Appendix 1.17

Augmentation to achieve Net Zero 2045 (NZ45)

Regulatory proposal for the ACT electricity distribution network 2024–29

Contents

List of tables

List of figures

Executive summary

The need for augmentation to meet Net Zero 45 targets

Under the capital expenditure objectives of the National Electricity Rules (NER), Evoenergy is required to meet and manage expected demand on its distribution network.

Evoenergy considers that initiatives designed to achieve net zero emissions within ACT by 2045 will transform Evoenergy operations and will have profound impact on the electricity network.

Net zero policy initiatives which are projected to dominate future impact on electricity network, relate to transformation of the two biggest remaining emission sources namely, gas energy and transport[1].

These conclusions are derived from the Net Zero Modelling[2] commissioned by Evoenergy, network and zone substation demand forecasts and network studies.

While the gas-to-electricity conversion is expected to have a major longer-term impact on the growth of network demand, the biggest projected medium-term driver is the electrification of transport.

Policy settings at state and federal level are decisively promoting the uptake of electric vehicles (EVs) to meet a net zero emissions target, set by the ACT government for 2045[3].

Charging infrastructure supporting uptake of electric vehicles is identified as important medium-term driver of the demand growth in the electricity network and emerging capacity constraints.

To assess the proposed expenditure, Evoenergy has commissioned Net Zero Modelling and conducted network studies of the existing and emerging network constraints.

Evoenergy's Net Zero model "Realistic Electrification Ad hoc" scenario (September 2022) has forecast that Winter peak demand will drive future investment in the capacity of the Evoenergy electricity distribution system. Modelled peak demand in winter increases from 659 MW in 2020-21 to 824 MW by 2033/34 (25% increase), which is significantly above the growth in annual electricity consumption to 3,123 GWh over the same period (12% increase). Major input variable driving that growth is an "optimistic" EV uptake consistent with ACT Government projection of more than 50,000 electric vehicle by 2030. The "Realistic Electrification Ad hoc" scenario is the main reference scenario for the proposed augmentation expenditure covered by this business case.

Furthermore, Evoenergy has prepared separately network and zone substation demand forecast. Notably, that forecast aligns with the forecast derived from the Net Zero Modelling (around 8% difference in the forecast by 2033/34). The forecasts were employed as the main reference to study localised network constraints and assess augmentation requirements covered by this business case.

Options framework

The EV charging infrastructure is the main medium-term factor behind projected capacity constraints within the electricity network. Therefore, Evoenergy has conducted detailed network studies to identify emerging network constraints for three different options. Each option corresponds to a different EV uptake trend. These EV uptake trends, and input assumptions are consistent with the trend projections prepared by Deloitte Access Economics for ACT Government. The options are also consistent with Net Zero Modelling commissioned by Evoenergy.

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[1] Evoenergy, Network Development Plan 2022 refers.
[2] Evoenergy Net Zero Modelling Journey, Marsden Jacob, January 2023.
[3] Zero Emission Vehicles Strategy 2002-30, ACT Government.

The scenarios with the corresponding forecasted capital can be summarised as follows:

- Option 1: Low EV uptake – $43.54m[4]
- Option 2: Medium EV uptake – $76.34m
- Option 3: High EV uptake – $226.34m

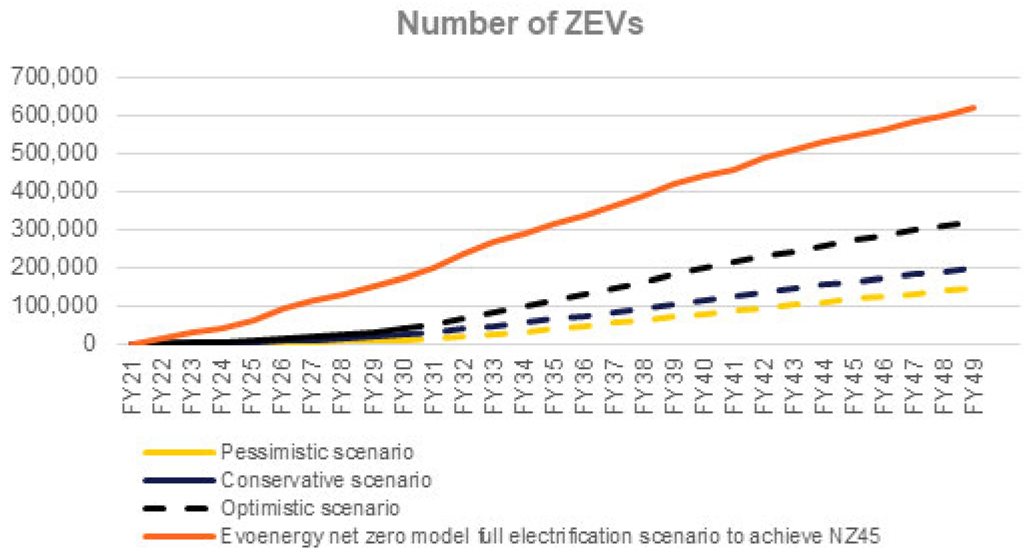
Option 1: EV uptake is in line with ACT Government "conservative" scenario of around 25 000 passenger EVs by 2030. This scenario does not achieve the legislated zero emission target by 2045.

Option 2: EV uptake is in line with the "optimistic" ACT Government EV scenario with over 40 000 passenger electric vehicles plus around 10 000 other electric vehicles. This does not achieve the legislated zero emission target by 2045.

Option 3: EV uptake is in line with a high ACT EV take up scenario. This scenario is consistent with the path of achieving net zero emissions by 2045.

Figure 1 depicts the key scenarios assessed by Evoenergy in terms of localised network constraints and "whole of network" Net Zero Modelling.

Figure 1 – Key zero emission vehicles roll-out scenarios.



Recommended option

Evoenergy has adopted the medium EV uptake augmentation scenario as the option which represents the best balance between efficiency of investment and addressing long term operational risks.

That option is congruent with the ACT government "optimistic" forecast for EV uptake and the ACT Government's Zero Emission Vehicle Strategy 2022-30.

[4] All expenditure in this business case is in 2023/24 dollars excluding corporate overheads, contingency and GST.

The proposed $76.3 million augmentation expenditure sets Evoenergy's path to accommodate projected medium-term growth in electricity demand, principally caused by the uptake of electric vehicles.

Appendix 1.16 Network Development Plan explains the planning approach taken by Evoenergy, long term context and the reasoning behind the proposed investment path. Appendix 1.15 Demand Driven Capital Expenditure Business Cases discusses the net zero projects within the context of all proposed augmentation projects.

The proposed investment in this business case comprises network augmentations required to accommodate growth in demand driven primarily by the EV uptake and the necessary charging infrastructure. The proposed expenditure was identified through detailed network studies and consideration of emerging constraints.

The proposed expenditure represents a prudent estimate of the EV uptake over 2024-29 and the necessary augmentation to facilitate EV growth. Notably, Evoenergy modelling indicates that while the path adopted by Evoenergy is consistent with the existing ACT Government EV uptake, it falls short of achieving legislated zero emissions target by 2045. Thus, Evoenergy considers that the ACT Government may adjust the policies to increase the pace of emissions reductions. The proposed path allows Evoenergy to manage that risk and escalate investment if the gas-to-electricity conversion or take up of EVs increase substantially.

If Evoenergy were not to undertake these augmentation works (Option 2) it would be exposed to the long-term operational risks. Specifically, initial failure to invest adequately in the network would create a backload of works in the forthcoming years – resulting in severe operational risks as well as potential inability to fulfill service obligations. The operational risk would be even greater if actual EV uptake exceeded the "optimistic" scenario[5] assumed in option 2.

Furthermore, the proposed expenditure assumes no material impact of the gas-to-electricity conversion within the 2024-29 period. Thus, operational risks would increase if the pace of the gas churn accelerates. Figure 3 shows the emissions trajectories for the modelled scenarios.

Based on the net zero modelling Evoenergy has forecast "whole of network" expenditure requirements from now until 2045 of $2.9–$3.4 billion, depending on the extent of electrification and adoption of EVs. This represents approximately $1.8–$2.4 billion of capital expenditure investment above business-as-usual no growth investment. Net Zero Modelling estimates the total 2024-29 capital requirement of $608 million. This modelling informed our detailed assessment of network needs including that covered by this business case. Notably, Evoenergy's total proposed capital program derived from the assessment of network constraints is below that indicated for similar (option 2) vehicle uptake by the Net Zero Model.

[5] Late 2022 data indicated that 9.5% of newly registered vehicles are EVs which is above the optimistic scenario.

1 Introduction and context

1.1 NZ45 and increased electrification in ACT

The ACT Government is committed to achieving net zero emissions in the ACT by 2045. To reach this goal, the Government has published a Climate Change Strategy and a set of policy measures under "Powering Canberra" umbrella. The key elements of the strategy will:

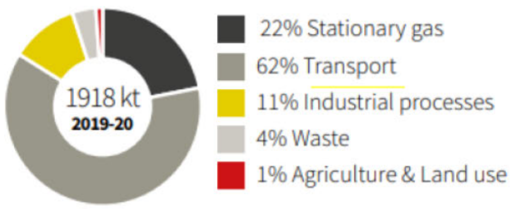
- Transition of transport to net zero emissions
- Phasing out gas as an energy source

The above drivers together with a range of other measures impacting the network are discussed in the Network Development Plan. This business case focuses on the impact of EVs as the primary factor driving the medium-term demand in the network.

1.2 Impact on Evoenergy's electricity distribution network

The transport sector accounts for most carbon emissions within the ACT, representing 62% of total carbon emissions, as per Figure 2. To reduce the emissions from the transport sector, the ACT Government has focussed on policies that incentivise the uptake of electric vehicles with cleaner fuel costs than petrol and diesel-powered internal combustion engines.

Figure 2 – Projected greenhouse gas emissions for 2019-20 by sector



Source: *ACT Climate Change Strategy 2019-2025*

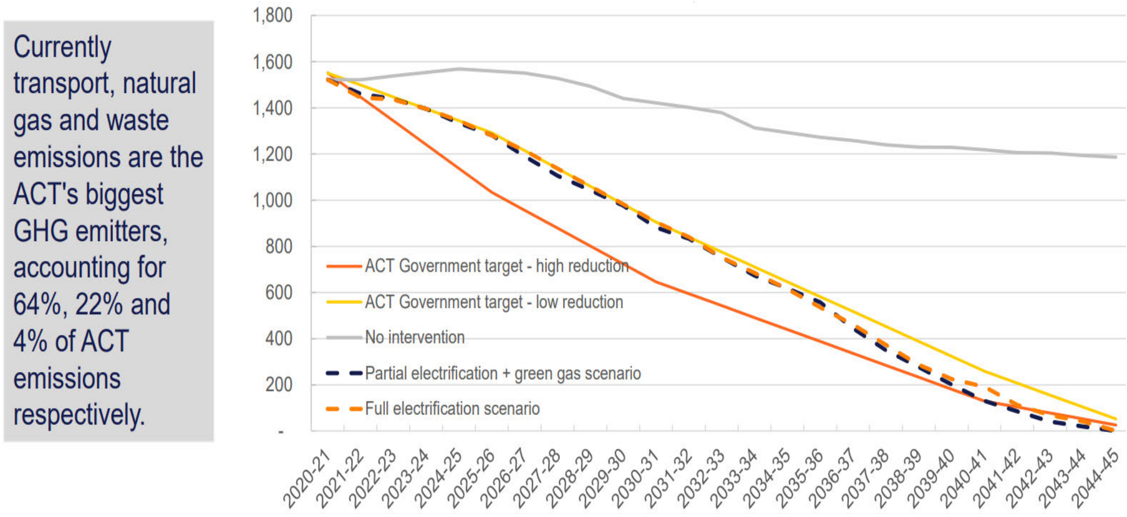
The ACT Government's strategy will have a direct impact on Evoenergy's electricity distribution network in the next regulatory period (2024-29), as well as ongoing impact through to 2045, Electricity demand is expected to increase and there will be changes to peak period and consumption patterns. In response to this, Evoenergy needs to prepare its network for major changes in demand and consumption patterns.

Evoenergy has carried out an area-by-area assessment of the localised emerging network constraints. The analysis accounted for unequal projected distribution of EVs across ACT. The assessment of localised projected peak demand has revealed that the existing network capacity is not sufficient to supply projected demand under all scenarios.

1.3 Emissions trajectory to meet Net Zero 2045

There is a significant effort required to reduce emissions from the current level to reach net zero targets by 2045. Figure 3 shows the emissions trajectory under a range of policy scenarios Modelled by Evoenergy. The "no intervention" scenario incorporates an assumption of no government intervention for consumers to purchase zero emission electric vehicles and limited augmentation to support increased electricity demand arising from EV charging. Other scenarios represent accelerated take up of EVs and gas-to-electricity conversion from the current level.

Figure 3 – ACT net vehicle and natural gas emissions in kilotonnes per annum



Source: *Source: Evoenergy modelling of ACT Government policy settings towards NZ45*

1.4 Electric vehicle uptake and charging infrastructure

The ACT Government have adopted the following transport policies which are expected to drive higher uptake of zero emission electric vehicle ownership in the ACT:

- EV sales target of 80-90% of light vehicle sales by 2030 (ACT vehicle strategy) (announced)
- Cease registration of new light non-zero emission vehicles by 2035 (announced)
- Free registration of electric vehicles for 2 years (existing)
- No stamp duty and interest free loans up to $15,000 for eligible zero emission vehicles (existing)
- Incentives of $2,000 for installation of EV charging at multi-unit buildings starting in 2023
- By 2023, enact regulations that require EV charging infrastructure for new multi-unit residential and commercial buildings
- Expand the public EV charging network, ensuring there are at least 180 publicly available charging stations in the ACT by 2025
- Deliver more than 70 publicly accessible charging stations in 2022-23.

Additionally, the Federal Government has committed to the following policies to encourage EV sales across the nation:[6]

- Exemptions of fringe benefits tax on use of cars that are zero or low emissions vehicles (Federal scheme introduced into legislation on 27 July 2022)
- Legislated a 43% emissions reduction and net zero emissions targets by 2050
- Establish a national EV charging network with charging stations established on average every 150 kilometres on major roads
- Committed $250 million to the future fuels fund to establish EV charging stations across Australia
- Target 75% of Commonwealth vehicle fleet to be low emission vehicles by 2025
- Removal of fringe benefits tax and 5% import tariff for eligible EVs

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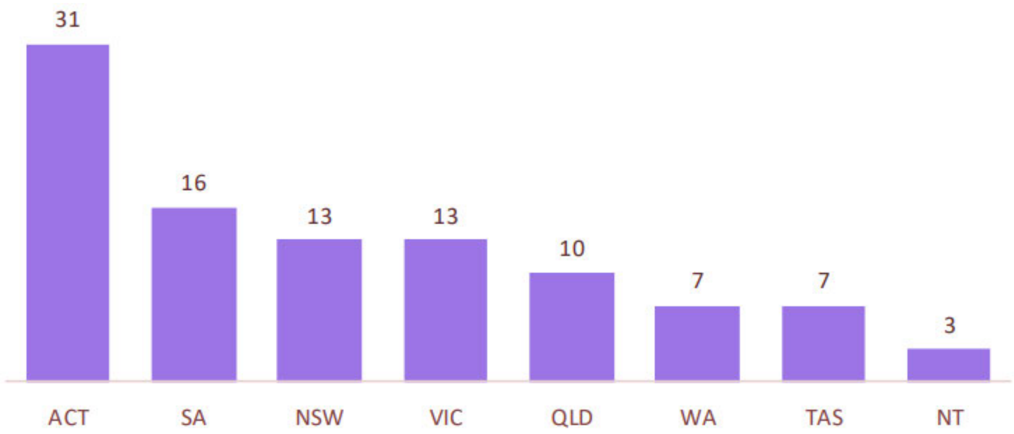
6 Minster for Infrastructure, Accelerating Australia's electric vehicle potential, accessed 16 December 2022.

In mid-2022, the ACT has the strongest uptake of EV's on the East Coast of Australia per capita of new registrations (Figure 4) and decisive position in relation to the installation of public chargers (Figure 5). The EV trend in the second half of the year has shown strong growth in EV registrations (Figure 7).

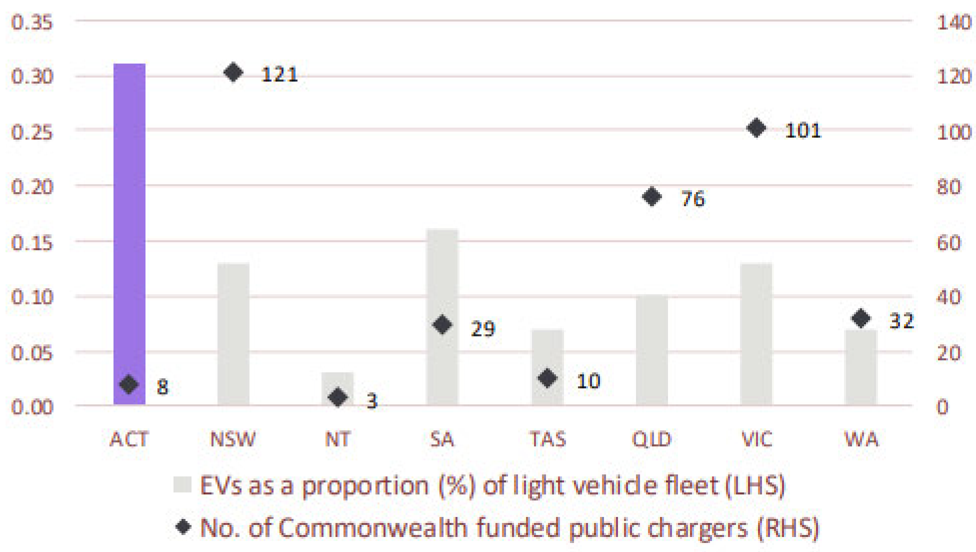
Figure 4 – State and territory electric vehicles per 10,000 registrations



Bar graph of number electric vehicles for every 10,000 vehicle registrations, across Australian States and Territories. Source: EVC, State of electric vehicles 2021

Source: *Electric vehicle council*

Figure 5 – Number of Commonwealth public charging sites awarded in 2021 and proportion of EVs by State/Territory



Bar graph demonstrating EVs as a proportion of light vehicle fleet, overlayed with a scatter plot chart demonstrating number of Commonwealth public charging sites which have been awarded through the Future Fuels Fund Round 1. Source: EVC State of EVs in 2021, ARENA Future Fuels Fund (Round 1), 2021

Source: *Electric Vehicle Council*

Table 1 – Public charging locations by region and power level as of 30 June 2022

State/Territory	Regular (below 24kW, AC and DC)	Fast (24kW – 99kW DC)	Ultrafast (100kW DC and above)	Grand Total	Population per charger
ACT	35	4	1	40	11,333
NSW	529	85	33	647	12,512
NT	22	1	0	23	10,841
QLD	301	57	10	368	14,307
SA	178	26	6	210	8,603
TAS	91	14	5	110	5,180
VIC	383	51	21	455	14,417
WA	252	36	6	294	9,395
Grand Total	1,791	274	82	2,147	11,999

Source: *Electric Vehicle Council*

The ACT Government announced the construction of 180 new publicly accessible EV charging stations to support uptake of EVs by 2025 and up to further 1000 public chargers by 2030. Additionally, the Commonwealth Government has promoted interconnectedness of EV charging networks by providing subsidies from the $250 million Future Fuels Fund initiative. A wider network of public EV chargers will reduce the anxiety about the ability to complete planned journeys. This is particularly the case for residents of apartment buildings and unit title organisations where a lack of access to EV chargers at home would act as a deterrent to purchasing an EV without a location to charge overnight. The majority (70%) of EV charging is expected to take place at the customers' residential household, therefore access to home charging is crucial.[7] An amendment to the National Construction Code: Class 2 Building (Apartment) Charging Requirements 2023 sets out the requirement to have all new apartment buildings to be EV ready for level 2-AC fast charging from October 2023 for all parking spots.

In addition, public charging infrastructure is set to grow significantly with a planned roll out of up to 1000 public chargers by 2030 within the ACT.

Much of the augmentation expenditure associated with net zero investments will be directed towards addressing higher demand resulting from EV charging at households and public spaces.

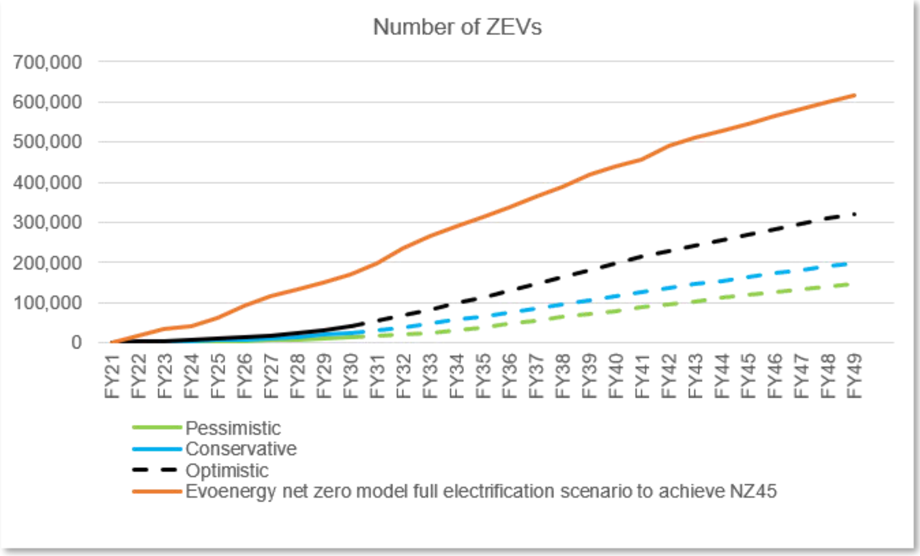
Source: *Up to 2019, the growth in EV uptake has been slow, however, since 2020 EV registrations have grown significantly and are expected to accelerate in greater volumes in the coming years (Source: ACT Government.*

[7] ACT Government, Electric Vehicle Charging Outlook for the ACT Guidance for industry, December 2021, p. 13.

Source: *Figure 7). The ACT Government's target of 80-90% of new vehicle sales by 2030, this would equate to slightly over 170, 000 EV sales by 2030.[8] In 2021 calendar year, the number of registered electric vehicles in the ACT was 1,300 but during 2022 calendar year, this number had rapidly grown to around 3000 EVs at 1 January 2023 (Source: ACT Government.*

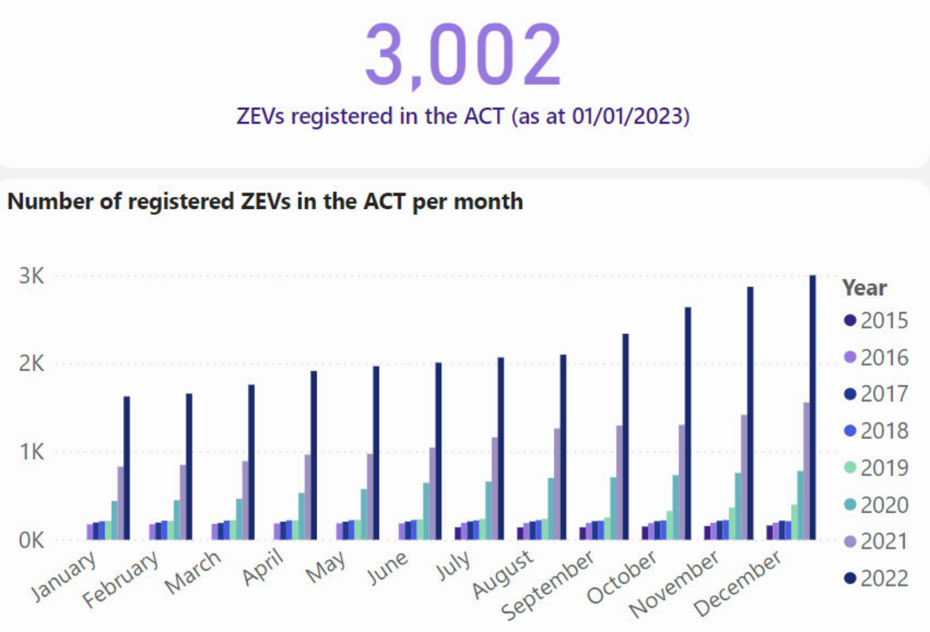
Figure 7 refers [9]) Current registration rates of EVs are currently above the ACT Government Optimistic uptake forecast shown in Figure 6 with over 230 added each month. Thus, the recent data is showing that 9.5% of new vehicles are EVs which is above uptake scenario assumed for option 2.

Figure 6 – Comparison of ZEV uptake scenarios



Source: *Source: ACT Government.[10]*

Figure 7 – Growth in EVs in the ACT



[8] ACT Government forecasts over 320 000 light vehicle registrations, EV forecast is 80-90% of this number. May have to be reduced given sales targets don't translate 100% into registrations.

[9] ACT Government, Everyday climate choices

[10] ACT Government, Zero Emission Vehicle Charge Rollout, Deloitte Access Economics

Source: *Source: ACT Government.*[11]

1.5 Transition of the gas network to electricity

ACT Government is committed to full electrification and phasing-out use of gas within ACT. Therefore, Evoenergy considers that in the long-term gas-to-electricity conversion will be one of the key factors driving electricity demand. However, currently the gas churn is proceeding at an organic pace without major policy interventions. The expected medium-term impact of gas churn is minor. The medium-term impact is considered minimal for brownfield sites with small increases being partially offset by residential batteries. The higher demand of electricity for new households at greenfield sites that use all electrical appliances will be covered by other proposed augmentation works outside the scope of this business case. Thus, Evoenergy's assessment of network augmentation requirements in this business case does not include projects arising from gas-to-electricity conversion. While, these projects are not included, the acceleration of the has churn would pose operational risk.

1.6 Policy uncertainty

Evoenergy is preparing this business case against the background of changing policy setting relating to zero emission vehicles and gas conversion.

Governments at State and Federal levels have adopted policies to encourage uptake of EVs e.g. vehicle emission targets, EV sales targets for government fleet, direct consumer incentives, and reduction in EV transaction costs.

More recently, the ACT Government has bolstered incentives to encourage EV purchases and it is expected that more incentives will be provided in the years to come. These stronger incentives have coincided with exponentially higher EV sales over 2022 compared to 2021. However, the change in future policy settings is unclear and may significantly affect the rate of growth in EV purchases over the 2024-29 regulatory period. In particular, the ACT integrated energy plan will address further plans for electrification and EV policy, due to be released in 2024, aligning with the timing of the next ACT election. The ACT government has indicated further incentives to discourage new gas connections and encourage gas disconnections, with the details yet to be confirmed as part of updated energy strategy.

This may add further demand from gas residential and commercial customers transitioning away from gas to electricity.

Federal Government policies may also have a significant bearing on the uptake of EVs over the 2024-29 period. Notably, the announcement to consult on the possible introduction of fuel efficiency standards which would regulate CO_2 emissions from new vehicles may further accelerate the transition to EVs. Similarly, the announcement to align Australian noxious emission standards with European standards from 2024 may further increase the purchase of EVs over the 2024-29 regulatory period. The precise wording on the new standards is still subject to further consultation and may raise some uncertainty regarding the potential for greater uptake of EVs. The new standards may further to apply from 1 November 2024 in respect of new heavy vehicles and existing heavy vehicles from 1 November 2025.[12]

On the 12 August 2022, Energy Ministers announced they would fast-track an emissions objective into the National Energy Objectives, under the National Energy Rules.[13] Such an amendment to the Rules would provide a legislative recognition of augmentation expenditure driven by net zero policies

[11] ACT Government, Climate choices vehicles and travel

[12] Australian Government, Dept. of Infrastructure, Transport, Regional development, Communications and the Arts, Vehicle emission standards, accessed December 2022.

[13] Australian Government Dept. of Climate Change, Energy, the Environment and Water, Energy Ministers communique, 12 August 2022.

such as proposed in this business case. If this legislative change is enacted before the next regulatory period, it may change the criteria for the regulatory approval of the net zero investment.

The evolving policy setting together with consumer preferences will determine impact on the electricity network. For example, the actual uptake of photovoltaics was higher than several prior projections.

This business case assumes the “optimistic” EV scenario but offers flexibility if the actual rate of EV uptake is higher. Recent registration data which tracks above the “optimistic” trend confirms that the higher uptake is plausible.

1.7 Network infrastructure to support electric vehicle uptake

There is increasing evidence of accelerating uptake of EVs and growing need for a charging infrastructure.

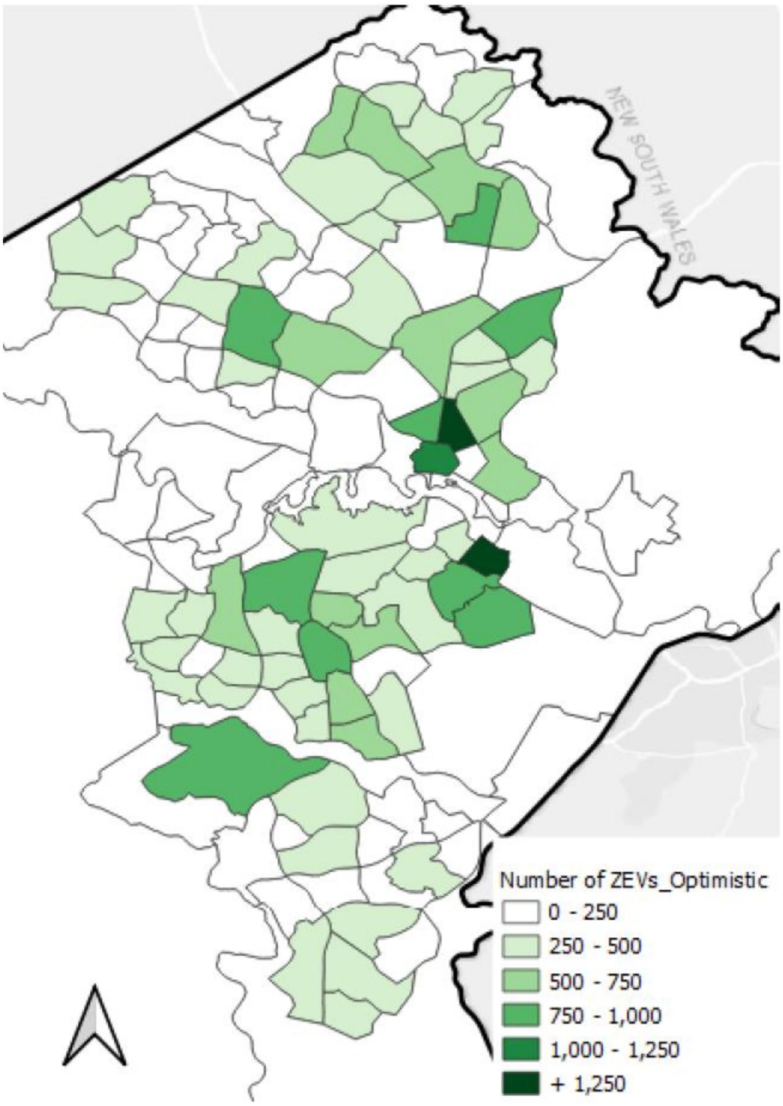
A number of connection applications for medium and high-density residential developments include onerous requirements relating to EV charging facilities. Recent examples include applications for apartment buildings which include a requirement for over 300 charging stations in Belconnen, 95 stations in Parks, over 700 stations in a development in Gungahlin and 900 stations in another Belconnen development. The estimated cost of installing charging stations in new apartments is $1,700-$2,500 per apartment, compared to the cost of retrofitting an EV charger to an existing apartment of $2,500-$8,000.[14]. However, that cost does not include the upstream network augmentation requirements which would be required to cater for the groups or clusters of chargers.

Apart from the private chargers ACT Government forecasts installation of up to 1000 public chargers by 2030[15].

The ACT Government has projected the likely distribution of EVs across the ACT, noting that some suburbs will experience above average uptake until 2030. Figure 8 depicts the unequal distribution of the EVs under the “optimistic” uptake scenario.

Figure 8 – Map of expected EV registrations by 2030

[14] ACT Government, EV ready Developments, December 2021, p. 4.
[15] Electric Vehicle Charging Outlook for the ACT, ACT Government 2021.



Source: *Source: ACT Government*

Notably, several centrally located areas such as Civic, Kingston and Braddon are expected to experience the highest uptake or EVs. Further, the unequal distribution results in a greater number of constraints in network

Evoenergy has conducted localised network studies to identify the network constraints resulting

From the EV charging infrastructure. The constraints are exacerbated by the unequal distribution of chargers with greater constraints projected in the locations with higher expected EV uptake.

The network studies have focus on the assessment of emerging specific constraints at:

- Zone substations
- Distribution feeders

The assessment of emerging constraints indicate that additional zone substation capacity will be required to support emerging constraints. Specifically, the proposed Mitchell Zone Substation would be designated to support load growth in Gungahlin and Inner North.[16] Furthermore, proposed Curtin Zone Substation would relieve the load growth in South Canberra, Kingston, and Woden.

[16] ACT Government, Electric Vehicle Charging Outlook for the ACT, December 2021, p. 18.

The assessment of localised constraints determined that new feeders are required Civic, Campbell, Hackett, Gungahlin, Garran, and Phillip to service various residential and commercial sites.

Furthermore, the network studies assessed that distribution substations capacity, and low voltage circuit upgrades will be required in various locations. However, these needs will be considered on case-by-case basis as they arise (e.g., due to new connection applications or increases in the existing load).

2 Purpose of this business case

The policy initiatives relating to the legislative net zero emission target, such as electrification of transport and gas substitutions are set to transform Evoenergy network. In the medium-term the growing uptake of electric vehicles and the supporting charging infrastructure are projected to result in multiple constraints across electricity network. This document outlines the options assessment, business case and qualitative and quantitative justification for the proposed net zero augmentation program that forms part of Evoenergy's 2024-29 regulatory proposal.

2.1 Strategic alignment of documents that support Net Zero integration

Together with this business case, the following documents further support the transition to net zero and the augmentation requirements for Evoenergy's network:

- **Evoenergy Annual Planning Report**– The annual planning report informs other network service providers, market participants, consumers and interested parties of near-term constraints impacting Evoenergy's network, and factors impacting long-term demand forecasts and network reliability.
- **Demand Driven Augmentation Capital Expenditure Business Case**[17] – This document provides the strategic context and justification for Evoenergy's proposed demand driven augmentation capital expenditure (augex) for the 2024-29 regulatory period.
- **Net Zero modelling documentation** – Marsden Jacobs and Associates key inputs and assumptions used to reach net zero target.
- **Tariff Structure Statement** – Provides details on tariff structures proposed in the upcoming regulatory period which will include tariff reform which support EV charging incentives through customer behaviour change, such as a solar sponge, export tariff and battery tariff. Tariff reform is not included in this business case.
- **Network Development Plan**[18] – describes Evoenergy's network planning methodology employed against the background of dynamic industry landscape and within the long-term network context.

3 Evaluation approach

In determining the net zero augmentation program for Evoenergy's 2024-29 regulatory proposal, Evoenergy applies a cost benefit analysis (CBA) which quantifies and compares the total costs and benefits associated with each investment item across a range of potential investment options.

The CBA provides an economic view of the costs, benefits, and net benefits across a 40-year period associated with each investment option. The costs and benefits included in the CBA are those relating

17 Appendix 1.15 of Evoenergy's regulatory proposal
18 Appendix 1.16 of Evoenergy's regulatory proposal

directly to the electricity network and the potential impact on customers if the network capacity is constrained, namely:

- the cost of network augmentation
- the value of risk primarily related to unserved energy

Thus, the focus of the analysis are network cost and operational risk resulting primarily from transport electrification[19].

For each proposed investment Evoenergy is considering a range of options including do-nothing, non-network, and network solutions. Evoenergy is applying the same rigour to all net zero investments including consideration of non-network solutions.

Feasible non-network solutions are explored through Annual Planning Report and through Regulatory Investment Test processes. The methodology is also described in Appendix 1.15.

ACT Government's EV projections have substantially increased in the second half of 2022 and those changes were followed by Net Zero Modelling commissioned by Evoenergy to assess network impact. Therefore, the available compressed timeframe did not allow for only a limited exploration of non-network options. Evoenergy experience to date is that only few projects of this type, with demand continuing to grow beyond the period, lend themselves to a viable non-network option. Moreover, in most cases, non-network solution results in a deferment rather a replacement of network investments. For these projects it is estimated that deferral values would not warrant interest from non-network option providers. Evoenergy assessment is that sheer scale and pace of net zero changes (e.g. EV uptake impact) makes implementation of non-network solutions even more challenging and potential deferments shorter. As the scope of forecasts constraints become firmer, Evoenergy will advertise the constraints, proposed network solution and deferral values as part of the Annual Planning Report and associated constraint map to engage with proponents and encourage non-network solutions.

The reduction of operational risk is considered an economic benefit. The calculation of the unserved energy is based on the value of energy to consumers which represents an economic value of energy. Each localised network constraint was assessed individually, and corresponding solutions costed. The constraints were analysed for the three options corresponding to three different electric vehicle uptake scenarios.

Key societal benefits and costs resulting from the net zero targets and related policy initiatives in the broad ACT context are summarised in Table 2. While these costs and benefits are recognised, they are not part of the CBA.

[19] Transport electrification is taking place with 100% renewable target in place

Table 2 – Benefits and costs of net zero augmentation requirements

Benefit/Costs type	Description
Vehicle fuel consumption savings (Benefit)	Largest benefits are fuel consumptions costs by avoiding petrol/diesel/gas fuel prices for transport and instead sourcing relatively cheaper electricity.
Reduced C02 emissions (Benefit)	Reduced C02 emissions from transport sector main sector for emissions in ACT from around 1,500 KT p.a. in 2022 to 0 KT p.a. in 2045. This has an estimated value of $1.6b, for an assumed carbon price of in the range of $35-$100 per tonne of C02 between 2023 and 2045 (Table 13 in Appendix).
Avoided cost of high gas and fuel prices (Benefit)	Benefits reduce consumer exposure to high gas prices, transitioning to relatively cheaper electricity supply. The high forecast wholesale gas price and the increase in gas network charges as customers remove their gas connections and costs are recovered over a smaller customer base. Over the 20-year forecast horizon, this is forecast to reduce consumer energy costs by 2045 under any of the electrification scenarios that include a further shift away from gas. The reduction in petrol and diesel cost is also achieved to lower the consumer total energy bill. Customer surveyed and supportive of network augmentation to allow greater EV penetration, with knowledge of bill impacts.
Gas network decommissioning (Cost)	Gas network decommissioning costs of $140 million factored into operating expenditure under electrification scenarios.

Source: *Evoenergy presentation to AER Networks Board*

For avoidance of doubt, the following value streams are not quantified and are also excluded from the CBA:

- The extent of switching customer usage from gas to electricity appliances
- Environmental benefits from avoided greenhouse gas emissions

4 Options Framework

Evoenergy has considered three feasible options to meet the investment need, assuming a medium forecast for electrification based on an assumed EV uptake:

- Option 1 – ACT Government conservative EV uptake
- Option 2 – Evoenergy expected EV uptake based on ACT government optimistic EV uptake
- Option 3 – Accelerated EV uptake that achieves net zero by 2045

All options consider impact of public and private charging required to support EV uptake. Moreover, all options assume that EV owners will charge at home for 70% of their charging needs, mostly overnight and sometimes choosing the convenience window of between 4 pm to 10 pm. This aligns with Evoenergy's Demand Management Strategy (Appendix 1.20) which outlines using demand management to shift EV charging load out of peak periods. Evoenergy's demand and time of use tariffs are also currently priced to discourage convenience charging at the time of network peak demand. In the future, it is expected that these tariff levels will be calibrated to create stronger dis-incentives to charge during the convenience window.

The long-term network planning context, our methodology and Net Zero Modelling are comprehensively discussed in the Network Development Report (Appendix 1.16).

4.1 Option 1 – Low EV uptake

This option assumes that around 25 000 passenger EVs will be registered in the ACT by 2030 which is consistent with the ACT Government "conservative" scenario. Under option 1, Evoenergy will need to install 5 new feeders across several suburbs to accommodate a modest uptake of EVs by consumers. The 11 kV feeder augmentations would be required to ease constraints. The constraints also are projected to impact transmission infrastructure, zone substation upgrades and low voltage network works. Table 3 provides a summary of the augmentation works to facilitate integration of EVs and the increased demand for electricity.

If the actual amount of EV uptake is greater than forecast, areas of the network may be constrained with insufficient augmentation works, leading to increases unserved energy. Backloading augmentation investment to meet net zero targets may result in serious deliverability issues in the future. Notably, under this option the EV uptake is insufficient to reduce emissions to meet net zero commitments by 2045 and the most recent (Dec 2022) data shows EV registrations are much higher than under the scenario assumed for that option.

The risk of unserved energy has been modelled under the base case scenario, where no augmentation is undertaken to accommodate load from EVs. This is particularly the case within areas of the network expected to experience high EV growth. Constraints result in unserved energy across multiple suburbs with the biggest impact on feeders and zone substation loading. The value of unserved energy is estimated to be $6.66 million over 2024–29 regulatory period. The forecast of un-served energy increases rapidly each year beyond the 2029 period, and reaches $8.68 million in 2032, necessitating feeder works in the 2024-29 period, given 2-year lead time to construct feeders. As zone substation have a 3-year construction lead time, some zone substations work must commence in 2024–29 period to avoid operational risks. The values of unserved energy by suburb are listed in Appendix E Table 16.

Table 3 – Summary of augmentation works for option 1

Augmentation works (direct costs excluding overheads)	Description $FY24, excluding corporate overheads, contingency and GST
11kV feeder works	• Supply to Braddon (2.2 km) $3.87m • Supply to Campbell 4 km $5.04m • Supply to Franklin 5.7 km $4.98m • Supply to Canberra CBD feeder 1 (from CE ZSS) (3 km) $3.16m • Supply to Canberra CBD feeder 2 (from Civic ZSS) (3.9 km) $2.61m • Total in 2024-29 – $19.66m
Zone substation works	• Curtin Zone Substation Stage 1 $11.76m • Establishment of Mitchell Zone Substation - early works $2.2m • ZS QoS Reactive Plant $2.06m

Transmission	• Woden to Curtin 132kV UG Cable $6.52m as part of Curtin ZS establishment
ENC Reliability and Quality improvements	• ENRQI Resilience – Covered HV conductor $1.55m
Total	**$43.54m**

4.2 Option 2 – Medium EV uptake

This option assumes a medium uptake of around 50 000 EVs by 2030 which is consistent with ACT Government "optimistic" EV uptake scenario. Under option 2, Evoenergy will require 10 new feeders across several suburbs to accommodate EV charging load. The network impact also includes transmission infrastructure, zone substation upgrades and low voltage network works. Table 4 provides a summary of the augmentation works to facilitate integration of EVs and the increased demand for electricity.

This EV uptake under this option is insufficient to reduce emissions to meet net zero commitments by 2045. This option is intended to initiate a program of works to accommodate uncertain EV growth over 2024-29, address forecast network constraints through a fiscally conservative solution. The base case scenario assumes no policy incentives implemented by the ACT Government to promote EV uptake.

Under this medium EV uptake scenario, Evoenergy has determined that unserved energy will occur if existing network capacity with no augmentation to accommodate the assumed EV uptake. This is particularly the case within areas of the network expected to experience high EV growth.

The risk of unserved energy has been modelled under the base case scenario, where no augmentation is undertaken to accommodate load from EV uptake (over 40 000 light passenger EVs and 10 000 other EVs). This results in unserved energy across multiple suburbs which are expected to experience significant growth, where there is limited available capacity in nearby feeders and zone substations. The value of unserved energy is estimated to be $8.57 million over 2024–29 regulatory period. The forecast of un-served energy increases exponentially beyond the regulatory period, and reaches $16.76 million in 2032, necessitating feeder works in the 2024-29 regulatory period, given 2-year lead time to construct feeders. Zone substation works are also required over 2024–29 to avoid network constraints, as they have a lead time of 3 years to construction. The values of unserved energy by suburb are listed in Appendix E Table 17.

Table 4 – Summary of augmentation works for option 2

Augmentation works (direct costs excluding overheads)	Description $FY24, excluding corporate overheads, contingency and GST
11kV feeder works	• Supply to Braddon (2.2 km) $3.87m • Supply to Watson (4.3 km) $2.97m • Supply to Ainslie (3.2 km) $4.77m • Supply to Campbell (4 km) $5.04m • Supply to Franklin (5.7 km) $4.98m • Supply to Garran and Red Hill (4.6 km) $2.54m • Supply to Phillip (3.6 km) $4.50m

	• Supply to Canberra CBD feeder 1 (from CE ZSS) (3 km) $3.16m • Supply to Canberra CBD feeder 2 (from Civic ZSS) (3.8 km) $2.61m • Supply to Canberra CBD feeder 3 (from Civic ZSS) (3 km) $0.28m (partial delivery, remainder in 2029-2034) Total in 2024-29 = $34.72m
Zone substation works	• Curtin Zone Substation Stage 1 $19.31m (partial works for commissioning in the 2029-34 period) • Establishment of Mitchell Zone Substation - early works $2.20m • ZS QoS Reactive Plant $2.06m
Transmission	• Woden to Curtin 132kV UG Cable $8.5m as part of Curtin ZS establishment
Distribution	• Distribution Substation upgrades $5.13m • Low Voltage Circuit upgrades $2.87m
ENC Reliability and Quality improvements	• ENRQI Resilience – Covered HV conductor $1.55m
Total	**$76.34m**

4.3 Option 3 – High EV uptake

This option assumes that around 170,000 EVs will be registered in the ACT by 2030 which is the projected uptake required to achieve net zero target by 2045. Under option 3, Evoenergy would require 17 new feeders across a number of suburbs to accommodate uptake of EVs. The network impact also includes transmission infrastructure, zone substation and low voltage network works. Table 5 provides a summary of the augmentation works to facilitate integration of EVs and the increased demand for electricity.

Under this option, the EV uptake is sufficient to reduce emissions to meet net zero commitments by 2045. This option assumes enhanced policy settings to aggressively promote the uptake of EVs.

The risk of unserved energy has been modelled under the base case scenario. Evoenergy has determined that significant unserved energy will occur under a base do-nothing (no augmentation) option constraints resulting from the high EV uptake. This is particularly the case within areas of the network expected to experience high EV growth.

This results in unserved energy across multiple suburbs which are expected to experience significant growth, primarily due to increased uptake in electric vehicles, where there is limited available capacity in nearby feeders and zone substations. The value of unserved energy is estimated to be $62.1 million over 2024–29 regulatory period. The forecast of un-served energy increases exponentially beyond the regulatory period, and reaches $542.03 million in 2032, necessitating feeder works in the 2024-29 regulatory period, given 2-year lead time to construct feeders. Zone substation works are also required over 2024–29 to avoid network constraints, as they have a lead time of 3 years to construction. The values of unserved energy by suburb are listed in Appendix E Table 18.

Table 5 – Summary of augmentation works for option 3

Augmentation works (direct costs excluding overheads)	Description $FY24, excluding corporate overheads, contingency and GST
11kV feeder works	• Supply to Braddon (2.2 km) $3.87m • Supply to Watson (4.3 km) $4.59m • Supply to Ainslie (3.2 km) $4.77m • Supply to Campbell (4 km) $5.04m • Supply to Franklin (5.7 km) $4.98m • Supply to Garran and Red Hill (4.6 km) $5.06m • Supply to Phillip (3.6 km) $4.50m • Supply to Canberra CBD feeder 1 and 2 (from CE ZSS) (3 km x 2 cables $4.47m • Supply to Canberra CBD feeder 3 and 4 (from Civic ZSS) (3.8 km x 2 cables) $4.02m • Supply to Canberra CBD feeder 5 and 6 (from Civic ZSS) (3 km x 2 cables) $5.83m • Supply to Bruce and Belconnen (2.6 km) $4.70m • Supply to Canberra Airport (3.8 km) $5.36m • Supply to Phillip and Mawson 2 (4.2 km) $2.78m • Supply to Coombs (6 km) $3.61m • Supply to Barton (1.6 km) $3.76m • Supply to Gungahlin (5.5 km) $3.67m • Supply to Braddon 2 (1.9 km) $1.36m • Total in 2024-29 = $73.53
Zone substation works	• Accelerate Curtin Zone Substation Stage 1 by 1 year $31.8m and associated feeder works $8m • Accelerate Mitchell Zone Substation by 2 years $27.6m and associated feeder works $6.5m • ZS QoS Reactive Plant ($4.73m)
Transmission	• Woden to Curtin 132kV UG Cable $17.8m as part of Curtin ZS establishment
Distribution	• Distribution Substation upgrades $16.26m • Low Voltage Circuit upgrades $9.9m • Customer initiated upgrades $29m
ENC Reliability and Quality improvements	• ENRQI Resilience – Covered HV conductor $1.55m
Total	**$226.34m**

5 Options evaluation

The NPV of the costs and benefits across the 40-year period for each of the options are outlined in Table 6.

The results of the net present value analysis reveal it is economic to do some augmentation under any scenario of EV uptake, compared to do-nothing (no augmentation) option to accommodate load from EVs. The do-nothing option is a reference base case in each scenario. The reduction of unserved energy is considered as a benefit.

Option 1 produces a negative NPV, while options 2 and 3 produce a positive NPV. Option 3 provides the most positive NPV over a 40 year horizon but requires significantly higher investment over the 2024–29 period, relative to options 1 and 2.

Table 6 – Net present value analysis of net zero augmentation works

Option	Cost over 5-years (FY24 $m)	NPV 40-year cost ($m)	NPV 40-year benefit ($m)
0.1 - Base Case for Low EV uptake	$4.71	-$106.92	$0
1 – Low EV uptake investment	$43.54	-$33.30	$73.61
0.2 – Base Case for Medium EV uptake	$5.78	-$202.33	$0
2 – Medium EV uptake investment	$76.34	-$58.43	$143.90
0.3 – Base case for High EV uptake	$35.36	-$6,272.90	$0
3 – High EV uptake	$226.34	-$175.52	$6,097.38

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6 Recommendations

Evoenergy has selected option 2 (medium EV uptake) for proposed augmentation works of $76.34 million over 2024–29.

Option 2 yields a positive NPV and represents the least regrets program to initiate what will be a long path to achieve net zero emission target. Option 2 provides balance between proactively managing expected higher electricity demand resulting from EV charging, and not undertaking excessive augmentation expenditure which may overestimate the impact of EV demand.

Option 1 was not selected as it relates to the EV uptake trend which is significantly below the currently (December 2022) observed trends. Option 1 is therefore associated with significant operational risks, potential widespread capacity constraints and inability to cater for growing EV demand.

While option 3 results in the highest NPV and provides the investment required to meet a trajectory of net zero emissions, it requires nearly three times the investment of option 2. EVs are an emerging technology, and forecasting EV uptake is inherently uncertain, not least due to developments in Government policies, as well as consumer preferences. Although, option 3 represents full electrification on the path to achieving net zero emissions by 2045, Evoenergy does not propose this option as the initial investment path. Evoenergy considers that under option 3 a high initial investment is currently uncertain as it represents maintaining an EV uptake significantly above existing trends.

Option 2 represents a conservative estimate that minimises the incidence of unserved energy resulting from network constraints that will likely occur if no augmentation takes place to accommodate EV charging. The most recent EV registration data shows[20] the uptake trend above that assumed for option 2. Thus, Evoenergy considers that option 2 represents minimum investment which allows Evoenergy to manage operational risks in the medium-term and avoids creating longer-term deliverability issues.

Likewise, option 2 represents a prudent investment which is required for the projected uptake of EVs consistent with the ACT Government projections and current EV trends. Furthermore, this option allows for the investment to be escalated to match observed EV trends.

[20] 9.5% of registrations are EVs (December 2022).

Appendix A – Cost breakdown for options

Table 7 – Total cost breakdown for Option 1

Investments	Costs over 24-29 (FY24 $m)					
	FY25	FY26	FY27	FY28	FY29	Total
New 11kV feeders						
Supply to Braddon - 2.2 km	$0	$0	$0	$0.96	$2.90	**$3.87**
Supply to Campbell - 4 km	$0	$0	$0.50	$2.26	$2.28	**$5.04**
Supply to Franklin - 5.7 km	$0	$0	$0.74	$3.23	$1.00	**$4.98**
Supply to Canberra CBD feeder 1 (from CE ZSS) - 3 km	$0	$0.45	$2.06	$0.64	$0	**$3.16**
Supply to Canberra CBD feeder 2 (from Civic ZSS) - 3.9 km	$0	$0	$0.26	$1.17	$1.18	**$2.61**
Zone substation works						
Curtin Zone Substation Stage 1	$0	$0	$0.48	$1.28	$10.00	**$11.70**
Establishment of Mitchell Zone Substation	$0	$0	$0	$0	$1.77	**$2.20**
ZS QoS Reactive Plant	$0.00	$0.51	$0.51	$0.51	$0.52	**$2.06**
Transmission works						
Woden to Curtin 132kV UG Cable	$0	$0	$0.00	$0.88	$5.64	**$6.52**
ENC Reliability and Quality improvements						
ENRQI Resilience – Covered HV conductor	$0.28	$0.28	$0.28	$0.28	$0.28	**$1.40**
Total	**$0.00**	**$1.21**	**$4.81**	**$11.88**	**$25.81**	**$43.54**

Table 8 – Total cost breakdown for Option 2

Investments	Costs over 24-29 (FY24 $m)					
	FY25	FY26	FY27	FY28	FY29	Total
New 11kV feeders						
Supply to Braddon - 2.2 km	$0	$0	$0	$0.96	$2.90	**$3.87**
Supply to Watson - 4.3 km	$0	$0	$0	$0	$2.97	**$2.97**
Supply to Ainslie - 3.2 km	$0	$0.71	$3.10	$0.96	$0	**$4.77**
Supply to Campbell - 4 km	$0	$0	$0.50	$2.26	$2.28	**$5.04**
Supply to Franklin - 5.7 km	$0	$0	$0.74	$3.23	$1.00	**$4.98**
Supply to Garran and Red Hill - 4.6 km	$0	$0	$0	$0	$2.54	**$2.54**
Supply to Phillip - 3.6 km	$0	$0	$0.45	$2.02	$2.03	**$4.50**
Supply to Canberra CBD feeder 1 (from CE ZSS) - 3 km	$0	$0.47	$2.06	$0.64	$0	**$3.16**
Supply to Canberra CBD feeder 2 (from Civic ZSS) - 3.9 km	$0	$0	$0.26	$1.17	$1.18	**$2.61**
Supply to Canberra CBD feeder 3 (from Civic ZSS) 3 - km	$0	$0	$0	$0	$0.28	**$0.28**
Zone substation works						
Curtin Zone Substation Stage 1 (Total for both works)	$0	$0.48	$1.28	$10.0	$7.55	**$19.31**
Establishment of Mitchell Zone Substation - early works	$0	$0	$0	$0.44	$1.77	**$2.20**
ZS QoS Reactive Plant	$0	$0.51	$0.51	$0.51	$0.52	**$2.06**
Transmission works						

Woden to Curtin 132kV UG Cable	$0	$0	$0.22	$0.66	$7.64	**$8.52**
Distribution						
Distribution Substations	$0.34	$0.68	$1.02	$1.37	$1.72	**$5.13**
Low Voltage Circuits	$0.26	$0.52	$0.52	$0.78	$0.79	**$2.87**
ENC Reliability and Quality improvements						
ENRQI Resilience – Covered HV conductor	$0.28	$0.28	$0.28	$0.28	$0.28	**$1.40**
Total	**$0.88**	**$3.65**	**$10.94**	**$25.28**	**$35.45**	**$76.34**

Table 9 – Total cost breakdown for Option 3

Investments	**Costs over 24-29 (FY24 $m)**					
	FY25	**FY26**	**FY27**	**FY28**	**FY29**	**Total**
New 11kV feeders						
Supply to Braddon - 2.2 km	$0	$0	$0.96	$2.90	$0	**$3.87**
Supply to Watson - 4.3 km	$0	$0	$0	$2.97	$1.62	**$4.59**
Supply to Ainslie - 3.2 km	$0.71	$3.10	$0.96	$0	$0	**$4.77**
Supply to Campbell - 4 km	$0	$0.50	$2.26	$2.28	$0	**$5.04**
Supply to Franklin - 5.7 km	$0	$0.74	$3.23	$1.00	$0	**$4.98**
Supply to Garran and Red Hill - 4.6 km	$0	$0	$0	$2.54	$2.52	**$5.06**
Supply to Phillip - 3.6 km	$0	$0.45	$2.02	$2.03	$0	**$4.50**
Supply to Canberra CBD feeder 1 and 2 (from CE ZSS) - 3 km x 2 cables	$0	$0.67	$2.24	$1.56	$0	**$4.47**

Supply to Canberra CBD feeder 3 and 4 (from Civic ZSS) - 3.8 km x 2 cables	$0	$0.60	$2.01	$1.41	$0	**$4.02**
Supply to Canberra CBD feeder 5 and 6 (from Civic ZSS) - 3 km x 2 cables	$0	$0	$0.87	$2.92	$2.04	**$5.83**
Supply to Bruce and Belconnen - 2.6 km	$0	$0	$0.71	$1.88	$2.12	**$4.70**
Supply to Canberra Airport - 3.8 km	$0	$0	$0.80	$2.14	$2.95	**$5.36**
Supply to Phillip and Mawson 2 - 4.2 km	$0	$0	$0.42	$1.11	$1.53	**$2.78**
Supply to Coombs - 6 km	$0	$0	$0.54	$1.44	$1.99	**$3.61**
Supply to Barton - 1.6 km	$0	$0	$0.56	$1.13	$2.07	**$3.76**
Supply to Gungahlin - 5.5 km	$0	$0	$0.55	$1.10	$2.02	**$3.67**
Supply to Braddon 2 - 1.9 km	$0	$0	$0.20	$0.41	$0.75	**$1.36**
Zone substation works						
Curtin Zone Substation	$0.48	$1.28	$10.00	$7.55	$20.49	**$39.80**
Mitchell Zone Substation	$0	$0.44	$4.77	$11.56	$17.33	**$34.10**
ZS QoS Reactive Plant	$0.51	$0.51	$1.10	$1.11	$1.51	**$4.73**
Transmission works						
Woden to Curtin 132kV UG Cable	$0	$0.22	$0.66	$7.64	$9.28	**$17.80**
Distribution works						
Distribution Substations	$1.02	$2.17	$3.57	$4.48	$5.02	**$16.26**
Low Voltage Circuits	$0.79	$1.39	$1.99	$2.59	$3.14	**$9.90**
Customer initiated upgrades	$2.20	$4.00	$5.80	$7.60	$9.40	**$29.00**

ENC Reliability and Quality improvements						
ENRQI Resilience – Covered HV conductor	$0.00	$0.25	$0.26	$0.51	$0.52	**$1.55**
Total	**$5.74**	**$16.35**	**$46.62**	**$72.11**	**$86.68**	**$226.34**

Appendix B – Sensitivity analysis

Evoenergy has conducted a sensitivity check of forecast numbers of passenger EVs expected to be registered in the ACT. The three scenarios primarily differ by the number of forecast EV uptake and the consequent constraints on Evoenergy's network that drive varying levels of augmentation expenditure. The range of forecast EVs for each of the three scenarios is shown below in Table 10.

Table 10 – Forecast number of EVs registered in the ACT

No. of EVs	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Low EV	851	1,450	2,341	3,613	5,369	7,711	10,747	14,565	19,255	24,911
Medium EV	851	2,063	3,759	6,134	9,287	13,205	17,991	23,964	31,681	41,944
High EV	1,000	15,926	33,135	40,773	62,440	92,027	115,674	133,027	151,206	170,107

Source: *Evoenergy, ACT Government*

Appendix C – Inputs and assumptions

For each option the main driver of the network demand is a projected up-take of EVs.

Option 1: EV uptake is in line with ACT Government "conservative" scenario of around passenger EVs 25 000 vehicles by 2030. This scenario is below the path required to achieve the legislated zero emission target by 2045.

Option 2: EV uptake is in line with the "optimistic" ACT Government EV scenario with over 40 000 passenger electric vehicles plus around 10 000 other electric vehicles. This scenario is below the path required to achieve the legislated zero emission target by 2045.

Option 3: EV uptake is in line with a high ACT EV take up scenario. This scenario is consistent with the path of achieving net zero emissions by 2045.

In the medium term we have assumed no material impact from gas-to-electricity conversion. This assumption results in a conservative estimate of the network demand. The demand would increase if the gas-to-electricity transition accelerates.

Consistent with the ACT Government's analysis, Evoenergy assumed that EV uptake would not be uniform across all ACT suburbs.

This is consistent with EV sales to date which have been concentrated in the suburbs listed above.[21] After 2035, it is expected that EV growth would be more evenly spread across other ACT suburbs due to higher second-hand EV sales volumes providing easier access to vehicles.

Increased electricity demand resulting from charging EVs was forecast out to 2045, reflecting that the lead time to construct a new feeder is 2 years and 3 years for a zone substation. Demand was forecast in both residential areas where EV charging will occur at home but also at commercial premises.

Evoenergy adopted a degree of conservatism in estimating augmentation expenditure requirements to minimise the construction of new feeders. This was achieved by using existing spare capacity of surrounding feeders connected to the same zone substation to share load growth across suburbs where EV growth is expected to be high. Where load could be transferred to existing feeders with spare capacity, a new feeder construction is not required.

Similar approach was taken in relation to zone substations. The existing substations capacity and load transfer between existing was considered in preference to augmentation proposals.

Assumed MVA for EV charging relative to existing zone substation capacity were estimated then allocated to feeders. Total EV charging requirements are summarised below in Figure 9:

Figure 9 – Forecast feeder demand and zone substation and feeder capacity for medium EV uptake scenario

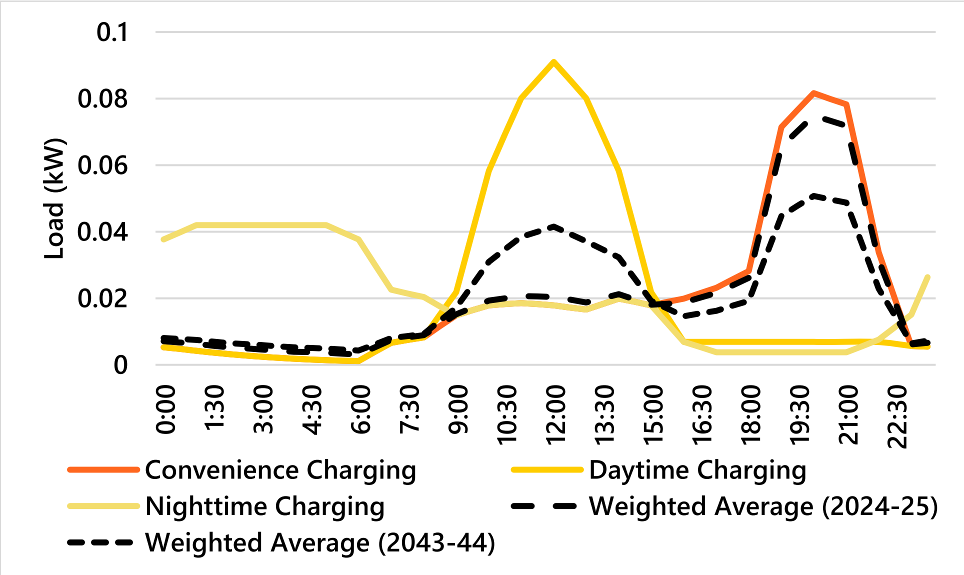
Zone substation	Suburb	EV Chg demand 2023 (MVA)	EV Chg demand 2024 (MVA)	EV Chg demand 2025 (MVA)	EV Chg demand 2026 (MVA)	EV Chg demand 2027 (MVA)	EV Chg demand 2028 (MVA)	EV Chg demand 2029 (MVA)	EV Chg demand 2030 (MVA)	EV Chg demand 2031 (MVA)	EV Chg demand 2032 (MVA)	Feeder name	Firm Rating (MVA)		Thermal Rating (MVA)		Proposed other loads(MVA)
													Winter	Summer	Winter	Summer	
	Braddon	0.15	0.25	0.40	0.60	0.86	1.21	1.69	2.35	3.16	4.12	Braddon	5.4	4.9	7.2	6.5	1.80
	Lyneham	0.04	0.06	0.09	0.13	0.18	0.25	0.35	0.49	0.66	0.85	Ijong	5.0	4.1	6.7	5.4	2.80
												Haig	6.2	5.2	8.3	7.0	0.85
												Lonsdale	6.0	5.4	8.0	7.2	0.28
	Total demand(MVA)	0.19	0.32	0.50	0.73	1.04	1.46	2.04	2.85	3.82	4.97						5.73
	Watson	0.08	0.14	0.22	0.31	0.44	0.59	0.79	1.05	1.35	1.69	Mackenzie	5.9	5.3	7.9	7.0	0.60
	Hackett	0.03	0.05	0.08	0.11	0.15	0.20	0.25	0.32	0.40	0.48	Stott	4.8	4.3	6.4	5.7	
City East	Total demand(MVA)	0.12	0.20	0.30	0.43	0.59	0.78	1.04	1.37	1.75	2.16						0.60
	Ainslie	0.06	0.10	0.15	0.20	0.26	0.34	0.43	0.54	0.66	0.79	Cowper	4.9	4.1	6.5	5.4	3.00
	Dickson	0.05	0.09	0.15	0.21	0.30	0.41	0.56	0.75	0.98	1.24	Wakefield	5.0	4.4	6.7	5.9	0.30
	Downer	0.03	0.06	0.09	0.13	0.18	0.24	0.33	0.44	0.57	0.73	Ebden	5.8	5.1	7.7	6.9	2.00
	Total demand(MVA)	0.15	0.25	0.38	0.54	0.74	0.99	1.31	1.73	2.22	2.76						5.30
	Campbell	0.09	0.15	0.23	0.33	0.44	0.58	0.75	0.97	1.21	1.47	Ferdinand	6.2	5.5	8.2	7.3	2.60
												Monash	5.7	5.1	7.6	6.8	2.20
	Total demand(MVA)	0.09	0.15	0.23	0.33	0.44	0.58	0.75	0.97	1.21	1.47						4.80
	Civic	0.79	1.37	2.18	3.26	4.67	6.53	9.05	12.55	16.81	21.91	Hobart Short	5.4	4.8	7.1	6.4	3.00
												Binara	5.4	4.9	7.2	6.5	1.75
												Hobart Long	4.9	4.4	6.5	5.8	0.68
												Electricity House	5.3	4.7	7.0	6.3	4.00
												Edinburgh	5.5	5.0	7.4	6.8	3.50
												Akuna	4.9	4.4	6.6	5.9	1.10
												Northbourne	4.4	4.0	5.9	5.3	1.60
Civic												Petrie	5.3	4.7	7.0	6.3	0.00
												Edmund Barton	3.8	3.4	5.0	4.5	3.10
												Girrahween	4.9	4.4	6.5	5.8	1.20
												Cooyong	5.3	4.7	7.0	6.3	0.00
												Lonsdale	6.0	5.4	8.0	7.2	0.28
												King Edward	3.9	3.4	5.1	4.6	2.80
												Jolimont	4.9	4.4	6.5	5.8	0.00
	Total demand(MVA)	0.79	1.37	2.18	3.26	4.67	6.53	9.05	12.55	16.81	21.91						23.01
	Gungahlin	0.06	0.10	0.16	0.24	0.34	0.48	0.68	0.96	1.31	1.73	Valley	5.6	5.1	7.5	6.9	3.41
	Harrison	0.06	0.10	0.16	0.22	0.30	0.39	0.49	0.62	0.76	0.89	Gribble	5.3	4.9	7.0	6.5	3.59
	Franklin	0.05	0.08	0.12	0.18	0.25	0.34	0.46	0.62	0.82	1.04	Riley	6.2	5.5	8.2	7.3	0.00
	Forde	0.04	0.06	0.09	0.13	0.17	0.21	0.26	0.32	0.38	0.44	Gungahlin	5.6	5.0	7.5	6.7	0.00
Gold Creek	Mitchell	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nona	4.5	4.5	6.0	6.0	0.00
	Throsby	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.11	0.14	0.17	West Street	6.2	5.5	8.2	7.3	0.69
												Hamer	5.6	5.1	7.5	6.9	0.53
												Anthony Rolfe	5.4	5.0	7.2	6.7	1.58
												Flemington	5.6	5.1	7.5	6.9	2.60
	Total demand(MVA)	0.22	0.36	0.56	0.80	1.11	1.49	1.98	2.64	3.41	4.28						12.40
	Garran	0.11	0.18	0.28	0.39	0.52	0.69	0.90	1.17	1.48	1.82	Wilson	5.9	5.3	7.9	7.0	0.00
	Curtin	0.06	0.10	0.14	0.20	0.27	0.36	0.47	0.61	0.78	0.96	Carruthers	5.9	5.3	7.9	7.0	0.00
Woden	Hughes	0.04	0.06	0.09	0.12	0.16	0.21	0.28	0.36	0.45	0.55	Throsby	5.4	4.8	7.2	6.4	0.00
	Red Hill	0.03	0.05	0.08	0.11	0.14	0.18	0.23	0.29	0.35	0.42						
	Total demand(MVA)	0.24	0.39	0.59	0.82	1.10	1.44	1.87	2.44	3.06	3.74						0.00
	Phillip	0.10	0.17	0.27	0.41	0.59	0.84	1.18	1.66	2.24	2.93	Pridham	5.4	4.8	7.2	6.4	0.30
Wanniassa	Farrer	0.03	0.05	0.07	0.10	0.14	0.18	0.24	0.32	0.41	0.51	Hawkesbury	6.2	5.6	8.3	7.4	
	Mawson	0.04	0.07	0.11	0.16	0.23	0.32	0.44	0.60	0.79	1.01	Lambrigg	5.4	4.8	7.2	6.4	0.40
	Total demand(MVA)	0.16	0.28	0.45	0.67	0.96	1.34	1.86	2.57	3.44	4.45						0.70

Source: ***Evoenergy***

21 ACT Government, Electric vehicle charging outlook for the ACT, December 2021, p. 14.

Evoenergy forecasts the EV charging profile shown in Figure 10. This reflects an assumption that initially, some EV "convenience" charging will occur at the same time as the evening peak. Evoenergy's demand and time of use tariffs will be calibrated over time to significantly discourage convenience charging and instead charge during the middle of the day when supply from renewable generators is typically higher. This is intended to smooth the profile of maximum demands across the network and minimise augmentation requirements over time.

Figure 10 – Daily EV charging profile in the ACT



Source: *Evoenergy*

The network LRMC is used to estimate the cost of additional capacity in the network to accommodate EV impacts. These are shown in Table 11.

Table 11 – LRMC assumptions

Tariff Class	Dollar terms	LRMC ($/kW p.a.)
LV Residential	Real $2024	$122
LV Commercial	Real $2024	$61
HV	Real $2024	$45

Source: *Evoenergy*

The unit rates of upgrading network assets are used to augment the network. These are shown in Table 12.

Table 12 – Per unit network upgrade cost assumptions

	Unit rate
LV ABC overhead (per km)	[redacted]

LV underground (per km)	[redacted]
11kV overhead (per km)	[redacted]
11kV underground (per km)	[redacted]
Pad mount substation upgrade	[redacted]
OTLC incremental cost	[redacted]

Source: *Evoenergy*

Table 13 – Carbon certificate price (ACCU) $December 2022

Year	$t/Co2e	Year	$t/Co2e	Year	$t/Co2e	Year	$t/Co2e	Year	$t/Co2e
2023	$34	**2028**	$46	**2033**	$80	**2038**	$100	**2043**	$100
2024	$36	**2029**	$49	**2034**	$90	**2039**	$100	**2044**	$100
2025	$39	**2030**	$51	**2035**	$100	**2040**	$100	**2045**	$100
2026	$41	**2031**	$60	**2036**	$100	**2041**	$100		
2027	$44	**2032**	$70	**2037**	$100	**2042**	$100		

Source: *Marsden Jacobs and Associates*

Appendix D - Zone Substation (ZS) works

The following suburbs are expected to experience network capacity constraints over the 2029-34 regulatory period, owing to a number of developments, urban intensification, and EV uptake:

- Woden Valley (Curtin substation)
- Molonglo (Curtin substation)
- Gungahlin (Mitchell substation)
- North Canberra (Mitchell substation)

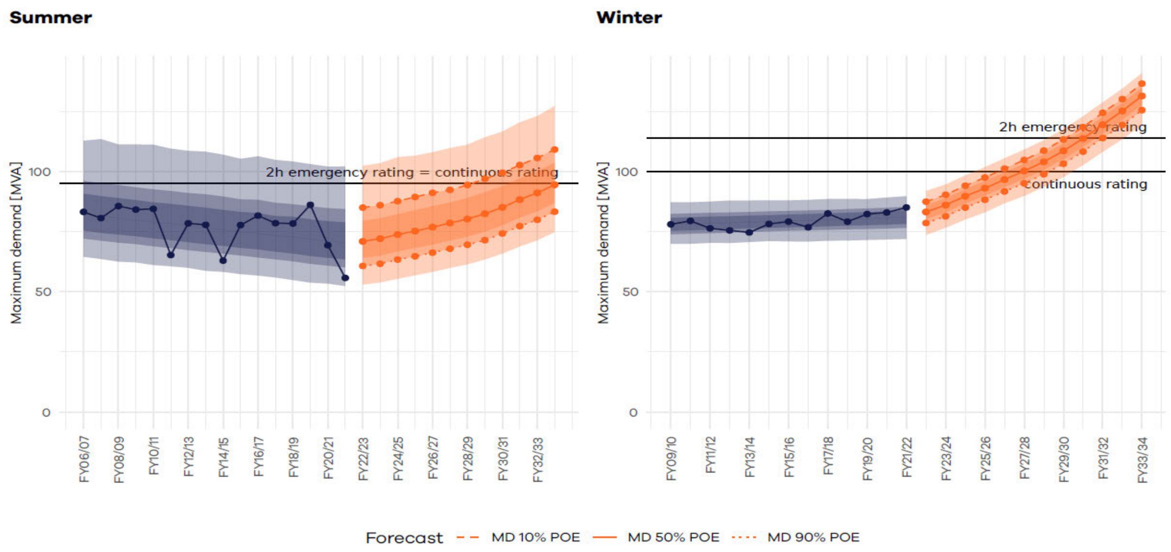
The commissioning of the Curtin and Mitchell zone substations are intended to address these constraints early in the 2029-34 regulatory period, necessitating their construction over 2024-29. Evoenergy has considered the need for these augmentation works, taking into consideration of the ability to share electricity loads across surrounding feeders and zone substations. The specific drivers for each substation are considered below.

This project also involves installing reactive plant at zone substations identified as experiencing quality of supply constraints due to increased penetration of DER in the Evoenergy network. There is an incidence of solar installation or existing solar load in suburbs that are expected to experience high EV uptake. This expenditure will ensure the load requirements of EV charging, general consumption and export of solar PV are managed so as not to compromise power quality across the network.[22]

Curtin Zone Substation

The Curtin ZS will primarily supply the Woden Valley area and ease the expected constraints on the Woden Valley ZS. Woden Valley is expected to experience a number of significant residential and commercial building developments, increasing electrification requirements. Woden Valley is also expected to experience a relatively high uptake in EVs relative to other suburbs, particularly from now until 2035 (See Appendix C). The Woden Valley ZS is expected to exceed 2 hour emergency rating (POE50) in Winter 2030/31 from supplying both the Woden Valley and Molonglo Valley areas (Figure 11).

Figure 11 – Woden Zone Substation historical and forecast maximum demand



Source: *Evoenergy 2022 annual planning report*

22 Evoenergy, 2022 Annual Planning Report, December 2022, p. 132.

This constraint on the Woden ZS is forecast despite the new Molonglo ZS which will share the load requirements of the Molonglo Valley area.[23] The Molonglo substation is intended to reduce the need for supply from the highly loaded Woden Valley ZS.

Evoenergy determined that there was a limited ability to use the surrounding Telopea Park ZS to share load and ease constraints at the Woden Valley ZS. The Telopea Park ZS is expected to exceed its forecast 2-hour emergency rating (POE50) in Winter 2032/33 and cannot accept additional load from the Woden Valley ZS. The new Curtin ZS would reduce the load requirements at Telopea Park and Woden Valley by transferring load from both substations. Curtin ZS could transfer western parts of south Canberra load from Telopea Park ZS and eastern parts of Woden Valley load from Woden ZS.

Evoenergy is anticipating submitting a RIT-D application to the AER in 2025 for regulatory approval to commence construction of the Curtin ZS.

Woden developments

To address the projected increase in demand resulting from the urban intensification and associated population uplift in the Woden Valley district, upgrades to key elements of public infrastructure will be required. The ACT Government's Planning Strategy identified the following projects increasing electrification in Woden:

- Canberra hospital expansion
- Transport Canberra electric bus depot
- Expansion and redevelopment of Canberra Institute of Technology campus
- Redevelopment of several government offices
- Infill developments in Curtin and Yarralumla
- Canberra light rail project and associated residential development
- Embassy development near Australian Governor General's residence

The Canberra Hospital expansion, and Transport Canberra Electric Bus Depots have been identified as major upgrades. With the higher demand because of the EV depots along with the expected population increase in the location.

Table 14 – Population uplift in Woden/Phillip

	Population Uplift		Additional Dwellings		Additional network capacity (MVA)
	2031	2041	2031	2041	2031
Medium growth scenario	7,039	12,467	3,200	5,667	11
High growth scenario	14,593	29,288	6,633	13,325	23

Source: *SMEC study on Woden urban intensification*

23 Evoenergy, Annual planning report 2022, December 2022, pp. 131-132.

Table 15 – SMEC study recommended expenditure for Woden

Proposed Upgrade	Expenditure 2031	Expenditure 2041
Medium Growth Scenario	**$ Millions**	**$ Millions**
Transmission and Zone Substation	$0	$10
HV Feeders	$26.6	$44.4
Distribution Substation	$3.3	$5.9
Total Cost	$29.9	$60.3
High Growth Scenario	**$ Millions**	**$ Millions**
Transmission and Zone Substation	$10	$40
HV Feeders	$53.3	$97.7
Distribution Substation	$6.8	$13.7
Total Cost	$70	$151.3

Source: SMEC study: Woden urban intensification

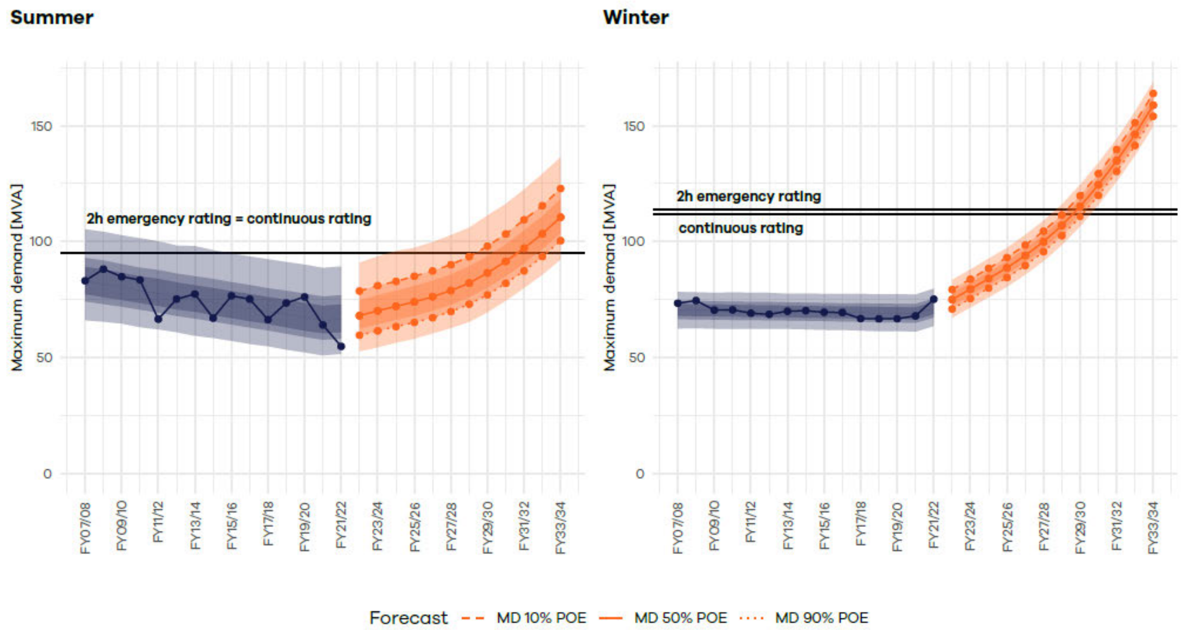
The growth scenarios forecast by SMEC likely significantly understate electrification requirements for Woden, as they did not account for light rail, electric bus depots, EV uptake or gas energy transition. Nevertheless, SMEC still recommended construction of an additional ZS to ease the forecast load requirements of the Woden Valley ZS.

Curtin ZS would be in a nationally significant area near the Australian Governor General's residence and future embassy precinct. To maintain the aesthetic the transmission and distribution equipment associated with the Curtin ZS would need to be located underground. This would likely mean Indoor 132kV Gas Insulated Switchgear, Indoor 11kV Switch rooms and Power Transformers to reduce noise and visual impact. The construction would also include underground 132kV transmission lines and 11kV feeders. The cost of undergrounding infrastructure is estimated above in Table 12.

Mitchell Zone Substation

The Mitchell ZS will accommodate the load growth in Gungahlin and North Canberra, and will be required to avoid exceeding the 2 hour emergency rating (POE50) of the City East ZS in Winter 2029/30 (Figure 12).

Figure 12 – City East zone substation historical and forecast maximum demand



Source: *Evoenergy 2022 annual planning report*

The City East ZS has a limited ability to share load with the surrounding Civic ZS which would become constrained in Winter 2029/30 if these transfers took place. Similarly, the Telopea Park ZS would be unable to share load due to constraints that it faces from 2032/33.

Maximum demand in Gungahlin is forecast to increase in next 10 years with land release in the Jacka (700 dwellings) and Kenny (1000 dwellings). Additionally, several commercial (165,000 square metres) and residential (3,100 dwellings) high-rise developments in the Gungahlin town centre area. Gungahlin is also expected to experience a relatively high uptake in EVs relative to other suburbs, particularly from now until 2035 (See Appendix C).

Evoenergy is anticipating submitting a RIT-D application to the AER in 2027 for regulatory approval to commence construction of the Mitchell ZS.

Appendix E – Unserved energy base case scenarios

Low EV uptake – utilising existing infrastructure

This scenario assumes an EV uptake of around 25 000 vehicles and existing network capacity to accommodate EV load on the network. The following table shows the unserved energy cost using the AER's value of customer reliability:

Table 16 – Value of unserved energy for low EV uptake ($000's)

Suburb	2025	2026	2027	2028	2029	2030	2031	2032
Braddon	0.18	0.32	0.36	0.46	0.65	1.03	2.23	5.69
CBD	0.00	0.00	0.00	0.16	0.99	1.08	1.22	1.46
Gungahlin & Franklin	0.54	0.59	0.67	0.76	0.89	1.04	1.24	1.51
Watson	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Total	**0.73**	**0.93**	**1.05**	**1.40**	**2.55**	**3.17**	**4.71**	**8.68**

Source: *Evoenergy, CutlerMerz*

Medium EV uptake – utilising existing infrastructure

This scenario assumes an EV uptake of around 50 000 vehicles and existing network capacity to accommodate EV load on the network. The following table shows the unserved energy cost using the AER's value of customer reliability:

Table 17 – Value of unserved energy for medium EV uptake ($000's)

Suburb	2025	2026	2027	2028	2029	2030	2031	2032
Ainslie	27	31	40	50	64	81	102	134
Braddon	191	337	386	498	698	1,094	2,051	4,669
Campbell	0	0	0	0	0	0	0	1
CBD	0	0	0	197	1,163	1,421	1,937	3,086
Garran	0	0	0	0	1	1	1	2

Gungahlin & Franklin	592	693	831	998	1,248	1,671	2,293	3,216
Phillip	0	0	0	16	77	325	1,358	4,612
Watson	35	48	69	105	169	311	580	1,037
Total	**845**	**1,110**	**1,327**	**1,865**	**3,419**	**4,905**	**8,321**	**16,756**

Source: *Evoenergy, CutlerMerz*

High EV uptake – utilising existing infrastructure

This scenario assumes an EV uptake of around 170 000 vehicles and existing network capacity to accommodate EV load on the network. The following table shows the unserved energy cost using the AER's value of customer reliability:

Table 18 – Value of unserved energy for high EV uptake ($000's)

Suburb	2025	2026	2027	2028	2029	2030	2031	2032
Ainslie	132	253	668	1,526	3,518	7,337	17,532	44,762
Airport	0	0	0	0	2	5	8	13
Belconnen	0	0	0	0	1	12	217	2,849
Braddon	276	614	814	1,167	2,247	6,604	30,325	119,857
Campbell	0	0	0	0	0	0	0	0
CBD	0	0	1	375	1,929	2,811	35,553	214,621
Garran	11	165	417	665	1,009	1,552	3,548	13,035
Gungahlin & Franklin	1,372	3,609	6,955	9,904	14,223	20,344	57,189	85,819
Hume	0	0	0	0	0	0	2	1,494
Phillip	0	13	94	309	977	2,671	8,444	32,246
Watson	294	812	1,576	2,434	3,690	5,616	11,282	27,339
Total	**2,085**	**5,467**	**10,526**	**16,381**	**27,596**	**46,951**	**164,101**	**542,035**

Source: *Evoenergy, CutlerMerz*