energy market consulting associates

Ausgrid 2024 to 2029 Regulatory Proposal

REVIEW OF AUSGRID'S PROPOSED EXPENDITURE FOR CLIMATE-DRIVEN NETWORK RESILIENCE

Report prepared for:

AUSTRALIAN ENERGY REGULATOR

August 2023

Preface

This report has been prepared to assist the Australian Energy Regulator (AER) with its determination of the appropriate revenues to be allowed for the prescribed distribution services of Ausgrid from 1st July 2024 to 30th June 2029. The AER's determination is conducted in accordance with its responsibilities under the National Electricity Rules (NER).

This report covers a particular and limited scope as defined by the AER and should not be read as a comprehensive assessment of proposed expenditure that has been conducted making use of all available assessment methods nor all available inputs to the regulatory determination process. This report relies on information provided to EMCa by Ausgrid. EMCa disclaims liability for any errors or omissions, for the validity of information provided to EMCa by other parties, for the use of any information in this report by any party other than the AER and for the use of this report for any purpose other than the intended purpose. In particular, this report is not intended to be used to support business cases or business investment decisions nor is this report intended to be read as an interpretation of the application of the NER or other legal instruments.

EMCa's opinions in this report include considerations of materiality to the requirements of the AER and opinions stated or inferred in this report should be read in relation to this over-arching purpose.

Except where specifically noted, this report was prepared based on information provided to us prior to 16th June 2023 and any information provided subsequent to this time may not have been taken into account. Some numbers in this report may differ from those shown in Ausgrid's regulatory submission or other documents due to rounding.

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ABBREVIATIONS

Term	Definition
ABC	Aerial Bundled Conductor
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
BAU	Business-as-usual
BCR	Benefit to cost ratio
BoM	Bureau of Meteorology
CBA	Cost Benefit Analysis
CB's	Circuit Breakers
CCT	Covered Conductor Thick
CFI	Case for Investment
CoF	Consequence of failure
CPD	Conditional Probability of Decay
CSIRO	Commonwealth Scientific Industrial Research Organisation
DNSPs	Distribution Network Service Providers
DT	Dead-tank
EAC	Equivalent Annualised Cost
ECL	East Coast Low
ESCI	Electricity Sector Climate Information
GCMs	Global Climate Models
LGA	Local Governance Authority
NARCLiM	NSW and Australian Regional Climate Modelling
NEM	National Electricity Market
NER	National Electricity Rules
next RCP	2024-2029 regulatory control period
NPV	Net Present Value
NSP	Network Service Provider
NSW	New South Wales
PoF	Probability of failure
RCMs	Regional Climate Models
RCP	Regulatory control period
RCP	Representative Concentration Pathway
RIT-D	Regulatory Investment Test for Distribution

Term	Definition
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAPS	Stand-alone Power Systems
SCADA	Supervisory Control and Data Acquisition
SCW	Severe Convective Winds
STPIS	Service Target Performance Incentive Scheme
the Royal Commission	Royal Commission into National Natural Disaster Arrangements
VCR	Value of Customer Reliability
WALDO	Widespread and Long Duration Outages

1 INTRODUCTION

The AER has asked us to review and provide advice on Ausgrid's proposed allowance for climate change-related network resilience capital expenditure for the 2024-29 Regulatory Control Period (next RCP). Our review is based on information that Ausgrid provided and on aspects of the National Electricity Rules (NER) relevant to assessment of expenditure allowances.

1.1 Purpose of this report

1. The purpose of this report is to provide the AER with a technical review of aspects of the proposed climate-driven network resilience capex forecast included in the revenue proposal for Ausgrid for the 2024-29 regulatory control period (next RCP).

2. The assessment contained in this report is intended to assist the AER in its own analysis of the proposed capex allowance as an input to its Draft Determination on Ausgrid's revenue requirements for the next RCP.

1.2 Scope of requested work

3. The AER is seeking a technical review of aspects of the capex forecasts proposed to be included in each of the NSW DNSPs[1] distribution revenue allowance for the next RCP, and which was submitted to the AER in January 2023.[2]

4. The scope of this review will include advice to the AER on the investment cases and cost benefit analysis provided in support of the proposed capital expenditure for climate change driven network resilience, where the term network resilience is defined in the AER guidance note.[3]

5. In Figure 1.1 we provide the scope of services requested by the AER for Ausgrid.

Figure 1.1: Scope of services[4]

> ***A targeted review***
>
> *The consultant is required to undertake a targeted review on certain aspects of the Ausgrid's expenditure proposals. These proposals were submitted in January 2023. A targeted review is required on Ausgrid's capex and opex forecast for Climate/Network resilience.*
>
> ***Work requirements***
>
> *A(i) Climate/Network resilience*
>
> *To assist the AER in its assessment as to whether Ausgrid's forecast expenditure for climate/network resilience is prudent and efficient consistent with clause 6.5.7 of the NER, the consultant is required to provide advice to the AER on the investment*

[1] Ausgrid, Essential Energy and Endeavour Energy

[2] As described in the RFQ, AER order for services issued to EMCa and subsequent advice received by email clarifying the scope of works

[3] AER guidance note 2022, Network resilience – a note on key issues

[4] The scope of expenditure that we have been asked to review was updated following clarification from each DNSP, and is presented in section 3 of this report

cases and cost benefit analysis provided in support of this expenditure. In particular, the consultant must consider:

- *Whether Ausgrid has sufficiently demonstrated a causal relationship between the proposed expenditure and the expected increase in extreme weather events; and*
- *Whether the proposed expenditure is required to maintain service levels and is based on the option that likely achieves the greatest net benefit of the feasible options.*

The consultant is required to assess the projects/programs associated with the proposed expenditure of $194 million quoted in Ausgrid's proposal.

As part of the assessment, the consultant is also required to:

- *Identify any overlap with other proposed expenditure; and*
- *Flag any proposed expenditure associated with community resilience that would require further review.*

Other requirements

The consultant will be provided with all material Ausgrid has provided to the AER in support of their expenditure proposals. The consultant is to have regard to this information and any other information it has available to it in coming to its advice.

Separate face-to-face workshops with Ausgrid to deep dive into aspects of their proposals.

The consultant will set out its advice and findings in draft and final reports. This advice must be in sufficient detail to enable the AER to interpret and apply the NER.

The consultant is to provide its reasons in the report and provide any relevant workings to the AER.

The consultant is to engage with Ausgrid including any information requests, through the AER.

Source: AER Order for Services issued to EMCa (extract of items related to this report)

6. In discussions with the AER, the focus of the review is on the proposed capex forecast related to climate-change driven network resilience. The AER is not seeking us to form a view on the reasonableness of Ausgrid's overall capex forecast or, where proposed, for capex that it has proposed for network resilience that is not presented as being driven by climate change nor for climate change-related expenditure that is not to provide network resilience (such as for 'community resilience'). Where we refer to network resilience or climate resilience in this report, we do so with reference to this definition of our scope.

7. In preparing our findings, we are required to have regard to the AER's role under s.6 of the NER and the AER's forecast assessment guidelines.

1.3 Our review approach

1.3.1 Approach overview

8. In conducting this review, we first reviewed the regulatory proposal documents that Ausgrid had submitted to the AER. This includes a range of appendices and attachments to Ausgrid's regulatory proposal and certain Excel models, and which are relevant to our scope.

9. We next collated some information requests. AER combined these with information request topics from its own review and sent these to Ausgrid.

10. In conjunction with AER staff, our review team met with Ausgrid at its offices on 17 April 2023 including team members via teleconference. Ausgrid presented to our team on the scoped topics and we had the opportunity to engage with Ausgrid to consolidate our understanding of its proposal.

11. Ausgrid provided AER with responses to information requests and, where they added relevant information, these responses are referenced within this review.

12. We have subjected the findings presented in this report to our own peer review and QA processes and we presented summaries of our findings to AER prior to finalising this report.

13. The limited nature of our review does not extend to advising on all options and alternatives that may be reasonably considered by Ausgrid, or on all parts of the capex forecast. We have included additional observations in some areas that we trust may assist the AER with its own assessment.

1.3.2 Conformance with NER requirements

14. In undertaking our review, we have been cognisant of the relevant aspects of the NER under which the AER is required to make its determination.

Capex Objectives and Criteria

15. The most relevant aspects of the NER in this regard are the ‘capital expenditure criteria’ and the ‘capital expenditure objectives.’ Specifically, the AER must accept the Network Service Provider’s (NSP’s) capex proposal if it is satisfied that the capex proposal reasonably reflects the capital expenditure criteria, and these in turn reference the capital expenditure objectives.

16. We have taken particular note of the following aspects of the capex criteria and objectives:

- Drawing on the wording of the first and second capex criteria, our findings refer to efficient and prudent expenditure. We interpret this as encompassing the extent to which the need for a project or program has been prudently established and the extent to which the proposed solution can be considered to be an appropriately justified and efficient means for meeting that need;
- The capex criteria require that the forecast ‘*reasonably reflects’* the expenditure criteria and in the third criterion, we note the wording of a ‘*realistic expectation’* (emphasis added). In our review we have sought to allow for a margin as to what is considered reasonable and realistic, and we have formulated negative findings where we consider that a particular aspect is outside of those bounds;
- We note the wording ‘*meet or manage’* in the first capex objective (emphasis added), encompassing the need for the NSP to show that it has properly considered demand management and non-network options;
- We tend towards a strict interpretation of compliance (under the second capex objective), with the onus on the NSP to evidence specific compliance requirements rather than to infer them; and
- We note the word ‘*maintain’* in capex objectives 3 and 4 and, accordingly, we have sought evidence that the NSP has demonstrated that it has properly assessed the proposed expenditure as being required to reasonably maintain, as opposed to enhancing or diminishing, the aspects referred to in those objectives.

17. The NER’s capex criteria and capex objectives are reproduced below.

Figure 1.2: NER capital expenditure criteria

NER capital expenditure criteria

(c) The AER must:

*(1) subject to subparagraph (c)(2), accept the forecast of required capital expenditure of a Distribution Network Service Provider that is included in a building block proposal if the AER is satisfied that the total of the forecast capital expenditure for the regulatory control period reasonably reflects each of the following (**the capital expenditure criteria**):*

(i) the efficient costs of achieving the capital expenditure objectives;

(ii) the costs that a prudent operator would require to achieve the capital expenditure objectives; and

(iii) a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objectives.

Source: NER 6.5.7(c) Forecast capital expenditure, v200

Figure 1.3: NER capital expenditure objectives

NER capital expenditure objectives

*(a) A building block proposal must include the total forecast capital expenditure for the relevant regulatory control period which the Distribution Network Service Provider considers is required in order to achieve each of the following (**the capital expenditure objectives**):*

(1) meet or manage the expected demand for standard control services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;

(3) to the extent that there is no applicable regulatory obligation or requirement in relation to:

(i) the quality, reliability or security of supply of standard control services; or

(ii) the reliability or security of the distribution system through the supply of standard control services,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of standard control services; and

(iv) maintain the reliability and security of the distribution system through the supply of standard control services; and

(4) maintain the safety of the distribution system through the supply of standard control services.

Source: NER 6.5.7(a) Forecast capital expenditure, v200

1.3.3 Technical review

18. Our assessments comprise a technical review. While we are aware of consumer and stakeholder inputs on aspects of what Ausgrid has proposed, our technical assessment framework is based on engineering considerations and economics.

19. We have sought to assess Ausgrid's expenditure proposal based on Ausgrid's analysis and Ausgrid's own assessment of technical requirements and economics and the analysis that it has provided to support its proposal. Our findings are therefore based on this supporting information and, to the extent that Ausgrid may subsequently provide additional information or a varied proposal, our assessment may differ from the findings presented in the current report.

20. We have been provided with a range of reports, internal documents, responses to information requests and modelling in support of what Ausgrid has proposed and our assessment takes account of this range of information provided. To the extent that we found discrepancies in this information, our default position is to revert to Ausgrid's regulatory submission documents as provided on its submission date, as the 'source of record' in respect of what we have assessed.

1.4 About this report

1.4.1 Report structure

21. The following sections of our report are structured as follows:

- In section 2, we present relevant context to our review;
- In section 3, we present what Ausgrid has proposed for network resilience, as the basis for our assessment; and
- In section 4, we describe our assessment of Ausgrid's proposed capex allowance, and our findings on the prudency and efficiency of that allowance for network resilience.

22. In Appendix A, we provide a comparison of the key assumptions applied for the proposed network resilience expenditure for each of the NSW DNSPs that we have been asked to review.

23. We have taken as read the material and analysis that Ausgrid provided, and we have not sought to replicate this in our report except where we consider it to be directly relevant to our findings.

1.4.2 Information sources

24. We have examined relevant documents that Ausgrid has published and/or provided to AER in support of the areas of focus and projects that the AER has designated for review. This included further information at virtual meetings and further documents in response to our information requests. These documents are referenced directly where they are relevant to our findings.

25. Except where specifically noted, this report was prepared based on information provided by AER staff prior to 16 June 2023 and any information provided subsequent to this time may not have been taken into account.

26. Unless otherwise stated, documents that we reference in this report are Ausgrid documents comprising its regulatory proposal and including the various appendices and annexures to that proposal.

27. We also reference information responses, using the format IR#XX being the reference numbering applied by AER. Noting the wider scope of AER's determination, AER has provided us with IR documents that it considered to be relevant to our review.

Consideration of updated information provided by Ausgrid

28. During our assessment, we were requested by the AER to consider updated information to be provided by Ausgrid in early July 2023.

29. On 17 July 2023, EMCa received Ausgrid's response to the AER's information request IR048, which included an updated proposal for network resilience. In discussion with the AER, given the timing of the updated information, we were asked to determine if this updated information would alter the findings of our assessment.

30. We have included statements in our report that relate to information provided as a part of Ausgrid's IR048 response, that we consider represent material factors for consideration by the AER and whether these factors alter our assessment. These statements do not constitute a complete assessment of the new proposal from Ausgrid, or the entirety of the information provided within IR048.

1.4.3 Presentation of expenditure amounts

31. Expenditure is presented in this report in $2024 real terms, to be consistent with Ausgrid's regulatory proposal unless stated otherwise. In some cases, we have converted to this basis from information provided by the business in other terms.

32. While we have endeavoured to reconcile expenditure amounts presented in this report to source information, in some cases there may be discrepancies in source information provided to us and minor differences due to rounding. Any such discrepancies do not affect our findings.

2 RELEVANT CONTEXT

Our review is conducted in the context that climate change is a global issue with localised impacts. Recent extreme weather events and more broadly trends in a changing climate are being experienced in Australia and felt at a local level by communities. This is occurring against a backdrop of the energy transition.

For electricity networks, this creates a prima facie case for considering the need to build resilience and adaptation to climate change into the provision of their network services.

We have necessarily undertaken our review in accordance with the current planning and regulatory framework that applies to electricity networks. We also provide a summary of the AER guidance provided on climate resilience, and which we have taken into account as a part of our assessment.

In assessing the need and justification for expenditure to mitigate the impacts of climate change, there is a need to make use of available climate change models, and to be able to justifiably deduce from this the potential impacts on the relevant electricity network and the services it provides. It is then necessary to identify potential interventions that may mitigate the impact on network services and to assess to what extent such solutions might be justified, taking account of the timeframe over which such impacts are best addressed.

These models, and the information on the impact of a changing climate on which they rely, continues to mature. This raises the significant possibility of later regret, from overinvestment in the short term predicated on assumptions regarding uncertain long-term impacts that could potentially be addressed more effectively on a more progressive basis. In the face of such uncertainty, there is an option value to undertaking investment progressively and of being able to adapt risk mitigation responses as both the climate impacts on the network and the efficacy of particular intervention solutions, becomes better understood. We have therefore focussed our assessment on the extent to which the NSP has justified its proposed mitigation measures against its assessment of a projected increase in climate related risks to its network assets for expenditure in the next RCP.

Finally, we summarise the implications of the material factors we have identified in the assessment of the proposed capex for the categories of expenditure we have been asked to review.

2.1 Climate change and the regulatory landscape

33. In Australia, there have been a number of recent natural disaster events that had a significant negative impact to our communities and economy, disrupting lives, and threatening our environment – namely bushfires and floods. Weather patterns appear to be increasingly variable.

34. The commonwealth government has established a clear strategic response to climate change which includes the climate impacts, risks and challenges Australia faces, and what actions the Government is taking and is committed to taking. In addition to a set of policy

measures for emissions reduction, there are a range of climate change agencies responsible for adapting to climate change.[5]

35. As noted in Australia's first annual climate statement[6] published in 2022, Australia's national adaptation efforts are underpinned by nationally agreed roles and responsibilities, built on the foundation that risks are dealt with most effectively by empowering those who are best placed to manage them.

2.1.1 Australian climate trends

36. According to both the Bureau of Meteorology (BoM) and the Commonwealth Scientific Industrial Research Organisation (CSIRO) Australia will experience ongoing future climate changes.

37. It is widely acknowledged that weather has an impact on Australia's energy system. As the climate changes, this impact is likely to increase.

38. In response to emerging risks to the National Electricity Market (NEM), the Electricity Sector Climate Information (ESCI) project[7] was launched to improve climate and extreme weather information for the electricity sector. According to the government website,[8] the ESCI project provides information for the electricity sector on likely future climate change scenarios. This is described as being to assist the NEM in being more resilient to climate change and extreme weather events.

39. Specifically, the project has delivered climate and weather information to support electricity sector resilience to climate change and extreme weather events.

2.1.2 Impact to communities of natural disasters and extreme weather events

40. A number of inquiries have looked into responses to natural disaster events, such as the NSW Bushfire Inquiry and the Royal Commission into National Natural Disaster Arrangements (the Royal Commission). As noted by the AER in its guidance note, recommendations from these inquiries focus on actions to address future preparedness for, response to, and recovery from, natural disasters. These inquiries highlighted the importance of "community resilience"– the ability of communities to withstand and recover from the impacts of natural disasters – and the role that different entities need to play to support community resilience.

41. More recently, Resilience NSW and the National Recovery and Resilience Agency have also been set up to assist in supporting communities affected or likely to be affected by natural disasters.

42. In 2022, the electricity distribution businesses in NSW/ACT/TAS/NT commissioned a report titled NSW/ACT/TAS/NT Electricity Distributors, Network Resilience - 2022 Collaborative Paper on Network Resilience. The objective of this report was to understand how DNSPs can best support the communities served in adapting to a changing climate over the next 10 years and the increased community reliance on reliable electrical networks.

43. Community-led approaches to disaster preparedness is critical, adopting a collaborative approach to building resilience. The role of NSPs in supporting network resilience is a collaborative one, shared with government, critical infrastructure operators, individuals and communities who all play a role in supporting community resilience.[9]

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5 https://www.dcceew.gov.au/climate-change/strategies

6 https://www.dcceew.gov.au/sites/default/files/documents/annual-climate-change-statement-2022.pdf

7 The ESCI project is a collaboration between CSIRO, the Bureau of Meteorology and the Australian Energy Market Operator. The Department of Industry, Science, Energy and Resources provided funding for the project.

8 https://www.energy.gov.au/government-priorities/energy-security/electricity-sector-climate-information-esci-project

9 This was emphasised also in the Royal Commission into National Natural Disaster Arrangements, Final Report, 2020, p. 230.

2.1.3 Industry in transition

Network investments and the transition to renewables and storage

44. In addition to responding to the need to build greater resilience, the NEM is experiencing a significant transition away from reliance on thermal generation towards renewable generation and storage. This is supported by the Powering Australia Plan including reducing emissions by boosting renewable energy.

45. As a result, the location of these larger renewable energy sources is also shifting to be more geographically distributed and diverse. This will require a substantial investment in transmission infrastructure to enable connection of these new technologies and to facilitate benefits for consumers by way of a lower cost of electricity.

46. At the same time, there has been significant growth in distributed energy resources led by roof-top solar. Customers are now more engaged with their energy system, which is demanding different services in terms of their ability to supply, consume and trade energy. This has implications for investments in energy infrastructure, and digital applications and infrastructure to support changes in how the energy system is used.

47. Adaptation to climate change is a key driver of the energy transition. Not only will this result in investments in new technologies, but there is also likely to be an increasing level of investment required to build resilience of the energy system, to mitigate the negative impacts of changes to the climate on existing infrastructure.

48. We recognise the importance of the energy transition, the need to build resilience and adaptation to climate change and the role of all participants including the network service providers. We have necessarily undertaken our review in accordance with the current planning and regulatory framework. Nevertheless, to the extent that benefits are based on an assessment of a future energy systems, or a projection of a future climate scenario, it is necessary to consider the likelihood of continuing changes to technologies and also changes to the regulatory and planning framework that may affect justification for projects of this type.

Taking account of uncertainty

49. Given the factors described above, and the reality that network investments tend to be both capital-intensive and attract long technical / economic lives, it is particularly necessary to consider option value in assessing deep investments into the electricity network.

50. Considerations of option value and the timeframe over which benefits are adequately able to be modelled, can help to ensure that any network investment is prudent and efficient in accordance with the regulatory objectives. This in turn helps in meeting the objective of ensuring that consumers do not end up paying the risk costs of projects that are developed earlier than required or which become stranded or ‘regretted’ due to changes in the electricity market, energy system, climate and the technologies deployed there.

51. While we have considered the factors described above, we also caution that these matters are best assessed as part of a regulatory investment test for each investment. No inference from our assessment should be drawn on the need for or benefit of projects generally or their role in facilitating the transition to renewables or adaptation to climate change.

2.2 Relevant AER Guidelines

2.2.1 Network resilience guidance note

52. In April 2022, the AER released its guidance note on the key issues of network resilience.[10]

[10] AER guidance note 2022, Network resilience – a note on key issues. Accessed on 1 June 2023 at https://www.aer.gov.au/system/files/Network%20resilience%20-%20note%20on%20key%20issues.pdf

53. The AER has described the purpose of this guidance note to:[11]

'..support broader discussions around network resilience, the AER is publishing a note to assist Network Service Providers (NSPs), consumer groups and advocates understand how resilience-related funding would be treated under the NER.'

Defining network resilience and community resilience

54. The AER has defined network resilience as:[12]

'..a performance characteristic of a network and its supporting systems (e.g. emergency response processes, etc.). It is the network's ability to continue to adequately provide network services and recover those services when subjected to disruptive events.'

55. The AER has described the relationship between network resilience and community resilience as:[13]

'Network resilience has sometimes been used interchangeably with community resilience. These are different but related concepts. A resilient electricity network can assist in building community resilience. But many different entities have a role in supporting communities to withstand and recover from the impacts of natural disasters. Government bodies, individuals themselves and several critical infrastructure operators (beyond electricity networks) have a role to support community resilience.'

Assessment under the NER

56. In the guidance note, the AER states that it will have regard to the following factors when assessing any funding for network resilience:[14]

- future network needs may not be the same as they are today.
- there is uncertainty as to what the future network needs are.
- there is also uncertainty from other related areas like changes in demand and energy mix as well as technological advances.
- consumer and community preferences will be very important in our consideration.

57. The focus of network resilience is typically to improve service level outcomes that the network provides to consumers. One of the methods available to assess the benefits of proposed expenditure is by measuring the value customers place on reliable electricity. Others may extend to the value of safety and security of the network. In its guidance note, the AER acknowledges the limitations in the application of the Value of Customer Reliability (VCR) for Widespread and Long Duration Outages (WALDO) to accommodate longer unplanned outages with localised impacts.[15] The AER encourages NSPs to demonstrate consumer preferences for proposed resilience-related expenditure using other supporting evidence.

58. The AER nominated a framework for evidence to support resilience expenditure as being prudent and efficient to achieve the expenditure objectives, to demonstrate, within reason, that:[16]

1. there is a causal relationship between the proposed resilience expenditure and the expected increase in the extreme weather events.
2. the proposed expenditure is required to maintain service levels and is based on the option that likely achieves the greatest net benefit of the feasible options considered.

[11] AER guidance note 2022, Network resilience – a note on key issues, page 4

[12] AER guidance note 2022, Network resilience – a note on key issues, page 6

[13] AER guidance note 2022, Network resilience – a note on key issues, page 7

[14] AER guidance note 2022, Network resilience – a note on key issues, page 9

[15] AER guidance note 2022, Network resilience – a note on key issues, page 10

[16] AER guidance note 2022, Network resilience – a note on key issues, page 11

3. consumers have been fully informed of different resilience expenditure options, including the implications stemming from these options, and that they are supportive of the proposed expenditure.

2.3 Implications for our review

As consultants to the AER, our assessment reflects our scope of review including the AER's definition of network resilience

59. Resilience of an electricity network may extend beyond climate change or weather-related risks to also encompass system strength and under-frequency related risks and can also extend to business continuity and cyber security risks. However, the focus of our review aligns with our terms of reference, which ask us to focus on resilience to any increase in risks related to climate change.

60. Furthermore, resilience-related funding is considered to be accommodated by the NER even though it is not explicitly mentioned in the NER.

Climate change is a global issue with localised impacts

61. Our scope of review does not extend to review of the supporting evidence of the science behind climate change or climate change projections. However, to determine its network resilience response and propose network resilience expenditure we expect the NSP to have had regard to evidence of climate change and climate change projections and to have established a causal link between a projected increase in extreme weather events and its proposed expenditure. For this purpose, we have considered the evidence relied upon by the NSP.

62. Factors that determine future climate change include scenarios for future greenhouse gas (GHG) emissions. We have not reviewed, nor have we been requested to review, the methods and tools used to make projections of climate, impacts and risks, and their development by the Intergovernmental Panel on Climate Change (IPCC) of the UN. Global climate models (GCMs) and Earth System Models (ESMs) provide the large-scale picture of the climate and the climate change signal as well as interactions between the components of the global earth system. However, lower resolution models are required to determine resilience and adaptation options at a local level.

63. Regional climate models (RCMs) are climate models in spatially limited domains, and which are developed based on GCMs with enhanced grid resolution that allows for a more realistic regional climate response.

64. To understand the likely impacts of changes to the climate, as a result of increasing levels of greenhouse gases to the atmosphere, NSPs have made reference to the greenhouse gas concentration trajectory adopted by the IPCC referred to as Representative Concentration Pathways (RCP). RCPs represent the range of GHG emissions established by other studies. They include a stringent mitigation scenario (RCP2.6) which is generally considered a low scenario; two intermediate scenarios (RCP4.5 and RCP6.0), and one scenario with very high GHG emissions (RCP8.5).

65. The impacts identified by these models have the potential to profoundly affect the provision of network services and have direct impact to communities that these networks serve at a local level. In the past, the localised impacts of changes in climate have been linked to severe bushfires, storms and floods.

Recognising the uncertainty of available climate models

66. The future is inherently uncertain and these uncertainties are inherent in the available climate models, climate impact modelling and modelling of potential mitigation interventions that NSPs may adopt. Importantly, the available models provide future scenarios and are not a single-path prediction of the future.

67. In our review, we have sought to understand the steps taken by the NSP to take account of the uncertainties of the available models and model outputs and to explore system sensitivities and vulnerabilities, to identify appropriate low-regret resilience options and their timing to be tested against the requirements of the NER.

68. Accordingly, our review considers the extent to which the NSP has demonstrated that the proposed expenditure reflects prudent and efficient investment to prevent or mitigate risks and/or their consequence to the network, associated with adverse outcomes of extreme weather events for consumers.

Evolving nature of climate models and their projections

69. The methods and tools used to make projections of climate, impacts and associated risks are evolving rapidly. We expect that as the models improve, there can be greater confidence in the ability to more accurately understand the nature of impacts and the efficacy of risk mitigation options.

70. We understand that climate models are reasonably accurate at simulating temperature. However, our understanding is that the accuracy is much less for the simulation of rainfall and windstorm and becomes still less accurate the more granular the locality being considered. Recognition of current levels of uncertainty regarding specific impacts at a local level, and the likelihood of their improvement, speaks to the need to carefully consider option value and potential regret in assessments of proposed investments in the short to medium term, where these are predicated on assumed long-term impacts.

We have assessed the classification of network resilience as proposed by the NSP

71. In the guidance note, the AER acknowledges that:[17]

> *'..NSPs play an important role in the provision of essential services to communities in the leadup to, during and after a natural disaster. There are regulatory and statutory requirements that prescribe minimum service levels or standards to ensure continued supply and restoration of services following unplanned outages. It is important to note that the role of NSPs in supporting network resilience is a collaborative one with other responsible entities.'*

72. As noted in the guidance note, we have considered the delineation of roles that different entities may have in supporting network resilience as a part of our assessment of the proposed resilience capex, and its relationship with community resilience expenditure. Our scope of review does not extend to assessment of expenditure proposed for community resilience.

We have had regard to the assessment framework included in the guidance note

73. The guidance note includes reference to four factors to take account of as a part of the assessment of proposed network resilience funding. We have also taken account of the framework proposed by the AER in the guidance note for supporting evidence.

74. Our assessments comprise a technical review. While we are aware of consumer and stakeholder inputs on aspects of what Ausgrid has proposed, our technical assessment framework is based on engineering considerations and economics.

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[17] AER guidance note 2022, Network resilience – a note on key issues, page 14

3 WHAT AUSGRID HAS PROPOSED

Ausgrid has proposed climate-related resilience expenditure totalling $202 million (totex) over the next RCP. The proposed expenditure is almost entirely focused on proposed mitigation measures to address assumed increase in vegetation impacts from an assumed increase in major windstorm events. We have assessed this proposal.

On 17th July 2023, Ausgrid provided 'updated information' which effectively comprises a new proposal with total proposed expenditure of $176.5 million, of which $170.4 million is for network resilience.[18] We have sought to take relevant information from this update into account in our assessment of Ausgrid's regulatory proposal, where it appears to be relevant, but it is not possible given the stage of our assessment process to definitively assess Ausgrid's new proposal.

3.1 Overview

75. Ausgrid has proposed climate-related resilience expenditure for the next RCP of $202.0 million. Ausgrid has included components of expenditure for network resilience and community resilience and separated these into capex and opex.

76. The breakdown of forecast expenditure is shown in Table 3.1.

Table 3.1: Total climate-related resilience expenditure for next RCP by year ($m real 2024)

Expenditure	2024-25	2025-26	2026-27	2027-28	2028-29	Total RCP
Capex	25.2	38.7	48.4	42.6	38.7	193.6
Opex	1.1	1.7	2.1	1.9	1.7	8.4
Total	**26.3**	**40.4**	**50.5**	**44.4**	**40.4**	**202.0**

Source: Attachment 5.5 Climate resilience program, Figure 1

77. Ausgrid has proposed the opex expenditure as an opex step change, and which is for 'community resilience'. The proposed capex amount of $193.6 million is for 'network resilience' and this is the subject of our assessment.

78. Ausgrid has allocated the proposed network resilience expenditure to each of the RIN expenditure categories as

- repex $154.9 million (80%),
- augex $29.1 million (15%) and
- non-network other $9.7 million (5%).

79. We observe minor variances between the network resilience total of $193.6 million in the table above and the total of $195.0 million for network resilience submitted in the AER capex forecast model referred to in *Attachment 5.1.b: Capex model - FY25-29, Calc| Project Costs*. We do not consider that these variances are material to our assessment.

[18] As discussed in section 3.3, Ausgrid's updated proposal for climate resilience comprises $170.6 million capital expenditure and $5.9 million operating expenditure. Our review relates to the proposed network resilience capex only, totalling $170.4 million.

3.2 Breakdown of proposed projects

80. Ausgrid did not provide a breakdown of the proposed capex by project in its submission, stating that it will provide updated information to the AER for review in July.[19] Accordingly, we have reviewed the proposed expenditure in total, and not by project or proposed investment case.

Intention to resubmit its proposal[20]

81. At the time of our assessment, we had understood that Ausgrid was undertaking further engagement on the proposed resilience program, and this may result in changes to the proposed expenditure for the next regulatory period. *Attachment 5.5.a: Resilience implementation plan* indicates the timing of this.

82. We requested that Ausgrid advise what materials it intends to submit to the AER in July 2023, following its further consumer engagement. In response, Ausgrid stated that this would include[21] an updated business case for its 2024-29 resilience program, including a more granular breakdown of the proposed expenditure; and updated modelling based on customer feedback of prioritised resilience solutions. Ausgrid indicated that the updated modelling would likely focus on investments for three Local Government Areas (LGAs), rather than the entire network area comprising all LGAs as has been included in the CBA model submitted in response to our questions.

83. Due to the absence of detailed information to support the proposed expenditure provided by Ausgrid and changing nature of the composition of its proposed program, it was not possible to ascertain the nature of the final investments that Ausgrid may propose to undertake, or the benefits to the consumers of those investments.

Breakdown of expenditure is revealed from Ausgrid's economic model

84. In Ausgrid's economic model it is possible to ascertain a breakdown of proposed capex for its preferred option 5 as shown in the table below.

Table 3.2: Total network resilience capex by category for next RCP by year ($m real 2024)

Option	Assets treated	Solution	Total (lower bound)	Total (higher bound)
1	Overhead mains - LV	Replace with underground cable	-	-
2	Overhead mains - 11kV	Replace with underground cable	65.4	65.4
3	Overhead mains - LV	Replace with ABC	-	-
4	Overhead mains - 11kV	Replace with ABC/CCT	85.5	98.1
5	Overhead mains - 11kV	Segmentation	34.9	34.9
	Total		**185.8**	**198.4**

Source: CBA model provided by Ausgrid in response to IR010, Option 5

85. Ausgrid calculated a lower and upper bound estimate by modifying its value of benefit to cost ratio (BCR), to seek a target value of expenditure of $195.6 million. The primary difference appears related to the extent of ABC/CCT used in Central Coast LGA.

86. We observe minor variances between the network resilience target value of $195.6 million used in its economic model, and the total of $195.0 million for network resilience submitted in the AER capex forecast model referred to in Attachment 5.1.b: Capex model - FY25-29,

19 Ausgrid - IR010 - Climate Change Resilience - 20230414 – Public

20 Ausgrid subsequently provided an updated forecast, which we received on 17 July. We describe what was provided in section 3.3, and how we took this into account in section 4.4.2

21 Ausgrid - IR010 - Climate Change Resilience - 20230414 – Public, page 8

Calc| Project Costs. We do not consider that these variances are material to our assessment.

87. The expenditure included in the economic model comprised the identification of solutions for a total of 19 LGAs of the 33 LGAs assessed. The largest capex was associated with Central Coast (44%) and Northern Beaches (33%).

3.3 Updated information received on 17 July

88. On 17 July 2023, EMCa received Ausgrid's response to information request IR048, which included an updated proposal for climate resilience. The updated proposal included an updated business case for its 2024-29 resilience program, including a more granular breakdown of the proposed expenditure; and a description of the outputs of its updated modelling based on customer feedback of prioritised resilience solutions. This aligns with the advice we received from Ausgrid as detailed in section 3.2 above. However, Ausgrid did not provide an updated economic model to support its updated proposal.

89. Ausgrid has resubmitted its climate resilience proposal now totalling $176.5 million for the next RCP, comprising $170.6 million capex and $5.9 million opex.

90. Ausgrid did not specifically identify network and community resilience components. However, from its descriptions, we have identified network resilience as comprising its whole-of-network and local network solutions capex as shown in the table below, totalling $170.4 million capex for the next RCP. By deduction, there therefore appears to be an allowance of $0.2m for 'community resilience'. The opex it has proposed also appears to be a further allowance for community resilience, and which is not within our scope of review.

91. The revised network resilience capex for the next RCP that we have considered in our review is shown in Table 3.3.

Table 3.3: Total network resilience capex by category for next RCP by year ($m real 2024)

Capex by category	Local Government Area			Total RCP
	Central coast	Lake Macquarie	Port Stephens	
Whole of network solutions				**45.3**
Local Network solutions				
Network solutions to protect highly vegetated areas from East Coast Lows	29.0	23.4	-	52.5
Network solutions to reduce outage and time for the most customers	37.6	-	-	37.6
Network solutions to reduce outage time and frequency for most customers	-	16.1	10.5	26.6
Network solutions which target critical community services - CCT	-	-	3.0	3.0
Network solutions which target critical community services - Undergrounding	-	-	5.4	5.4
Total	**66.7**	**39.5**	**18.9**	**170.4**

Source: Ausgrid Climate Resilience Business Case 14 July 2023

92. The total proposed capex has been reduced from its initial assessment included in its regulatory proposal, both in total and for the network resilience capex component.

93. The total network resilience directed to local network solutions is proposed to be $125.1 million. The nature of the solutions proposed by Ausgrid are outlined in Table 3.4. Ausgrid has not provided a reconciliation between the local network solutions included in Table 3.3 and Table 3.4.

Table 3.4: Breakdown of local network solutions

	Number of 11 kV feeders identified for climate resilience expenditure consideration	CCT (km)	Reclosers (Number)	UG (m)
Central Coast	44	157	43	29,506
Lake Macquarie	71	186	71	5,468
Port Stephens	31	76	31	3,000

Source: Ausgrid Climate Resilience Business Case 14 July 2023, page 106

3.4 Summary of the basis for Ausgrid's proposed expenditure

94. As a new program for the next RCP, there is no separately identified expenditure for 'resilience' in the current RCP. Ausgrid recognises in its submission, and in discussions with the AER, that 'resilience' has been historically built into repex and augex, however the standards to which this has been achieved implicitly assumed no increasing negative impacts associated with climate change relative to historical levels.

95. Ausgrid has claimed adherence to the AER guidance note and we have reviewed these claims as a part of our assessment.

Identified need

96. Ausgrid has claimed that the projected change in climate reflects an increasing level of risk to supply interruptions to customers. Ausgrid states that the proposed program of work for the next RCP is aimed at mitigating the projected increase in climate-related risk compared with current levels, assessed as being at 2020 levels.

97. Ausgrid describe the 'lived experience' of customers across Australia, as having demonstrated an increase in the impact of climate-related events. Ausgrid specifically refers to major incidents in 2007, 2015, 2020 in the Ausgrid network area as evidence of this.

Forecasting of requirements

98. Ausgrid has undertaken a three-step process to understand the potential impacts of a changing climate,[22] and which we understand resulted in the development of several models:

- Climate model – Climate data is collected by Risk Frontiers and this data is used as inputs to its proprietary models to produce input data for catastrophic loss and climate parameters to the risk assessment.
- Climate/network impact model – the results of the climate risk impact assessment by KPMG of the climate futures on Ausgrid's network.
- Economic model – a CBA model used to support the climate resilience expenditure envelope by Ausgrid by calculating the costs and benefits of climate resilience investments at an LGA level.

99. Ausgrid has applied a weighting of three Representative Concentration Pathway (RCP) scenarios of 15%, 75%, 15% for RCP 2.6, 4.5 and 8.5 respectively, for the possible climate 'futures' that it has included in its modelling.

100. Based on this modelling, Ausgrid claims that the primary driver of its projected increase in climate-related risk is the increase in windstorms, and corresponding network impact of windstorms to loss of supply to customers and asset damage.

[22] Ausgrid - IR010 - Climate Change Resilience - 20230414 - Public

101. The economic model recommends a package of investments to address modelled increase in climate risk, where the maximum risk reduction can be achieved and the BCR >1.2. The proposed program is then adjusted to align with Ausgrid's research of customer preferences following customer support for investing to build greater climate resilience.

Proposed solutions

102. Ausgrid describes the package of solutions it has proposed as providing a focus on 'strengthening of the network' to address the increase in climate risk. The solutions are primarily aimed at the HV distribution network, where Ausgrid claims that 80-85% of climate related failures occur.

Consideration of updated proposal received 17 July

103. In its climate resilience business case Ausgrid has identified a combination of local network solutions and 'whole of network' solutions, that it claims will materially reduce the growth in risks, caused by climate change driven increases in the number and intensity of extreme weather events, to Ausgrid's network and its customers. The local network solutions have the greatest alignment with its original regulatory proposal, whereby they comprise increased segmentation, undergrounding and covered conductors.

4 REVIEW OF AUSGRID'S PROPOSED NETWORK RESILIENCE EXPENDITURE

We consider that Ausgrid has overstated the climate impact risk that it has assumed, which includes not adequately accounting for the uncertainties in its modelling assumptions and other factors relied upon in its economic modelling. This also appears evident in the 'calibration' undertaken by Ausgrid of the modelled network impacts that required on average a 69% reduction.

In determining mitigation options, we consider that Ausgrid has overstated the level of benefits that it could reasonably achieve by the proposed solutions. The effectiveness of the proposed solutions assumes an ability to target interventions to specific asset locations where increased windstorm impacts are predicted. Ausgrid does not provide evidence to support this crucial assumption and also has not adequately accounted for optionality or prudent timing.

Importantly, we note that the updated information provided by Ausgrid in July 2023 as a part of IR048 is based on a materially different program of works to that which was initially proposed in its regulatory proposal. Where possible, we have included statements in our report that relate to information provided as a part of Ausgrid's IR048 response. However, these statements do not constitute our assessment of this new proposal, or the entirety of the information provided within IR048.

Our assessment suggests that Ausgrid's proposed expenditure for network resilience does not reasonably satisfy the capex objectives of the NER and represents a considerable overstatement of prudent expenditure requirements.

4.1 Overview

104. We have reviewed the information provided by Ausgrid to support the proposed network resilience capex included in its climate resilience program, including its investment cases and relevant supporting information as outlined in section 3. Our focus is to assess the extent to which the forecast expenditure is likely to meet the NER criteria and the relevant AER guidance material.

105. In this section, we have considered:

- The investment need – to review the extent that Ausgrid has demonstrated a causal relationship between the proposed resilience expenditure and the expected increase in the extreme weather events, including the reasonableness of the assumptions of any risk modelling; and
- The economic modelling – to review (as relevant) the reasonableness of the approach taken by Ausgrid to model the benefits of the proposed program, including consideration of alternate options and option value.

106. We have included additional observations to assist the AER with its review, where issues we have identified may extend beyond the scope of our review and require further review by AER staff.

107. As requested by the AER, we have also considered the justification for specific investment cases included by Ausgrid.

4.2 Our assessment

4.2.1 Investment need

Ausgrid claims to be targeting increased risk from extreme weather events

108. Ausgrid describes its method[23] to forecast its climate resilience expenditure requirements to address increasing climate risk by first understanding the changing risk due to climate change from 2020 levels ('baseline') through a climate impact assessment.

109. Ausgrid describe the overall climate risk to the Ausgrid network as:[24]

> *'The climate risks that were modelled were extreme heat days, heatwaves, bushfire (frequency of fire weather days, not liability associated with a network fire start), windstorms (East Coast lows, rain, wind speed), riverine flooding and coastal inundation (and the precipitation associated). The areas of our network with the biggest exposure to extreme weather from climate change are:*
>
> *• the Upper Hunter - heatwave and bushfire*
>
> *• the East Coast – windstorms.'*

110. Ausgrid has developed its climate resilience program to target its assessment of the increase in risk, being an increase in the frequency and severity of climate related hazards as a result of climate change, based on an assessment of climate risk impact to its network.[25]

111. We looked at the degree to which Ausgrid was targeting a general increase in weather related events, or that the investment was targeting extreme weather events as suggested. Also, how whether Ausgrid had reasonably assessed the increase in risk.

Impact of climate change dominated by effects of windstorm modelling

112. The extreme weather events modelled were:[26]

- Extreme heat;
- Bushfire;
- Windstorms (primarily related to intense East Coast Low storms); and
- Riverine Flooding and Coastal Inundation.

113. The impact analysis was broken into three primary sets of results: asset failure rates, costs, and customer minutes without supply. Ausgrid state that the highest impact peril, across all of its modelled scenarios, was windstorms in terms of the value of unserved energy to customers.[27]

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[23] Ausgrid – Attachment 5.5 – Climate resilience program, page 31

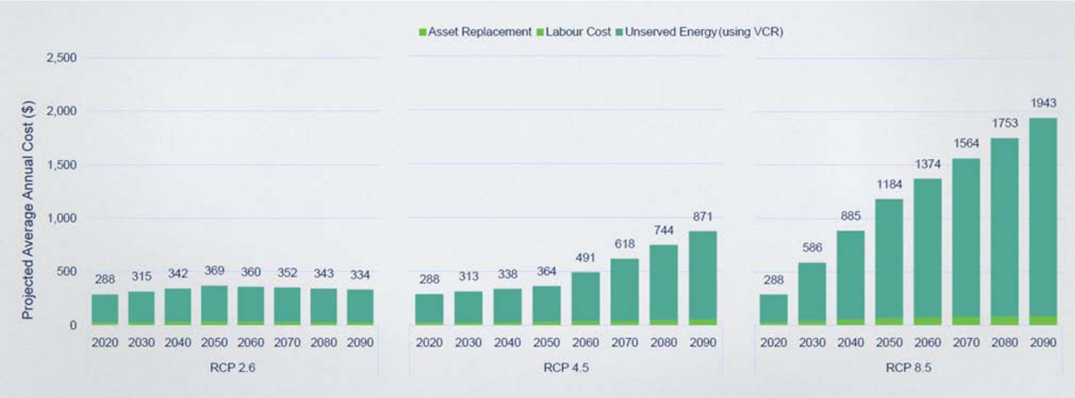
[24] Ausgrid - Attachment 5.5.b - Climate impact assessment - 31 Jan 2023, page 7

[25] Ausgrid – Attachment 5.5 – Climate resilience program, page 3

[26] Ausgrid - Attachment 5.5 - Climate resilience program - 31 Jan 2023 – Public, page 13

[27] Ausgrid - Attachment 5.5 - Climate resilience program - 31 Jan 2023 – Public, page 13

Figure 4.1: Projected average annual costs by scenario by cost type

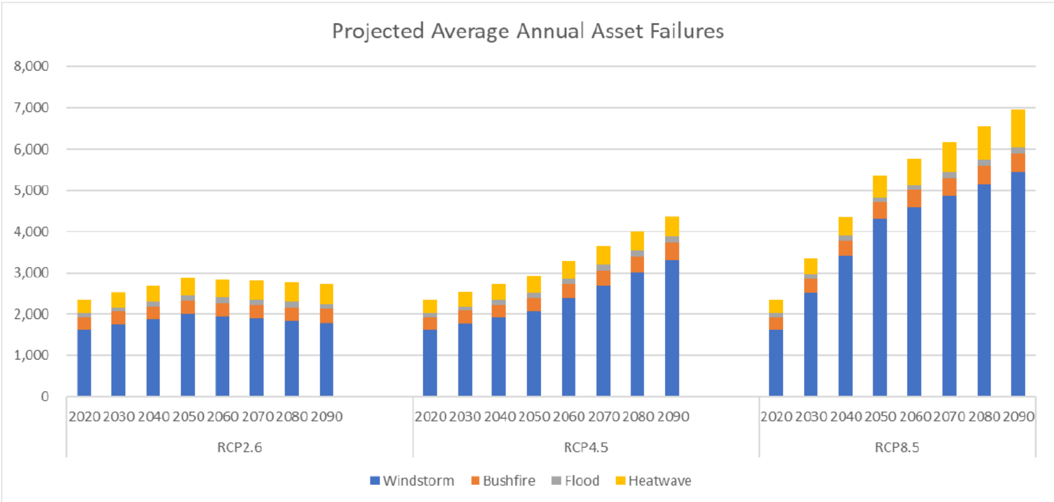


Source: Ausgrid presentation to AER and EMCa

114. It was noted that the most significant change in asset failures was driven by the windstorm peril, which can be observed by the increasing proportion of unserved energy in RCP4.5 and RCP8.5 in Figure 4.1.

115. This trend is also evident in the projections for asset failures as shown in Figure 4.2.

Figure 4.2: Ausgrid's predicted annual climate related asset failures by peril and RCP scenario



Source: Ausgrid – Attachment 5.5 – Climate resilience program – 31 Jan 2023 – Public, Figure 6

116. We asked Ausgrid to describe the nature of the historical windstorm events that have impacted Ausgrid's service areas and customers. In response, Ausgrid refer to a range of windstorm events most notable being extreme events occurring in 1974 (Sygna storm), 2007 (Pasha Bulka storm), 2015 and Feb 2020 storms. Ausgrid also claim that:[28]

> *'There have been dozens of other severe windstorms besides those listed above. They have typically led to between 50-100k customer losing supply for up to 4-6 days.'*

117. Ausgrid describe the criteria applied for determination of an adverse windstorm that leads to an asset failure as:[29]

> *'The climate modelling data provides forecast maximum sustained windspeeds which are converted to a 3s wind gust. This is the primary metric that determines asset failure in a*

28 Ausgrid - IR010 - Climate Change Resilience - 20230414 - Public

29 Ausgrid - IR010 - Climate Change Resilience - 20230414 - Public

windstorm, when combined with wind vulnerability curves of different pole types a probability of failure is produced for a range of pole types and wind speeds.'

118. In its climate risk assessment report provided with IR010, windspeed is defined as the:[30]

'..specific metric of concern within the storm hazard – as such we refer to the "windstorm" peril throughout the remainder of this document. For the Ausgrid network area, projects for 2050 under RCP 4.5 show ECL events increasing in frequency by ~23%, heavy rainfall days increasing by ~20% and maximum windspeed increasing by ~3%.'

119. We also noted that modelling of maximum windspeed did not indicate material changes over time. We found confirmation of this conclusion in Ausgrid's documentation that states:[31]

'Projections for maximum annual wind speed were calculated from the NARCliM1.5 ensemble of regional climate model simulations. Ensemble mean projections for maximum annual wind speed in 2050 under RCP4.5 show a small, non-significant increase of 3%. We attach medium level of confidence to the projection that there will not be a significant change in maximum annual windspeed. This is consistent with the ESCI (2021) report on extremes which assigned a low confidence to projections that there would be a significant trend in future windspeed extremes.'

120. We therefore looked for evidence to support the modelling of increases in windstorm related events, based on Ausgrid's projections of a high frequency of east coast low (ECL) events.

Ausgrid has not adequately accounted for uncertainty in climate models for wind speed and ECL events

121. We independently sought evidence to support the increase in ECLs. The impact of east coast lows was recognised in the ESCI review prepared for the Electricity sector. However, ESCI concluded that east coast lows are not increasing in frequency[32]

'East coast lows occur on average about 22 times per year. There is large year-to-year variability in the number, with no clear trend over recent decades. Climate models project fewer east coast lows. The projections show larger reductions for higher greenhouse gas emission scenarios. However, rising sea levels are likely to increase the impact of large waves on coastal regions, and extreme rainfall is predicted to increase in intensity resulting in increased risk of flooding. There are still considerable uncertainties in scientific understanding of how some east coast low characteristics may change, including the intensity of extreme wind and wave direction.'

122. Of the references cited, we reviewed Dowdy (2019)[33] which recognised the inconsistencies in data:

'Several studies have examined historical trends in ECL characteristics using observations and reanalysis products. The large interannual variability in ECL occurrence together with the temporal inconsistencies of the underlying data (e.g., changes in the type/amount of assimilated data in reanalyses) has made it difficult to clearly identify significant trends in the historical record.'

123. This publication further suggests that climatological changes in extreme winds are less certain in general for this region. Modelling included in this report shows a decline in the

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30 Ausgrid – IR010 – Climate risk assessment – CONFIDENTIAL

31 Ausgrid – IR010 – Climate risk assessment – CONFIDENTIAL, page 32

32 https://www.climatechangeinaustralia.gov.au/media/ccia/2.2/cms_page_media/785/ESCI_User_Guide_Pt4b_Step_3_2.pdf

33 Dowdy (2019), Review of Australian east coast low pressure systems and associated extremes, accessed at https://nespclimate.com.au/wp-content/uploads/2019/05/2.2-Review-of-Australian-east-coast-low-pressure-systems-pre-print.pdf

number of ECL days per year, using a range of models. However, the mechanisms behind projected future changes in wind extremes associated with ECLs remain to be investigated.

124. The following summary concludes that the impact of extreme windspeeds arising from ECL events remain uncertain:[34]

> *'Table 1 provides a summary of the information presented in Section 6 on long-term trends and projected future changes. This includes details on the influence of climate change on the occurrence of ECLs as well as on their associated weather and ocean extremes.'*

125. We have reproduced the Table 1 referred to in this quote from Ausgrid, in Table 4.1.

Table 4.1: Summary of climate change influences on ECLs and their associated extremes

Climate change influences on ECLs and associated weather and ocean extremes	
ECL occurrence frequency	Fewer ECLs likely due to increasing greenhouse gas emissions, primarily due to fewer ECLs during the cooler months, with larger uncertainties around ECL numbers during the warmer months.
ECL intensity and duration	Intensity changes are largely uncertain based on current knowledge, as are changes in associated extreme wind speeds.
ECL-related rainfall	Fewer events, particularly during winter, but with increased rainfall intensity in some cases (estimated at ~7% per degree of warming for heavy daily rainfall and ~15% per degree of warming for short duration extremes), corresponding to increased flood risk factors.
ECL-related convective hazards	Convective rainfall extremes likely to have large increases but larger uncertainties for future convective wind extremes and lightning activity associated with ECLs.
ECL-related waves	Fewer large wave events are likely in the future, particularly during winter, while noting uncertainties around the intensity of extreme wave events (given uncertainties around projections of ECL intensity).
ECL-related coastal hazards	Sea levels will continue to rise, thereby increasing risks from ECLs associated with storm surge, coastal flooding and erosion (while noting uncertainties around changes in wave direction).

Source: Dowdy (2019), Review of Australian east coast low pressure systems and associated extremes

126. We also found other related evidence, including:

- In relation to severe convective winds (SCWs) cited by the ESCI project as peer reviewed papers.[35] These studies amongst others, highlight the current variability of climate projections based on reanalysis of historical events.
- The state of the climate 2022[36] stated that they expect fewer east coast lows on average, particularly during the cooler months of the year.
- Similar projections of fewer ECLs based on two references cited in the NSW climate extremes baseline assessment[37] published by the NSW Department of planning, industry and environment.

127. Windstorm events such as ECLs occur frequently along the east coast of Australia. However, we have not found sufficient evidence that supports Ausgrid's contention that

[34] Dowdy (2019), Review of Australian east coast low pressure systems and associated extremes, accessed at https://nespclimate.com.au/wp-content/uploads/2019/05/2.2-Review-of-Australian-east-coast-low-pressure-systems-pre-print.pdf

[35] https://www.climatechangeinaustralia.gov.au/en/projects/esci/esci-publications/esci-peer-reviewed-papers/

[36] http://www.bom.gov.au/state-of-the-climate/2022/documents/2022-state-of-the-climate-web.pdf

[37] https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-06/NSW%20Climate%20Extremes%20Baseline%20Assessment%20Full%20Report.PDF

these events will increase in frequency to the level that Ausgrid has proposed, or that the modelling is sufficiently robust to predict the associated damage to the levels proposed by Ausgrid.

128. This is further supported by adjustments to windstorm modelling undertaking by other NSW DNSPs, including in one instance excluding wind speed as a driver of its proposed network resilience expenditure, as summarised in Appendix A.

Highest impact of the windstorm climate peril is related to vegetation

129. In its climate assessment report, Ausgrid claim that 87% of asset failures within the windstorm peril are related to failing vegetation:[38]

> *'..based on assessment of Ausgrid data, the model assumes that approximately 87% of asset failures within the windstorm peril are related to falling vegetation. Where this is modelled to occur the vulnerability of a pole is modelled to be directly linked to a vegetation failure rate. The vulnerability of each pole is assumed to be the same as a 50-year-old wooden pole6 (i.e. each pole is assumed to be damaged as often as the most vulnerable class of poles), adjusted to account for the density of vegetation (measured by the Normalised Difference Vegetation Index, or NDVI) in the suburb of the pole (i.e. lower vegetation density reduces the likelihood of pole failure due to vegetation).'*

130. We have not been able to ascertain from Ausgrid's documentation how the vulnerability of a pole is modelled to be directly linked to a vegetation failure rate.

131. Vegetation related damage is difficult to predict as it is not confined to vegetation within or close to the protected zone around the electricity network infrastructure, and specifically overhead lines. Also, failure of vegetation (that leads to equipment damage) may occur at lower windspeeds than the electricity network infrastructure is designed to withstand.

132. A key question is the extent to which vegetation related damage to the electricity network infrastructure can or should be protected against. At its extreme this would drive retrospective undergrounding of large parts of the infrastructure across the country, which is clearly uneconomic.

133. We assessed the historical data provided by Ausgrid to confirm the impact of vegetation. We were not able to replicate the 87% impact by vegetation claimed by Ausgrid. We determined the ratios in Table 4.2, which vary between 36% and 52% and are much lower than Ausgrid's assumption.

Table 4.2: Historical outages for HV network 2011-2022

Criteria	Units	Total	Vegetation related	Percent Vegetation related
Incidents: All	Number	20,442	7,591	37%
Incidents: Weather MED only	Number	1,526	797	52%
Incidents: Climate event only	Number	4,221	2,174	52%
CMI (per year): All	Number	204,836,613	76,715,221	37%
CMI (per year): Climate event only	Number	130,979,129	57,855,427	44%
VoUSE (per year): All	Dollars	122,123,848	44,143,110	36%
VoUSE (per year): Climate event only	Dollars	76,617,919	33,001,958	43%

Source: EMCa analysis of historical outages from CBA model (AGD outages sheet)

38 Ausgrid – IR010 – Climate risk assessment report – 20230421 - CONFIDENTIAL, page 14

Asset vulnerability assumptions appear overly conservative

134. Ausgrid describes its calibration of windspeed to historical events including:[39]

'We worked with KPMG to calibrate climate risks to historical events in our service area. This included calibrating gusts of 3 seconds and 135km/h recorded in the Pasha Bulker storm of 2007 to align with the 1 in 20-year return period. Wind gusts reaching 165km/h which were recorded in the Sygna storm of 1974 were also calibrated to align with the 1 in 50-year return period (see Section 7.2 of the report submitted in response to Question 4a). This calibration step is explained in further detail within Ausgrid - IR010 – Ausgrid – Climate Risk Assessment Report – 20230421 – PUBLIC.'

135. The AS/NZS7000 recommended design return period for a typical distribution line (with security level I) and a design life of 50 years is 50 years.[40] This suggests that the probability of exceeding the minimum design wind pressures (or windspeed) is therefore 2%. This is not the same as the probability of failure of the structure, as the probability would need to consider the loss of strength of the pole material. At the time of construction, there should be no loss of strength.

136. The basis of Ausgrid's assumptions to calibrate at what appears to be a lower standard than its construction requirements has not been explained.

137. We therefore looked at how Ausgrid has assessed the probability of failure of assets failing when subjected to its climate risks, such as the windstorm perils. Ausgrid describes this as using its vulnerability curves:[41]

'The number of asset failures in extreme wind events was initially calculated using vulnerability curves (which relate windspeed to pole failure probability) that were derived from international data. These vulnerability curves resulted in forecast failures at windspeeds that were higher than Ausgrid has observed in past events. To account for this the vulnerability curves were adjusted to produce lower failure rates, in line with previous experiences. This adjustment is described in the 'Wind Failure Rates' section of Ausgrid - IR010 – Ausgrid – Climate Risk Assessment Report – 20230421 – Confidential. In addition to reducing the modelled climate risks, Ausgrid further lowered the unserved energy baseline for Windstorms to align the baseline to historical average annual unserved energy from climate events (see response to 4b).'

138. In IR010, Ausgrid describes the windstorm failure rates were sourced from literature review. Ausgrid states that the most material assumption within this category is the windstorm failure rate for poles. We therefore sought to verify this assessment, given it applies to over 445,000 poles.

139. Design wind pressures for a typical line indicate a minimum design windspeed of approximately 140km/h.[42] Based on Ausgrid's vulnerability assumptions, a pole subject to windspeeds of approximately 140km/h (corresponding to the minimum design windspeed of the current design standard) have a 80% probability of failure. We consider this is overly conservative.

140. In its Climate Risk Assessment Report,[43] Ausgrid refers to determination of the probability of failure of its 'older' wood poles based on a literature review and cites a particular study.[44] We have reviewed this study, and consider that based on Ausgrid's representation of its vulnerability curve it has likely applied its conversion factor incorrectly when converting windspeed from m/s to km/h.

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39 Ausgrid - IR010 - Climate Change Resilience - 20230414 - Public

40 AS/NZS7000 Table 6.1, Page 60

41 Ausgrid - IR010 - Climate Change Resilience - 20230414 - Public

42 based on region A3, terrain category 2 and 10m pole height

43 Ausgrid - IR010 – Ausgrid – Climate Risk Assessment Report – 20230421 – Confidential

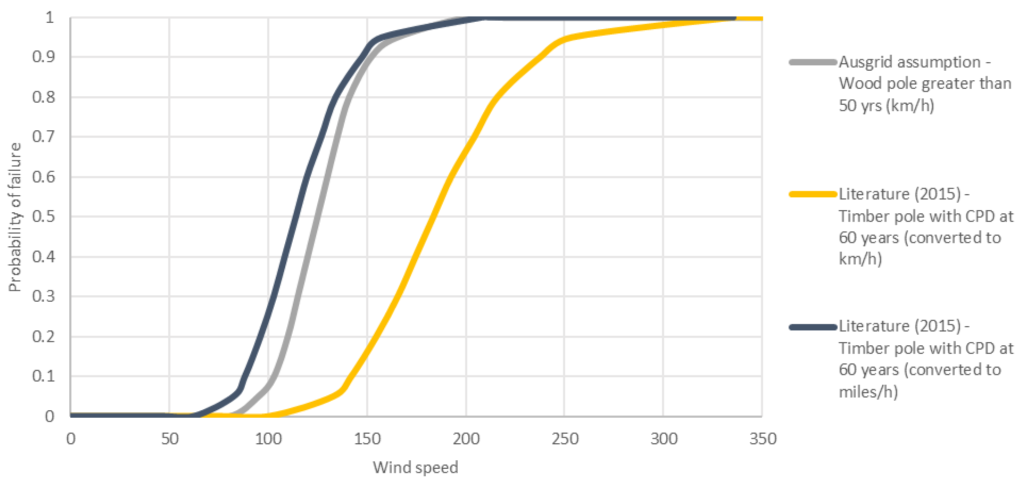
44 Age-dependent fragility and life-cycle cost analysis of wood and steel power distribution poles subjected to hurricanes, Abdullahi M. Salman, Yue Li, Structure and Infrastructure Engineering 12 (8), 2015.

141. We note that a similar probability of failure versus windspeed chart for timber poles was produced by Ausgrid. On closer examination of the version of the chart produced by Ausgrid, the windspeed curves follow a similar characteristic shape, based on a sample of results comparing the Wood_GT50 curve (for wood poles greater than 50 years old), and Timber with CPD curve for wood poles at 60 years (see figure 3.9), where CPD refers to conditional probability of decay (CPD). We did not make any adjustment for construction type or timber species. However, the x-axis used in the study is based on windspeeds of miles per hour, and there does not appear to have been a correction to the scale for Ausgrid's version expressed in km per hour.

142. We provide a representation of the data from both sources in Figure 4.3 below. In this figure we show:

- Ausgrid's probability of failure for a wood pole greater than 50 years, versus windspeed expressed in km/h (grey curve)
- Original source for probability of failure for a wood pole with TPD at 60 years, versus windspeed converted to miles/h from metres per second (blue curve)
- Original source for probability of failure for a wood pole with TPD at 60 years, versus windspeed converted to km/h from metres per second (orange curve)

Figure 4.3: Approximation of the probability of failure curves for wood pole by wind speed



Source: EMCa analysis based on information provided by Ausgrid in IR010

143. We observe that the vulnerability curve assumed by Ausgrid approximates that provided in the literature when converted to miles per hour.[45] We anticipate that the curve was also likely adjusted for poles at age 50, rather than 60 (and which likely shifts the lower end of the curve to the right). However, is more conservative than the curve when correctly converted to km/h. In our comparison, we did not make any adjustment for construction type, age or timber species from the material cited by Ausgrid.

144. We observe that for a range of windspeeds the approximate probability of failure for pole assets assumed by Ausgrid corresponds with the values in Table 4.3 below.

[45] We observed a similar relationship to the vulnerability curves included in the 2014 version of this paper, which expressed the probability of failure of wood poles against wind speeds in units of miles per hour.

Table 4.3: Probability of failure for Wood pole greater than 50 years old

Speed (km/h)	Equivalent speed (mph)	Probability of failure (Wood_GT50)
60	38	0%
90	56	3%
135 (Pasha Bulker storm, 2007)	84	70%
165 (Sygna storm, 1974)	103	95%

Source: EMCa analysis of information provided by Ausgrid in IR010

145. This suggests to us that Ausgrid has assumed a very high probability of failure of its pole assets, at wind speeds approximating that included for the minimum design of overhead lines. Where this has been applied, the assumptions are very conservative.

146. This appears to align with Ausgrid's own statements that:[46]

> *'Wooden poles older than 50 years present a significant asset risk to Ausgrid. Once 3s windgusts reach 135km/h, which was recorded in the Pasha Bulker storm of 2007 and has been calibrated to align with the 1 in 20-year return period, it can be seen in figure 11 that wooden poles older than 50 years would have had a 70% failure rate, while concrete poles would have had less than 5% failure rate. Once 3s windgusts reach 165km/h, which was recorded in the Sygna Storm of 1974 and has been calibrated to align with the current 1 in 50-year return period, there is over a 90% modelled probability of failure'*

147. Ausgrid states that its failure rates were calibrated based on average costs, the 2015 cost pass through, which exhibited 135km/h windgusts, and consultation with external consultants (KPMG and Risk Frontiers) and Ausgrid engineering staff. We remain concerned that extrapolating this level of asset failure across the network, is likely to overstate the number of failures.

148. According to the BOM, a thunderstorm is defined as producing damaging or destructive wind gusts (generally wind gusts exceeding 90 km/h).[47] Also, using the 40% rule of thumb,[48] this would imply average[49] wind speeds in the order of 64km/h to around 75km/h at which trees may lose branches. This aligns with the Beaufort wind scale.[50]

149. Based on our reading of the case study materials presented in Ausgrid - IR010 – Ausgrid – Climate Risk Assessment Report – 20230421 – Confidential, Ausgrid appears to have placed significant weight on the impact to overheads assets for windstorms defined as having windspeeds greater than 75km/h.

150. Ausgrid states that:[51]

> *'In addition to 135km/h, a 75km/h threshold was added for windstorm to show the occurrence of the low range of wind gust that could damage assets.'*

151. In its analysis, Ausgrid commented on the reduction to the return periods of 75km/h wind gusts of projections compared with the baseline climate scenario.

152. To demonstrate how Ausgrid appears to have applied this in its modelling, we reviewed the case studies referred to as the northern beaches area in the climate impact assessment

[46] Ausgrid – IR010 – Climate Risk Assessment Report – 202304021 – CONFIDENTIAL, page 66

[47] http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/WarningsInformation_SW_STSW.shtml

[48] http://www.bom.gov.au/marine/knowledge-centre/reference/wind.shtml

[49] Wind speeds are given as the equivalent speed, averaged over 10 minutes at a standard height of 10 metres above open flat ground

[50] http://www.bom.gov.au/info/wwords/

[51] Ausgrid - IR010 – Ausgrid – Climate Risk Assessment Report – 20230421 – CONFIDENTIAL

report. We selected the northern beaches area as we considered this area would provide a reasonable example of a part of Ausgrid's network located close to the coast, with potential exposure to ECL events.[52] Ausgrid describes the change in return period within Frenchs Forest[53] of >75km/h wind gusts (for the windstorm peril) from 6 in 2020 to 4 by 2050 under RCP 4.5, representing a reduction over this period.[54] In its description Ausgrid does not show any change in return periods for the windstorm peril described as >135km/h. However, Ausgrid describes the windstorm risk as being highly material for Frenchs Forest. Similar trends exist for other case study areas. We conclude from the information provided by Ausgrid that the claimed increase in risk from windstorms is more likely related to lower wind speed conditions.

153. Ausgrid has not explained the selection of the nominated windspeeds for its modelling, or whether any further moderation factors have been applied. Ausgrid also refers to the 75km/h threshold as the 'ESCI max sustained windspeed' in its documentation.[55] However, this is not explained. At the low range windspeed, given the average speed is approximately 40% lower than a short duration gust, Ausgrid has not demonstrated that vegetation is likely to cause damage to electricity infrastructure.

154. We understand that Ausgrid has further classified conductor failures being failures due to leaning assets and conductor clashes, separately from asset failures, defined as failures due to falling assets. It is not clear to us, how the model arrives at these separate figures.

155. Ausgrid identifies that the results are sensitive to its pole vulnerability assumptions, including to relatively small changes in the underlying modelled windspeeds. However, Ausgrid has not provided its sensitivity analysis or detailed how it has adequately accounted for the impact of varying its input assumptions.

Inadequate considerations of alternative risk mitigation methods

156. As a part of good asset management and vegetation management, NSPs have plans in place for management of vegetation and specifically its impact on electricity infrastructure to minimise interruptions to customers. We would expect that these measures are similarly deployed for, and in anticipation of, extreme weather events (where possible). These include vegetation clearing,[56] hazard tree removal, tree planting guides as well as methods to mitigate the impact of vegetation contact on overhead lines.

157. We asked Ausgrid to provide details of its consideration of other options to manage the risk of vegetation related risks, however none were provided.

158. We note that Ausgrid had included the requirement that all resilience solutions should be considered against criteria in its Climate resilience framework. We also note more extensive consideration of options in Section 9 and 10 of climate risk assessment report. However, we have not seen sufficient evidence of how Ausgrid has considered these in its proposed expenditure forecast.

Resolution of projections for east coast low events is coarse

159. Ausgrid states that variables for projections of east coast lows, winds, extreme heat and a suite of variables required for bushfire modelling are sourced from NSW and Australian Regional Climate Modelling (NARCLiM) 1.5 as they are not part of the ESCI climate projections. We understand that NARCLiM 1.5 climate projections were released in 2020, and are provided on a 10km grid cell resolutions across south-eastern Australia and 50km grid cell resolution across the whole of Australia. This contrasts with other references that refer to downscaling from General Circulation Models (GCMs) which cover the whole world,

[52] Northern Beaches Council has five wards – Pittwater, Narrabeen, Frenchs Forest, Curl Curl and Manly

[53] Ausgrid - IR010 – Ausgrid – Climate Risk Assessment Report – 20230421 – CONFIDENTIAL, Table 23

[54] Ausgrid - IR010 – Climate Risk Assessment Report – 20230421 – CONFIDENTIAL

[55] Ausgrid – IR010 – Climate Risk Assessment Report – 20230421 – CONFIDENTIAL, Figure 11

[56] Including compliance to the minimum standard for the management of vegetation in the vicinity of electricity supply infrastructure in NSW

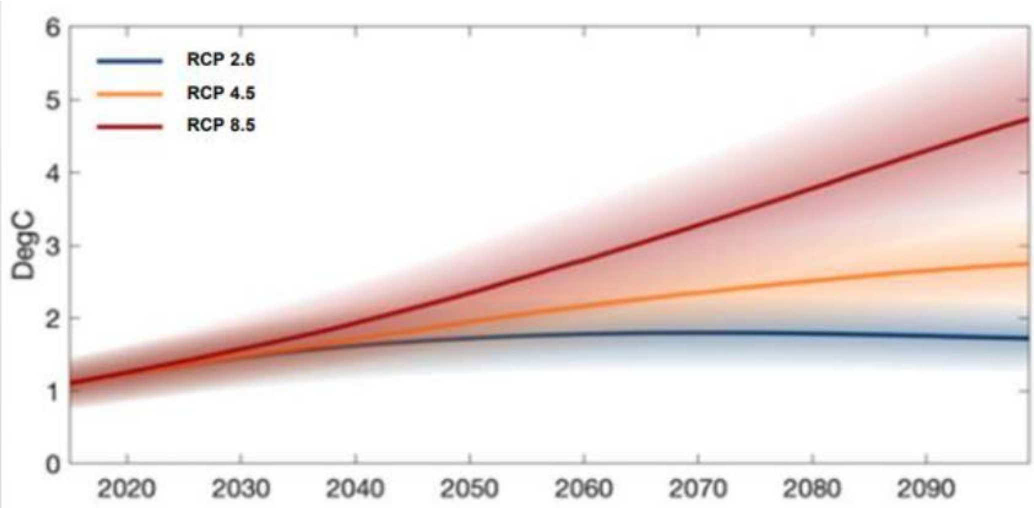
and which are downscaled to 50km grids into Regional Climate Models (RCMs), and vegetation data using similar resolutions.

160. Despite Ausgrid's claims that this dataset provides high resolution climate change projections, we remain concerned that the resolution is too coarse to be used to project asset failures as an input to forecasting of future risk, asset replacement volumes and expenditure requirements for infrastructure with the level of precision implied by Ausgrid, such as to a specific feeders and feeder section.

Inclusion of RCP 8.5 results in upward bias

161. Ausgrid has considered the three most accepted climate projection scenarios as shown in Figure 4.4 below. RCP 4 5 is considered the 'most likely' of these three scenarios, where RCP 2 6 is generally considered unachievable based on global responses to date.

Figure 4.4: Multiple climate future scenarios



Source: Ausgrid – Attachment 5.5 – Climate resilience program – 31 Jan 2023, Figure 4

162. Ausgrid has included a weighting for its RCP scenarios of 15% for RCP2.6, 70% for RCP4.5 and 15% for RCP8.5 based off Ausgrid's discussions with expert climate scientists and Ausgrid's risk tolerance as a critical infrastructure provider.

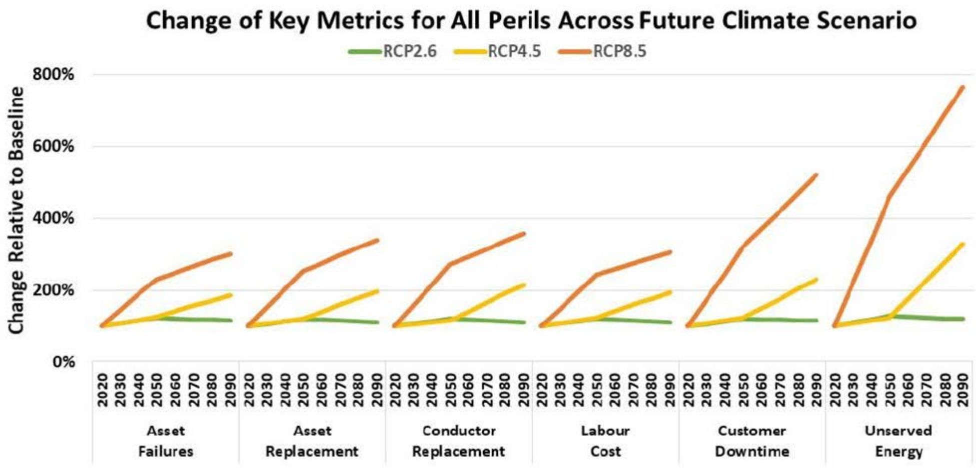
163. In its supporting information, Ausgrid has attached advice from Risk Frontiers that recommends removal of any weighting on RCP2.6, and a higher weighting of 75% for RCP 4.5 on the basis of what has been historically demonstrated by society. In its advice, the author states that there is high uncertainty around the timing and magnitude of thresholds, tipping points and non-linear responses within the climate system.[57]

164. We observe that inclusion of the RCP8.5 scenario adds an upward bias to the calculation of risk cost. For the windstorm related risk, the risk is similar for RCP2.6 and RCP4.5 (relatively flat) then shows an accelerated pace of change beyond 2050 for RCP4.5. For RCP8.5, there is accelerated pace immediately beyond the baseline.

165. This is evident in Figure 4.5 which clearly shows the change relative to the baseline across each of the key metrics modelled. The change relative to the baseline for RCP 8.5, corresponding with the highest warming, results in the highest and earliest increase across each metric.

[57] Ausgrid - Risk Frontier - Att. 5.5.f - Risk Frontiers letter for climate impact assessment work

Figure 4.5: Change of key metrics for all perils across future climate scenarios



Source: Ausgrid IR010 – Climate Impact assessment, Figure 1e

4.2.2 Economic analysis

Top-down modelling

The results of Ausgrid's top-down assessment result in a level of expenditure that exceeds the identified risk cost in the next RCP

166. Ausgrid states that resilience related expenditure should be based on a different top-down test of its portfolio than it applies for other expenditure:[58]

> *'The top-down tests applied to reliability-focused investments are not good metrics when applied to resilience because reliability investments aim to maintain average levels of network performance in normal operating conditions, while resilience relates to a network's ability to absorb and recover from extreme events.'*

167. It is consistent with the requirements of the AER guidance note that resilience expenditure, should be directed to extreme weather events that have a large impact to consumers.

168. From Ausgrid's documentation[59] we understand that it had determined from modelling that proactive spend of around $40 million per annum could be justified based on its historical experiences in recent years where ECL events occurred in 2015 and 2020.

169. In response to our questions to explain how the estimate of $40 million per annum expenditure was determined, Ausgrid stated that:[60]

> *'This was informed through early iterations of our climate risk forecasts that indicated that climate risk was increasing at approximately 1% p.a. These early models suggested that the net present value of this growing risk to 2050 was approximately equivalent to $50m p.a. in capital expenditure.*
>
> *Recognising that when making a change to our investment mix in responding to an emerging risk, it is prudent to respond with a considered approach, and we adjusted this initial amount down, applying the equivalent of our higher investment threshold test for climate resilience investment to arrive at an indicative figure of $40m p.a. This value*

58 Ausgrid - Attachment 5.1 Proposed capital expenditure, page 16

59 Ausgrid - Attachment 5.5 – Climate resilience program, page 32

60 Ausgrid – IR010 – Climate risk assessment – CONFIDENTIAL, page 2

was used to inform our early engagement on the topic while refinements were being made to our underlying climate modelling.

Our current climate modelling supports investment of up to $319m in the 2024-29 period (or c.$63m p.a.) to address growth in our climate risks. This figure assumes that in aggregate, all growth in climate risk can be mitigated cost effectively, and by way of sustained capital investment from 2025 to 2050.'

170. We found reference to the value of $319 million in Ausgrid's draft economic model used for its option 2. Ausgrid describes this option to mitigate the annual risk growth in the next five regulatory periods to 2050 with equal economic investments in each period of $319.0 million per period.

171. Ausgrid also included an estimate of the increase in the direct costs and indirect costs of climate risk in Table 1d and Table 1e of IR010 climate risk assessment report. These are reproduced in Table 4.4.[61]

Table 4.4: Current and projected annual risk-costs, derived from Ausgrid climate impact model ($ millions)

	2020 baseline (pa)	2050 projection (pa)	Average annual increase in risk cost
Direct cost	42	51	0.3
Indirect cost	227	281	1.8
Total cost	**269**	**332**	**2.1**[62]

Source: EMCa analysis of information provided by Ausgrid in IR010

172. Based on the above information, Ausgrid's assessment of the risk cost at the end of any 5-year period, assuming a linear relationship, would be $10.5 million higher than at the commencement of the 5-year period.[63] From this, we derive that the aggregate increase in risk-cost that Ausgrid's modelling derives over a 5-year period, would equate to $31.5 million.[64]

173. The value of $10.5 million calculated above closely approximates the value of risk cost included in Ausgrid's economic model of $11.1 million, [65] for Ausgrid's option 5 if we were to assume 100% weighting of RCP 4.5. For Ausgrid's modelling purposes, the difference in risk-cost between 2050 and 2020 is applied. Ausgrid describes this in its model as the target risk reduction over 5 years, whereas from above, it more accurately represents the annual increase in risk ***after*** 5 years.

174. If the basis of the derivation of increased risk-cost that Ausgrid has proposed was accepted, then a value of $31.5 million over the RCP would represent the aggregate increase in risk-cost to be mitigated over any given 5-year RCP, if the objective was to maintain the current risk level. However, we consider that Ausgrid's claimed investment support for up to circa $63 million per year is significantly overestimated by failing to account for its own assumption that the risk will increase progressively over the period it is considering. This progressive increase would imply that such mitigation expenditure as can be justified would also tend to increase over time (other factors being equal) rather than being evenly spread over the 30-year period that Ausgrid has used as the basis for its analysis.

61 Direct costs include asset replacement, feeder replacement and labour cost. Indirect costs include the value of unserved energy, which represents the total unserved energy, utilising the value of customer reliability.

62 = ($332m – $269m) / 30 years

63 = $2.1m x 5 years

64 On a linear basis with increments of 2.1m per year = 2.1 + 4.2 + 6.3 + 8.4 + 10.5 = $31.5m

65 Refer to cell DG6 of the Economic model provided with IR010, worksheet 'Final Option 5'. This value is higher, at over $15 million, if the weighting of the three RCP scenarios is re-introduced (as Ausgrid has assumed).

175. While an estimate of the potential increase in risk-cost is relevant in assessing proposed investment that seeks to mitigate it, we have referred in other sections of this report to a range of factors that must be taken into account as part of such assessment, including:

- Uncertainty in the estimation of the long-term increase in risk-cost that the five-year estimate is based on. This includes the multiplicative impact of uncertainties in the climate change scenarios themselves, uncertainties in the future increases in specific 'perils' associated with those climate change scenarios and uncertainties regarding the impact of those perils on the network.
- Cautions regarding the ability to target interventions that will address the modelled increase in risk cost, and the relationship between investment in such interventions and consequent risk-cost reduction.
- The necessary assumption that the investment cost will be less than the expected reduction in risk-costs, by a sufficient margin for it to be reasonable to assume that there will be a net benefit.

176. A counter to the cautions above is that resilience investment in an RCP, to the extent that it successfully manages to maintain the existing network risk level, will bestow benefits beyond the RCP. However, the benefits will be finite (based on the remaining economic and technical life of the relevant assets and the services provided from them) and are necessarily dependent on the reductions in risk-costs identified now (and on which the proposed program is based) turning out to be correct in nature, in quantum and in terms of timing.

Ausgrid states that it has applied a lower expenditure level than is indicated by its top down modelling, and applied constraints to its assessment of BCR

177. Ausgrid also explains that it has capped the proposed expenditure for the next RCP at $202 million, in response to feedback from consumers:[66]

> *'Ultimately, we capped our FY25-29 resilience expenditure forecast at $202m in response to Voice of Community (VoC) feedback. We recognise that this approach will require us to reevaluate risk and effectiveness of potential controls for future periods, but this approach seeks to strike a considered balance between increasing climate risk, ongoing developments in climate modelling, sustainable operational delivery, and building knowledge and experience in a new area of investment, while addressing affordability concerns for customers.'*

178. Our review of the provided cost benefit analysis (CBA) suggests that this has been done by modification of the target BCR for investments at each LGA, by selection of the solution with the highest risk mitigation over the next RCP, and which is assumed to be fully mitigated into the future.

179. Whilst we endorse the approach of identifying investments aimed at mitigating the identified risks, with a view of preserving optionality by not investing too early, we looked for evidence that the portfolio reflected an optimised program of works.

Assumed effectiveness of solutions

The effectiveness of the three identified solutions is not sufficiently justified

180. The CBA model applies three 'network strengthening' solutions:

1. replace with underground cable;
2. replace with Aerial Bundled Conductor (ABC) or Covered Conductor Think (CCT); and
3. segmentation;

with sub-options applied separately for LV and HV for option 1 and 2.

66 Ausgrid - IR010 - Climate Change Resilience - 20230414 – Public, page 2

181. We observe that Ausgrid has nominated an effectiveness of each option to mitigate the risk, where:

- Underground cable is assumed to be 99% effective at addressing the asset loss and loss of supply consequence for all perils.
- CCT is assumed to be 25% effective at addressing the asset loss and loss of supply consequence for the windstorm peril only.
- Segmentation is assumed to be 100% effective at addressing the loss of supply consequence for the windstorm peril only.

182. These are also shown in Figure 4.6 with the estimated unit costs, and which are consistent with those applied in the CBA model.

Figure 4.6: Effectiveness of network solutions and estimated costs

Current Asset	Resilience control	Bushfire		Heatwave		Windstorm		Cost	
		Asset Damage	Outages	Asset Damage	Outages	Asset Damage	Outages		
LV Bare	Replace with underground cable	99%	99%	99%	99%	99%	99%	$1,300,000	per km
HV Bare		99%	99%	99%	99%	99%	99%	$1,500,000	per km
LV Bare	Replace with ABC/CCT	0%	0%	0%	0%	25%	25%	$150,000	per km
HV Bare		0%	0%	0%	0%	25%	25%	$130,000	per km
HV Overhead	Segmentation	0%	0%	0%	0%	0%	Calculated per feeder using Ausgrid's reliability model	$100,000	per HV feeder

Source: Ausgrid presentation to AER and EMCa

183. We consider that the principle of moderating the effectiveness of the identified solutions is reasonable, however we have not been provided with sufficient justification to demonstrate that these assumptions are reasonable. For example:

- We understand that the segmentation solution essentially divides the HV feeder into two parts for each installation. Assuming that the faulted section of the feeder is downstream of the sectionalising device, the sectionalising device is opened and the upstream feeder section is re-energised and customers reconnected to supply. The solution does not assist if the faulted section is upstream of the sectionalising device. This suggests to us that the solution is not 100% effective.
- Where the effectiveness of the CCT solution has been based on historical experience, this is likely to be related to the most heavily vegetated or highest risk areas. We consider that the effectiveness is highly unlikely to be uniform across the network. Moreover, the effectiveness assumption adopted by Ausgrid implies that the impact (in terms of reduced risk-cost) is linearly proportional to the level of the assumed treatment solution.

Selection of options follows a ranking process and not development of an optimised portfolio, based on a prudent level of work

Ausgrid's multiple methods of risk reduction contribute to prioritisation and ranking of its proposed program to an expenditure constraint

184. We also observe that Ausgrid applies a factor to allocate risk across the HV and LV network, and then by conductor type. This is applied to the allocation of potential benefit in its calculation. On closer examination, the risk cost used for the prioritisation of solutions is the sum of the 2020 climate risk impact plus the incremental climate risk impact over the

next five years (optimised risk reduction).[67] This suggests that a risk cost is calculated as at the end of the regulatory control period, and the options seek to mitigate this risk rather than the incremental risk above the baseline introduced by climate change as Ausgrid has claimed.

185. Ausgrid makes use of different assessments of risk cost that it is seeking to mitigate, including:

- ‘optimised’ risk reduction, used in derivation of the penetration level to mitigate the risk for each option.
- ‘target’ risk reduction, being the delta between the 2050 risk cost and the 2020 risk cost without the adjustments made above.
- ‘actual’ risk reduction as the product of a number of factors, being target risk reduction, optimised risk reduction and derived concentration level used to select the preferred solution.

186. The use of different calculations of risk costs in this way is not explained by Ausgrid.

187. The aggregate risk reduction of the portfolio is then the aggregate of solutions where the highest value of target risk reduction is achieved. The investment portfolio is adjusted by modifying the BCR which identifies the ‘optimised’ concentration level and risk outcome, which effectively filters out concentration levels to reduce the risk reduction achieved and associated level of expenditure to approximate $195.6 million.

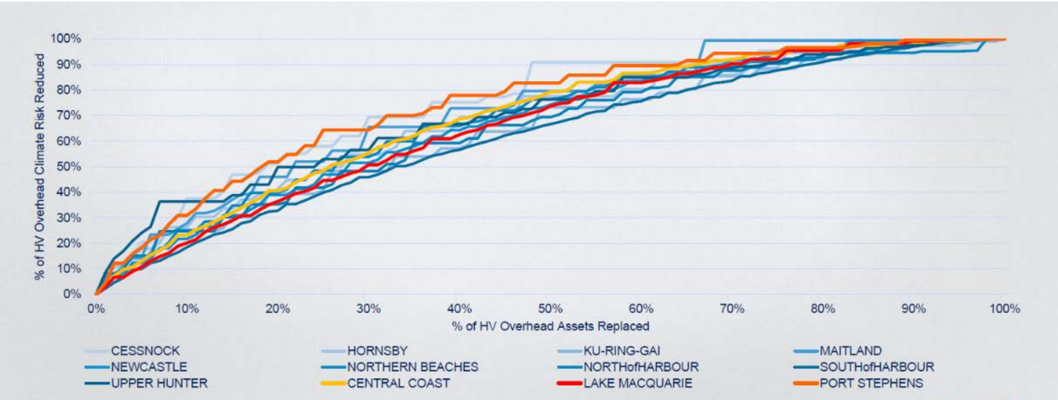
188. In this way, Ausgrid appears to be determining a portfolio to achieve an expenditure constraint rather than determining an optimise portfolio for a particular risk or service improvement outcome.

Disproportionate factors have a critical role in driving the levels of work proposed by Ausgrid and which are not explained

189. In addition, Ausgrid has adopted a disproportionate factor to adjust for risk reduction at concentration levels of the solution from 0 to 100% in increments of 10%. The basis for the determination of these factors, applied to CCT and segmentation is not adequately explained by Ausgrid.

190. An example of the effect of these factors is as shown in Figure 4.7, and these differ between CCT and segmentation solutions, and for each LGA.

Figure 4.7: Benefit Distribution example



Source: Ausgrid presentation to AER and EMCa

191. These factors have a significant effect on the amount of each ‘solution’ that the model determines to be viable. Absent this disproportionality factor in its model, each of these solutions would present as being either 100% viable or 100% non-viable, and it is only the

67 This is calculated as the difference between eh 2050 climate risk impact and the 2020 climate risk impact, divided by the 30 year observation period and multiplied by the 5 year regulatory period.

'shape' of disproportionality that drives the model towards determining that there is an economic benefit to applying this solution to a percentage of the line, and what that percentage is. In other words, this unexplained assumption has a critical role in driving the levels of work that Ausgrid has proposed to be economically justified.

The 'test' used in the model to determine viability of each solution understates the cost and therefore overstates the 'justified' amount of work

192. Ausgrid's model includes a sub-routine that is intended to compare the annuitised cost of a solution (or solutions at different levels of treatment) with the annual benefit (in terms of potential reduced risk cost). However, the annuitised cost calculation effectively fails to account for the finite remaining life of the 'solution' assets. While comparison of the annuitised cost against the annual potential benefit that can be achieved is an appropriate method for determining whether and when an investment should be undertaken, the understatement of the solution cost by Ausgrid is creating an inappropriately low hurdle and consequently its model is producing an overstatement of the level of justifiable investment.

4.2.3 Investment cases

We assessed the expenditure provided in Ausgrid's CBA model

193. Ausgrid indicated an allocation for repex ($154.9m), growth / augex ($29.1m) and non-networks ($9.7m) in Table 17 of Attachment 5.5, and which represents a ratio of approximately 80%:15%:5% of the total capex that it has proposed. We requested Ausgrid to provide a breakdown of the proposed expenditure including identification of individual projects and programs, and expenditure by year of the next RCP.[68]

194. In its response to IR010, Ausgrid states that:[69]

> *'We are unable to provide a breakdown of this nature at this stage. We are still in the process of working with our customers to identify the individual projects and programs which will make up our proposed resilience program.'*

195. Ausgrid did subsequently provide a CBA model to support its climate resilience expenditure envelope at an LGA level. Ausgrid describes its CBA model as follows:[70]

> *'The CBA model selects an optimal suite of investments that seeks to minimise the growth in risk over the next RCP, with additional scenarios covering the period to 2050. This model uses outputs of the Ausgrid Climate Impact Assessment as key data inputs.'*

196. We have reviewed the CBA model provided by Ausgrid as a part of our assessment.

Correcting for upward bias in economic model reduces the number of projects

197. As described in the previous section, we observe that the model is very sensitive to a number of its inputs. Adjustment to these inputs individually has a material impact of the calculated risk cost avoidance and therefore benefit assumed by Ausgrid. These include:

- Application of 'calibration steps' using historical values.
- Inclusion of very long outage times.
- Selection and application of the value of VCR.
- Inclusion of a weighted RCP scenario. Adjustment to remove the weighting of scenarios reduces the assessed increase in risk by around 30%.

68 Refer Attachment 5.5 Table 17, where we interpret the column titled 'reduction in risk' as being capex and which totals to $193.6 million, that approximates the total included in the submission of $193.7 million

69 Ausgrid - IR010 - Climate Change Resilience - 20230414 – Public, page 1

70 Ausgrid - IR010 (Part 2) - Climate Change Resilience - 20230421 – Public, page 1

- Modelling of the annualised cost of each option. Application of estimates that account for finite asset lives increases the annualised cost and reduces the extent to which solutions are found to provide a net benefit.
- Effectiveness of proposed solutions assumes ability to target benefit, including disproportional benefit relative to penetration levels. No evidence was provided by Ausgrid to support its assumptions that, particularly for perils caused by vegetation, that it can identify and then target works at the level of granularity assumed in its modelling, such that it can provide an enhanced level of risk mitigation benefit for a given level of solution investment.

Risk impact that Ausgrid is seeking to mitigate appears to go beyond the increase of extreme weather events

198. Ausgrid describes the calibration of its climate risk impact model as:[71]

> *'We have also undertaken a process to calibrate the outputs of our climate risk model using available average historic outage data from the same or similar modelled time period. This process has been completed by isolating climate related events in our outage data from 2010 to 2020 and setting this as the 'known' input on which to calibrate forecast model outputs. i.e. comparing historical actuals to the 'baseline' climate model outputs (derived from the average of climate model results from 2000 to 2020), then deriving and applying a scaling factor to model outputs at an LGA level to align them with historical averages. This calibration step can be seen applied in the 'AGD Outages' tab within the CBA model Ausgrid - IR010 – Climate change resilience – Economic model – 20230421 – PUBLIC.'*

199. Based on our understanding of the 'AGD outages' worksheet in its CBA model, the average calibration to historical events was -69% which suggests to us that the climate risk impact model had significantly overstated the baseline risk. Individual calibration adjustments were determined and applied for each LGA area.

200. While Ausgrid has applied a 'calibration' to the climate impact risk modelling, the extent of the discrepancy in baseline results inevitably raises questions about the extent to which this model can be relied on to have assessed the future increase in risks (by 2050 and 2070) that Ausgrid is seeking to mitigate.

201. In calibrating the model, of the weather events identified, the vast majority were considered climate-driven rather than weather-driven,[72] with a small number considered both. Climate-driven events also included causes such as no weather impact and "unselected". Taken together with comments made against each event suggests a level of doubt over the robustness of the data and degree of reliance that can be place on this data without further moderation via sensitivity analysis.

202. Major events that occurred in 2015 and 2020 are included in the 11-year data to develop a historical average for the purpose of calibrating the baseline by Ausgrid. It is appropriate to include these events where an assessment of large weather-related events are modelled, however inclusion of smaller random weather events over the observation period has not been adequately explained.

203. The inclusion of all weather events, and calibration on this basis suggests that the risk impact that Ausgrid is seeking to mitigate goes beyond the increase of extreme weather events.

Composition of Ausgrid's preferred option is not yet determined

204. Ausgrid calculated a lower and upper bound estimate of its required expenditure in its economic model by modifying its BCR value, to seek a target value of expenditure of $195.6

[71] Ausgrid - IR010 (Part 2) - Climate Change Resilience - 20230421 – Public, page 3

[72] Climate-driven and weather-driven are categories identified by Ausgrid in its model

million. The primary difference between the lower and upper bound estimate appears related to the extent of ABC/CCT used in Central Coast LGA, as shown in Table 3.2.

205. As identified in section 3, Ausgrid has allocated the proposed expenditure to each of the RIN expenditure categories. The proposed expenditure is broadly based on the following components:

- Undergrounding solution $65 million;
- CCT solution $98 million; and
- Switching solution $35 million.

206. It we assign undergrounding and CCT to repex, and switching solution to augex, we arrive at percentages of 85% repex and 15% augex and which are broadly aligned with Ausgrid's proposal. Ausgrid does not indicate how the proposed allocation to the RIN categories in section 3 has been applied, or indeed what is proposed for the allocation of expenditure for non-network capex, and which has not been included in the components of the proposed expenditure nominated above. We suspect that Ausgrid has based its allocation of expenditure to RIN categories on percent ratios and not on a build-up of individual projects, noting its intention to resubmit its proposal including the composition of projects:[73]

> *'..the projects and programs that underpin our CBA model have been (and should continue to be) treated as indicative only, as they are subject to refinement through the ongoing customer engagement process.'*

207. Assessment against the NER is therefore difficult in absence of clear justification for the included projects and programs that comprise the forecast.

208. Due to the absence of information provided by Ausgrid, it is not possible to ascertain the nature of the final investments that Ausgrid may undertake, the reasonableness of the proposed expenditure, or the benefits to the consumers of those investments.

4.3 Additional observations

4.3.1 Relationship to BAU capex program

Ausgrid should clearly demonstrate that the proposed level of risk mitigation is prudent

209. Ausgrid has claimed that it has calibrated its proposed expenditure against historical cost pass through events in relation to extreme weather events. We consider that due to the inability to predict the location and potential impact of extreme weather, the cost pass through mechanism included in the NER provides a means for NSPs to recover incurred expenditure. Further, that extreme weather events are likely to continue to occur and to require reactive expenditure incurred by NSPs in the future. It is likely uneconomic to remove this risk entirely, nor would it be technically possible to achieve. Achieving a prudent and efficient level of proactive and reactive expenditure remains the challenge.

Review of repex requirements is required to ensure programs are not duplicative

210. Ausgrid describes climate resilience as having historically been captured into BAU capex programs, on the basis that the climate was at that time not considered to be changing. We asked Ausgrid how the benefits arising from the resilience program, through expenditure to harden the network are excluded from the BAU capital program, including replacement needs.

211. In response, Ausgrid stated that:[74]

[73] Ausgrid - IR010 (Part 2) - Climate Change Resilience - 20230421 – Public, page 1

[74] Ausgrid - IR010 - Climate Change Resilience - 20230414 – Public, page 7

'At a detailed level, climate impacts were not included in any failure or risk modelling as part of repex modelling. For example, asset failures and unserved energy experienced during historical storm events were not included in the repex analysis. This means that the benefits of risk mitigation from climate events are excluded from our repex forecast.'

212. We were not able to confirm these statements, specifically that Ausgrid had excluded failures associated with historical storm events from its assessment of repex needs, or by reference to the repex modelling that includes historical failure analysis. We suggest that AER staff review these statements in context of its review of Ausgrid's repex requirements.

4.3.2 Impact on reliability

Reliability improvement not adequately accounted for

213. We asked Ausgrid to describe the reliability improvement in terms of reduction to the number and frequency of interruptions, and duration of outages from the proposed projects and programs included in the forecast climate resilience expenditure over the next 5 years.

214. In response, Ausgrid stated that:[75]

'The climate resilience expenditure is focused on mitigating risk growth due to increased frequency and severity of weather events. Coupled with relatively steady repex, the proposed climate resilience program is expected to assist in maintaining, rather than improving reliability.'

215. We consider that the nominated solutions will provide ongoing reliability benefits to consumers, to outages including those incurred due to normal weather events and to third party forces. These benefits do not appear to have been captured by Ausgrid.

216. Accordingly, we suggest that AER staff consider the benefits that any climate resilience expenditure allowance may have on the determination of reliability for consumers and adjustments to STPIS.

4.3.3 Observations on proposed community resilience programs

We do not consider there to be a material overlap between Ausgrid's proposed community resilience expenditure and the network resilience expenditure that we have reviewed

217. While Ausgrid's proposed community resilience expenditure was not within the scope for our review, AER requested that we provide any observations on it. In particular, AER asked that we identify any overlap with other proposed expenditure (including the network resilience expenditure that we have reviewed).

218. We understand that Ausgrid had initially proposed $8.4 million as an opex step change for a range of community resilience programs. In the updated information, a similar list of programs is included. This updated list comprises capex and opex initiatives that total a lower proposed expenditure. The relationship of this new amount to the initial proposal is not evident from the information provided to us.

219. Based on our review of the climate driven network resilience capex, we do not consider there is a material overlap between the network resilience projects proposed by Ausgrid and those separately included as community resilience.

220. As requested by the AER, we offer the following further observations:

- We are inclined to the view that the role of NSPs in providing for community resilience is a collaborative one, shared with government, critical infrastructure operators, individuals and communities. Accordingly, review of community resilience should include consideration of whether the NSP is best placed to manage the identified risk and deliver the proposed service.

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75 Ausgrid - IR010 - Climate Change Resilience - 20230414 – Public, page 6

- Review should necessarily consider whether the proposed expenditure is required for the delivery of direct control services to which the revenue determination applies and meets the requirements of the NER.
- Review should consider the extent to which the proposed expenditure reflects consumer and community preferences, and that consumers have been fully informed of the expenditure options and their implications.

4.4 Our findings and implications

4.4.1 Summary of our findings

Analysis provided for the proposed investment case is not justified

221. Ausgrid's proposed climate-related network resilience capex is primarily driven by its analysis of an assumed increasing impact of windstorms, and specifically ECL events on its network, of which 87% of asset failures are related to vegetation. We do not consider that Ausgrid has adequately accounted for uncertainty in the climate models for wind speed and ECL events that Ausgrid has relied upon, and which is stated in the reports provided, to conclude the level of impact to its network and customers that it has assumed.

222. We find a lack of adequate justification for the proposed network resilience program. We have identified a number of material issues in the supporting analysis provided by Ausgrid that cast a level of doubt over the robustness of the analysis and conclusions that Ausgrid has drawn from that analysis.

Assumptions of increased climate risk exhibit an upward bias

223. Whilst Ausgrid claims to be targeting an ***increase*** in climate risk associated with ***extreme weather events***, our review of its methodology suggests that it is in effect seeking to undertake significant additional investment that has a more generalised weather-related cause.

224. The asset vulnerability assumptions and calibration steps applied by Ausgrid appear to further reinforce the presence of an upward bias to its assessment of the impact of climate risk on its network. The combination of poor calibration of the direct results from the climate impact risk model, and the basis on which Ausgrid has sought to calibrate these, suggest a significant overstatement of the increase in risk cost within the period to 2029, and which Ausgrid is claiming to require investment to mitigate.

Benefits assumed by Ausgrid are overstated

225. In determining its preferred mitigation options, Ausgrid has overstated the level of benefits that it could reasonably achieve by the proposed solutions. We consider that this especially applies in assessing the benefits that can be mitigated through solutions that aim to address the impact of windstorms, and which Ausgrid has considered to be the dominant climate-related increasing risk driver.

226. The effectiveness of the proposed solutions assumes an ability to target benefit, including disproportionately high benefit relative to solution penetration levels. Ausgrid has not sufficiently supported these disproportionality assumptions, particularly for perils caused by vegetation. We consider that it has unrealistically assumed (or at least assumed, without evidence) that it can identify and then target specific works at a level of granularity that will provide an enhanced level of risk mitigation benefit for a given level of solution investment. This leads to an overstatement of benefit.

Modelling assumptions also exhibit an upward bias

227. We also found evidence of further upward bias in the application of assumptions in its modelling, and which include:

- Overestimate of risk identified as guidance from its top-down modelling assessment by failing to account for its own assumption that the risk will increase progressively over the period it is considering (primarily, to 2050), and which has been used as a reference for its program.
- Inclusion of RCP8.5, corresponding with the highest warming, results in the highest and earliest increase across each climate metric it has assessed.
- Inadequate consideration of alternate risk mitigation methods, and in the options it has progressed, incorrect modelling of the annualised cost of each option that fails to account for the finite life of the relevant assets.

228. Collectively, the identified issues result in an overstatement of the level of risk that may be reasonably attributed to increases in extreme weather events within the next regulatory period and a consequent overstatement of investment that can be justified against the NER objectives and criteria, to meet such increases in risk.

4.4.2 Impact of updated information received on 17 July 2023

Ausgrid did not provide a full suite of information or analysis to support its recently-provided and materially different forecast

229. Ausgrid provided a materially different forecast than it had proposed in its regulatory proposal, after the time when we had undertaken our assessment and presented our preliminary findings to the AER on its regulatory proposal.

230. Ausgrid's new proposed expenditure for climate-driven network resilience is changed in both magnitude and scope and the scale of the proposed solutions. The economic basis relied upon by Ausgrid in determining this change from its original proposal is not clear as a new economic model was not provided in support of its business case for the proposed new amount.

It is not possible to provide definitive findings on the updated forecast that Ausgrid has now provided

231. Under the propose/respond regulatory model in place in the NEM, the onus is on Ausgrid to present clear, consistent and compelling information and evidence to the AER and its consultants in support of its regulatory proposal. The regulatory review process also provides Ausgrid (and other NSPs) with the opportunity to review and respond to the AER's Draft Determination and matters raised in reports provided to the AER, as a part of its revised regulatory proposal.

232. As a part of our technical review, our approach is impacted by Ausgrid's ability to provide sufficient information and evidence to credibly demonstrate that its proposal meets the NER expenditure criteria. We have sought to assess Ausgrid's expenditure proposal based on Ausgrid's analysis and Ausgrid's own assessment of technical requirements and economics and the analysis that it has provided to support its proposal. This information was provided in part in association with Ausgrid's regulatory proposal (in January 2023) and then progressively Ausgrid provided further information, explanations and analysis on this aspect of its regulatory proposal on request by AER and us over a period of some four months. This information and opportunity for discussion with Ausgrid assisted with our review of what Ausgrid had proposed in its regulatory proposal.

233. It is not possible to assess an 'updated' proposal provided over 5 months after the regulatory proposal was submitted, and without the supporting information and opportunities for clarification that have already been undertaken for the program proposed in its regulatory proposal.

The additional information provided by Ausgrid does not materially change the findings included in our assessment

234. While we could not assess a late stage updated forecast, we nevertheless sought to consider whether the updated forecast might assist in resolving any aspect of our findings on the allowance that Ausgrid had proposed in its regulatory proposal.

235. We observe that the ‘error bars’ now provided from the modelling of climate perils for Ausgrid’s service area reinforce the uncertainty that we consider exists in the modelling of each of the climate perils, and which we consider that Ausgrid has not adequately taken account of.

236. Ausgrid has acknowledged that there are complex relationships between perils, including windspeeds and windstorm, and which also need to be considered as a part of its sensitivity analysis. Based on our review of these error-bars, the increase in occurrence of the identified climate related perils is very sensitive to the selected observation period. For example, east coast lows days and wind maxima show very little change for the 20-year ensemble mean for RCP 4.5 over the next 10 years.

237. With regard to the additional information provided by Ausgrid in support of its adopted set of RCP scenarios, we observe that this is one of several assumptions that Ausgrid has applied that determine the level of risk and inform the level of required expenditure to address the identified assumed increase in risk. We have referred to a number of input assumptions that, in aggregate, we consider result in an overstatement of the identified risk, and which for the basis of Ausgrid’s proposed justification to mitigate this risk in the next regulatory period. We remain concerned that the assumptions relating to the modelling, calibration and application of the modelling result in an overstatement of the expenditure requirements that Ausgrid has proposed for the next RCP.

4.4.3 Summary of adherence to AER resilience guidance note

238. We have reviewed the relevant factors of the framework for evidence to support resilience expenditure as being prudent and efficient to achieve the expenditure objectives.

Ausgrid has not established an adequate causal relationship between the proposed resilience expenditure and the expected increase in extreme weather events

239. We find that the methodology proposed by Ausgrid targets network resilience beyond the impact of extreme events and beyond the impact of ***increases*** in such events, and in doing so has overstated the expenditure requirements.

Ausgrid has not effectively demonstrated that the proposed expenditure is required to maintain service levels and is based on the option that likely achieves the greatest net benefit of the feasible options considered

240. We find that Ausgrid’s assessment options provided in support of its proposed expenditure are limited, and that its assessment of risk cost overstates the likely benefit provided by the options it has assessed.

4.4.4 Implications of our findings for proposed expenditure

We consider that the proposed expenditure does not reasonably satisfy the capex objectives of the NER and represents a considerable overstatement of prudent expenditure requirements.

APPENDIX A – COMPARISON OF ASSUMPTIONS APPLIED BY NSW DNSP

241. In this appendix, we provide a comparison of the assumptions applied for each of the NSW DNSPs in the development of its climate-driven network resilience capex proposed for the next RCP. This covers:

- Comparison of proposed capex;
- Climate impact modelling assumptions;
- Projected asset failures; and
- Projected total financial cost.

A.1 Comparison of proposed capex

A.1.1 Proposed capex

242. In Table A.1 we provide a comparative analysis of the proposed capex included for network resilience.

Table A.1: Comparison of proposed capex for network resilience

Metric	Ausgrid[76]	Essential Energy	Endeavour Energy
Proposed capex ($m, real 24)	193.7	127	28
Average number of customers	1,837,757	969,252	1,225,827
Average route line length (km)	40,588	180,640	30,976
Capex / customer ($)	105	131	23
Capex / route km ($)	4,772	703	904

Source: EMCa analysis of information provided by Ausgrid, Essential Energy and Endeavour Energy

243. The customer numbers and route length are based on reported information in the Reset RIN for each NSW DNSP, using the average of the forecast over the next RCP.

244. From Table A.1 we observe that:

- Essential Energy has the highest proposed capex per customer of the NSW DNSPs, with approximately half the customers of Ausgrid, and lower than Endeavour Energy.
- Ausgrid has the highest proposed capex per route km of network of the NSW DNSPs. This is likely to be higher if the route length was limited to overhead network only.

245. These metrics are not intended to be used exclusively or form the basis of our assessment. For example, the metrics do not include other factors that may further differentiate the operating environment for each NSW DNSP, and which include urban versus rural networks, overhead versus underground networks etc.

76 The updated information provided by Ausgrid on 17 July includes a lower proposed capex, however does not materially change the results of the comparison between NSW DNSPs

246. Further, these metrics should not be relied upon to review a category of the proposed capex without considering the remainder of the capex forecast, and interaction with the opex forecast to meet service standards. We have not undertaken, nor were we asked to undertake or to review, comparative benchmarking analysis of DNSPs whose network prices are subject to the AER's regulation.

A.1.2 Source of proposed capex

247. In Table A.2, we provide a summary of the primary sources of proposed capex included by each of the NSW DNSPs for the next RCP. Our focus is on comparing the primary network solutions proposed to be applied to address local impacts of extreme weather events.

Table A.2: Summary of primary sources of network resilience capex by NSW DNSP

Sources of expenditure	Ausgrid[77]	Essential Energy	Endeavour Energy [78]
Proactive pole replacement		☑	
Undergrounding	☑	☑	
Covered conductor (or similar)	☑		☑
Switching / sectionalising	☑		
Conductor raising			☑

Source: EMCa analysis of information provided by Ausgrid, Essential Energy and Endeavour Energy

248. From Table A.2, we observe that:

- Two DNSPs have included solutions of CCT and undergrounding, being the dominant sources of expenditure.
- The remaining solutions have been adopted by a single DNSP only.

77 The updated information provided by Ausgrid on 17 July introduces additional sources of capex associated with its 'Whole of Network solutions' proposal

78 IR011, Endeavour Energy state that where projects have not been cost justified (for example, the proactive replacement of in service timber poles with alternates), these have not been part of its Proposal

Table A.3: Summary of perils responded to by NSW DNSP

Included drivers of network expenditure	Ausgrid[79]	Essential Energy	Endeavour Energy
Extreme heat	☑		
Bushfire	☑	☑	☑
Windstorm	☑	☑	
Flood		☑	☑
Coastal inundation			

Source: EMCa analysis of information provided by Ausgrid, Essential Energy and Endeavour Energy

249. From Table A.3, we observe that:

- All three DNSPs have included the increased risk from bushfire as a driver of network resilience capex.
- Two DNSPs have included the increased risk from windstorm and flood as drivers of network resilience capex.
- One DNSP has included the increased risk from extreme heat as a driver of network resilience capex.

250. We have assessed each of these drivers in our reports for each DNSP.

251. Despite having considered multiple potential perils, it is notable that:

- Almost all of Ausgrid's proposed network resilience capex is proposed as mitigation for assumed increase in windstorm impacts.
- Essential Energy's and Endeavour Energy's dominant proposed network resilience capex is against assumed increase in bushfire impacts. Of these, Essential Energy's bushfire related programs target exogeneous fire starts and Endeavour Energy's bushfire related program targets fire starts from the network.

A.2 Climate impact modelling assumptions

252. In Table A.4, we provide a summary of the assumptions applied for each of the NSW DNSPs in development of its climate impact modelling.

79 The updated information provided by Ausgrid on 17 July introduces responses to all climate perils, when considering the additional sources of expenditure (capex and opex) associated with its 'Whole of Network solutions' proposal

Table A.4: Summary of model input assumptions by NSW DNSP

Input assumption	Ausgrid	Essential Energy	Endeavour Energy
Climate impact 'peril' addressed by capex	Bushfire, windstorm, flood, heatwave	Bushfire, windstorm, flood	Bushfire, flood
Climate impact modelling undertaken	Yes	Yes	Yes
Climate impact model relied upon for capex forecast	Yes, fully	Yes, partly	Yes, partly
Dominant climate impact 'peril' driving capex	Windstorm	Bushfire	Bushfire
Climate projection assumed for determination of its proposed capex	Weighted approach: 15% RCP 2.6, 70% RCP 4.5, and 15% RCP 8.5	100% RCP 4.5	100% RCP 4.5
Projection scenarios developed	2050, 2070 ,2090	2050, 2070, 2090	2050, 2090

Source: EMCa analysis of information provided by Ausgrid, Essential Energy and Endeavour Energy

253. From Table A.4, we observe that:

- All three DNSPs have developed and relied upon in some form climate impact modelling to develop the proposed capex forecast.
- However, the climate impact (or perils) modelled differ considerably across the DNSPs, with Ausgrid including a higher incidence of climate impacts.
- Similarly the climate projections assumed and projected scenarios differ across NSW DNSPs, and may impact the rate of increase in climate risk, amongst other things.
- The climate impact of increasing bushfire risk was the dominate climate impact driving capex for two of the three NSW DNSPs.

254. While it is to be expected that climate change will impact different networks differently, we consider that the extent of the differences between the DNSPs' in their projected impacts also reflects the significant challenges and uncertainties that are inherent in the modelling that they have relied on.

A.3 Climate impact to 2050 for RCP4.5

255. In Table A.5, we provide a summary of the percentage increase in climate impact for RCP4.5 to the year 2050 for each NSW DNSP. This is based on our assessment of the material provided. Where items are left blank, we were not able to identify information on a common basis to include in this table.

Table A.5: Climate impact: Assumed percentage increase to 2050 for RCP4.5 by NSW DNSP

Input assumption	Definition	Ausgrid	Essential Energy	Endeavour Energy
Consecutive hot days – total	The total number of heatwave days (3 or more days > 35 deg C)	103%	-	89%
Consecutive hot days - maximum	The longest run of consecutive hot days > 35 deg C	22%	21%	-
Windspeed maximum	Speed of sustained wind gusts	3%	2.1%	-
Windstorm	Impact of intense East coast low events	23%	10%	-
Very heavy precipitation days	Days with more than 30mm of precipitation linked to flooding	20%	-	-
Flooding	Flood level > 0.6m	-	1.9%	-
Flooding	1 in 20 year extreme rain event	-	-	3%
Very high fire danger days	Days with a forest fire danger index FFDI >25	0%	-	39%
Extreme (and above) fire danger days	Days with a forest fire danger index FFDI > 50	13%	-	-
Bushfire footprint	The number of assets within a bushfire footprint	-	10%	-

Source: EMCa analysis of information provided by Ausgrid, Essential Energy and Endeavour Energy

A.3.1 General observations

Extreme heat

256. In general, all DNSPs are forecasting an increase in heatwaves.

Windspeed & windstorms

257. In general, all DNSPs consider that there is very little change seen to maximum sustained wind speed, however, are projecting a higher number of windy days.

258. The climate modelling includes a projection of the number of East Coast Low Pressure System (ECL) events. DNSPs describe ECLs as often leading to damaging winds and thus increased asset failures from direct impacts and vegetation fall/blow ins.

259. The data relied upon by each DNSP differs materially as shown in Table A.5. For example:

- Essential Energy has made corrections to the climate modelling for windspeed, noting that it peaks in 2050 before reducing in 2070. Accordingly, Essential Energy has adopted a straight-line projection of impacts from 2020 to 2070, to account for overstatement in 2050.
- Endeavour Energy has stated that the advice from climate scientists is that the confidence in current climate modelling is not high. Accordingly, Endeavour Energy has not included or relied on wind exposure modelling into its climate projections until such time that better data becomes available.[80]

80 Endeavour Energy 10.34 Climate resilience methodology

Flooding

260. In general, all DNSPs are forecasting a minor increase in the frequency of flooding. However, Essential Energy includes an increase in flood severity within its projection.

Bushfire

261. In general, all DNSPs are forecasting a minor increase in the frequency of bushfire exposure.

A.4 Asset failures

262. The asset failures modelled for each of the NSW DNSPs are provided for RCP 4.5, not considering any incremental costs for other RCP scenarios. Values are expressed as the average number of asset failures (units) per year.

Ausgrid

Table A.6: Projected asset failures by year – Ausgrid (units)

Input assumption	2020	2050	2070	2090
Bushfire	303	317	364	410
Windstorm	1623	2074	2698	3323
Flood	22	23	23	22
Total	1948	2414	3085	3755
Increase relative to 2020	-	24%	58%	93%

Source: EMCa analysis of information provided by Ausgrid

263. In addition to the above, Ausgrid nominate feeder replaced expressed in km pa.

264. The dominant driver of asset failure for Ausgrid is windstorms which accounts for 80% of all modelled asset failures.

265. The rate of change is highest for Ausgrid was windstorm followed by bushfires.

Essential Energy

Table A.7: Projected asset failures by year – Essential Energy (units)

Input assumption	2020	2050	2070	2090
Bushfire	491	545	610	685
Windstorm	318	550	400	426
Flood	248	255	257	259
Total	1057	1350	1267	1370
Increase relative to 2020	-	28%	20%	30%

Source: EMCa analysis of information provided by Essential Energy

266. The dominant driver of asset failure for is bushfire, however this accounts for approx. 46% in the baseline asset failures.

267. The rate of change is highest for Essential Energy is bushfires followed by windstorms.

Endeavour Energy

268. Projected asset failure information was not provided. Instead, the increase in exposure risk was used as an escalation factor.

269. Climate modelling commissioned by Endeavour Energy from Deloitte has indicated that across a range of future emission scenarios, localised risks across the network are changing because of climate change. The climate modelling has indicated that risks such as bushfire risk are forecast to increase due to a higher likelihood of bushfire favourable weather in future climatic conditions.

270. The escalation factors make use of risk levels in 2090 for each geographical area.

A.5 Total financial cost

271. The total financial costs modelled for each of the NSW DNSPs are provided for RCP 4.5, not considering any incremental costs for other RCP scenarios. Values are expressed in total financial cost $m per annum, including direct and indirect cost components (such as Value of Unserved energy).

Ausgrid

Table A.8: Projected total financial cost by year – Ausgrid ($m per annum)

Input assumption	2020	2050	2070	2090
Bushfire	22	23	27	31
Windstorm	244	306	560	814
Flood	2	3	3	3
Total	268	332	590	848
Increase relative to 2020	-	24%	120%	216%

Source: EMCa analysis of information provided by Ausgrid

272. A similar relationship exists for financial costs as identified for asset failures.

273. Increases in financial cost for Ausgrid are far in excess of other DNSPs, largely due to its assumed cost (and rate of increase in cost) of windstorms.

Essential Energy

Table A.9: Projected total financial cost by year – Essential Energy ($m per annum)

Input assumption	2020	2050	2070	2090
Bushfire	11.2	12.6	14.1	15.9
Windstorm	3.4	5.8	4.3	4.6
Flood	10.2	10.5	10.6	10.7
Total	24.8	28.9	29	31.2
Increase relative to 2020		17%	17%	26%

Source: EMCa analysis of information provided by Essential Energy

274. A similar relationship exists for financial costs as identified for asset failures.

Endeavour Energy

275. Projected financial costs information was not provided.