EMCa
energy market consulting associates

TransGrid Revised Revenue Proposal 2018-23

Review of aspects of TransGrid's revised forecast capital expenditure

Report to

Australian Energy Regulator

from

Energy Market Consulting associates

April 2018

This report has been prepared to assist the Australian Energy Regulator (AER) with its determination of the appropriate revenues to be applied to the prescribed transmission services of TransGrid from 1st July 2018 to 30th June 2023. 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.

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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 by AER staff prior to 11th April 2018 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 TransGrid's regulatory submission or other documents due to rounding.

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About EMCa

Energy Market Consulting associates (EMCa) is a niche firm, established in 2002 and specialising in the policy, strategy, implementation and operation of energy markets and related network management, access and regulatory arrangements. EMCa combines senior energy economic and regulatory management consulting experience with the experience of senior managers with engineering/technical backgrounds in the electricity and gas sectors.

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Executive Summary

Purpose of this report

1. The purpose of this report is to provide the AER with our assessment of elements of TransGrid's revised capex proposal for the 2018-23 Regulatory Control Period (RCP) as set out in TransGrid's 2018-23 Revised Revenue Proposal (RRP). Our assessment is based on our review of TransGrid's RRP document, its supporting documents including its analysis workings and models, TransGrid's responses to our requests for information and other information provided by TransGrid such as at RRP review onsite meetings.

2. This assessment builds on the analysis and findings from our assessment of TransGrid's initial capex proposal for its 2018-23 Revenue Proposal (RP)[1] as set out in our initial RP report[2].

Scope of work and Approach to our review of TransGrid's RRP

3. The scope for our assessment of TransGrid's RRP revised capex proposal comprises

    i. Repex (including security and compliance); and

    ii. Economic-benefit driven augex projects.

4. In addition to the assessment of these components of expenditure, we have also been asked to review TransGrid's scope and costing allowance for the Powering Sydney's Future (PSF) project.

[1] TransGrid Revenue Proposal 2018-23.

[2] EMCa, TransGrid Revenue Proposal 2018-23, Review of aspects of TransGrid's forecast capital expenditure, June 2017.

Response to general assertions in TransGrid's RRP

5. TransGrid has asserted in its RRP, that EMCa's initial RP report contained over 30 factual errors and errors of interpretation[3]. After reviewing each of these assertions by comparing further information from TransGrid against the text in our initial RP report, we have identified four items that appear to be erroneous. None of these items affected our findings in that report and, to the extent that it is relevant to our current report, we have taken account of the information that TransGrid provided in its review.

6. The remainder of the matters that TransGrid has labelled as 'errors in fact' and 'errors in interpretation' either do not describe any discernible factual error or inconsistency, or they provide new information that TransGrid did not provide for our initial RP assessment. We have nevertheless considered all of this information in the current assessment.

7. We have documented our review of TransGrid's claims regarding our initial RP report in Appendix A of the current report.

Assessment of new information on expenditure justification methodologies

8. TransGrid has claimed that EMCa misunderstood its risk cost methodology and used input values out of context and that as a result EMCa concluded that TransGrid's risk analysis was overly risk averse and that its capital expenditure requirements were overstated.

9. At the RRP review onsite meetings and through information requests, we sought further information from TransGrid on its risk cost methodology and how it has applied it to each of the expenditure categories that we have reviewed. We sought to identify a possible basis for TransGrid's assertions. However, we can find no area of misunderstanding of TransGrid's risk cost methodology or with how it has used its assumed input values in applying its methodology.

10. From the further information that TransGrid provided, we have confirmed our opinion that, as per our initial RP report, some elements of TransGrid's application of its risk cost methodology have led it to overstate risk and therefore to overstate its required expenditure. Our chief concerns in this regard are that:

    - TransGrid has used an unsupported and high Consequence of Failure cost assumption for the risk of bushfires. Evidence of such events that TransGrid provided, suggests to us that it has overstated this risk by a factor of at least four times. Correcting for this assumption removes justification for some significant proposed lines expenditure[4];
    - TransGrid has not always supportably moderated safety risk costs relating to the possibility of a fatality, to allow for hazard zone occupancy – that is, the likelihood not just that a person is near an asset when it fails with a

[3] TransGrid's list of claims was made available for the current review and contains 35 claimed errors in fact and 26 claimed errors in interpretation. Note that two claims of error in fact relate to IT Capex which was reviewed in our initial RP report, but has not been reviewed in the current report.

[4] In its RRP, TransGrid suggests that its moderating factors for this consequence cost have not been understood. The further information that TransGrid has provided on these moderating factors accords with our understanding of its approach in this regard.

safety consequence, but that they are within a zone where the likely consequence is a fatality. This leads to some overstatement of safety risk in substations, and in respect of transmission line failures and of the resulting justification for some of its proposed projects;

- We consider that TransGrid has tended to over-estimate reliability consequences as justification for some of its proposed expenditure, for example a NSW system black, in the absence of any TransGrid historical evidence of such an extreme event having resulted from the asset failures that are relevant to its assessment.

11. We sought further information from TransGrid on any portfolio-level ('top down') assessment that it may have relied on in helping to justify its proposed expenditure. The information provided further confirms the view in our initial RP report that TransGrid has not meaningfully sought to determine the optimal timing or extent of its proposed program of work.

12. For example, TransGrid has incorrectly claimed that the positive NPVs that it has determined for (most of) its projects[5] is evidence that it has optimised project timing. We find that even the example that TransGrid has used in its RRP[6] (and which is similar to that we present in the current report)[7] does not support this claim.

13. TransGrid has also disputed a graph included in EMCa's initial RP report, and which was based on data that TransGrid provided, which we used to illustrate that some of its proposed projects require significant expenditure for little reduction in risk cost. TransGrid has provided updated data and, while there is a 'scaling' shift in the numbers, the data still clearly shows that a significant proportion of TransGrid's proposed repex comprises projects with only a marginally positive NPV.

14. TransGrid has not provided evidence of having identified and more closely scrutinised the more marginal projects to confirm validity of the assumptions which drive the claimed 'need'. Moreover, and contrary to TransGrid's assertions in its RRP, the evidence appears to suggest that by prudent deselection of projects, TransGrid's expenditure could be considerably less than it has proposed, with relatively little impact on safety, reliability or environmental risk.

Assessment of new information on repex

15. In its RRP, TransGrid has proposed a repex allowance of $937.1 million. Since its RP, TransGrid has made minimal change to its proposed repex allowance, and the changes it has made are almost entirely due to its revised inflation and labour escalation assumptions.

16. TransGrid has based the justification of its proposed repex allowance on application of its risk-cost methodology, and we describe our category-level assessment in this way:

- We consider that TransGrid's over-statement of risk cost for bushfires, as we describe in our assessment of its expenditure justification

[5] TransGrid proposes justification for some projects based on ALARP or other drivers, which it has documented.

[6] TransGrid RRP, Figure 4.16.

[7] Figure 4 in Section 3.3.

methodologies, results in a material over-statement of the requirement for transmission lines projects. We have also identified opportunities where the scope and timing of projects are not sufficiently justified, including opportunities where work may be reasonably reduced and/or deferred. However, based on the stated condition of TransGrid's transmission line assets, some more-targeted works would be required to address these issues, if the full-scale projects that TransGrid has proposed are not undertaken in the next RCP, or are materially deferred;

- For substation projects, we consider that reductions TransGrid has suggested to us subsequent to its RRP[8] broadly address our concerns with its RRP, which relate to over-stated risk cost and opportunities for optimisation in this asset category;
- For secondary systems projects, we consider that TransGrid has materially overstated the likelihood of the consequence factors included in its analysis, which we consider has led to an overstatement of the expenditure requirements. We have identified opportunities where projects may be reasonably reduced, and optimisation of the included projects may result in a reduced expenditure forecast;
- For communications projects, TransGrid has advised subsequent to its RRP that it will remove its proposed fibre optic roll-out project. In addition to this, we consider that TransGrid has not justified the benefits it has relied upon for inclusion of its remaining SDH replacement project; and
- The remaining repex projects, categorised as 'other' repex, would not normally be considered repex and, as with our initial RP report, we consider it should be re-categorised and assessed as part of the remainder of the capex forecast.

17. For security & compliance projects, we consider that TransGrid's application of its risk-cost methodology and input cost assumptions are over-stated and result in an over-estimate of the required expenditure. However, based on the stated condition of TransGrid's assets, we consider that a prudent operator would prioritise and undertake some more focussed work within the next RCP.

Impact of repex assessment

18. In our initial RP report, we assessed that the issues we identified resulted in an over-estimate of between 15% and 25% of TransGrid's proposed replacement expenditure. In its RRP, TransGrid has reduced its proposed repex by approximately 3%. Subsequent to the RRP, TransGrid has advised further reductions which in aggregate total 8% of its RRP repex proposal.

19. We consider that TransGrid has not provided sufficient justification for its RRP repex proposal. We have assessed its proposed RRP repex according to its risk cost methodology and using our assessment of input assumptions based on the evidence that TransGrid has now provided. On balance, we consider that a reduction of between 20% and 30% of its RRP proposed repex is more reflective of a prudent and efficient level of expenditure. Most of this reduction arises from our assessment for transmission lines, while the reduced requirements for substations

[8] TransGrid documented reductions it has proposed subsequent to its RRP in the document 'CAM and PTRM Update 21/02/2018' and provided an updated Capital Accumulation Model and Post Tax Revenue Model with this document reflecting the reductions.

and communications have largely been advised by TransGrid subsequent to its RRP. We have assessed reductions to proposed security and compliance expenditure, by assessing TransGrid's individual project justifications.

20. While the areas of concern that we describe in our assessment above of TransGrid's RRP repex are much the same as we expressed in our initial RP report, the further information that TransGrid has provided has allowed us to better assess the impact of our findings. Principally these have allowed us to better assess the impact of moderating bushfire risk cost (for transmission lines) and the corrected modelling of benefits (for communications), and this drives the increased adjustment that we propose.

Assessment of new information on augex

21. In our initial RP assessment, we considered that:

    i. TransGrid had not adequately justified the parameters and/or key assumptions applied in its risk-cost analyses for the augex projects we considered, and that these concerns have the effect of overstating the required expenditure,

    ii. TransGrid's risk-cost methodology was flawed in some projects, and

    iii. TransGrid had not provided sufficient justification of the timing of some of the proposed work.

22. In its RRP, TransGrid has removed one project[9] from its expenditure forecast. It has provided additional information that leads us to accept the need to address likely dynamic voltage control issues. However, we consider that a reasonable forecast for this requirement is lower than TransGrid has proposed. For other projects, we found evidence that the issues identified in our initial RP report are present in TransGrid's RRP forecast.

23. We have assessed the impact of our findings on the augex projects that TransGrid has proposed and we consider that a reasonable prudent and efficient expenditure allowance is approximately 40% less than TransGrid has proposed.

Assessment of scope and cost estimates for 'Powering Sydney's Future' project

24. We were asked by the AER to provide advice on the likely prudent and efficient scope of work and capex for key aspects of the project that TransGrid proposes to deliver through to the end of the next RCP.

25. The project scope and the estimate we have been provided is commensurate with a relatively early stage of project development – TransGrid categorises the cost estimate to be at 'pre-feasibility study' level of accuracy (±25%). Due to the current state of planning, design, and prospective supplier and other stakeholder engagements, the estimate is conservative. TransGrid makes provision for known and potential unknown issues through the addition of allowances and contingencies, particularly with respect to the 330kV cable installations and related work.

[9] Project 1480, Travelling wave fault locators.

26. Based on the information provided, we consider that:

    i. the scope of work on which the Stage 1 cost estimate is based is reasonable in that it adequately identifies the major activities required, and

    ii. the provisions for uncertainties built into the current estimate of $252.3 million over-state the required cost by around 7%, though this would still be well within TransGrid's +/- 25% uncertainty range.

1 Introduction

1.1 Purpose of this report

27. The purpose of this report is to provide the AER with our assessment of elements of TransGrid's revised capex proposal for the 2018-23 Regulatory Control Period (RCP) as set out in TransGrid's 2018-23 Revised Revenue Proposal (RRP). This assessment builds on the analysis and findings from our assessment of TransGrid's capex proposal for its 2018-23 Revenue Proposal (RP) as set out in our initial RP report[10]. For this assessment, our primary information source has been TransGrid's RRP. In addition to the RRP, we have considered:
    - TransGrid responses to Information Requests received after 29 May 2017;
    - Information provided by TransGrid during onsite meetings with the AER and EMCa on 5th, 6th and 7th of February 2018 (the RRP review onsite meetings); and
    - TransGrid responses to Information Requests received on or before 28 February 2018.

28. We have assessed those aspects of TransGrid's RRP that are directly relevant to the scope of requested work.[11] This does not take into account all factors, or all reasonable methods, for determining a capital allowance in accordance with the National Electricity Rules (NER). We understand that the AER will establish a capital expenditure allowance for TransGrid based on assessments undertaken by its own staff.

29. This report also responds to TransGrid's response to our initial RP report at Appendix A.

[10] EMCa, TransGrid Revenue Proposal 2018-23, Review of aspects of TransGrid's forecast capital expenditure, June 2017.

[11] AER, Request for Quote, 6 December 2018.

1.2 Scope of requested work

30. The scope for our assessment of TransGrid's RRP proposed capex includes:
    - Repex (including security and compliance); and
    - Economic-benefit driven augex projects.[12]

31. In addition to the above expenditure assessments, the scope also includes a review of the scope and costing for the Powering Sydney's Future (PSF) project.

32. For our RRP assessment we have not been requested to further assess TransGrid's ICT capex.

1.3 Our approach

33. Our approach to this work was as follows:
    - Desktop review of updated expenditure proposal in RRP, responses to information requests received after 29 May 2017, and TransGrid's response to our initial RP report;
    - Onsite information gathering on 5, 6 and 7 February 2018;
    - Review of responses to information requests made following the RRP review onsite meetings (and received by 28 February 2018);
    - Assessment and reporting indicative findings to the AER; and
    - Report drafting and finalisation.

1.4 Structure of this report

34. Our main findings are summarised in the executive summary of this report.

35. In the subsequent six sections, we describe our assessment and conclusions regarding TransGrid's new information in its RRP:
    - In Section 2, we provide a summary of TransGrid's revised capital expenditure in its RRP (relevant to this scope of work), and how it has changed from its RP;
    - In Section 3, we consider and respond to the new information provided by TransGrid regarding its expenditure justification methodologies;
    - In Section 4, we consider and respond to the new information provided by TransGrid regarding its revised repex categories, including security and compliance;
    - In Section 5, we consider and respond to the new information provided by TransGrid regarding its revised augex categories (relevant to our scope of work); and

[12] As defined in our terms of reference to include economic benefits driven augex, dynamic voltage support and two Ausgrid cable connection projects; our scope does not include NCIPAP projects.

- In Section 6, we provide advice on the likely prudent and efficient scope and costing for the PSF project.

36. Appendix A responds to the claims made by TransGrid in relation to our initial RP report and the evidence we relied upon to determine these findings.

1.5 Information sources

37. We have examined relevant documents provided by TransGrid in support of the projects and programs in the categories of expenditure that the AER has designated for review. These documents are referenced directly where they are relevant to our findings. In general, we have reviewed:

- TransGrid responses to Information Requests received after 29 May 2017[13] and on or before 28 February 2018;
- TransGrid's RRP; and
- Information provided by TransGrid during the RRP review onsite meetings on 5th, 6th and 7th of February 2018.

38. Unless otherwise stated, the basis of all expenditure is real June 2018 dollars and expenditure figures have been sourced from TransGrid's Capital Accumulation Model (CAM).

[13] This was the date up to which we were provided with information that we considered in our assessment of TransGrid's initial RP.

2 Background

2.1 Introduction

39. This section provides a high-level overview of TransGrid's RRP proposed capex, and how this compares to the AER's Draft Decision and TransGrid's RP. This section also responds to TransGrid's claims of errors in our initial RP report.

2.2 Overview of TransGrid's revised capex proposal

40. In its RRP, TransGrid has proposed a revised capex of $937.1 million for repex and $60.0 million for economic driven augex[14] for the 2018-23 RCP. This reflects a reduction of 3% from its RP. These figures are shown in the table below.

Table 1: Proposed capex, 2018-23 ($m, June 2018)

Expenditure Category	RP	Draft Decision	RRP	Variance (RP vs RRP)	Variance %
Repex (including security and compliance)	961.8	757.9	937.1	-24.7	-3%
Economic driven Augex	61.9	30.4	60.0	-1.9	-3%
Total	**1,023.7**	**788.3**	**997.1**	**-26.6**	**-3%**

Source: TransGrid's RP, RRP and AER Draft Decision.

41. A break-down analysis of the relevant components of our repex and augex expenditure assessments is provided in sections 4 and 5.

42. Following requests for information and onsite discussions as part of our assessment process, TransGrid has proposed further reductions to its RRP proposed capex due to the correction of errors and portfolio optimisation. We have assessed TransGrid's RRP based on the figures submitted in its RRP but have

[14] This figure includes elements of augex reviewed by EMCa including economic driven augex, dynamic voltage support project, and two Ausgrid cable connection projects. Note this figure does not include the NCIPAP projects.

noted the further adjustments made by TransGrid in our findings in sections 4 and 5.

43. In accordance with our Terms of Reference, we have reviewed TransGrid's responses to our initial RP report and its RRP, including any relevant new information. In undertaking our assessment, including the quantification of risk and the extent of any likely overestimation of expenditure (where required), we have taken account of the further adjustments made by TransGrid. We review each of these adjustments in sections 4 and 5.

2.3 Consideration of TransGrid's claims of errors in our initial RP report

2.3.1 Overview

44. In its RRP, TransGrid has referred to advice provided to the AER in August of 2017 regarding[15] "*…more than thirty factual and interpretative errors*" following its review of our initial RP report. TransGrid added that[16] "*(t)he EMCa report contained more than 30 factual errors but the AER published it uncorrected and relied on the report to support many of its own conclusions.*"

45. In August 2017, TransGrid provided AER a review of our initial RP report[17] comprising claims of: (i) errors in fact; (ii) errors in interpretation; (ii) opinions; and (iv) updated information.

46. We refute all except four of TransGrid's claimed errors. Our assessment of TransGrid's claims is summarised in the following sections. We conclude that consideration of the claimed errors would not have led us to form a different opinion in our initial RP assessment.

2.3.2 Review process

47. The findings in our initial RP report were based on information provided to us by TransGrid at the time of preparing that report. This included TransGrid's RP (and supporting material), information provided at the RP review onsite meetings, and also responses to our information requests. We based our findings on information available to us at the time the findings were made, and which was stated in our report; however, TransGrid responded to many of our information requests after we had concluded our report.

48. Where TransGrid has supplied new information following our report for the initial RP process, we have taken this new information into account in the assessment that we document in the current report.

[15] TransGrid RRP, page 38.

[16] TransGrid RRP, page 44.

[17] TransGrid, TransGrid Response, EMCa Report to AER – Review of Aspects of TransGrid's Forecast Capital Expenditure, August 2017.

49. In comparing TransGrid's claims of 'errors' against the text in specific paragraphs from our initial RP report that TransGrid references, in most cases TransGrid has not explained what 'error' has occurred. Rather, we observe additional information or TransGrid expressing a difference of opinion. We have nevertheless taken the information and opinions that TransGrid has provided into account in reviewing the findings for the current report.

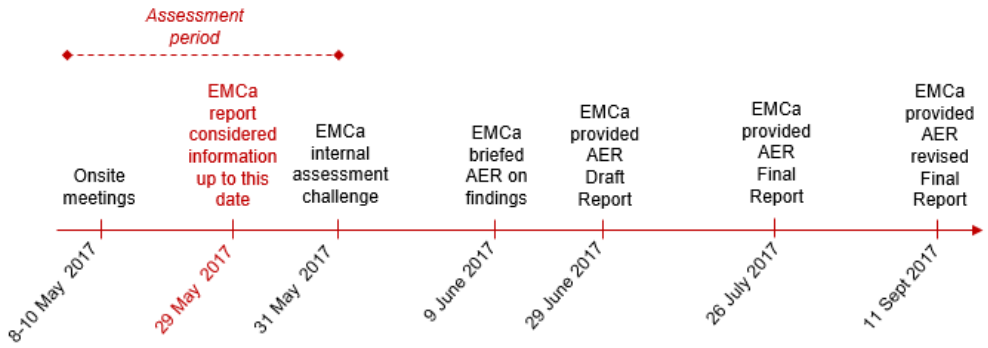
2.3.3 Our RP assessment timeline

50. The figure below outlines the RP assessment timeline that we followed. This shows the period available to EMCa to undertake our assessment, and make our findings, allowing time to document the findings for the AER by 29 June 2017. Our assessment was undertaken in the period up to 29 May, as is documented in our RP report. However, we understand that TransGrid continued to provide information to the AER after that date.

51. In accordance with our Terms of Reference, our Draft Report on TransGrid's initial RP included the outcomes of our assessment and was provided to the AER for final review. This allowed time for the AER to complete its own assessment in the knowledge that our assessment was complete.

52. In response to feedback received from the AER, we clarified some aspects of our report and provided a Final version of our report on 26 July 2017. TransGrid provided AER with its review of our report after that finalisation date. The AER subsequently requested that we generate a Public version of our Final Report, which was provided on 11 September 2017.

Figure 1: Assessment timeline



2.3.4 Our assessment of TransGrid's claims

53. EMCa has reviewed all TransGrid's claimed errors. The table below shows the total number of claims by TransGrid. The adjacent column shows the count of claimed errors we have assessed as errors, based on information available at the time of our initial RP report.

54. Where an error has been identified, we have assessed its impact, and we have concluded that the four acknowledged errors that TransGrid has identified would not have affected our findings.

55. To the extent that TransGrid provided new information in the review of EMCa's initial RP report that it provided to the AER in August 2017, we have considered this

information in our RRP assessment (i.e. the current report). Where TransGrid has expressed an opinion in that review, we have also taken this into account in our RRP assessment.

Table 2: EMCa assessment of TransGrid's claims[18]

Description of TransGrid Claim	Number as claimed by TransGrid	Number as assessed by EMCa	EMCa paragraph No
Error in Fact	35	4	105, 245, 295 and 338
Error in Interpretation	26	0	

Source: EMCa analysis of TransGrid's list of claimed errors

56. Our response to each of TransGrid's claimed errors is provided at Appendix A.

[18] Note this table includes two claimed 'errors in fact' relating to IT Capex which was reviewed in our initial RP report, but which has not been reviewed in the current report.

3 Expenditure justification methodologies

3.1 Introduction

57. In this section, we describe our assessment of the information provided in TransGrid's RRP on relevant expenditure forecasting methodologies. Specifically:
    - Aspects of TransGrid's risk-cost methodology, which TransGrid has relied on for project-level justification, and which it claims EMCa and AER misunderstood; and
    - TransGrid's overall portfolio assessment methodologies and the extent to which this corroborates its proposed expenditure program at an aggregate level.

3.2 Assessment of TransGrid's risk-cost analysis

3.2.1 Risk-cost methodology

TransGrid's claims

58. TransGrid states that "…the AER concluded that our use of "**worst case**" risk assumptions in risk analysis is "**overly risk averse**" and so "**capital expenditure is likely to be overstated** (Draft Decision 6-3)." TransGrid asserts that "(t)his appears to be based on a poor understanding of our actual approach."[19]

59. TransGrid claims that "*Input values (are) used out of context to support program-wide cuts*". To illustrate its assertion, TransGrid shows how a bushfire consequence cost of $400 million is moderated by the probability of asset failure and by the

[19] TransGrid RRP, page 38. Emphasis is as shown in the RRP.

likelihood of consequence of that failure.[20] Elsewhere in its RRP (page 66), and as we find in TransGrid's other supporting documentation, TransGrid moderates the Consequence of Failure (CoF) by the Likelihood of Consequence (LoC) only and it appears that TransGrid's illustration in its RRP is itself a mis-statement of its methodology.

TransGrid's risk-cost methodology

60. In Figure 4.12 in its RRP, TransGrid describes its quantification of risk cost as being based on the Probability of Failure (PoF), LoC and CoF. TransGrid assesses a number of risk dimensions, with three primary dimensions: safety risk, reliability risk and environmental risk. The aggregate risk-cost for a project is summed for the 'base case' and 'options' and the difference, being the 'avoided' risk-cost, therefore represents the assessed benefit of undertaking the project.

61. EMCa described this risk-cost methodology in our initial RP report.[21] There is also extensive reference in our initial RP report to risks having been 'moderated' in TransGrid's analysis, by the LoC and PoF factors referred to above. There is no new information provided in TransGrid's RRP that is inconsistent with our understanding of TransGrid's risk-cost methodology and TransGrid has stated that "*EMCa has correctly reported the methodology applied…*"[22].

62. In its RRP, TransGrid has not specified the aspects of its methodology that it claims EMCa misunderstood. From careful scrutiny of TransGrid's RRP, and of the list of claimed errors and misunderstandings that TransGrid provided to the AER subsequent to being provided with our initial RP report, and from our discussions with TransGrid during the RRP review onsite meetings, we cannot discern any misunderstanding of TransGrid's risk-cost methodology.

63. The concerns that we highlighted in our initial RP report relate to TransGrid's application of this methodology as evidenced by the project documentation it provided to us for review. This includes concerns regarding TransGrid's evidence for certain key assumptions that, in our assessment of its RP, we considered to "*…reflect a bias for over-estimation of risk and therefore a bias to over-estimation of TransGrid's capex forecast.*"[23] We now reassess those findings based on the further information that TransGrid has provided.

CoF – 'use of 'worst case'

64. TransGrid states that it "*…uses a moderated 'worst case' consequence to value risk*." Whilst EMCa has (in our initial RP report) already taken into account that the risk cost methodology involves factors which moderate these consequence costs, our concerns with TransGrid's selection of worst case consequences remain.

[20] TransGrid RRP, page 39.

[21] For example, in Section 3.4.1 of our initial RP report. The methodology is also extensively referenced in our assessment of TransGrid's analysis for specific projects.

[22] TransGrid, TransGrid Response, EMCa Report to AER – Review of Aspects of TransGrid's Forecast Capital Expenditure, August 2017, page 4. For completeness, we note that the remainder of TransGrid's sentence is that "*…(EMCa) appears to not recognise this is consistent with good asset management and risk management practice.*" This is incorrect, as evidenced by the fact that EMCa's RP assessment was made using the risk-cost methodology that TransGrid described in its proposal.

[23] EMCa RP report, paragraph 6.

65. While the possibility of 'worst case' consequences cannot be dismissed, TransGrid creates a challenge for itself in determining appropriate moderating factors for such extreme events, particularly where they have never occurred in TransGrid's history or from 'like events' in the combined history of electricity transmission utilities in Australia. As a result, TransGrid has in many instances been unable to substantiate the moderating factors that it has used. Examples of this include moderation of extreme bushfire risk and moderation of the risk of failures leading to 'system black' for the whole state of NSW or for the whole of Sydney. TransGrid has adopted assumptions without evidence for these likelihood values.

66. From these assumptions, the risk costs that TransGrid determines in some cases far exceed our expectations from the transmission management experience of our team members, or what we have observed in applications of risk cost methodologies in other Australian transmission utilities. As we observed in our initial RP report, where the assumptions suggest payback periods of less than a year, this would further suggest either that TransGrid's assessment of its risk costs is not consistent with its management practices because it has not considered it necessary to address these risks, or that TransGrid has been carrying an unwarranted amount of risk[24].

67. In Section 3.2.2 we assess TransGrid's bushfire risk cost, as we have determined that TransGrid's risk cost bias for this factor has resulted in a material over-statement of its required expenditure.

Likelihood of Consequence (LoC) and moderating factors

TransGrid's application of moderating factors

68. The primary moderating factor in TransGrid's application of its risk cost methodology, is the likelihood that, given the relevant 'failure', the consequence will occur. However, TransGrid applies other moderating factors – for example allowing for progressive restoration of supply, or factors moderating the risk of a fatality from a failure that might otherwise have the potential for such an outcome. Conceptually, moderating factors can be taken into account within the CoF or the LoC calculations, and we observe some variation within TransGrid's presentation of its projects. This is not in itself a concern, as long as the moderating factors are considered appropriately within the overall risk cost calculation[25].

69. The following aspects of risk-cost calculation arise in TransGrid's risk-cost analyses. TransGrid has not provided sufficient information for assessment of these matters in the RRP itself, therefore our assessment also relies on responses to Information Requests that the AER submitted on our behalf, as well as observations from our assessment of TransGrid's application of these factors to sample projects.

[24] In its RRP, TransGrid incorrectly inferred that EMCa endorsed payback analysis in preference to NPV analysis. This is not the case. However, a payback period of less than a year is clear evidence of a project with a very high NPV, relative to cost.

[25] For example, a 10% likelihood of a CoF of $10m produces the same risk cost as a 100% likelihood of a CoF moderated to a lower cost $1m outcome (such as through consideration of factors that will result in less impact).

Conditional probabilities – multiple contingencies, as independent events

70. There are two types of instance where conditional probabilities typically arise in assessing the LoC in risk-cost assessment.[26] The first situation arises where the 'consequence' (which may be a supply outage) is a function of the time for which the two components are in failure mode, and as soon as one component is restored, the consequence ceases. Transformer outages are examples of this.

71. In the second situation, if failure of a parallel component occurs while the first is in failure mode (i.e. having failed but not having been repaired), then this causes a 'consequence' (such as a supply outage) which is not then necessarily related to the time for which the two components remain in failure mode. A protection failure is an example of this situation.

72. In both situations, the relevant annual risk cost is a function not only of the probability that any of the relevant components fail in a year, but also the mean time to repair those failures. This is because the relevant service interruption occurs only when a component fails during the 'repair' time after a first component has already failed.

73. The relevant formulae differ because in the first case the consequence cost is a function of the repair time, whereas in the second case it is not.

74. In Table 4.9 of its RRP, TransGrid describes its approach to moderation of risk cost for transformers and this description is consistent with the theory. In sections 4 and 5, we describe our review of TransGrid's application of conditional probability in its risk cost calculations. This is relevant to its assessments of risk costs for transformers, protection systems, switchgear and lines. For a sample of projects covering each of the relevant asset categories, we sought to reconcile TransGrid's LoC calculation methodology to the formulae required for such situations.

75. While there is some variation in TransGrid's order of calculation and what it includes in each of the components of PoF, LoC, and CoF, we found that its application of its calculations for repex was correct. For some augex projects we consider that it has not applied a correct methodology. We describe this in our assessment in Section 5.

Hazard zone occupancy

76. Where a safety risk is being assessed, it is necessary to properly define the risk that the 'failure' leads to the 'consequence'. A fatality does not necessarily result from explosive failures in a substation or collapse of a tower or from a dropping conductor. Within a substation, the risk needs to be moderated for example by the probability of a person being within the substation, and then further by the person being within the hazard zone, being in proximity of the equipment whose failure risk is being assessed. Within that hazard zone, there may be a further moderation as to the risk of any injury being fatal.

77. For lines, similar logic applies. The risk is first moderated by the probability that a person is in proximity to the line, and further by the probability that they are

[26] For simplicity, in this section we will refer to parallel components installed to N-1 security – i.e. where failure of one component does not lead to failure of the 'service' supplied by the two components, but the service fails when both components are in failure mode at the same time.

sufficiently close to the location of the failure being a structure or conductor, to be at risk. Finally, there may be a further moderation as to the risk of any injury being fatal.

78. EMCa queried an apparent bias in TransGrid's calculations for lines hazard risks. TransGrid replied in an information response acknowledging that in its RRP, it had overstated the fatality risk by failing to properly define the relevant hazard zone[27]. In Section 4 we address the impact of this bias, along with the impact of other moderating factors.

Restoration times and the impact of progressive restoration

79. Where a customer interruption occurs, we understand that TransGrid follows industry practice in seeking to progressively restore supply where possible. TransGrid's normal customer impact mitigation strategies need to be taken into account in moderating the risk cost.

General comment on risk moderation

80. Management of an electricity grid constantly involves measures to mitigate risk. This particularly includes mitigation of safety risks, environmental risks and risks of customer interruption, notwithstanding the reality that equipment failures can and will occur from time to time. The assumptions in the LoC and in the CoF estimates need to model realistically the risk mitigation measures that TransGrid has in place and/or would prudently adopt in the 'failure' circumstance being modelled.

Probability of Failure (PoF)

81. As we observed in our initial RP report, for the most part we find that TransGrid's PoF assumptions are supported by evidence. It is important that historical evidence of failures, used in determining failure rates for predictive purposes, are events of the type that potentially cause 'consequences' consistent with the risk cost assessment. This distinction is explicitly recognised in some of TransGrid's information, although it is unclear in other cases as discussed in sections 4 and 5.

3.2.2 Significant risk cost consequence assumptions

Bushfire risk cost

82. On page 39 of its RRP, TransGrid purports to show how its bushfire consequence cost of $400 million has been used out of context on what it claims is an unreasonable basis. TransGrid's explanation in the highlighted box on this page, is that the risk is moderated by the PoF and by the LoC. Both these moderating factors are well-recognised by EMCa in our initial RP report and by the AER in its Draft Decision as components in the overall risk-cost methodology.

83. In its explanation of its moderation of the $400 million 'starting point' to produce an 'average bushfire risk cost' of $2.9 million per incident, TransGrid includes the 'Probability of asset Failure' as well as the 'Likelihood of Consequence'. However, on page 66 of its RRP, TransGrid describes the moderating factor of 0.7% that

[27] In TransGrid IR050/Q9, page 2, TransGrid states: '*Upon further review of the risk calculations it has been identified that the safety LoC has been used on a per span basis rather than on a per transmission line basis. This results in a reduction in the risk associated with all transmission line projects*.' TransGrid then identifies two projects which are not justified once this bias is removed...

results in the derived cost of $2.9 million as being solely the LoC. TransGrid more commonly uses the word 'moderated' to describe its moderation of risk **in the event that a failure occurs** – in other words through factors in its LoC and CoF – and we consider this to be a more accurate description of the methodology it has applied and described throughout the many documents we have reviewed.

84. Because of the errors and incomplete descriptions in TransGrid's RRP, we sought further information on bushfire risk cost assumptions. TransGrid provided its response to IR050/Q7, which sets out TransGrid's full risk cost calculations for an example (Line 86), and information on the historical incidence and cost of bushfires in NSW. TransGrid also provided bushfire risk cost information in its response to IR047.

85. From our inspection of TransGrid's bushfire risk cost calculation spreadsheets and from a worked example TransGrid provided in response to our information request[28], we can see that TransGrid's reference on page 66 of its RRP to LoC being the sole moderating factor, is correct, and that TransGrid's purported explanation on page 39 is erroneous. We also observe that TransGrid's description of this cost on page 39 as being 'per transmission line' is erroneous, and that the cost TransGrid derives there represents a cost 'per failure'.

86. TransGrid presented us a list of 'significant' bushfire events covering NSW and ACT, for 50 years back to 1968[29]. The cost of the smallest of these 'significant' fires was assessed at $6 million while the largest, the Canberra ACT fires in 2003, had a cost of $765 million. From this data, TransGrid deduces an 'average' major fire consequence cost of $160 million, and an average frequency of once every 5 years.

87. In its response to IR050/Q7, TransGrid did not advise if it was responsible for any of these significant fires. From the very wide spread of data, it can be seen that different ways of interpreting this data would result in very different estimates for both the CoF and LoC of bushfires. For example, if the Canberra ACT 2003 fire data was considered to be an outlier, then the average consequence cost derived from this data would drop from $160 million to around $100 million. Given the skewed nature of the data, it could also be considered that the median value is more relevant than the mean; the median value is $63 million.

88. Fifty years of historical data seems to suggest 'worst case' fire cost consequence assumptions for TransGrid would be of the order of $100 million or less rather than $400 million. Moreover, TransGrid has not identified whether it has caused any fires of this magnitude within the past 50 years.

89. TransGrid illustrates its moderation of this cost in its response to our information request[30]. In brief this comprises:

- A factor of 0.2 to account for a one-year-in-five likelihood of major NSW bushfire weather conditions;
- The proportion of days in such a year that are 'Bushfire Danger Days', and which is region-specific; and

[28] TransGrid IR050/Q7, page 6, Table 2.

[29] TransGrid IR050/Q7, page 4, Table 1.

[30] TransGrid IR050/Q7, page 6, Table 2.

- A fire propagation score, and a fire impact score – both of which are line-specific.

90. The product of these factors gives a LoC factor, which is specific to each line. The derivation of these factors appears reasonable when applied to a CoF such as we have derived from TransGrid's NSW fire data as above. However, as we describe further below, we consider that it overstates the likelihood that a line failure causes a bushfire with the much higher CoF that TransGrid has assumed.

91. On page 1 of its IR050/Q7 response, TransGrid states that it has on average three 'transmission line failures' per year and, in Table 1 of this same response, it shows that lines failures have started four fires in five years. In other words, four fires have resulted from around fifteen lines failures, or a ratio of around 1 in 4, and the remaining lines failures have not caused a fire. TransGrid's risk cost calculations assume that any line failure occurring under the conditions that it allows for in its LoC calculation, will lead to a fire. In our experience, there is a considerably lower risk of transmission line failures causing a fire compared with distribution line failures[31]. Nevertheless, for the purpose of the current analysis, we consider that TransGrid's assumption is reasonable in this respect, given that its LoC calculations already assume that a fire will result only under the combined conditions of high risk fire impact and fire propagation in 'one-in-five-years' bushfire risk circumstances.

92. In its table on page 1 of its IR050/Q7 response, TransGrid shows that all seven fires that it has caused in the past 5 years[32] have had a cost of less than $100,000 each. We consider it reasonable to consider the risk of a 'worst case' fire, despite TransGrid not having provided evidence of having caused one. However, correcting the 'worst case consequence' to a value that can be reasonably inferred from the 50 years of NSW bushfire data that TransGrid has provided, results in a 'moderated' risk cost that would be a quarter, or less, of the value that TransGrid has used in its analysis[33]. In Section 4, we assess the implications of this finding for TransGrid's proposed transmission lines repex.

93. While we consider that it is preferable not to use an extreme CoF assumption that is unsupported by relevant evidence, we have nevertheless considered TransGrid's LoC moderation of the CoF value of $400m that it has used. TransGrid has assumed that the risk of a 'worst case consequence' applies on bushfire danger days that are defined as 'very high', 'severe', 'extreme' and 'catastrophic'. In the example it has provided[34], there are 37 such days per year and it has assumed that any line failure on such a day in a 'high bushfire danger' year, in an environment with high-risk fire propagation and fire impact characteristics, will inevitably cause a 'worst case' fire with a consequence cost of $400m.

94. If TransGrid was to assume that a 'worst case' fire consequence of this magnitude would result from a line failure on 'severe', 'extreme' or 'catastrophic' bushfire

[31] We refer to this in our initial RP report, paragraph 101.

[32] In addition to the four fires caused by lines events, TransGrid reports that a further three fires were caused by substation events.

[33] Derived from $100m/$400m, or $63m/$400m 'worst case consequence' values. This would imply an average moderated consequence cost of between 63/400 x 2.9 = $0.46m and 100/400 x 2.9 = $0.73m per failure. This compares with TransGrid's value of $2.9m per line failure.

[34] TransGrid IR050/Q7, page 6, Table 2.

danger days, (i.e. excluding 'very high' fire danger days), then TransGrid's data shows that there are only between one and six such days per year (depending on region), and the LoC would be correspondingly lower[35].

Value of Statistical Life (VoSL)

95. Where safety is a relevant risk, TransGrid used an assumed Value of Statistical Life (VoSL) of $10 million in its RP supporting documentation. In EMCa's initial RP report, we stated our view that TransGrid did not provide sufficiently compelling information to support the use of this figure, and we noted that the report that TransGrid itself had largely relied on provides an Australian VoSL figure of $6.9 million in 2017 dollars[36].

96. TransGrid reiterates this assumption in its RRP[37]. However, at our onsite, TransGrid stated that it would re-present its proposed program using a VoSL of $6.9 million.[38] It has since done so, and the resulting reductions in its required program are accounted for in Section 4.

Value of Customer Reliability (VCR)

97. For its reliability-related risks, TransGrid has used 'industry' values of the Value of Customer Reliability (VCR). This is a reasonable assumption in most circumstances, the exception being where the load at risk is clearly not analogous to the 'typical' loads considered in these industry-wide averages. In our initial RP report we listed a range of concerns with the application of this value[39] and these concerns remain.

98. In reviewing TransGrid's RRP background information on risk cost for protection systems, TransGrid has used a VCR value where its stated consequence is 'loss of two generators'. The VCR cost applies to loss of load and it is not valid to apply this value to the cost of incremental generation, which is several orders of magnitude lower.

99. In sections 4 and 5, we consider the impact of these concerns with the application of VCR, on TransGrid's proposed expenditure.

3.2.3 Inconsistencies between TransGrid's risk cost explanations and its calculations

100. TransGrid describes its methodology as involving the three factors: PoF, LoC and CoF.

101. In reviewing its application of this methodology, we observed misleading labels and inconsistencies in what was described as PoF, LoC and CoF. We have not

[35] TransGrid data from 2012 to 2015, as provided in TransGrid IR047.

[36] EMCa initial RP report, paragraph 98.

[37] For example, in RRP Table 4.8.

[38] Presentation to EMCa, Portfolio Optimisation and Project Timing.

[39] EMCa initial RP report, paragraph 99.

identified erroneous results arising from these, however they present a risk of error to future users of the analysis. Examples are:

- Bundling of LoC and CoF values into 'risk costs per hour', without it being clear whether these are continuous risk-costs, or risk costs that apply during the assumed repair or replacement time following a failure, or risk costs that apply prior to any reinstatement of service (which may be less than the repair or replacement time);
- Inclusion of an 'average load factor' (of 0.65) into the LoC, whereas it is more properly a factor in calculating the CoF;
- Use in TransGrid's models of entirely synthesised data, for example for MW load lost and/or hours off supply, and which are completely unrelated to the accompanying project documentation. TransGrid explains that this data is required to overcome limitations in the capability of its investment risk tool and, after being provided with this explanation, we confirmed for a sample of such calculations that the 'wrong' assumptions were nevertheless synthesising the 'correct' outcome; and
- Risk cost analysis and the economic analysis resulting from it, being undertaken in multiple spreadsheets that appeared not to be directly linked.

3.2.4 Corrected calculation of annualised capex for ALARP

102. In our initial RP report we considered that inclusion of a test to assess whether the cost was disproportionate to the benefits of the proposed projects was reasonable. TransGrid has proposed its network safety test to undertake this assessment including adoption of disproportionate multipliers.

103. We considered that TransGrid should include the cost of capital when annualising the cost of the investment for use in its ALARP test. TransGrid has advised that it has[40] "*… revised the ALARP methodology to include the cost of capital (using 6.75%). This correction has led to the reduction in scope of two projects and a reduction in the replacement expenditure of $0.95 million*."

104. We have not been provided with information to verify that this has been correctly applied to all affected projects. In section 4 we comment on specific projects that are no longer justified when this change (which has the effect of increasing the annualised capital cost) is combined with other changes to the application of its risk cost methodology (which has the effect of decreasing the benefits). In Section 5, we describe further impacts of this correction.

3.3 Portfolio assessment

3.3.1 The role of portfolio assessment

105. 'Top-down' assessment of the overall portfolio of projects and programs provides a significant and worthwhile step in governance and review, by providing information that helps in answering:

- What aggregate outcomes does the program achieve?

[40] TransGrid RRP, page 77.

- How do these outcomes compare with the investment required to achieve them?
- What are the 'marginal' projects and has the 'cut-off point appropriately included and excluded the 'right' projects?
- Are there project 'synergies' that might be harnessed to reduce delivery costs for the program in aggregate?

106. We cover our assessment from this perspective in the following subsections.

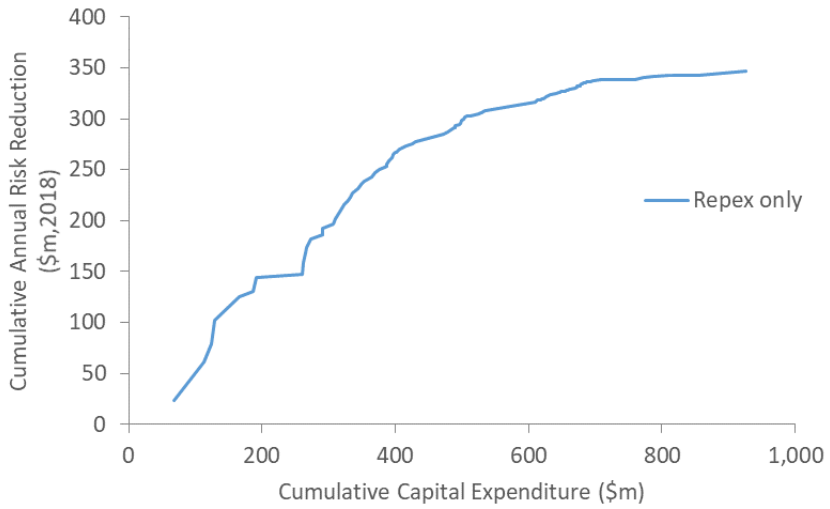
3.3.2 Portfolio-level justification

Cumulative risk cost versus capex for proposed projects

107. In our initial RP report, we stated that we observed an *'(a)bsence of a rigorous top-down challenge to (TransGrid's) portfolio'*[41]. Absent such evidence, we sought information from TransGrid through an information request, and we produced Figure 16 in that report as an illustration of the kind of portfolio assessment that can be helpful. TransGrid has presented a corrected and updated version of this graph, as Figure 4.4 in its RRP.

108. TransGrid has provided updated data to us in response to further Information Requests[42], and we have used this data to facilitate further top-down review. The revised data is presented in the figure below. While the updated scale helps with interpretation of this data, the message is essentially the same as we stated in our initial RP report, namely that '…*the cumulative risk cost savings flattens for increasing capex*' and that '…. *the general shape of the relationship suggests that there may be an opportunity to test that the level of capex is optimised.*'[43]

Figure 2: Capital expenditure versus cumulative annual risk savings



Source: EMCa graph, from TransGrid data in response IR50-Q6

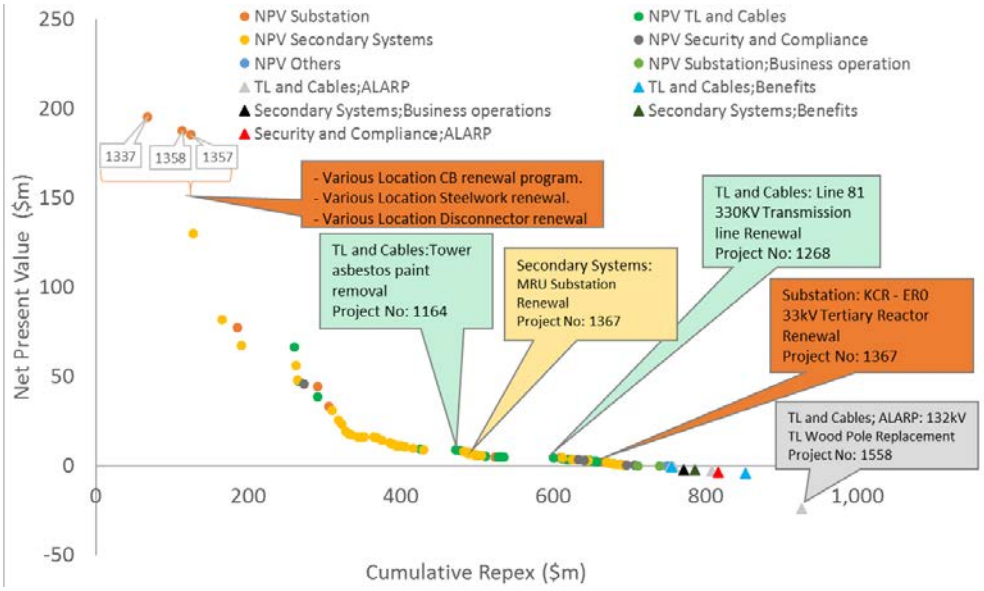
[41] EMCa Initial RP report, paragraph 10.

[42] TransGrid IR050 - Q4, Q5 and Q6.

[43] EMCa Initial RP report, paragraph 188.

109. We undertook further analysis to plot the NPV of the portfolio against the cumulative repex, with projects sorted in diminishing NPV.

Figure 3: Cumulative Repex versus NPV



Source: EMCa analysis from TransgRid response to IR050-Q6

110. While some of the proposed projects have a negative NPV and have been justified based on ALARP or other criteria, almost all of the positive NPV risk cost benefits arise from around half of the proposed repex program, and the incremental net benefit of the remainder of the proposed program is relatively low. We consider that TransGrid's assertion that a reduction relative to its proposed program would '*…increase the risk of loss of supply events, lead to higher asset lifecycle costs and has potential safety and environmental impacts'* and that it would *'increase risks for customers and the community'* is misleading in materially overstating this risk. It does not demonstrate that the investment cost is justified.

111. We consider that an effective governance process would have involved identification and more detailed scrutiny of projects at the marginal end of the spectrum and a realistic appraisal of the risk cost implications of incremental and decremental investment levels relative to the proposed program. We have not been provided with evidence of such a process. This leads us both to apply greater scrutiny of the large element of proposed expenditure that appears to provide marginal benefit; secondly, it indicates to us that if TransGrid was to incur a materially lower repex than it has proposed, the risk cost outcome would not be significantly higher.

Aggregate risk cost reduction from proposed program

112. Following a presentation at the onsite of TransGrid's pre-investment and post investment risk cost, we sought further information as this appeared as if it might provide a measure of the change in TransGrid's aggregate risk cost over the next RCP, resulting from the proposed expenditure. However, TransGrid's response (IR50/Q4) explained that this data was a 'snapshot' for 2021, that only took account of the proposed projects included in the RRP expenditure forecast. TransGrid's explanation in effect is that this is the aggregate across all projects of '*…the benefit to consumers in the first year after the project*.'

113. It is unclear why TransGrid presented this information; in our view it has limited relevance and TransGrid's response essentially cautions as to what this information does not represent.

114. It appears that it would be possible, from TransGrid's risk assessment tool to quantify its aggregate risk cost across its whole system prior to the commencement of the RCP, and at the end of the RCP assuming (1) the proposed program of work and (2), by way of a counterfactual, if none of the proposed work was undertaken. For context, this would allow comparison of the proposed risk cost to be addressed, against TransGrid's aggregate current risk cost and would show the movement in that aggregate risk cost over the next RCP, with and without the proposed program.

115. This information would assist with justification of the proposed program. However, it appears not to have been prepared and therefore has not formed part of TransGrid's governance process.

Aggregate risk cost by asset category

116. We sought information on the pre-investment risk cost for the assets for which investments are proposed in the next RCP.

117. In its response[44], TransGrid states that the pre-investment risk cost for the relevant assets in 2017 is $46 million for transmission lines, $46 million for substations, $271 million for secondary systems and $6 million for security. Without the proposed expenditure, TransGrid calculates that the annual risk cost for the relevant transmission lines and substations would rise to $67 million and $60 million respectively by 2021[45], but that the risk cost for secondary systems and security would remain the same.

118. TransGrid's information is that its risk cost from secondary systems comprises two-thirds of all of the risk-cost that the proposed program will address. As we noted in our initial RP report, this would suggest that the entire secondary systems program that TransGrid has proposed will pay back within one year. If TransGrid's risk cost estimate is valid, then it would logically follow that the proposed secondary systems program should be commenced immediately and undertaken as quickly as possible. It is, in effect, overdue. In Section 4, we have therefore focused particular attention on TransGrid's secondary systems risk cost assessment.

Sensitivity analysis

119. As it did in the RP, TransGrid has undertaken Monte Carlo analysis in which it modelled a range of risk cost outcomes based on varying input parameters.

120. Monte Carlo analysis is a potentially useful tool for understanding the sensitivity of a proposed forecast to the underlying assumptions. In this instance, however, TransGrid has presented only the 'P50' value in its RRP, and which it states is 0.75% less than the amount it has proposed in its RRP.

[44] TransGrid-IR50/Q5.

[45] TransGrid appears to draw an erroneous conclusion from this data, where its states (on page 2 of TransGrid IR50/Q5) that these are the increases in risk cost '*(o)ver the five year RCP period…*', when the period from 2017 to 2021 is a four year period to the mid-point of the next RCP.

121. This result would appear to be simply a mathematical result arising from some probability distributions not being symmetrical. It would be of more relevance for TransGrid to have used its Monte Carlo analysis to indicate the resulting aggregate probability distribution - for example by showing P10, P25, P75 and P90 values. If undertaken with valid central assumptions and associated probability functions, such analysis would have provided an indication of the level of confidence in the scale of the program that TransGrid has put forward.

3.3.3 Timing optimisation and claims regarding economic justification

122. TransGrid has erroneously claimed that, by selecting projects with a positive NPV, it has optimised their timing. This is incorrect.

123. In its RRP, TransGrid has made two statements which illustrate the erroneous conclusions that it has drawn from its analysis:

> *"…each project in the forecast...has a positive net benefit. This indicates that project timing is optimised."*[46]

124. TransGrid states that it agrees with the statement from the AER's Draft Decision (6-75) that "(t)he economically optimum project implementation time is when the annual risk cost exceeds the annualised cost of avoiding/mitigating the risk."[47] In Figure 4.16 of its RRP, TransGrid illustrates this and states that this is "…the point which maximises the net benefit of the investment."[48] We concur with this statement. However, the project timing that maximises the NPV is not equivalent to claiming that including projects with a positive NPV indicates that timing is optimised.

125. We refer to the following diagram, which is conceptually similar to that which TransGrid has provided in Figure 4.16 of its RRP. The blue line shows the NPV of an illustrative project, which is plotted above the annuitised risk cost of treatment and an annual risk cost (which is assumed to rise over time). The maximum NPV is obtained if the project is undertaken in the year in which the annual risk cost first exceeds the annuitized cost of treatment – which in this case is around year 4. However, importantly, the project does have a positive NPV even if it is undertaken prior to this optimum timing.

126. TransGrid's Figure 4.16 similarly shows a positive NPV (though not the 'maximum NPV) if the project in its illustration is undertaken prior to the optimum year (being year 3 in its example).

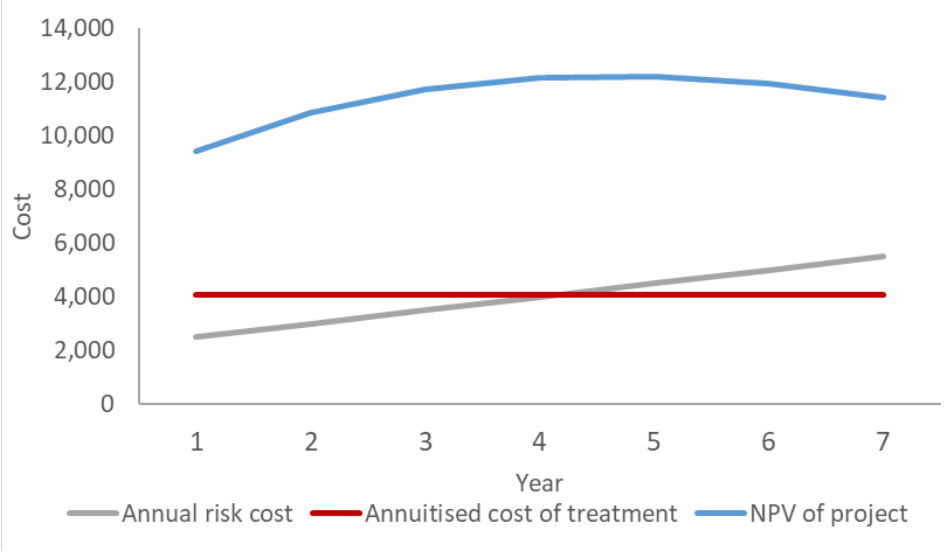
127. We reiterate the conclusion from our assessment of TransGrid's RP, that TransGrid has not provided evidence of having optimised the timing of its proposed projects. By conflating the inclusion of 'projects with a positive NPV' with a claim that, therefore, those project timings are optimised, TransGrid has not demonstrated that the timing of its proposed work program is justified.

[46] TransGrid RRP, page 74.

[47] Ibid

[48] Ibid

Figure 4: Project timing optimisation - illustration



Source: EMCa illustration

3.3.4 Delivery optimisation

128. Subsequent to its RRP, TransGrid has undertaken a portfolio-level assessment to optimise delivery of the proposed program, and as a result has subsequently made a $12.2 million reduction to its RRP proposed capex.

3.4 Summary

129. TransGrid has confirmed that EMCa's understanding of its risk cost methodology is correct. In sections 4 and 5, we provide our assessment of TransGrid's application of this methodology in seeking to justify its proposed expenditure requirements for the next RCP.

130. As we found in our initial RP assessment, we consider that TransGrid's RRP exhibits a degree of bias towards over-estimating risk that arises from certain assumptions that TransGrid has made. We remain concerned that TransGrid's approach of using 'worst case' consequences makes it impossible for TransGrid to evidence their 'likelihood' to a reasonable standard. However, we consider that these biases exist and have material impacts only for pockets of the proposed expenditure, which we highlight in sections 4 and 5.

131. For example, the further information that TransGrid provided at our request subsequent to the RRP, reinforces our finding that TransGrid has significantly overstated bushfire risk costs. This has led it to materially overstate an element of its proposed expenditure.

132. At the portfolio level, TransGrid has undertaken a delivery optimisation assessment subsequent to the RRP review onsite meetings and has now proposed a lower expenditure requirement than it seeks in its RRP.

133. TransGrid has not meaningfully used portfolio-level aggregate risk cost analysis, which it could have used to justify the cut-off for which projects to include and which to exclude from its proposed program. It has also mis-construed the implications of its own analysis in claiming to have optimised the timing of its projects. We consider

that when TransGrid does optimise the timing of its proposed projects, and identifies and more carefully assesses the net benefits of the more marginal projects, it is likely to spend less than it has currently proposed in its RRP. Further, and contrary to its claims in its RRP, this reduced program will have very little risk cost impact.

4 Assessment of new information on repex including security & compliance

4.1 Overview

134. In this section, we review the new information provided in TransGrid's RRP as it relates to its repex forecast including security & compliance, and we provide our findings as updated from our initial RP report.

135. TransGrid has proposed a revised total repex forecast in its RRP[49] as presented in the table below. Total repex is $937.1 million, comprising $888.6 million condition & risk driven and $48.5 million security and compliance driven. TransGrid's RRP reflects a $24.7 million reduction in total repex compared to its RP.

[49] The expenditure forecast was derived from information provided in TransGrid's RRP CAM.

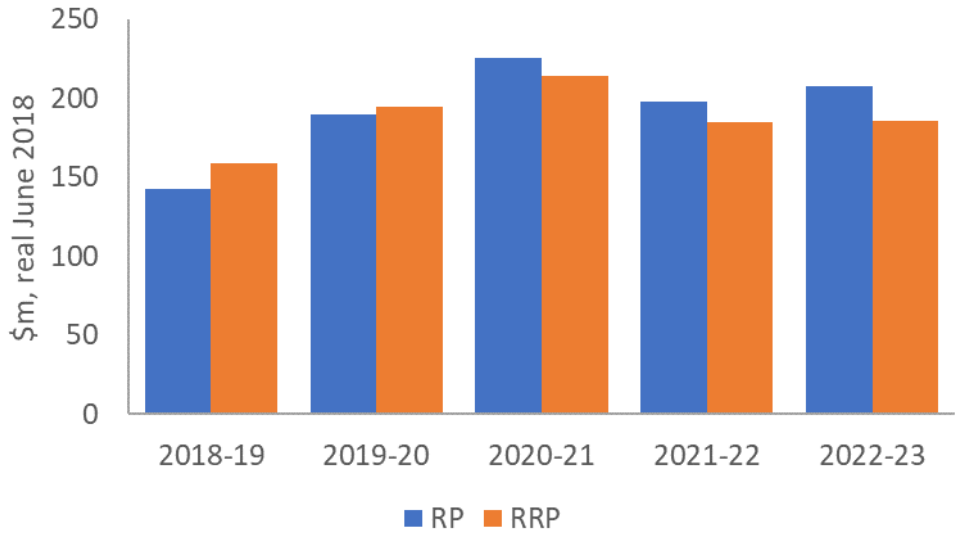
Table 3: Summary of revised repex ($m, June 2018)

Project category	RP	RRP	Variance (RP vs RRP)	Variance (%)
Transmission lines	342.6	335.9	-6.7	-2%
Substations	308.5	304.3	-4.2	-1%
Secondary systems	191.0	184.3	-6.7	-4%
Communications	52.8	51.3	-1.5	-3%
Uncategorised	12.9	12.8	-0.1	-1%
Security & compliance	54.0	48.5	-5.5	-10%
Total	**961.8**	**937.1**	**-24.7**	**-3%**

Source: EMCa analysis based upon comparison of TransGrid's RP CAM and RRP CAM

136. As noted in its RRP,[50] only $9.2 million of the reductions are associated with discrete changes to the scope of project expenditure and the remainder of the reductions are due to changes in TransGrid's treatment of inflation and labour escalation. From the figure below, we observe what appears to be a reprofiling of the expenditure throughout the RCP, and this reprofiling can also be observed at the asset category level as shown in the table below.

Figure 5: Differences in proposed repex ($m, June 2018), between RP and RRP



Source: EMCa analysis based upon comparison of TransGrid's RP CAM and RRP CAM

[50] TransGrid's RRP, page 78.

Table 4: Summary of RRP proposed repex ($m, June 2018)

Asset Category	18/19	19/20	20/21	21/22	22/23	Total
Transmission lines	43.8	57.1	86.0	76.0	73.0	335.9
Substations	61.0	71.5	66.4	51.4	54.0	304.3
Secondary systems	39.2	48.6	36.4	31.2	28.8	184.3
Communications	6.8	8.4	13.1	13.0	9.9	51.3
Uncategorised	2.6	2.6	2.6	2.6	2.6	12.8
Repex sub-total	**153.5**	**188.2**	**204.4**	**174.2**	**168.3**	**888.6**
Security & compliance	5.2	6.2	9.5	10.6	17.1	48.5
Total	**158.6**	**194.4**	**213.9**	**184.8**	**185.4**	**937.1**

Source: EMCa analysis based upon TransGrid's RRP CAM

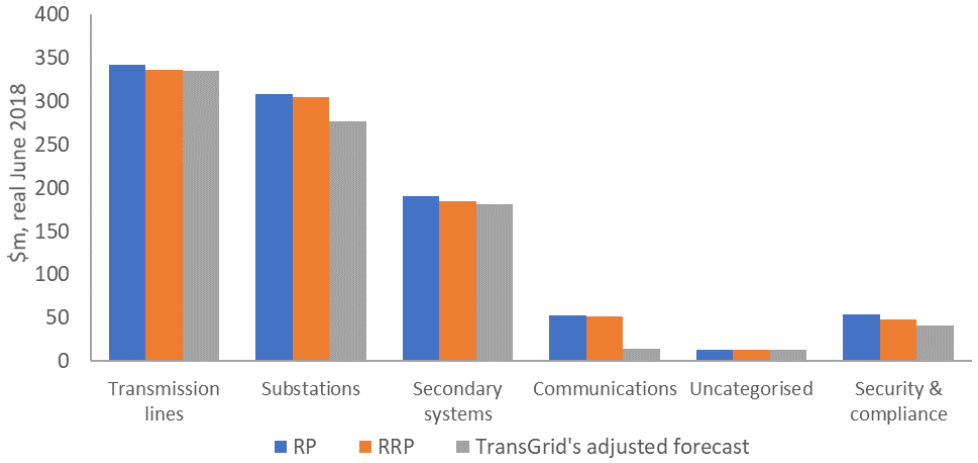
137. Following challenges from EMCa at the RRP review onsite meetings, TransGrid has proposed subsequent reductions of $75.7 million[51] to its RRP proposed repex. We have summarised these changes in the table and figure below, and we refer to these changes in our assessment that follows.

Table 5: Summary of proposed repex ($m, June 2018), TransGrid's RP, RRP and TransGrid's further adjustments subsequent to its RRP

Project category	RP	RRP	TransGrid's adjusted forecast	Variance to RRP
Transmission lines	342.6	335.9	334.8	-1.1
Substations	308.5	304.3	276.7	-27.6
Secondary systems	191.0	184.3	180.7	-3.6
Communications	52.8	51.3	14.8	-36.5
Uncategorised	12.9	12.8	12.8	0.0
Security & compliance	54.0	48.5	41.7	-6.8
Total	**961.8**	**937.1**	**861.5**	**-75.7**

Source: EMCa analysis based upon comparison of TransGrid's RP CAM, RRP CAM, and Adjusted CAM

Figure 6: Differences in proposed repex ($m, June 2018), between TransGrid's RP, RRP, and TransGrid's further adjustments subsequent to its RRP



Source: EMCa analysis based upon comparison of TransGrid's RP CAM, RRP CAM, and Adjusted CAM

138. From the table and figure above, we observe reductions across all asset categories, with the largest reductions being applied to communications and substations.

[51] CAM and PTRM update 20180220 PUBLIC FINAL.

139. TransGrid has provided new information to support its revised forecast in its RRP and the adjustments it has made since that time. We consider this new information within our assessments in each of the asset categories below. In general, it reflects information previously provided to the AER on TransGrid's risk cost methodology and which was considered in our initial RP review. TransGrid has provided more detailed information on the condition of its assets, and clarification of some concerns we raised in our initial RP report.

4.2 Assessment of transmission lines

4.2.1 Summary of AER Draft Decision

140. The AER considered that TransGrid had significantly overstated the environmental risk cost, associated with bushfire risk, which therefore resulted in a forecast that did not reflect a prudent and efficient level of transmission lines capex.[52] The AER also considered that TransGrid's likelihood of consequence values had not been sufficiently moderated.

4.2.2 Summary of new information in TransGrid's RRP

141. For transmission lines, TransGrid has proposed a revised expenditure forecast of $335.9 million, being a reduction of $6.7 million (2.0%) from its RP. The reductions are largely associated with changes to inflation and labour cost escalation updates across the forecast.

142. Following the RRP review onsite meetings, TransGrid has proposed a further reduction of $1.12 million from its RRP expenditure forecast, as a result of an error identified in Project 1346 Line 959/92Z Renewal.[53]

143. We have considered the impact of the above changes in our assessment of the RRP. We note that TransGrid has stated[54] that the proposed increase from historical levels of expenditure is above the forecast expenditure from its Repex Model due to inclusion of three remediation projects[55], and that when these three projects are removed, the forecast falls under the Repex Model output. We have included comments on these three projects in our assessment that follows.

4.2.3 Our assessment

The bushfire consequence cost is overstated

144. In its risk reports, we have observed examples where TransGrid has applied a consequence cost of $500 million in place of the $400 million CoF it has claimed to have used in its RP and RRP. In response to our questions for Line 11, TransGrid

[52] AER - Draft decision TransGrid transmission determination - Attachment 6 - Capital expenditure - 28 September 2017, page 6-77.

[53] CAM and PTRM update 20180220 PUBLIC FINAL.

[54] TransGrid Transmission Lines Renewal and Maintenance Strategy, page 75.

[55] Line 86 Renewal, Tower grillage foundations, and Tower asbestos paint remediation.

has advised that[56] "*the original risk assessment calculations for both these projects, an incorrect value for the bushfire consequence of $500 million was applied instead of the stated $400 million value. This has been corrected and the revised pre-investment risk is presented in Section 7. This change has not led to any revision to the scope (and therefore total cost) for the project.*" The reference to two projects in the risk assessment for Line 11 is not clear.

145. We have observed the use of a $500 million bushfire consequence cost in several other projects. We have not been provided with updated copies of the risk analysis relied upon for transmission line projects. Following the RRP review onsite meetings, we requested a consolidated list of projects and the corresponding input assumptions to verify that these (and other) adjustments had been applied by TransGrid. TransGrid replied by providing an updated project list but did not provide corrected input parameters.

146. As discussed in Section 3, the additional information that TransGrid has provided confirms that we correctly understood the derivation of its risk cost assessment in our assessment for our initial RP report. From the additional information that TransGrid has provided as part of the RRP assessment process, we have formed the view that TransGrid's bushfire risk CoF input assumption of $400 million overstates reasonable values drawn from its evidence by a factor of at least four times.

147. TransGrid has relied heavily on the reduction of bushfire risk to justify its proposed transmission line projects, by demonstrating a positive NPV or on the basis that it satisfies its ALARP test. More realistic bushfire consequence cost assumptions considerably reduce this element of the benefit that TransGrid has assumed. Also, as discussed in Section 3, changes to the calculation of the annualised capital costs used in its ALARP test has the result of requiring higher benefits to justify the project.

148. When these changes are applied to TransGrid's proposed transmission lines projects, a number of projects are no longer justified. For example, when these adjustments are made to the input assumptions for Line 86, the project is not justified using either NPV analysis or the ALARP test.[57] To test the sensitivity of the proposed Line 86 project to the bushfire risk cost, we calculated the threshold CoF at which project justification relies on TransGrid's ALARP test (applying the revised calculation of annualised capex).. The threshold value is calculated as a bushfire CoF of $160 million as opposed to TransGrid's value of $400 million.

Safety-related consequence is overstated

149. In our initial RP report, we stated that we considered that the safety-related costs attributable to transmission lines of $20 million were also overstated. In its RRP, TransGrid has identified that it had made an error, stating that[58] "*the addition of legal and legislative costs incorrectly brought the total to $20 million; this total should have been $11 million. The correction has been made, however it results in no change to the required investments in the transmission line portfolio*."

[56] TransGrid IR026/Q6 ,1600 Line 11 Summary notes 20170607.

[57] Including adoption of a discount rate to the calculation of annualised capital cost.

[58] TransGrid RRP, page 77.

150. We note that this is a large reduction to the safety-related consequence costs used in the analysis. As stated above, we have not been provided with information to verify that this has been correctly applied to all affected projects.

Insufficient moderating factors for LoC in safety risk cost

151. As noted in our initial RP report, we consider that other moderating factors exist that reduce the likelihood of a fatality as a result of a conductor failure or structure failure, and which have not been incorporated into the LoC for transmission lines.

152. Following discussion at the RRP review onsite meetings, TransGrid has confirmed an error in the application of its safety LoC for transmission lines, where it was used on a per span basis rather than on a per transmission line basis.[59] TransGrid advised that this change results in a reduction in the risk associated with all transmission line projects. However, TransGrid advised that only a single proposed project in the transmission lines category – Project 1346 Line 959/92Z renewal – was no longer justified as a result.

153. As discussed in Section 3, we have not seen adequate consideration of other moderating factors that are likely to further reduce the likely risk cost.

Condition information suggests alternative options are likely to exist

154. We were provided with detailed condition assessments undertaken for some of the projects included in the forecast. Due to our concerns with the potential for input assumptions in its risk cost assessment to be overstated, we also reviewed the line condition information to ascertain whether, in our experience, it was likely for a prudent network operator to undertake the nominated projects. We make the following observations on these projects, from the documentation provided to us.

Replacement of Line 86

155. We understand that Line 86 is a critical element of the network to support flows across the QNI and that it was constructed to a design standard normally associated with a transmission line assigned a lower level of criticality. However, Line 86 has been in service for 36 years[60] with the only reported major event being a single pole failure in this time. TransGrid has not provided new information to respond to the concerns raised in our initial RP report, where we stated that we did not find compelling evidence to support the basis for replacement of the remaining 391 pole structures, being full replacement of the line. Based on the information provided, we consider that it is more reasonable to replace pole structures as identified by declining condition than by replacement of the entire line.

Various 132kV wood pole replacements (18 projects)

156. We reviewed the defect rates and the derivation of the replacement volumes from those defect rates by TransGrid. We identified that the quantity of poles identified for replacement was double the number identified by the forecast defects. Whilst some level of growth in defects is likely to occur over the period, TransGrid was not able to explain the discrepancy. We specifically requested clarification by TransGrid of its derivation of pole replacements. However, TransGrid's response

[59] TransGrid IR050/Q09. Occupancy calculation for Lines 20180216 CONFIDENTIAL

[60] Constructed in 1982.

did not adequately explain the rationale for the higher level of pole replacements proposed in the forecast.

330kV line renewal (25 projects)

157. Whilst condition issues are evident on the nominated 330kV lines based on the condition assessment reports, the determination of the prudent level of work is not adequately supported. We found statements in the condition assessment reports which suggest that the identified condition issues were not widespread and did not require immediate attention. For example: "*(b)ased on the six sample towers inspected, there do not appear to be any widespread condition issues on 17 Line that require immediate attention. Corrosion of insulators, tower legs at ground level and overhead earthwires are the main condition issues on this transmission line.*" [61]

158. We reviewed a number of condition assessment reports to determine whether these statements also applied to other lines. We found several instances of similar statements. This suggests to us that there is opportunity to prioritise this work, whilst other projects are likely to slip and result in work deferred to the subsequent RCP.

Replacement of suspension towers in Line 11

159. The condition assessment states that action on this line is required within the next 10 years. However, it does not indicate any priority within this time period. Our review of the proposed expenditure profile indicates that the majority of expenditure is forecast to be incurred in the last year of the next RCP. We have not been able to replicate the economic NPV results provided for this project and note that this is already only marginally positive in TransGrid's own analysis. Adjustments to the bushfire and safety-related consequence costs as discussed in Section 3 are likely to further reduce the economic value of this project. TransGrid has included the project as it considers that it satisfies ALARP. However, the prudent timing of the work has not been adequately justified, and on balance it would appear that most or all of this project is likely to be deferred into the subsequent RCP.

Transmission line asbestos impregnated paint remediation

160. Our review of TransGrid's condition assessment leads us to conclude that there is opportunity to prioritise this program to the most critical sites or higher risk sites in the next RCP and to adopt other control measures for lower risk sites. This approach is likely to lead to a significantly lower capex requirement than proposed by TransGrid, which we consider is more reflective of a prudent and efficient level.

Summary

161. We consider that the condition information confirms the need to progress some work. If significant projects were removed from the forecast, TransGrid would nevertheless need to do some level of more targeted replacement for these assets. However, the condition assessment does not indicate the extent of work in the next RCP is as extensive as TransGrid has proposed.

162. For other lines expenditure not referred to above, the condition information suggests that there are opportunities to consider reduction of scope and deferral of some works beyond the next RCP.

[61] TransGrid IR030/Q15, NACA 1352 line 17.

Preliminary nature of tower grillage foundation investigations is likely to overstate requirements

163. TransGrid has included an increase in expenditure to address 'end of life' renewal of grillage foundations for a sub-set of its transmission line structures. TransGrid does not have detailed records of its grillage foundations, the condition assessments of the grillage steelwork, or details of historical corrosion mitigation measures over previous years. In April 2016, TransGrid commissioned an investigation to examine the condition of the cathodic protection and the grillage foundations, including advice from AECOM on a small sample of towers.[62] From this sample, a predictive model based on soil types was developed to determine the towers requiring replacement of the sacrificial anode or cathodic protection, or reinforcement of the foundations.

164. We understand that TransGrid has targeted a population of towers that are typically 50-60 years old for the work included in Project 1523. In the absence of detailed records, preliminary investigations indicate that corrective work is required to mitigate further metal loss in the buried foundation steelwork. The condition of the grillage foundations for these towers indicates to us that these assets have not been well-maintained, as indicated by the failure to replace cathodic protection before or at the nominal useful life (albeit based on a small sample size).

165. Whilst TransGrid continues to undertake investigations[63] to confirm the condition of individual grillage foundations, and the cathodic protection is likely to require replacement, we consider that the limited investigation it has undertaken is not sufficient to justify an assumption that it will undertake the remaining volume of work that it has proposed in the next RCP.

Application of reliability risk appears reasonable

166. In our initial RP review, we raised concerns regarding TransGrid's application of very high values of lost load that lead to large reliability risk costs. As discussed in Section 3, TransGrid determines reliability risk costs expressed as $/hr for failure of a line based on its modelling of subsequent lines being unavailable. To assist our review of the reliability risk assumptions applied to its project expenditure, we sought clarification of the derivation of the reliability risk cost, including Line 86 as a case example.

167. TransGrid has now provided its assumptions for the derivation of load at risk, following failure of subsequent network elements based on the criticality of the line. For Line 86, TransGrid has identified that a second contingency on Line 85 will result in loss of [redacted] of load. The reliability risk cost is calculated as [redacted], including a level of uncertainty for the impact of network contingencies not modelled. TransGrid has sought to verify the reasonableness of its assumptions against recent load patterns.

168. Given the highly meshed nature of TransGrid's transmission network, we requested additional information concerning the criticality of Line 86 and the extent of loss of

[62] Initial sample of 20 sites, and excavation of two footings.

[63] TransGrid IR026, 1523 Grillage Summary Notes 20170607.

load in the event of a contingency on the adjacent Line 85, and calculation of reliability risk cost. TransGrid provided the requested information.

169. The accuracy of TransGrid's network load-flow and contingency modelling to determine possible outage scenarios are a large determinant of the reliability risk cost calculations. We have not been able to verify these assumptions however we have been able to review the process that TransGrid describes and it is as we would expect. In reviewing TransGrid's application of its reliability risk cost methodology and assumptions associated with its network models, including its application for Line 86, we find that the results are reasonable

4.2.4 Implications for proposed expenditure allowance

170. We consider that the systemic issues identified in our initial RP report have not been addressed by TransGrid for its transmission lines expenditure. We have identified a number of areas of concern that indicate to us that the forecast is overstated:

i. We have identified opportunities for removal of unjustified projects based on more appropriate input assumptions and modelling, particularly for bushfire risk. We estimate that this comprises approximately 45% of the revised expenditure forecast;

ii. With the reductions above, there remains a requirement to proceed with some more targeted works on these transmission line assets based on their stated condition. We have therefore made provision for re-inclusion of expenditure of approximately 20% of TransGrid's revised forecast for this purpose; and

iii. For the remaining projects, opportunities to reduce/modify scope or defer work on some projects, or where further optimisation across the portfolio is likely to result in a reduction to the level of expenditure a prudent network operator would undertake. We estimate that this comprises approximately 10% of TransGrid's revised expenditure forecast.

171. To reflect that these opportunities are likely to act differently on individual projects in the forecast, we present the estimate of the impact of the issues we have identified as a range. We consider that TransGrid's revised transmission lines repex, reduced by this amount, more reasonably reflects the level of expenditure that a prudent network operator would undertake. We estimate that the transmission lines forecast in TransGrid's RRP is overstated by between 30% and 40%.

172. In the table below, we show this impact in relation to TransGrid's proposed RRP allowance, and the adjustments that TransGrid proposed subsequent to its RRP.

Table 6: Impact of issues identified for transmission lines ($m, June 2018)

Impact of Issues- Transmission Lines	
TransGrid's RRP	335.9
EMCa's assessment of impact	-30% to -40%
TransGrid's adjustments subsequent to its RRP	*-0.3%*

Source: EMCa analysis

4.3 Transmission substations

4.3.1 Summary of AER Draft Decision

173. The AER considered that[64] TransGrid had not always demonstrated the most efficient timing in its proposed capex, or where projects may be considered for deferral into the subsequent RCP.

174. The AER also raised concern with the justification provided to support TransGrid's selection of its VoSL and LoC input assumptions as they relate to safety risk, citing lower assumptions in a recent decision for another transmission business.

4.3.2 Summary of new information in TransGrid's RRP

175. For substation equipment, TransGrid has proposed a revised expenditure forecast of $304.3 million, being a reduction of $4.2 million (1.4%) from its RP.

176. TransGrid has included some new information regarding the substation projects that we reviewed, to support its revised forecast.

177. The net aggregate reduction arises from TransGrid's changes to its forecast inflation and labour escalation rates.

178. During the RRP review onsite meetings, and subsequently confirmed in writing[65], TransGrid presented further reductions of $26.1 million from the expenditure forecast included in its RRP, as follows: [66]

- $6.2 million due to reduction or removal of replacement sub-projects that did not pass TransGrid's optimal timing criteria:
  - $2.8 million reduction in project 1338 CT renewal;
  - $1.7 million reduction in project 1442 VT renewal; and
  - $1.6 million reduction in project 1525 Bushing renewal;
- $8.4 million due to optimisation of delivery of capital projects by bundling design work or site delivery; and
- $11.5 million due to a reduction in the VoSL assumption.

179. Following the RRP review onsite meetings, TransGrid has proposed further adjustments of $1.5 million from the expenditure forecast included in its RRP, as a result of an error identified in its assessment for Project 1708 of transformer and reactor expected failures.[67]

180. We have considered the impact of the above changes in our revised assessment.

[64] AER - Draft decision TransGrid transmission determination - Attachment 6 - Capital expenditure - 28 September 2017, page 6-77.

[65] TransGrid, CAM and PTRM update, 21/02/2018.

[66] EMCa analysis of TransGrid's RRP CAM, Adjusted CAM, TransGrid IR050/Q12, and CAM and PTRM update 21/02/2018.

[67] TransGrid, CAM and PTRM update, 21/02/2018.

4.3.3 Our assessment

Substation asset renewal program

181. In our initial RP report we observed an increase in proposed substation related expenditure. This increase is driven by TransGrid's introduction of a new assessment process based on condition and network criticality. TransGrid has suggested that this process has identified several assets with poor health indices predominantly due to condition data, and that[68] "*an increase in expenditure is required to reduce the network risk and maintaining the reliability.*" At that time, we did not see sufficient evidence to justify the proposed increase.

182. In its RRP, TransGrid has provided additional information. We observe that the renewal programs typically include a preliminary assessment of remaining life, which TransGrid then uses to identify assets to proceed to economic evaluation.

Replenishment of transformer and reactor spares reflects a reasonable approach

183. TransGrid has included a program for the replenishment of transformer and reactor spares on the basis of expected failures. The derivation of the forecast is based on the aggregate PoF for transformers that are not included in the transformer replacement or refurbishment program, across each voltage class, multiplied by the unit cost.

184. In our initial RP report, we were not convinced by the inclusion of this program in addition to the transformer replacement and refurbishment program. TransGrid has provided additional historical data to verify the forecasting approach applied to this program as a spares replenishment program. We consider that this is a reasonable approach.

185. Following discussion during the RRP review onsite meetings, TransGrid acknowledged[69] there were some minor errors in the supporting information for this program, that once corrected reduce the capital expenditure forecast included in the RRP for Project 1708 – Transformer-Reactor Expected Failure by 5.0%.

Inadequate assessment of the counterfactual for transformer refurbishment

186. In TransGrid's assessment of the benefits of refurbishment, it modelled the benefits as being the difference in risk cost over an assessment period of 20 years between the pre- and post-risk cost based on differences in the PoF due to reduced effective age of the transformer. We expected to see the base case and the refurbishment options include the replacement of the transformer at end of life, and to compare the refurbishment options with replacement at a later date. Without adequately considering the future investment, the analysis is distorted.

187. Whilst we consider the modelling of the base case should be corrected to provide a better indication of the economic value, our own modelling of the input assumptions

[68] TransGrid response to EMCa report, para 295.

[69] TransGrid IR050/Q16, Need 1708 Transformer Refurbishment Calculations 20180216 CONFIDENTIAL.

to account for the future capital investments in an alternate NPV model did not materially change the decision based on NPV.

Insufficient consideration of hazard zone occupancy

188. TransGrid has advised that the calculated Substation Safety LoC provides an assessment of the likelihood of staff (a single person) being present on site undertaking routine maintenance activities. As discussed in Section 3, the substation occupancy level doesn't include consideration of proximity to the hazard zone, or likelihood of fatality in its calculation.

189. Whilst we consider that this value is overstated, our analysis suggests that the overall influence of this factor on the decision to proceed with the substation renewal projects we reviewed is likely to be low, as they are more heavily influenced by the reliability risk.

Derivation of reliability risk costs appear reasonable for substation renewal projects

190. As discussed in more detail in Section 3, TransGrid applies a number of methods to determine the reliability risk cost for its projects, based on the asset class and associated function. Once calculated, TransGrid has applied a derived $/hr assumption to calculate the reliability consequence of load at risk for loss of a major substation element (i.e. line, transformer etc).

191. Following our review of additional supporting information provided by TransGrid, we consider that it has consistently applied the methodology to its substation renewal projects.

192. In our initial RP report, we stated our concern that TransGrid may have overstated its calculation of the probability that loss of supply to end use customers will occur following the failure event for the load at risk, to which the value of customer reliability can be applied. We requested confirmation of the analysis undertaken by TransGrid for its substation renewal projects, and how it had accounted for the ability to restore supply from alternative sources. In its response, TransGrid advised that:[70]

- *"The likelihood of loss of supply to consumers includes consideration of the network configuration, included meshed arrangements, and the associated contingencies which must occur…"* and
- *"Alternative TransGrid and DNSP network supply paths were considered in the calculations for determining the load at risk on the basis of the ability to restore supply in relation to the reduced capability of TransGrid's network arising from the asset failure."*

193. We are satisfied that based on its explanation of its process, TransGrid has included in its analysis provision for the restoration of supply where the network topology allows this to be achieved within the asset failure repair time.

[70] TransGrid IR058.

Reliability risk costs for other systems appear high

415V AC distribution systems

194. In our initial RP report, we stated that TransGrid's review of options for replacement of its 415V AC distribution and 50V Rack Power Supply (RPS) systems did not demonstrate robust options analysis and indicated that the forecast was likely to over-estimate the prudent level of expenditure.

195. In the *Secondary Systems Site installation strategy*, TransGrid states that the primary risks it is responding to are[71] (i) protection from electric shock, and (ii) risk of cable fires spreading to control cables. Based on our experience, and having reviewed the projects and programs of other transmission network businesses, we have seen evidence where alternate risk treatment options are considered to mitigate these failure risks at a lower cost than full replacement of the system.[72]

196. In the documentation provided by TransGrid, the reliability supply risk appears to be a driver of this work, which appears to differ from the strategy reference provided. Whilst we accept that a supply outage is possible from failure of the 415 AC supply system, including spread of fire started by supply cables, we remain of the view that failure of a non-critical power supply at a substation used for lighting and general outlets is unlikely to result in a supply loss to consumers. Accordingly, we consider that the assessment used to justify this program overstates the supply risk and leads to overstating the required level of expenditure.

50V RPS systems

197. In the case of the 50V RPS systems we remain concerned that the input assumptions, including TransGrid's assumptions of loss of [redacted] for 8 hours at a LoC of 1%, are not backed by evidence and are likely to overstate the risk. The conditions for loss of supply include multiple events including failure of the 50V RPS in a N-1 system (including its duplicated supply) at the same time as a network condition that requires a remote protection operation and removes a network element that results in loss of supply for 8 hours.

198. We have reviewed additional condition information pertaining to the replacement of 50V RPS systems provided by TransGrid that indicates to us that these systems are in poor condition and separate to consideration of the concerns we have with the application of the risk cost methodology, confirms that replacement should be considered as an option along with consideration of other remedial actions.

Steelwork / Gantry failure

199. Similarly, for steelwork or gantry failure in a substation, we considered in our initial RP report that TransGrid "*over-states the LoC, and that TransGrid has not provided evidence that supports the estimate of reliability consequence cost as being reasonable.*"

200. In response to our concerns, TransGrid presented its rationale for selection of its input cost assumptions. As stated in Section 3, we remain concerned that

[71] TransGrid IR050/Q22, Secondary Systems Site Installation Strategy 20161201.

[72] For example, application of fire retardant to 415VAC cables in a common cable trench to minimise risk of cable fires spreading to control cables.

TransGrid's selection of worst case consequences such as loss of substation load for the repair time of 30 days adds further complexity to the selection of reasonable moderating factors that form the LoC for this project. However, on balance we consider that TransGrid has presented sufficient information, including its condition assessment and conservative modelling, to demonstrate the need for this project to be included in the forecast.

Application of Transformer redundancy factor

201. TransGrid has clarified the inclusion of its redundancy factor when considering events that are likely to result in loss to supply. As a heavily meshed transmission network, loss of a single component is unlikely to result in loss of supply. TransGrid has modelled this as considering the failure, after a first component is already unavailable, of a subsequent component and which therefore results in loss of supply.[73]

202. We consider that the use of a redundancy (or unavailability) factor as a moderating factor applied to the CoF provides a reasonable method of recognising the low likelihood of the consequence event in its risk cost assessment.

203. TransGrid's redundancy factor is based on an assessment of all transformer outages over 2009 to 2015, which should provide an average unavailability rate. However, TransGrid includes an outage of 821 days and two further outages of 137 and 126 days relating to 330kV transformers. We consider that retaining these data points biases its calculation of unavailability as these are not representative of typical replacement times when a critical transformer needs to be returned to service. TransGrid does not explain the rationale for including these data points in determining its assumed redundancy factor (representing the average unavailability of transformers), given that it assumes a 30-day repair window for a failed transformer. If adjustments[74] are made to the formula, including removal of the 821-day outage, the unavailability factor is halved to 0.0022.

204. Application of the revised transformer unavailability into the risk cost calculation[75], results in a corresponding reduction to the calculated avoided risk cost. On review of the transformer renewal program[76] the economic justification becomes marginal for two transformers – Liverpool No. 2 and Moree No.1. In the NPV analysis for these two replacement projects, the capital cost is modelled in the final year of the next RCP, which suggests to us that TransGrid should have considered the deferral of this work in the next RCP.

Correction of cash flow analysis required for CB renewal

205. In its RRP, TransGrid claims that EMCa made an error in stating that 64 CBs had a payback period of 1 year, and that we recommended using payback period as part of the economic analysis. We drew attention to the extremely short payback periods in our initial RP report, which suggested to us that based on the assumptions used by TransGrid the work should have already been undertaken or should be urgently

[73] Network asset criticality framework.

[74] Correction to time period, and removal of 66kV outages as no transformer numbers are assigned.

[75] 1354 transformer risk costs v15 – base case and options.

[76] TransGrid IR026/Q03, NPV calculations 1354 Transformer renewal 20170530 CONFIDENTIAL.

undertaken before the next RCP. The fact that it had not undertaken the work, led us to question the assumptions.

206. We based our initial assessment on materials provided by TransGrid to the AER in its RP.[77] We requested that TransGrid provide details to explain its view that we made an error. In its response, TransGrid acknowledged that it had made an error in calculating the payback period in the NPV spreadsheet provided for the CB renewal program in its RP. TransGrid has now corrected the error. TransGrid has not made any change to the proposed expenditure for this program in its RRP.

207. As noted in Section 3, we remain of the view that the high benefits associated with some of these projects, resulting in high NPVs and short payback period, suggest either that TransGrid's assessment of its risk costs is not consistent with its management practices because it has not considered it necessary to address these risks, or that TransGrid has been carrying an unwarranted amount of risk.

Review of optimal project timing

208. In our initial RP report we expressed concern that we did not see adequate demonstration of the optimal timing of projects. In its RRP TransGrid advised that "*We have selected projects on positive NPV, which is also a function of the optimal timing of investment. This is an example of where the sensitivity of our method to time is demonstrated and projects are prioritised in order to address risk in an optimal order to maximise benefit to consumers."*

209. TransGrid also states[78] that "*The asset replacement programs have been developed with consideration of the entire asset population, which has then been refined through our risk assessment methodology. The resultant assets which have been included are only those which are evaluated as positive when replaced within the next RCP. The program NPV analysis provided to the AER demonstrates that TransGrid has considered and indeed planned replacements in the following RCP (post 2023).*"

210. We respond to the timing of projects more generally in Section 3.

211. TransGrid advised at the RRP review onsite meetings that following submission of its RRP it had reviewed its optimal timing criteria of the repex portfolio. The results identified assets that were not deemed to be optimally timed for replacement, resulting in removal of $6.2 million from the expenditure forecast for Project 1338, Project 1442 and Project 1525.[79] We have reviewed TransGrid's approach to making this adjustment[80] and consider that TransGrid has responded to the basis of our concerns relating to the opportunity for greater delivery efficiencies and optimisation of its portfolio.

[77] NPV calculations_1337_Circuit Breaker Replacement Program Final.

[78] TransGrid's response to EMCa report, para 154.

[79] Onsite presentation to AER.

[80] TransGrid IR050/Q12, Risk Cost vs Annual Cost.

4.3.4 Implications for proposed expenditure allowance

212. We consider that the adjustment to forecast requirements that TransGrid has made following the RRP review onsite meetings, closely approximates the level of adjustment that we consider is warranted.

213. However, we have identified parts of the expenditure forecast that TransGrid are more likely than not, upon closer examination, to identify further opportunities for optimisation of its substation program. We estimate that the substations forecast in TransGrid's RRP is overstated by up to 15%.

Table 7: Impact of issues identified for substations forecast ($m, June 2018)

Impact of Issues- Substations	
TransGrid's RRP	304.3
EMCa's assessment of impact	-10% to -15%
TransGrid's adjustments subsequent to its RRP	*-9%*

Source: EMCa analysis

4.4 Secondary systems

4.4.1 Summary of AER Draft Decision

214. Based on its review of the forecasting methodology applied by TransGrid, the AER considered that TransGrid's forecast is overstated.[81] Specifically, the AER considered that TransGrid's proposed increase[82] in its secondary systems expenditure was not justified.

4.4.2 Summary of new information in TransGrid's RRP

215. For secondary systems equipment, TransGrid has proposed a revised expenditure forecast of $184.3 million, being a reduction of $6.7 million (3.5%) from its RP.

216. TransGrid has included some new information regarding the secondary systems projects that we reviewed, to support its revised forecast including a reduction of its SCADA replacement project of $3.1 million. The aggregate reductions are largely associated with TransGrid's changes to its forecast inflation and labour escalation rates.

217. During and following the RRP review onsite meetings, TransGrid has proposed further adjustments of $3.6 million from the expenditure forecast included in its RRP, as a result of portfolio optimisation undertaken for 12 protection relay protection projects.[83]

[81] AER – Draft decision TransGrid transmission determination – Attachment 6 – Capital expenditure – 28 September 2017, page 6-61.

[82] When the much higher expenditure during the start of the current RCP is excluded.

[83] TransGrid, CAM and PTRM update 20180220 PUBLIC FINAL.

4.4.3 Our assessment

SCADA replacement project brought forward

218. TransGrid has brought forward its SCADA replacement project into the current RCP to facilitate completion by 2020[84] and to meet its NSW licence compliance obligations. Accordingly, a reduction of expenditure is included in its RRP to cover only the remainder of this project in the next RCP.

Determining a prudent level of expenditure

219. In our initial RP report, we indicated that TransGrid had cited age of the individual devices as an investment driver. We observed that a large proportion of the protection relay replacement program was based on forecast end of technical life and obsolescence risks. We are satisfied that the risks posed by end of life, exhaustion of spares and lack of support from manufacturers are evident in the management of protection relays.

220. We also noted that[85] "*whilst the Automation Systems Renewal and Maintenance strategy identified increasing defect rates across the population, we did not find quantitative evidence of how the individual projects were selected for inclusion in the forecast*."

221. TransGrid has subsequently provided a document to summarise the condition of protection assets.[86] On review, the population and condition description provided is not entirely consistent with the proposed projects included in the expenditure forecast. In some cases, TransGrid states that there are no issues with the protection relays included in the forecast. Relays that are at or above 8 years of age in 2016, and therefore will be at or above 15 years at the end of the next RCP, appear to have been targeted for replacement in the next RCP. Whilst an age of 15 years typically corresponds to an elevated risk of technical obsolescence for modern protection relays, TransGrid has not provided evidence of analysis to support its assumed criteria for replacement.

222. In reviewing the economic analysis for each protection replacement project, TransGrid has forecast a PoF for each relay, being an increasing linear trend forecast based on historical defect rates as initial values and an intercept at (0,0).[87] This is inconsistent with the constant PoF value that TransGrid has applied to its forecast.

223. Multiple criteria are required to understand the drivers of failure and that the highest priority devices are targeted for replacement. We had expected to see a greater level of analysis[88] presented by TransGrid for each asset population to assist identify the priorities for replacement and support the required work. In the absence of this information, we do not consider that it has adequately justified its forecast.

[84] TransGrid RRP, page 78.

[85] EMCa initial RP report, page 73.

[86] TransGrid IR026/Q6, NACA SSAP Protection 20170607 CONFIDENTIAL.

[87] TransGrid IR026/Q6, NACA SSAP Protection 20170607 CONFIDENTIAL.

[88] Including detail of the known issues/defects, failure modes, failure frequency and maintenance history.

Overly conservative risk assessment applied

224. In our initial RP report, we were concerned by the treatment of high consequence low probability events to determine the avoided risk cost for secondary systems projects. TransGrid has clarified how it has applied its LoC values and provided information to support its calculation of the input assumptions.

225. TransGrid has modelled the failure (including non-operation) of the back-up protection, assuming that a failure of the primary protection relay has already occurred and has assigned a CoF that assumes that a coincident network event has also occurred.

226. The loss of supply that result from the failure of two protection systems could be large, however has a very low probability of occurring and is unlikely to be long in duration. The moderation of these high consequence events should therefore consider the time required to restore supply to customers, should a loss of supply event occur, rather than the time required to repair / replace the failed network element. At our request, TransGrid provided additional information to confirm that the return to service time had been moderated.

227. For the protection systems on the 330kV and 500kV network TransGrid has not adequately justified its application of the consequence cost, being the combination of the LoC and CoF parameters. TransGrid has developed a consequence model to quantify the "*impact of an uncleared or slow-to-clear fault [which] is one of the main risks presented by TransGrid's protection systems to the primary transmission 500 kV and 330 kV network.*"[89] The model includes a range of scenarios with associated probabilities:

- Low Impact Scenario, associated with the loss of the two largest generating units on the NSW system (approximately [redacted]), restoration over 8 hours and a LoC of 50%;
- Medium Impact Scenario, associated with large scale load shedding (60% of NSW nominal average demand of [redacted]), restoration over 24 hours and a LoC of 40%; and
- High Impact Scenario,[90] associated with complete loss of load ('Black Start'), restoration over 24 hours and a LoC of 10%.

228. TransGrid determines a weighted average loss of load of [redacted] for 8 hours[91] for use in the reliability risk cost for these events.

229. Whilst the loss of the entire network is a possible outcome for failure of the primary and secondary protection schemes, the likelihood is extremely low. TransGrid has not supported its selection of the values for the LoC and CoF with evidence of similar failures to validate the selection of this worst-case scenario. In fact, TransGrid acknowledge that there is a "*lack of relevant historical data to support the analysis.*"[92] We consider that an alternate set of probabilities may be reasonably

[89] TransGrid Network Asset Criticality Framework-1216, page 14.

[90] For the Medium Impact and High Impact Scenarios it has also been assumed that no load is restored for the first four hours immediately after the event.

[91] TransGrid IR030/Q19, Estimation of Black Start Conseq~.

[92] TransGrid Network Asset Criticality Framework-1216, page 14.

applied which result in an alternate and lower estimate of reliability risk. When applied to the related projects, the result is a material reduction of the benefits attributed to these projects.

230. For protection systems on other parts of its network, TransGrid has adopted lower estimates of reliability risk costs which are more likely to reflect the consequence of a failure event.

Biased options analysis for secondary system replacement projects

231. TransGrid's *Secondary Systems Site Installation Strategy* describes the adoption of site-wide secondary system replacement philosophies, and purports that this "*is not a new concept within the organisation but rather has been part of informal strategies*."

232. We observed that the protection relay replacements included in these projects are broadly consistent with the protection relays identified for replacement, however decisions to include other scope items in the options analysis were not as evident.

233. We found that the AC and DC systems were often excluded from scope of strategic replacement (or partial replacement) despite having a material impact on the base case risk cost, and therefore benefits of the replacement project. We consider that the strategic replacement could not be reasonably compared with 'complete in-situ replacement' on a like-for-like basis. As a result, TransGrid's analysis is biased to selecting the option of 'complete in-situ replacement'[93], rather than 'partial replacement'. Based on a like-for like comparison, the replacement of the AC and DC systems should be considered in both options. If the operational benefits and delivery efficiency associated with the additional scope of the complete in-situ replacement option (including greater modernisation of devices) provided greater economic value, then it should have a higher NPV than the partial replacement option.

4.4.4 Implications for proposed expenditure allowance

234. While TransGrid has reduced its proposed allowance by 2% following the RRP review onsite meetings, we estimate that the secondary systems forecast in TransGrid's RRP is overstated by between 5% and 15% due to the aggregate impact of the upward biases to the forecast, as described above.

Table 8: Impact of issues identified to secondary systems forecast ($m, June 2018)

Impact of Issues- Secondary Systems		
TransGrid's RRP		184.3
EMCa's assessment of impact	-5% to	-15%
TransGrid's adjustments subsequent to its RRP		*-2%*

Source: EMCa analysis

[93] Or alternatively an 'upgrade to IEC 61850' or 'Secondary Systems Building'.

4.5 Communications

4.5.1 Summary of AER Draft Decision

235. The AER noted its concern that the scope of the proposed network communication projects may not be prudent and efficient, and that TransGrid has not sufficiently justified the economic benefits of IT and OT convergence in relation to these projects.

4.5.2 Summary of new information in TransGrid's RRP

236. For communications equipment, TransGrid has proposed a revised expenditure forecast of $51.3 million, being a reduction of $1.5 million (2.8%) from its RP.

237. Based on our analysis of TransGrid's CAM, the forecast reductions appear largely associated with changes to inflation and labour escalation updates across the forecast.

238. There are only two projects included in this category: phase 2 fibre roll-out, and SDH replacement. During and following our RRP review onsite meetings, TransGrid has proposed a further adjustment by removing $36.5 million from the expenditure forecast included in its RRP, corresponding with removal of project 1355A - Phase 2 of the proposed fibre roll-out.

4.5.3 Our assessment

Review of forecast benefits

239. In its RRP, and at the RRP review onsite meetings, TransGrid confirmed that the benefits associated with phase 2 of the proposed fibre roll-out (project 1355A) were based on the same methodology that was applied for calculating benefits under Phase 1. TransGrid did not provide this methodology to justify its expenditure for project 1355A in its RP. We requested evidence of the reasonableness of this forecast, including whether the proposed benefits were being realised by TransGrid as part of Phase 1 as had been forecast in the current RCP.

240. In response to our requests for information, TransGrid advised of an error in its benefits calculation and following further review by management, has removed this project from its RRP.[94]

241. As noted in our initial RP report, TransGrid has included project 1365 SDH replacement at a forecast expenditure of $14.8 million to meet a claimed compliance obligation under the NER, specifically clauses 4.3.4 and 4.11.1. According to TransGrid, the system is at end of life, and vendor support ceased as of June 2016.[95] TransGrid has proposed to progress replacement of its 'A' system during the next RCP as its preferred option (Option B – Staged replacement), with spares recovered from its network to manage the remainder of the population, prior to replacement of its 'B' system in the subsequent RCP.

[94] TransGrid IR050/Q21.

[95] NOS 1365 Telecommunications SDH Network Condition 0117, page 2.

242. The economic assessment has included $1.7 million per annum benefits for increased communications capabilities to remote sites that more modern equipment will provide as identified in the OPGW business case. These benefits have been broadly applied to all 103 sites on TransGrid's network and have a material impact to the economic analysis. In its consideration of options TransGrid has included the same quantum and timing of benefits for both options.[96]

243. We reviewed the NPV calculation for the preferred option (Option B)[97] and we determined that the project is very sensitive to the quantum of assumed non-risk related benefits. Due to the uncertainty associated with realisation of the OPGW benefits we tested the sensitivity by modelling two scenarios: (i) deferring the 'comms benefits' by one year, and (ii) reducing the 'comms benefits' by 10%. Under both scenarios, the project has a negative NPV across all modelled discount rates. Also, TransGrid has determined that this project is not required to satisfy the organisation's SFAIRP/ALARP obligations.[98]

4.5.4 Implications for proposed expenditure allowance

244. Noting that, subsequent to its RRP, TransGrid has acknowledged that the proposed OPGW Phase 2 project is not justified, from our assessment we consider that the other communications project (1365 SDH replacement) is also not justified.

245. With neither of the full-scale replacements justified, we consider that a prudent operator would nevertheless undertake some priority works on the SDH replacement project to meet its compliance obligations, given the stated condition of these assets. We have therefore made provision for inclusion of expenditure of approximately 10% to 20% of the RRP expenditure forecast for this purpose.

Table 9: Impact of issues identified to communications forecast ($m, June 2018)

Impact of Issues- Communications	
TransGrid's RRP	51.3
EMCa's assessment of impact	-80% to -90%
TransGrid's adjustments subsequent to its RRP	*-71%*

Source: EMCa analysis

4.6 Other items of repex

4.6.1 Summary of AER Draft Decision

246. The AER removed this component of capital expenditure from TransGrid's RP forecast on the basis that for:

- Tools and equipment: appears to be already allowed for within the "Non-network" capital expenditure; and
- RIT-T costs: compliance with new requirements reflects good industry practice, and no additional costs should be provided.

[96] TransGrid response to EMCa report.

[97] NPV calculations 1365 Option B.

[98] OER 1365 Telecommunication SDH Network Condition 0117.

4.6.2 EMCa response

247. In its RRP, TransGrid has clarified that:

- The test & equipment capex is not duplicated in other parts of the capital expenditure forecast; and
- The RIT-T costs reflect reasonable additional costs associated with implementing the "replacement expenditure planning arrangements" Rule, introduced in 2017.

248. As non-technical expenditure, EMCa has not reviewed this component.

4.7 Security & compliance

4.7.1 Summary of AER Draft Decision

249. The AER did not accept TransGrid's proposed security and compliance related expenditure of $54.0 million. The AER's alternative estimate was $43.0 million (-20%).[99] The AER noted in its Draft Decision our specific concerns with TransGrid's application of the LoC and the ALARP test in its justification of Security and Compliance projects. It also recognised our general concerns with TransGrid's justification of its forecast repex, which we have described for the other repex categories above and which are also relevant to the proposed Security and Compliance expenditure.[100]

4.7.2 Summary of new information in TransGrid's RRP

250. TransGrid reduced its forecast Security and Compliance expenditure by $5.5 million (-10%) to $48.5 million in its RRP supporting documentation in response to the AER's Draft Decision.[101] The major changes include:

- Reduced scope of thermal imaging cameras component for Project 1398 (CCTV systems);
- Reduced scope due to re-evaluation of the potential risk and risk mitigation strategies for Project 1454 (Noise compliance);
- Removal of Project 1606 (Yanco 33kV clearance) due to applying a revised ALARP methodology; and
- Increased estimated rectification costs for Project 1556 (Low spans).

251. The remainder of the reductions are due to changes in the treatment of inflation and labour escalation.

[99] AER – Draft decision TransGrid transmission determination – Attachment 6 – Capital expenditure – 28 September 2017, page 6-55.

[100] *Ibid*, page 6-14.

[101] TransGrid RRP, pages 77-78.

Table 10: *TransGrid's revised Security and compliance Repex forecast ($m, June 2018)*

Project	Project No.	RP	RRP	Variance (RP vs RRP)	Variance %
CCTV System renewal	1398	11.3	7.9	-3.4	-30%
Access Card/ Intrusion detect	1595	10.9	10.6	-0.2	-2%
Electric Fence topping	1451	4.1	4.1	-0.1	-2%
Motion detector replacement	1452	4.2	4.1	-0.1	-2%
Substation Lighting repl	1455	8.2	8.1	-0.1	-1%
Physical security- comms eq't	1583	1.2	1.2	0.0	-2%
TL low spans	1556	3.0	6.8	3.8	128%
Substation noice compliance	1454	10.6	5.6	-4.9	-47%
Yanco sub low 33kV clearance	1606	0.6	0.0	-0.6	-100%
Total		**54.0**	**48.5**	**-5.5**	**-10%**

Source: EMCa analysis from TransGrid's CAM

252. Following our request for information, TransGrid has proposed an adjustment subsequent to its RRP of -$6.9 million to account for the removal of project 1556 (Low spans) from its work program for the next RCP because TransGrid has formed the view that the project is no longer justified.[102]

4.7.3 Our assessment

Derivation of PoF

253. We expressed our concerns regarding TransGrid's derivation and application of PoFs for Security and Compliance projects in our initial RP report. In it we referred to project 1398, as an example, challenging TransGrid's use of a PoF of 100% for devices that had not been installed, then attributing the risk of unauthorised substation entry, electrocution and service interruption to the devices' absence without recognition of the contribution of other controls. TransGrid has responded, stating that "*the use of a 100% rate is a valid methodology to capture the benefits of installing a new technology.*"[103]

254. In its RRP, TransGrid has revised aspects of its risk-cost analyses for project 1398 and no longer applies a PoF of 100%. Instead:

- The justification for the proposed new quad lens cameras is now based only on forecast cost savings, with no risk-cost reduction derived or claimed;[104] and
- The PoF is no longer applied to the proposed new thermal cameras, but to a single hazardous event, that being the probability of a conductor drop within the substation due to a hotspot not being detected by the thermal image cameras.[105]

[102] TransGrid IR050/Q9, page 2.

[103] TransGrid, Errors of fact and interpretation, response to paragraph 376.

[104] TransGrid, OER 1398 CCT System Renewal revision 5 (November 2017), pages 4 and 8.

[105] *Ibid,* page 5.

255. However, TransGrid's revised approach to project 1398 perpetuates what we consider to be instances of high PoF assumptions. For example, it assumes the post-investment conductor-drop PoF in a substation is 50% less than the pre-investment PoF due to introducing thermal imaging cameras. TransGrid provides no evidence to support this assumption.[106]

Derivation and application of LoC

256. In our initial RP report we considered that TransGrid's derivation of and application of LoC parameters in its substation security projects was flawed and was likely to result in overstated risk costs. Whilst TransGrid did not agree with our conclusion, it conceded that "*the relationship and interdependencies between the physical security programs of work has not been clearly articulated…"*[107]

257. Specifically, we considered that the following TransGrid LoCs are overstated:

- Personal injury LoC in substation security-related projects – TransGrid has retained 0.06%, which we consider overstates the likelihood of electrocution due to a further assumption that unauthorised entry is not identified because of a failed motion detector;[108]
- Service interruption LoC in project 1455 (substation lighting) – too high by a factor of ten,[109] leading to an over-estimate of the Base risk cost; and
- An LoC of 60% to represent the likelihood of a failed conductor damaging equipment, which we consider to be unreasonably high.[110]

258. In response to our concerns, TransGrid has unbundled the quad lens camera and thermal imaging camera components from the replacement of the CCTV system (comprising the CCTV, DVR and UPS at each site) in project 1398. In doing so it has significantly revised its approach to determining and applying the LoC. However, we remain of the view that there is insufficient justification of the LoC factors used and which we consider overstate the risk. For example, TransGrid provided no supporting information to justify "*applying a 50% factor that a conductor drop would result in electrocution."* [111]

259. In our initial RP report, we provided another example of our concerns with TransGrid's LoC assumptions, citing project 1556 (Low spans). In its RRP, TransGrid increased the proposed expenditure to account for revisions to the remedial treatment for certain structures but did not change the number of spans to be remediated, nor, apparently, its derivation and application of the LoC. In

[106] (i) TransGrid state that "*the probability that the group of thermal imaging cameras will not cover and therefore will fail to detect an asset issue is 80%"* (TransGrid, OER 1398 CCT System Renewal revision 4 (November 2016), page 3), and (ii) other issues not detectable by thermal imaging (such as metal fatigue at connection points) can lead to conductor drops.

[107] TransGrid, Errors of fact and interpretation, response to paragraph 377.

[108] TransGrid IR023/Q4.

[109] TransGrid IR023/Q5, in which TransGrid advises it has had one break-in 10 years at 100 substations leading to service interruption, which implies an LoC of 0.1%, however TransGrid uses 1% in its analysis.

[110] TransGrid, OER 1398 CCTV System Renewal UPDATE – 1 December 2017, page 5, footnote 11.

[111] Refer to footnotes 9, 10 and 11 and related explanations of the basis for the personal injury and service interruption and repair cost LoCs in TransGrid OER 1398 CCT System Renewal revision 5 (November 2017), page 5.

response to a follow-up question on its LoC assumption for this project, TransGrid subsequently advised that it had made an error in applying the LoC to project 1556 and that the project was no longer justified.[112]

Timing of proposed work

260. In our initial RP report we questioned whether TransGrid should already be investing in rectifying substation security issues (i.e. in the current RCP). TransGrid did not change its RRP expenditure in response to our challenge and advised, among other things,[113] that there were no risk-based issues justifying large-scale security projects.[114] Whilst we remain of the view that there was likely to have been time and justification to undertake more high priority work in the current RCP, this opportunity has now passed.

261. In our initial RP report we also considered it likely that TransGrid could prudently defer some of the noise compliance program work (project 1454). TransGrid disagreed with our proposition[115] in its review of our initial RP report. However, in its RRP, it has *"re-evaluated the potential risk and risk mitigation strategies"* and *"... as a result [TransGrid] reduced the total number of targeted sites from six down to two."*[116] This has led to a $4.9 million (-47%) capex reduction in its RRP.

Other matters

262. We note that there is an apparent discrepancy between a statement in TransGrid's RRP following correction of the ALARP methodology and in other documentation provided. In its RRP, TransGrid states that *"TransGrid has also redone the ALARP test for all projects which are justified by ALARP only in the manner proposed by EMCa… the result is that only one project, 1455 – Substation Lighting Replacement, no longer passes the investment criteria with an impact to the portfolio of $7.7M or less than 1%."*[117] However, TransGrid reports no adjustment to project 1455. We have taken this into account in our assessment.

263. We further observe that in its revised risk cost analysis for project 1398:

- TransGrid seeks to justify the quad lens camera component of project 1398 based on what we consider to be speculative and optimistic cost savings from reduced inspections and callout costs. For example, TransGrid states that "the quad lens camera will provide total aerial coverage of a substation site and provide an opportunity for remote visual inspection", but says elsewhere that the 'probability that a quad lens camera will fail to detect an issue is 55%";

[112] TransGrid IR050/Q9, page 2.

[113] TransGrid referred to its responses to IR030 - Q26 and 28, and to IR031 - Q2, Q7, Q9, Q11, and Q13 in its Errors of fact and opinion report in relation to EMCa paragraphs 382 and 383.

[114] TransGrid IR031/Q2, page 1.

[115] TransGrid, Errors of fact and opinion, in relation to EMCa paragraphs 384 and 385.

[116] TransGrid RRP, page 77.

[117] TransGrid, Errors of fact and opinion, in relation to EMCa paragraphs 150 and 151.

- The economic NPV is weakly positive for adding quad lens cameras and thermal imaging cameras and is strongly negative for the movement activated lighting; and
- The quad lens camera and thermal imaging camera expenditure does not satisfy the ALARP test; the movement activated lighting expenditure marginally satisfies the ALARP test.

4.7.4 Implications for proposed expenditure allowance

264. We consider that TransGrid's PoF and LoC assumptions remain biased towards overstating risk cost in all projects. However, based on the condition and poor performance of the existing substation security controls,[118] we consider that (i) these existing systems need to be replaced, (ii) the scope of work is reasonable, and (iii) the work is likely to be required within the next RCP. Whilst we remain of the view that some of this work (i.e. the highest priority based on condition, performance and criticality) should have been completed in the current RCP, this opportunity is no longer available. We also consider that adding locks to enhance the physical security of critical communications equipment (project 1583) is justified.

265. We do not consider that TransGrid has justified the inclusion of any additional functionality to substation controls, namely quad lens cameras, infrared cameras, and movement activated lighting.

266. We remain of the view that the 'low spans' project 1556 was not justified based on the information provided in the RP. TransGrid did not provide any new information in the RRP but it has subsequently advised that it will no longer proceed with the 'low spans' project.

267. We estimate that the security and compliance repex forecast in TransGrid's RRP is overstated by between 20% and 30% as shown in the table below.

Table 11: Impact of issues identified for Security & Compliance capex forecast ($m, June 2018)

Impact of Issues- Security and Compliance	
TransGrid's RRP	48.5
EMCa's assessment of impact	-20% to -30%
TransGrid's adjustments subsequent to its RRP	*-14%*

Source: EMCa analysis

[118] CCTV system (CCTV camera, DVR, and UPS), Access Card/ Intrusion detect, Electric fence topping, Motion detectors, Substation lighting.

5 Assessment of new information on relevant augex

5.1 Overview

268. TransGrid has proposed a forecast of $60.0 million in augex projects relevant to our review for the next RCP, as shown in the table below. Relative to our initial RP assessment, the AER has asked us to review two additional projects involving connection of new/replacement Ausgrid 132kV cables at Beaconsfield and at Haymarket substations.

269. The AER has not asked us to review the expenditure related to ten NCIPAP projects that TransGrid has added to the economic benefits driven category of its RRP. Because of its recategorisation, TransGrid's headline figure for economics-driven augex shows an increase of 29% since its RP.

Table 12: *TransGrid's revised economic benefits driven augex forecast ($m, June 2018)*

Project	Project No.	RP	RRP	Variance (RP vs RRP)	Variance %
Yass 330kV Bus CB capacity augmentation	1399	5.1	5.1	-0.1	-2%
Tomago 330kV Bus capacity augmentation	1416	5.2	5.1	-0.1	-1%
TG Operational telephone network	1423	2.6	2.6	-0.1	-2%
Smart grid control projects [1]	Various	21.1	20.6	-0.6	-3%
Transposition of line 87 and 8C/8E	1460	1.2	1.2	0.0	-2%
Travelling wave fault locators	1480	2.5	0.0	-2.5	-100%
Other economic benefit driven [2]	Various	0.4	0.4	0.0	-4%
Dynamic voltage support	1650	23.8	24.4	0.6	2%
Ausgrid cable connection projects	1440, 1448		0.8		
Sub-total for EMCa assessment		**61.9**	**60.0**		
NCIPAP		-	20.9		
Ausgrid cable connection projects	1440, 1448	0.8			
Total used in TransGrid proposals		**62.7**	**80.9**	**18.2**	**29%**

[1] Includes projects 1484, 1487, 1491, 1472, 1482, 1522, 1473

[2] Includes projects 1412, 1421, 1425, 1458

Source: EMCa analysis based on TransGrid's RP CAM and RRP CAM

270. At the project level, TransGrid no longer proposes to proceed with project 1480 (Travelling wave fault locators). Other variances shown in the table above are due to TransGrid's changes to its treatment of inflation and labour escalation.

5.2 Summary of AER's Draft Decision

271. In its Draft Decision, the AER did not accept TransGrid's forecast of $61.9 million[119] for economic benefit driven augex projects and substituted an alternate forecast of $30.4 million (-51%), as shown in section 2.

272. In its assessment of the economic benefit driven projects (excluding dynamic voltage support), the AER considered, among other things, our concerns regarding aspects of TransGrid's proposed projects, including:

- Inadequate justification of risk cost;
- Flawed calculation of likelihood of consequence factors; and
- Lack of rationale for the timing of work.

273. Further, the AER considered that there was too much uncertainty regarding the need and cost for the dynamic voltage stability project and suggested TransGrid consider it as a contingent project as part of its RRP.[120]

[119] The AER recategorised the Ausgrid cable connection point projects of $0.8m, and therefore in its Draft Decision AER refers to TransGrid's RP forecast as being for $61.9m. The AER has however asked EMCa to consider these two projects as part of our RRP repex assessment.

[120] AER - Draft decision TransGrid transmission determination - Attachment 6 - Capital expenditure - 28 September 2017, page 6-36.

5.3 Assessment of new information in TransGrid's RRP

5.3.1 Smart grid control projects

274. In our initial RP report[121] we identified the lack of compelling information to support: (i) the use of maximum system demand without a moderating factor to account for the possibility of less than peak system demand at the time a bushfire is assumed to affect the relevant transmission lines; and (ii) selection of 1% for what it refers to as the '*overall failure rate*' given that no such event has occurred (i.e. total system voltage collapse).

275. TransGrid advises in its RRP and in supporting documentation, "*that the reliability risk calculation does include moderation of peak load in case it is not at the peak time when the fault occurs. A factor of 0.5 is applied.*" [122, 123] Elsewhere, TransGrid states "*Furthermore, during works to restore the load, it is expected that the demand will decrease over time, as such a factor of 0.5 is used to account for this*"[124]

276. In other augex projects,[125] TransGrid recognised the impact of progressive load restoration by moderating the time to fully restore load by a factor of 0.5, which we consider reasonable. However, this does not recognise the likelihood that demand may not be at the system peak level if/when the bushfires pass through the specific part of the network. TransGrid has, in our view, misconstrued the purpose of this factor in its RRP and in its response to our initial RP report, and has not addressed our concern.

277. Regarding the '*overall failure rate,*' the following sequence of events is required to occur concurrently to result in system voltage collapse for which smart grid controls would be the indicated solution:[126, 127]

> Extreme weather event day + large bushfire + in a specific (and relatively confined) location of the network + occurring at a time of high transfer, leading to loss of a minimum of three specific transmission lines + operator unable to prevent system collapse.

[121] EMCa initial RP report, pages 43,44, and 47.

[122] TransGrid, RRP, page 83.

[123] TransGrid, Errors of fact and opinion, in relation to EMCa paragraph 221 – 1st bullet.

[124] See for example, TransGrid-OER 1472 Yass_Marulan_Bannaby330kV SmartGrid Ctrl-0117.

[125] For example, in the OER for project 1399 TransGrid states: "*restoration can begin immediately after an incident so a factor of 0.5 is used to account for this in the calculation" (TransGrid-OER 1399 Yass 330kV Bus CB Capacity Augmentation New-0117).*

[126] TransGrid-NOS 1472 Yass_Marulan_Bannaby330kV SmartGrid Ctrl-0117, pages 1-5.

[127] In arriving at the 1% likelihood of the event occurring and leading to system voltage collapse, TransGrid is combining the PoF (lines tripping) with the LoC (likelihood of shedding 8000MW).

278. Whilst we consider the combination of circumstances is possible,[128] in our view a reasonable estimate of the likelihood of occurrence in a particular year is significantly less than 1:100.[129] TransGrid has not provided compelling new information to support its assumption for this factor.

5.3.2 Travelling wave fault locators

279. In our initial RP report we considered that assumptions underpinning the costs of line patrols were likely to be overstated. In response to our request for information, TransGrid withdrew the project following its discovery of two errors in its risk cost calculation.[130]

5.3.3 Yass 330kV Bus CB capacity augmentation

280. In our initial RP report we did not understand the difference between TransGrid's 'outage rate of a 330kV bay CB' and '330kV CB failure rate', noting the values differed markedly. TransGrid has satisfactorily clarified the definitions and explained its rationale for applying them in subsequent information provided to us.[131]

281. We also considered that TransGrid's approach to calculating the probability that both circuit breaker (CB) components are concurrently out of service in the analysis of the risk cost for this project was flawed. TransGrid has responded by referring to its assumptions for the restoration of load.[132] However, this does not address our original concern, that TransGrid's methodology (as applied to this project) fails to recognise that the second CB outage must occur at the same time as the other CB is unavailable.

282. Instead TransGrid has applied the PoF for circuit breaker outages as the probability of the concurrent outage, i.e. not taking account of the fact that the average restoration time is a small fraction of the year. This is inconsistent with the approach we have observed for other parts of TransGrid's capex program as described in Sections 3 and 4. It has the effect of grossly overstating the likelihood of the consequence occurring, and therefore the avoided risk benefit of this project. After correcting for this error, the project is no longer justified.

[128] TransGrid notes two previous events (in 2001 and 2002) in which multiple concurrent line outages occurred. The system was close to voltage collapse in the 2001 event, but operator intervention avoided it; it is not clear whether the system collapsed in the 2002 event, but we assume that TransGrid would have highlighted this if it were the case - refer to TransGrid-NOS 1472 Yass_Marulan_Bannaby330kV SmartGrid Ctrl-0117, pages 2-3.

[129] For example, TransGrid estimates that extreme bushfire weather event conditions occur in NSW once every five years (TransGrid, Network Asset Criticality Framework, page 9), or 20 per 100 years. TransGrid effectively assumes that 1 in 20 of these occasions will result in a bushfire traversing the specific location and trip the specific lines required to lead to voltage collapse.

[130] TransGrid IR030/Q23, 24 Project 1486 & 1480-20170526-PUBLIC.

[131] In TransGrid IR050/Q26, CB Unplanned Outage Stats-20180216-CONFIDENTIAL. TransGrid differentiates between the annual unplanned CB outage rate with and without outages for 'SF6 top-ups'. It assumes the 2.4% PoF is representative of catastrophic circuit breaker failure and therefore requiring replacement, and the 7.9% PoF is intended to represent all causes of unavailability.

[132] TransGrid, Errors of fact and opinion, in relation to EMCa paragraph 223 – 1st bullet.

5.3.4 Tomago 330kV bus capacity augmentation

283. In our initial RP report, we raised concerns with the cost of unserved energy applied in the risk cost calculation. TransGrid used the industrial sector VCR of $44,720/MWh to determine the value of unserved energy from loss of a Tomago Aluminium Company (TAC) potline. TransGrid has advised that it sourced this information from AEMO.[133] Whilst TransGrid has selected the AEMO generic VCR for industrial sector loads, the TAC is a Direct Connect customer, for which AEMO publishes an applicable VCR of $6,050/MWh ($2014).[134, 135] This adjustment alone to TransGrid's cost of unserved energy calculation would mean that the project is not economically viable.

284. In our initial RP report, we were also not convinced that the requirement of NER S5.1.8 was a relevant driver in the case of the Tomago augmentation project. Furthermore, we did not consider that TransGrid had presented sufficient evidence that temporary loss of a TAC potline will lead to cascading network failure. TransGrid has subsequently advised that the project is not driven by NER clause S5.1.8,[136] although TransGrid's NOS is explicit about the NER requirement that it is responding to.[137]

285. Further, and as described in our assessment of the Yass 330kV CB capacity augmentation project, TransGrid has failed to adequately recognise conditional probability of coincident unavailability in this project.[138]

286. In summary, TransGrid did not provide new information that changes our view that TransGrid has not justified the proposed project.

5.3.5 Dynamic voltage support

287. In our initial RP report we considered that two aspects of TransGrid's assumptions underpinning the need for dynamic voltage support were not adequately explained. We referred to the lack of current indications from AEMO[139] of pending issues in NSW with system strength, for example NSCAS[140] gaps, RoCoF[141] constraints, or other inertia-related issues. Our major concern was that there was insufficient

[133] TransGrid, Errors of fact and opinion, in relation to EMCa paragraph 218.

[134] AEMO, Value of Customer Reliability Review, Final Report, September 2014, Table 1, page 2.

[135] TransGrid identifies that "*loss of TAC potlines can have major impact on the NSW interconnector flows and also a major economic impact*". Its analysis is based on the value of energy not supplied to TAC, per TransGrid - OER 1416 Tomago330kVBus Capacity Augment-0117-CONFIDENTIAL.

[136] TransGrid, Errors of fact and opinion, in relation to EMCa paragraph 218, and TransGrid IR030/Q23_24, page 1.

[137] TransGrid-NOS 1416 Tomago 330kVBus Capacity Augment-0117-CONFIDENTIAL, page 2.

[138] The Tomago case is predicated on concurrent unavailability of two bus breakers at Yass terminal station.

[139] AEMO 2016 Statement of Opportunities.

[140] Network Support and Ancillary Control Services, which can augment system strength.

[141] Rate of Change of Frequency – RoCoF constraints are another indicator of inadequate system strength and in turn require mitigating actions.

evidence to support the timing, scope and proposed capex of $23.8 million in the next RCP.

288. TransGrid advises in its RRP[142] that "*(s)ince January 2017, renewable energy generation has been committed in the areas in question and increasing levels of proposed renewable generation are progressing through the connection process.*" TransGrid provided an updated account of generation activity in the three areas outlined in its RP and advised that it considers the "*south west need is very likely to be triggered and potentially very soon.*"[143] Consequently it did not change its proposed expenditure forecast from the RP.

289. We had also questioned TransGrid's assumption that *"the renewable energy source most likely to connect will be solar PV"*[144] and that without this project, 300MW of renewable generation "*will not be built, or will be constrained off at two or more areas identified for potential connection opportunities*".[145] In our initial RP report, we considered that: (i) constraining off/preventing connection of solar PV is not a given in the absence of TransGrid's proposed SVC(s); (ii) gas-turbine supplied generation would be a cheaper alternative, not a more expensive alternative as purported by TransGrid;[146] and (iii) if TransGrid's methodology is accepted, a more reasonable amount of 'unserved load' would be 165MW,[147] not 300MW.

290. It is now clearer that large scale PV has or will soon become cheaper than gas turbines.

291. We remain of the view that an SVC is likely to represent the best technical solution if there are unacceptable system strength issues in its network. Despite our residual concerns with TransGrid's risk calculations, and which TransGrid has not addressed, the new information provided by TransGrid regarding the extent of committed and prospective new renewable connections (particularly in the south west) considerably strengthens the case for provision for an SVC in the next RCP.

5.3.6 Line transposition

292. In our initial RP report we questioned why TransGrid had not undertaken the proposed line transposition work (project 1460) in the current RCP. TransGrid has not provided relevant additional information and our concerns therefore remain.

5.4 Additional augex projects considered

293. Ausgrid has requested TransGrid via its Joint Planning process to carry out appropriate works to disconnect Ausgrid's existing 132kV cables and connect and

[142] TransGrid RRP, page 84.

[143] *Ibid,* page 84.

[144] TransGrid-OER 1650 Various Locations Dynamic V Support-0117.

[145] Again, based on information in AEMO's 2016 Statement of Opportunities.

[146] Due to the combination of capacity factors and levelised costs assumed by TransGrid for solar PV and for gas generation which we consider are unreasonably biased in favour of solar PV.

[147] 5% of the estimated 6000MW TransGrid estimated would be required to connect *in the NEM* to achieve Australia's renewable energy need by 2020.

commission the new cables at (i) Haymarket Substation end – Project 1448; and (ii) the Beaconsfield Substation end – Project 1440.

294. We have reviewed TransGrid's justification for the two projects. We do not consider TransGrid's risk cost calculation of over $240 million per year in each case to be credible. Nonetheless, based on the results of our review of these two projects, TransGrid is required to undertake the proposed work in response to Ausgrid's decision to replace the two 132kV cables.

295. On the basis that Ausgrid's cable replacement projects proceed in the 2018-23 RCP, we consider that the scope and cost of the components required to be completed by TransGrid ($0.2 million at Beaconsfield and $0.6 million at Haymarket)[148] are reasonable.

296. The decision on whether these costs should be included in TransGrid's RRP is a regulatory matter for the AER to consider.

5.5 Implications for proposed expenditure allowance

297. TransGrid has provided responses to some of the concerns we expressed in our initial RP report.

298. We consider that the new information about the prospective connection of significant renewable energy generation to the network means that it is prudent to make provision for installation of an SVC in the next RCP. However, we question the validity of TransGrid's allowance for commencement of a second SVC project in the final year of the next RCP.

299. TransGrid has proposed seven smart grid control projects. Our residual concerns with TransGrid's assumed 'overall failure rate' for these projects leads us to conclude that only those projects with an order of magnitude difference between TransGrid's calculated annualised benefit and annualised cost are likely to be justified in the next RCP.

300. Based on the information provided by TransGrid for its RRP, we do not consider that projects 1399 (Yass 330 kV bus CB augmentation) or 1416 (Tomago 330kV bus capacity augmentation) are justified.

301. The impact of these findings would be to allow approximately 40% less than TransGrid has proposed for the relevant augex projects described above. We consider that this would reflect a reasonable, prudent and efficient expenditure requirement.

[148] The figures for projects 1440 and 1448 are derived from TransGrid's RRP CAM.

6 Assessment of scope and cost estimates for 'Powering Sydney's Future' project

6.1 Overview

302. TransGrid has proposed forecast expenditure of $252.3 million in its RRP for the PSF project, being a reduction of $78.6 million from its RP.

303. TransGrid's RRP includes a summary of the revised options analysis for its PSF project undertaken as part of its compliance with the RIT-T requirements. It has selected a new option (option 8), the key features relevant to our assessment are in 'stage 1':

- Installation of one new 330 kV cable (with provision of a second cable at a later time) and new GIS switchgear, with commissioning of the cable prior to the summer of 2022/23; and
- Converting the existing Cable 41 from 330kV operation to 132 kV.

304. The table below shows the PSF major cost components within the scope of our review. The largest two cost components are the cable installation, at $186.1 million and the 330kV cable Non-Construction Works (DCF[149], NCF[150], and property) at $33.0 million. The Cable 41 conversion cost ($8.2 million) is only 3% of the proposed capex. We have focussed our assessment on the highest cost items.

[149] Design Cost Factor - includes all design costs (whether by TransGrid or contractors), site design investigations, specification preparation, tendering, environmental assessment and project management.

[150] Network Cost Factor - includes all costs associated with field supervision, site management and commissioning (whether by contractor or TransGrid) of the project.

Table 13: TransGrid cost breakdown for PSF Stage 1[151]

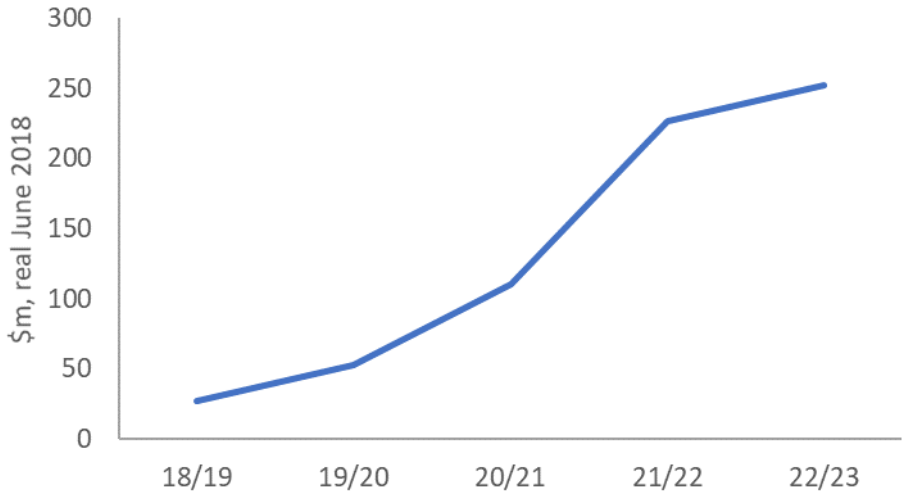
Cost component	18/19	19/20	20/21	21/22	22/23	Total
Non- Construction Works (NCF, DCF and property)	*21.7*	*3.5*	*3.0*	*3.4*	*1.4*	*33.0*
Scope Allowance	*0.1*	*4.8*	*2.9*	*0.0*	*0.0*	*7.8*
One 330kV cable (with provision for a second cable)	*4.8*	*14.7*	*46.4*	*99.3*	*21.0*	*186.1*
330 kV substation works [1]	*0.5*	*1.3*	*4.1*	*9.3*	*2.0*	*17.1*
Sub total - 330kV cable supply and installation	27.0	24.3	56.4	111.9	24.3	244.0
Cable 41 conversion	0.0	1.3	1.1	4.8	1.1	8.2
Total	**27.0**	**25.6**	**57.5**	**116.7**	**25.4**	**252.2**

[1] RWR 330 GIS extension- 330kV GIS new and BFW- 330kV augmentation

Source: TransGrid-IR050/Q2 PSF Costs Breakdown-20180216-CONFIDENTIAL, converted to $2018

305. The figure below shows the capex profile for the scope of works included in our assessment.

Figure 7: TransGrid's capex profile for PSF stage 1 [152]



Source: TransGrid-IR050/Q2 PSF Costs Breakdown-20180216-CONFIDENTIAL, converted to $2018

306. In the figure above, the proposed expenditure follows a typical S-curve with the 330kV cable installation work in 2020/21 and 2021/22 representing the largest component of expenditure.

6.2 Assessment of approach to cost estimate

6.2.1 Overview

307. The PSF project has been in development for several years. TransGrid has expended approximately $5 million (nominal) on preliminary design and planning studies to date, [153] however we are advised that TransGrid has not yet sought

[151] The figures in the source data were converted to $ real June 2018 by application of escalation percentages used in TransGrid's CAM.

[152] 330kV cable installation and provision for second cable in the future including Rookwood Rd substation augmentation (GIS building extension and switchgear) and Cable 41 conversion to 132kV (relocation to the 132kV busbars at both Beaconsfield and Sydney South substations).

[153] TransGrid IR050/Q2.

indicative pricing from suppliers.[154] The estimates we have reviewed are based primarily on TransGrid's commercial estimating tool 'Success Estimator'. We understand that TransGrid has entered actual cost data from previous projects into a database in a specific cost breakdown structure and used this data to derive estimates for a variety of activities from which the total cost estimate is built up for new projects.

308. This is a commonly used approach which normally provides a more accurate estimate than simply basing it on the last project completed – provided there are several sets of data from previous relevant projects to help moderate the effects of any unusual (outlying) costs in calculating the typical values used in new estimates. It is typically necessary to recognise the impact of specific issues relating to the new project and introduce adjustments to the basic estimate developed for a project.

309. The use of the estimating database, rather than budget pricing from suppliers and contractors, tends to reflect the current stage of planning/design of the project, including uncertainties from significant issues yet to be investigated and solutions found by TransGrid.

6.2.2 PSF project delivery approach

310. Our discussions with TransGrid identified that the proposed project delivery method for both the cable installation and associated switchgear works is to engage a contractor who would be responsible for the detailed design, procurement and installation of the respective assets. Thus, TransGrid will be responsible for all pre-contract activities, after which they are primarily managing the contracts, as opposed to providing the detailed project management.

311. We would expect TransGrid to explore performance-based contracts during the tender selection and contract negotiation phases. While this would include some risk / gain sharing mechanisms, it would not be realistic to assume that TransGrid could use this to share or reduce risks relating to Westconnex[155].

6.2.3 Estimation accuracy

312. TransGrid state that the cost estimate accuracy is ±25%.[156] TransGrid also incorporates a contingency allowance in its estimate which is its estimate of the amount needed to render the overall estimate at a P50 level of accuracy.[157] This is a lower level of estimate accuracy than we would have expected for a project of this size at its current state of development, particularly given the proposed commissioning date (prior to summer 2022/23).

[154] TransGrid IR055 - Q3, Q4, & Q5.

[155] See under heading Compensation payment to Westconnex, in section 6.3.4.

[156] TransGrid IR049, page 1. We also note that in its RIT-T PACR (Nov 2017, page 51), TransGrid advises that it has refined the capital cost estimates from the PSCR (Oct 2016) but it does not nominate the updated estimate accuracy range.

[157] Evans & Peck, *TransGrid Estimating Risk Assessment, 2014/15 – 2018/19 Regulatory Submission, July 2013,* page 2

313. The information we have reviewed leads us to conclude that the accuracy of the cost estimate should have been improved. For example,

- TransGrid engaged AECOM to carry out a route selection project in 2014, which (using the AECOM terminology/definitions) was defined as a Pre-Feasibility study with estimates classified as being "Order of Magnitude" at ±25% accuracy.[158] Since 2014, substantial further work has taken place including detailed studies of access issues and options at each of the termination substations as well as significantly upgrading the level of detail on the main 330kV cable route, which was reported in mid-2017.[159] In addition, detailed searches have been undertaken on the services along the chosen route to help identify specific excavation issues; and
- TransGrid has identified a prospective cable supplier and we would expect that up-to-date material costs should be available (to compare with assumptions based on previous 330kV cable projects). Whilst TransGrid has identified some issues with the regulatory body for roads (Roads & Maritime Services, RMS) over the depth of laying the circuits, there should be good excavation and reinstatement cost data available on the roadworks aspects of the project.[160]

314. Based on the available information, we consider that the most components of the cost estimate should be approaching an accuracy of ± 15% or better, with the few specific cost components that are not well defined, based on P50 estimates from the best available data.

315. We have assessed the reasonableness of TransGrid's cost estimates for the major cost components of the scope, including TransGrid's adjustment factors (i.e. DCF, NCF and AWF), property, and contingency. We have also sought to identify any aspects of scope that we consider should not be included, or are missing, or are over- or under-stated.

6.3 Assessment of 330kV cable cost elements

6.3.1 Non-construction works – DCF and NCF

316. TransGrid has included Design Cost Factors (DCF) and Network Cost Factors (NCF) in its estimate, both of which are applied to aspects of the base capital costs to account for labour and expenses. Of the $33.0 million allocated to Non-Construction Works, approximately 50% is for DCF and NCF allowances and the [redacted].

317. In our review of TransGrid's use of DCF and NCF, we have considered whether: (i) the factors are reasonable, and (ii) the factors have been applied appropriately.

[158] TransGrid IR045,60305223 Transgrid 330kV Reinforcement RevD-20180202-CONFIDENTIAL, App E.

[159] TransGrid/AECOM, Route Selection Report, Powering Sydney's Future – Rookwood Road to Beaconsfield West, 28 June 2017; this report identified the preferred route option, page 203.

[160] Noting that there are currently other works underway in the Sydney's CBD, which would indicate that contractor rates should also be known.

Information provided by TransGrid

318. TransGrid has calculated the DCF and NCF based on past project costs, as a percentage of total construction costs captured in work orders. TransGrid has excluded some costs[161] and has allocated labour, materials and non-excluded expenses to design, network, or construction costs, depending on the task. This review was completed in mid-2016.[162]

319. For the 330kV cable works, including at Brookfield West (BFW) and Rookwood Road (RWR) substations, TransGrid applies a range of DCFs and NCFs, as shown in the table below.

Table 14: TransGrid's 330kV cable DCF and NCF

Cost Component	DCF	NCF	Total
330kV cable	7%	3%	10%
330kV substation works augmentation (BFW)	17%	16%	33%
330kV substation works GIS New (RWR)	10%	8%	18%

Source: TransGrid-IRO45-OFS DCN43E_Cost Estimate-20180202-CONFIDENTIAL

320. TransGrid has provided a list of the cost components to which it has applied DCF and/or NCF.[163] The factors are included in TransGrid's Success Estimator database and *"…are not applied to the elements of the estimate that are not normal construction costs (e.g. TransGrid labour rates, property costs, operating costs, capitalised interest, lump sums for non-construction activities)."*[164]

Assessment

321. It is typical within the construction industry to define and add allowances such as DCF and NCF in lieu of attempting to define such costs more accurately in pre-feasibility study (±25% accuracy) and even feasibility study (±15% accuracy) cost estimates. Such factors are not typically applied in budget estimates (±10% accuracy).

322. DCFs and NCFs vary with the complexity of the work and good industry practice is to base them on actual results from similar projects, calibrating them as appropriate with engineering judgement to reflect the comparative characteristics of the project in question. TransGrid has provided evidence that it has followed this approach.[165] In addition to the use of historical project costs, TransGrid has supported its selection of the quantum of the DCFs and NCFs it has applied in the PSF project by describing:

- The rationale for the selection of the factors from the historical data; and

[161] For property-related expenses, capitalised interest, pre-planning (opex), legal, 65% of feas bility tasks (with the balance allocated to design costs) Source: TransGrid-IR049-PSF Factor Data and Calculations-20180209-Confidential.

[162] TransGrid IR049, PSF Costs from EMCa Meeting-20180212-CONFIDENTIAL, page 1.

[163] TransGrid IR049, PSF Factored Items-20180206-Confidiential.

[164] TransGrid IR049, PSF Costs from EMCa Meeting-20180212-CONFIDENTIAL, page 1.

[165] TransGrid IRO45m, OFS DCN43E_Cost Estimate-20180202-CONFIDENTIAL, pages 1-6.

- The difference between the DCF factors and between the NCF factors across the three work types, which generally reflect the complexity and other characteristics of work.

323. The granularity of the historical information provided does not distinguish between:
    - TransGrid's costs vs costs competitively sourced from external suppliers;
    - TransGrid's costs applied to 'oversee' external contractors, noting that (i) external contractors will typically include their own project management and other costs covered in TransGrid's definitions of DCF and NCF; and
    - The extent of indirect costs vs direct costs in the actual costs.

324. This level of detail in the information we have been provided precludes us from commenting on the extent to which the past costs relied upon in the derivation of the DCF and NCF are efficient.

325. We are satisfied that, based on the information we have been provided, that TransGrid's approach and factor amounts are both reasonable, given the overall cost estimate accuracy level.

6.3.2 Non-construction Works - Property

Information provided by TransGrid

326. TransGrid has estimated property costs of [redacted] for property acquisition (based on sales evidence from Corelogic sales data from [redacted]). TransGrid has subsequently advised that a more up-to-date estimate for property acquisition is [redacted] (but this is not incorporated into its estimate).[166] TransGrid advise that "*[t]his variance in property costs in a maturing project plan is as expected within a P50 forecast and supports the merits of the forecast cost estimating method and the need for the lump sum allowances…"*[167]

Assessment

327. TransGrid has allowed an additional [redacted] for property in its 'Scope allowance', which we consider to be reasonable given the uncertainty in property movements in Sydney.

6.3.3 Scope allowance

Information provided by TransGrid

328. TransGrid has allowed a risk-based contingency amount of $7.8 million (3%) referred to as a 'scope allowance' for the 330kV cable and GIS components. This is dominated by an allowance for route length uncertainty, with smaller amounts for GIS switchgear interface issues, property purchase cost variance, weather impacts,

[166] TransGrid IR049, Revised Estimates for PSF-20180206-Confidential, the preceding cost data is assumed to be nominal.

[167] TransGrid IR049, PSF Costs from EMCa Meeting-20180212-CONFIDENTIAL, page 3.

[168] TransGrid IR049, 2016B Stage 1 Allowances_Transmission Line work Rev03.

and design delays.[169] TransGrid has not included any provision for financing costs in its scope allowance.

Assessment

329. We have considered whether it is reasonable for TransGrid to add a contingency amount to the whole project to achieve an overall P50 level of accuracy. Given the other adjustment factors and the stated level of accuracy, we consider that sufficient allowance for unbiased contingency is already included and that it is not reasonable to include this additional risk-based contingency amount.[170]

6.3.4 330kV cable installation (with provision for a second cable)

Information provided by TransGrid[171]

330. The table below summarises the major cost components of the contract and plant schedules for the installation of the 330kV cable, including provision for ducts for the proposed future second cable circuit. We have presented the components as they have been provided to us, which when accounting for the year in which the expenditure is incurred, result in a forecast total of [redacted] (2016 base year).

Table 15: Major cost components for the 330kV cable[172]

Cost Component (2016 Base year project)	
330kV cable supply and install	[redacted]
Extra 330kV duct	
Deeper and wider trench	
Ancillary works Factor	
Compensation payment to Westconnex	
Elecrical Fittings etc	
Bridge crossing	
Other cable crossings	
Other work	
Total	

Source: TransGrid-IR049-PSF Factored Items-20180206-Confidential

[169] TransGrid IR049-2016B Stage 1 RWR Allowances _ All Substation Works Rev 1-20161028-Confidential and TransGrid IR049-2016B Stage 1 Allowances _ Transmission Line Work Rev 03-20161001-Confidential.

[170] TransGrid has advised of a small increase in the route length and the potential for higher than forecast property costs in its document 'TransGrid-Response to EMCa Review of PSF Costs-20180410-CONFIDENTIAL'. We consider it likely there will also be reductions from current cost estimate elements over the duration of the project.

[171] TransGrid IRO45-OFS DCN43E_Cost Estimate-20180202-CONFIDENTIAL.xls.

[172] [redacted]

Assessment

Single 330kV cable

331. TransGrid has forecast [redacted] ($2016) for the supply and installation of the 330kV cable for an assumed route length of [redacted]. There is limited publicly available data on EHV transmission costs for cable installation, however in 2012 an Independent Report endorsed by the Institution of Engineering & Technology was published in the UK to provide information on the relative costs of transmission alternatives – overhead lines, direct buried cables, deep tunnelled cables, Gas Insulated Systems and DC transmission.[173] The circuit voltage considered in this report is 400kV and various circuit ratings were considered from approximately 3,000MVA to 6,000MVA.

332. For the PSF project, the voltage is 330kV and the single circuit cable rating is 750MVA, so it is significantly less than the UK study configuration. However, if the UK data scaled to 750MVA is used, a per km cost of approximately [redacted] million is calculated.[174]

333. TransGrid provided a detailed analysis of its build-up of the per km cost from its most recent projects.[175] TransGrid has applied a per km cost of [redacted] ($2016),[176] which includes 9% cost escalation from [redacted] ($2011) derived from its assessment of previous projects. When we consider information provided in the AECOM report provided by TransGrid,[177] the UK report data, and TransGrid's information, we consider the cable estimate to be reasonable.

Extra 330kV duct work

334. TransGrid has allowed [redacted] (2016 base year) for the additional work to include a second (empty) cable duct, based on a cost per km of [redacted], and discriminating between major and minor roads. This is equivalent to 24% of the [redacted] estimate for the first cable circuit.

335. Based on our experience, the installed cost of an EHV cable is approximately twice the material cost.[178] Adding ducts for a future cable circuit will require additional time, trench width and/or depth, laying, backfilling, and reinstatement costs compared to installing a single cable circuit. However, there are significant efficiency gains from undertaking this work at the same time as installing the first cable circuit and we consider that the additional non-material costs for the extra ducts would be only around 50% of the costs for the equivalent items (i.e. non-materials) for the first cable. Combining these factors would produce an allowance

[173] Parsons Brinkerhoff, Electricity Transmission Costing Study, An Independent Report Endorsed by the Institution of Engineering & Technology, 2012 CONFIDENTIAL, page 122.

[174] Corrected to 2017 and converted to $AUD, and then simply back-projected on a straight-line basis to a 1,500MVA circuit and then scaled to 750MVA.

[175] TransGrid-IR055 - Cable Installation Costs-20180221 – CONFIDENTIAL and TransGrid-IR045-OFS DCN43E_Cost Estimate-20180202-CONFIDENTIAL.

[176] TransGrid-IR049 - Cable Data – 20180208-Confidential, page 3. Escalated to $2016.

[177] TransGrid-IR045 - 60305223 TransGrid 330kV Reinforcement RevD-20180202-CONFIDENTIAL, page 5.

[178] i.e. the excavation, laying, backfilling and reinstatement costs are, as a 'rule of thumb', approximately 50% of the total installed cost.

of 25% (i.e. 50% of 50%), which is equivalent to the 24% that TransGrid has allowed.

336. On balance, therefore, we consider the [redacted] estimate to be reasonable in the absence of detailed engineering design and tendering for supply and installation.

Deeper and wider trench

337. NSW's Road & Marine Services has advised TransGrid of its requirements to have the proposed cable systems buried deeper than TransGrid's standard depth. TransGrid has therefore included a separate cost item for this 'variation' of [redacted] (2016 base year). The sum is based on a simple volumetric percentage increase over base costs for excavation/reinstatement on the assumption that the base costs are half cable and half excavation/reinstatement. This appears to effectively model a "worst case" approach, as no discussions have yet taken place to look at the issue in detail or to consider alternatives.

338. As the RMS requirement has not yet been challenged by TransGrid and no account has been taken of potential cost reduction techniques, we consider this is well above a 'P50' level estimate. Based on our industry experience, we consider that there are likely to be engineering solutions[179] that could be applied to significantly reduce TransGrid's estimated cost allowance for this factor. Whilst an increased cost to meet the road authority's requirements is likely, we consider an amount of [redacted] (i.e. 67% of the TransGrid's estimate) to be a more reasonable estimate.

Ancillary Works Factor

339. TransGrid has applied a 10% Ancillary Works Factor (AWF) to cable estimates,[180] where costing is based primarily on generic per km rates amounting to [redacted] (2016 base year). The AWF is designed to account for the difference between the standard cost assemblies in its estimating database and the expected additional costs that will be encountered for the PSF project. In this case, the 10% AWF accounts for the expected 'higher-than-standard' costs in the 330kV line route,[181] with TransGrid including a separate amount for a 'special' bridge crossing, which is discussed below.

340. Application of adjustment factors such as the AWF is consistent with common estimating practice. TransGrid has provided evidence that the difference in estimated cost and the actual cost in the case of its Holroyd (HYD) to Rockwood Road (RWR) 330kV cable project was +6%. This was used to test the AWF assumption for the PSF project. It is not possible to discern from the information provided whether the HYD-RWR project was efficiently delivered (i.e. was the variance due to reasonable cost overruns compared to the estimate or not).

341. The differences between the HYD-RWR project and the PSF project derive mainly from the PSF work occurring in the inner west and CBD areas of Sydney, whereas

[179] Such as improved backfill materials, additional compaction, and/or geo-textile matting.

[180] Excluding the variation to meet the NSW's Road & Marine Services requirement for additional depth and width of trenching.

[181] TransGrid IR049, AWF review-20180208-Confidential.

the HYD-RWR project was in more accessible areas. The major sources of cost difference between the PSF cable works and the HYD-RWR project are:[182]

- Higher percentage of the routes located in roadways;
- A significant amount of other underground services to avoid or be undercrossed;
- Potential for high numbers of latent conditions during excavation;
- Significant number of property accesses affected;
- More remote locations for laydown areas;
- Reduced productivity for vehicles to move to and from the construction site; and
- Reduced efficiency with restricted working hours in the case of night works.

342. We have reviewed the rationale for, the derivation of, and the application of the AWF, DCF, and NCF. We are satisfied that there is no overlap in the application of these factors to the 330kV cable costs, with all three factors adjusting for different cost estimate aspects.

343. Based on the information provided and given the relatively immature level of detail that the project estimate is based on, we consider that (i) TransGrid has provided sufficient information to support its position that an AWF is required, and (ii) that an AWF of 10% is reasonable. As TransGrid states, at later stages of the project, as detailed designs are completed, the AWF should be replaced by more accurate cost estimates.

Compensation payment to Westconnex

344. [redacted]

345. [redacted]

346. We understand from the information provided, that no further investigations or negotiations have taken place since the quotation was received. In the absence of better information, it is reasonable to include [redacted] on the basis that some cost of this nature is likely to be incurred.

[182] *Ibid,* page 3.

[183] TransGrid IR049-PSF Costs from EMCa Meeting-20180212-CONFIDENTIAL, TransGrid IR049-RMS-Letter to KReynolds Re Change Order-20170817-Confidential.

Electrical fittings, etc

347. There are two significant items in this cost sub-category that comprise the [redacted] (2016 base year) estimate:

- A [redacted] allowance for the additional costs (due to reduced efficiency) expected to be caused by night working in some sections of the project.[184] Whilst the need for an allowance is recognised, we consider that the item is reasonably covered by the AWF;[185] and
- An allowance of [redacted] for community engagement, which has been developed in detail by TransGrid's consultant.[186] We consider the provision to be reasonable.

348. The remaining expenditure of $0.2m in this category is for cable termination work which we have not reviewed.

Bridge crossing

349. The information provided by TransGrid indicates that this is a very preliminary cost estimate. At [redacted] (2016 base year), it represents nearly 4% of the total cable estimate and detailed engineering investigations and design are needed to establish a more reliable figure. In response to a request for more information, TransGrid confirmed that engagement with Sydney Trains over this issue has only just commenced.[187] Given the paucity of detail supporting the estimate, we consider that it is more likely to be at ±50% accuracy, but we have no basis on which to suggest an adjustment.

Other cable crossings

350. TransGrid has included a provision of [redacted] (2016 base year) being for six 'easy' crossings of roads/railways and three 'hard' crossings. These amounts have been derived from previous projects and are to recognise the incremental costs to the [redacted] cost per km assumed for the supply and installation of the 330kV cable in a (standard) trench. We consider the estimates to be reasonable.

Other work

351. TransGrid has included [redacted] (2016 base year) for other works. Other work comprises line items in TransGrid's cost breakdown structure that have not been commented on elsewhere in this section. The majority of 'other work' line items are for amounts less than [redacted] and no anomalies were observed in the estimates for the minor works. An amount of [redacted] (2016 base year) is included for 'Establishment, management, Project Plans and Dis-establishment'. Based on information provided by TransGrid,[188] we consider that the activities included in the

[184] TransGrid IR049-PSF Costs from EMCa Meeting-20180212-CONFIDENTIAL, page 3

[185] TransGrid advises in its document 'TransGrid-Response to EMCa Review of PSF Costs-20180410-CONFIDENTIAL' that the AWF does not account for night working. However, this advice is inconsistent with section 4, page 3 of its document 'TransGrid-IR049-AWF review-20180208-Confidential', which states that the 10% AWF quantum is justified because of (among other things) '*reduced efficiency associated with restricted working hours in the case of night works'* in comparison to a recent benchmark project.

[186] TransGrid IR049 - Aurecon-PSF _ community impact cost estimate-20170314-Public.

[187] TransGrid IR055/Q5.

[188] TransGrid-Response to EMCa Review of PSF Costs-20180410-CONFIDENTIAL.

[redacted] are in addition to the amounts covered by the DCF and NCF and the cable construction cost and should reasonably be included.

6.3.5 330kV GIS substation works

Information provided by TransGrid

352. TransGrid has included [redacted] to account for work to establish the 330kV GIS bay and bus at BFW (augmentation) and RWR (new).

Assessment

353. The data for the 330kV GIS switchgear in the cost estimate spreadsheet reflects recent projects which appear to be of a similar nature (for the substation aspects of the projects). On this basis we consider application for a feasibility or pre-feasibility estimate is reasonable. However, as it is usually only practical to extend existing switchboards with equipment from the original manufacturer, we would expect that TransGrid would have liaised with the supplier as part of its extended options analysis as part of the RIT-T process to secure a more accurate price.

354. For the civil/building aspects of the switchgear installation, the use of previous projects as the starting point is reasonable as the buildings are special purpose with unique features to suit their use. Standard building data would be unlikely to provide an estimate with greater than ±25% accuracy.

355. In summary, for a pre-feasibility estimate, TransGrid's approach and estimated cost is reasonable for this component of the work.

6.4 Assessment of conversion of Cable 41 from 330kV to 132kV

Information provided by TransGrid

356. TransGrid has included a total of $8.2 million for this aspect of the project.

Assessment of 330kV cable component

357. The underlying data set for the cost per km rates in the estimation spreadsheet provided by TransGrid for our review includes a substantial number of past, relevant projects. We consider the estimate to be appropriate for use at this stage of the project lifecycle.

6.5 Summary

358. The information we have been provided reflects TransGrid's assertions that the cost estimate for the PSF project is at ±25% level of accuracy. The cost estimate is based on preliminary planning/design, with a number of high-uncertainty components yet to be resolved.

359. TransGrid's approach to the estimate matches the stated phase of the project lifecycle, being prepared in the Success Estimator software, using data from past

project with various allowances for anticipated different conditions. For the estimate to be at a greater level of accuracy the following are required: (i) at least budgetary figures from suppliers/contractors; and (ii) resolution of non-standard aspects of the planning/design (such as bridge crossings, the Westconnex project requirement, and RMS's requirements).

360. We have identified the following adjustments to TransGrid's 330kV cable cost components:

- Removal of the $7.8 million scope allowance;
- Reduction of the estimated cost to meet RMS requirements by [redacted]; and
- Removal of the [redacted] allowance for the additional costs attributed to night working in some sections of the project.

361. We consider that:

- The scope of work included in the estimate is appropriate;
- Of the stage 1 total of $244.0 million for the 330kV cable installation work, we consider the cost estimate should be reduced by approximately $17 million (or 7%), which is within the current level of accuracy of ±25%; and
- The estimate for the conversion of Cable 41 to 132kV is reasonable because it is based on an appropriate scope of work and from a good source of recent relevant project costs.

Appendix A: Our assessment of TransGrid's Response to EMCa Initial RP Report (June 2017)

A. Review of TransGrid's claims of errors in EMCa's report for the RP process

As discussed in Section 2.3, TransGrid has claimed that our initial RP report contained more than 30 factual and interpretive errors. We refute TransGrid's claimed errors, except for those relating to paragraphs 105, 245, 295 and 338.

The table below provides our response to each of TransGrid's claimed errors. We have not included in this table items that TransGrid categorised as an 'opinion' or 'update'; this information has however been considered in our RRP assessment. We have also excluded any of TransGrid's claims relating to ICT expenditure, as consideration of ICT expenditure is not included within scope for our current assessment.

In our response to each of TransGrid's claims, we have indicated the reason for our response to that claim. We have considered the relevant topic areas in the current report and, where relevant, we refer the reader to the relevant sections in the current report where we have addressed these matters.

<table>
<tr><th>EMCa initial RP report paragraph no.</th><th>EMCa initial RP report paragraph text</th><th>Relevant information request</th><th>TransGrid claim</th><th>TransGrid claim description</th><th>EMCa response</th></tr>
<tr>
<td>97</td>
<td>TransGrid describe that it has developed its risk consequence costs as the outcome of an event expressed qualitatively or quantitatively, affecting TransGrid's objectives. Whilst TransGrid identifies a range of possible outcomes associated with an event, it often selects the worst-case value for use in its risk cost analysis. A sample of the worst-case consequence costs is provided in Table 4 below.
<table>
<tr><th>Hazard type</th><th>Consequence type</th><th>Cost of consequence</th></tr>
<tr><td>Community cost of bushfire</td><td>Bushfire Urban fringe</td><td>$400,000,000</td></tr>
<tr><td>Compensation of injury</td><td>Fatality</td><td>$10,000,000</td></tr>
<tr><td>Legislation breach</td><td>Extreme breach</td><td>$5,000,000</td></tr>
<tr><td>Litigation type</td><td>Extreme - Supreme Court</td><td>$5,000,000</td></tr>
</table>
</td>
<td>IR 030
Q1 17/05/17</td>
<td>Error in Interpretation</td>
<td>EMCa has correctly reported the methodology applied however appears to not recognise this is consistent with good asset management and risk management practice.
TransGrid's risk methodology applies the worst case consequence value in accordance with good practice (for example UK Office of Gas and Electricity Markets), whereby this worst case value is taken and then moderated down to the likely consequence scenario through the use of the LoC factor.
As an example, the largest moderated bushfire consequence value applied on any transmission line asset once moderated is $4.8M, with an average of $2.6M across all transmission line assets for a bushfire incident. The moderated values used are substantially lower than the worst case bushfire consequence value of $400M. TransGrid refutes any suggestion that worst case consequence values are often selected or applied without moderation
IR030 Question 1 demonstrates that the portfolio is robust to changes in consequence values. A calibration document was also provided demonstrating that the network risk levels.
- Bushfire Consequence: Halving the bushfire consequence (e.g. taking the average $2.6M per bushfire incident value down to $13M) sees no change in the portfolio. Furthermore, the bushfire</td>
<td>This is not an error in interpretation from the information provided during our RP assessment. Our initial RP report correctly described and represented the evidence that TransGrid presented at that time.
Risk cost methodology is consistent with good asset management and risk management practice, and we acknowledge this in our initial RP report.
Use of worse case consequences requires verifiable moderating factors which were not provided in TransGrid's RP and associated information responses.
Refer to Section 3 for more detail.</td>
</tr>
</table>

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				consequence is moderated using a likelihood of consequence factor, which varies based on the geographic characteristics (e.g. vegetation) of the location of the line. A likelihood of consequence is applied to moderate this value, which is discussed further in TransGrid's response to paragraph 101. - Fatality Consequence: The safety consequence is moderated using a likelihood of consequence factor which accounts for the varying likelihood of an explosive mode of failure and having people in proximity. This is discussed further in TransGrid's response to paragraph 101. The sum of litigation, media, investigation, contacts, consultation, and legislation consequences collectively contribute 11% of the overall risk cost and are a realistic reflection of the costs the business will incur when an event of this nature occurs.	
98	TransGrid has applied a Value of Statistical Life (VSL) of $10m as the standard consequence cost for a fatality. This is much higher than the $4.4m ($2017) VSL in the Australian Government's Office of Best Practice Regulation 2008 Guidance Note (BPR Guide), which, according to TransGrid, the AER has indicated the VSL should be based on.[1] TransGrid considers that the BPR Guide systemically undervalues the occupational safety risks that are most relevant for TransGrid's risk framework because it is heavily weighted by results for the health sector.	IR 030 Question 4 06/06/2017	Error in Interpretation	TransGrid is pleased that EMCa has recognised the merit of utilising occupational safety standards EMCa has based their consideration of the VoSL on the average of a limited number of studies, being 4 Australian Occupational Safety studies (in reality 3 once the outlier is removed). Due to the small sample size of Australian studies, it is more statistically valid to look at the full range of Australian and International studies, which give a mean value of $11.1M ($14.1M in $2017). This shows that the figure used by TransGrid is both appropriate (in that it is	This is not an error in interpretation from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). TransGrid's RRP is based on a figure of $10m. Subsequently at the RRP onsite meeting of 6/2/18, TransGrid advised that it now considers a VoSL value of $6.9m to be appropriate.

[1] TransGrid response to AER information request 030, Question 4 VoSL, page 1

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	TransGrid instead refers to AS/NZS 7000:2010, and to Australian and international studies relevant to the occupational health sector, which "*provides a range of $6.8m to $11.2m on a 2006 dollar basis (or approximately $8.5m to $14.1m in 2017 dollars*)."[2] It therefore considers its VSL to be reasonable. We have reviewed the literature sources cited by TransGrid and believe there is merit in considering the Australian study results focused on the occupational health sector, for the reasons stated by TransGrid. We do not however consider that TransGrid has provided sufficiently compelling information to support the use of $10m, given that the 'Health of Nations' report which it predominantly relies upon, notes that the mean Australian VSL is $5.5m ($6.9m in 2017 dollars), excluding the outlier study.[3]			based on the Occupational Safety sector) and conservative. The safety consequence is moderated using a likelihood of consequence factor which accounts for the varying likelihood of an explosive mode of failure and having people in proximity.	
99	The reliability risk consequence, expressed as a dollar per hour ($/hour), is biased to extreme consequences of low probability, such as failure events occurring at times of peak load including 'Black Start'– that is, the de-energisation of the entire NSW transmission grid. Further, the assumptions used in its analysis are not sufficiently supported by TransGrid, including: • Reasonableness of using a black start consequence for protection failure for an un-cleared fault; • Reasonableness of estimating the potential load at risk based on the next worst	IR 026 Question 17 02/06/2017	Error in Interpretation	TransGrid refutes the suggestions that reliability risk consequences are biased toward low probability events and that assumptions used in analysis are not sufficiently supported. "Reasonableness of using a black start consequence for protection failure for an un-cleared fault;" System instability risk has only been applied to 330kV and 500kV assets as uncleared faults at this level have the potential to destabilise the network. To quantify this risk TransGrid modelled a number of scenarios,	This is not an error in interpretation from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). TransGrid did not justify its assumptions adequately in its RP. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to sections 3, 4 and 5 for more detail.

[2] *TransGrid, op. cit.* page 4

[3] Viewed from website at https://www.safeworkaustralia.gov.au/system/files/documents/1702/thehealthofnations_value_statisticallife_2008_pdf.pdf, page 55, Table 4-4

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	contingency/contingencies on the network in terms of supply connections to load, system voltage management and system security, occur; • Explanation of the differences in approach to calculating average demand and load at risk using both a factor of 0.65 from peak load, apparent derivation from annual energy consumption, and inclusion of uncertainty allowances; and • Adopting length of load interruption times at the upper end.			one of which was black start, under average system load conditions. This process is documented in the Network Asset Criticality Framework. "Reasonableness of estimating the potential load at risk based on the next worst contingency/contingencies on the network in terms of supply connections to load, system voltage management and system security, occur;" As TransGrid's network is often sufficiently meshed, typically subsequent contingency event(s) would be required in order for a loss of load to eventuate. Therefore an analysis was conducted to determine which subsequent contingency event(s) (or combination thereof) would result in actual loss of load with consideration to the consequence and probability of occurrence. In practice, multiple contingencies do occur albeit less frequently than single contingencies, which is reflected in the probability of occurrence "Explanation of the differences in approach to calculating average demand and load at risk using both a factor of 0.65 from peak load, apparent derivation from annual energy consumption, and inclusion of uncertainty allowances;" The mean to peak load ratio of 0.65 is based on one year's actual state-wide demand data. In the case of black start events, this ratio was not required to be used because average annual state-wide demand figures were available for use, however for smaller loss of supply events the TAPR/DAPR documents were used as	

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				data sources instead which only contain peak loads, hence the requirement to only apply this 0.65 factor for these events relying upon TAPR/DAPR data. In addition, an explanation of the need to apply uncertainty allowances in the transmission line reliability figures only was provided in IR 026 Question 17. The reliability risk is not a significant driver of the transmission line program in any case. "Explanation of the selected load interruption times assumed in the analysis, with reference to TransGrid's own experience" Load interruption times have been derived from TransGrid's extensive experience in network emergency responses. Leveraging on this experience, average times for typical response and correction have been applied to the various asset classes.	
101	However, we have identified a number of examples from TransGrid's application of its LoC that suggest that the moderating factors are not effective: • In its assessment of safety risk for transmission lines, TransGrid identifies the event as failure of a structure or conductor. The consequence is identified as a fatality (by impact or electrocution). In determining the LoC for a particular line, TransGrid adds the likelihood that one of its workers will be in the vicinity of the line, to the likelihood that a member of the public will be in the vicinity of the line. We consider that this approach is likely to overstate the LoC of a fatality because it assumes that there is a 100%	IR 026 Question 17 02/06/2017, IR 030 Question 4 06/06/2017	Error in Interpretation	TransGrid considers that should a transmission line fail catastrophically, anyone located at the transmission line during this event will suffer fatal injuries. This is due to impact/electrocution from falling structure/conductor or electrocution from earth potential rise which affects an area much wider than just the area under the transmission line EMCa's view fails to consider the following conservatisms through the LoC: • Only a single fatality is considered • Only the time in which TransGrid staff spend at transmission lines for maintenance works have been	This is not an error in interpretation from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have correctly understood and described TransGrid's methodology. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	likelihood that if the event occurs, the person in the vicinity of the line will be killed. We consider that this likelihood is much less than 1.			considered • A minority of high public exposure transmission lines (e.g. transmission lines which traverse schools) have had a small allowance added for time that members of the public will spend at the transmission line • High public exposure scenarios, such as road and rail crossings have not been included • Persons remote from the easement in contact with metallic objects passing through TransGrid's easements (such as fences and pipelines which could become energised) have not been considered This has been stated in TransGrid's response to IR 026 Question 17. For the majority of its lines, the LoC value is based only on the probability that one or more TransGrid staff members is in proximity to the line in the undertaking of standard maintenance tasks. For 32 lines which are located in areas frequented by members of the public and listed in TransGrid's Public Electricity Safety Awareness (PESA) Plan, an additional conservative allowance was made for one or more persons being in proximity to the line for only one hour per day. TransGrid has not considered any scenario or made allowance for multiple fatality consequences.	
101	• In its assessment of environmental risk for transmission lines, TransGrid identifies the event as failure of a structure or conductor. The consequence is a bushfire of the	IR 026 Question 6 15/06/2017,	Error in Interpretation	As stated in TransGrid's response to IR 026 and IR 030, TransGrid considers that its evaluation of the economic risk of bushfire events tends to a bias for understating,	This is not an error in interpretation from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	magnitude and destruction of the 2009 Victorian bushfire. In determining the LoC for a particular line, TransGrid seeks to determine the likelihood of a NSW equivalent of the 2009 Victorian bushfire occurring. TransGrid multiplies the likelihood of 'major NSW bushfire weather conditions' by a scaling factor to account for location-specific bushfire impact/propagation features and multiplies this by the proportion of time that the region has very high or greater bushfire ratings. Our principle concern is that TransGrid's approach does not appear to adequately account for the likelihood that a broken transmission structure/conductor will start a bushfire. This factor would be much less than 1.0 and lower than the equivalent moderating factor for distribution networks (which were involved in the 2009 bushfire) due to differences such as the effectiveness of protection systems;	IR 030 Question 1 17/05/2017		rather than overstating, the actual economic impact of a major fire, due to its use of the legal settlement amount as the source of its risk consequence rather than the full economic impact, estimated at over $4 billion by the Victorian Bushfire Royal Commission, and estimated at $7 billion by Deloitte Access Economics1. As noted by EMCa, TransGrid has applied a number of moderating factors to this value in its application of the LoC factor, to normalise for the likelihood of major NSW bushfire conditions and location specific bushfire impact/propagation features. Conservatively, the value has been further moderated to only account for the average number of days where the bushfire rating of very high or worse, typically only 20-30 days a year. In order for a fire to start, conditions need to be such that there is a sufficient amount of dry fuel and energy to enable the fire to be started. TransGrid has conservatively applied LoC moderating factors to account for these conditions, and the energy from a flashover, due to high fault currents on the transmission network even when accounting for fast protection operation, is sufficient enough to enable a fire to start under these conditions. The calculation of the bushfire consequence and the LoC value for each transmission line has been provided in TransGrid's response to IR 026. Further, TransGrid has undertaken sensitivity analysis to determine the impact of adjustments to the bushfire LoC value to TransGrid's REPEX portfolio. It is found that halving the bushfire LoC would result in no	correctly understood and described TransGrid's methodology. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				(0%) change to the REPEX portfolio. Additionally, a summary of the results of TransGrid's sensitivity analysis was provided in the response to IR 030 Question 1.	
101	• In its assessment of reliability risk at substations, TransGrid identifies the event as failure of steel structures within a substation. The consequence is loss of the entire substation for 720 hrs (30 days). TransGrid determines the LoC to be 2% or approximately once in the lifetime of every substation. We do not consider this to be a credible LoC.		Error in Interpretation	The LoC cannot be used to determine the likelihood of an event occurring in the lifetime of every substation. This approach by EMCa reflects a misunderstanding in their review of the calculation and application of risk which is comprised of the probability of failure (PoF), the likelihood of consequence (LoC) and the value of the consequence of failure (CoF). The substations identified under the steelwork need have undergone detailed engineering modelling to determine when they will reach the end of their life and the corresponding increase in PoF. The PoF values used are around 1% (refer to 1358 steelwork risk cost v5 – Base Case and Options) which is the probability of a wind event occurring with a magnitude greater than the strength of the structures at a future point in time with no action taken. The LoC value of 2% represents the probability that, following catastrophic failure as per the PoF, the failure will result in the full effects being realised, not a 2% probability of failure. In this case, the 2% LoC means that only 2% of the substation's load is considered as being lost in the event of a structure failure. EMCa's interpretation that the 2% LoC means the full load will be lost in every substation is incorrect because:	This is not an error in interpretation from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have correctly understood and described TransGrid's methodology. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to sections 3 and 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				• It does not consider the PoF. The actual likelihood of failure and complete load loss is more broadly calculated as 1% (PoF) x 2% (LoC) = 0.02% or 1 in 5,000 years. • It does not consider the assets are reaching their end of life and therefore the associated probabilities and risks cannot be extrapolated to other substations. This leads to a misjudgement of the likelihood of failure of a gantry which is beyond its end of life	
103	The development of risk cost is an approximation for the prudent timing of expenditure on the network. We therefore consider that TransGrid should apply confidence bands and sensitivity analysis to provide greater confidence in the results of the risk cost analysis.	IR 030, Question 1 17/05/2017	Error in Fact	Summary of Sensitivity Analysis results was provided in IR 030, Question 1.	This is not an error in fact from the information provided during our RP assessment. We are aware of the reference to sensitivity analysis in the '03 Session 3 – REPEX Forecast presentation' (IR 030, part of Question 1 response). This does not show confidence bands or sensitivity analysis results other than a P50 value. Refer to Section 3 for more detail.
104	During our onsite review meeting, TransGrid advised that it had undertaken sensitivity analysis on the selection of the values used in its analysis, however we have not been provided with this analysis.	IR 030, Question 1 17/05/2017	Error in Fact	Summary of Sensitivity Analysis results was provided in IR 030, Question 1.	This is not an error in fact from the information provided during our RP assessment. See response provided above to paragraph 103.
105	In considering the impact of a potential bias to over-stating the risk cost observed in the capital forecast we considered the aggregate level of risk that TransGrid claims existed in its transmission network. TransGrid advised that the pre-investment risk cost is $1.6 trillion per annum, and the proposed expenditure would reduce this to $132m per annum. A large proportion of the		Error in Fact	The EMCa review incorrectly identifies TransGrid's pre-investment risk as $1.6 trillion, where it is actually orders of magnitude less at $1.7 billion. This level of risk across the existing network is deemed reasonable, especially as it represents a future risk level should the next RCP investments not be made.	$1.6 trillion was a typographical error which did not influence our findings. The correct figure is illustrated in Figure 16 of our initial RP report.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	risk cost saving is associated with augex related projects. TransGrid advised that for repex only, the risk cost saving is $344m per annum. We consider that these values do not represent a reasonable estimate of the current level of risk to TransGrid. If the current risk exposure were credible, it suggests that the Board should be investing a greater amount of expenditure in its network in the current RCP to prudently manage the risk to consumers, and it has not decided to do so. This indicates to us that the risk cost claimed by TransGrid is over-stated.				

Assessment of Forecasting Methods

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
141	The process for identifying options (risk treatments) is not clear in every case. TransGrid occasionally refer to the use of risk assessment tools such as bow-tie analysis, however we identified cases where credible options exist (or at least options worthy of inclusion in the 'Evaluate' step) that were not discussed in the OER. Some options analysis considered only the 'chosen' option and a 'do nothing' base case.		Error in Fact	Credible options are screened through the OSA process and all credible options which address the asset risk are included for analysis.	This is not an error in fact from the information provided during our RP assessment. TransGrid did not provide evidence of screening from all credible options, as claimed. For example, TransGrid did not provide copies of its OSA reports.
142	The NPV analysis in some cases was undertaken for a combination of sub-projects, where the expenditure and benefits were aggregated. In these cases, it was not	IR 001 08/02/2017 and IR 026	Error in Fact	The NPV analysis for substation projects and programs have been completed on an individual asset basis. The NPV spreadsheets have been provided (in IR 001 and IR 026 Question 6) and	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	clear if the sub-projects also presented a positive NPV. In other cases, we found examples of the benefits being recycled, or re-used across multiple projects where the individual contribution from each of the identified projects was not clear.	Question 6 15/06/2017		EMCa's review includes reference to these calculations (for example CB program which includes reference to individual CB NPV analysis). No clarification has been requested on the analysis of sub-projects. Broken Hill (project 1193) is the exception where it was prudent in this case to complete both HV switchgear and secondary systems replacements at the same time, as detailed in the NOS. EMCa in this instance have not recognised the interdependency of metalclad HV switchgear and associated secondary systems and therefore not considered the project efficiencies in delivering them together. Combining these projects is an example of TransGrid's optimisation process Pre-DG1, which EMCa has not recognised in its report (for example, in paragraph 58).	report (i.e. 29 May 2017). The NPV analysis that TransGrid provided for programs of work did not always show NPV analysis that justified the sub-projects within those programs. In forming our views, we drew on the examples such as Broken Hill (as acknowledged by TransGrid) and security and compliance projects. For the latter, we note that TransGrid has now unbundled the individual projects which have common benefits. Examples of projects being bundled together for delivery efficiencies are not evidence of overall portfolio optimisation which we refer to in paragraph 58. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
142	The NPV analysis in some cases was undertaken for a combination of sub-projects, where the expenditure and benefits were aggregated. In these cases, it was not clear if the sub-projects also presented a positive NPV. In other cases, we found examples of the benefits being recycled, or re-used across multiple projects where the individual contribution from each of the identified projects was not clear.		Error in Fact	EMCa's opinion that project benefits have been re-cycled between multiple projects throughout our submission is an error in fact. EMCa has made a high level general claim unsubstantiated by reference to any specific project. TransGrid will be happy to engage with the EMCa on any specific projects they have concerns with.	This is not an error in fact from the information provided during our RP assessment. We identified examples of the same benefits being associated with more than one project for some aspects of the communications program, paragraph 225, and for substation security systems, paragraph 377. We did not claim that this issue applies throughout TransGrid's submission. Refer to Section 4 for more detail.
149	TransGrid has provided its rationale for the use of the disproportionality multipliers, based primarily on work undertaken by the Health & Safety Executive (HSE) UK. We consider that TransGrid has satisfactorily		Error in Interpretation	The ALARP multipliers are not considered in the selection of consequence costs, which are moderated, as discussed in response to paragraph 97, prior to the application of ALARP multipliers.	This is not an error in interpretation from the information provided during our RP assessment. EMCa has fully understood that CoF is moderated by the LoC. Refer to Section 3 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	demonstrated that the disproportionality multipliers are appropriate for determining whether the cost of risk mitigation is disproportional to the benefit or not. However, we have not seen sufficient evidence to conclude these multipliers are not already considered in its selection of the worst-case consequence costs it has used in its analysis, and therefore are likely to result in a bias to over-state the level of risk				
150 and 151	The annualised capex is derived by the division of the total capex by the remaining life of the asset in years. This calculation does not consider the cost of capital over the comparison period on a Discounted Cash Flow (DCF) basis, to then calculate the annual capital cost. For example, the recommended option (Option B) for Project 1555, Line 86 renewal, has a cost estimate of $66.2m and an economic life of 50 years. TransGrid calculate an annual capital cost of $1.3m for its ALARP test. By including the cost of capital applying a DCF of 10%, the annualised capex used for the analysis increases to $6.7m. In this case the network safety risk reduction proposed by TransGrid for Option B is $6.9m, and is only marginally passed. Reflecting a more reasonable estimate of the annualised capital cost to the ALARP test, where it has been relied upon to proceed with the project, is likely to change the outcome of the assessment.		Error in Interpretation	The ALARP cash flow is based on a methodology from UK HSE (http://www.hse.gov.uk/risk/theory/alarpcheck.htm) and is based on the best guidance available. TransGrid has also redone the ALARP test for all projects which are justified by ALARP only in the manner proposed by EMCa. Contrary to EMCa's conclusion, the result is that only one project, 1455 – Substation Lighting Replacement, no longer passes the investment criteria with an impact to the portfolio of $7.7M or less than 1%.	This is not an error in interpretation from the information provided during our RP assessment. TransGrid has acknowledged the method that it used in the RP was as described by EMCa. TransGrid has modified this on the basis EMCa suggested. TransGrid has shown here that this has changed the outcome of its assessment.
153	Whilst we consider the application of sensitivity analysis to be a reflection of good practice, the application of a sensitivity		Error in Interpretation	The intention of the Sensitivity Analysis is to demonstrate that despite the existence of uncertainty, variations in the risk values do not	This is not an error in interpretation from the information provided during our RP assessment. TransGrid's sensitivity analysis

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	analysis does not address any underlying systemic bias in the assumptions and parameters.			significantly impact the portfolio CAPEX. Note that the sensitivity analysis only considers the CAPEX portfolio downside (i.e. reduction not expansion), and as TransGrid has used a conservative application of risk, there is likely to be at least equal likelihood of an expanded capital portfolio being required, further demonstrating the robustness of the proposed portfolio.	does not show confidence bands or sensitivity analysis results other than a P50 value which is lower than its proposed capex. Refer to Section 3 and response to paragraph 103.
155	Good industry practice now includes demonstrating that the timing of expenditure is economically optimised by comparing the annualised capital cost of the 'solution' against an increasing annual risk cost over time. The economically optimum project implementation time is when the annual risk cost exceeds the annualised cost of avoiding/mitigating the risk.		Error in Fact	TransGrid agrees with EMCa that comparing the annualised capital cost of a 'solution' against the increasing annual risk cost over time is good industry practice, and this is the approach that TransGrid has taken to justify its investments through the NPV calculations. The optimal timing of the expenditure is proven by the NPV calculations being positive. The NPV calculations provided demonstrate that the annual risk cost exceeds the annualised cost of avoiding/mitigating the risk. Any delay to the project would result in a reduced NPV and therefore a reduction in benefit to the consumer.	This is not an error in fact from the information provided during our RP assessment. TransGrid did not show analysis comparing annualised capital costs of solutions against increasing risk costs, for a range of different project timings. A positive NPV does not prove the optimal timing of a project. Alternative timing might deliver a more positive NPV. Refer to Section 3 for more detail.
168	TransGrid's activity-based forecasting methodology lacks a rigorous approach to confirm that the timing of expenditure is optimal: • Of the sample of programs and projects we reviewed, the required by date - typically recorded in the NOS - was designated as 2023 (corresponding with the end of the next RCP). • As indicated elsewhere in this document, we are not convinced that, among other things, TransGrid has applied sufficient scrutiny to the		Error in Fact	EMCa's review has focused on programs of works which account for less than a third of the capital expenditure forecast, and have a designated needs date of 2023. The individual projects within these programs are prioritised based upon asset risk and timed for completion within the next RCP. EMCa have not considered standalone projects which account for more than two-thirds of the capital expenditure forecast, such as 330kV transmission line renewal projects, and have specific needs dates in the next RCP based upon the condition and risk. The optimal timing of the expenditure is proven by	This is not an error in fact from the information provided during our RP assessment. In our sample of projects and programs we reviewed approximately 80% of the proposed repex and a similar proportion of augex (within the scope of our review). We highlighted that the designated needs date of the programs of work was 2023 as TransGrid has confirmed in its response. We were not provided evidence to demonstrate that timing of expenditure is optimal. A positive NPV does not prove the

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	proposed timing of the network and non-network activities that we have reviewed.			the NPV calculations being positive. The NPV calculations provided demonstrate that the annual risk cost exceeds the annualised cost of avoiding/mitigating the risk. Any delay to the project would result in a reduced NPV and therefore a reduction in benefit to the consumer. The revenue proposal includes projects which are required to occur within the next RCP.	optimal timing of a project. Alternative timing might deliver a more positive NPV. Refer to Sections 3, 4 and 5 for more detail.
187	TransGrid includes a step for portfolio optimisation in its capital governance framework as shown in section 3. From the description provided by TransGrid during the onsite meeting, and our review of the available information, TransGrid's reference to optimisation is directed to managing the scope and timing impact of changes once the project has commenced. There is no reference to optimisation or management of the portfolio prior to approval to proceed.	IR 026, Question 1 26/05/2017	Error in Interpretation	Through the need identification and options evaluation process, needs which may impact on each other are considered and optimised where appropriate. An example of optimisation is the analysis of Broken Hill secondary systems project to include consideration for the renewal of 22kV primary plant in order to optimise the development of the most effective solution due to the inherent interaction between these asset types. This is an example of optimisation before the project has been given an approval to proceed, which EMCa has not recognised in its report (for example, in paragraph 58). Similarly, transmission lines projects which may interfere with each other due to outage constraints are timed appropriately for efficient delivery through outage coordination, considered through the Option Feasibility Studies.	This is not an error in interpretation from the information provided during our RP assessment. Evidence of such delivery optimisation is now acknowledged but was not provided during the RP assessment stage. Delivery optimisation is part of, but not all of portfolio optimisation as described in Section 3.
188	As shown in Figure 16, the cumulative risk cost savings flattens for increasing capex for both repex and total capex. Whilst it is not possible to draw conclusions from this chart alone, the general shape of the relationship suggests that there may be an opportunity to test that the level of capex is optimised. We have not seen evidence of this form of		Error in Interpretation	TransGrid has presented a top down repex model in the revenue proposal and at the on-site meeting. The forecast expenditure of this top down challenge exceeds the bottom-up forecast expenditure in the revenue proposal.	This is not an error in interpretation from the information provided during our RP assessment. In its RP, TransGrid did not provide assessment of accumulative risk costs against capex. In its RRP it has now done so. We acknowledged TransGrid's repex model

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	analysis or any other 'top-down challenge' approach applied.				in paragraph 74 of our report. Assessment of this modelling was not within our scope.

Assessment of Economic benefits driven Augex

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
218	However, for Project 1416 Tomago 330kV bus capacity augmentation. TransGrid has not provided evidence that the temporary loss of a TAC potline will lead to cascading network failure. TransGrid cites the requirements of NER clause S5.1.8 as the cornerstone of its justification for the project, which relates to 'minimising disruption to the transmission network and to significantly reduce the probability of cascading failure.' Our interpretation of NER clause S5.1.8 is that it is not designed to result in all customers subsidising an increase in supply reliability to a single customer.		Error in Fact	EMCa claims that TransGrid cites the requirements of NER clause S5.1.8 as the cornerstone of its justification for the project. This is factually incorrect. TransGrid has used a positive NPV as the cornerstone of its justification for the project, with the benefits of reduced unserved energy, as set out in OER-1416. EMCa has not provided evidence or analysis to the contrary that the project is justified by a positive NPV. EMCa has also raised concerns with the cost of unserved energy. TransGrid calculated the cost of unserved energy using the value of customer reliability (VCR) in AEMO's Value of Customer Reliability – Application Guide of $44,720/MWh for industrial loads in NSW.	This is not an error in fact from the information provided during our RP assessment. TransGrid's economic benefits driven project Need/Opportunity Statement (NOS) documents cite NER cl. S5.1.8. Refer to Section 5 for more detail on the justification including VCR.
221 – 1st Bullet	Examples of our concerns from the sample projects we considered include: In its smart grid control projects, whilst we consider that it is reasonable to assume that system demand will be high when severe bushfires occur, the load may not be at the		Error in Interpretation	TransGrid has used the factor of 0.5 to moderate uncertainties in all the assumptions, in particular the uncertainly in the peak value and the variation of the load during the load restoration period. The factor is based on historic demand profiles, and was selected as a value at the lower end of	This is not an error in interpretation from the information provided during our RP assessment. TransGrid did not provide evidence to support application of a moderation factor to the pre-fault peak system demand assumed by TransGrid in

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	peak in the areas assumed to be affected, and a moderating factor should be applied to the load. TransGrid's approach to moderating the duration for which the load is at risk is appropriate, however TransGrid provides no supporting analysis to demonstrate that the two assumptions are reasonable			estimated unserved energy than is likely to occur in practice.	its analysis. Refer to Section 5 for more detail.
221 – 3rd Bullet	In Project 1399 Yass 330kV Bus CB Capacity Augmentation, the difference between an 'outage rate of a 330kV bay CB' and a '330kV CB failure rate' is not clear and the reason for the former being more than three times higher than the latter is also not clear. We note that in at least one other project, TransGrid only uses the lower failure rate of 0.024 /unit/year; and		Error in Interpretation	EMCa has misinterpreted the failure rates used in assessing the unserved energy, and considered that the circuit breaker outage rate and circuit breaker failure rate need to be the same. TransGrid has considered the following sequence of events leading to a double bus outage at Yass 330 kV substation: 1. A bus outage due to an unplanned outage (this includes manually removing equipment from service to address an unplanned condition, and not only equipment failure) 2. A CB failure to operate when attempting to clear a fault while the other bus is out of service, causing both buses to be out of service simultaneously Historical outage/failure statistics demonstrate that event type 1 is more frequent than event type 2. These historical failure rates are reflected in the values used in the calculation, 0.079/unit/year for event type 1 and 0.024/unit/year for event type 2.	This is not an error in interpretation from the information provided during our RP assessment. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 5 for more detail.
221 – 4th Bullet	In Project 1650 Dynamic voltage support, our reading of AEMO's 2016 Statement of Opportunities (SOO) document contradicts statements made by TransGrid, and the discrepancies are not adequately explained. Furthermore, assumptions surrounding the level of installed generation, and resulting		Error in Fact	EMCa's assessment is based on two errors of fact: 1. That the purpose of proposed SVCs are for providing FCAS, inertia, and FFR (as EMCa states in footnote 94) 2. That the proposed SVCs are only for mitigating issues associated with Solar PV connections	This is not an error in fact from the information provided during our RP assessment. This is an error of interpretation by TransGrid, in that its claimed error does not seem to relate to EMCa's report text. Refer to Section 5 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	generation that may be constrained, including its 5% assumption, is similarly not explained. Even if 150MW (5% of 3,000 MW) of renewable generation is not available, this may not be a material constraint at a national level. The appropriate pricing signals should be provided to prospective generators to ensure that they are aware of the potential for contribution to network augmentation costs at the designated renewable generation hubs.			As clearly stated in NS-1650, section 2 (on page 4), the purpose of the dynamic voltage support is not for providing FCAS, inertia, or FFR. It is for improving (a) the voltage stability of the power system, when power is transmitted over the weaker parts of the system (b) the "system strength", compensating for the low short circuit ratios at the connection points, enabling the connection of renewable generation to weak parts of the grid. The need for improving the "system strength" and "short circuit level" at weak parts of the grids, in many parts of the NEM, including those in NSW, has been articulated during the recent AEMC rule change consultation: http://www.aemc.gov.au/Major-Pages/AEMC-work-overview/System-security-review Not having sufficient "system strength" will constrain the connection of both grid connected solar and grid connected wind generation. Based on the connection enquiries received by TransGrid at the locations outlined in Table 1 of NOS 1650, TransGrid considers that the new generation connecting to the weaker parts of the grid is more likely to be solar than wind. If the connection of wind generation is assumed to be constrained, due to lack of "system strength", the assessed benefits will be higher, due to the slightly lower levelised cost of wind compared to solar in 2020.	
223 – 1st Bullet	In our review of the sample projects we have material concerns with the approach TransGrid has taken to determine the risk-cost in two cases: Project 1399 Yass 330kV Bus CB Capacity Augmentation: we consider that TransGrid's		Error in Fact	EMCa has erroneously indicated that TransGrid has not considered the ability to repair the CBs and return them into service in a short period of time. For the assessment of the cost and benefits of the project 1399, Yass 330 kV Bus CB Capacity	This is not an error in fact from the information provided during our RP assessment. The information provided here by TransGrid accords with our understanding of its approach and did not address our concern.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	methodology for determining the LoC overestimates the risk of unserved energy because TransGrid does not account for the fact that the CBs in question are repairable. We believe that the determination of the probability that both components are concurrently out of service should account for the relatively small CB mean time to repair.			Augmentation, TransGrid has assumed the supply restoration will begin immediately and full supply will be restored within 8 hours. It has been assumed that most of the supply can be restored via alternative supply paths within 8 hours, even if the breakers cannot be returned to service within 8 hours. Therefore, the supply restoration time and thence benefits calculation are insensitive to the time in which CBs can be repaired.	We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 5 for more detail.
223 – 2nd Bullet	Project 1650 Dynamic voltage support: based on our assessment of the assumptions and parameters used by TransGrid in its economic analysis, we consider its approach to be fundamentally flawed.		Error in Fact	TransGrid considers that EMCa's assessment of the Project 1650 Dynamic Voltage Support is factually incorrect. The project will facilitate the connection of renewable energy (both solar and wind) to "weak" parts of the AC grid, and improve voltage stability and system strength. Refer our response to paragraph 221 – 4th bullet (above).	This is not an error in fact from the information provided during our RP assessment. The information provided here by TransGrid accords with our understanding and does not describe a factual error. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 5 for more detail.
224 – 2nd Bullet	In the case of the dynamic voltage support project, TransGrid has clearly identified the triggers that would lead to the requirement of reactive compensation. However, whilst it is possible dynamic voltage support may be required by 2023, the timing and location(s) at which it may be required (if any) are speculative. Our concerns regarding the amount of renewable energy generation assumed to be installed by 2020 in NSW discussed above reinforce the uncertainty regarding the need for this work in the next RCP. TransGrid estimate a 60% likelihood that 2 x SVCs will be required in the next RCP, but in the absence of analysis to support this conclusion, we consider that		Error in Fact and Opinion	EMCa's assessment is based on several errors of fact and information that is out of date: 1. That timing and location of renewable generation connections (and therefore the SVC locations) are speculative 2. The amount of the renewable generation to be installed and connected to the NSW transmission system 3. That the need for the project is driven by solar generation only (ref: footnote 94) EMCa's assessment has been informed by information in AEMO's 2016 ESOO. Considering the rapid developments in renewable energy in the NEM and in particular NSW, this information is now outdated. The new information available in	This is not an error in fact from the information provided during our RP assessment. TransGrid has provided here updated information including from a more recent version of AEMO's ESOO, which was not available at the time of our assessment. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 5 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	there is a stronger likelihood that the work may be reasonably deferred or be undertaken at a lower cost.			AEMO's generation information webpage indicates that the interest in solar generation in NSW has increased four fold compared to that reported in 2016. Further, AEMO's 2017 Supply Outlook indicates that: "Most recent market responses involve proposals for new renewable generation projects that are expected to become operational over the next two years, and have been included … over 900 MW to be located in Queensland and New South Wales. Since the modelling for this ESO assessment was completed, a further 392 MW of new renewable generation projects across the NEM have been announced as very advanced developments, with commercial use dates expected within the next two years. … it demonstrates the speed at which new projects are facilitated by the Large-scale Renewable Energy Target (LRET)…." TransGrid's Transmission Annual Planning Report 2017 indicates the interest in generation connections to the NSW transmission grid at specific locations (Table 3.1). The above comments by AEMO and the increased level of connection enquiries received by TransGrid confirm increased interest for connection of renewable generation (solar and wind) to the transmission grid and difficulty in pre determining the quantity or location of the connections. TransGrid has demonstrated the possibility of the new connections, location and quantity, using the most up to date information available. TransGrid has recognised the uncertainty in timing of the need of the dynamic reactive support and	

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				therefore moderated the likelihood of its implementation during the next revenue period to be 60%. While TransGrid notes the opinion expressed by EMCa that "there is a stronger likelihood that the work may be reasonably deferred or undertaken at a lower cost", it also notes this opinion has not been substantiated, has no basis and does not align with the trend in renewable generation development in NSW.	

Assessment of repex – Transmissions Lines

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
245	TransGrid has identified project 1558 for replacement of 996 132kV wood poles at a cost of $74.6m with a corresponding annual risk cost of $3.03m. TransGrid states that the project is required by 2023, and is included to satisfy the organisation's ALARP obligations.		Error in Fact	As per NOS 1558 and OER 1558, TransGrid has identified 966 wood poles for replacement in this project, not 996. This appears to be a typographical error.	This is a typographical error in this paragraph, but which is stated correctly in paragraph 247. Paragraph 262 of the initial RP report should have referenced 966 poles rather than 993. These typographical errors did not influence our assessment.
256	TransGrid has assessed a single option that addresses the nominated asset condition issues, design and type issues associated with each transmission line. The condition issues are captured in a Network Asset Condition Assessment (NACA), and vary between project. However, at the time of preparing our report, copies of these documents were not provided to support the	IR 026 Question 6 15/06/2017	Error in Fact	Condition assessments and consultant reports provided in IR 026 Question 6.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	proposed expenditure forecast.				
260	The expenditure profile evident from the RIN analysis suggests that wood pole replacement projects appear to have included replacement of all poles. It is not clear how to us, how entire pole replacement and the proposed strategy of targeted pole replacement based on condition is evidence of uniform application of its asset management approach		Error in Interpretation	TransGrid revised its risk assessment methodology across its network. Proposed projects in the current RCP were re-assessed. The application of the targeted replacement strategy for the wood poles extended to the current RCP projects. The line replacement projects which have been, or are being completed in the current RCP are on lines which have been identified with higher risks, and where a larger proportion of the structures had been identified as having condition issues, such as line 96H. Accordingly, transmission lines with widespread condition issues have been prioritised within the current RCP. A targeted approach to wood pole replacement has been deemed as prudent and efficient for those lines included in the next RCP, with the exception of line 86 where widespread condition issues exist.	This is not an error in interpretation from the information provided during our RP assessment. TransGrid has confirmed here that it is undertaking both targeted pole replacements and entire pole replacements. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
262	We did not find compelling evidence to support: • The stated decline in asset condition as the basis for inclusion of the assets identified in the respective projects, nor adequate consideration of the optimal timing of expenditure. For example, whilst the proposed replacement of 993 132kV wood poles in project 1558 is lower than the 1,163 wood poles forecast to exceed the nominal design life in the next RCP, the determination of a prudent level of expenditure for the next RCP is not clear; • The savings claimed following pole replacement, which are significant. We would expect to see the basis for the	NOS 1558 and IR 026 Question 6 15/06/2017	Error in Fact	A summary of the defect issues, using existing defect rates that TransGrid has experienced, has been provided in NOS 1558 and TransGrid's response to IR 026 Question 6.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	savings documented and reflected in the operating expenditure forecast, which we have not been asked to review; and • The basis for replacement of the remaining 391 structures for Line 86. We would expect to see an increasing defect rate, or elevated failure history to drive a change in replacement strategy.				
262	Pasted above	NOS 1558 and IR 026, Question 6 15/06/2017	Error in Fact	The timing of the wood pole replacement project was based on TransGrid's requirements to meet its ALARP obligations.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). ALARP is not a tool to optimise timing. Refer to Sections 3 and 4 for more detail.
262	Pasted above	OER 1558	Error in Fact	TransGrid has consistently undertaken in the order of 1,000 wood pole replacements in each of the previous and current RCPs. The present operating expenditure forecasts have been based on a similar number of forecast REPEX wood pole replacements in the next RCP. Accordingly, it can be expected that there will be a corresponding increase in operating expenditure should the pole replacement project not be undertaken. The operating expenditure savings shown in the NPV analysis therefore represent a future step up in operating costs should the capital expenditure not go ahead. This was discussed with the AER and EMCa during the workshops conducted in May 2017.	This is not an error in fact from the information provided during our RP assessment. Our initial RP report stated that savings should be reflected in the opex forecast. TransGrid has stated that they are.
262	Pasted above	NOS 1555 and IR 026 Question 6 15/06/2017	Error in Fact	TransGrid considers the condition issues on the line, identified in NOS 1555 and TransGrid's response to IR 026 Question 6, to be of increasing criticality concern especially given the critical nature of the transmission line on the Queensland - New South Wales Interconnector path.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). Whilst TransGrid claimed condition issues, at the time of writing our initial RP report the claimed

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
					condition issues had not been adequately supported with evidence. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
263	We found evidence of a bias in the risk cost analysis that is likely to overstate the benefits associated with projects: • The selection of the worst-case consequence cost of $400m based on the Black Saturday bushfire in Victoria is likely to inflate the estimate of risk cost for TransGrid. Whilst TransGrid seeks to moderate the selection of this consequence cost by using a LoC factor to account for conditions in NSW, the consequence cost fails to recognise other conditions that differ for a transmission network or its operating environment, as discussed in section 3. • TransGrid's assessment of residual risk is often understated, which in turn leads to an over-estimation of the benefit of the option – for example, in project 1558, the bushfire risk posed by failure of the proposed new concrete poles is close to zero, whereas the risk from the remaining wood poles is greater than zero; • Similarly, whilst not a major driver of risk cost in the line repex projects considered, TransGrid has calculated the safety risk using a VSL of $10m and legal consequence costs totalling a further $10m, and a LoC based on the		Error in Interpretation	TransGrid has considered the worst case consequence cost of $400M and reduced this to account for conditions in New South Wales by applying a factor of 0.2 to the worst case cost. Furthermore, the consequence value is moderated by the environmental factors which each transmission line traverses. In Paragraph 120 of its review, EMCa has indicated that it considers the process TransGrid undertook in relation to the PoF's reasonable, and that its application was likely to produce a reasonable PoF estimate. However, EMCa does not consider this statement valid when applied in the estimate of residual risk. In its calculation of residual risk, TransGrid has only changed the PoF value in the risk equation, and in doing so, has applied a different point in the same PoF curves used in the determination of the current risks. In Project 1558, TransGrid has applied this methodology, and has considered the PoF associated with a new concrete pole structure to be negligible, and has considered the risk to be zero accordingly. This is in accordance with TransGrid's experience with new concrete poles during the early years of their life. This is considered reasonable for the period of analysis performed in the NPV. Further, for its transmission line assets, TransGrid has flat lined the risk levels at the median year of FY2021 rather than use the increasing risk over the time of the NPV	TransGrid has not clearly described an error in interpretation. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	likelihood a member of the public may be in proximity to the line. This assumes that if the structure fails, and the person is in the vicinity at the time of the failure, then they will suffer fatal injuries. It is more likely that other moderating factors exist that further reduce the likelihood of a fatality in these conditions, as discussed in section 3. • Where the ALARP test has been applied, the annualised capex calculation is flawed. When adjusted for the cost of capital in the calculation, the ALARP test is marginal for some projects and when considered with other biases, is likely to result in changing the scope of the proposed expenditure.			calculation, as per the PoF curves. This has the effect of understating the level of risk reduction, with a bias toward the under-estimation of the benefits of the option.	

Assessment of repex - Transmission Substations

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
295	The modelling of the substation equipment projects included detailed assessment of risk cost, and selection of projects for inclusion into the expenditure forecast. However, we did not find compelling justification for the proposed expenditure increase for this asset category over the previous and current RCPs. For example, whilst the population of CTs are generally assessed to have an effective age to be younger than their natural	IR 026 Question 22 18/05/2017	Error in Fact	Asset replacements have been justified on the basis of positive NPV and/or ALARP evaluation only, and not on the basis of 10 years remaining life. OER 1338 describes the criteria for inclusion in the expenditure forecast which is the NPV and ALARP evaluations. The 10 years remaining life criteria was only used to identify those assets which should proceed to the NPV and ALARP evaluation stage.	The statement should have read that the selection of 10 years remaining life as a criterion for identifying those assets which should proceed to economic analysis has not been justified. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	age, which can be above 60 years, the selection of 10 years remaining life for inclusion into the expenditure forecast has not been justified.				
301	TransGrid apply a $/hour assumption to calculate the reliability consequence of load at risk for loss of a major substation element (i.e. line, transformer etc). It is not clear how the analysis considers the moderation of the 'effective' outage duration by load restoration activities and is likely to overstate the reliability impact. For example:		Error in Fact	Reliability risk does consider moderation through load restoration activities. Where load restoration is available as an option, the reliability consequence is multiplied by a factor which is equal to the ratio of the load restoration time duration to the equipment repair time (which is <1). This is built into the reliability consequence value. Concerning the change in load over time, there is no significant reduction in load forecast anticipated that would have a material impact on the risk. The AEMO NEFR 2016 forecasts a largely flat profile over the coming years.	This is not an error in fact from the information provided during our RP assessment. For the RP assessment, TransGrid did not describe derivation of its $/hr reliability consequence cost. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
302 1st Bullet	• In the analysis of CB renewal Group 1, a 132kV bus section CB at Muswellbrook 330kV substation includes a reliability risk cost saving of $1.0m pa. When factoring in the 132kV CB replacement cost of $267,000, the NPV analysis results in a positive NPV of $9.6m, resulting in a payback within 1 year. Within the CB renewal project a total of 64 sub-projects have a payback period within 1 year. This casts a level of doubt on the assessment of reliability risk cost, as a reasonable estimate of benefits (avoided risk costs) and therefore the robustness of the NPV model;	IR 001 17/02/2017 and IR 030 Question 1 17/05/2017	Error in Fact	EMCa response indicates within the CB renewal project a total of 64 sub projects have a payback within 1 year. This is on the basis of reliability risk cost saving per annum (avoided risk cost) being greater than the CB replacement cost. This number is incorrect. Within the CB renewal project there are a total of 22 sub projects with a 1 year payback period based on avoided risk cost. These 22 replacements have a combination of a high criticality network location and high probability of failure related to poor evaluated asset health. Evaluation of pay back periods is an inadequate financial KPI to determine the suitability of asset renewals and is not a factor in asset renewal business cases. Only NPV and ALARP evaluation have been used to justify asset replacements. In the example location referenced by EMCa, loss of the Muswellbrook 330kV Substation 132kV Bus	This is not an error in fact from the information provided during our RP assessment. TransGrid corrected an error in its analysis after the RP assessment period, which resulted in the lower number of sub projects. We drew attention to the extremely short payback periods which imply that the work should already have been undertaken. This led us to question the assumptions in TransGrid's analysis. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				Section CB will result in the loss of all load supplied from Muswellbrook 330kV Substation until the isolation of the failed CB and restoration of the 132kV bus sections. This restoration time ("short outage duration") has been modelled as 4 hours as included in the CB risk calculations spreadsheet provided under IR01. The very high network criticality at this location is reflective of this severe network consequence. The reliability risk cost calculations are based on the AEMO report on the Value of Customer Reliability (VCR). A summary of the sensitivity analysis was presented to EMCa during the meetings with TransGrid and the slides were subsequently provided to EMCa under IR30 Question 1.	
303	We also observed that in some instances, such as for the transformer renewal project, the reliability consequence cost also includes the failure of the availability incentive scheme. The inclusion of the availability incentive scheme does not appear to be consistent with an investment test for consumers			EMCa have correctly identified an error where the incentive scheme loss was erroneously included. This was included for the CVT and Power Transformer asset classes only. After removing these from the calculation it was determined that the portfolio CAPEX value did not change (i.e. its contribution to the overall risk is so small that it has no effect).	We acknowledge TransGrid's confirmation of its error.
313	TransGrid has considered a single option in its analysis to replace individual systems without adequate evidence or supporting information to justify this option. We would typically expect to see defect analysis and condition assessments, and evaluation of targeted risk mitigation strategies and increasing risk or observed failures. The options analysis would then consider, partial replacement options, packaging with other works or both. For example, TransGrid is		Error in Interpretation	In the case of 415V AC projects, full compliance with AS3000 for those identified 415V AC systems was the only viable option. From a safety risk perspective TransGrid believes this is justified to meet obligations to AS3000. Partial compliance is not deemed as an acceptable solution in managing safety risk so far as is reasonably practicable as required by regulation, hence the only viable compliant option has been selected. For 50V RPS projects, system replacement was identified as the single viable option. As part of	This is not an error in interpretation from the information provided during our RP assessment. TransGrid provided insufficient information to determine how it had scoped the project. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	proposing to replace over 60% of its RPS systems in the next RCP, and has not adequately established this as a prudent level of replacement based on age or condition			TransGrid's routine maintenance of RPS's, battery cells/strings are replaced as required, however asset condition data for these systems indicate significant increases in defects for those older than 7 years irrespective of such maintenance. For this reason piecemeal replacement was eliminated as an option to address on-going increasing risk. RPS system replacement is therefore considered as the single feasible option.	
314	Whilst we expect that TransGrid has included projects to mitigate a material risk, and it is likely that expenditure is able to be readily justified for this work, TransGrid has not adequately supported the proposed scope of works as being a prudent and efficient forecast		Error in Interpretation	For all proposed 415V AC and RPS projects TransGrid believes the scope is both prudent and efficient. 415V AC projects have been selected based on systems exceeding threshold safety risk levels evaluated against comprehensive asset condition data assessments per the project documentation included with the revenue proposal. Such sites were deemed to pose unacceptable levels of safety and reliability risks and in need of immediate replacement within RP2. TransGrid's 50V RPS asset replacements have been prudently scoped based on age and the known escalation of defects (refer to response to paragraph 315) resulting in unacceptable levels of risk to the network. For this reason TransGrid therefore has decided to replace assets greater than 10 years of age rather than continuing maintenance and corrective actions.	This is not an error in interpretation from the information provided during our RP assessment. TransGrid provided insufficient information at the time of our initial RP assessment, to determine the proposed program was prudent. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
319 & 320	The risk cost analysis includes an elevated and overly conservative assessment of reliability risk cost. For example, at Sydney South substation, TransGrid has included a $11.1m pa risk cost associated with failure of the holding down bolts plus a further $6.2m pa risk cost for a member failure, associated with loss of 1,307MW. The analysis assumes that failure of the steelwork will		Error in Interpretation	Refer to response to statement 101.	This is not an error in interpretation from the information provided during our RP assessment. Refer to our response re statement 101. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	result in the catastrophic failure of the gantry structure and loss of the entire substation for 720hrs (30 days). TransGrid allocate a 2% LoC, based on its assessment that the whole substation will lose this level of load for this period of time, which is comparable to a 1 in 50 years event. The corresponding reliability consequence cost applied in this analysis is $72 billion pa for this site, and this value is used for both the failure of the holding down bolts and failure of a steel member. We consider the analysis over-states the LoC, and that TransGrid has not provided evidence that supports the estimate of reliability consequence cost as being reasonable.				

Assessment of repex - Secondary Systems/Communications

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
328	From Figure 26, the historical expenditure levels evident in 2014/15 and 2015/16 are not supported by statements in the Automation Systems Renewal and Maintenance strategy, which suggests that this expenditure was either unplanned or associated with other replacement projects. TransGrid forecasts a continuing focus on protection system replacement/renewal in		Error in Interpretation	There is not a direct correlation between the assets under the scope of the automation renewal and maintenance strategies and the asset classes defined in the RIN reporting referenced by the EMCa. For the major replacement projects delivered in the current regulatory period, there can be significant difficulty in separating expenditure between automation, metering, telecommunications and their shared civil	This is not an error in interpretation from the information provided during our RP assessment. We note TransGrid's clarification of the category definitions of the relevant RIN class.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	the next RCP			infrastructure assets to provide meaningful analysis, which is the intention of the comment in TransGrid's strategy document.	
336	Project 1379 GE Multilin is the largest project totalling $38.9m in which TransGrid proposes replacing all the identified assets. There is a discrepancy between the NOS and OER regarding the population of assets that are covered by this need, with the latter increasing the population by 35 units. TransGrid recognises that the population is reduced by 131 assets to account for the secondary systems renewal projects or those that are used on negotiated services, however the resulting population for replacement is not included. A major driver appears to be the age of the units as "approximately 46.9% of these relays were installed prior to 2008, and will have reached the end of their estimated life by 2023."		Error in Interpretation	TransGrid acknowledges the discrepancy between the population counts in the Need/Opportunity Statement (which included only the prescribed assets) (NOS) – 1379 Protection - GE Multilin Condition and the Options Evaluation Report (which included both prescribed and negotiated assets) (OER) – 1379 Protection – GE Multilin Condition for this program. The 35 units are those installed as negotiated services which were not included in the NOS-1379. The population for replacement is included in the OER-1379 table 1, 2 and 3 according to voltage level. The costing for this project in the revenue proposal accurately reflects the prescribed assets only.	This is not an error in interpretation from the information provided during our RP assessment. We note TransGrid's acknowledgement of the discrepancy in its population count, and that the expenditure forecast accurately reflects the prescribed assets only.
336	Pasted Above	Section 2 of Need/ Opportunity Statement (NOS)-1379 Protection – GE Multilin Condition	Error in Interpretation	The major driver for this replacement program is the high comparative failure rate for this suite of assets and the severe failure modes that TransGrid has experienced. This was covered in Section 2 of Need/Opportunity Statement (NOS)-1379 Protection – GE Multilin Condition. EMCa have incorrectly interpreted general background information provided in NOS-1379 as a driver for investment.	This is not an error in interpretation from the information provided during our RP assessment. The increasing defect rate is stated in paragraph 337.
337	TransGrid has identified an increasing defect rate over the period 2013/14 to 2015/16. The forecast defect rate and, more specifically, the effect of the corrective actions currently being implemented to manage this risk (if any), do not appear to have been described. The total risk per annum is estimated at	IR 026 Question 6 15/06/2017 SSAP - Protection	Error in Fact	Failure Rates and the process used to derive this are described in full in the documentation supplied under IR 026 Question 6.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	$26m	Systems Condition Assessment			Refer to Section 4 for more detail.
338	TransGrid identified options to prioritise the replacement by criticality (load, voltage) however opted to progress the entire program. The project was justified on the basis of meeting ALARP obligations (the NPV was marginally negative).		Error in Fact	This program is justified on significantly positive Economic NPV, which is the measure for demonstrating benefit to consumers. EMCa have not considered the results of the Economic NPV evaluation in claiming that this project is marginally NPV positive, The Financial NPV is marginally positive, but this is a measure of the value of the work to TransGrid and is not considered in assessing the benefit of a project to consumers. In addition to the positive NPV, the Options Evaluation Report (OER) – 1379 Protection – GE Multilin Condition identifies that ALARP is also met by the preferred solution	The statement should have read that the project was justified on the basis of economic NPV and satisfied TransGrid's ALARP obligations.
341	Whilst the Automation Systems Renewal and Maintenance strategy identified increasing defect rates across the population, we did not find quantitative evidence of how the individual projects were selected for inclusion in the forecast.	IR 026 Question 6 15/06/2017 SSAP - Protection Systems Condition Assessment	Error in Fact	Individual Asset Models were identified through the methodology described in the Protection Systems Condition Assessment supplied in response to IR 026 Question 6. The sites considered for site wide renewals were identified through the methodology described in the Secondary Systems Site Installation Strategy and Smart Network Vision that were provided with the Revenue submission.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
342	The secondary systems renewal projects and other projects in this category are inter-dependent. TransGrid has adjusted replacement volumes based on other works being included in the expenditure forecast for this asset category. However, the basis for inclusion of the entire remaining population of assets in the preferred option not evident.		Error in Fact	The justification for replacement of the assets included in the replacement programs in the regulatory proposal is the positive Economic NPV, which demonstrates that annualised risk exceeds the annualised cost of replacement. This is supported in a number of programs by meeting TransGrid's ALARP test. Where classes of assets have not met either of these requirements, they have not been recommended for replacement. The rationale for the secondary system renewal projects is discussed in the Secondary Systems	This is not an error in fact from the information provided during our RP assessment. We were not provided with sufficient information at the time of our initial RP assessment, to conclude the proposed program was prudent. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 4 for more detail.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
				Site Installation Strategy and Smart Network Vision. TransGrid acknowledges that some assets that have not reached the end of their economic life will be replaced under these projects; however, the Write-Off costs for these assets were included in the NPV analysis and selection of the site wide option still provides greatest overall benefit as demonstrated by the highest economic NPV.	
343	For the SCADA replacement project, TransGrid states that other factors justify the selected option but were not included in the NPV analysis (including time to deliver, and difficulty in modelling failure modes). We consider that additional options could have been reasonably assessed, including life extension for the SCADA system. Details such as installation date, failure modes, defect and risk analysis, renewal and maintenance expenditure history would have assisted with demonstrating that the project is justified		Error in Fact	The Need/Opportunity Statement (NOS)-1254 SCADA EMS Replacement articulates the qualities of the current system which demonstrate that life extension was not feasible. Installation Date (NOS-1254) and defect analysis (Section 4 of Options Evaluation Report-12 54 SCADA EMS Replacement) were discussed in the documentation provided contrary to EMCa's assertions.	This is not an error in fact from the information provided during our RP assessment. TransGrid explored a single option for this project, and whilst this may be the preferred option there was insufficient information provided to dismiss other potential options. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
345	When we recalculated the annualised capex for the protection replacement project, it does not pass TransGrid's ALARP test		Error in Fact	As discussed in the response to paragraph 338, the protection replacement program is justified based on positive economic NPV across all categories of assets, irrespective of the ALARP test.	This is not an error in fact from the information provided during our RP assessment. The ALARP test is not met for project 1379 when the annualised capex is correctly calculated as stated in TransGrid's response to paragraph 338. However, TransGrid has included the project on the basis of positive economic NPV.
346	For secondary systems, TransGrid has captured the risk information in the IRT. We were advised during onsite that the load at risk and interruption duration values used as the basis for calculating reliability risk in the IRT are not real, rather they represent back-	IR 026 Question 6 15/06/2017	Error in Fact	The substation risk calculations were completed outside of the IRT and have been provided to the AER. They were also part of the walkthrough provided during the onsite review. The only variable subject to external change for secondary systems projects was the LoC with the details of	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	calculated values from an external source to make the IRT operate correctly. We remain concerned with TransGrid's reliance on the IRT, given the number of calculations that are performed external to the tool. We have requested explanation of these values, and the supporting external calculations. At the time of preparing this report, this had not been received from TransGrid. We are therefore unable to comment on the reasonableness of these input values.			how these values were calculated being provided in IR 026 Question 6.	provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
347	The high risk costs included in the IRT are driven by the reliability cost, and appear to assume a reliability consequence of "black start for assets protecting primary plant at 330kV and above with "N-1" redundancy. The restoration time has been set as 8 hours with an assumed 1,296MW of load interrupted to mixed customers (residential, commercial, and agricultural) to model a number of potential network scenarios based on this consequence." As discussed in section 3, these assumptions suggest an inflated consequence due to the summed load interrupted, and duration of event included in these calculations		Error in Interpretation	The risk of a fault not being cleared on the main transmission network is statistically possible and could lead to system instability, and potentially a Black Start event. This has been modelled as described in the Network Asset Criticality Framework. As this is an extreme consequence/low probability event, it has been significantly moderated to account for multiple factors. Our calibration testing of the model suggests it is not disproportionately inflated. An example of this is Lower Tumut Secondary Systems Renewal Project. The protection devices at this site only carry the system instability risk as it is a prescribed connection to a generator and has no directly connected load. If the system instability risk was inflated, it would be expected that Lower Tumut Risk would be higher than those sites that do not carry this risk (Panorama, Molong, Broken Hill, Darlington Point), however it ranks third lowest pre-investment risk of all Secondary Systems Renewal Projects proposed.	This is not an error in interpretation from the information provided during our RP assessment. The information provided here by TransGrid accords with our understanding and does not describe an error in interpretation. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
348	It is not clear how the optimal timing of this expenditure was investigated, nor was there		Error in Interpretation	The economic NPV demonstrates that the assets are at a point where annualised risk reduction	This is not an error in interpretation from the information provided during our RP

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	evidence of whether undertaking this program over a longer period was investigated by TransGrid. Whilst we expect that TransGrid has included projects to mitigate a clear and identified risk, and it is likely that expenditure is able to be readily justified for this work, TransGrid has not adequately supported the proposed scope of works as being a prudent and efficient forecast.			exceeds replacement cost and is therefore optimal time for replacement. This statement can be challenged by citing a number of other protection replacement programs, for example 1356 - Protection Reyrolle OHx Condition. Under this program 25% of current assets were recommended for replacement in the 18-23 RP based on NPV analysis. The remaining assets will be investigated for replacement in subsequent periods with updated condition information. The conclusion drawn here highlights the inaccuracies and error in interpretation in the review process undertaken by EMCa by only looking at selected projects and drawing incorrect assumptions about the risk assessment process applied by TransGrid. EMCa have made the errors in fact addressed in TransGrid's response to paragraph 338 and used this error to draw incorrect conclusions with regards to the validity of TransGrid's analysis and justification for timing. These incorrect conclusions on this one reviewed project have then been used to unfairly characterise the entire Secondary Systems Repex portfolio.	assessment. Our initial review included a sample of projects from each category of expenditure, and in aggregate included approximately 80% of the proposed repex within the scope of our review. Where systemic issues were identified, these were reported in our initial RP report. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Sections 3 and 4 for more detail.
361	We have not seen sufficient evidence to support the calculation of benefits from the proposed expenditure, and there is suggestion that the "benefits of increased communications capabilities to remote sites that more modern equipment will provide were identified in the OPGW business case" which suggests that these may have been claimed across multiple projects. Notwithstanding that the installation of fibre networks is a program commenced in the current RCP, we did not see evidence to		Error in Fact	The statement explains that the same methodology that was applied for calculating benefits under Phase 1 was also applied to Phase 2. EMCa have misinterpreted this to suggest benefits are being double counted, which is factually incorrect.	This is not an error in fact from the information provided during our RP assessment. In response to our request for information, TransGrid has advised that following management review of its benefits calculation, it identified an error. TransGrid has proposed to remove this project from its forecast expenditure.

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	support the proposed forecast expenditure, including where the benefits have been included in the capex and opex forecast.				
362	We are unconvinced that the expenditure forecast for phase 2 of the fibre rollout, as currently presented, meets the requirements of an asset replacement project or that the input assumptions relating to benefits are reasonable despite this being a continuing project from the current period. In the absence of this information, the degree of expenditure required to prudently manage the asset versus providing additional capacity and functionality to the business is not evident.		Error in Interpretation	The rationale for Phase 2 is identical to that presented for Phase 1 in their review of TransGrid's revenue submission for the 2014-18 Regulatory period. TransGrid is replacing trunk microwave systems with Optical Fibre as microwave is an obsolete technology, incapable of meeting the data requirements of a modern transmission business.	This is not an error in interpretation from the information provided during our RP assessment. In response to our request for information, TransGrid has advised that following management review of its benefits calculation, it identified an error. TransGrid has proposed to remove this project from its forecast expenditure.
364	The allocation of a reliability risk cost based on an estimate that 16 hours will be required to recover any loss of load after an unplanned outage from the communications network once spares become exhausted, appears overly conservative and likely to lead to significantly overstating the risk cost		Error in Interpretation	The situation considered in the risk assessment is a second failure on the communications network which has the capacity to disrupt control, protection and dispatch communication to a large section of the network and would take significant time to recover if spare parts were not available. 16 hours is an approximation for the time to replace an entire multiplexer shelf, reconfigure and commission. AEMO would have ultimate authority in this scenario. Due to the low probability/ high consequence nature of this kind of event, an appropriate LoC modifier (equivalent to a 1 in 13,500 year event) has been applied.	This is not an error in interpretation from the information provided during our RP assessment. TransGrid did not provide sufficient evidence that the time to replace the failed unit would equate to loss of load. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.

Assessment of repex - Security and compliance capex

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
376	With respect to TransGrid's derivation of PoF parameters, we consider that its use of relevant historical data (which it does when it is available in sufficient quantity) is a reasonable approach. However, applying a 100% failure rate to devices that are not installed and then attributing the devices' 'absence' to unauthorised entry, electrocution and service interruption is not adequately justified by TransGrid. TransGrid has not provided sufficient evidence to support its assumption regarding the PoF for electronic devices.	IR 031 Question 8 20/06/2017 and Question 10 20/06/2017	Error in Interpretation	The use of a 100% rate is a valid methodology to capture the benefits of installing a new technology. This allows the differential risk or cost benefit from the status to be quantified and compared with the spend to determine if the investment is warranted.	This is not an error in interpretation from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We described the methodology used in paragraph 370. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
381	TransGrid has provided insufficient justification for the additional functionality it proposes in some projects (e.g. quad lens cameras and infra-red cameras). The incremental value of these initiatives on a risk avoided basis appears to be too small to justify the expenditure.	IR 031 Question 8 20/06/2017 & Question 10 20/06/2017	Error in Fact	TransGrid has provided analysis of the benefits of both the quad lens and infrared cameras in IR 031 Question 8 and Question 10. These benefits are to reliability, and capturing asset failures earlier. These benefits are additional to the safety and reliability risk reductions provided in the base security projects and are fully justified in their own right. There are benefits to bundling these with the overall security works which is why they have been included in the same project.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
383	The absence of consideration of works in the current RCP, casts a level of doubt on the claims made in the supporting information, and in the risk cost analysis provided to support the proposed expenditure	IR 031 Question 2 14/06/2017	Error in Fact	TransGrid has fully considered the current RCP Security works as part of IR 031 Question 2 which outlines the current regulatory period security program. This combined with the responses to IR's listed in the response to paragraph 382 provide a comprehensive assessment of the timing of the security program of works.	This is not an error in fact from the information provided up to the 'as at' date of our RP assessment as documented in our report (i.e. 29 May 2017). We have assessed the new information provided in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.
384	TransGrid advises that it has undertaken 'a detailed noise assessment' at Molong		Error in Fact	In TransGrid's desktop Noise Risk Assessment, a noise exceedance of 14dB was modelled for a	This is not an error in fact from the information provided during our RP

EMCa initial RP report paragraph no.	EMCa initial RP report paragraph text	Relevant information request	TransGrid claim	TransGrid claim description	EMCa response
	substation and now predicts potential for limit exceedance of between 0.6-3.3dB. In our view, this is indicative of the potential for material variances between desktop modelling and actual measurements. We consider that TransGrid should confirm whether there are significant noise compliance breaches by taking measurements in accordance with the applicable international or jurisdictional standard			residential structure just north the TransGrid northern property boundary. As a result of the detailed noise assessment, structure reference R_R01a was identified as having a 4dB noise exceedance. This particular structure was later identified as likely being unoccupied. The measured exceedances of 0.6 / 3.3 dB relate to the nearest confirmed occupied dwelling, reference R_2002L2 (which is about 480m away, further than R-R01a). The Noise Risk Assessment was completed by a reputable and qualified consultant. TransGrid believes a desktop study for sites identified at risk, followed by detailed on site studies for selected high risk sites is a justified approach.	assessment. TransGrid's additional information is consistent with EMCa's finding. We have assessed the new information provided here and in TransGrid's RRP, onsite meeting and information responses. Refer to Section 4 for more detail.