Augex Capacity & Thermal - Investment Case

Overview

The purpose of thermal augmentation is to sustain the thermal capacity of the network for carrying loads, including when the network is overloaded. Specifically, it refers to the ability of network infrastructure to service a load while withstanding the heating effects of transporting that load (meeting Demand and Quality requirements of NER 6.5.7 capital objectives).

While thermal overloads can be both load-driven (forward) or generation-driven (reverse), this investment case and proposed expenditure is to address forward overloads. Addressing reverse overloads will be captured under the **Attachment 10.05 Future Network Business Case Overview**. As solar PV is at its greatest output between 10am - 4pm, the thermal overloads in this analysis are only those that occur before 10am or after 4pm.

Forward thermal overloads are expected to increase in coming years due to electrification and increased consumer energy resources including electric vehicles. If not managed, overloads can result in:

- degradation of transformer insulation and oil, resulting in failure, outages and potentially fire or explosion
- blown fuses, resulting in customer outages and fault & emergency costs

This proposal is primarily for upgrading overloaded distribution transformers. This is approximately 176 transformers added and 756 transformers upgraded over the 2024-29 regulatory period.

This investment will allow the optimal capacity utilisation of existing network assets while maximising the value of being connected to the grid. This is to ensure equipment is operated within design ratings, to minimise damage and degradation of equipment caused by thermal overloads.

Forecasting Approach

A detailed thermal overload analysis (**Attachment 7.01.01 Hosting Capacity Study**), was performed on a sample of 97 feeders, and is considered reliable at a population level for 2022 – 2029. This was scaled-up to be representative of the entire network using the number of transformers in each 'cluster' (e.g. Urban medium overhead, or Small rural shared overhead).

Assets were selected as overloaded when they exceeded 120% of their nominal rating for at least 48 hours per year, with a Value of Customer Reliability interruption of at least $10,000 per year.

The interventions were selected as the most appropriate from a menu of possible options (e.g. Steel to ACSR, or add 50kVA transformer & split LV).

It should be noted that Australian Standards allow distribution transformers to temporarily operate above their nameplate rating under normal cyclic conditions.

Investment Options

Traditionally, the network assets that are overloaded past their thermal capacity are substations, overhead conductor and underground cables. The cost of intervention is proportional to the length and type of conductor, and to the nameplate rating of the transformer.

Intervention	Average Cost	Range
Reconductor	$63,042	$15,000 - $85,000
Substation	$35,963	$15,000 - $200,000

There are also opportunities for non-network solutions such as demand management. This will be considered for individual projects where a non-network solution is more cost effective than a network intervention. For example, a grid-connected battery energy storage system could be installed on the low-voltage side of a distribution transformer to alleviate a short-term thermal constraint of an overloaded transformer.

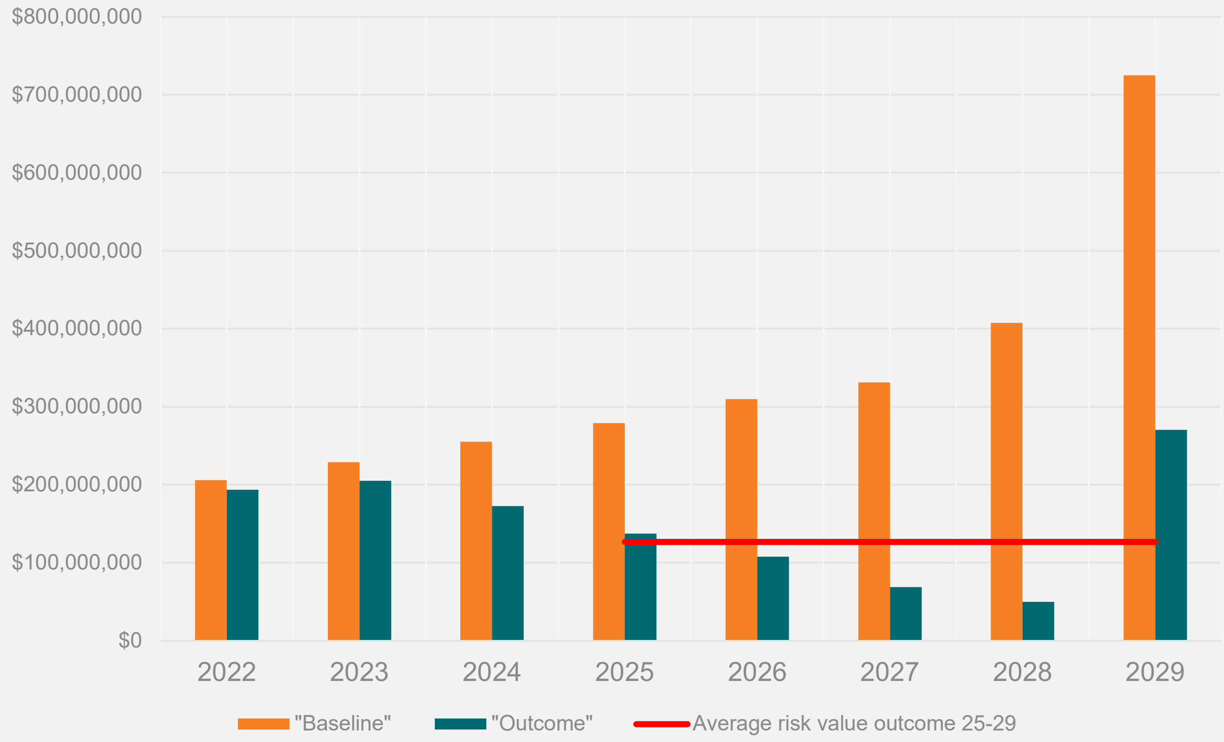
Options are determined from a menu of available interventions for specific projects, including:

- Add a new transformer
- Upgrade an existing transformer
- Split the LV network
- Reconductor HV or LV conductor

Risk Analysis

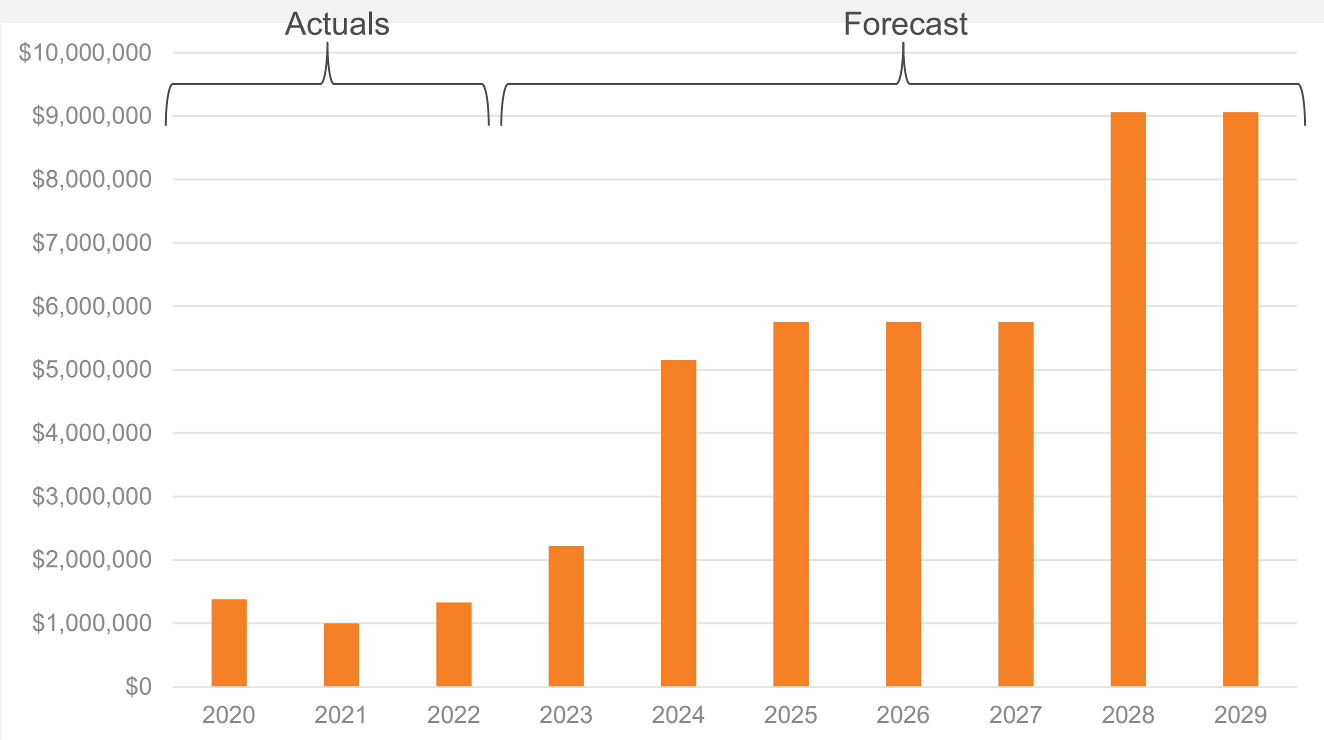
Using our **Appraisal Value Framework** (**Attachment 6.03.03**), an analysis was performed to estimate the 'baseline' and 'outcome' risk of overloaded transformers. If no investment is made, the baseline risk will continue to increase.

Note: there is a significant increase in risk in 2029, which is primarily a result of forecast electric vehicle uptake and electrification. This increase in risk is especially pronounced from 2030 onwards, when electric vehicle penetration increases substantially.



Capex Forecast

Forecast capital expenditure across the 24-29 period is $34.5M which comprises of $1M of reconductor and $30M of transformer upgrades. The allowance for 2019-24 period is $24.2M (with actual/forecast of $9.5M), however to date we have only spent approximately $1M per annum. The increased expenditure is due to improved visibility of overloaded network elements as modelled in **Zepben hosting capacity** analysis (**Attachment 7.01.01**)



Data source: Actuals: Internal delivery reports, Forecasts: Internal analysis documented in 'Forecasting approach'

Note: All values are in middle of the year 2023-24 real dollar terms

Justification

We are confident that our approach delivers an efficient and prudent level of investment because:

- **Clear, prudent drivers from Asset Management Objectives** for Quality, Safety and Compliance (as detailed in **Attachment 10.01 SAMP**). Delivers the sustained network performance our customers expect, and build an infrastructure platform capable of supporting value from CER penetration.
- **NER 6.5.7 Capex objectives:** This investment is to meet or manage the expected demand, and to maintain the reliability of the network.
- **Review and moderation:** Our forecasts have been tested and reviewed, and the forecasts have been moderated based on feedback and discussion.

The major benefits expected from these investments are:

- **Improved network risk:** Assets are at increased risk of failure when operated above their thermal ratings.
- **Maintain service level outcomes:** will result in fewer unplanned failures and unplanned outages than if no investment were made, with a target of maintaining service levels.

Forecast expenditure for the 2024-29 period is $35.4M. The change from 2019-24 actual/forecast of $9.5M is due to an increased number of transformers, lines & cables becoming overloaded, as customers energy demands grow.

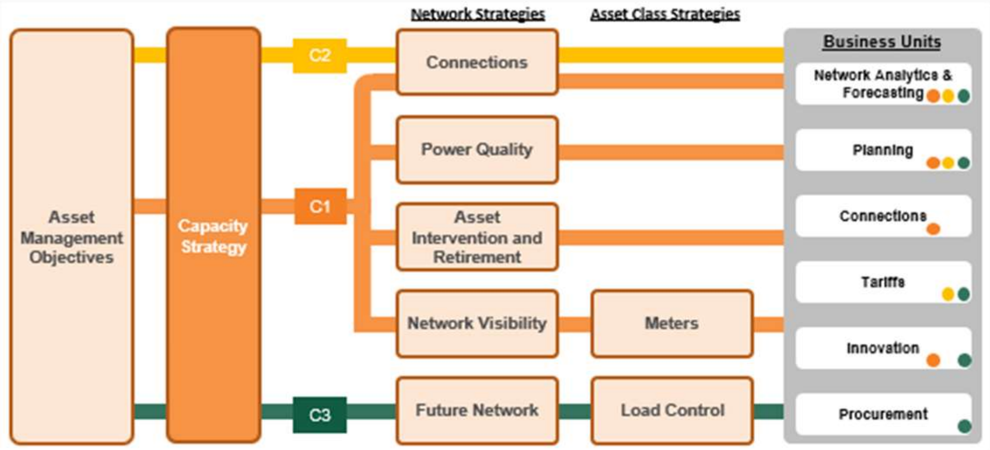
If investment is not made to address the thermal constraints, the most likely impact is customer outages occurring either due to blown fuses or failed assets. Almost all of the risk is network reliability, and is calculated using the Value of Customer Reliability (as per **Appraisal Value Framework**) and documented in **10.03.05.01 Value of Thermal Constraint Investments**.

Network constraints are expected to significantly increase in the 2029-34 period (**Attachment 7.01.01**) due to increased electrification and uptake of electric vehicles. We will continue to monitor as thermal overloads may be alleviated through the uptake of consumer or grid-scale batteries, use of non-network solutions, and appropriate tariffs.

Strategic Direction

Strategy Implementation

The figure to the right outlines the paths of implementation for each strategic direction. Some aspects of the implementation for each will reside within other Network Strategies where Network Capacity is an additional lens to place over existing direction. Through these other Network Strategies all asset classes will be impacted by direction from the Capacity Strategy. The metering and controlled load asset classes are addressed more directly. Business units involved in implementing the strategic direction have been shown at the right of the figure.



Network Strategy – Capacity: Summary

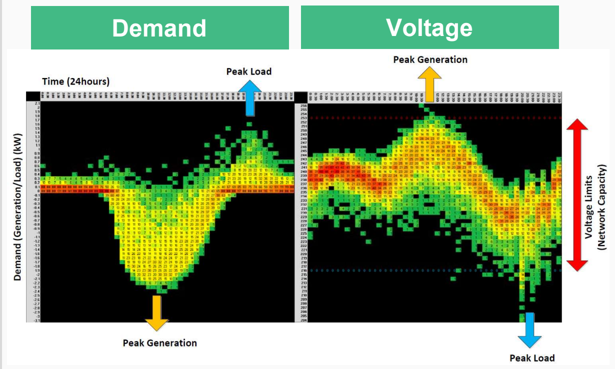
Essential Energy's Capacity Strategy provides direction to meet existing and forecast customer demand for capacity (both generation and load), focussing on the optimal capacity utilisation of existing network assets while maximising the value of grid connection.

Context

The transition to renewable energy has been the catalyst for the biggest and fastest change to the electricity supply chain since its inception. Key thematic changes include:

- DER technology uptake due to falling costs due to scale of PV, battery storage, smart meters, EV's providing opportunities.
- Evolving regulatory changes to accommodate the transition to renewables including incentives and investment framework for increased DER deployment through increased network hosting capacity.
- Continued growth in upstream large-scale renewables connections driven by the transition to renewables and retirement of coal generators altering transmission flow paths

In the absence of a proactive strategy, the continuing uptake of rooftop PV will present numerous challenges for distributors including deteriorating load factor and difficulty managing voltage levels, as illustrated (on the right) in the demand and voltage density plot for a single connection point:



The key observations being:

- Peak load – minimal change, later in the day and shorter duration
- Widening of the range of voltage in the LV network
- Localised power quality issues through rapid load change (e.g. voltage flicker caused by cloud event impacts on PV production) – i.e. masked demand

Line of Sight

The Capacity Strategy is an enabler for Essential Energy's Corporate Strategy, Pillar 1 - Strengthen the core business, and Pillar 2 - Realise the full value of our network resources. The Asset Management Objectives (AMO) related to the Capacity Strategy are AMO-06, AMO-08 and AMO-10. Subsequent Network Targets (NT) C1, C2 and C3 have been developed to align with the AMOs

C1	C2	C3
Develop ability to forecast network utilisation and capacity limitations at all levels in the network in a timely manner	**Improve availability of localised incremental augex cost to address voltage or thermal limitations**	**Establish access to a wide range of readily deployable credible demand management options**

Performance and Targets

	Current Performance	Target Performance
C1	Reliable forecast of demand and capacity limitations is available at sub transmission, emerging at HV and absent at LV levels of the network.	**Medium term:** 5 year forecast of thermal and voltage limit utilisation for HV network down to distribution-level substation. Maintain annual DER related power quality complaints at or below 2019 levels. Establish reporting on the value of curtailed generation in the LV network. **Long term:** 15 year rolling forecast of thermal and voltage limit utilisation for both LV and HV network.
C2	Incremental augex cost is calculated at a system-wide level. Network augmentation solutions are costed at a project level typically within two years of implementation.	**Medium term:** Develop a handbook of augex project costs categorised by constraint type and location to inform the cost envelope of future projects. Develop a value of deferred augex framework incorporating a TOTEX view, to inform comparison with DM solutions.
C3	Demand management solutions have been trialled under the DMIAM, and a small number of agreements are in place. This includes load control of hot water and limited use of large customer load curtailment agreements.	**Short term:** Implement a BAU business practice to investigate load control as a first pass for addressing capacity constraints. **Medium term:** Incorporate go-to-market procurement of network support into BAU (establish network support contract). Establish reporting on number of positive demand business cases, both absolute and as a proportion of all growth business cases. **Long term:** Incorporate asset-based demand management solutions into BAU (pole-top capacitors etc.) Process established and embedded that requires a non-network solution to be considered before a network solution is selected to capacity limitations.