



Vector's approach to climate change resilience

Discussion document for public
feedback

May 2026

Executive summary

As Aotearoa New Zealand faces more extreme and damaging weather, we understand how important it is to make sure our electricity infrastructure is resilient. With the electrification of transport and heat - electricity is becoming more essential for homes, businesses, communities, and entire economies.

This paper outlines Vector's strategic approach to climate change adaptation, shaped by climate risk assessments, partnerships, and long-term investment planning. Vector manages risk across its network on a day-to-day basis including capital investment and operational expenditure with the aim of delivering safe and reliable electricity to our customers. Specifically for climate resilience, we have identified a potential capital expenditure of about \$400 million over the next decade. This identified expenditure is a high level estimate, and targeted at providing optimal risk return through network hardening to mitigate against climate impacts. It represents a proactive step beyond current network risk management activities to address the growing challenges posed by climate change to our network.

We believe now is the time to rethink where and how resilience is built, with customers contributing to the process. With the increased adoption of technologies such as electric vehicles, household batteries, and solar generation, there is a growing opportunity for decentralised, customer-led resilience. Should customers have the option to invest in their own energy security, instead of paying more for shared network-level upgrades? With increased cost of living in Aotearoa New Zealand, would communities prefer longer outages due to storms over paying more for a climate-resilient network?

These are just some of the questions this paper discusses, and we invite your feedback at consultation@vector.co.nz on these and any other matters.

“New Zealand's environment and geography mean that our critical infrastructures are exposed to a broader and more consequential range of potential shocks than any other highly developed country”

Strengthening the resilience of Aotearoa New Zealand's critical infrastructure system, New Zealand government

Disclaimer

This report is a summary of Vector's assessment of climate change risk and its resulting strategy. It is intended to inform readers about Vector's climate change resilience strategy but it is not earnings guidance nor financial advice, and it is unaudited.

Given its focus on future risks, this report contains estimates, projections and assumptions about future weather patterns, socio-economic, policy and regulatory, technological, and other conditions, as at 24 April 2026. Although the use of scenario analysis is rapidly developing to support this future focus, there are limitations to the modelling methodology and available data, and therefore scenario analysis.

While Vector has made efforts to ensure that its assumptions have a reasonable basis and are coherent and plausible (including basing them on modelling, public scientific information, market knowledge and projections, government policy proposals, and reasonable/expert opinions), assessments of the future are challenging and inherently uncertain. The assumptions, estimates, projections and modelling relied on in this report may not be realised at the scale and pace anticipated and/or the future may involve circumstances that are different to those anticipated in this report.

In light of the above, while Vector has taken all due care in preparing this report, including its scenarios and assumptions, Vector makes no representation as to the report's accuracy, completeness or reliability, in particular in relation to Vector's assumptions regarding future events.

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Scope of this paper

About Vector

Vector is an Aotearoa New Zealand energy company, which runs a portfolio of businesses, delivering energy services to more than 639,000 residential and commercial customers across the wider Auckland region. We are New Zealand's largest distributor of electricity and gas, owning and operating networks across the greater Auckland region which span over 25,000km in length. For comparison, the circumference of the earth is 40,000km.

About Auckland

Every region in Aotearoa New Zealand has their own unique issues and this paper focuses just on the Auckland region which is exposed to worsening floods, cyclones, landslips, wind events and wildfire risk. These risks are detailed further in page 12.

Scope: Robustness within resilience

Vector considers that resilience is one component of overall network security, which is represented by the Venn diagram below. For more information on reliability and adequacy, refer to our asset management plan [2].

Resilience, as defined by the International Energy Agency, can be divided into robustness (ability to withstand long term changes), resourcefulness (ability to continue operation during shocks), and recovery (ability to restore a systems function after a shock) [1]. This paper primarily focuses on robustness which involves largely irreversible investment decisions. Investments into resourcefulness and recovery, such as enhanced network visibility, customer experience and operational efficiency, can be deployed quickly, are often reversible, and scale incrementally over time. While no less important, they follow a different decision methodology and are not included in scope of this paper.

This paper also specifically focuses on the electricity distribution network and its interconnection with the wider sector. We believe that the methodologies presented in this paper can form a blueprint for other critical infrastructure providers.

Our electricity network is already 99.98% reliable, though we acknowledge that for some rural and weather exposed communities that may not always seem like the case. Maintaining this existing quality of service would require hundreds of millions of dollars in infrastructure upgrades to mitigate emerging climate risks. This paper proposes a resilience prioritisation framework which enables Vector to optimise its capital investments to deliver the greatest resilience outcomes for customers in Auckland per dollar invested. The analysis largely focuses on Vector's electricity distribution network which is most vulnerable to the impacts of climate change.

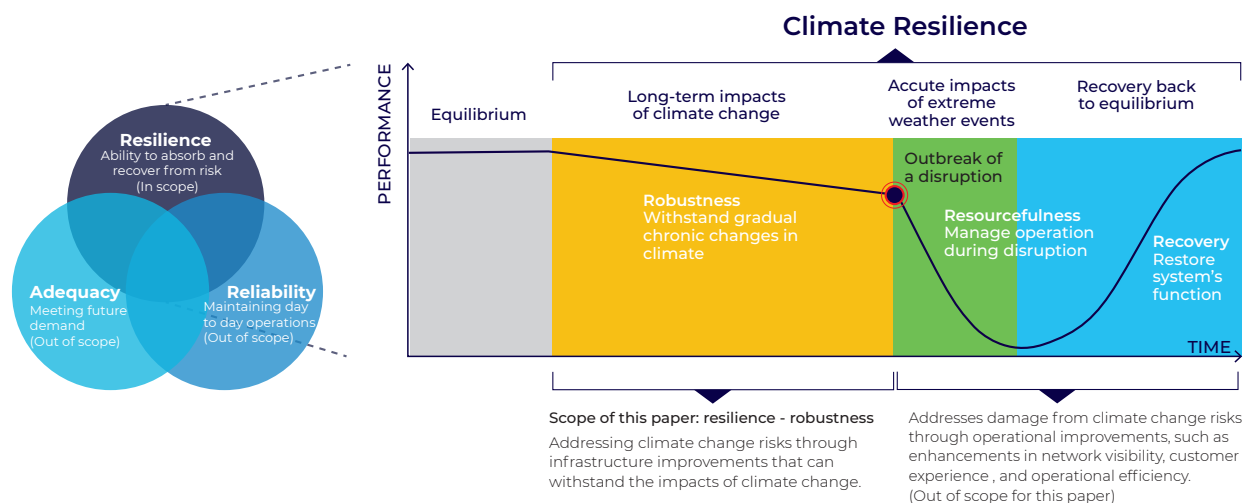


Figure 1

Left: The trifecta of energy security, right: breaking down resilience into robustness, resourcefulness, and recovery.

Key challenges

We invite your thoughts on the following issues

Customers want resilience, yet are not all willing to pay more for resilience

Vector has to meet quality of supply standards that are regulated by the Commerce Commission - which may become increasingly difficult to meet with increasing climate change impacts. Further to this, during storm events, customers expect their power to stay on. In contrast, only 56% of customers want to pay more on their electricity bill to fund resilience projects. Should New Zealand reduce its electricity quality standards, or invest in resilience at a cost to the electricity consumer?

We have identified about \$400 million of expenditure over the next 10 years for resilience

On a high-level basis, a full programme of capital works to mitigate all known climate risk would cost approximately \$1.75 billion. Spread over 600,000 customers this equates to a cost of \$3000 per customer. On the contrary we could make no investment, thus saving the customer money, and giving them the option to invest in their own self-resilience. We have currently identified about \$400 million, which comes at an approximate cost increase of \$650 per customer. Does this strike the balance between centralised resilience investment and customer self-resilience?

Community resilience

Community resilience refers to the ability of local people, systems, and institutions to anticipate, respond to, and recover from disruptions - whether through shared resources, decentralised technologies, or localised planning. What could Vector do to enable more community resilience initiatives?

Centralised vs decentralised resilience

Traditional electricity resilience relies on centralised solutions such as investment in hardening infrastructure. However with technologies, such as electric vehicles, solar, generators, and household batteries, there is an opportunity for customers to invest in their own electricity resilience. For example, the first emissions reduction plan had a goal of 30 per cent of the light vehicle fleet being electric by 2035. As many electric cars have 'vehicle to load' capability - in other words the car can be used as a back up power source for home appliances - electric vehicle owners would have this self-resilience option. What could Aotearoa/New Zealand do to enable more decentralised resilience, and how should Vector consider this in its resilience planning?

Amend regulation for climate change resilience

Vector's view is that the existing economic regulatory regime should be amended to provide a statutory requirement for climate change resilience. Do you agree with this approach?

Socialising of resilience investment and maintenance

There are regions on Vector's network that are more vulnerable to climate change than others, and are therefore becoming increasingly expensive to maintain. If those customers were paying the true cost of maintaining the network in the region, such as via a regional tariff, then it could incentivise the investment in off-grid solutions such as solar or battery. This could then result in a redesign of that region as a smaller micro-grid or retreat of the network altogether - which could result in overall cost savings for all Aucklanders. Our customer engagement however indicated a stronger preference for maintaining socialised cost - where costs are spread across our customer base. Do you think cost-reflective pricing is a fair approach? Or should resilience remain a socialised cost?

Managed retreat

Vector currently has a legal obligation to keep customer connections that were made before 1993. In the event of a managed retreat, Vector would need to request amendments to the Electricity Act 1992 to remove existing assets. We believe that this should be considered in any policy development regarding managed retreats.

Focus on projects which tackle the problem at its core - such as making spaces for water to flow

There are projects that can create natural overland streams to improve water flow - which has a cascading impact of mitigating the flood risk at its source. This doesn't just support the local community, but could also defer Vector resilience investment. What information would government or councils require to support their business cases on such core climate change projects?

Cascading failure of infrastructure

When electricity networks fail, wider critical infrastructure that depends on power such as hospitals, telecommunication towers, and water infrastructure can also fail. Vector cannot guarantee continuity of supply for customers, and therefore supports an approach whereby essential service providers take accountability for the resilience of their own assets to support their customers. For example, hospitals have invested in multiple lines of connection to the network, and also have back up power generation. The same goes for water infrastructure. This 'user pays' approach also protects Vector's electricity customers from paying for wider systems resilience.

Self insurance

A 2018 Lloyd's report ranks New Zealand's annual expected disaster losses by country at 0.7% of GDP, which is second worst in the world after Bangladesh [5]. Vector cannot get access to reasonable premiums, and therefore has to self-insure the majority of its assets.

Case study: Cyclone Tam

April 2025 - deep subtropical cyclone

On the 16 April Tropical Cyclone Tam had evolved into a deep subtropical cyclone causing extensive damage to the Auckland and Northland regions. On the 19 April Auckland was hit by a subsequent thunderstorm leading to a further set of outages.

Vector had recorded 1600 low voltage incidents, many of which required sending a maintenance truck to fix. Vector's 231 high voltage faults resulted in more than 79,000 unique customers affected.

Ninety-eight percent of all high-voltage outages were fixed within a day, however there were 77 customers that were without power for three to four days. This is largely attributed to Vector prioritising restoration of the high voltage network with high customer outage numbers to get the majority of customers back on power.

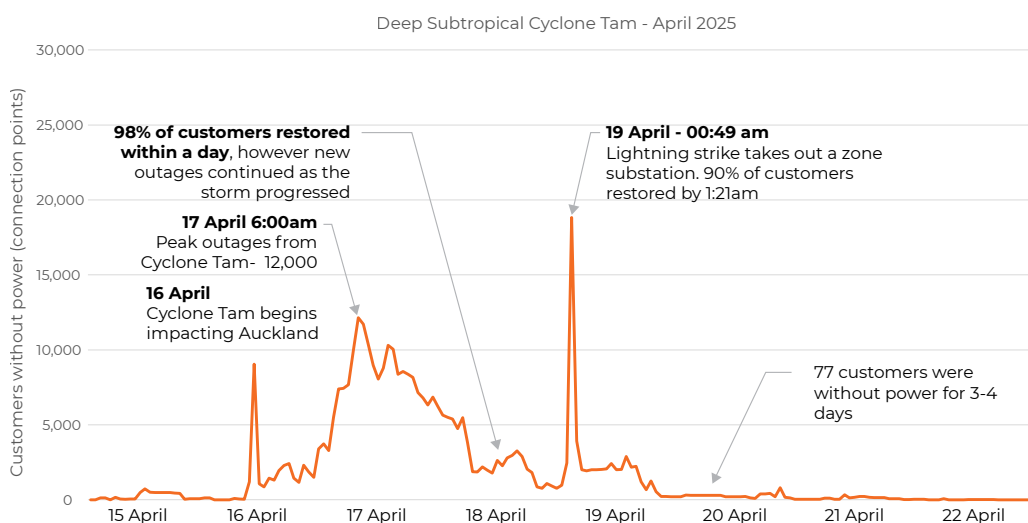


Figure 2

High voltage outages on Vector's electricity network during Cyclone Tam in April 2025.

Further reading:

- [1] [International Energy Agency 2021, Climate Resilience.](#)
- [2] [Vector 2025, Electricity Asset Management Plan](#)
- [3] [New Zealand Government Department of Internal Affairs 2024, Final report of the Government Inquiry into the Response to the North Island Severe Weather Events](#)
- [4] [New Zealand Government DPMC 2024, Strengthening disaster resilience and emergency management](#)
- [5] [Lloyds 2018, A world at risk - closing the insurance gap](#)

Methodology

Vector's climate resilience strategy begins with the modelling of the physical impacts of climate change, such as floods, wind speeds, cyclones and landslips. Vector commissions third party research agencies, such as Earth Sciences NZ, Climsystems, and the University of Auckland to study changes in the climate, and provide geospatial data sets. Where possible, we model the impacts through to the year 2100 and use IPCC scenarios to evaluate the different plausible trajectories of the global climate. Further details of our physical modelling can be found on page 12.

These geospatial datasets are then analysed by Vector's in-house data science teams. For example, flood modelling involves layering flood data over critical Vector assets, and highlighting those assets at risk.

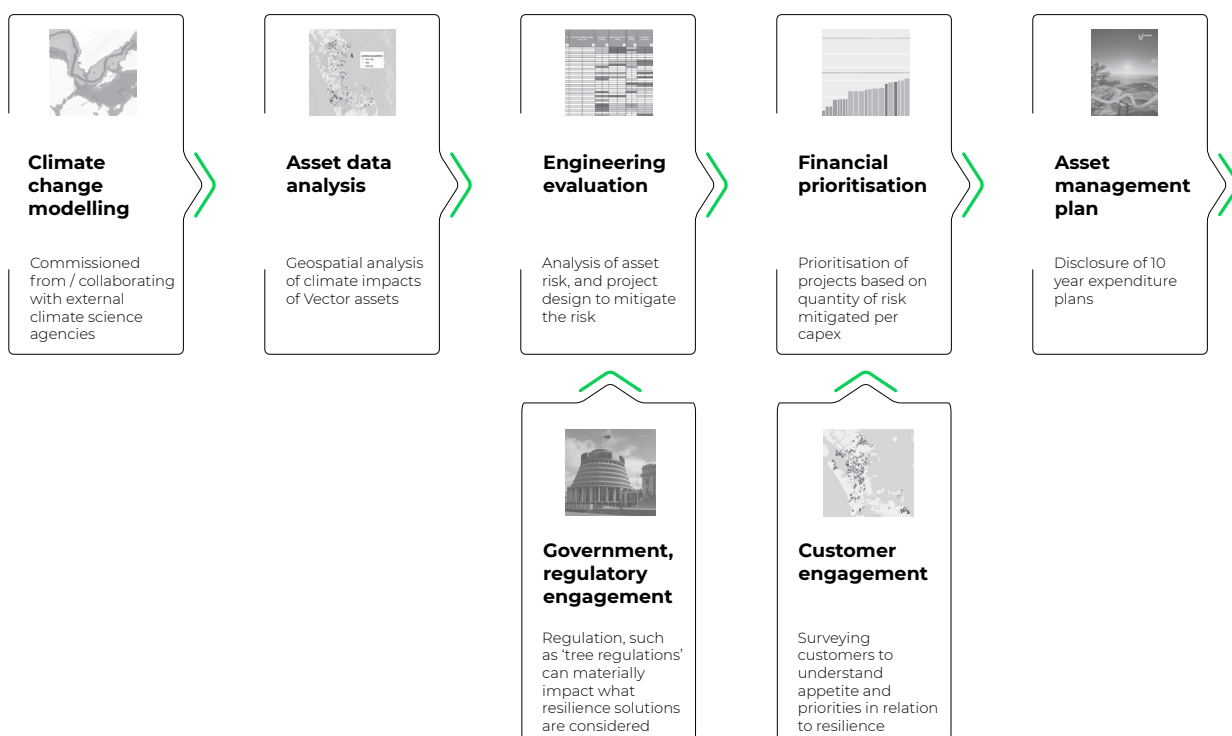
Vector's asset engineering team analyses the at-risk assets and use subject matter expertise to quantify the significance of the risk. In some cases an asset may be exposed to climate change impacts (such as sitting in a future flood plain), but may already be sufficiently resilient (such as being adequately raised above the flood waters). Each at-risk asset is given a risk-score based on its impact on customer outages, network load at risk, public safety, and ability to back-feed the network to maintain power. Each at-risk asset is also given a mitigation project plan with

approximated capital expenditure to mitigate the risk.

We then prioritise resilience projects with the greatest risk reduction at lowest capital cost.

In parallel, Vector ran a customer survey to understand the customer priorities in relation to resilience. In essence Vector wants to know how much customers are willing to spend to have a more reliable service in the future. We are also interested in knowing what customers want in terms of power supply resilience. This will be discussed further on the following page.

Outcomes from this resilience work are budgeted into Vector's asset management plan that discloses Vector's electricity asset management policy, objectives, 10-year expenditure plans and the context in which expenditure decisions are made.



The voice of customers

Cost of living pressures often conflict with desires to have a more resilient network

Methodology

The research was conducted in two phases:

1. Preliminary interviews with 10 customers from a range of customer groups to support Vector with survey design
2. An online survey of 1,847 responses (with 29,486 randomly selected residential and small-medium-enterprise customers invited to it).

This section summarises findings from both the interview and survey.

Customers' willingness to pay for resilience

During interviews, customers expressed a conditional willingness to pay more on top of their current power bill. Cost of living pressures were frequently raised as a constraint.

In the survey, 60% of respondents were unwilling to pay more with only 20% who were willing to pay more

However, in the same survey, when customers were given two specific options:

- Option A: 30% decrease in the risk of storm-related power outages at a cost of \$2/month extra on their bills
- Option B: 70% decrease in the risk of storm-related power outages at a cost of \$4/month on their bills.

35% preferred option A, while 21% preferred option B. It is interesting to note that the lift from 20% willingness to 56% willingness was purely based on the question context which includes tangible outcomes and costs.

The main reasons for reluctance was the view that electricity is already expensive along with general affordability concerns. A small proportion were satisfied with current levels of outages, and/or have invested in individual resilience solutions.

Socialised costs vs targeted costs for impacted customers

We asked customers whether they prefer socialising costs for customers in regions that are more vulnerable to climate change impacts.

Findings showed a strong preference for sharing resilience investment costs across all Auckland residents and businesses, rather than burdening only those in affected areas. This approach was viewed as equitable and aligns with the unpredictable nature of severe weather - even though we tend to have the same areas impacted by repeat storms.

- 46% of respondents preferred fully shared costs
- 30% supported a combined approach
- Only 8% supported a model where only customers in affected regions pay for resilience investments - even among customers not impacted by storms

From interviewed participants, this strong preference for socialisation of resilience investments was underpinned by desire for equitable costs, and the interconnected nature of Auckland's infrastructure delivering cross benefits across the region and nation.

Customer preferences for communication

Customers strongly agreed that communication is a vital part of resilience planning - especially during major storms. They want clear, updated restoration times, transparency on resilience investments, and practical advice on preparing for outages. Many also called for better coordination with local services. Around 76% of surveyed customers were interested in hearing more from Vector on our resilience efforts.

How customers define power supply resilience

In interviews, customers described power resilience as more than just having reliable electricity. It also includes clear, timely communication from Vector about what is being done to restore power during an outage. Additionally, access to backup energy options - provided by themselves, neighbours, or Vector (e.g. generators, batteries, solar) - was also seen as important. Many customers, especially in rural areas affected by long outages during recent storms, also linked resilience to related essential services like water supply, caring for livestock, road access, and telecommunications.

Customer preferences for tree trimming

Our customer interviews highlighted a strong preference for complete tree removal close to power lines as this would be more cost-effective in the long term compared to repeated trimming requiring ongoing maintenance costs. Another theme uncovered in the customer interview phase is the need for better preventative maintenance of trees before storms hit. This includes regular inspection and maintenance of trees near power lines, better communication about property owner responsibilities regarding trees, and a unified approach on vegetation management with Auckland Council to ensure responsibilities between different organisations are clear. Almost two thirds of respondents believe trimming of trees on private land near power lines should be the responsibility of the landowner or Auckland Council. Only 15% see tree trimming as the responsibility of Vector.

What this means for Vector

Customers want a more resilient network but are generally unwilling or unable to pay more due to current cost-of-living pressures.

Vector acknowledges this tension. During outages, customers expect greater resilience, but they also expect bills to remain affordable. In response, Vector has adopted a conservative, balanced approach - prioritising the most cost-effective resilience measures. Further details on this strategy are provided in the next sections.

Framework for prioritising investment

Introducing Vector's climate resilience marginal cost curve

What resilience projects should be done first?

To systematically assess the climate resilience risks facing the network, Vector developed a risk scoring framework that combines outputs from climate change models with internal engineering expertise. The methodology evaluates each risk at asset level against four criteria that reflect real-world network performance and community impact:

- the customer outage impact measured in SAIDI (customer minutes lost)
- the total network load at risk (kW)
- public safety implications
- the ability to back-feed the network and maintain power.

Each climate risk to a specific asset is assessed across the criteria and assigned a score accordingly. Aggregating scores comes to a total risk score of 437 risk points. This is not an exhaustive list, and more risks will be added as Vector's climate change modelling continues to mature.

Why not model financial risk?

A conventional infrastructure investment framework would seek to quantify the financial impact of each risk and subject potential mitigations to a cost-benefit analysis. While this approach has intuitive appeal, it has challenges. The core difficulty lies in the compounding sensitivity of inputs. For example, estimating the financial value of outages to customers involves significant assumptions, and those assumptions interact with a large number of compounding risks across the network. Layered upon this is the inherent uncertainty in projecting weather patterns out to 2100 - a timeframe that reflects realistic asset lifetimes. Together these factors make a financially-grounded cost-benefit approach highly resource-intensive to construct and defend with confidence. Vector's risk-scoring methodology offers a more pragmatic alternative. It is faster to implement, is transparent in logic, and most importantly can be reassessed annually with limited overhead. This allows the framework to remain current as Auckland's energy demand grows, and climate modelling evolves.

Mitigating risks and visualising the framework

Mitigation projects are designed for each at-risk asset with a corresponding cost and risk score reduction. This enables Vector to quantify a normalised metric across each project (cost per risk point reduction). In many cases there are multiple mitigation options that could be considered. An example case study can be read on page 13.

Vector developed a marginal resilience cost curve to help visualise this framework, figure 3. Each bar on this curve represents a climate resilience project. The width of each bar corresponds to how much risk is mitigated. Thin bars mitigate a small amount of risk, while wide bars mitigate a lot of risk. The width of the entire horizontal axis is related to the total known risk score of 437 points.

The height of each bar details the cost. The cost is normalised by \$/risk-point to allow for comparison between projects. The most

cost effective projects have the lowest normalised cost/risk-point which are positioned on the left, with the most expensive projects being on the right.

Setting capital expenditure

A high level estimate of undertaking all projects on this current curve would cost approximately \$800million - which would come at a cost of \$1300 per customer. Vector's asset management plan for 2025 has identified about \$400m of these projects which comes at a cost of approximately \$650 per customer. Asset costs are usually recovered around 45 years via depreciation rates set by the Commerce Commission. This brings us under the \$2/month figure from the customer engagement on page 7.

It is possible to mitigate a larger component of the known risk by undergrounding the entire sub-transmission network exposed to storms. However this could cost up to \$1.75 billion, be disruptive to the community and may not be economically prudent under regulatory settings. Furthermore, based on customer feedback we have therefore chosen not to include such initiatives in figure 3 on page 9.

From a pure financial efficiency of resilience lens - Vector would complete the projects in figure 3 from left to right, in other words the most cost effective to the least. In reality we also integrate with existing renewal planning, such as the replacement of aging assets. We also choose to substitute some of these projects with cheaper operational expenditure solutions as detailed below.

Operational solutions can be more cost effective, but mitigate less overall risk

Operational solutions such as vegetation management can provide resilience at much lower costs than capital infrastructure solutions. For example, an overhead power line exposed to tree-fall and bush-fire risk could be undergrounded for \$9million and reduce the risk rating exposure of that line to 0. Alternatively, the vegetation surrounding the tree could be managed to keep it away from the line costing only \$120,000 and reducing the risk points for this asset by 50%.

Figure 4 summarises mitigation actions where permanent solutions are substituted by cheaper operational solutions where possible. As these are operational costs, they are funded separately from our \$400 million capital expenditure.

What about resourcefulness and recovery?

This paper focuses on the long term hardening of assets against climate risk. This requires complex asset level modelling, and involves largely irreversible investment decisions.

Investments into resourcefulness and recovery, such as enhanced network visibility, customer experience and operational efficiency, can be deployed quickly, are often reversible, and scaled incrementally over time. While no less important, they follow a different decision methodology and are not included in scope of this paper.

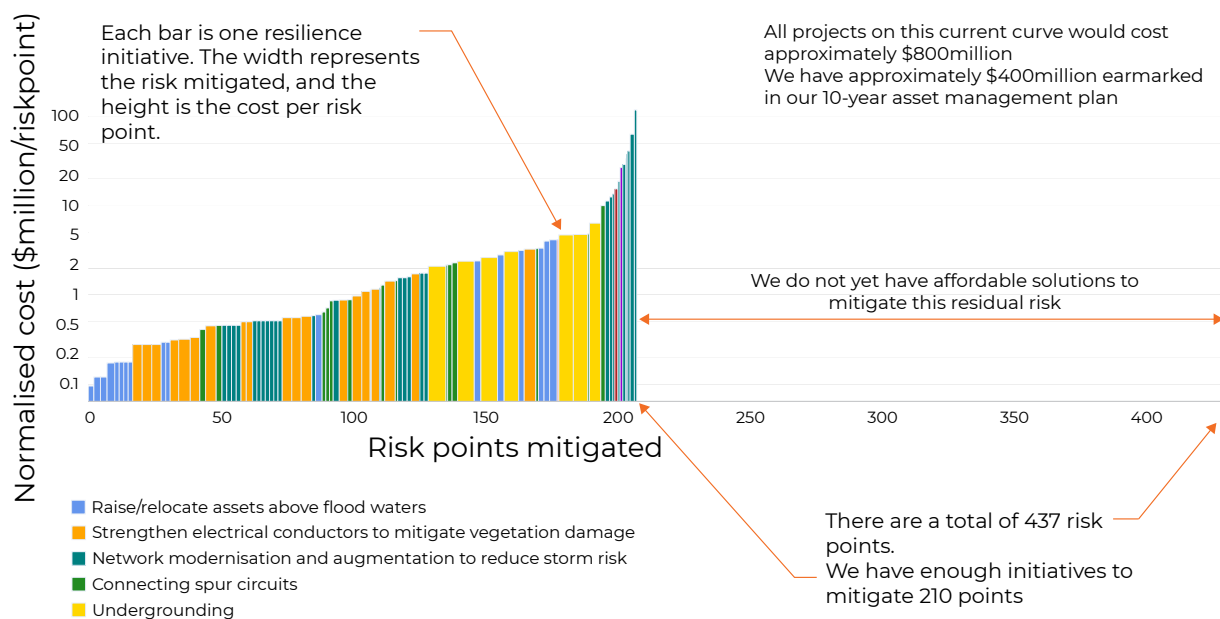


Figure 3

Vector's marginal resilience cost curve highlighting permanent solutions only. The horizontal axis corresponds to Vector's total risk points for its electricity assets. Each bar relates to a potential resilience initiative where the thickness of the bar details the amount of risk point reduction estimated to be possible as a result of the initiative. The vertical axis represents the estimated cost - normalised by risk points. Initiatives are ordered from left to right with the most cost effective to the least.

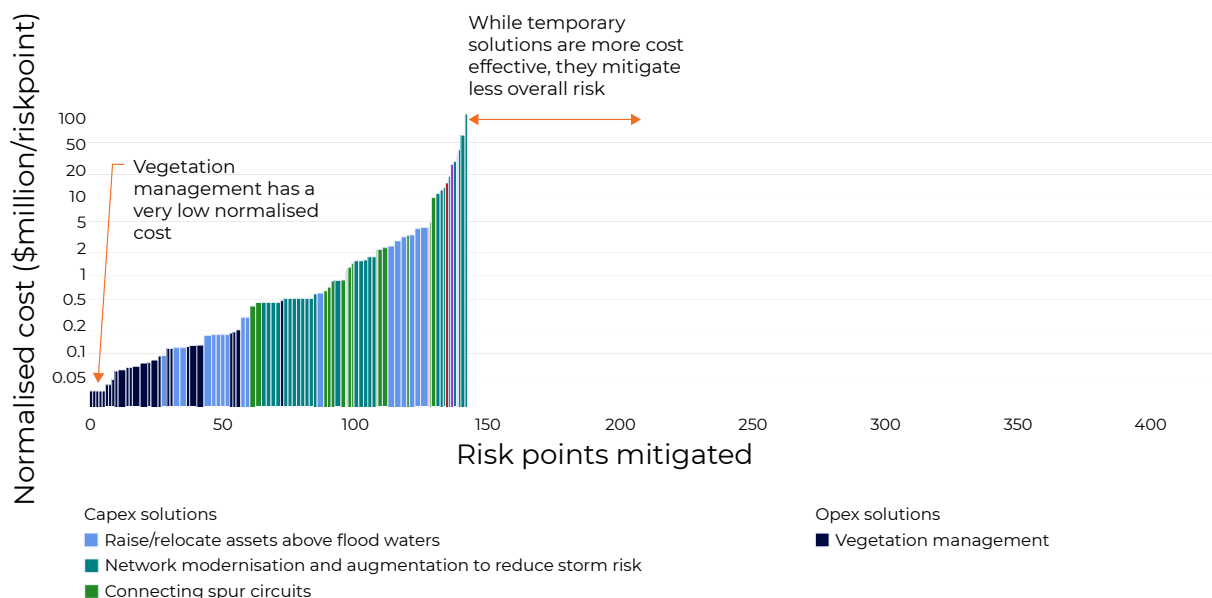


Figure 4

Hybrid network cost curve highlighting a blend of capex and opex solutions. For example, instead of undergrounding areas of the Vector network, or strengthening electrical wires, we could proactively manage the vegetation around those assets. While this is more cost effective, it does mitigate less overall risk. Where there are no operational solutions, the permanent capex network solutions are kept.

Interconnection of critical infrastructure

Energy systems are a backbone of society

Electrical infrastructure is deeply interconnected with other critical infrastructure systems, forming a complex web of interdependencies that underpin modern society. Mobile towers, for instance, rely on a constant and stable electricity supply to maintain communications, including emergency services and digital connectivity. Likewise, electricity infrastructure depends on transportation resilience to repair outages after storm events. Further to this, the electricity distribution network relies on a resilient upstream electricity transmission and generation assets to deliver power.

Disruptions in one infrastructure provider can therefore cascade across sectors, highlighting the need for integrated planning and investment.

Interlink between electricity and other infrastructure assets

Vector cannot guarantee continuity of supply for customers, and therefore supports an approach whereby essential service providers take accountability for the resilience of their own assets to support their customers. For example, critical services such as hospitals or waste water treatment plants will have multiple lines of connection and/or back up diesel generation. We consider this to be the most economically rational to avoid cost increases on Vector's entire customer base.

There are nevertheless options for increasing operational collaboration between critical service providers during outages. Vector recently initiated a conversation with a forum of telecommunication companies to brainstorm changes that could support the restoration process for both infrastructure providers.

Case study - Interlink of transportation and energy

If electrical assets fail, they often need road access to conduct the repair. Auckland Transport and Vector analysed all zone substations (which are critical Vector assets), that could become inaccessible in the event of a flood due to road closures. There are two solutions to this problem

- 1) Auckland Transport increases the resilience of the roads to Vector assets. This cost is borne through road user charges to the end consumer; or
- 2) Vector increases the resilience of its assets so they're less likely to fail in the event of a storm. This cost is borne through electricity tariffs to the end consumer.

In both cases, it is the end consumer that pays the bill, so the question was formulated to determine the least cost option.

Analysis found that it was cheaper for Vector to increase the resilience of its assets than for Auckland Transport to increase the resilience of its roads.

Figure 5

Vector's electricity operations centre



Climate change scenarios

Vector has developed three group scenarios as outlined below, which adapts data from the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 6 for physical analysis [6]. More details on these scenarios can be found in Vector's climate-related disclosure [7].

Orderly decarbonisation

• Limits warming to 1.5°C (SSP 1-1.9) by 2100

Under the orderly decarbonisation scenario, the world shifts gradually but pervasively towards decarbonisation. This scenario describes a future where global net-zero emissions are reached by 2050, and global temperatures peak around 1.6°C by 2050 and then decline to 1.4°C by 2100. This prevents the most extreme predicted impacts of climate change (which are described in the hothouse scenario below). However, this scenario will still result in an increase in extreme weather impacts including flooding, increased heavy wind events, land erosion and increased sustained hot and dry weather.

For New Zealand, the orderly decarbonisation scenario describes a future where domestic actions and policies are consistently aimed at achieving net-zero domestic emissions by 2050. This scenario sees actions and policies providing for clear and early

decarbonisation actions that integrate a whole-of-system approach, including both the supply side and demand side of the energy system.

In relation to the electricity sector, the orderly decarbonisation scenario's future provides for the New Zealand electricity grid supplying near to 100% renewable electricity by 2050. It also assumes regulatory settings that incentivise and prioritise demand-side energy management solutions, distributed generation, and energy-efficiency measures, which allow the energy sector to manage electrification and renewable generation while avoiding substantial increases in peak-time electricity demand.

Disorderly decarbonisation

• 2.7°C of warming (SSP 2-4.5) by 2100

Under the disorderly decarbonisation scenario, the world follows a decarbonisation pathway whereby emission trends do not shift markedly from historical patterns, with some countries making relatively good progress while others fall short. CO₂ emissions are expected to remain at current levels until approximately 2050 and then fall by 2100 causing global temperatures to reach 2.0°C by 2050, and 2.7°C by 2100.

Consequently, with respect to physical risks of climate change, the increased temperatures that are assumed to occur under the disorderly decarbonisation scenario (when compared to the orderly decarbonisation scenario) would cause more significant weather impacts to be felt in New Zealand. These weather impacts

include physical risks to Vector's physical assets, including in particular its electricity assets.

In regards to transition risks, under the disorderly decarbonisation scenario New Zealand achieves its net-zero emissions target by 2050. However, policy measures in the lead up to 2030 lack cohesion and the failure to coordinate policy stringency across sectors results in inefficient capital investments.

In the electricity sector, this delay and incoherent policy approach results in a high cost burden on energy consumers (due to inefficient investment in physical electricity assets to respond to higher peak energy demands), and creates energy reliability issues.

Hothouse

• 4.4°C of warming (SSP 5-8.5) by 2100

The hothouse scenario describes a future where minimal and fragmented efforts towards climate change mitigation have resulted in severely increased physical impacts.

Under this scenario, the rest of the world prioritises economic and social development over decarbonisation efforts leading to the exploitation of fossil fuel resources. As a result, under the hothouse scenario greenhouse gas emissions triple by 2075 and global temperatures reach 2.4°C by 2050 and 4.4°C by 2100.

With respect to physical risks, there would be a significant increase in extreme weather events leading to expensive climate change adaptation measures and low grid reliability.

Consumers continue to bear the cost of fossil fuel energy and ongoing climate change adaptation.

Physical Impacts Modelling

See following pages for a detailed explanation

Vector works with external climate scientists to conduct physical climate change projections for the Auckland region - such as future flood maps. These data sets are then analysed by Vector's in-house data science and asset engineering teams to understand the physical impacts on Vector's assets.

We also work with international entities in regions such as North Eastern Australia and Florida that are highly exposed to extreme weather events to share best practices.

Where possible we model 1:100 year and 1:500 year return periods, and if available - project these across Vector's group scenarios to the year 2100.

Our modelling to date includes:

Flood risk (page 13)

Vector has analysed the impacts of storm-driven extreme sea level flooding (coastal inundation), fresh water flooding, and cyclone-induced flooding. We are anticipating further development in our flood modelling after the release of the Earth Sciences NZ flood data for New Zealand.

Landslip risk (page 14)

Landslip susceptibility analysis has been conducted across Vector overhead assets and underground gas distribution assets.

Hot dry weather risk (page 15)

Vector conducts short-term year ahead fire assessments. We are yet to extend this analysis to the long term 2100 horizon.

Wind speed Risk (page 16)

Vector has analysed and evaluated windspeed change across the Auckland region in general. However we are yet to develop a methodology to geospatially map these against our assets due to the significant variability in wind.

Cyclone risk (page 17)

Vector commissioned Earth Sciences NZ to analyse the impacts of a cyclone of similar magnitude to Cyclone Gabrielle if it had tracked directly over Auckland.

Figure 6

Power-lines damaged by tree-fall and landslip after Cyclone Gabrielle in 2023



Flood risk

There are three common types of flooding

Fluvial floods - when an existing waterway, such as a river or stream breaks its banks causing water to flow out to adjacent low-lying areas.

Pluvial floods - when the amount of rainfall exceeds the capacity of the urban storm water system causing excess flows overland.

Coastal inundation - caused by windstorm events (particularly when it coincides with a high tide) where the land along the coast is inundated by sea water.

Auckland is heavily exposed to climate change induced flood events, and in particular pluvial floods and coastal inundation. For reference, the Auckland Anniversary flooding in 2023 was a pluvial flood event.

Coastal inundation modelling

In 2022 Vector commissioned Climsystems and the University of Auckland to conduct coastal inundation modelling. Both results highlighted imminent risk at Ngataranga Zone Substation on Auckland's North Shore which has been planned for decommissioning in 2026.

Fluvial and pluvial flood modelling

In 2022 Vector commissioned Climsystems to conduct surface flooding maps based on historic precipitation. While the results showed significant exposure in Auckland (as highlighted by the subsequent Auckland Anniversary floods in January 2023), the lack of flood water depth data prevented any useful asset planning.

In 2023 Vector subsequently commissioned Climsystems for a more detailed flood maps around critical Vector assets with depth data. Out of Vector's 113 zone substations (as of 2023) 47 zone substations had water levels higher than 300mm in close proximity of the zone substation.

A subsequent criticality assessment by Vector engineers highlighted 13 zone substations that have flood risk exposure. The remaining 34 zone substations were already raised above predicted flood waters.

Across these 13 zone substations, 15 projects were identified that supported the mitigation of flood risk which have been integrated in Vector's 2024 asset management plan [1].

Next steps

Vector is integrating the Earth Sciences NZ flood data which will be used to extend this analysis to smaller assets, such as our 15,000 ground mounted distributed transformers.

Notes for council and government

Whilst Vector can prepare its assets for flood impacts, there is an opportunity to mitigate flooding in general by enabling more overland flow paths to prevent pooling. As an example, we highlight the blue-green initiative from Auckland Council which creates natural stream features to improve water flows. Such activities could not only defer adaptation investment for Vector, but also support the local communities surrounding Vector's assets.

Case study: Ngataranga zone substation

Multiple climate change studies have highlighted Ngataranga zone substation at critical risk of coastal inundation and it is already estimated as being a 1-in-10 year flood risk. Vector considered four mitigation options

- 1) do nothing and accept the security of electricity supply risk;
- 2) reinforce the nearest Belmont zone substation to accommodate the demand and decommission Ngataranga Bay;
- 3) relocate Ngataranga Bay zone substation in a suitable flood risk free location; or
- 4) rebuild Ngataranga Bay zone substation on elevated foundations.

Option 2 was preferred due to a significantly lower cost than options 3 and 4. This project has commenced starting in 2024 and is estimated to be completed in 2026 at an anticipated cost of around \$8 million.

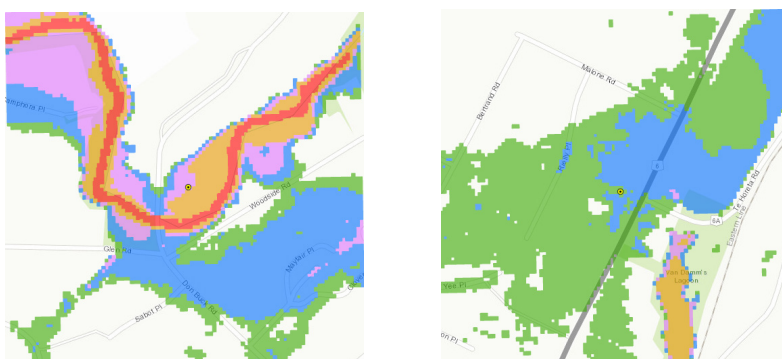


Figure 7

Geospatial extracts of two flood events around zone substations. The proposed measure for the left image involves building a bund-wall around the substation, whereas the right image requires raising of assets above the flood-plain.

Landslip risk

Scientific modelling

The University of Auckland's department of civil engineering developed a landslip susceptibility map for Auckland. Vector overlaid these landslip maps against our overhead electricity assets and underground gas assets.

Analysis against power poles

Overlaying landslip maps against Vector's 125,950 power poles revealed that 5% sit in moderate, high, or very high risks zones. Clusters of very high landslip risk can be observed in the Waitakere Ranges and Kawau Island.

Analysis of customer impact

The number of customers impacted was a key metric to prioritise the criticality of the risk. Out of the 331 very high risk poles, 27 would cause an outage for more than 1000 customers if they were to fail.

Next steps

We anticipate further developments in our landslip analysis upon completion of the national wide Hōretireti Whenua Sliding Lands programme lead by Earth Sciences NZ.

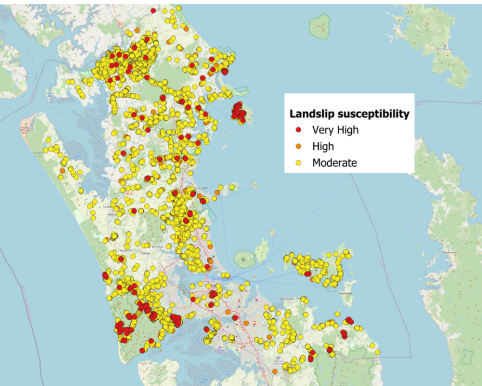


Figure 8

Power poles in moderate to very high landslip susceptibility with table below highlighting the network overview. There are notable clusters around Kawau Island, and Waitakere.

LANDSLIP SUSCEPTIBILITY	LOW VOLTAGE	MEDIUM VOLTAGE	HIGH VOLTAGE	TOTAL
Very Low	30,527	39,175	162	69,864
Low	18,646	29,915	15	48,576
Moderate	1,281	4161	4	5,446
High	306	981	2	1,289
Very High	83	248	0	331
Uncategorised	174	269	1	444
Total	51,017	74,749	184	125,950

Further reading:

[7] [Vector 2024, Climate-related disclosure](#)

[8] [GNS Science, Hōretireti Whenua Sliding Lands programme](#)

Fire risk

Electrical infrastructure can cause wildfires - and is also impacted by them

Electrical infrastructure

There is a risk that sparks from electricity equipment or damaged power lines falling on dry vegetation can cause wild fires. One of the most notable examples is the Camp Fire in California (2018) which resulted in 85 fatalities and USD\$16.5 billion in damage.

Auckland can also be subject to periods of sustained dry weather that brings elevated wildfire risk.

Mitigating fire risk through collaboration

Vector works with Earth Sciences New Zealand, and Fire and Emergency New Zealand (FENZ) to analyse fire risk over the upcoming summer. A governance framework exists to enable public safety shut-downs in the event that FENZ declares an extreme wildfire risk.

Mitigating sparks

In hot, dry conditions, certain types of fuses used on our overhead lines can eject small pieces of molten metal when they operate. If this metal lands on dry vegetation, it can potentially start a wildfire. In 2024, we began trialling a safer type of fuse on our 11kV overhead network, known as current-limiting expulsion fuses. These fuses are designed to reduce the chance of hot debris being released when they activate, helping to lower the risk of fires starting beneath power lines.

Impact of hot dry weather on electricity lines

During hot dry weather, the amount of electricity that can be carried by the network decreases. During these times, the network ratings are lowered, thus limiting the maximum current that can be transferred. As New Zealand's peak electricity occurs on the coldest night of winter, this is not an immediate concern. However, if increasing temperatures push peak demand to a hot summer day, like in Australia, then this could pose a material risk.

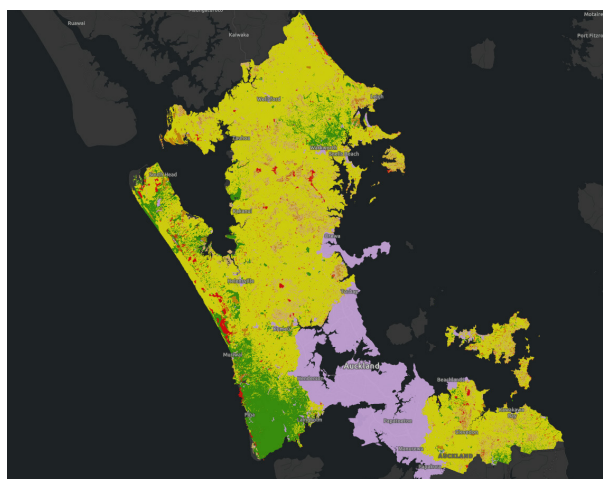


Figure 9

Fire risk map of summer 2025 mapped against Vector's asset base

Further reading:

[9] NIWA 2024, [Wildfire risk in New Zealand 1997 - 2023](#).

Wind risk

The electricity network is resilient to wind, but not resilient to trees that fall on powerlines during periods of heavy wind

It's the trees not the wind

Vegetation and other overhead items landing on power lines are responsible for approximately 70% of power outages in a storm. Heavy wind speeds are responsible for the most damage to the Vector network. Further to this, dry vegetation falling on power lines can cause wild-fire risk.

Modelling future wind

In 2022, Vector commissioned Climsystems to analyse extreme wind speed changes across our three scenarios. Figure 10 highlights the results of this analysis that shows the hours per year of wind speed greater than 70km/h.

It is at 70km/h that Vector starts noticing damage to power lines due to vegetation fall. In all scenarios, the hours per year of high wind speeds increases through to 2100.

However, even though extreme wind speeds are increasing, the average wind speed appears to be decreasing. This is highlighted

in the 2024 Earth Sciences NZ release of wind speed projections via the Ministry for the Environment's climate projection dataset portal.

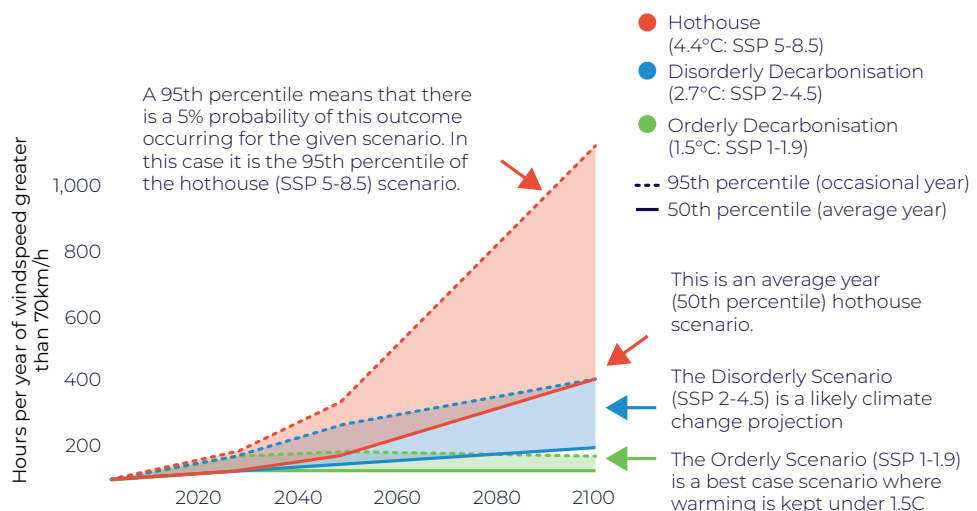
This can largely be attributed to the increasing tropical climate of the Auckland region. While we may be seeing on average lower wind speeds, climate change is increasing the risk of tropical storms. This increases the magnitude and frequency of these extreme wind events.

Capex vs opex solutions

Operational solutions, such as vegetation management, can provide resilience at much lower costs. To illustrate an example, a overhead power line exposed to tree-fall and bush-fire risk could be under-grounded for \$9million and reduce the risk rating exposure to 0. Alternatively, the vegetation around the tree could be managed costing only \$120,000 and reducing the risk points for this asset by a half.

Figure 10

Hours of heavy wind-speed per year are expected to increase to 2100. This would increase customer outages, and additional expenditure would be required for network repair



Cyclone risk

Impact of cyclones

Ex-Tropical Cyclone Gabrielle was the most expensive weather disaster to have ever affected Aotearoa New Zealand, and was particularly devastating in Hawke's Bay. Insurance costs alone have been estimated by PERILS (a Zurich-based insurance organisation) to have been over \$2.2 billion, while overall losses were estimated to exceed \$13 billion. While Auckland did experience strong winds, rainfall, flooding and landslides, it was fortunate to largely escape the worst of the damage and economic impacts seen in other regions.

Modelling cyclones - Gabrielle

Vector, Transpower and Auckland Council commissioned Earth Sciences NZ to explore plausible outcomes for the Auckland region if Ex-Tropical Cyclone Gabrielle had taken a different track and directly impacted Auckland as opposed to Hawke's Bay. This involved re-simulating the cyclone's trajectory multiple times with slight shifts in New Zealand's landmass to assess the effects of extreme wind, heavy rainfall, storm surge, and flood inundation on Auckland and its surroundings.

One unexpected result was the impact the Coromandel Peninsula had in sheltering Auckland from rainfall. Initial simulations highlighted that the heaviest rainfall (up to 600 mm) that occurred with the actual Gabrielle event in Hawke's Bay ranges was now occurring over the Coromandel and Kaimai range, in effect placing Auckland in somewhat of a rain-shadow region, although most parts of Auckland still received around 100 mm.

Modelling highlights that the most extreme wind gusts - up to 180km/h, would impact the regions around Omaha and Leigh with central Auckland experiencing notably less wind.

Predictive short term analysis

Vector also works closely with Earth Sciences NZ to understand cyclone impacts before they hit. The modelling enables us to optimise our emergency response.

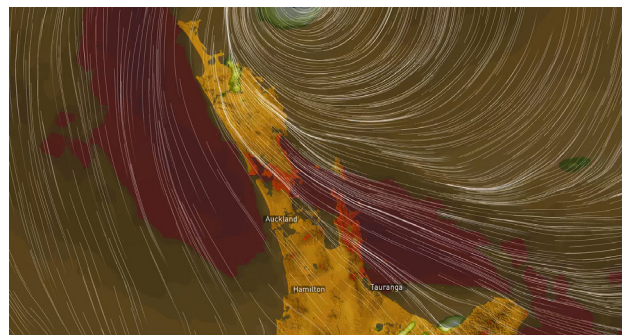
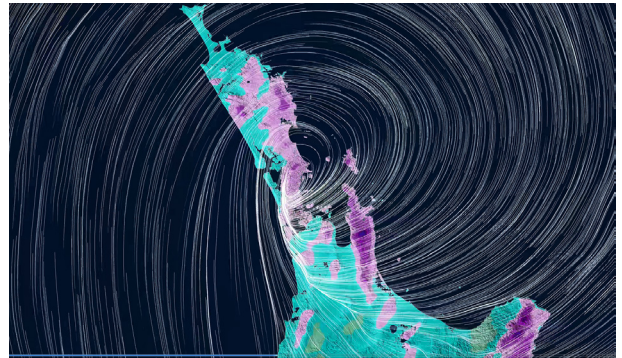


Figure 11

Geospatial extracts of cyclone analysis. Above - rainfall accumulation over a 48 hour period where dark purple colours indicate heavy rainfall. Bottom - wind gust analysis highlighting the impact on the east coast north of Auckland.

Further reading:

[10] Nick Wilson, Adele Broadbent, John Kerr 2023, *Cyclone Gabrielle by the numbers - A review at six months*

Gas network resilience

Complexities in supporting assets undergoing degrowth

While the scope of this paper focuses on Vector's electricity distribution business our gas infrastructure business also has some climate change risk exposure.

Resilience of gas networks

Gas networks are underground and largely made of durable PVC piping, making them highly resilient to most impacts of climate change. Gas networks nevertheless are still exposed to landslip and wildfire risk. Our preliminary landslip susceptibility analysis highlights that only 1.4km (0.033%) of gas lines are in very-high landslip zones.

To shut down or to repair

Infrastructure companies, like Vector, invest in long-term assets based on the expectation of earning a return that reflects the cost of financing those investments. However, scenario modelling shows that in a "wind-down" situation - where an energy network is expected to shrink or be retired - the financial returns on new investments would steadily decline and could even turn negative over time. This creates a serious challenge when it comes to future investment decisions, especially after extreme events like natural disasters.

If there's a high risk that the company won't be able to recover its costs, and directors are legally required to act in the best interests of the company, it may actually be more rational - legally and financially - not to reinvest in repairs. In these cases, parts of the network might have to be shut down earlier than planned, potentially leaving customers without service.

To mitigate this risk, we recommend a change to Part 4 of the Commerce Act 1986 to preserve the principle of financial capital maintenance. Historically the system has served New Zealand well, but the rules of a de-growth economic paradigm are fundamentally different to growth based regulatory models. Updates to the Commerce Act and associated regulations need to provide greater certainty around cost recovery for regulated infrastructure.

Further reading:

[\[1\] Vector 2023, *managing the gas transition*](#)

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 - 2 Vector Limited. 2025. Vector Electricity Asset Management Plan. <<https://www.vector.co.nz/about-us/regulatory/disclosures-electricity/asset-management-plan>>
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 - 5 Loyds 2018, A world at risk - closing the insurance gap <https://assets.loyds.com/assets/pdf-loyds-underinsurance-report-final/1/pdf-loyds-underinsurance-report-final.pdf?utm_source=chatgpt.com>
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 - 9 NIWA 2024, Wildfire risk in New Zealand 1997 - 2023. <<https://environment.govt.nz/assets/publications/wildfire-risk-in-new-zealand-1997-2023.pdf>>
 - 10 Nick Wilson, Adele Broadbent, John Kerr 2023, Cyclone Gabrielle by the numbers - A review at six months <<https://knowledgeauckland.org.nz/publications/cyclone-gabrielle-by-the-numbers-a-review-at-six-months/>>
 - 11 Vector Limited. 2023. Managing the gas transition - options preserving solutions to manage consumer risks from gas asset stranding. <<https://blob-static.vector.co.nz/blob/vector/media/vector-2024/vector-2023-managing-the-gas-transition.pdf>>
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