wellington electricity™

Innovation allowance application low voltage constraint modelling

May 2024

1 Application and contact details

Purpose	Innovation allowance application
Submitted to	Commerce Commission
Submission address	Ben Woodham, Electricity Distribution Manager infrastructure.regulation@comcom.govt.nz
Date submitted	21 May 2024
Submitter	Scott Scrimgeour, Commercial and Regulatory Manager, Wellington Electricity Lines Limited (**WELL**)
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2 Confidential information

There is no confidential information provided in this application. This application can be publicly disclosed.

3 Introduction

This is Wellington Electricity Lines Limited's (**"WELL", "we", "us", "our")** application for innovation project allowance for our low voltage (**LV**) constraint and capex modelling project (the **Project**). Under the Default Price-Quality Path Determination (**DPP Determination**) non-exempt Electricity Distribution Businesses (**EDBs**) may seek approval from the Commerce Commission (**Commission**) for additional allowances to part-fund innovation projects. Schedule 5.3 of the DPP Determination provides the application criteria.

Like many distribution networks in New Zealand, we do not have visibility of our LV network and we do not know when new capacity will be needed to meet the decarbonisation-related demand increase. We also do not know where the LV network is constrained and where and when demand-side flexibility could be used to defer network reinforcement. EDBs must develop new capabilities to manage their LV networks and incorporate flexibility using customer devices connected to those networks into their demand-side management. Our Asset Management Plan (**AMP**) provides an overview of what new capability is needed and how it fits within our wider development plans[1].

A key objective of our LV investment programme is the ability to forecast when we need to build new capacity to meet the expected increase in electricity demand. This will allow us to develop a capex investment profile which we can then use to inform the regulatory allowance setting process.

4 The Project

The purpose of the Project is to develop LV management tools that will forecast when and where we need to build new network capacity and to provide a forecast of that investment. Appendix 1 provides a high-level project plan. The Project has two workstreams:

1. **Workstream one**: Partner with ANSA to model when residential LV assets will become constrained under different decarbonisation growth scenarios. This model will then be used to develop an investment profile that will solve those constraints.
2. **Workstream two**: Refine and calibrate the timing of the capex programme by using actual consumption data. As an asset approaches the point it is forecast to become constrained, the Project will test whether near real-time actual consumption data can be used to confirm the available capacity headroom and refine the timing of the Network Growth capex. This workstream has started with an LV Management Software trial with Ara Ake.

This application relates to Workstream one and is requesting to draw down from the innovation allowance pool to recover half of the cost of the Project's spend to date.

Funding for Workstream two to date is from a separate Ara Ake funding pool and is not included in this innovation allowance funding request. The Project could include a request to draw down funding for Workstream two next regulatory year (the year ending March 2025)[2].

4.1 Workstream one – work programme

In 2023, WELL commissioned ANSA to implement a limited study of 10 LV networks to understand the impact the potential transition of residential gas to electricity could have on the capacity of the LV network. The results of this study were provided in our 2023 AMP[3]. This workstream expands the ANSA study to all residential LV networks and includes electric vehicle (EV) growth in the demand

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[1] Chapter 10.2 and 10.3, https://www.welectricity.co.nz/disclosures/asset-management-plan/document/336

[2] This will depend on DPP4 allowances including whether there is an opex step change for purchasing consumption data and to operate an LV management function.

[3] Chapter 4.2.1.3, https://www.welectricity.co.nz/disclosures/asset-management-plan/document/318

forecast.

The ANSA tool applies a range of future load conditions including EV growth, demand transitions such as gas-to-electricity and urban infill, and photovoltaic (PV) export. Constraints considered for every LV asset included conductor loading, voltage excursions, and transformer loading. The ANSA tool modelled each constraint under the different load scenarios to produce a constraint risk curve for each LV asset. The ANSA capex model then identifies the appropriate solution to each constraint and applies standard asset costs to each solution, with the aggregated costs of the solutions forming the capex programme.

This has allowed us to forecast where and when LV investment is needed. We have now incorporated the capex programme into our 2024 AMP[4]. The constraint risk curves also highlight where flexibility might be used to reduce future investment, and the model provides the inputs to calculate the value those services can provide from deferring that investment.

A summary of the ANSA hosting capacity model is provided in Appendix 2. Appendix 3 provides the implementation steps. The next and final step for WorkStream one is to refine the model with an updated GIS data set and a larger sample of consumption data.

4.2 Workstream two – work programme

We used funding from the Ara Ake EDB Challenge project to test the ability of the Future Grid LV management software to provide visibility of the LV network. The project successfully highlighted the key functionality and data inputs needed for a future LV management system.

The key learnings from this project are the importance of having access to meter data, specifically:

- 100% coverage of 5 min consumption data
- 100% coverage of voltage data.

Without this data, the software can not identify network constraints and large new loads (like EV chargers) at the level of accuracy needed.

The Ara Ake EDB Challenge project is now complete and the trial results will soon be published by Ara Ake.

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[4] Chapter 9.7, https://www.welectricity.co.nz/disclosures/asset-management-plan/document/316

4.3 Next steps

The Project's next steps will focus on:

1. Refining the constraint forecast and LV capex model by updating the model with a more accurate GIS data set and better load profiles based on a larger consumption data set. This step is planned for late 2024.
2. The Are Ake Future Grid project provided valuable insights into what visibility can be provided using smart meter data and an LV management tool. These insights will be used to develop the user requirements to support the procurement of LV management software to provide near-real-time visibility on the LV network. The results have also confirmed what smart meter data is needed to support it (i.e. five-minute data).
3. Once we have this capability, we will refine the capex programme. As a forecast date for LV reinforcement is approached, we will use actual voltage and consumption data to refine when the reinforcement is required. This will allow us to refine the probabilistic forecasts, ensuring that we are not building new capacity or purchasing non-wire solutions earlier than is needed.

4.4 Sharing what we learn

To benefit other EDBs, and the wider industry, we will publish a final report outlining the process and our learnings on our website. We will do this once the model has been refined with updated GIS and consumption data.

We have also:

- Provided an overview of the project and have included the results in our 2024 AMP[5].
- Submitted an abstract about the Project to the Electricity Engineering Association to consider whether a Paper can be included in this year's conference.

[5] Chapter 9.7, https://www.welectricity.co.nz/disclosures/asset-management-plan/document/316

5 Meeting the innovation allowance eligibility criteria

Schedule 5.3 of the Determination[6] provides the process and criteria for applying for allowances to partly fund innovation projects. Figure 1 provides the application criteria and demonstrates how those criteria have been meet.

Figure 1 - Innovation application criteria and the Project

Criteria	Assessment	Supporting evidence
Schedule 5.3, clause (1) submitting an application to draw down from the innovation allowance		
Clause (1) (a) submit an application no later than 50 days from the end of an assessment period	This application was provided to the Commission on 21 May 2024. This date is before the 12-06-2024 deadline for submissions for the regulatory year ending 31 March 2024.	n/a
Clause (1) (a) (i) projects incurs costs we want to draw down	The project has incurred $131k in costs and WELL is applying to draw down 50% or $66k from the innovation allowance.	Section 6.2 provides a detailed cost breakdown and Section 6.1 provides the amount to draw down.
Clause (1) (a) (ii) cost details	None of the costs have been subject to a draw down from the innovation allowance. All of the costs are capital expenditure.	Section 6.2 provides the cost details.
Clause (1) (a) (iii) project purpose and project plan	The purpose of the Project is to develop LV management tools that will forecast when we need to build new network capacity and to provide a forecast of the investment needed The Project has a project plan and project team to ensure we will achieve the Project's intended purpose.Good progress has been made to date with the development of the ANSA model and the completion of the Are Ake project which tested LV management software.	Section 4 describes the purpose of the project and provides a high-level project plan.
Clause (1) (b) Publish this application on our websites	This application has been published on our respective websites.	Published on our website[7]
Clause (1) (c) Commission approval to draw down	TBA	n/a
Schedule 5.3, clause (2) Assessment of an application		

[6] Electricity Distribution Services Default Price-Quality Path Determination 2020 (Consolidated 20 May 2020) available here https://comcom.govt.nz/__data/assets/pdf_file/0025/216862/Electricity-distribution-services-default-price-quality-path-determination-2020-consolidated-20-May-2020-20-May-2020.pdf

[7] https://www.welectricity.co.nz/disclosures/regulatory-applications/

Criteria	Assessment	Supporting evidence
Clause (2) (a) Draw-down amount does not exceed the available allowance	The requested draw-down amount does not exceed the available innovation allowance.	Section 6.1 compares the draw-down amounts and the available allowances.
Clause (2) (b) The networks have funded 50% of the project value	We have spent more than 200% of the draw-down amount being requested (i.e. we are funding at least 50% of the total project cost).	Section 6.1 compares the draw-down amounts with the total amount spent on the project.
Clause (2) (c) expert report confirming the project is innovative	Richard Kingsford has provided a letter confirming the project meets the innovation definition provided in the Input Methodologies and the benefits of the innovation project will be of general application to other EDBs.	Appendix 4 provides the letter from Richard Kingsford (from Edison Consulting Group) confirming the project meets the definition of innovation.
Clause (2) (d) CV for the expert providing the expert report.	Richard Kingsford provided the relevant CV in his letter demonstrating his expertise in the electricity sector and LV management.	The CV is provided in Appendix 4 as part of the letter.

6 Project cost and application amount

6.1 Requested draw-down for the regulatory year ending 31 March 2024

Figure 2 provides the project spent to date and the requested draw-down amount for each network. The figure also provides the innovation allowance for each network, net of other applications. The project values do not exceed the available allowances.

Figure 2: Requested drawdown amounts

Draw-down assessment	**$**
Spent to date	131,294
Requested draw-down for this project	**65,647**
Other draw-down requests (including previously approved and yet-to-be-approved draw-down requests)	15,891[8]
Total drawdowns	81,538
Total innovation project allowance (from Determination schedule 5.3)	376,000
Allowance available for other projects and future drawdowns	294,462

[8] The Resi-Flex project was submitted in a separate application.

6.2 Expenditure details

Figure 3 provides the details of the expenditure to date, including the type of expenditure.

Figure 3 - Expenditure details

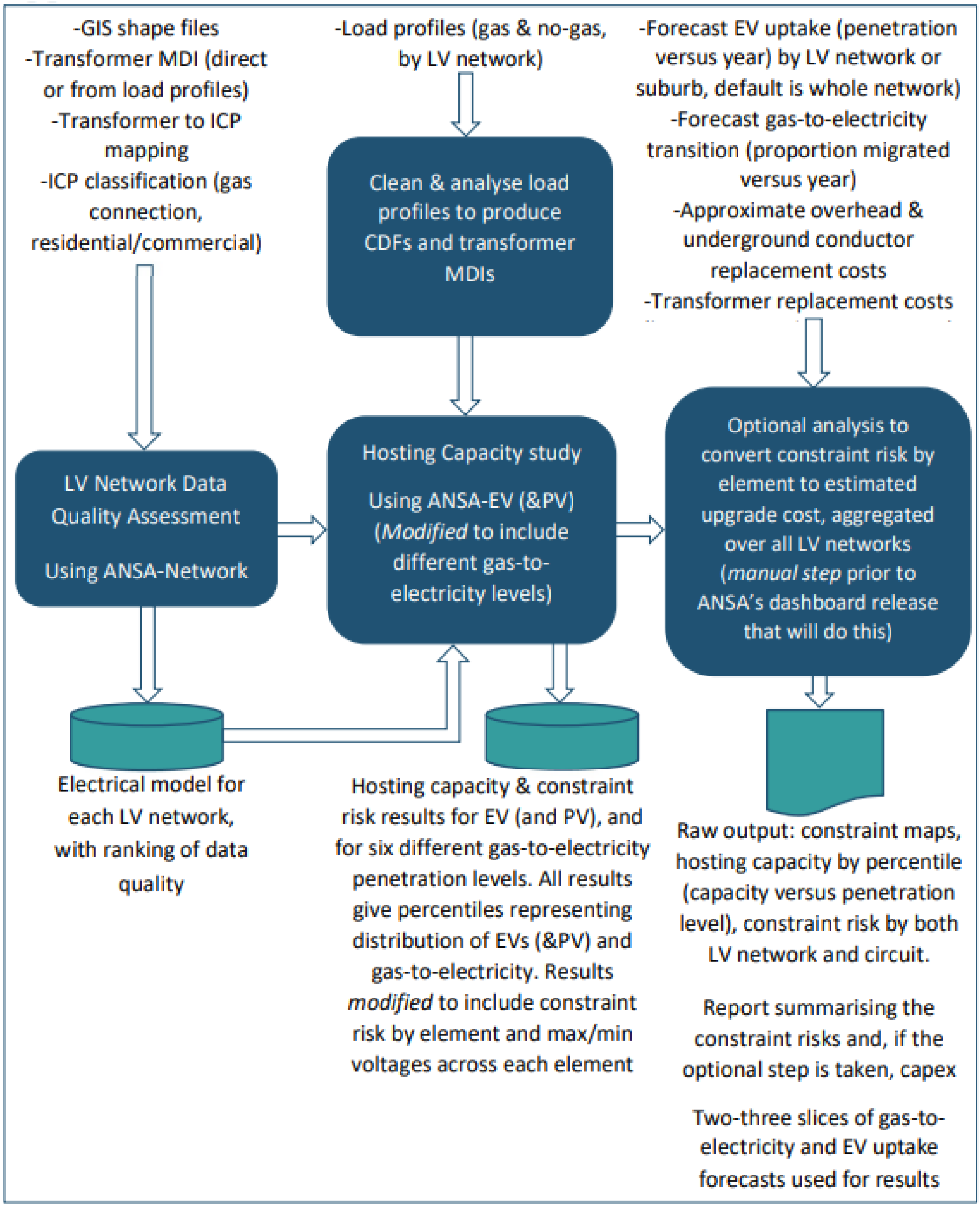
Workstreams	CAPEX or OPEX	Spend
Workstream one – payment to ANSA for model development	Capex	131,294
	Total	131,294
	Application	65,647

7 Appendix 1: Project Plan

Note, the project actions for the 2024/25 regulatory year are draft and could change.

Deliverable	Reg year ending March 31 2024				Reg year ending March 31 2025			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Workstream 1 - forecasting LV network capacity and constraints								
Test LV gas study (10 networks) - concept model	■							
Select scope for full study - 2,000 residential networks		■						
Consumption data from retailers		■	■					
Develop ICP load curves			■					
Load GIS into ANSA model - repair errors		■	■	■				
Develop load curves and growth scenarios			■	■				
Develop constraint curves for every LV assets			■	■				
Develop standard cost model and capex				■				
Update AMP to include capex				■				
Update with more accurate GIS data							■	
Update with 100% consumption data coverage						■	■	
Update constraint curves and capex model								■
Workstream 2 - Near-real-time LV Management tools								
Consumption data from retailers		■	■					
Load ICP data into Future Grid model		■	■					
Develop GIS model in Future Grid		■	■					
Test functionality including EV detection				■				
Collect data for LV networks identified as constrained by ANSA							■	
Update model and confirm constraints							■	
Report of accuracy of ANSA constant forecast							■	
Develop LV Management software requirements								■

8 Appendix 2: The ANSA model



9 Appendix 3: Detailed project plan for Workstream One

Ref	Description	Data Requirement
1.	Select the range of LV networks to be studied – as listed in the Wellington Electricity Proposal	
2.	ANSA uses ANSA-Network to build the network models of the 2,090 LV networks in (1).	GIS database for LV network
3.	Obtain load profiles of consumers representative of the consumers in the chosen LV networks.	50% consumption date coverage
4.	ANSA analyses the load profiles to produce cumulative probability distributions of load by time of day (defaults are 6pm, 9pm, 12am, and 3am).	Load profiles of consumers identified in (3).
5.	Assess load profiles of ICPs with gas heating and cooking and load profiles of similar consumers with electric heating and cooking, provided by WELL, to understand the additional demand from electric heating and cooking.	Load profiles referred to in (3) as well as load profiles of similar consumers using electricity for heating and cooking.
6.	ANSA runs ANSA-EV, providing results in tabular format by percentile, as well as constraint maps and graphs of capacity versus penetration.	Load profiles processed from (4). Exact LV network models from (2), as determined using ANSA-Network. Any assumptions about changes to 11 kV network voltage with increased load.
7.	Determine and provide uptake forecasts of: -Gas-to-electricity transition proportion versus year, ideally by LV network, or for the whole network by default. -EV penetration level versus year, ideally by LV network, or for the whole network by default. Using 2025, 2030, 2035, 2040, 2045, and 2050 Determine and provide replacement costs of: -Conductor replacement costs (overhead and underground). -Transformer replacement costs (by capacity and mounting type).	
8.	Determines capex versus time (2025, 2030, 2035, 2040, 2045, 2050) using the results from (6), and the information provided in (8).	Information identified in (7).
9.	Summarise and collate	

10 Appendix 4: Expert Letter

15 September 2023

Scott Scrimgeour
Wellington Electricity Limited
85 The Esplanade
Petone
Lower Hutt 5040

Dear Scott

INNOVATION ALLOWANCE APPLICATION: LOW VOLTAGE CAPEX DEVELOPMENT

I have reviewed and I support WELLs application for the Innovation Allowance for their Low Voltage Capex Development Project. I am a Chartered Professional Engineer with over 20 years of experience (registration number: 245077). I have expertise in responding to Network Capex provisions in the light of changing technologies from my four years in WEL Networks where I was Network Planning and Engineering Manager. In this role I was responsible for all Network Capex.

I believe this project will lower the cost of delivering electricity lines services and improve voltage quality for consumers when compared to other options. WELL, and other distribution networks, must plan and respond to the voltage fluctuations that will result from Electric Vehicle (EV) chargers.

This project is innovative on two fronts:

1) The ANSA network modelling
2) The measurement of voltage to drive investment timing

Furthermore, the methodology developed during this project will be able to be replicated by other distribution networks, further improving outcomes for consumers.

The challenge being addressed

The distribution networks of New Zealand are facing new growth challenges on their LV networks that require a new approach to Capex provisioning. Electric Vehicles (EVs) are a key part of New Zealand's decarbonization efforts and this electrification should be enabled by distribution networks. However, adoption of EVs presents a unique challenge to distribution networks as the density of power consumption increases (referred to as After Diversity Maximum Demand or ADMD). Switching on an EV charger also results in a rapid change in load, and this impacts voltage. Voltage quality must be maintained and therefore the network must be strengthened.

The exact location and timing of EV uptake is impossible to predict accurately. Thus, it is not possible to forecast the exact projects required to enable EVs (the projects to maintain voltage once EV chargers are installed). My modelling within other distribution networks has shown that ~2% of network connections are in areas where network weakness would result in voltage fluctuations outside of the regulatory limits if a single EV charger was switched on. As the cost to strengthen that area of Network may be in the order of $100k, it is important that budget is provisioned.

Two areas where this project is innovative

Wellington Electricity are proposing to work with ANSA in order to create a long-range forecast of the budget required to maintain voltage quality with EV uptake. ANSA must overcome limited network data to model the probability of voltage excursions over time. I'm confident in ANSA and their approach as I've had positive experiences with the model they developed with the University of Canterbury to address and assess solar capacity.

The second innovation suggested by this project is the monitoring of the network voltage to determine where and when upgrades are required. This is a cost-effective approach that ensures voltage quality. This innovation is superior to relying on modelling or investing ahead of EV uptake.

I give permission for this letter to be used with the application and to be contacted.

I understand that this letter may accompany the Wellington Electricity Innovation Allowance Application. I give consent for this and for recipients of this Application to contact me for further clarification.

Kind regards

Richard Kingsford | General Manager Design & Engineering Solutions

Edison Consulting Group | *good people, **great results***
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