,802	470	1,429	One
15	Harrison	1,986	2,082	389	1,136	One
16	Narrabundah	2,485	2,244	453	650	Five
17	Kambah	2,227	1,924	536	610	Four - Six
18	Mawson	2,544	2,166	330	806	Three - Five
19	Curtin	2,596	2,332	569	321	Three - Five
20	Ngunnawal	1,576	1,408	377	720	One
21	Dickson	2,865	3,038	218	832	Five
22	Casey	1,589	1,396	303	492	One
23	Greenway	2,767	3,040	134	1,619	Four - Six
24	Deakin	3,057	3,170	261	282	Five
25	Ainslie	2,061	1,730	353	247	Five
26	Lyons (ACT)	1,519	1,218	293	599	Three - Five
27	Pearce	1,458	1,776	293	368	Three - Five
28	Forrest	2,196	2,146	188	545	Five
29	Downer	1,668	1,244	294	237	Five
30	Hughes	1,513	1,389	334	188	Three - Five
31	Nicholls	1,144	1,233	273	454	One
32	Chifley	1,235	1,019	279	454	Three - Five
33	Red Hill (ACT)	1,462	1,660	261	208	Five
34	Gordon (ACT)	1,059	898	268	719	Four - Six
35	Watson	4,002	3,662	488	NA	Five
36	Wanniassa	1,434	1,539	259	234	Four - Six
37	Amaroo	1,203	1,346	250	350	One
38	Farrer	1,369	1,176	357	153	Three - Five
39	Reid	1,566	3,352	110	384	Five
40	Macgregor (ACT)	1,230	1,108	278	229	Two
41	Holt	1,129	1,047	202	649	Two

42	Bonner	1,403	1,254	287	154	One
43	Kaleen	1,226	1,155	262	154	Two
44	Macquarie	1,033	1,044	163	437	Two
45	Hackett	1,221	974	228	212	Five
46	Crace	1,161	1,041	232	193	One
47	Dunlop	1,120	948	268	159	Two
48	Forde	1,033	929	212	242	One
49	Calwell	975	915	202	324	Four - Six
50	Coombs	819	733	139	915	One - Two
51	Duffy	986	927	245	161	One - Five
52	Holder	985	985	205	196	One - Five
53	Palmerston	740	686	187	672	One
54	Moncrieff	544	467	282	537	One
55	Torrens	981	861	235	109	Three - Five
56	Fisher	903	791	218	187	One - Five
57	Isaacs	740	596	226	256	Three - Five
58	Conder	787	740	173	270	Four - Six
59	Florey	750	768	152	315	Two
60	Rivett	993	857	228	88	One - Five
61	Hume	4,895	4,932	67	NA	Two - Four
62	Yarralumla	1,419	1,273	259	NA	Five
63	Banks	702	561	173	340	Four - Six
64	Evatt	916	868	191	108	Two
65	Isabella Plains	627	522	143	393	Four - Six
66	Chapman	852	855	248	46	One - Five
67	Bonython	556	461	132	610	Four - Six
68	Acton	3,249	6,545	25	NA	Five
69	Hawker	568	588	120	384	Two
70	Canberra Airport	3,427	3,591	20	NA	Two - Four
71	Monash	468	419	182	442	Four - Six
72	Chisholm	794	706	174	65	Four - Six
73	Stirling	645	570	146	120	One - Five
74	Cook	512	437	112	445	Two
75	Theodore	577	508	132	193	Four - Six
76	Denman Prospect	898	874	44	133	One - Two
77	Melba	573	575	122	157	Two
78	Waramanga	966	1,077	196	NA	One - Five
79	Page	528	468	100	377	Two
80	Lawson	421	330	85	878	Two
81	Latham	583	514	131	101	Two
82	Giralang	547	486	122	97	Two
83	Scullin	497	435	102	220	Two
84	Aranda	511	525	116	88	Two
85	Flynn (ACT)	525	442	134	40	Two
86	Gowrie (ACT)	502	503	113	48	Four - Six
87	Wright	749	654	139	NA	One - Two
88	Charnwood	481	453	85	124	Two
89	Fadden	466	424	126	57	Four - Six
90	Higgins	501	418	111	76	Two
91	McKellar	419	343	104	57	Two
92	Weetangera	532	496	136	NA	Two
93	Spence	434	375	97	51	Two
94	Richardson	440	373	92	48	Four - Six
95	Gilmore	384	322	92	76	Four - Six
96	Jacka	378	318	25	129	One
97	Oxley (ACT)	227	186	56	114	Four - Six
98	Throsby	352	328	49	52	One
99	Fraser	316	308	77	44	Two
100	Macarthur	218	184	55	16	Four - Six
101	Hall	75	70	16	16	One
102	Canberra East	375	370	96	2	Two - Four

103	O'Connor (ACT)	NA	NA	NA	717	Five
104	Weston	NA	NA	329	NA	One - Five
105	Taylor	377	329	36	NA	One
106	Fyshwick	19	19	1	NA	Five
107	O'Malley	NA	NA	NA	115	Three - Five
108	Duntroon	NA	NA	99	NA	Five
109	Majura	NA	NA	43	NA	Two - Four
110	ACT - South West	NA	NA	27	NA	One - Three
111	Kowen	NA	NA	8	NA	Two - Four
112	West Belconnen	NA	NA	4	NA	Two
113	Namadgi	NA	NA	2	NA	One - Three
114	Molonglo Corridor	NA	NA	1	NA	Two
115	Tuggeranong	NA	NA	1	NA	Four - Six
116	Gooromon	NA	NA	1	NA	Two
117	Arboretum	NA	NA	0	NA	One - Two
118	Kenny	NA	NA	0	NA	One
119	Scrivener	NA	NA	0	NA	One - Five
120	Tuggeranong - West	NA	NA	0	NA	Four - Six
131	Mitchell	NA	NA	NA	NA	One
131	Gungahlin - East	NA	NA	NA	NA	One
131	Gungahlin - West	NA	NA	NA	NA	One
131	Black Mountain	NA	NA	NA	NA	Five
131	Parkes (ACT) - North	NA	NA	NA	NA	Five
131	Russell	NA	NA	NA	NA	Five
131	Lake Burley Griffin	NA	NA	NA	NA	Five
131	Parkes (ACT) - South	NA	NA	NA	NA	Five
131	Mount Taylor	NA	NA	NA	NA	Four - Six
131	Molonglo	NA	NA	NA	NA	One - Two
131	Molonglo - North	NA	NA	NA	NA	One - Two

Source: Deloitte Analysis

Note: *Criteria 4 is a qualitative assessment at the SA3/substation level.

Appendix D Terminology

Terminology used frequently throughout the report is detailed below:

- **Power**
  - **Kilowatt (kW)** measurement of electrical power (how fast a car is charging) and also used to measure demand on the electricity network
  - **Alternating Current (AC)** charger that outputs alternating current (AC) power. Used in home chargers or smaller public stations where drivers are likely to park for longer
  - **Direct Current (DC)** a charger that outputs direct current which flows directly into the battery. This is more efficient than AC charging; often found on highways or locations where speed is a priority
- **Vehicle energy and range**
  - **Kilowatt Hour (kWh)** measurement of energy (how full a car battery is); equal to one kilowatt of power delivered for one hour. Conversion of 1kWh is equivalent to consuming 1000 Watts for one hour.
- **Charging:**
  - **Level 1** charging from a General Power Outlet (GPO) using a portable charging cable.
  - **Level 2** charging from an AC charging station at home or in public.
  - **Level 3** charging from a DC charger. Stations of this size and speed are generally only available on select public networks or for commercial use.
  - **Guarantee dwell time** how long a ZEV driver spends charging their vehicle
  - **State of Charge (SOC)** refers to the % of currently available capacity (kWh) of a vehicle battery
- **Plug types**
  - The considerations for the charging station rollout will require compatibility and common standards for charging types. With a number of different charging plug types available, the prevailing public charger plug types are CHAdeMO, Type 2 and CCS (Combined Charging System) (Type 2). A comparison of the vehicle plug types are shown in the table below.

Table D.1 – Vehicle plug types

Description	CHAdeMO	Type 2	CCS (Type 2)
Connector			
AC (up to 22kW)			
DC (> 22kW)			✓

Source: Jetcharge, vehicle plug types

Appendix E Scope of analysis

Government Statistical Areas (SA) 2 and 3 were adopted for the purposes of analysis. The catchments comprised all ACT jurisdictions and surrounding New South Wales jurisdictions of Young-Yass and Queanbeyan. The respective SA2 and SA3 maps are shown in the two below figures.

Figure E.1 Map of SA3 regions in the ACT

Source: ABS

Figure E.2 – Map of SA2 regions in the ACT

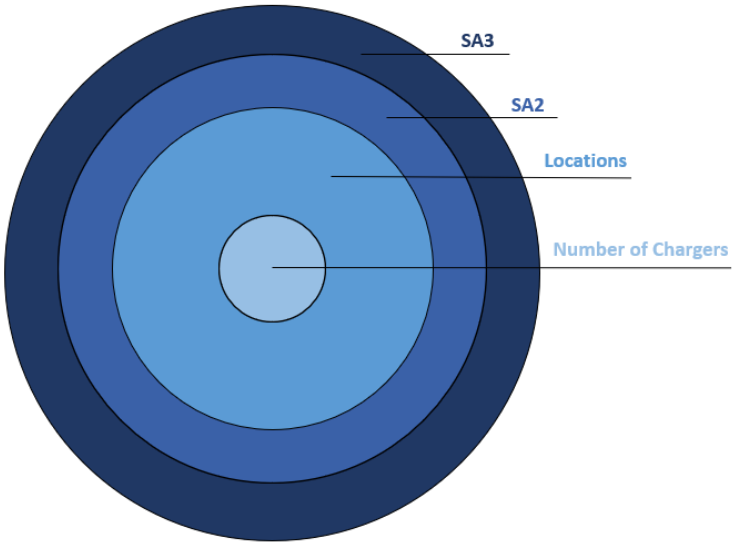
Source: ABS

Appendix F A framework for location level analysis

The long list of potential charging locations has been assessed using both a quantitative and qualitative assessment to identify suitable SA2 locations.

Following the identification of the short list of SA2 options, specific land uses within the SA2 for charger placement have been identified in Chapter 7. The number of chargers within each location will additionally be identified. The figure below provides an illustration of the varying levels of granularity considered in this approach.

Figure F.1– Levels of granularity considered in short list approach



Source: Deloitte analysis

F.2. Overlay of existing charging infrastructure

This analysis will form part of the next phase of work.

Sch 2 s2.2(a)(xi)

Table F.2 – Description of charging location objectives

Charging location objectives	Description		
Visibility	Improved visibility of charging stations can increase awareness of ZEVs and related charging infrastructure.	Charging infrastructure is entirely obscured from public view and promotes minimal awareness of ZEV charging infrastructure.	Charging infrastructure is highly visible and promotes increased awareness.
Accessibility	Charging infrastructure ensures accessibility by users through:		
	a) *Useability* – Charging equipment is user-friendly and easy to operate	The location and placement of charging stations makes it difficult to use.	Charging stations are easy to operate and provides a seamless user experience.
	b) *Convenience* – The location of charging stations provides EV users with the choice to charge when and where they choose.	The location of charging stations is inconvenient and require ZEV users to go 'out of their way' to charge their vehicles.	Charging stations are situated where users are most likely to carry out their day-to-day activities, and/or need charging.
Journey Destinations	ZEV users are not restricted by the range of their vehicle when undertaking longer journeys.	Charging stations are poorly distributed and ZEV users frequently encounter range concerns.	Charging stations are available along the origin-destination journey and provide ZEV users with greater comfort on range concerns.
Security	ZEV users feel confident and safe to use and leave their vehicles docked at charging facilities, at any time of the day.	Charging locations do not appear safe, are poorly lit and not well monitored.	Charging infrastructure is placed in a secure location that is well-lit and frequently monitored
Commercialisation	The location of charging stations is attractive for potential charge point operator partners and provides reasonable opportunity for profit.	The charging location results in poor utilisation of infrastructure and increased risk of 'stranded assets''.	High utilisation of charging infrastructure and good profitability for charge point operators in line with market risks.

Source: Deloitte

Appendix I Long list of SA2's

Table I.1 – Long list of 131 SA2s in the ACT by the four key ZEV criteria

		Criteria 1	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Rank	**SA2**	**Origin (trips) - FY30**	**Destination (trips) - FY30**	**ZEV vehicles - FY30**	**Dwelling (# of non/semi-detached) - FY30**	**Distribution Capacity - FY30*** Six = High One = Low
1	Braddon	8,960	8,439	879	3,675	Five
2	Civic	47,788	44,759	621	2,388	Five
3	Kingston (ACT)	7,646	6,890	1,124	3,682	Five
4	Belconnen	7,112	7,973	466	3,552	Two
5	Phillip	7,067	7,837	497	2,193	Three - Five
6	Griffith (ACT)	4,124	4,129	549	1,865	Five
7	Turner	3,450	3,044	500	1,958	Five
8	Bruce	3,696	7,917	298	2,212	Two
9	Lyneham	3,750	3,418	356	1,497	Five
10	Campbell	3,696	3,714	366	985	Five
11	Barton	7,775	8,101	240	1,084	Five
12	Garran	4,957	4,991	420	440	Three - Five
13	Gungahlin	3,068	2,936	329	1,520	One
14	Franklin	1,991	1,802	470	1,429	One
15	Harrison	1,986	2,082	389	1,136	One
16	Narrabundah	2,485	2,244	453	650	Five
17	Kambah	2,227	1,924	536	610	Four - Six
18	Mawson	2,544	2,166	330	806	Three - Five
19	Curtin	2,596	2,332	569	321	Three - Five
20	Ngunnawal	1,576	1,408	377	720	One
21	Dickson	2,865	3,038	218	832	Five
22	Casey	1,589	1,396	303	492	One
23	Greenway	2,767	3,040	134	1,619	Four - Six
24	Deakin	3,057	3,170	261	282	Five
25	Ainslie	2,061	1,730	353	247	Five
26	Lyons (ACT)	1,519	1,218	293	599	Three - Five
27	Pearce	1,458	1,776	293	368	Three - Five
28	Forrest	2,196	2,146	188	545	Five
29	Downer	1,668	1,244	294	237	Five
30	Hughes	1,513	1,389	334	188	Three - Five
31	Nicholls	1,144	1,233	273	454	One
32	Chifley	1,235	1,019	279	454	Three - Five
33	Red Hill (ACT)	1,462	1,660	261	208	Five
34	Gordon (ACT)	1,059	898	268	719	Four - Six
35	Watson	4,002	3,662	488	NA	Five
36	Wanniassa	1,434	1,539	259	234	Four - Six
37	Amaroo	1,203	1,346	250	350	One
38	Farrer	1,369	1,176	357	153	Three - Five
39	Reid	1,566	3,352	110	384	Five
40	Macgregor (ACT)	1,230	1,108	278	229	Two
41	Holt	1,129	1,047	202	649	Two

42	Bonner	1,403	1,254	287	154	One
43	Kaleen	1,226	1,155	262	154	Two
44	Macquarie	1,033	1,044	163	437	Two
45	Hackett	1,221	974	228	212	Five
46	Crace	1,161	1,041	232	193	One
47	Dunlop	1,120	948	268	159	Two
48	Forde	1,033	929	212	242	One
49	Calwell	975	915	202	324	Four - Six
50	Coombs	819	733	139	915	One - Two
51	Duffy	986	927	245	161	One - Five
52	Holder	985	985	205	196	One - Five
53	Palmerston	740	686	187	672	One
54	Moncrieff	544	467	282	537	One
55	Torrens	981	861	235	109	Three - Five
56	Fisher	903	791	218	187	One - Five
57	Isaacs	740	596	226	256	Three - Five
58	Conder	787	740	173	270	Four - Six
59	Florey	750	768	152	315	Two
60	Rivett	993	857	228	88	One - Five
61	Hume	4,895	4,932	67	NA	Two - Four
62	Yarralumla	1,419	1,273	259	NA	Five
63	Banks	702	561	173	340	Four - Six
64	Evatt	916	868	191	108	Two
65	Isabella Plains	627	522	143	393	Four - Six
66	Chapman	852	855	248	46	One - Five
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68	Acton	3,249	6,545	25	NA	Five
69	Hawker	568	588	120	384	Two
70	Canberra Airport	3,427	3,591	20	NA	Two - Four
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81	Latham	583	514	131	101	Two
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83	Scullin	497	435	102	220	Two
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100	Macarthur	218	184	55	16	Four - Six
101	Hall	75	70	16	16	One
102	Canberra East	375	370	96	2	Two - Four

103	O'Connor (ACT)	NA	NA	NA	717	Five
104	Weston	NA	NA	329	NA	One - Five
105	Taylor	377	329	36	NA	One
106	Fyshwick	19	19	1	NA	Five
107	O'Malley	NA	NA	NA	115	Three - Five
108	Duntroon	NA	NA	99	NA	Five
109	Majura	NA	NA	43	NA	Two - Four
110	ACT - South West	NA	NA	27	NA	One - Three
111	Kowen	NA	NA	8	NA	Two - Four
112	West Belconnen	NA	NA	4	NA	Two
113	Namadgi	NA	NA	2	NA	One - Three
114	Molonglo Corridor	NA	NA	1	NA	Two
115	Tuggeranong	NA	NA	1	NA	Four - Six
116	Gooromon	NA	NA	1	NA	Two
117	Arboretum	NA	NA	0	NA	One - Two
118	Kenny	NA	NA	0	NA	One
119	Scrivener	NA	NA	0	NA	One - Five
120	Tuggeranong - West	NA	NA	0	NA	Four - Six
131	Mitchell	NA	NA	NA	NA	One
131	Gungahlin - East	NA	NA	NA	NA	One
131	Gungahlin - West	NA	NA	NA	NA	One
131	Black Mountain	NA	NA	NA	NA	Five
131	Parkes (ACT) - North	NA	NA	NA	NA	Five
131	Russell	NA	NA	NA	NA	Five
131	Lake Burley Griffin	NA	NA	NA	NA	Five
131	Parkes (ACT) - South	NA	NA	NA	NA	Five
131	Mount Taylor	NA	NA	NA	NA	Four - Six
131	Molonglo	NA	NA	NA	NA	One - Two
131	Molonglo - North	NA	NA	NA	NA	One - Two

Source: Deloitte Analysis

Note: *Criteria 4 is a qualitative assessment at the SA3/substation level.

Appendix J Terminology

Terminology used frequently throughout the report is detailed below:

- **Power**
  - **Kilowatt (kW)** measurement of electrical power (how fast a car is charging) and also used to measure demand on the electricity network
  - **Alternating Current (AC)** charger that outputs alternating current (AC) power. Used in home chargers or smaller public stations where drivers are likely to park for longer
  - **Direct Current (DC)** a charger that outputs direct current which flows directly into the battery. This is more efficient than AC charging; often found on highways or locations where speed is a priority
- **Vehicle energy and range**
  - **Kilowatt Hour (kWh)** measurement of energy (how full a car battery is); equal to one kilowatt of power delivered for one hour. Conversion of 1kWh is equivalent to consuming 1000 Watts for one hour.
- **Charging:**
  - **Level 1** charging from a General Power Outlet (GPO) using a portable charging cable.
  - **Level 2** charging from an AC charging station at home or in public.
  - **Level 3** charging from a DC charger. Stations of this size and speed are generally only available on select public networks or for commercial use.
  - **Guarantee dwell time** how long a ZEV driver spends charging their vehicle
  - **State of Charge (SOC)** refers to the % of currently available capacity (kWh) of a vehicle battery
- **Plug types**
  - The considerations for the charging station rollout will require compatibility and common standards for charging types. With a number of different charging plug types available, the prevailing public charger plug types are CHAdeMO, Type 2 and CCS (Combined Charging System) (Type 2). A comparison of the vehicle plug types are shown in the table below.

Table J.1 – Vehicle plug types

Description	CHAdeMO	Type 2	CCS (Type 2)
Connector			
AC (up to 22kW)			
DC (> 22kW)			

Source: Jetcharge, vehicle plug types

Appendix K Scope of analysis

Government Statistical Areas (SA) 2 and 3 were adopted for the purposes of analysis. The catchments comprised all ACT jurisdictions and surrounding New South Wales jurisdictions of Young-Yass and Queanbeyan. The respective SA2 and SA3 maps are shown in the two below figures.

Figure K.1 Map of SA3 regions in the ACT

Source: ABS

Figure K.2 – Map of SA2 regions in the ACT

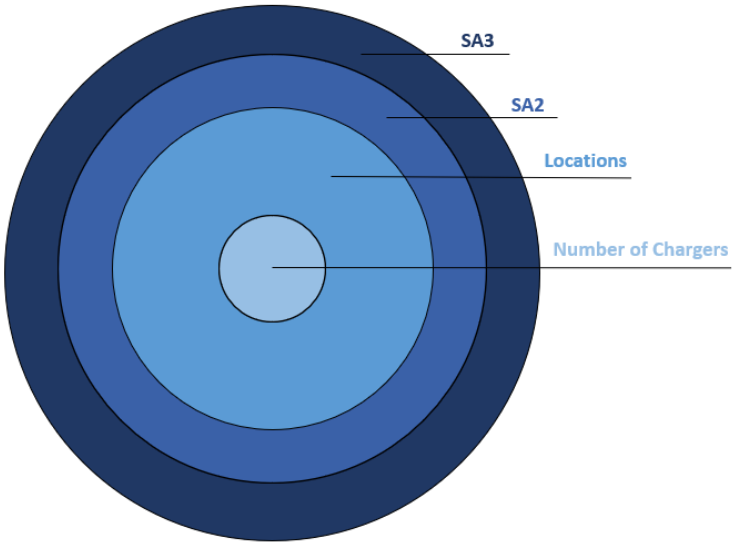
Source: ABS

Appendix L A framework for location level analysis

The long list of potential charging locations has been assessed using both a quantitative and qualitative assessment to identify suitable SA2 locations.

Following the identification of the short list of SA2 options, specific land uses within the SA2 for charger placement have been identified in Section 7.4. The number of chargers within each location will additionally be identified. The figure below provides an illustration of the varying levels of granularity considered in this approach.

Figure L.1– Levels of granularity considered in short list approach



Source: Deloitte analysis

L.2. Overlay of existing charging infrastructure

This analysis will form part of the next phase of work.

Sch 2 s2.2(a)(xi)

Table L.2 – Description of charging location objectives

Charging location objectives	Description		
Visibility	Improved visibility of charging stations can increase awareness of ZEVs and related charging infrastructure.	Charging infrastructure is entirely obscured from public view and promotes minimal awareness of ZEV charging infrastructure.	Charging infrastructure is highly visible and promotes increased awareness.
Accessibility	Charging infrastructure ensures accessibility by users through:		
	c) *Useability* – Charging equipment is user-friendly and easy to operate	The location and placement of charging stations makes it difficult to use.	Charging stations are easy to operate and provides a seamless user experience.
	d) *Convenience* – The location of charging stations provides EV users with the choice to charge when and where they choose.	The location of charging stations is inconvenient and require ZEV users to go 'out of their way' to charge their vehicles.	Charging stations are situated where users are most likely to carry out their day-to-day activities, and/or need charging.
Journey Destinations	ZEV users are not restricted by the range of their vehicle when undertaking longer journeys.	Charging stations are poorly distributed and ZEV users frequently encounter range concerns.	Charging stations are available along the origin-destination journey and provide ZEV users with greater comfort on range concerns.
Security	ZEV users feel confident and safe to use and leave their vehicles docked at charging facilities, at any time of the day.	Charging locations do not appear safe, are poorly lit and not well monitored.	Charging infrastructure is placed in a secure location that is well-lit and frequently monitored
Commercialisation	The location of charging stations is attractive for potential charge point operator partners and provides reasonable opportunity for profit.	The charging location results in poor utilisation of infrastructure and increased risk of 'stranded assets''.	High utilisation of charging infrastructure and good profitability for charge point operators in line with market risks.

Source: Deloitte

The short list of locations has been scored against the key criteria as outlined above in Chapter 6. High-level considerations of Public chargers

Residents in larger cities are typically more responsive than residents in regional and rural areas in the context of potential adopters and attributed this to the driving range. This could be an influencing factor for the number of charging stations the government has made available to the public.

The following table summarises the variety of land uses and activities which provide suitable potential charging infrastructure locations.

Table L.3 – Overview of the range of charging station capabilities

Current Type	Level	Power (kW)	Range added (km) per hour	Charge time	Suitable location
AC	1	2.4-3.7	10-20 km	5-16 hours	Home
	2 (slow)	7 -11	30-45 km	2-5 hours	Home, work, shopping
	2 (fast)	11-22	50-130 km	20min – 2 hours	Key routes
DC	3	25-50	250-300 km	20-60min	Regional near highways, key routes
	4	50-350	400-500 km	20-40min	Regional near highways, key routes
	5	350	+1000 km	10-15min	Highways

Source: Deloitte analysis

For the purposes of this analysis, only the following levels of charging were considered:

- Level 2 charging from an AC charging station at home or in public.
- Level 3 charging from a DC charger. Stations of this size and speed are generally only available on select public networks or for commercial use.