EMCa
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Revenue Proposal to AER 2018-2022

Review of Forecast Non-load driven capital expenditure in Powerlink's Regulatory Proposal

Report to

Australian Energy Regulator

from

Energy Market Consulting associates

July 2016

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 Powerlink from 1st July 2017 to 30th June 2022 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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In particular, this report is not intended to be used to support business cases or business investment decisions nor is this report intended to be read as an interpretation of the application of the NER or other legal instruments. EMCa's opinions in this report include considerations of materiality to the requirements of the AER and opinions stated or inferred in this report should be read in relation to this over-arching purpose.

Except where specifically noted, this report was prepared based on information provided by Powerlink prior to 23rd June 2016 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 Powerlink'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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Date saved:	12/09/2016 10:42 a.m.
Version:	Version 7

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Executive Summary

Purpose of this report

1. The purpose of this report is to provide the AER with technical advice on the reasonableness of Powerlink's proposed non-load driven capital expenditure, the main component of which is replacement/refurbishment capital expenditure (repex – which Powerlink sometimes refers to as 'reinvestment'), based on a review to identify any systemic issues in its governance, management and forecasting process and of a sample of projects and programs. The assessment contained in this report is intended to assist the AER in establishing an appropriate capital expenditure allowance as an input to its Draft Decision on Powerlink's allowable revenue.

2. Our assessment is based on a limited scope review of certain aspects of Powerlink's expenditure forecast.[1] It does not take into account all factors or all reasonable methods for determining a capital expenditure allowance in accordance with the National Electricity Rules (NER).

Scope of work

3. In the context of the NER capital expenditure criteria, objectives and factors, the AER has sought EMCa's independent advice regarding the prudency and efficiency of Powerlink's non-load driven projects and programs (referred to by Powerlink as reinvestment, security/compliance and 'Other').

Governance and management

4. From our review of Powerlink's governance and management policies, processes and systems, we consider that a bias for over-estimation of risk for non-load driven capex expenditure is evident:

   - Application of Powerlink's risk-based prioritisation methodology is still in progress, and is not yet fully embedded within the business;
   - Powerlink's risk-cost economic analysis to determine the optimum scope and timing of work at a project level is immature and not widely applied; and

[1] The scope of our review considers specific capex projects and programs for non-load driven projects and programs as agreed with the AER and limited review of Powerlink's use of top-down 'repex' model outputs in developing its forecast of expenditure requirements. This expenditure is a subset of the capital expenditure within Powerlink's Revenue Proposal.

- The significant underspend of the forecast expenditure for the current Regulatory Control Period (RCP) is indicative of an inadequate 'top-down' challenge process having been applied to that forecast and we do not see evidence that the inadequacies in that process have been fully rectified.

5. The significant underspend of the forecast requirement in the current regulatory period will have led to a difference in asset health at the end of the period from that which would have been had the forecast projects and programs been undertaken. The underspend could reflect inaccurate forecasting, inability to deliver, efficient deferral of work and/or changes in asset management practices. Whilst it is probable that the underspend was, to some extent, due to a combination of causes, we found no evidence that the underspend has led to an undesirable deterioration of overall asset health.

Forecasting methods

6. From our review of Powerlink's forecasting methods, we consider that an over-forecasting and over-estimating bias is evident:

    - Comparison of expenditure in the current RCP with forecast non-load driven capex indicates a bias to over-forecast the prudent and efficient scope, timing and cost of work required;
    - Powerlink has identified that it is in the process of improving its approaches to risk assessment and prioritisation methodologies (among other things) – these improvements are likely to lead to further optimisation of required expenditure;
    - Powerlink's approach to adapting the AER's repex model is based on sound principles, however its Hybrid Repex Model is reliant on prudent and efficient inputs, yet the unexplained repex variances in the early part of the current RCP in particular undermine the validity of the outputs;
    - Powerlink has not undertaken a robust top-down challenge of its bottom-up forecast repex expenditure as a means of confirming a prudent and efficient level, and which we consider to be important given the 'inaugural' nature of the repex model being applied to a transmission network and being relied on to such an extent;
    - Powerlink's application of trending analysis leads to potential over-forecasting of the efficient level of required expenditure in the security, compliance, and 'other' capex categories; and
    - There is inadequate linkage of forecast expenditure to asset health and/or network risk, with limited evidence of quantified 'what-if' or sensitivity analyses being undertaken to help demonstrate that its expenditure forecast reflects optimal expenditure programs.

Sample project review

7. From our review of a sample of Powerlink's approved and proposed repex projects and programs for the next RCP, we found evidence that the risk and forecasting biases identified were reflected in the proposed expenditure. We consider these to be systemic in nature. We find that:

    - There is insufficient evidence to suggest that all of the proposed work should, or will be, carried out in the forthcoming RCP; and
    - There are opportunities to reduce the scope of some works and to consider sub-options to address the major risks, at a lower cost.

Conclusions

8. From our review of Powerlink's governance and management of relevant expenditure forecasting processes, our review of its expenditure forecasting methods and from our review of a sample of proposed projects, we observe systemic biases that we consider likely to have led Powerlink to over-forecast its non-load driven capital expenditure requirements for the 2018-2022 RCP.

1 Introduction

1.1 Purpose of this report

9. The Australian Energy Regulator (AER), in accordance with its responsibilities under the National Electricity Rules (NER), is required to conduct an assessment of the revenue to be obtained from provision of prescribed transmission services provided by Powerlink for the 2018-2022 regulatory control period (RCP). The process that the AER is required to follow is described in chapter 6A of the NER.

10. Powerlink provided its Revenue Proposal for the 2018-2022 RCP to the AER in January 2016. The AER engaged EMCa as a Technical Consultant to review and provide advice on the prudency and efficiency of the non-load driven capital expenditure proposed in Powerlink's Revenue Proposal. The purpose of this report is to provide the AER with our findings from this review.

1.2 Scope of requested work

11. In the context of the NER capital expenditure criteria, objectives and factors, the AER has sought our independent advice regarding the prudency and efficiency of Powerlink's non-load driven capital expenditure (referred to by Powerlink as reinvestment, security/compliance and 'Other'). We were asked to explain the basis for Powerlink's non-load driven capex forecast and (on the basis of the information available) to form a view as to whether the forecast cost is materially higher than would be incurred by an efficient service provider to meet the capital expenditure objectives.

12. We were also asked to include a review of a sample of the 25 projects (provided by the AER) for which Powerlink has provided "project packs". We proposed to the AER a selection of a reasonable sample size from these projects and the reasons for the sample. Subject to agreement from the AER of the selected projects, we were asked to:

- Assess the primary driver for the proposed expenditure. For example, we were required to assess whether Powerlink has correctly identified the primary driver and whether the driver identified is reasonable and evidenced;

- Assess any analysis Powerlink has relied on to demonstrate the need, timing and proposed investment and specifically identify whether Powerlink has undertaken risk assessment, economic assessment or used engineering judgement or another basis for demonstrating and evidencing its proposal (and if the latter then describing and defining such other method(s)) as the basis of its justification;
- Provide an opinion on the degree to which the business has considered, and made provision for, efficient and prudent non-network alternatives or opex; and
- Provide an opinion of whether Powerlink's asset management approach and its processes for identifying the need for and justification of the timing and proposed investments over the next RCP are reasonable, and reflect good industry practice.

13. The AER has also requested that we review the documentation to explain how Powerlink has reconciled its top down and bottom up forecasts, in determining its proposed capex forecast.

1.3 Approach

14. In this review, we first assess Powerlink's actual expenditures compared to planned expenditures for the prior RCP[2] and consider the reasons for any significant variances from the expectations and assumptions on which the revenue allowance was based. This assessment also takes into account material variations between historical expenditures (planned and actual) and forecast expenditures in the Revenue Proposal. This aspect of the review provides insights into Powerlink's forecasting performance and governance of its expenditure programs as circumstances change.

15. Our approach to the review of proposed non-load driven capital expenditure (capex) can be summarised as comprising the following components:

Asset governance and management structure and practices	Assessment of Powerlink's asset management framework as an integral part of the assessment of its capex forecast. Assessment of Powerlink's governance framework, investment planning process and risk assessment as tools and information to inform its decision-making.
Non-load driven capex forecast methodologies and assumptions	Description and assessment of the suitability of the methodologies and assumptions used by Powerlink when determining the non-load driven capex forecast. Identification of Powerlink's use of innovation and efficiency management and reasonable incorporation of these assumptions into the capex forecast.

[2] 2012-2017

Replacement capex projects review	Review of a subset of the sample repex projects provided for review by the AER (with supporting information provided by Powerlink) that are included in the development of the non-load driven capex forecast, including asset fleet strategies, use of condition information, options analysis and trends.

16. The review included on-site reviews with Powerlink on 23-24 May 2016.

1.4 Structure of this report

17. The structure of this report is, to the extent possible, aligned with the structure of the AER Scope of Work, on-site review and the review approach described above.

Section	Title	Content
1	Introduction	This section sets out the purpose and scope of our review.
2	Background	This section provides a summary of Powerlink's proposed replacement expenditure and prior RCP trends.
3	Assessment of governance and management framework	This section provides an overview of Powerlink's governance and management framework for the non-load driven works program, and the implications for the replacement capital expenditure program.
4	Assessment of repex forecasting methodology	This section provides an overview of Powerlink's repex forecasting methods, and the implications for the replacement capital expenditure program.
5	Assessment of other forecasting methodologies	This section provides an overview of forecasting methods applied for Powerlink's Security/compliance and 'Other' capex, and the implications for the non-load driven capital expenditure program.
6	Project-level assessment	This section provides a summary of the reviewed projects from the sample of 25 projects nominated by the AER.

1.5 Information sources

18. We have examined relevant documents provided by Powerlink in support of the projects that the AER has designated for review. Powerlink provided further information at the on-site meetings and further documents in response to our information requests. These documents are referenced directly where they are relevant to our findings.

1.6 Rounding of numbers and real conversion

19. Numerical totals in tables may not present as being equivalent to the sum of the individual numbers due to the effects of rounding. This Report refers to costs in real 2016/17 dollars unless denoted otherwise[3].

[3] Escalators to convert nominal 2012/13 prices onwards to 2016/17 real prices were provided by Powerlink and have been used in our analysis to convert nominal information to real 2016/17 prices. We used the 2011/12 CPI index sourced from the Australian Bureau of Statistics and forecast 2016/17 CPI provided by Powerlink via its RIN to convert 2011/12 prices to real 2016/17 prices.

2 Background

2.1 Introduction

20. In this section we provide an overview of Powerlink's forecast non-load driven capex for the 2017/18-2021/22 (2018-22) RCP and we contrast this with an analysis of the corresponding expenditure in the current RCP.

2.2 Overview of proposed non-load driven capex

21. Powerlink defines non-load driven capex as comprising of three expenditure sub-categories: reinvestment[4] (which we refer to as replacement and/or refurbishment), security/compliance,[5] and Other.[6]

22. Powerlink has forecast total non-load driven capital expenditure for the 2018-22 regulatory period of $843.1m. Powerlink considers that this expenditure is reasonably required to achieve the associated capital expenditure objectives. This is $87.3m or 9% lower than actual/forecast expenditure in the 2013-17 regulatory period.

23. Tables 1 and 2 show that Replacement capex (repex) comprises 94% of the forecast non-load driven expenditure (and 83% of all proposed capex) for the next RCP. Figure 1 highlights the relatively flat 2018-2022 expenditure profile, with annual average expenditure forecast to be $169m.

[4] Expenditure is primarily undertaken due to end of asset life, asset obsolescence, asset reliability or safety requirements and includes replacement with assets of an equivalent/ different type, configuration or capacity, refurbishment, or non-network alternatives (source: Powerlink RP, Table 5.1)

[5] Expenditure undertaken to ensure (i) the physical security (as opposed to network security) of Powerlink's assets, or (ii) compliance with amendments to technical, safety or environmental legislation (source: Powerlink RP, Table 5.1)

[6] All other expenditure associated with the network that provide prescribed transmission services, such as communications systems enhancements, improvements to network switching functionality and insurance spares (source: Powerlink RP, Table 5.1)

Table 1: Non-load driven RCP1 capex (real $m, 2016/17)

Non-load driven current RCP expenditure	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Replacement	253.6	192.4	137.2	115.6	177.0	**875.8**
Security/compliance	5.6	6.3	4.8	2.4	3.7	**22.8**
Other	13.5	6.6	2.2	5.4	4.1	**31.8**
Total	272.7	205.3	144.2	123.3	184.9	930.4

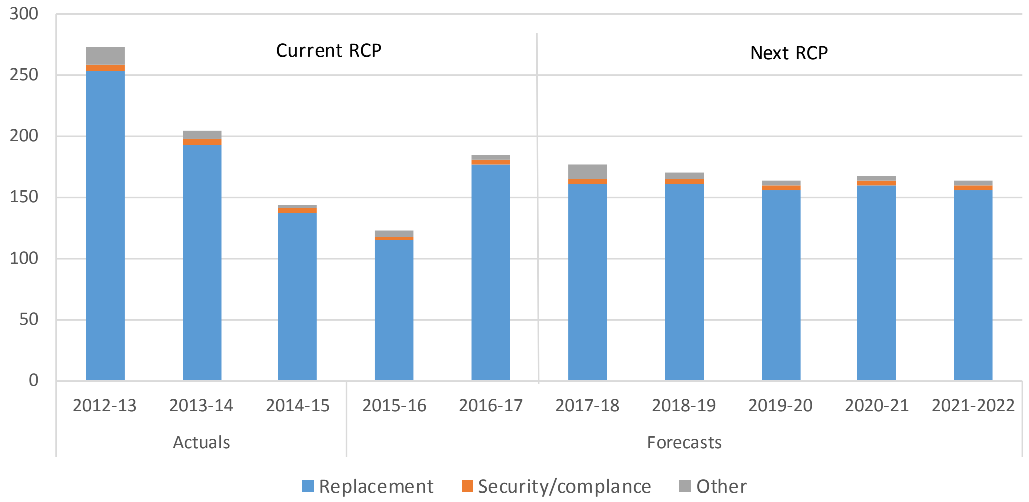
Source: Powerlink RRP 2012-2017 Table 4.1 modified by EMCa

Table 2: Non-load driven RCP2 capex forecasts (real $m, 2016/17)

Non-load driven next RCP expenditure	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-2022	
Replacement	161.6	161.2	155.8	159.6	156.0	**794.2**
Security/compliance	3.7	3.7	3.8	3.8	3.8	**18.8**
Other	12.0	6.1	4.0	4.0	4.0	**30.1**
Total	177.3	171.0	163.6	167.4	163.8	843.1

Source: Powerlink RP 2018-20122, Table 5.4 modified by EMCa

Figure 1: Non-load driven capex actual and forecast capex (real $m, 2016/17)



Source: Powerlink RP 2018-20122, Table 5.4 and RRP 2012-2017 Table 4.1 modified by EMCa

24. Table 1 and Figure 1 clearly show the dominance of historical and forecast repex on the non-load driven capex. We examine Security/compliance and Other capex in more detail in section 2.3.

25. Table 3 shows the major components of Powerlink's actual and forecast repex in the current RCP based on recent advice from Powerlink.[7] Table 4 shows the major components of Powerlink's forecast $794.1m replacement capex for the 2018-2022 RCP. Replacement/refurbishment of transmission lines is the dominant expenditure sub-category (35%).

[7] Powerlink's advice provided in May 2016 in response to an EMCa Information Request shows a different total repex amount ($855m) to that shown in Table 1 ($875.8m) due to a lower (updated) forecast 2016/17 amount.

Table 3: Current RCP repex by expenditure sub-category (real $m, 2016/17)

Repex	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Transmission lines	107.1	53.8	18.1	18.6	38.8	236.4
Substations Primary Plant	83.9	53.7	42.6	35.3	45.4	260.9
Substations Secondary Systems	48.8	68.7	68.2	51.6	54.6	291.9
Communications and Other Assets	11	12.9	7.8	10.1	15	56.8
Network Switching Centres	2.8	3.4	0.5	0	2.3	9
Total	**253.6**	**192.5**	**137.2**	**115.6**	**156.1**	**855.0**

Source: Powerlink response PQ0129 to EMC Information Request[8]

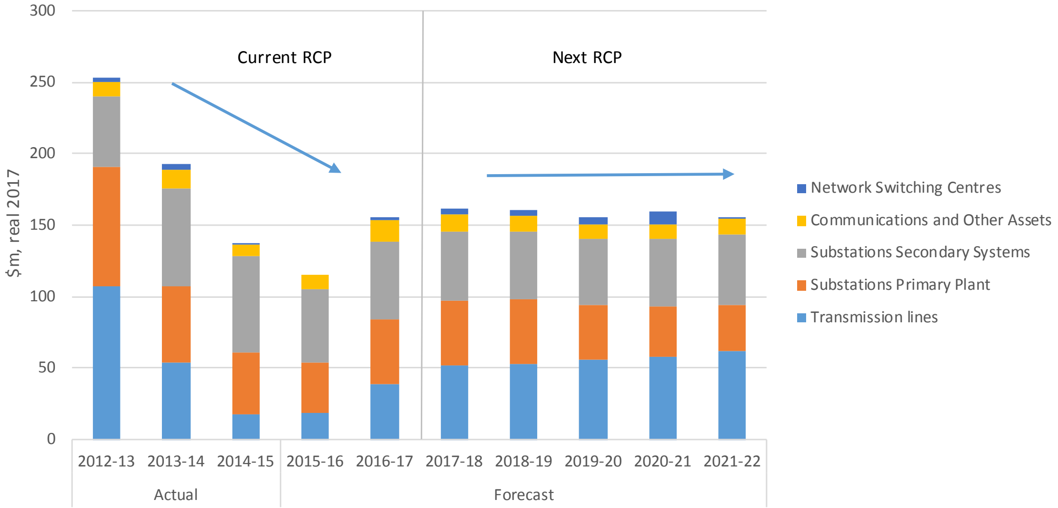
Table 4: Next RCP repex by expenditure sub-category (real $m, 2016/17)

Repex	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Transmission lines	52.3	52.5	55.8	58.2	61.6	280.4
Substations Primary Plant	44.9	46	38.9	35	32.3	197.1
Substations Secondary Systems	48.6	47.1	45.6	47	49.3	237.6
Communications and Other Assets	12.1	10.7	10.2	10.3	11	54.3
Network Switching Centres	3.7	4.9	5.2	9.1	1.8	24.7
Total	**161.6**	**161.2**	**155.7**	**159.6**	**156**	**794.1**

Source: Powerlink response PQ0129 to EMCa Information Request

26. Figure 2 illustrates the relatively flat expenditure profile of all sub-categories over the 5-year RCP and also illustrates the historical repex expenditure trend. Actual expenditure is shown as declining steadily to less than half of the 2012/13 amount. Powerlink has forecast sharply increased expenditure for the final year of the current RCP which, at $156m[9], is close to the average proposed annual expenditure for the next RCP of $159m.

Figure 2: Actual and forecast repex (real $m, 2016/17)



Source: Powerlink RP 2018-20122, Table 5.4 and RRP 2012-2017 Table 4.1 modified by EMCa

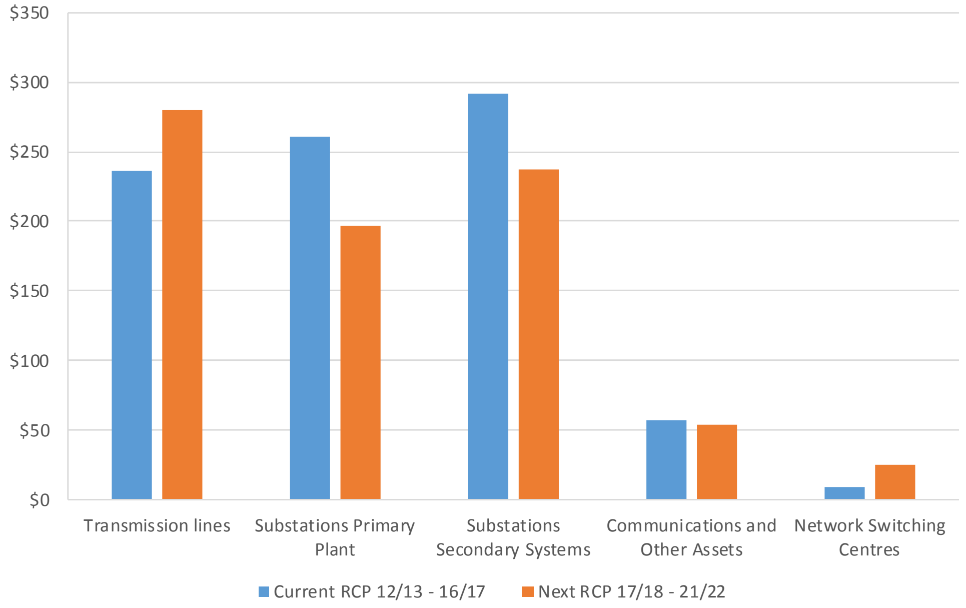
27. As illustrated in Figure 3, total expenditure on transmission line replacement/refurbishment is forecast to increase over the next RCP, whereas total expenditure on substation primary

[8] We note that the 2016/17 estimate provided by Powerlink in response to PQ0129 (total repex $156.1m) is different to the 2016/17 estimate provided in its RRP submission (total repex $177m, real 2016/17).

[9] See foot note 7.

plant and secondary plant/systems is forecast to drop. The relatively high 2012-13 expenditure and forecast increase in 2016/17 expenditure in the current RCP and the relatively steep decline through to 2015/16 are notable features of the current RCP profile.

Figure 3: Current and next RCP repex (real $m, 2016/17)



Source: Powerlink RP 2018-20122, Table 5.4 and RRP 2012-2017 Table 4.1 modified by EMCa

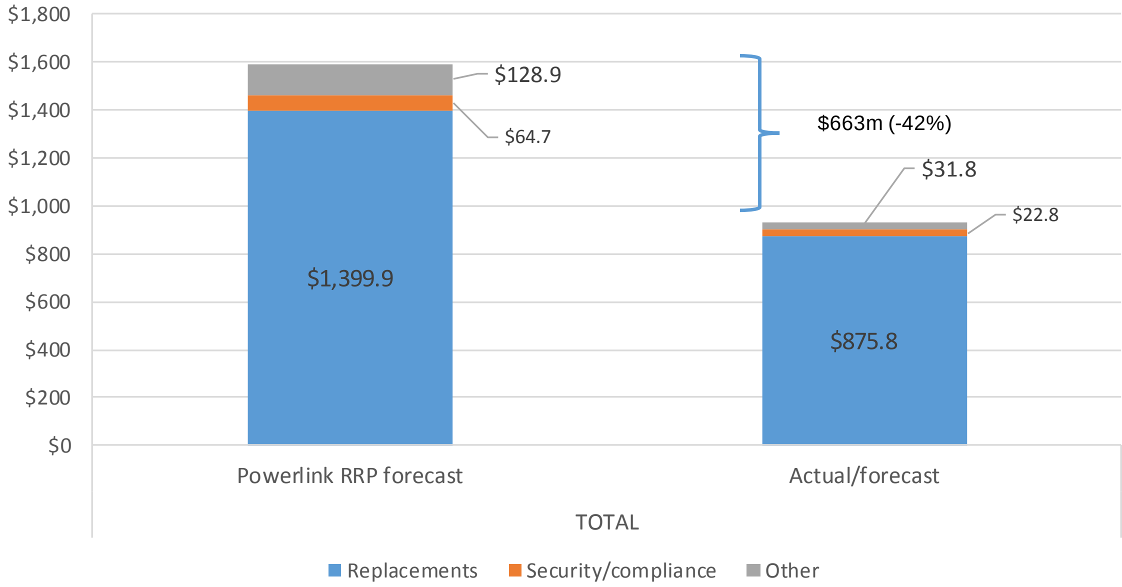
2.3 EMCa assessment of prior RCP trends and performance

2.3.1 Non-load driven capex trends and performance

28. Figure 4 shows that Powerlink expects to underspend its non-load driven expenditure forecast (per its Revised Revenue Proposal 2012-2017) for the current RCP by $663m (-44%). The bulk of the under-spend was in the replacements (i.e. repex) category.[10]

[10] Powerlink, 2013-2017 RRP Table 7.4 and RP 2018-2022 Table 5.4

Figure 4: Powerlink's non-load driven capex actual/forecast performance (real $m, 2016/17)



Source: Powerlink RP 2018-2022, Table 5.4 and RRP 2012-2017 Table 7.4 modified by EMCa

2.3.2 Link between expenditure and outcomes

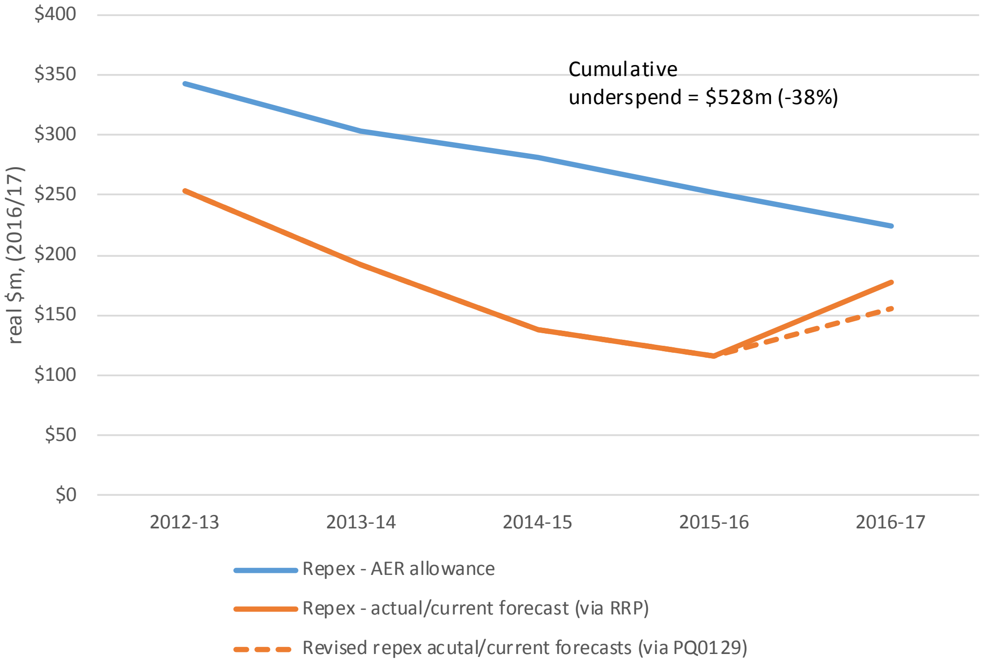
29. Powerlink did not provide information to the AER regarding the anticipated impact on the overall health of the network as a result of the proposed non-load driven capex for the next RCP, nor did it provide an assessment of the health of the network at the end of the current RCP with the reduced expenditure it now expects to spend.

2.3.3 Repex trends and performance

30. Powerlink forecasts an aggregate $528m (-38%) underspend of Powerlink's 2012-2017 Revised Revenue Proposal (RRP) forecast repex. As shown in Figure 5, the total underspend will be even more pronounced if 2016/17 repex expenditure does not increase by $41m (35%) from the 2015/16 level, as Powerlink now plans[11]. All sub-categories of repex contribute to the forecast increase in 2016-17, with transmission lines (+$20m) and substation primary plant (+$10m) the major contributors.

[11] Based on updated repex estimate of $156.1m for 2016/17 which Powerlink provided in response to PQ0129.

Figure 5: Powerlink's actual/forecast repex (real $m, 2016/17)



Source: Powerlink, AER Site Visit - 2 Current Period Performance[12]

31. Powerlink advises that the increase in 2016/17: [13]

> *'…reflects a correction from lower levels of expenditure in 2015/16 to a more typical profile of investment … largely been driven by Powerlink's decision to take a more detailed review of its overall network planning and investment process (including a review of Area Plans), in response to the changed demand environment, the timing of establishment of Powerlink's transmission line refit panel and other factors…'*

32. In its Revenue Proposal, Powerlink identifies the major driver of the underspend in the current RCP as the reduced peak demand compared to forecast, which resulted in Powerlink cancelling or deferring not only demand-driven expenditure but also its planned repex program: [14]

> *'The reduction in forecast demand growth also had a significant impact on Powerlink's planned reinvestment program. In this changed environment, Powerlink has adapted its approach to reinvestment decisions, with a particular focus on assessing whether there was an enduring need for the key assets and alternative investment options to manage asset condition and risks at a lower cost (such as network reconfiguration or asset retirement).'*

33. We sought further explanation from Powerlink on this correlation between demand and replacement capex.[15] In its response, Powerlink referred to the analysis contained in its Asset Management Plan (Vol 3) which identifies assets that it no longer has an 'enduring

[12] The AER allowance figures quoted in the table provided at the site visit were reported as nominal figures however the numbers quoted were close to the real 2011/12 allowances published in the RRP and Draft Determination publications therefore we have assumed the AER allowance numbers quoted were in real 2011/12 prices. We have therefore converted them to real 2016/17 on this basis.

[13] Powerlink, response PQ0151 to EMCa Information Request

[14] Powerlink, RP, section 4.4.2, page 25

[15] Via an Information Request and subsequently at on-site discussions

need' in the context of forecast lower long term peak demand. Rather than replacing or refurbishing these assets, Powerlink cancelled planned expenditure.

34. The information in Table 5 identifies that project deferral due to lower demand accounted for 38% of the $528m repex underspend[16]. The balance was due primarily to (i) detailed planning based on updated asset condition data – which Powerlink collects and analyses for relevant assets relatively close to the planned year in which expenditure is planned to occur, and (ii) 'softer' market conditions, which allowed Powerlink to secure lower prices from suppliers.

35. With respect to its 2018-2022 forecast repex requirement, we would expect Powerlink's 'bottom-up' assessment of projects which have been included in the repex forecast to take into account the impacts and opportunities identified in Table 5. We have considered these factors, among other things, in our review of projects provided by Powerlink, as discussed in section 5.

36. However, 89% of repex forecast for the next RCP is derived from Powerlink's Repex Model.[17] We have therefore sought to understand how the Powerlink model takes into account the approaches applied in the current RCP to ensure the 2018-2022 expenditure forecast is prudent and efficient. Our assessment is discussed in section 4.

Table 5: Summary of Powerlink's reasons for the forecast repex underspend in the current RCP

Core driver of under-spend	Contribution	Elaboration	Sub-category contribution
Project deferral	-65%	Lower load demand has led to revised approach to reinvestment (i.e. replacement/refurbishment) allowing projects to be deferred	-38%
		Deferral pending customer commitments	-13%
		Deferral from more 'selective operational works'	
		More recent asset condition information allows deferral into the next RCP	-14%
Reduced scope	-10%	*More up-to-date condition data allowed reduced scope*	-10%
Reduced procureme nt costs	-25%	Pilot program for transmission line refits led to reduced unit costs	-12%
		More competitive pricing environment	-13%

Source: Powerlink, response PQ0131 to EMCa Information Request

2.3.4 Security, compliance expenditure trend and performance

37. Powerlink has forecast its Security/compliance capex for the next RCP based on a 'trend analysis technique.' This category of expenditure is not within its Repex Model.

38. Tables 6 and 7 shows the actual and forecast expenditure over the current and next RCPs.

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[16] Based on real $m, 2016/17. Note Powerlink quoted $466m (nominal) repex underspend in response to PQ0131. However, it is not clear whether the AER allowance figures quoted to calculate the underspend were on a nominal basis as the numbers were close to the real 2011/12 allowances published in the RRP and Draft Determination publications.

[17] The balance is derived from individual projects (such as transformer replacement); Source: Powerlink, response to EMCa Information Request, PQ0129, 27 May 2016

Table 6: Current RCP Security/compliance capex (real $m, 2016/17)

	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Security/compliance	5.6	6.3	4.8	2.4	3.7	22.8

Source: Powerlink RP 2018-2022, Table 4.1 modified by EMCa

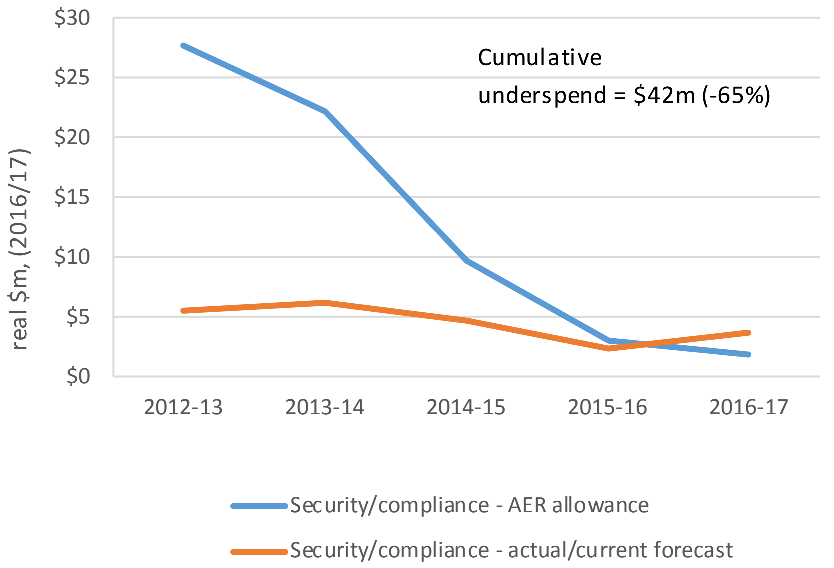
Table 7: Next RCP Security/compliance capex (real $m, 2016/17)

	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Security/compliance	3.7	3.7	3.8	3.8	3.8	18.8

Source: Powerlink RP 2018-2022, Table 5.4 modified by EMCa

39. Figure 6 shows that actual and forecast security/compliance expenditure in the current RCP is expected to be $18.8m, which is $42m (65%) less than the $64.7.m (real 2016/17) Powerlink forecast in its RRP.

Figure 6: Powerlink's actual/forecast security/compliance capex (real $m, 2016/17)



Source: Powerlink RRP 2012-2017, Table 7.4 modified by EMCa

40. Powerlink has attributed this reduction to the same reasons for the repex underspend: [18]

> *'For the reasons outlined above, capital expenditure driven by asset condition, compliance and other non-load related factors has also significantly reduced in the 2013-17 regulatory period compared to the AER allowance.'*

41. Based on: (i) Powerlink's explanation of the sources of reduction of planned repex in the current period (summarised in Table 3); and (ii) its Expenditure Forecasting Methodology document,[19] reduced demand is *not* the only significant driver of the underspend. Rather, after undertaking more detailed assessment of options and by securing better prices from suppliers, Powerlink has found prudent ways to defer and/or reduce the cost of physical security activity and compliance activity to satisfy technical, safety, and environmental

[18] Powerlink, RP, section 4.4.2, page 25

[19] Powerlink, Expenditure Forecasting Methodology, section 2.4.2: '*Non load-driven network projects include reinvestment in network assets, physical security of network assets, compliance with mandated asset standards, and other minor network assets. As overall expenditure in these categories is not directly linked to demand growth it typically exhibits a smoother profile of expenditure over time than load-driven capital expenditure.*'

legislation. The gap between Powerlink's RPP forecast and actual capex in the first two years of the current RCP is indicative of a systemic issue with its forecasting methodology, at least for this category of work.[20] It appears from the relatively flat expenditure profile in the current and next RCPs that whatever was driving the relatively high expenditure forecast in 2012-13 and 2013-14 is no longer required and Powerlink expects recent expenditure to be a reasonable predictor of future requirements.

2.3.5 'Other' expenditure trend and performance

42. Powerlink has forecast its 'Other' capex for the next RCP based on a 'trend analysis technique.'

43. Tables 8 an 9 show Powerlink's actual and forecast 'Other' capex.

Table 8: Current RCP 'Other' capex (real $m, 2016/17)

	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Other	13.5	6.6	2.2	5.4	4.1	31.8

Source: Powerlink RP 2018-2022, Table 4.1 modified by EMCa

Table 9: Next RCP 'Other' capex (real $m, 2016/17)

	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Other	12.0	6.1	4.0	4.0	4.0	30.1

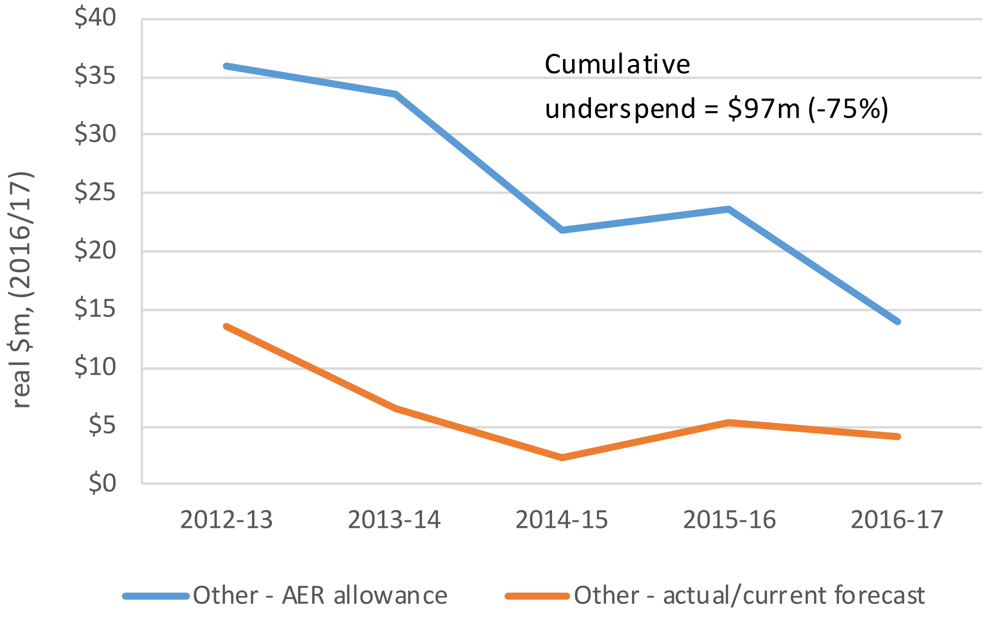
Source: Powerlink RP 2018-2022, Table 5.4 modified by EMCa

44. Actual/forecast 'Other' expenditure is expected to be $31.8m in the current RCP, which is $97m (75%) less than the $128.9m (real 2016/17) Powerlink forecast in its RRP. Powerlink has attributed this reduction to the same reasons linked to the reduction in repex.[21] As shown in Figure 7, and as with Security/compliance capex, the gap between Powerlink's RRP forecast and actual capex in the first two years of the current RCP is indicative of a systemic issue with its forecasting methodology.

[20] We would expect forecasts and actual expenditure to diverge less in the first/second years of the next RCP

[21] Powerlink, RP, section 4.4.2, page 25

Figure 7: AER-approved versus actual/forecast 'Other' capex (real $m, 2016/17)



Source: Powerlink RRP 2012-2017, Table 7.4 modified by EMCa

2.4 Summary

45. Powerlink currently expects a $663m (-42%) underspend of its RRP forecast for non-load driven capex categories by the end of the current RCP.

46. According to the information provided by Powerlink, the drivers of the underspend were:

- Refinement of project scope and timing arising from detailed assessment;
- Refinement of project scope and timing as a result of a review of ongoing asset requirements in the context of the unexpected downturn in forecast demand; and
- Achievement of lower that forecast prices for work, due primarily to softer market conditions and improvements to its contracting strategy.

47. Whist we consider it appropriate (and necessary) for Powerlink to revisit its plans due to the revised demand outlook, we consider that the significant deferral/re-scoping of the planned repex program following detailed project-level analysis indicates a systemic issue with the expenditure forecasting and cost-estimation methodologies it applied for this period. We consider that the significant gap in actual and forecast Security/compliance and Other capex from the first year of the current RCP is similarly indicative of fundamental issues with the expenditure forecasting and cost estimation methodologies used to derive the previous RCP expenditures in these categories. In our subsequent review of Powerlink's governance and management, forecasting methods and sample projects, we sought evidence to confirm or refute the existence of systemic issues indicated from this trend information.

48. Powerlink has not demonstrated the impact on the overall performance and/or health of the network as a result of its under-expenditure. We would expect Powerlink to have drawn the AER's attention to any deterioration in performance or health of the network, had it occurred; it has not done so. Based on the information provided, we consider it reasonable

to conclude that Powerlink's recent actual expenditure more closely represents its prudent and efficient requirement, and that it over-forecast its requirements for the current RCP.

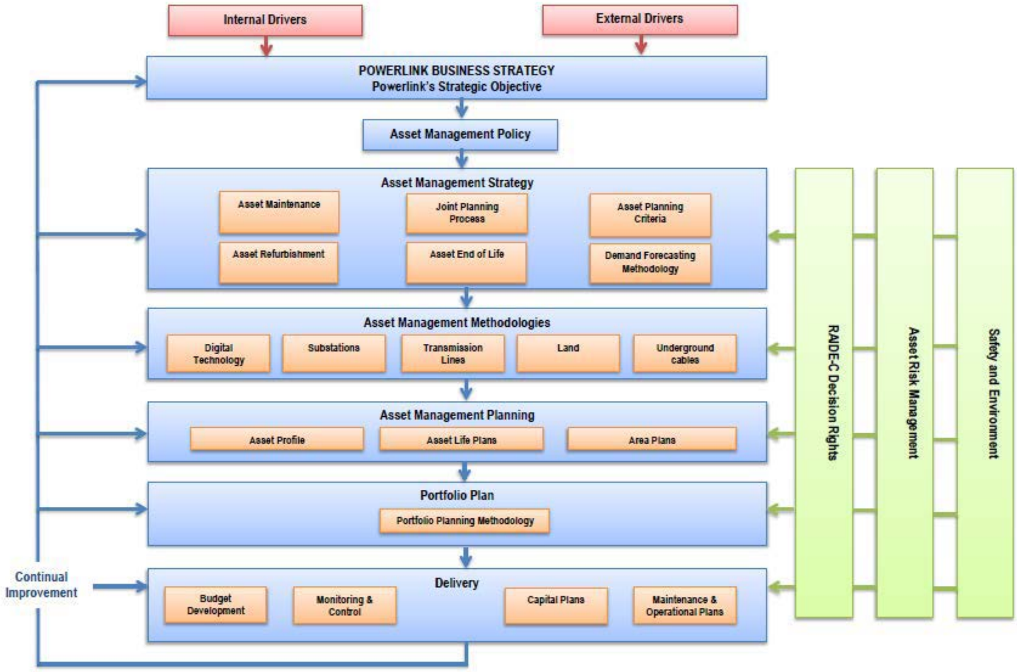
3 Assessment of governance and management framework

3.1 Overview of Powerlink's asset management governance framework

49. Powerlink's asset management governance framework is set out in its asset management plan (AMP). The framework is described as a 'needs' driven process where strategy, policy, management methodologies and planning flow from identified internal and external drivers.

50. Powerlink's description of the framework is represented in Figure 7, which is reproduced from Powerlink's AMP.

Figure 8: Powerlink's asset management framework



Source Powerlink[22]

51. We consider that good governance features of the framework include (but are not limited to):

- Approval of the asset management policy by Powerlink's Board;
- Service levels are derived from strategic drivers;
- Alignment of business and asset management strategies;
- Asset Management Strategy is based on asset life cycle which ensures that "whole of life" is considered;
- Risk, safety and other statutory obligations considered at each level in the framework process; and
- The inclusion of continuous improvement feedback loops.

52. The Asset Management Strategy is supported by a range of documents governing how Powerlink plans, develops and manages transmission network assets, including the Demand Forecasting Methodology, Joint Planning Process, Asset Planning Criteria, and Asset Reinvestment Policy.

3.2 Network Investment Risk Assessment Methodology

53. Powerlink has a methodology for appraising and managing asset risks in accordance with its corporate risk management standard and procedures, and the Asset Risk Framework. Powerlink describes its asset risk framework as providing:[23]

[22] Powerlink, Asset Management Framework_CONFID.pdf

[23] Powerlink_Asset Risk Framework_CONFID.pdf Section 2.1

'…a quantitative based method to assess the key risks for assets reaching the end of their technical or economic life in a structured, consistent and transparent manner.'

3.2.1 Risk optimisation

54. Powerlink's asset risk framework is typical of those used by utilities to identify, highlight and prioritise risks. Powerlink derives a quantified value for the probability and consequence of a risk event by determining a 'cost of risk'. Powerlink's formula for calculating risk cost is given as:[24]

'Risk Cost = Likelihood of Failure (LOF) x Consequence of Failure (COF)'

55. Powerlink has concluded that its risk approach: [25]

'… provides a quantitative based method to aggregate the key risks for assets approaching the end of their technical or economic life. The key risks relate to a range of disparate consequences of failure, including financial, safety, network and environmental impacts. Providing a quantitative measure for the key risks in a structured, consistent and transparent manner allows Powerlink to make relative comparisons between competing investment needs.'

56. A feature of the risk assessment process used by Powerlink is that the output, normally seen as a risk table or matrix, can produce a very wide range of outcomes: risk costs range from $29 to $7,031,250,000. This can result in an assessment that does not provide focus and is also difficult to communicate across the business.

57. Given the broad range of risk costs in the risk matrix it is likely that only a section of it is actually relevant to the management of key risks associated with assets approaching the end of their technical or economic life.

58. To obtain a perspective on the extent that the risk framework described and applied by Powerlink helps to produce a risk-optimised repex forecast we reviewed three Risk Spreadsheets provided by Powerlink[26]. The Risk Spreadsheets demonstrate how Powerlink has applied its risk assessment framework to calculate the risk cost. The range of Risk Consequence Costs is shown in Figure 9.

[24] *Ibid, page 6*

[25] *Ibid,* Section 2.6

[26] The Ashgrove West 132kV Primary Plant replacement; Greenbank to Mudgeeraba 275kV line refit; and Dysart 132_66kV transformers replacement

Figure 9: Risk consequence cost values

Risk Consequence Cost Lookup Table

Level	Description	Cost ($M)
7	Catastrophic	225
6	Extreme	45
5	Major	9
4	Moderate	1.8
3	Minor	0.36
2	Insignificant	0.072
1	Negligible	0.0144

Source Powerlink[27]

59. When applying the above risk consequence range Powerlink's asset management process considers a broad range of risk consequence costs. It is likely that the asset managers will, on most occasions only use levels 4,5 and 6 with the other levels being either too low or only applicable to catastrophic corporate level risks. Given the range of costs, the number of levels used could be reduced to 3 or at most 4 for asset management and network planning purposes.

60. When applied appropriately and multiplied by the risk potential value (likelihood of failure), Powerlink is able to apply risk based prioritisation to its schedule of replacement/refurbishment projects. As discussed in paragraph 54, Powerlink's approach calculates a 'risk cost' which it defines as *the probability weighted cost of the consequence associated with the risk event*[28]. Powerlink uses a quantitative Asset Risk Management Framework based on the Cumulative Act Model, or "Swiss Cheese" model. Through the use of this methodology Powerlink take into account the coincidence of failures that would be required to trigger the consequences arising from the multiple failures. This risk assessment takes into account the probability of failure for each individual component of the system.

61. We consider that the Powerlink approach for risk assessment of its 'reinvestment' projects is adequate for selecting between identified options and whilst we have reservations about Powerlink's aggregation of risks to create its total risk cost, this is not a significant issue if the aggregated risk cost is only used to help with portfolio optimisation and (at a project level) to choose between options.

3.2.2 Project-level decision-making

62. Our review of a subset of the sample repex projects (as discussed in section 6) indicates that Powerlink does not yet use the risk cost to economically justify the scope and timing of the selected option.

63. In the three project Investment Options Papers that Powerlink provided, we found evidence of use of the risk assessment framework (non-quantified) to distinguish between options. We consider that the approach is consistent with that typically used by TNSPs for options analysis (i.e. looking at pre-treatment and residual risk). We found that the qualitative

[27] Ashgrove West 132kV Primary Plant - Risk Spreadsheet.xlsx

[28] Powerlink_Asset Risk Framework_CONFID.pdf Section 2.1.1

commentary provided is useful in distinguishing how particular outcomes are rated. As noted above, we consider that the Powerlink approach for risk assessment of its 'reinvestment' projects is adequate for selecting between identified options, however this does not extend to confirming that all reasonable options are identified and assessed.

64. We consider that the total aggregated risk cost as derived by Powerlink is not a valid basis for economically justifying selected options, nor have we seen Powerlink attempt to do so. We note below that Powerlink has a number of improvement initiatives underway which we expect will include adopting a valid risk-cost based analysis to select the optimal scope and timing of work at a project level (i.e. as well as at the portfolio level). [29]

65. Importantly, the risk spreadsheets provided to us relate to specific replacement/refurbishment projects and not to the repex forecast which is produced through the predictive modelling. Therefore, they have not been applied in the forecasting method that has been used for the majority of such expenditure

3.2.3 Improvement initiatives

66. Powerlink advises that AMCL had concluded that: [30] '*Powerlink has demonstrated significant progress in the development of the Risk and Prioritisation methodology that aligns with industry leading best practice* however also noted that *the approach has yet to be fully embedded into the organisation.'*

67. Powerlink states that it has been: [31]

'…progressively enhancing methodologies and techniques to assess and evaluate strategic asset risks in accordance with a roadmap that is focused on achieving the following key objectives:

i. at a corporate level, build knowledge of Powerlink's corporate risk management framework, risk assessment philosophy and techniques;

ii. develop and where necessary expand the corporate risk matrix so that parameters applied to determine likelihood, consequence and overall risk levels are aligned with asset management decision making;

iii. develop a detailed first principles model for key asset risks that drive a significant component of Powerlink's expenditure, focused on failure modes, probabilities, exposure factors and consequences;

- *develop risk metrics and scoring methodologies calibrated across the different classes of network assets so that investment proposals and associated timings can be more effectively ranked and prioritised; and*
- *develop supporting information technology systems for greater transparency and to support the systematic assessment of strategic asset risk linking to the prioritisation of work portfolios based on typical constraints.'*

68. It is now becoming good practice for TNSPs to adopt techniques, such as the 'bowtie' risk assessment methodology, which provide more clarity on the relationship between hazards,

[29] We consider the cost-risk assessment methodology being developed and applied by Ausgrid for confirming the economically optimum volume and timing of project activity to be worthy of consideration by Powerlink

[30] Powerlink response PQ0140 to EMCa Information Request

[31] Powerlink Appendix A 5.09 Asset Management Plan (Volume 1) page 7

their causes and consequences, and the controls and responses that can be applied to manage them.

69. Powerlink informed us that it does, to some extent, use the bowtie methodology.[32] However, we did not witness how this was applied in practice and it does not appear to be a feature of Powerlink's risk management framework, nor does it appear to be incorporated into Powerlink's expenditure forecasts.

70. We observed that the risk assessment matrix in Powerlink's risk methodology was applied at a project level for a number of projects. This approach appears to be a work in progress and its development and integration in the business appears to be part of a broad range of risk- and condition-based asset management improvement initiatives. We understand therefore that the risk-cost based portfolio optimisation[33] methodology has not been applied to the development of the non-load driven expenditure forecast for the next RCP.

71. We expect that an outcome of Powerlink's improvement initiatives will be, over time, refined expenditure forecasts, leading to lower overall required expenditure.

3.3 Asset management plan development

72. Asset management planning is a component of Powerlink's asset management framework discussed in section 3.1.

73. Powerlink's AMP sets out the annual process through which it develops its views on the need for investment in the network. When developing its plans Powerlink takes into account the following inputs[34]:

- Investment Drivers & Needs
  - Updated demand and energy forecasts;
  - Analysis of asset condition, performance and related risks;
  - Analysis of network capability and emerging limitations (including customer connection needs);
  - Compliance with system standards;
  - Analysis of competition and market impacts;
  - Analysis of operational impacts and constraints;
  - Review customer and consumer engagement; and
  - Confirm pending investment decisions & portfolio of approved projects (cost & timing)
- Planning & Network Optimisation
  - Integrated review of investment needs and risks;

[32] Discussion at on-site meeting 23 May 2016

[33] Optimisation is undertaken to ensure prudent and efficient outcomes are achieved. For example, when viewed at a portfolio level, opportunities to reduce costs above those seen at an individual project or program level may be seen.

[34] This list has been derived from information provided by Powerlink in section 3 of Powerlink Appendix A 5.09 Asset Management Plan (Volume 1)

- Development of investment options (network reconfiguration, non-network solution, network solution;
- Risk and cost benefit analysis of options; and
- Market and regulatory consultation (e.g. RIT-T).

74. Powerlink undertakes a needs assessment based on the primary drivers of investment, it then applies its knowledge of asset condition, location and performance to take into account the associated risk. The individual components are optimised to form an integrated plan. Through this process Powerlink considers the interaction of collective groups of assets that have some level of interaction. For example, common drivers or where there are opportunities to apply alternatives that produce a lower cost overall solution.

75. For non-growth driven network planning, Powerlink undertakes routine assessment of the condition of its assets. The condition information is used as an input to its total asset life cycle approach through which Powerlink identifies potential emerging asset risk factors such as safety, reliability and obsolescence.

76. The Area Plans form a substantial part of the AMP.

77. In its AMP Powerlink states that: [35]

> *'The Asset Management Plan is part of an annual cycle of network assessment and investment review. Following publication of the plan, the investment works and projects identified through the Asset Management Plan are used as inputs to the related capital budget review and corporate planning processes.'*

78. The annual process described by Powerlink for the development of its AMP sets out a 'bottom up' development process that takes into account the best and most up to date information available, including:
    - approved asset policies and strategies;
    - key drivers of investment;
        - updated demand forecasting;
        - the current state of the network;
        - topography of the network and location of the assets;
        - risk;
    - current and forecast interaction between components of the network through area plans;
    - potential investment stranding risks; and
    - the level of work required to develop and maintain the network assets.

[35] Powerlink Appendix A 5.09 Asset Management Plan (Volume 1) page 8

3.4 Network planning process

3.4.1 Inputs to planning process

79. Powerlink identifies the following significant inputs to its network planning process: [36]

- *'the forecast of customer electricity demand (including demand side management) and its location;*
- *location, capacity and arrangement of new and existing generation (including embedded generation);*
- *condition and performance of assets and an assessment of the risks associated in allowing assets to remain in-service; and*
- *the assessment of future network capacity to meet the required planning criteria.'*

3.4.2 Impact of demand forecasts

80. The 2015 TAPR provides the 10-year forecasts of demand and energy for Queensland and Powerlink uses these forecasts as inputs for its network planning process. Using this data together with forecast changes in generation location and capacity, Powerlink carries out power flow analysis and establishes the need for augmentation of the network. For the purposes of establishing a capital expenditure forecast this process differs from that previously used by Powerlink as it is undertaken for the TAPR forecast only and not across a range of scenarios.

81. The change in approach outlined above appears to be appropriate for growth driven capex due to the reduced growth drivers and subsequent reduction in forecast growth capex. However, there is also potential for a fall in future demand to influence replacement/refurbishment capex, because there may be opportunities to replace existing assets with lower capacity ones. Powerlink has explicitly taken account of this in its real-time work planning, however we saw evidence in our review of sample project plans to increase capacity in some instances in the next RCP.

3.4.3 Asset condition

82. A specific current issue considered by Powerlink in its AMP is the management of corrosion on its steel lattice towers. Powerlink owns 22,500 galvanised steel lattice structures with many over or approaching 50 years old. Powerlink considers that this age profile suggests that corrosion management will be a challenging issue during the next 10 years. The implications can be seen in the increased expenditure on transmission lines in the proposed repex forecast.

83. To address this issue Powerlink has developed the concept of 'Corrosion Zones'. The definitions used by Powerlink for its six corrosion zones are reproduced in Figure 10.

[36] Powerlink Appendix A 5.09 Asset Management Plan (Volume 1) Section 5.1, page 11

Figure 10: Powerlink's designated Corrosion Zones

Corrosion Zone Designation	Environmental Conditions
A	Benign corrosion environment, such as arid rural areas with very low humidity and rainfall, minimal or no rural activity, and/or little or no vegetation encroachment into the easement. Average Annual Rainfall < 400 mm.
B	Very mild corrosion environment, such as semi-arid rural environment, with low humidity and rainfall, some rural activity, and/or minor vegetation encroachment into the easement. Average Annual Rainfall 400 – 900 mm.
C	Mild corrosion environment, such as typical rural areas with moderate humidity and rainfall, average rural activity, and/or moderate vegetation encroachment into the easement. Average Annual Rainfall 900 – 1200 mm.
D	Moderate corrosion environment, such as low density urban development or high activity rural areas, inland coastal regions, moderate to high humidity and rainfall, and/or moderate to heavy vegetation encroachment into the easement. Average Annual Rainfall 1200 – 1800 mm.
E	Aggressive corrosion environment and/ or close proximity to high salt coastal regions. Average annual rainfall may vary. Moderate to dense urbanised area with high public exposure will be included in this category.
F	Very aggressive corrosion environment in immediate proximity to heavy industry (incl. power stations), major highways or roads, and/or high salt coastal areas. Average Annual Rainfall may vary.

Source: Powerlink Transmission Line Asset Methodology Framework

84. For replacement/refurbishment capex Powerlink includes assets that it has determined fall into corrosion zones D, E and F (DEF).

85. Inspections of assets provide an assessment of the corrosion levels observed. The definitions used by Powerlink to define the grades of corrosion are reproduced in Figure 11.

Figure 11: Powerlink's corrosion grades

Terms	Definition
Grade 2 Corrosion	Defined as the "Initial onset of rust – light rust in the form of scattered pinholes, up to the equivalent to AS/NZS 2312 2% level."
Grade 3 Corrosion	Defined as the "Breakdown of the protective coating. Bare, rusting steel over most of the surface, with isolated traces of remaining galvanising. The steel surface is rough but not pitted, exceeding AS/NZS 2312 50% level."
Grade 4 Corrosion	Defined as the "Complete rusting of the steel surface. Minor or deep pitting of bare steel leading to noticeable reduction of cross-section."

Source: Powerlink Transmission Line Asset Methodology Framework

86. By applying both locational and condition criteria to its assets Powerlink is rating assets across a reasonably broad scale. This approach has particular relevance for how Powerlink has structured its repex model. The application of these classifications to the replacement profiles within the repex model effectively provides a basic risk-based prioritisation of the asset portfolio. The consequences of failure of particular assets within sections of line are not considered in the corrosion grading (e.g. a risk cost is not applied in Powerlink's repex model). A risk cost assessment would be expected to be applied prior to the project or work program being approved and undertaken. For the purposes of forecasting expenditure, we consider that this is an appropriate approach, however as discussed in section 4, the application of this approach does not necessarily result in a prudent and efficient forecast.

3.4.4 Outputs from planning process

87. Outputs from the network planning process are the 10-year investment plan and the individual Area Plans included in the AMP.

88. Powerlink's approach to network planning is developing to meet the challenges of increasing uncertainty of primary investment drivers. An important issue for all TNSPs is the uncertainty introduced for network planners from the current and potential further impact of emerging technologies such as solar power generation, energy storage batteries, electric vehicles and low energy appliances.

89. Powerlink has considered this issue in its revised Area Plans and as a result has sought to identify assets that may no longer be required and in some cases plans to reconfigure the network to provide lower-cost network development plans. Powerlink has also revised its network strategy to place greater emphasis on life extending strategies. This approach reduces stranding risks for investments that are subsequently seen as being not required or are over-sized. However, our review of a sample of proposed projects suggests that overall, Powerlink's planning process still generates a forecast biased to over-forecasting the required expenditure.

3.5 Performance drivers and outcomes

90. At a whole of business level Powerlink focuses on four key strategic areas: [37]

- Safe for Life;
- Efficient Performance and Delivery;
- Agile People and Processes; and
- Stakeholder Value Proposition.

91. Key performance indicators have been established at the corporate level to monitor performance against the above objectives.

92. Powerlink's proposed replacement/refurbishment capital expenditure is aligned with broader strategic drivers defined in its Asset Management Strategy[38], these are:

- *'Ensure compliance with relevant safety and environmental legislation, regulations and procedures;*
- *Conform with the requirements of the National Electricity Rules and related standards;*
- *Meet reliability of supply obligations in Powerlink's Transmission Authority; and*
- *Maintain plant in a prudent and efficient manner to provide safe, reliable and cost effective electricity supply to customers and consumers.'*

93. Depending on the quality of information and data inputs, asset health indices provide useful information on the current state of the network. The information can allow prioritisation of work and should improve expenditure forecasting.

[37] Powerlink, response PQ0140 to EMCa Information Request

[38] Powerlink Asset Management Strategy section 2.9.1

94. Powerlink advises that at an asset fleet level it has developed and adopted asset health metrics that take into account a range of input information including; age, failure rates, tests and inspections, number of operations, mode type failure, obsolescence, use of spares, etc. We have observed indices for transformers and tower bolts and the weighted average age of asset categories.[39]

95. Whilst Powerlink claims to have integrated asset health measurement into its overall asset management planning process we have not observed the wide use of the health indices as a performance measure. For example, none of the Asset Management Plan volumes includes health indices or dashboards, and Powerlink has not produced a dashboard of expected and actual changes in health over the forthcoming regulatory period. We consider that the asset management framework and risk methodology would be significantly improved by an expected outcomes feedback loop which would inform measurement of the performance of its asset related investment programs against the identified drivers and facilitate Powerlink's development of a prudent and efficient expenditure forecast.

96. Furthermore, the widespread use of asset health performance monitoring and performance prediction would complement the use of predictive modelling for the development of repex forecasts by linking expenditure and expected outcomes. We consider that development and application of such indices over the next RCP will lead to improved expenditure focus, allowing Powerlink to spend less to achieve the same outcomes.

3.6 Implications for proposed repex

3.6.1 Network health delivery

97. Powerlink has in place governance and management policies, frameworks, and procedures that are aligned with common industry practice. The governance structure, if applied consistently in practice should, in our view, provide an appropriate framework for guiding and monitoring the extent to which network performance and investment are achieving the strategic objectives.

98. Development and use of a wide base of asset health indicators provides an opportunity for Powerlink to demonstrate compelling linkages between input expenditure and expected outcomes. This will provide a valuable measure of the effectiveness of Powerlink's actual delivery of the planned investment activities. Currently reporting against this network-level measurement is not evident. The implication of this is that the forecast increases in repex are not seen against the network status measures at the start and end of the regulatory period.

99. Powerlink has taken steps to optimise expenditure in the context of an outlook for subdued load growth (via the Area Plans) and to improve its investment decision-making process. This should improve the prudency of its expenditure over the next RCP.

100. As discussed in section 3.2.3, Powerlink's application of its risk methodology appears to be a work in progress and we understand that the risk-cost based portfolio optimisation methodology has not been applied to the development of the non-load driven expenditure forecast for the next RCP. In the absence of such an optimisation it is not possible to conclude that the resulting repex forecast is prudent and efficient.

[39] Powerlink response PQ0140 to EMCa Information Request

3.6.2 Changing and improving strategies and methodologies

101. Through its documentation and during the onsite sessions Powerlink has demonstrated that it continues to review, revise and improve its asset related strategies and methodologies. A number of important changes have been developed and implemented since 2014. As the actual expenditure incurred during the period 2010-2014 is used to adjust the input RIN data to Powerlink's repex model, the changes, particularly those that occur later in the period, have implications for the validity of the modelled outputs. These implications are discussed further in section 4.

102. Some of the effects of the changes can be seen as drivers for the variation between forecast and actual expenditure during the current regulatory period. We expect that the ongoing alignment of its asset management decision tools and processes will lead to more targeted expenditure to address key risks only, leading to lower overall expenditure being required for the desired outcomes.

103. Whilst Powerlink has restructured the repex model to align with its asset strategies and methodologies (e.g. corrosion zones), the strategy and methodology changes need to be considered when reviewing the appropriateness of the use of historical data to calibrate the repex model as a reliable forecasting tool. The calibration and adjustments that Powerlink makes to the repex model are unlikely to reflect the full impact that the changes in policy and practice will have on actual work undertaken.

4 Assessment of repex forecasting methodology

4.1 Introduction

104. Powerlink uses three methods to forecast repex:

- A Powerlink 'hybrid' version of the AER's repex model (a practice-adjusted - age/condition-based replacement) - for towers, overhead conductors, switchgear, secondary systems and telecommunications (and metering), buildings/site infrastructure. Powerlink has started with the AER's model and calibrated[40] it, and has then further used historical asset replacement practices to adjust the input repex RIN data significantly with the aim of 'enhancing' forecast accuracy. It has also introduced sub-categories (see more detail below);
- Detailed engineering assessment – some asset classes are excluded from the repex model but included in the repex forecast (e.g. transformer replacement); as discussed below, the DEA is limited in scope;
- Base-step-trend – typically for SCADA and telecoms facilities, security and compliance, and 'other network capex' (a balancing item).

105. Almost 90 percent of the forecast expenditure is generated by the repex model.

106. Powerlink's descriptions and demonstration of the methodology it has used to form the network repex forecast is through a largely top-down approach that utilises the AER repex model populated with RIN data. Powerlink has adjusted its input data and made adjustments to the AER repex model so that the data better reflects Powerlink's actual historical asset management practices and is able to produce what Powerlink considers to be a more credible and reasonable forecast. Powerlink does this by adjusting its repex model so that it reflects the proportions of assets is that category and condition grade that were replaced impervious years. Implicitly this should adjust the model to reflect the

[40] Powerlink uses the term 'calibrated' for adjustments that are made to Powerlink historical repex RIN data. Powerlink's use of the term and method is different to that the AER has used in its repex model guideline. In this section we have applied Powerlink's use of 'calibrated' where it refers to this in the same sense as the AER Guideline, but have used the term 'adjusted' or 'hybrid model' (Powerlink's term) for other adjustments that it has made.

business decisions that applied at the time actual work was undertaken, including decisions made based on the actual asset conditions found on site.

107. In addition, an adjustment is applied to the model to reflect Powerlink's view of the most likely option for replacement projects, including assets planned to be decommissioned. Powerlink achieves this by removing assets (e.g. a transmission line that the model has scheduled for replacement) from its repex model asset schedule. We observed how this had been achieved for a number of repex projects.

108. The Powerlink calibration and adjustments, when applied appropriately should produce a predictive replacement schedule that reflects historical practice and takes into account other additional engineering factors that the model does not.

109. For repex categories that have sample sizes that are insufficient to produce reliable forecasts (e.g. power transformer replacements), Powerlink has produced an individual investment needs-based forecast.

110. A bottom-up approach was applied where drivers of capital expenditure were specific and/or one-off and include projects:

- Already underway or committed; or
- Where specific investment triggers had been confirmed and which were progressing towards approval.

111. Powerlink has also adopted a trend modelling method that has been used where:

- Expenditure does not fall within the asset categories in the repex model (generally small upgrades or enhancements to existing assets);
- For security and compliance expenditure; and
- Other expenditure such as enhancements to communications systems and insurance spares.

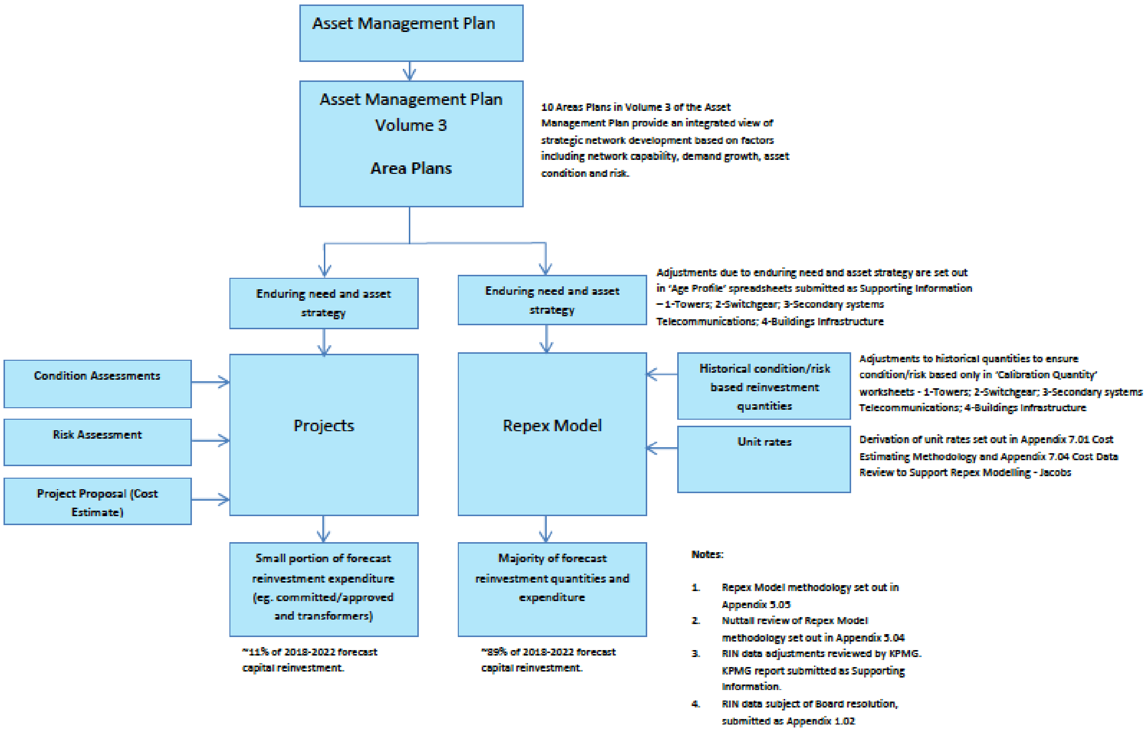
112. Powerlink's view is that the forecasting approach that it has taken can be considered as a hybrid that includes both top-down and bottom-up elements.

113. Trend modelling has not been applied for network repex, but it is the methodology applied by Powerlink for Security/compliance and 'Other' expenditure categories.

4.2 Powerlink's 'hybrid' repex forecasting methodology

114. The repex model is shown in Figure 12 and describes Powerlink's approach to forecasting repex.

Figure 12: Powerlink Repex Forecasting & Planning – Overall Approach



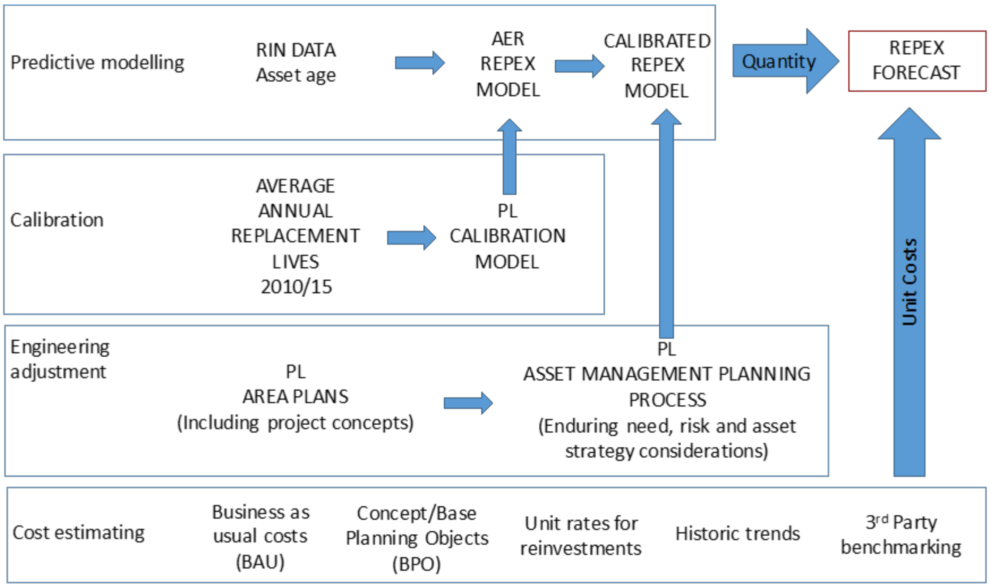
Source: Powerlink response PQ0129 to EMCa Information Request

115. Figure 12 shows that a small proportion of repex has been determined through individual project development, with the majority forecast using the repex model.

116. The Area Plans identify projects that have an enduring need. Powerlink only includes assets with an enduring need in its consideration of replacement or refurbishment expenditure. This can be considered to be an example of a top-down challenge adjustment to a bottom up forecast. If this assessment of enduring need is sufficiently rigorous it would consider the uncertainties and develop a view on the most likely outcome and apply these views to the bottom-up plan. A test of how Powerlink has applied its assessment in practice has been included in our review of proposed repex projects (refer to section 6).

117. Our understanding of the Repex Model-based process used by Powerlink to forecast its repex is represented in Figure 13.

Figure 13: Our understanding of Powerlink's Repex forecasting process



Source: EMCa

118. Key features of Powerlink's process include:

- Powerlink has used RIN data as the base data to populate its repex model;
- Powerlink's repex model is calibrated by using the asset age profile and replacements from an earlier year and, from this, deriving the forecast annual average replacement quantities from that time to the present to produce a set of mean replacement lives for the period. The derived mean replacement lives have then been applied to the current asset age profile (RIN data) to generate the forecast 'calibrated' replacement quantities for each type of asset;
- Powerlink has adopted the most recent five years as the calibration period;
- Powerlink has assumed a normal distribution for all categories of assets and equipment;[41]
- The Area Plans, which include project concepts, are considered to take into account the enduring need, risk and asset strategy. In situations where, in Powerlink's opinion, use of the RIN would produce an inappropriate repex forecast (e.g. where a better option is likely to be used than that forecast by the repex model), the input RIN data is adjusted to produce the desired adjusted output forecast; and
- For categories of expenditure where some capital expenditure has already been approved on a bottom-up basis, Powerlink applies a stepped decision process to determine the adjustment that is made to integrate the top-down and bottom-up forecasts

Standard replacement ages

119. Powerlink's calibration model determines a calibrated standard asset life from the asset age profile as it was at the start of a period (i.e. 2010) of actual replacement volumes. Powerlink's repex forecasting takes the mean replacement lives determined from the

[41] Powerlink states in Appendix 5.05 non load driven network capital expenditure forecasting that it considers the use of a normal distribution to be reasonable *as transmission assets are overwhelmingly replaced or retired prior to failing in-service. Alternative distributions, such as the Weibull distribution, are appropriate where there is a history of actual failures.*

calibration model and applies them to the asset age profile at the start of the forecast period to derive the replacement/refurbishment schedule and repex forecast.

120. The calibration model uses the actual historical replacement volumes to calculate the average annual replacement volume and mean asset replacement life. Powerlink applies the historical mean replacement lives to the current asset age profile in the repex forecasting model to produce a current age based forecast that is scaled or 'calibrated' to the historical replacement volumes that implicitly take into account the drivers of the historical replacement program.

121. We have reviewed the standard replacement ages that Powerlink has calculated and used in the repex model. Table 10 below reproduces the asset replacement ages that Powerlink has applied in its repex model.

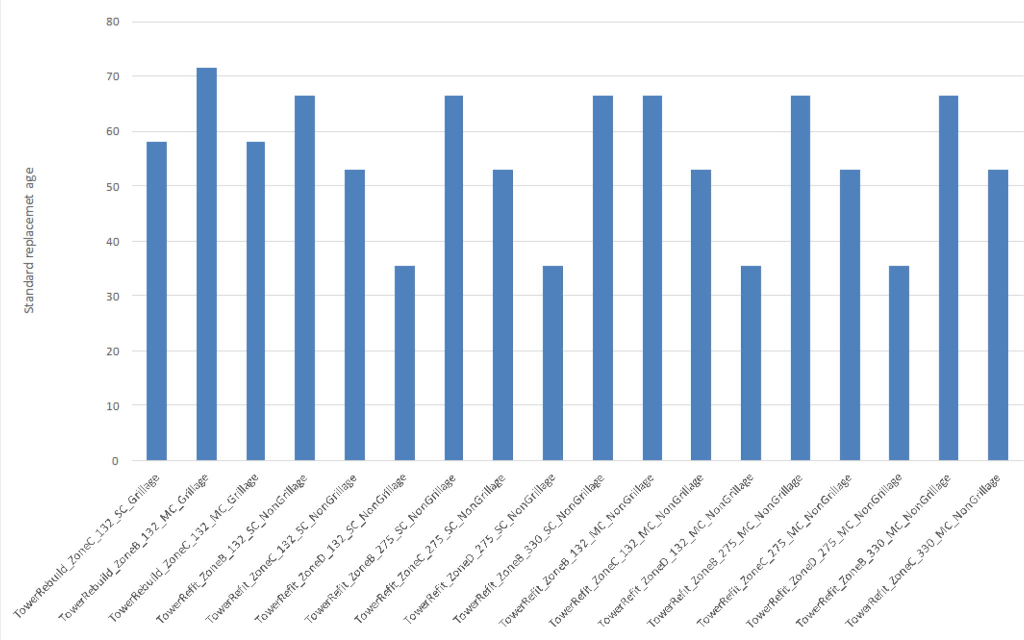
Table 10: Powerlink's assumed calibrated asset replacement lives[42]

Primary category	Sub category	Calibrated standard life
Transmission towers (all voltages and circuit configurations)	Corrosion zone DEF	40.3
	Corrosion zone C	57.9
	Corrosion zone B	71.4
Substation switch bay equipment (all voltages)	Circuit breakers	34.2
	Isolators/earth switches	39.8
	Voltage transformers	34.6
	Current transformers	33.2
SCADA, Network control and protection	Secondary systems bay and non-bay (excluding Metering)	20.2
	Communications	10.7
Building and infrastructure	Substation buildings	34.3
	Communications buildings	42.3
	Site infrastructure	50.6

122. For towers, Powerlink has derived calibrated standard lives for defined corrosion zones, as shown in Figure 14. Replacement ages for Zone D are relatively young at 40.3 years, however Powerlink considers that the highly corrosive environment is leading to the need for earlier replacement or refurbishment. The resulting repex forecast is scaled to Powerlink's actual historical replacement program and so should reflect the condition of the towers actually encountered in the field, assuming that assets are not replaced or refurbished if this is not required.

[42] Powerlink_Appendix_5.05_Non-Load Driven Network Capital Expenditure Forecasting Methodology Section 4.3, Page 31

Figure 14: Lives for tower rebuilds and refurbishments



Source: Powerlink repex model[43]

123. The asset replacement ages are within a broad range of those that we have observed in other TNSP reviews.

124. For example, New Zealand's transmission system owner and operator Transpower sets out its approach to tower management in its fleet strategy for transmission lines and poles[44]. Transpower has adopted an asset lifecycle cost model to establish the replacement age for its towers if life extending painting was not undertaken and the optimum time to apply the paint to its towers. Transpower uses an asset health index methodology to determine the pre and post treatment health of its tower fleet.

125. Through this approach Transpower has determined that:

- tower painting continues to have lower lifecycle cost than replacement;
- by managing the impact of corrosion through painting, the life of towers can be extended indefinitely, provided they are re-painted prior to significant paint failure occurring;
- newer, better condition towers should be left to age, allowing them to reach the optimum condition for painting;
- towers should be painted before the condition goes significantly beyond the economically optimum point, to avoid excessive future costs for maintaining overall asset health.[45]

126. Transpower has modelled the probable impact on its towers if they were not painted. The results from Transpower's modelling can be seen in the chart below.

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[43] Powerlink_Replacement capex (repex) Model - Forecast Model - 2015 Profile – Age Profile (Inst) tab

[44] https://www.transpower.co.nz/node/10951/fleet-strategies TS01 TL Towers and Poles

[45] Transpower TS01 TL Towers and Poles, section 4.1.2, page 40

Figure 15: Tower steel degradation curves for unpainted towers

Source: Transpower TS01 Towers and Poles Fleet Strategy

127. Like Powerlink Transpower has identified corrosion zones; in Transpower's case six have been established. The life expectancy for unpainted towers in each corrosion zone is provided in the table below.

Table 11: Transpower's tower life expectancy

Corrosion zone	Typical exterior environment	Life expectancy (years)
Extreme	Geothermal/exposed	18
Very severe	Sea-shore (surf)	25
Severe	Sea-shore (calm)	44
Moderate	Sheltered/coastal with low salinity	62
Low	Arid/rural/inland	86
Benign	Dry, rural/remote from coast	120

Source: Transpower TS01 Towers and Poles Fleet Strategy

128. Based on the modelled life expectancy Transpower has determined the optimum time to paint the towers, as shown in table 12 below.

Table 12: Transpower's tower age for painting

Corrosion Zone	Condition	Typical age at first paint (years)
Extreme	CA 50	13
Very Severe	CA 40	20
Severe	CA 40	35
Moderate	CA 30	56
Low	CA 30	78
Benign	CA 30	111

Source: Transpower TS01 Towers and Poles Fleet Strategy

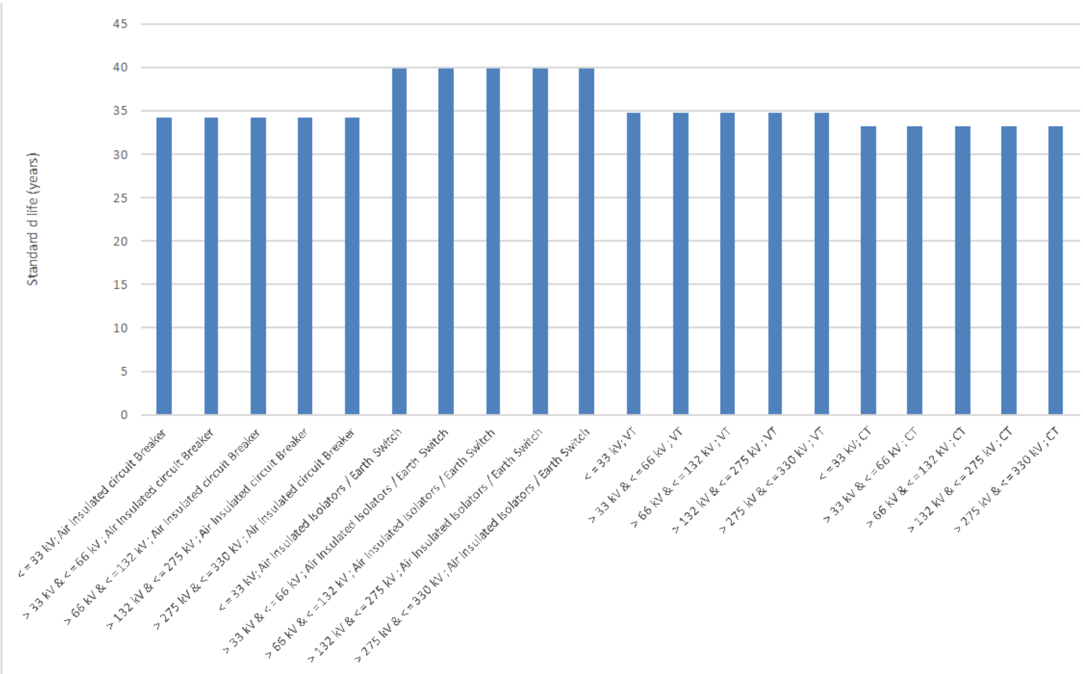
129. Transpower's life extending painting of towers is seen to occur five years prior to the end of expected life for the most severe corrosion zones. This is again consistent with Powerlink's practices.

130. Whilst Powerlink's assumed replacement ages are not out of step with Transpower's modelled results, importantly, we have not seen evidence from Powerlink of the same level of survival curve analysis, which we consider would enhance the robustness of the model.

131. Powerlink's standard asset lives for substation assets are provided in figure 15. For substation assets the expected lives of assets are broadly similar to those that we have seen in other TNSPs. Whilst CTs and VTs included in substation assets may have longer survival rates, these are normally replaced with other substation assets such as circuit breakers and therefore their lives are linked to these assets. Thirty-five years for a CB is not unreasonable and is consistent with what we have seen in other TNSPs.

132. Power transformers are not included in the Powerlink repex model due to low statistical volumes, and replacement is undertaken on an individual transformer age and condition assessment basis.

Figure 16: Substation asset standard lives



Source: Powerlink repex model[46]

133. Unit costs are developed using Powerlink's established base planning objects which included feedback loops and review.

134. Powerlink's use of the Hybrid approach represents a significant departure from the capex forecasting methodology used for its previous revenue proposal. Coincident with this change in forecasting approach is a significant change in the primary driver of Powerlink's capex, from growth to replacement/refurbishment.

135. Given the dependency on the Hybrid repex model for a significant proportion of its capex Powerlink has sought independent review of its forecasting approach and undertaken some

[46] Powerlink_Replacement capex (repex) Model - Forecast Model - 2015 Profile – Age Profile (Inst) tab

validation of the results from its calibrated repex model. These assessments are considered in the following subsection.

4.3 Validation and review of Powerlink's approach

136. Powerlink has commissioned several independent reviews and validation assessments of its Hybrid approach. Nuttall Consulting undertook a review of Powerlink's forecasting methodology[47] and Jacobs Group (Australia) Pty Limited (Jacobs) undertook a review of cost data[48].

137. In its review, Jacobs generated unit cost estimates independently from Powerlink. Powerlink then compared its internal unit costs against the Jacobs industry average unit costs. The conclusion from the Jacobs' work is that the unit rates used as inputs to the Repex Model are reasonable.

138. In addition Powerlink has undertaken the following validations including comparisons of:

- The calibrated replacement lives against industry norms;[49]
- Repex Model quantities against Asset Management Plans.

139. Whilst the reviews and validation noted above are relevant to our assessment of Powerlink's repex forecasting methodology, most relevant is the Nuttall Consulting review.

4.4 Issues raised by Nuttall Consulting

140. Nuttall Consulting is generally supportive of Powerlink's use of the AER's repex model for asset replacement, considering it to be an appropriate method for *preparing the replacement forecast for many asset classes, for these regulatory purposes*[50]*.* Nuttall Consulting also concluded that: [51]

> *(i)* *the base-step-trend method [is] an appropriate approach for preparing the forecast for the non-demand-driven capex categories; and*
>
> (ii) *that Powerlink has implemented this approach appropriately.'*

141. In the report Nuttall Consulting identifies a relatively small number of issues and also some areas where, in its view, Powerlink could make improvements. In terms of greatest potential to affect the repex forecast Nuttall Consulting raises two issues: [52]

> *(i)* *For towers, concern that Powerlink's approach to deriving the tower lives is resulting in lives for some towers, which are not supported by the input data. Importantly, my indicative analysis of the data through the model suggests that*

[47] Powerlink_Appendix_5.04_Forecasting Methodology Review Nuttall Consulting

[48] Powerlink_Appendix_7.04_Cost Data Review to Support Repex Modelling_Jacobs_CONFID

[49] Powerlink_Appendix_5.05_Non-Load Driven Network Capital Expenditure Forecasting Methodology Section 4.3, Page 31

[50] Powerlink_Appendix_5.04_Forecasting Methodology Review Nuttall Consulting Page 4

[51] Powerlink_Appendix_5.04_Forecasting Methodology Review Nuttall Consulting Page 6

[52] *Ibid, page 6*

the lives Powerlink is deriving are shorter than the lives it has achieved in recent history for towers in low corrosion zones.

(ii) *For secondary systems, concern that asset age profiles that form an input to the modelling process suggest that the model may not be set up correctly or there is an issue with the age profile that means it is not suitable for use in the repex model.*

142. Nuttall Consulting considered that the above two issues had the potential to result in significant changes to the replacement forecast but noted that they acted in opposite directions.

Transmission Lines

143. Transmission line replacement and refits represent the largest category of forecast expenditure in the next RCP. As discussed in section 3.4, Powerlink has addressed the Nuttall Consulting concern by calibrating each corrosion zone independently. We consider this to be an appropriate action to address this concern.

Secondary systems

144. Secondary systems replacement represents the second-largest category of forecast expenditure in the next RCP. To address Nuttall Consulting's primary concern, Powerlink splits the secondary systems age profiles between bay assets, non-bay assets and metering assets:

- A single weighted average unit rate is used for both bay and non-bay assets; and
- The forecast quantity of non-bay asset replacement is used to derive a forecast of the quantity of metering assets to be replaced based on the relative populations of bay, non-bay and metering assets[53].

145. In response to Nuttall Consulting's further, less significant concerns regarding secondary systems, Powerlink has:[54]

- Identified and addressed some issues relating to erroneous data;
- Limited its consideration to the major protection and control equipment such as protection relays and Remote Terminal Units (RTUs); and
- Clarified the forecasting of metering replacement.

146. Powerlink considers that the above actions are sufficient to address Nuttall Consulting's concerns regarding using a single mean replacement life to model substation secondary systems assets. The post revision results support Powerlink's proposition that use of a single mean life is appropriate. Based on the information provided by Powerlink we consider that this position is reasonable.

Other matters

147. In addition to its concerns with aspects of modelling the replacement/refurbishment of the two largest repex categories, Nuttall Consulting identified the following issues that it noted were likely to have a smaller effect on the forecast:

[53] Powerlink_Appendix_5.05_Non-Load Driven Network Capital Expenditure Forecasting Methodology Page 19

[54] *Ibid*

- in addition to the possible issue with the secondary system age profiles possible issues in other age profiles were identified; and
- modelling of current transformers associated with dead-tanks circuit breaker was likely to be incorrect.

148. We have reviewed Powerlink's advice on how it has addressed each of Nuttall Consulting's issues and we consider it has addressed them adequately.

149. Nuttall Consulting also raised a question regarding Powerlink's Unit costs: [55]

> *'The unit costs in the model reflect Powerlink's estimates of their forecast unit costs. I am unable to say whether these unit costs are above or below Powerlink's historical costs (as could be derived through the RIN data). This is likely to be a consideration of the AER, and so, Powerlink may need to investigate whether it can demonstrate this matter.'*

150. We have reviewed the process through which Powerlink establishes its unit costs. The process is substantially the same as that used and reviewed by EMCa for Powerlink's previous regulatory proposal. This process includes the establishment of Base Planning Objects (BPO's) using historical costs from actual projects and the most recent unit costs seen in project tenders. Periodic reviews are applied to the unit cost data which is revised to reflect any changes in actual costs.

151. As discussed above, Powerlink also undertook unit cost benchmarking by comparing its own unit costs with those produced independently by Jacobs and applied this in its replacement expenditure model.[56]

152. We did not identify any systemic issues relating to the appropriateness of the unit costs used to produce the repex forecast.[57]

4.5 Key issues with Powerlink's Repex Model

4.5.1 Reliance on prudent and efficient assumption

153. Implicitly the scaling or calibration of the RIN asset replacement ages using historical replacement volumes assumes that Powerlink's historical replacement/refurbishment practice has been efficient and optimal. If this is not the case, then the repex modelled outputs will also be suboptimal and inefficient.

154. Importantly, Nuttall Consulting noted that its review relied on the assumption that historical practices represent prudent and efficient decisions, however it had not considered if this underlying assumption was valid: [58]

> *'Should Powerlink consider that this assumption is not valid then it may need to apply some form of adjustment to the forecasts produced through these methods. and using these as the basis for the forecast.'*

[55] Powerlink_Appendix_5.04_Forecasting Methodology Review Nuttall Consulting Page 6

[56] Powerlink - 2018-22 Revenue Proposal - January 2016 Page 31; Powerlink further advises that the difference between the Jacob's unit cost estimates and its own is 'within 2%' (Powerlink, AER Site Visit - 7 Repex Forecasting Methodology)

[57] We found one case in our review of sample projects where the average cost per tower was significantly (20%) higher than the Jacob's reference unit cost. There was insufficient detail provided in Powerlink's project information to understand the reason for the higher cost per tower in this case

[58] Powerlink_Appendix_5.04_Forecasting Methodology Review Nuttall Consulting Page 9

155. The use of historical data to calibrate the Repex Model means that any lack of prudency and/or inefficiency in Powerlink's management of its asset replacement program in the five year period used to calibrate the model, will deliver a repex forecast that mirrors this performance. Implicitly the forecast produced using Powerlink's calibration and repex model approach would effectively continue any trend (efficient and prudent or otherwise) into the future. Similarly, improvements to asset management decision-making and focus in recent years, or which is in the course of deployment, will not be fully captured by the model calibration. If the later years of the calibration period represent more efficient years, then this would be captured, but would also be distorted by the previous, less efficient years.

156. To conclude that the repex forecast produced from the Hybrid model reflects the prudent and efficient costs needed to maintain the network requires an assessment of Powerlink's actual performance when implementing its asset replacement programmes.

157. Our discussion on this matter in section 2, highlights a wide variation between the forecast and actual repex that occurred in the five-year period, particularly in the early years of the current RCP, which Powerlink has not satisfactorily explained. Without detailed and convincing explanations for the 2012-13 and 2013-14 variations it is difficult to conclude that a calibration based on them would reflect prudent and efficient costs for the next RCP.

158. We have considered two additional means of addressing this key issue:

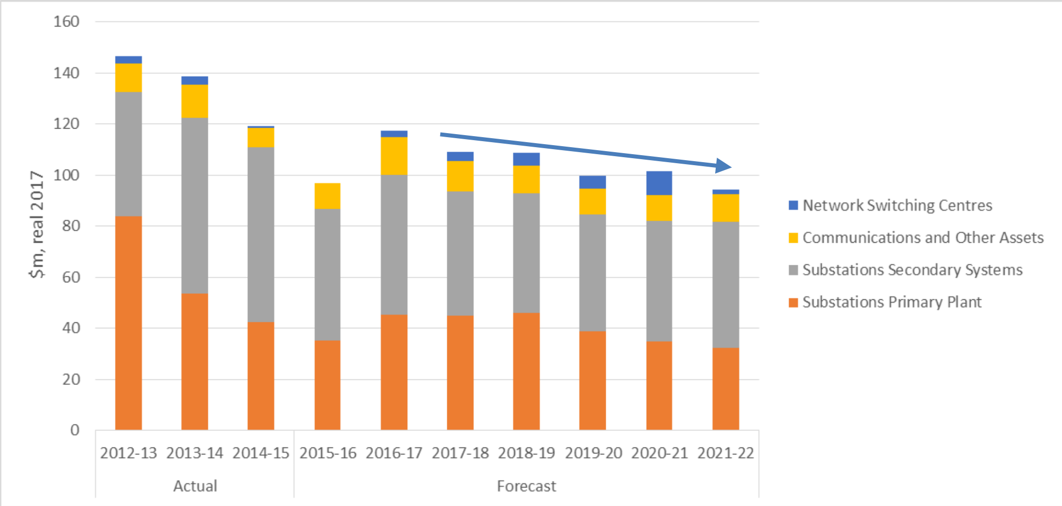
- ***Project-level assessment*** – as discussed in section 5, we consider that Powerlink's bottom-up expenditure forecast is likely to be materially overstated. In our experience, this is typical of NSP bottom-up forecasts. Good governance practices include the application of a strong 'top-down' challenge process to bottom-up expenditure forecasts, and which can identify material opportunities to significantly reduce the required aggregate forecast expenditure. We consider that when Powerlink undertakes detailed analysis (on the most recent data) it should be able to repeat its past practice of finding prudent means of deferring expenditure and delivering the projects at a significantly lower than forecast cost (over the portfolio).

  Powerlink's bottom-up repex forecast is, despite its limitations, approximately 20% higher than the output of the repex model. The margin between the repex model and the bottom-up forecast is an indicator that the repex model is not overly conservative. However, this does not mean that the outputs produced by the Powerlink repex model is necessarily prudent and efficient;

- ***Trend analysis –*** as shown in Figure 17, if the impact of the forecast increase in transmission line expenditure is excluded, the outlook for the other four repex categories is a declining trend, and 17% lower overall expenditure ($619m vs $514m). This indicates that the forecast from the Powerlink repex model output is not overly conservative. Again, this does not mean that the outputs produced by the Powerlink repex model is necessarily prudent and efficient as it relies on calibration from previous years.

  We have considered the basis for the forecast increase in transmission line projects and aside from the common set of reservations we have regarding its bottom-up forecast, we consider Powerlink has a bona fide case for increased expenditure on transmission lines over the next RCP compared to the 2015-16 level.[59]

Figure 17: Actual and forecast repex profile excluding transmission lines (real $m 2016/17)



Source: EMCa analysis of Powerlink's response PQ0129 to EMCa Information Request

159. In the absence of a more extensive ex-post review, these two 'cross-checks' mitigate but do not eliminate the concern expressed by Nuttall Consulting (which we share) that Powerlink's approach to repex modelling propagates ineffective investment in the current RCP.

[59] As discussed in section 6, Powerlink advises that it paused its planned replacement/refurbishment program (including for transmission lines) to take into account opportunities for deletion or deferral of planned work resulting from the lower peak demand outlook. Therefore, the 2015/16 expenditure is uncharacteristically low.

5 Other forecasting methodologies

5.1 Security/compliance capex

160. Powerlink advises that it has forecast the 2018-2022 security/compliance capex using a '*trend analysis technique*': [60]

> *'Powerlink has developed a forecasting methodology similar to the AER's base-step-trend approach for forecasting operating expenditure and applied this to these categories of capital expenditure[61]… The key difference will be that, instead of identifying a single efficient base year as for operating expenditure, the capital expenditure forecast will identify an efficient base trend from historical expenditures.'*

161. Powerlink provides further insight to its approach in Appendix 5.05 to its RP.[62] However, it is apparent from Figure 17 that Powerlink has based its forecast expenditure on the 2016/17 forecast capex with a small positive rate of change to determine the annual 2018-2022 capex in this category. Powerlink advises that the forecast base expenditure is derived from the annual average historical expenditure from 2010/11 – 2014/15, after removing non-recurrent, abnormal expenditure.[63]

162. In the absence of the detailed analysis undertaken by Powerlink to arrive at the 'base expenditure' we cannot confirm the prudency of $3.7m as an assumed, required average annual requirement (with slight real escalation). However, the contribution to the overall non-driven load expenditure forecast is relatively small and the methodology is broadly consistent with the AER's preferred approach for such categories of expenditure.

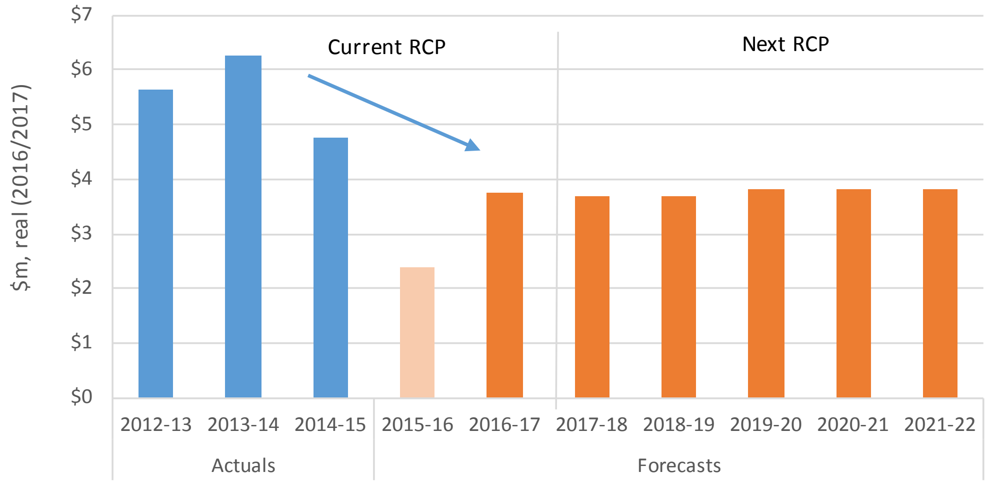
[60] Powerlink, Expenditure Forecasting Methodology, section 2.4.2

[61] Powerlink, RP, section 5.4.2, page 46

[62] Powerlink, Appendix 5.05, Non Load Driven Network Capital Expenditure Forecasting Methodology, section 3

[63] *Ibid, section 3.2.2, 3.2.3, page 28,*

Figure 18: Actual & forecast Security/compliance capex (real $m, 2016/17)



Source: Powerlink RP 2018-2022, Table 4.1 and 5.4 modified by EMCa to present $real expenditure

5.2 'Other' capex

163. Powerlink advises that its forecasting methodology for 'Other' non-load driven capex is the same as for security/compliance capex (i.e. 'trend analysis technique'). Whilst Powerlink provides further insight to the approach in Appendix 5.05 (in which it advises that it has used the historical average from 2010/11 – 2014/15 adjusted for abnormalities as the basis for the 'Other' forecast for the next RCP), it appears from Figure 19 that Powerlink has assumed the pattern of expenditure in the next RCP will be very similar to that in the current RCP. This approach, if it is what Powerlink applied, is at odds with its declared methodology and has not been explained.

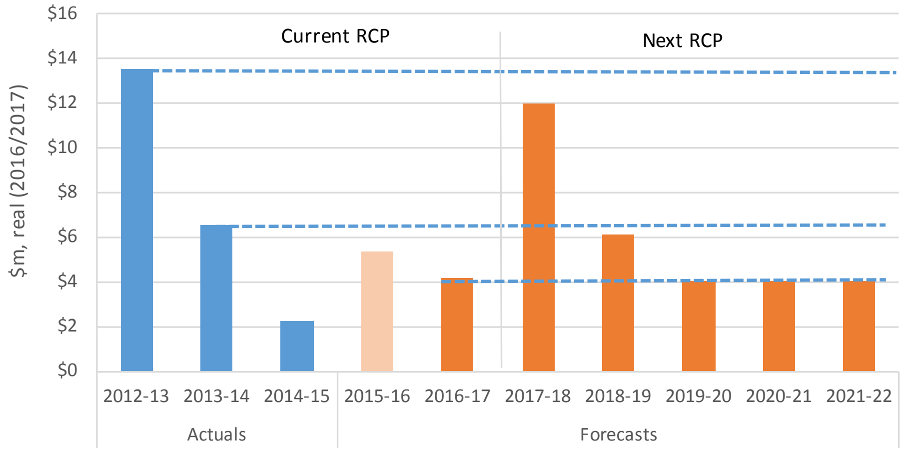
164. Powerlink has not provided a health index or other indicator to help show the trend in network health or risk for this asset sub-category with the historical and proposed expenditure.

165. Whilst at $30.1m the total annual forecast capex in the next RCP is slightly less than the $31.8m Powerlink expects to spend in the current RCP, the relatively high levels in the first years of each RCP tend to distort the average. If instead of the five year range Powerlink used, the average of the last three years of revealed cost in the current RCP were used as a more recent basis for trending,[64] the total forecast expenditure for the next RCP would be $19.6m, a reduction of $10.5m or 35%.

166. We do not consider that Powerlink has provided sufficient evidence to support its forecast expenditure.

[64] Noting that the 2015/16 amount is likely to be based on a combination of actual expenditure, projects underway, and approved projects and is therefore a good proxy for a 'revealed' cost

Figure 19: Actual and forecast 'Other' capex (real $m,2016/17)



Source: Powerlink RRP 2012-2017, Table 7.4 modified by EMCa to present $real expenditure

6 Project-level assessment

6.1 Introduction

167. In this section we discuss the result of our review of a sub-set of a sample of 25 repex projects for which Powerlink provided supporting information to the AER. At a forecast cost of $563m, the sample projects represent 71% of the forecast repex for the next RCP, which is a meaningful proportion.

168. The purpose of our assessment is to test: (i) whether Powerlink 'does what it says it does' (i.e. how well and how consistently it applies its policies and procedures); and (ii) our concerns with its forecasting methodology (as expressed in sections 3-5).

169. In undertaking the assessment, we have noted Powerlink's project approval process/lifecycle, the purpose of Area Plans, and the role its 'bottom-up' or project-level assessments play in the 'hybrid' expenditure forecasting methodology it has adopted for its RP. We briefly consider each of these aspects of expenditure forecasting

6.2 Powerlink's project approval process

170. Powerlink advises that it follows a four step approach to developing and approving projects:[65]

- Needs identification – which includes consideration of asset health, condition and risk assessment (for non-load driven projects); Condition Assessment Reports (CAR) and Risk Spreadsheets (RS) are identified artefacts;
- Develop options - which includes development of an Investment Options Paper (IOP) which captures the detailed analysis of the investment need and feasible investment options;
- Confirm option and define project – which includes preparation of a Project Scope Report and a Project Proposal Report (PPR). The latter '*is to provide detailed cost and qualitative delivery information for the selected option. It also conducts a*

[65] Powerlink, Project Approval for Network Capital Projects Procedure, Section 2

deliverability analysis against the general constraints of the option, including outlining resource requirements'; and

- Approve Project – The key approval document is the Business Case.

171. We refer to the key documents denoted above in our assessment, noting that we do not expect Business Cases to be available for projects that are not planned to commence for several years.

6.3 Powerlink's Area Plans

172. Powerlink's nine Area Plans provide a high level analysis of the harmonisation of future network capacity requirements (i.e. in response to load and generator connection projections) and end-of-life issues (i.e. in response to condition/obsolescence assessment). The Area Plans each describe the options considered (at a high level) and the revised network development and replacement/refurbishment plans.

173. Importantly, Powerlink has demonstrated through the Area Plans that it has responded to the change in demand forecast by identifying assets that no longer have an 'enduring need' (i.e. that can be decommissioned, in due course), allowing in turn for:

- Reconfiguration of the network, including by:
  - Eventually 'retiring' assets;
  - Changing network development plans – e.g. by re-routing new lines;
  - Changing asset replacement plans – e.g. by changing the planned capacity of replacement transformers; and
- Reducing the forecast repex (and presumably opex) formerly planned to be directed to the 'to be retired' assets.

174. In assessing a subset of the sample projects, we have considered the applicable aspects of the Area Plans to Powerlink's replacement/refurbishment capex.

6.4 Non-network solutions

175. Powerlink recognises the role of non-network solutions in its AMP and advises that it has[66] (i) …*entered into a range of non-network solutions in various areas to assist or augment the power transfer capability of the high voltage transmission grid*, and (ii) is *looking to … expand the use of non-network solutions to address limitations within the transmission network when technically and economically feasible to do so*.

176. Powerlink also advises that its network planning studies as captured through the Area Plans have, among other things, focussed on the potential for deployment of non-network solutions.[67] However, it would appear that Powerlink has not yet adopted any new non-network solutions to address network issues for projects proposed for the next RCP,

[66] Powerlink, Appendix 5.09, Asset Management Plan (Vol 1), section 6

[67] Powerlink, Appendix 5.10, Asset Management Plan (Vol 2), Section 2.3

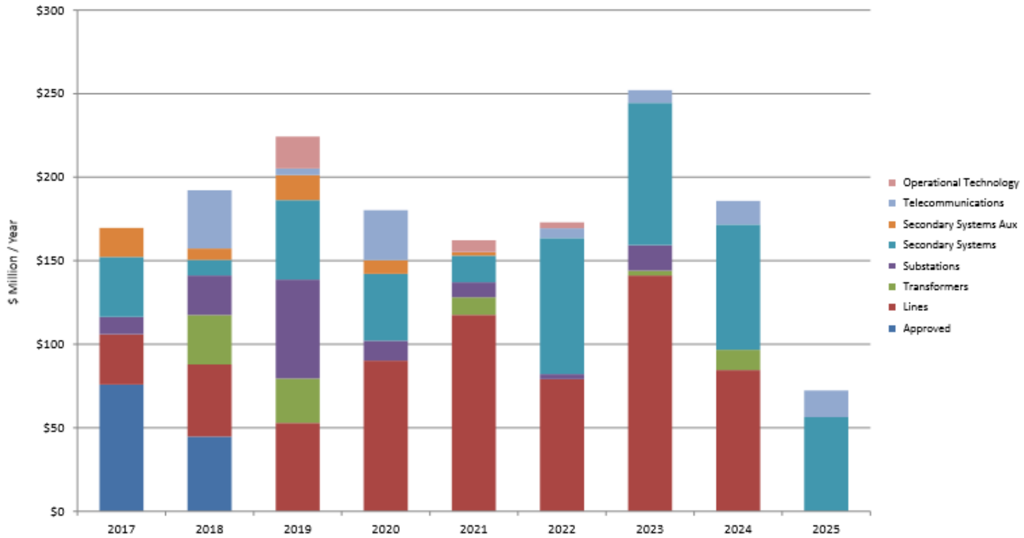
instead referring to potential opportunities and the intention to undertake Non-Network Feasibility Studies prior to confirming the preference for the network-based solution.[68]

177. Typically, non-network solutions are not directly targeted at addressing asset-condition or obsolescence issues, but indirectly they may provide the opportunity to reduce the cost of replacement or refurbishment that would otherwise be required.[69] They *may* be viable alternatives to enable deferment of line replacement/rebuild projects.

6.5 Powerlink's 'bottom-up' expenditure forecast

178. Powerlink's AMP Volume 2 includes an indicative aggregated replacement capital project expenditure forecast, noting that the indicative expenditure profile is heavily qualified, but nonetheless is the best representation of a 'bottom up' expenditure forecast for the next RCP available. [70] Figure 19 is extracted directly from the AMP and indicates aggregate expenditure of approximately $960m (2016/17 base) over the 2018-2022 period. The projects with expenditure > $5m which underpin Figure 20 are provided in Table 3.1 of the AMP. It would appear from comparing the constituent cost estimates underlying Figure 19 with the information in the 'project packs' provided by AER for the sample projects, that contingency allowances are not included in the c$960m total.

Figure 20: Replacement/refurbishment capital projects – "Indicative" timings



Source: Reproduced from Powerlink's AMP volume 2, Figure 3.1

179. The aggregate amount of forecast expenditure in the 2018-2022 RCP from Powerlink's 'bottom-up' analysis is about 20% higher than Powerlink's proposed expenditure for the

[68] *Ibid, pages 13, 15* and Asset Management Plan (vol 3) for the North Queensland, Mackay, Central-South Queensland, Greater Brisbane, and Gold Coast Areas.

[69] Powerlink has identified the possibility of replacing only one rather than two 132/66kV transformers at Garbutt substation through applying non-network alternatives in the Townsville area (Powerlink Transmission Annual Planning Report 2015, Table 4.3)

[70] For example: '*Figure 3.1 includes a number of projects which have currently been approved, and are under construction and have projected spend within the 2016-25 period. These expenditures are based on actual projected project timings and annual spends. For other projects which are not approved, no spend profiling has been performed and the entire project spend is assumed to occur in the year they are delivered in Figure 3.1.*' Powerlink, AMP Vol 2, section 3, page 28

next RCP generated from its 'hybrid' forecasting methodology.[71] We refer to this information in our project level assessment, which follows.

6.6 Identification of projects for review

180. Powerlink identified the status of the 25 sample projects in one of three classes:

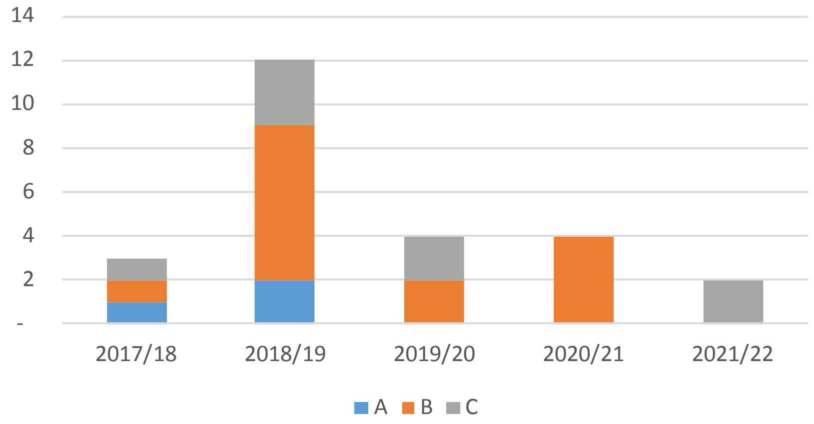
   A. Projects are approved/committed and directly contribute to the 2018-2022 repex forecast (i.e. they are excluded from Powerlink's Repex Model)

   B. Projects are not yet approved/committed and do not contribute directly to the 2018-2022 forecast repex (i.e. they are 'within' the scope of the Repex Model output)

   C. Projects which are not yet approved/committed but will contribute directly to the 2018-22 repex forecast (i.e. they are excluded from Powerlink's Repex Model)

181. The completion date profile of the 25 projects is shown in Figure 21. The majority of projects are forecast to be completed within the next three years. We would therefore expect most of the projects to be approved and underway or at least close to final approval. In turn we would expect at least the CAR and IOP to be available for a significant portion of the sample projects. As discussed below, Powerlink has provided a limited number of CAR and IOP documents for our review, despite our request for such information.

Figure 21: 25 sample project forecast completion date



Source: EMCa analysis of AER sample project list, in turn provided by Powerlink

182. Table 13 summarises the characteristics of the sample projects from two perspectives: project class and expenditure category. Powerlink advises that there are only three A-class projects in the sample.[72] At $65.6m they represent only a small proportion of Powerlink's proposed expenditure. The C-class projects comprise seven transformer replacement projects and an EMS replacement project. The other 15 projects are 'B-class'.

183. We selected projects for review that were: (i) representative of the various sub-categories of expenditure, and (ii) the largest as measured by estimated cost. Appendix A lists the 25 projects, the projects reviewed, and the project classifications.

[71] Powerlink has not included contingency allowance in its list of projects in Volume 2 of its AMP and therefore contingency is not included in the approx. $960m bottom-up forecast expenditure. At an individual project level, Powerlink appears to allow between 10-15%, which is a typical cost estimation approach.

[72] Two secondary systems renewal projects and one line refit project

184. To assist with our assessment, we requested that Powerlink provide all relevant documentation used to support the expenditure forecast, including the CAR, IOP, PPR, and Business Case. As denoted in Appendix A, contrary to our expectation, only one Business Case, two IOP, and nine CARs were provided. PPRs were provided for the majority of projects. As the PPR provides only a summary of the preceding evaluation (and typically does not provide options analysis) the basis on which to base our project assessment was limited when the PPR was the only document provided.

185. Powerlink did refer us to analysis in the relevant Area Plans. Typically, the Area Plans show high level area investment strategies (which is very useful context) but for most projects do not provide the level of options analysis that we consider is necessary to assess the prudency of the scope and timing of the work selected.

Table 13: Characteristics of Powerlink's sample projects versus total forecast 2018-2022 repex

Type	Elaboration	Forecast expenditure Sample projects[1]	2018-2022[2]
Expenditure category	Transmission lines	288.1	280.4
	Substation primary plant	Transformers: 50.3 Substations: 105.2	197.1
	Substations secondary systems	34.7	237.6
	Communications and other assets	105.3	54.3
	Network switching centres	0.0	24.7
	Total	**583.6**	**794.1**

Source: EMCa analysis

Note 1: Sample project list provided by AER and with forecast expenditure provided by Powerlink
Note 2: EMCa analysis and Powerlink response PQ0129 to EMCa Information Request

6.7 Assessment

6.7.1 Transmission lines

186. In its Asset Management Plan,[73] Powerlink has identified 16 transmission line repex projects to be completed in the next RCP, with an estimated total value of $340m.[74] As shown in Tables 14 and 15 and Figure 22, the output from the Repex Model is 21% lower, at $280.4m. Powerlink's assessment is that it requires significantly more expenditure per annum than it did in the most-recently completed year (2014/15) and the current financial year. The forecast for the next RCP is $44m (19%) more than the current RCP forecast.

[73] Powerlink, Asset Management Plan Vol 2, Table 3.1

[74] With expenditure greater than $5m

Table 14: Current RCP Powerlink transmission line repex, (real $m, 2016/17)

	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Transmission lines	107.1	53.8	18.1	18.6	38.8	**236.4**

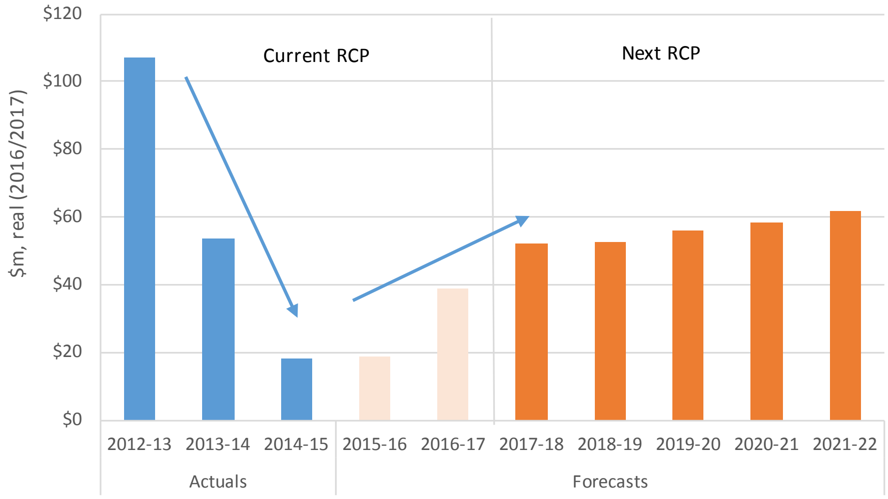
Source: Powerlink response PQ0129 to EMCa Information Request

Table 15: Next RCP Powerlink transmission line repex, (real $m, 2016/17)

	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Transmission lines	52.3	52.5	55.8	58.2	61.6	**280.4**

Source: Powerlink response PQ0129 to EMCa Information Request

Figure 22: Transmission line historical and forecast repex (real, $m 2016/17)



Source: Source: Powerlink response PQ0129 to EMCa Information Request

187. The set of seven sample transmission line projects provided by Powerlink have a combined forecast cost of $288m. Five of the projects are line refits, with the key activity being refurbishing transmission towers. The other two are line replacement projects. As the transmission line projects represent such a large proportion of total repex and because the individual sample projects presented by Powerlink were high cost projects, we reviewed five of the seven projects.[75]

Collinsville Proserpine Inland Section Transmission Line Refit

188. This was the only A-class (i.e. approved/committed) project in this category and Powerlink provided an Investment and Planning Business Case as supporting information.[76] The project scope is to refit the 74km inland section, including surface preparation and painting of 94 of 194 towers at an estimated cost of approximately $34m (including 15% contingency). The project was due to commence in 2015/16 and to be completed by 2018/19. The driver for the investment is the condition of the towers (and fittings), which

[75] Greenbank to Mudgeeraba 275kV TL Refit, Clare South - Strathmore - Collinsville Transmission Line Refit, Biloela to T027 Moura 132kV Transmission Line Replacement, Bergins Hill to Goodna to Belmont 275kV TL Refit, Collinsville Proserpine Inland Section Transmission Line Refit

[76] We invited Powerlink to provide copies of the other documentation referenced in this document (Condition Assessment Report, Project Scope Report, Project Concept Estimate, NPV Calculation) but Powerlink did not provide the information with its response.

include grade 2 and grade 3 corrosion. The condition assessment was undertaken in 2013/14. Four options were considered, with NPV analysis based on 'Concept Estimates'.

189. We consider that the scope of work is consistent with Powerlink's asset management strategy of undertaking life extension rather than asset replacement wherever technically and economically prudent to do so. We further consider that the approach of refitting a subset of the 194 towers in the inland section is a superior approach to the other options considered. However, we consider that:

- The further option of undertaking the minimum work necessary in the next RCP by considering refurbishing only the towers in the worst condition, and perhaps increasing proactive maintenance (opex) on the rest of the line section should have been properly assessed (or if it has been considered, then included in the support documentation). We have viewed the small number of pictures Powerlink has provided to us [77] on the understanding that these are examples of grade 2 and grade 3 conditions. They are indicative of the asset condition, but as we have not been provided with the Condition Assessment Report for the transmission line in question, we are unable to discern whether it is prudent to undertake work on 94 towers through to 2021/22;
- There is little justification of the estimated cost of $0.36m per tower, which is: (i) a Concept Estimate', and (ii) significantly higher than the Unit Cost for such a line.[78] Given the project is underway, we would expect Powerlink could have provided the contracted costs for 2015/16 and other supporting information to demonstrate that the costs were efficient; and
- Delivery risk – Powerlink identifies this and quality of work by external suppliers as a key risk, but does not provide any risk mitigation strategies in the documentation provided, particularly given:
    - the planned increased volume of work over the course of the next RCP, and
    - The shift in dominant work mode from line replacement in the early part of the current regulatory period to line refurbishment, which requires a fundamentally different skill set.

Other transmission line projects

190. Powerlink has provided Project Proposal documents in support of the other sample line replacement/refurbishment projects. Table 16 summarises our assessment of the prudency and efficiency of the four proposed projects we reviewed.

Table 16: Summary assessment of other sample transmission line projects reviewed

Project aspect	Summary of information provided by Powerlink
Business need/driver	The driver is identified as poor asset condition in each case
Scope	The scope of the selected approach is well defined in each case
Investment strategy	The approach selected is broadly consistent with adopting a life-extension rather than replacement were prudent to do so

[77] Powerlink, AER Site Visit – Case Studies Powerlink_Appendix_7.04_Cost Data Review to Support Repex Modelling_Jacobs_CONFID

[78] Powerlink_Appendix_7.04_Cost Data Review to Support Repex Modelling_Jacobs_CONFID, Section 7.3

Project aspect	Summary of information provided by Powerlink
Condition assessment	No information/evidence is provided to support claims that conditions require the scope and timing selected (i.e. no CAR was provided)
Options analysis	No options analysis was provided for any of the projects to confirm that the selected option is optimal, although typically there is some mention of other options considered
Economic analysis	No economic analysis provided in support of options
Opex-capex trade-off (including non-network solutions)	As no options analysis was provided for the projects, it is not possible to assess the extent to which additional opex was considered, if at all
Cost estimate basis	For line refit projects, costs vary markedly on a per tower basis without explanation; Estimates are based on Base Planning Objectives, which we are advised have been updated to reflect better prices achieved due to 'soft' market conditions. Assumptions are typically listed, noting that estimates are based on preliminary/desktop designs
Project delivery	The procurement strategy relies on a combination of internal and external resources
Interrelationship with other projects	Typically identified
Risk assessment	Deliverability risk is either not assessed or not convincingly addressed within the project documentation; there is no explicit link to corporate risk framework except for Greenbank to Mudgeeraba in the docs provided

Source: EMCa analysis

Other considerations

191. Powerlink has provided separate advice that it has developed a delivery strategy to accommodate the forecast program of transmission line refit work in the next regulatory period and included the requirements in its contracting arrangements.[79] Based on the information provided, we consider that the delivery risk for this category of expenditure has been satisfactorily addressed.

192. We also note that with the proposed expenditure program, Powerlink predicts a slight increase in Grade 3 bolts over the course of the next RCP with its proposed line repex program.[80] This is an indicator that the proposed program of work is not excessive, but the robustness of this conclusion is dependent on the quality of the information and assumptions underpinning the analysis (which we have no visibility of).

193. Furthermore, Powerlink advises that the weighted average age of transmission lines (non-grillage tower foundations) will increase from 23.1 years to 27.4 years from 2015 to 2022

[79] Powerlink, response PQ0141 to EMCa Information Request

[80] Powerlink, response PQ0140 to EMCa Information Request

with its assumed refit program. This would normally be an indicator that the proposed program is not likely to be excessive. However, an average age of 27.4 years is still relatively young for transmission lines and there could well be scope for a greater increase in average age without a material concern about overall transmission line health, particularly if effective asset management practices are applied.

194. Our review of transmission line projects has also led us to question the effectiveness of Powerlink's transmission line asset management program. Whilst it is out of scope of our review, the rate and extent of degradation of its tower assets *indicates* sub-optimal asset management strategies, practices, and past expenditure.

Implications for proposed expenditure

195. Powerlink has provided insufficient information for our assessment to either confirm or otherwise that project scope and timing is prudent.

196. From the information we have been provided, including the expenditure profile in the current RCP and the reasons provided for the variance, we consider Powerlink's expenditure and cost forecasting methodology is likely to result in over-forecasting the volume of work required and over-estimating the final cost in this asset category.

197. This finding is consistent with the approximately 20% difference between Powerlink's bottom-up forecast of transmission line refurbishment work ($340m) and the output of Powerlink's Repex Model ($280m).

6.7.2 Transformer replacement

198. In its Asset Management Plan,[81] Powerlink has identified seven transformer replacement projects to be completed in the next RCP, with an estimated total value of $68m. [82] All of the transformer projects are C-class (unapproved, directly included in the repex forecast) and all are included in the sample set Powerlink provided.

199. Powerlink has not provided the amount of expenditure on transformer replacement/ refurbishment in the previous RCP – it is included with substation replacements/rebuild category.

200. We reviewed the documentation provided for five of the seven projects provided. The documentation included Condition Assessment Reports (CAR) and, in the case of one project, a Risk Assessment spreadsheet.

201. Our assessment is summarised in Table 17.

Table 17: Summary assessment of sample transformer replacement projects

Project aspect	Summary of information provided by Powerlink
Business need/driver	The driver is identified as poor asset condition in each case
Scope	The scope of the selected approach is well defined in each case
Investment strategy	References to Powerlink's asset investment strategy is evident

[81] Powerlink, Asset Management Plan Vol 2, Table 3.1, NOTER: this is significantly more than the $50.3m nominated in the sample project list provided via the AER

[82] With expenditure greater than $5m

Project aspect	Summary of information provided by Powerlink
Condition assessment	The Condition Assessment Reports appear to provide adequate information (i) to confirm some action is required within the next RCP, and (ii) to form a basis for options analysis
Options analysis	Limited options analysis is provided in most cases although there is typically a discussion of one or two alternatives to the recommended approach in the Project Proposal Report or Area Plan. Issues we identified include: • In several cases, it would appear from the CAR that transformer refurbishment is a viable option, and yet in most cases there is no discussion of technical viability of life extension rather than replacement • In at least one case, replacing one transformer and refurbishing the other two seems to be a viable technical option based on the CAR; • Where replacement of transformers with larger units and/or higher total installed capacity is recommended, there is no justification presented[83]
Economic analysis	Little or no economic analysis is presented to support the selected option
Opex-capex trade-off (including non-network solutions)	Not explicitly considered
Cost estimate basis	Cost estimates appear to be preliminary in each case but as we assume Powerlink replaces and refurbishes transformers fairly regularly we assume it has a good basis of recent historical costs on which to base its estimates
Project delivery	The delivery strategy is typically provided in sufficient detail and comprises a mix of internal and external suppliers.
Interrelationship with other projects	Typically identified
Risk assessment	Deliverability risk is either not assessed or not convincingly addressed. However, we consider that the volume of transformer replacements is not likely to cause significant issues with deliverability. There is limited linkage to the corporate risk framework except for the Dysart project

Source: EMCa analysis

Other considerations

202. We note that with the proposed expenditure program, Powerlink predicts a slight increase in the number of transformers with a HI ≥ 5 over the course of the next RCP with its

[83] We note that this could be a standardisation strategy

proposed program of work.[84] This is an indicator that the proposed work is not excessive, but based on our analysis we consider that a similar outcome may be able to be achieved through application of life extension techniques in some cases rather than replacing transformers.

Implications for proposed expenditure

203. Powerlink has provided insufficient information for our assessment to either confirm or otherwise that the project scope and timing is prudent in each case. From the information we have been provided, we consider that it may be possible for Powerlink to prudently reduce the proposed transformer replacement expenditure by deferring transformer replacement by applying transformer refurbishment and more regular maintenance.

6.7.3 Substation renewal and primary plant replacement

204. In its Asset Management Plan,[85] Powerlink has identified nine substation/primary plant replacement projects to be completed in the next RCP, with an estimated total value of $136m.[86] Five of the projects are included in the sample project list (total = $105.2m) and all are B-class (unapproved, include in the repex forecast via the Powerlink repex model). Tables 18 - 19 and Figure 23 show the actual and forecast expenditure for substation primary plant.[87] Direct comparison between the bottom-up forecast and the top down forecast of $197.1m is imprecise due to the inclusion of transformer replacements in the latter, but the combined bottom-up expenditure forecast (i.e. including $68m attributed to transformer replacement project) is approximately $204m.

Table 18: Current RCP Substation primary plant actual/forecast repex (real $m 2016/17) – note includes transformer replacement expenditure

	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Substations Primary Plant	83.9	53.7	42.6	35.3	45.4	**260.9**

Source: Powerlink response PQ0129 to EMCa Information Request

Table 19: Next RCP Substation primary plant actual/forecast repex (real $m 2016/17) – note includes transformer replacement expenditure

	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Substations Primary Plant	44.9	46	38.9	35	32.3	**197.1**

Source: Powerlink response PQ0129 to EMCa Information Request

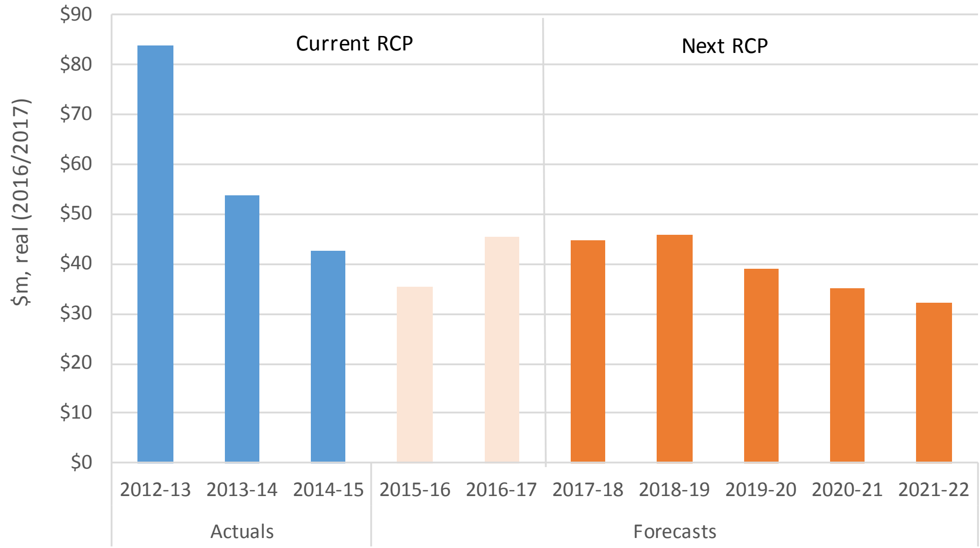
[84] Powerlink, response PQ0140 to EMCa Information Request

[85] Powerlink, Asset Management Plan Vol 2, Table 3.1

[86] With expenditure greater than $5m

[87] Which includes transformer replacement expenditure

Figure 23: Substation primary plant actual/forecast repex profile (real $m 2016/17) – note includes transformer replacement expenditure



Source: EMCa analysis of Powerlink's response PQ0129 to EMCa Information Request

205. We assessed three of the five projects provided. The documentation provided by Powerlink included a CAR for one of the projects. Project Proposal Reports were provided for all projects. No IOPs or Business Cases were provided.

206. Our assessment is summarised in Table 20.

Table 20: Summary assessment of sample substation rebuild and primary plant replacement projects

Project aspect	Summary of information provided by Powerlink
Business need/driver	Poor asset condition is the primary driver of the work, although in one case (Bouldercombe) the driver is not evident from either the Area Plan or the PPR
Scope	The scope of the selected approach is well defined in each PPR
Investment strategy	References to Powerlink's asset investment strategy is evident except in the case of Bouldercombe
Condition assessment	The single Condition Assessment Report appears to provide adequate information to (i) confirm some action is required within the next RCP, and (ii) form a basis for options analysis
Options analysis	Limited options analysis is provided in most cases although there is typically a discussion of one or two alternatives to the selected approach in the Project Proposal Report or Area Plan (but not for Bouldercombe). There is insufficient information provided to form an informed view of the prudency of the scope and timing of the proposed work
Economic analysis	Little or no economic analysis is presented to support the selected option

Opex-capex trade-off (including non-network solutions)	Not explicitly considered
Cost estimate basis	Cost estimates appear to be preliminary in each case, but we would expect Powerlink to have recent cost data from completed projects on which to base the forward estimates
Project delivery	Strategy is typically provided in sufficient detail and comprises a mix of internal and external suppliers.
Interrelationship with other projects	Typically identified
Risk assessment	Deliverability risk either not assessed or not convincingly addressed. However, we consider that the volume of work proposed is unlikely to cause significant deliverability issues. There is limited linkage to the corporate risk framework.

Source: EMCa analysis

Other considerations

207. We note that Powerlink advises that the weighted average age of substation switchgear equipment will increase from 12.8 years to 16.3 years from 2015 to 2022 with its assumed repex program.[88] This is an indicator that the proposed program is not likely to be excessive, but it is from a relatively young starting point. We consider on this basis that there could well be scope for a greater increase in average age without a significant impact on overall substation switchgear health, particularly if effective asset management practices are applied.

Implications for proposed expenditure

208. Powerlink has provided insufficient information for our assessment to either confirm or otherwise that project scope and timing is prudent. From the information we have been provided, we consider that it may be possible to prudently reduce the proposed expenditure by staged replacement rather than rebuilding in some cases.

6.7.4 Secondary systems renewal

209. In its Asset Management Plan,[89] Powerlink has identified 19 secondary systems renewal projects to be completed in the next RCP, with an estimated total 'bottom-up' value of $223m,[90] the second-largest expenditure category after transmission line refits/replacement. The historical and forecast expenditure is shown in Tables 21 - 22 and Figure 24. The 'bottom-up' expenditure forecast is less than the current RCP forecast ($292m), as is the top-down forecast of $238m.

[88] Powerlink, response PQ0140 to EMCa Information Request

[89] Powerlink, Asset Management Plan Vol 2, Table 3.1

[90] With expenditure greater than $5m; this is less than the output of the Repex Model (at $237.6m)

Table 21: Current RCP Secondary systems repex (real $m, 2016/17)

	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Substations Secondary Systems	48.8	68.7	68.2	51.6	54.6	**291.9**

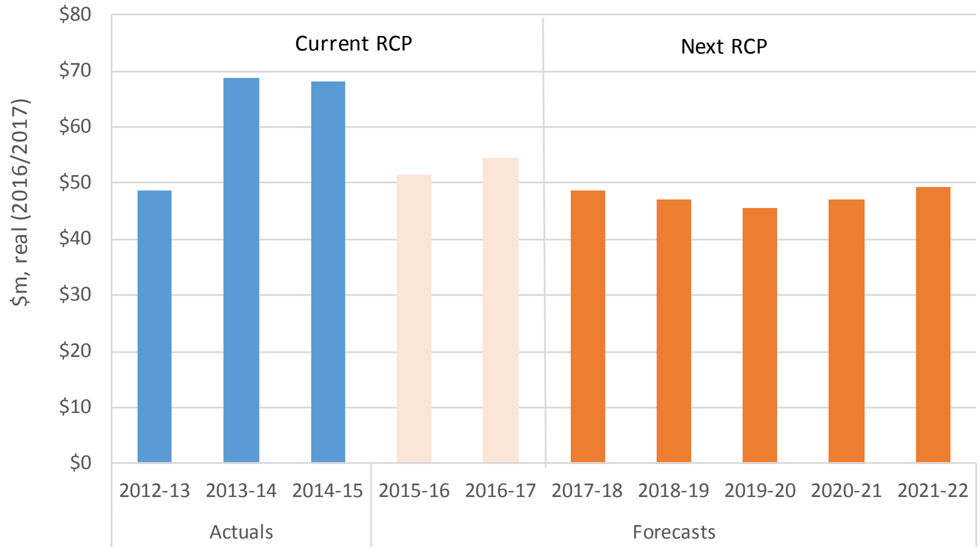
Source: Powerlink response PQ0129 to EMCa Information Request

Table 22: Next RCP Secondary systems forecast repex real $m, 2016/17)

	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Substations Secondary Systems	48.6	47.1	45.6	47	49.3	**237.6**

Source: Powerlink response PQ0129 to EMCa Information Request

Figure 24: Secondary systems actual and forecast repex (real, $m 2016/17)



Source: Powerlink response PQ0129 to EMCa Information Request

210. Powerlink included only two of the projects in the sample project list (total = $34.7m) and both are A-class (approved, directly included in the repex forecast).

211. We reviewed both projects. The documentation provided comprised an Investment Options Paper and a Business Case for both projects. Our assessment is summarised in Table 23.

Table 23: Summary assessment of sample secondary systems replacement projects

Project aspect	Summary of information provided by Powerlink
Business need/driver	Poor asset condition and/or obsolescence is the primary driver of the work in most cases reviewed
Scope	The scope of the selected approach is well defined in each case
Investment strategy	References to Powerlink's asset investment strategy is evident
Condition assessment	The condition and obsolescence assessment appear to provide adequate information to (i) confirm some action is required within the next RCP, and (ii) form a basis for options analysis
Options analysis	Comparison of credible options is presented

Economic analysis	Very basic NPV analysis is presented; the option with the lowest NPV is selected in one case but not the other (in the latter, the technical benefits are deemed to outweigh the minor NPV savings)
Opex-capex trade-off (including non-network solutions)	Opex-capex trade-off considered in qualitative terms
Cost estimate basis	Cost estimates appear to be based on historical costs. As Powerlink has undertaken a significant volume of work in the last few years, we consider that if the database has been updated, the cost estimates are likely to be reasonable
Project delivery	Strategy is typically provided in sufficient detail and comprises a mix of internal and external suppliers.
Interrelationship with other projects	Identified
Risk assessment	Powerlink's risk assessment points to selection of either the staged replacement or full replacement option, but there is insufficient information in the document provided to determine that Powerlink has selected the best approach. Deliverability risk is either not assessed or not convincingly addressed. Given the expenditure in this category is 20% less than forecast for the current RCP, delivery risk should be able to be satisfactorily managed.

Source: EMCa analysis

Other considerations

212. We note that Powerlink advises that the weighted average age of secondary systems *and* telecommunications systems will increase from 9.6 years to 12.1 years from 2015 to 2022 with its assumed program.[91] This is an indicator that the secondary systems proposed program is not likely to be excessive, but it is from a relatively low starting point. We consider on this basis that there could well be scope for a greater increase in average age without a significant impact on overall secondary system performance.

Implications for proposed expenditure

213. Powerlink has provided sufficient information for us to conclude that the proposed scope and timing is likely to be prudent and efficient for the two projects assessed. However, this category is not a statistically valid sample. We note that the top-down forecast is approximately 5% higher than the bottom-up forecast.

6.7.5 Communications and other operational technology

214. In its Asset Management Plan,[92] Powerlink has identified four communications-related projects and one OT project[93] with total forecast expenditure of $99m. Powerlink included three of the four communications projects in the sample selection and advised the status of

[91] Powerlink, response PQ0140 to EMCa Information Request; from the AMP, we consider that the secondary systems age dominates the combined result;

[92] Powerlink, Asset Management Plan Vol 2, Table 3.1

[93] EMS Replacement, $20.1m

each was B-class. The OT project is unapproved and directly contributes to the repex forecast i.e. C-class).

215. As shown in Tables 24 - 25 and Figure 25, the proposed 'hybrid' expenditure forecast is $54.3m, which is similar to the current RCP forecast repex ($56.8m) but significantly less than the 'bottom up' forecast of $99m.

Table 24: Current RCP Communications and Operational technology actual/forecast repex (real $m, 2016/17)

	actual			forecast		Total RCP
	2012-13	2013-14	2014-15	2015-16	2016-17	
Communications and Other Assets	11	12.9	7.8	10.1	15	**56.8**

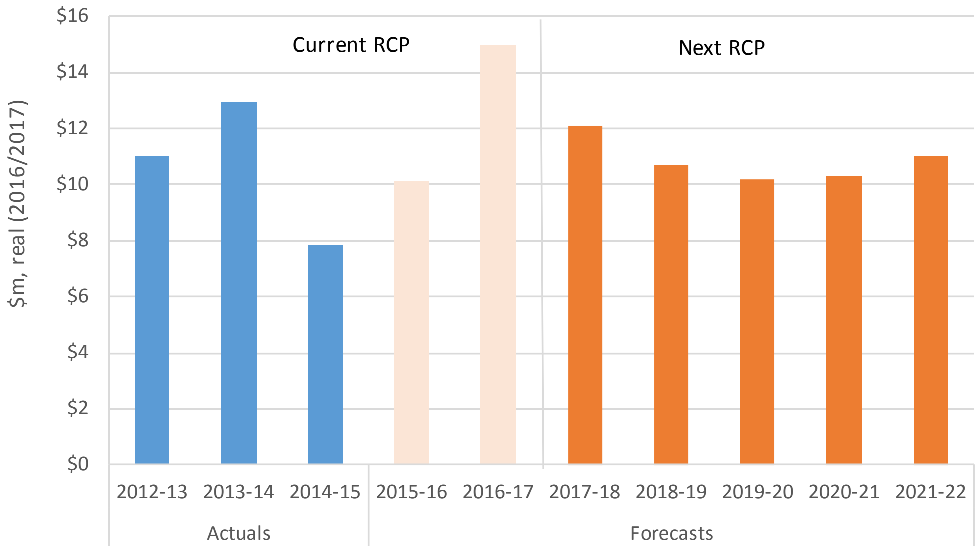
Source: Powerlink response PQ0129 to EMCa Information Request

Table 25: Next RCP Communications and Operational technology forecast repex (real $m, 2016/17)

	forecast					Total RCP
	2017-18	2018-19	2019-20	2020-21	2021-22	
Communications and Other Assets	12.1	10.7	10.2	10.3	11	**54.3**

Source: Powerlink response PQ0129 to EMCa Information Request

Figure 25: Communications & OT actual/forecast repex profile (real $m, 2016/17)



Source: Powerlink response PQ0129 to EMCa Information Request

216. We have reviewed all four projects. The documentation provided for the communications systems projects comprises Project Proposal Reports only. Powerlink provided a consultant report in support of the EMS Replacement project. Our assessment of the communications projects is summarised in Table 26.

Table 26: Summary assessment of sample communications replacement projects

Project aspect	Summary of information provided by Powerlink
Business need/driver	The WAN project is a continuation of a project commenced in 2012 to implement a MPLS network at all Powerlink sites Age, condition and obsolescence is the driver for all three projects

Scope	The scope of the selected approach is well defined in each case
Investment strategy	Powerlink's strategy of replacing (and upgrading where appropriate) when existing equipment is obsolete is consistent with industry practice
Condition assessment	No condition assessment information was provided, however given the age and technology of the plant, reliability and obsolescence risk is to be expected
Options analysis	The information provided did not consider alternatives
Economic analysis	No economic analysis of options is included in the information provided
Opex-capex trade-off (including non-network solutions)	Not apparent
Cost estimate basis	Cost estimates appear to be based on historical costs in the case of the WAN project, which should lead to reasonable cost estimates The basis for the costing in the other projects is uncertain The DWDM project includes a $11m asset write-off charge for the current system which is obviously a large amount even in the context of a $35m project. There is insufficient information in the documents provided to assess whether Powerlink made the appropriate decision 15-20 years ago and needs to replace the existing system prematurely as a result.
Project delivery	The delivery strategy is typically provided in sufficient detail and comprises a mix of internal and external suppliers
Interrelationship with other projects	Identified where relevant
Risk assessment	A brief description of operational risk is provided. Deliverability risk is either not assessed or not convincingly addressed. However, we consider that the volume of work proposed is unlikely to cause significant issues.

Source: EMCa analysis

Other considerations

217. In the Hunter H20 report provided for the EMS replacement project, there is a reasonable assessment of the need and a brief options analysis. The major issue is with the approach taken to estimate the cost of the project, which includes $8m for Powerlink labour. Unless these resources need to be back-filled, this appears to be a conservative approach. The preliminary cost estimates from potential vendors are *significantly* less than the Powerlink estimate – possibly because they do not include assumed Powerlink staff costs.

Implications for proposed expenditure

218. For the three communications projects, Powerlink has provided sufficient information to confirm that remedial work is likely to be required within the next RCP. However, with the exception of the ongoing WAN replacement project, Powerlink has not provided sufficient evidence that the forecast cost for the other projects is likely to be representative of an efficient level.

6.8 Summary

219. It would appear that Powerlink has not followed its designated capital approvals process for a significant number of the 25 sample projects it nominated for our review. Of the 25 projects, it provided Investment Options Papers and Business Cases for only three projects and Condition Assessment Reports for nine projects. We expected from its process, from the individual project lifecycles, and from the Project Proposal Reports provided,[94] that more comprehensive documentation would be available.

220. The lack of supporting documentation has made meaningful assessment of the sample projects challenging. From the information provided (including Area Plans), we consider that:

- Powerlink has identified projects with expenditure drivers that in each case provide a compelling case for some form of remedial expenditure within the next RCP to address the condition/obsolescence issues;
- Powerlink has, in the main, not provided sufficient evidence that the option selected (scope and timing) is prudent;
- Powerlink has, in the main, not provided sufficient evidence that the cost estimate for the work is likely to be representative of the efficient cost; and
- Deliverability of the projects is unlikely to be an issue for any of the repex categories of work.

221. We note that Powerlink's aggregate bottom-up expenditure forecast for the next RCP, as represented in AMP Vol 2, exceeds the forecast expenditure derived from the hybrid forecasting model by approximately 20%. This is consistent with our findings from the assessment of the sample projects and our expectations given that Powerlink has advised that the bottom-up forecast has not been subject to a rigorous 'top-down challenge' but the focus has instead been on calibrating the hybrid forecasting model output. However, the fact that its un-challenged bottom up forecast exceeds the forecast produced by Powerlink's hybrid repex model in no way validates the output from that model.

[94] Which typically refer to CARs, IOPs and Concept Estimation Reports

Appendix A Sample project list, classifications and subset of reviewed projects

Figure 26: Characteristics of Sample Projects provided by Powerlink

Program Name	Cost estimate (real ($206/17)	Proposed sample project	Proposed project completion date	Supporting information provided by Powerlink	STATUS
Substation renewal					
Gin Gin Substation Rebuild	27.7	27.7	2019	PP + CA	B
Kamerunga Substation Rebuild	25.2	25.2	2019	PP	**B**
Ashgrove West Substation Rebuild	13.4		2019	PP + RS	B
Dysart Substation Rebuild	12.1		2019	PP + CA	B
Bouldercombe Primary Plant Replacement	26.8	26.8	2019	PP	B
Secondary systems renewal					
Calvale & Callide B Secondary Systems Replacement	20.5	20.5	2018	FULL	A
Mudgeeraba 110kV Primary and Secondary Systems Replacement	14.2	14.2	2017	FULL	A
Communications & systems					
PDH Mux Replacement	39.2	39.2	2019	PP	B
DWDM Replacement	35.2	35.2	2020	PP	B
Wide Area Network Deployment Stage 2	10.8	10.8	2018	PP	B
EMS Replacement	20.1	20.1	2020?	H2O	C
Transformer replacement					
Dysart Transformer Replacement	10.2	10.2	2019	PP + CA + RS	C
Lilyvale Transformer Replacement	9.7	9.7	2020	PP + CA	C
Ingham South No 1 & 2 Transformer Replacement	7.4	7.1	2019	PP + CA	C
Bouldercombe Transformer 1 & 2 Replacement	7.3	7.3	2022	PP + CA	C
Garbutt Transformer Replacement	6.9	6.9	2018	PP + CA	C
Blackwater Transformer 1 & 2 Replacement	5.3		2022	PP + CA	C
Kemmis No. 2 Transformer Replacement	3.5		2019	PP + CA	C
Transmission lines					
Greenbank to Mudgeeraba 275kV TL Refit	72.2	72.2	2019	PP + RS	B
Clare South - Strathmore - Collinsville Transmission Line Refit	57.1	57.1	2021	PP	B
Biloela to T027 Moura 132kV Transmission Line Replacement	46.5	46.5	2021	PP	B
Bergins Hill to Goodna to Belmont 275kV TL Refit	37.7	37.7	2021	PP	B
Collinsville Proserpine Inland Section Transmission Line Refit	30.9	30.9	2018	BC	A
Callide A to Biloela 132kV Transmission Line Replacement	24.4		2021	PP	B
Karana Downs to South Pine TL Refit	19.3		2020	PP	B
	583.6	**505.4**			

Legend
PP = Project proposal
CA = Condition assessment
IOP = Investment options paper
RS = Risk sheet
Full = BC + IOP
BC = Investment & Planning Business Case
H2O = report by Hunter H2O

Category	Description	Supporting information provided with Revenue Proposal
A	Committed/approved, directly contributes to forecast reinvestment	Investment Options Paper, Business Case, Approval Memo
B	Future/sample, within Repex Model Forecast, does not directly contribute to forecast reinvestment	Project Proposal
C	Future/bottom up, directly contributes to forecast reinvestment	Consultant reports, Planning Statements, Condition Assessments, Project Proposals

Source: Sample project list provided by AER to EMCa; Project classifications provided by Powerlink