Powerlink Revenue Determination: Technical Review

Forecast Capital Expenditure Advice on Powerlink's Revised Revenue Proposal

Report to

Australian Energy Regulator

Public Version

Energy Market Consulting associates
Strata Energy Consulting

FINAL 18th April 2012

[NOTE: This report is based on Powerlink's capex forecast as proposed in its Revised Revenue Proposal. It is understood that subsequent to the date of this report, Powerlink has agreed to provide an updated capex forecast based on demand and other assumptions provided by AER.]

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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 access and regulatory arrangements. Its Director, Paul Sell, is an energy economist and previous Partner in Ernst & Young and Vice President of Cap Gemini Ernst & Young (now Capgemini). Paul has advised on the establishment and operation of energy markets and on matters such as electricity network open access, pricing and regulation and forecasts for over 30 years.

About Strata

Strata Energy Consulting Limited specialises in providing services relating to the energy industry and energy utilisation. The Company, which was established in 2003, provides advice to clients through its own resources and through a network of Associate organisations. Strata Energy Consulting has completed work on a wide range of topics for clients in the energy sector both in New Zealand and overseas.

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Date:	18/04/2012 12:25 p.m.
Version:	V7.0 FINAL
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1 Introduction

1.1 Background

1. This report provides an updated alternative capex forecast for consideration by the AER in making its final decision on Powerlink's Revised Revenue Proposal for 2012/13 to 2016/17. The revised alternative capex forecast in this report responds to the capex forecast in Powerlink's Revised Revenue Proposal (RRP), which was provided to AER on 16th January 2012. The revised alternative capex forecast supersedes the alternative forecast provided by Energy Market Consulting associates (EMCa) in its 2011 report[1], and which was based on Powerlink's initial revenue proposal.

2. The revised alternative capex forecast is derived by making specific adjustments to the capex forecast that Powerlink proposed in its RRP. This report describes the basis for those adjustments, some of which are based on advice from EMCa to the AER while other adjustments have been made based on specific requests from the AER following its own analysis.

1.2 Scope

3. This report is provided in response to the following primary request from the AER:

> *"Based on inputs to be provided by AER staff and the outcomes of EMCa's alternative demand forecast, produce an alternative capex forecast and provide capex models to the AER. In addition, incorporate AER escalators into alternative capex forecasts.*

4. Subsequent to this scope request, EMCa was asked to provide specific advice on the 500kV-capable projects proposed by Powerlink and to provide advice on allowances for

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[1] *Forecast Capital Expenditure and Service Targets; Report to the Australian Energy Regulator* (EMCa in association with Strata Energy Consulting, 6th September 2011)

efficiency. EMCa reported to the AER on each of these matters and the AER asked EMCa to make adjustments to the capex forecast consistent with this advice. EMCa's advice on these matters is included as annexures to the current report.

5. EMCa, in conjunction with NZIER, was engaged to advise on Powerlink's revised demand forecast and as part of this advice EMCa proposed a revised alternative demand forecast. The revised alternative capex forecast in the current report takes account of this revised alternative demand forecast. EMCa/NZIER's demand forecast report is provided separately[2].

6. For clarity of scope, we note that the AER did not ask EMCa to review Powerlink's Revised Revenue Proposal except with regards to the specific matters described above. The AER also did not ask EMCa to update our 2011 Technical Review, which was a review of Powerlink's initial revenue proposal. While we observe that many of the matters raised in that review remain relevant, the current report should not be read as a comprehensive review of or response to Powerlink's RRP, nor as an update to our 2011 review except in regards to matters specifically within the scope of the currently requested advice.

1.3 Structure of this report

7. Section 2 of this report presents the revised alternative demand forecast, while section 3 describes the specific adjustments that were made in calculating this revised forecast.

8. In annexures, we provide our advice on matters relating to Powerlink's proposed 500kV projects (Annex A) and on allowances for efficiency (Annex B), together with summary resumes for the authors of this report (Annex C).

9. Some confidential information is provided in a separate confidential annex (Annex D).

[2] *Review of Revised Demand Forecast; Report to the Australian Energy Regulator* (EMCa in association with NZIER, 18th April 2012)

2 The revised alternative capex forecast

2.1 Introduction

10. The following tables and associated graph summarise the revised alternative capex forecast, showing the specific adjustments made to Powerlink's RRP capex forecast, the associated capex expenditure breakdown and time-profile. The revised forecast is based on Powerlink's revised capex forecast, with specific adjustments to account for:

- lower projected demand;
- exclusion of the proposed 500kV-capable uncommitted projects;
- de-rating of the Halys-Blackwall 500kV-capable line to 275kV equivalent cost;
- re-weighting of uncommitted capex scenarios to include only those based on lower carbon reduction;
- allowance for efficiency;
- allowance for different cost escalation factors.

11. The tables and graph in this section update similar ones in our 2011 report, and we have placed cross references in brackets to facilitate comparison.

2.2 Total adjusted capex

12. Table 1 and figure 1 show the revised capex as proposed by Powerlink[3], and the revised alternative capex that we propose following adjustment.

Table 1: Summary of Capex Adjustments - Year by Year (previous report table 17)

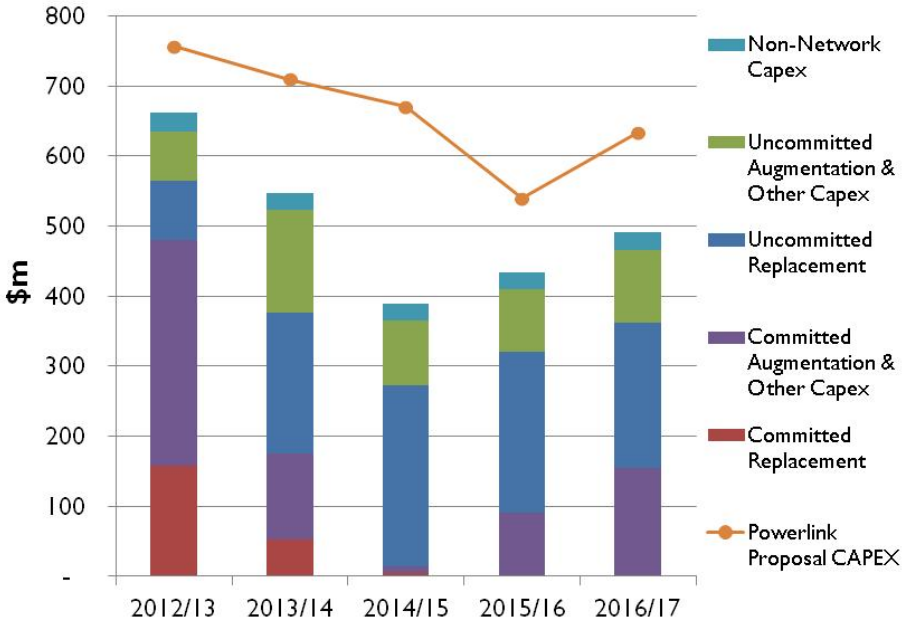
$million (real 2011/12)

	Uncommitted Network	Committed Network	Non-Network	Total Capex
2012/13				
Powerlink Forecast	204	526	27	757
Adjustment	- 51	- 45	-	- 96
Adjusted Capex	**153**	**481**	**27**	**661**
2013/14				
Powerlink Forecast	431	255	24	710
Adjustment	- 109	- 52	- 0	- 161
Adjusted Capex	**322**	**204**	**23**	**549**
2014/15				
Powerlink Forecast	413	232	25	670
Adjustment	- 78	- 170	- 1	- 248
Adjusted Capex	**335**	**62**	**25**	**422**
2015/16				
Powerlink Forecast	467	49	24	540
Adjustment	- 132	93	- 0	- 39
Adjusted Capex	**336**	**142**	**23**	**501**
2016/17				
Powerlink Forecast	606	3	25	634
Adjustment	- 315	24	- 1	- 292
Adjusted Capex	**291**	**27**	**25**	**343**
Total RCP				
Powerlink Forecast	**2,122**	**1,065**	**126**	**3,312**
Adjustment	- 684	- 150	- 2	- 835
Adjusted Capex	**1,438**	**915**	**124**	**2,477**
Less Disposals				4
Total Adjusted Capex				**2,472**

Source: EMCa/Strata

[3] There were some minor discrepancies between information provided in Powerlink's RRP document and some supporting information provided by Powerlink. EMCa requested further information from Powerlink and the Powerlink forecast shown in table 1 takes account of some minor reconciliation adjustments based on this information.

Figure 1: Alternative Capex Proposal – Comparison with Powerlink's RRP Capex Proposal (previous report figure 14)



Source: EMCa/Strata

2.3 Specific adjustments

2.3.1 Adjustments if made independently

13. Table 2 shows each of the adjustments, if each was made individually (i.e. in the absence of any of the other adjustments). For clarity, we have shown separately the impact of removing the uncommitted and committed 500kV projects from the capex forecast and (further to our 2011 report) we have also separately shown the impact of applying the revised escalators.

Table 2: Alternative Capex Proposal - Impact of Individual Adjustments (previous report table 1/table 15)

$million (real 2011/12)

	Adjustment
Demand Forecast Reduction	- 451
"500kV" Uncommitted Project Adjustment	- 411
"500kV" Committed Project Adjustment	- 143
Carbon Reduction Target 5%	- 17
Efficiency	- 44
Revised Escalators	- 112

Note the overall adjustment is not cumulative because these adjustments are interdependent

Source: EMCa/Strata

2.3.2 Incremental adjustments

14. The impact of the aggregate calculation of the proposed adjustments is less than the sum of applying the specific adjustments independently[4]. In particular, there is a significant interaction between the demand forecast reduction and the exclusion of the uncommitted 500kV-capable projects, since the majority of the uncommitted 500kV expenditure is deferred in any case under the alternative demand scenario (which is equivalent to Powerlink's low demand scenario).

15. We have taken these interactions into account in our calculation of the aggregate revised alternative capex forecast and the resulting Adjusted Capex shown below results from the cumulative effect of applying all of the listed adjustments.

Table 3: Incremental Adjustments to Total Capex (previous report table 2)

$million (real 2011/12)

	Incremental Adjustment	Cumulative Aggregate Adjustment	Adjusted Total Capex
Powerlink Forecast Capex			**3,312**
Demand Forecast Reduction	- 451	- 451	- 451
"500kV" Uncommitted Project Adjustment	- 105	- 556	- 556
"500kV" Committed Project Adjustment	- 143	- 699	- 699
Carbon Reduction Target 5%	- 23	- 723	- 723
Efficiency	- 33	- 755	- 755
Revised Escalators	- 80	- 835	- 835
Adjusted Capex		**- 835**	**2,477**
Less Disposals			- 4
Total net of Disposals			**2,472**

Source: EMCa/Strata

[4] For further explanation, refer to paragraph 341 of our 2011 report. It should be noted that the adjustments can be made in any order without affecting the overall adjusted capex; the order shown in table 3 reflects only a presentational choice.

3 Adjustments made in determining revised forecast

3.1 Demand

3.1.1 Demand forecast advice

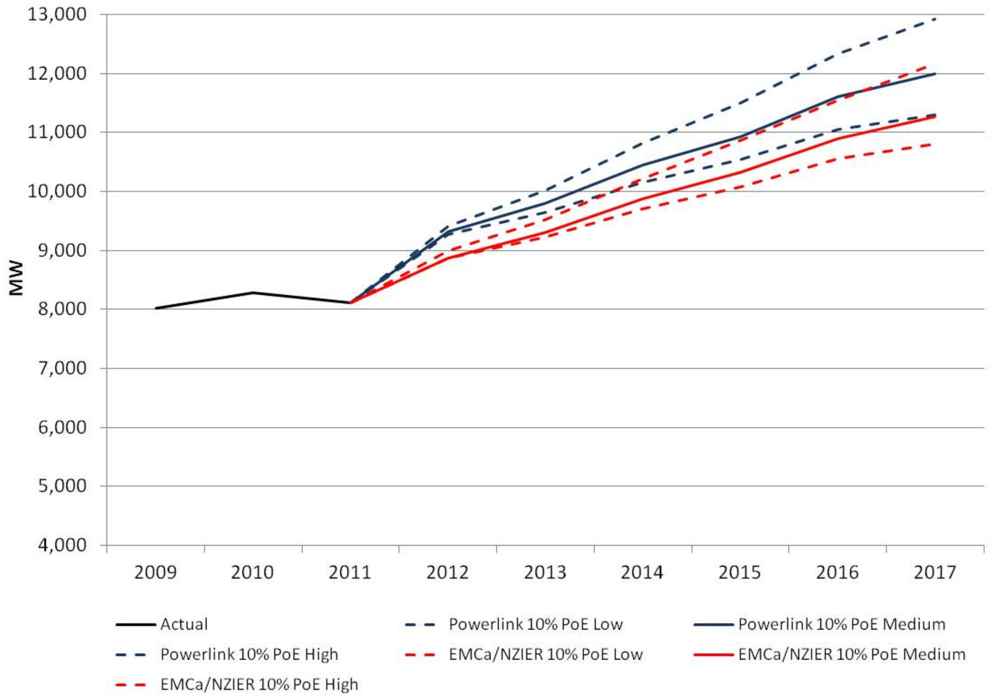
16. Our advice as to a revised alternative demand forecast is provided in a separate report[5]. While that advice focuses on the medium demand forecast, we have indicatively provided a low / high range around this forecast and, using the same factors as Powerlink, a 10% PoE equivalent low and high forecast. Figure 2 illustrates the revised alternative demand forecast that is relevant to augmentation capex requirements and compares it with Powerlink's RRP demand forecast[6].

17. EMCa/NZIER's medium demand forecast is less than Powerlink's low forecast over the RCP until the final year when it is effectively the same as Powerlink's low demand forecast. EMCa/NZIER's high demand forecast is below Powerlink's medium demand forecast until the final year of the RCP, when it is just above Powerlink's medium demand forecast.

[5] Ibid

[6] The 10% PoE forecast is the forecast used by Powerlink for capex planning purposes. EMCa has accepted that this is a reasonable basis.

Figure 2: Comparison of Powerlink and EMCa/NZIER demand forecasts (at 10% PoE)



Source: EMCa/NZIER

3.1.2 Adjusting forecast capex for lower demand forecast

18. We have considered how Powerlink's capex forecast should be adjusted to reflect the lower demand forecast. As proposed by Powerlink, the demand forecast affects the timing of uncommitted projects, through Powerlink's probabilistic planning model.

19. First, we considered the need to use scenarios involving low and high (alternative) demand forecasts in determining the revised alternative capex forecast. We analysed outputs from Powerlink's probabilistic planning model, examining subsets of the outputs from this model for the low, medium and high demand scenarios respectively and re-weighting the scenarios such that the relative weights within each subset remained as per Powerlink's model.

20. The results of this analysis are in tables 4 and 5. As we found in 2011, the capex budget from the medium demand scenarios was very close to the capex budget that Powerlink had derived from a probability-weighted calculation involving all twenty scenarios (comprising low, medium and high demands along with other variants). For example, for the non-500kV projects we found that considering the medium demand scenarios alone leads to a forecast capex that is $5m higher than the result from considering all twenty scenarios, this difference being 0.3% of uncommitted capex and 0.2% of all capex. For all projects (i.e. including the 500kV projects) Powerlink's medium demand forecast leads to a $12m lower forecast than considering all twenty scenarios.

Table 4: Powerlink probabilistic planning model – analysis of demand scenarios for uncommitted capex

	Uncommitted Capex	Difference (cf. all scenarios)	
All (20) scenarios	**2,122**		
High demand scenarios only	2,789	31.4%	667
Medium demand scenarios only	2,110	-0.6% -	12
Low demand scenarios only	1,692	-20.3% -	430

Source: EMCa analysis using Powerlink CAM model

Table 5: Powerlink probabilistic planning model – analysis of demand scenarios for uncommitted capex (excluding 500kV projects)

	Uncommitted Capex	Difference (cf. all scenarios)	
All (20) scenarios	**1,711**		
High demand scenarios only	1,973	15.3%	262
Medium demand scenarios only	1,716	0.3%	5
Low demand scenarios only	1,586	-7.3% -	125

Source: EMCa analysis using Powerlink CAM model

21. On this basis we consider that a suitable alternative capex forecast can be obtained by focusing on the EMCa/NZIER medium demand forecast by comparison with Powerlink's demand forecasts, and no material accuracy would be gained by attempting to produce low and high demand capex scenarios and weight them. We note that Powerlink ascribes an 80% weighting to its medium scenario.

22. Since the EMCa/NZIER medium demand forecast is below the Powerlink low demand forecast until the final year of the RCP, we then considered whether an alternative capex forecast should be below the Powerlink RRP low demand forecast capex.

23. We noted that capex in the earlier years has a higher proportion of committed expenditure, which in Powerlink's modelling is not sensitive to demand. In considering the impact on uncommitted capex, EMCa/NZIER's medium demand forecast is equivalent to Powerlink's low demand forecast by the end of the RCP, suggesting that the overall capex in the RCP should also be equivalent and that any reduction relative to Powerlink's low capex forecast in the early years would need to be made up in the later years of the RCP; that is, it would be only a deferral, within the RCP.

24. There would be limited ability to delay projects in the early years, relative to projects in later years of the RCP. Also, as a pragmatic matter, we had a detailed project-based Powerlink capex forecast that aligned with its low demand forecast; we did not have an equivalent capex forecast for a demand forecast below this level.

3.1.3 Conclusion on demand forecast adjustment

25. Taking account of these factors, we have therefore estimated a revised alternative capex forecast by using the capex forecast that Powerlink provided in its RRP for an equivalent level of demand by the end of the RCP; that is, based on Powerlink's low demand forecast.

3.2 Uncommitted 500kV–capable projects

26. Powerlink has proposed that expenditure on two uncommitted 500kV-capable augmentation projects should be included in the RCP. As per Powerlink's probabilistic planning model, these projects are included in certain scenarios, with weighted probabilities and different commissioning dates according to the scenario.

27. Powerlink proposes expenditure on a Halys – Greenbank line, with varying commissioning dates, under its high and medium scenarios. No expenditure is proposed under a low demand scenario.

28. Powerlink proposes expenditure on a Halys – Western Downs first 500kV-capable line (3rd and 4th circuits), with varying commissioning dates, under its high and medium demand scenarios. With a low demand scenario combined with aggressive LNG development and low carbon reductions, Powerlink proposes this line for commissioning in October 2016 and, under a medium carbon reduction scenario, in October 2015. With low demand and without aggressive LNG development, Powerlink does not include this line within the RCP.

29. An amount of $105m, comprising a probability-weighted proportion of this expenditure, is included in Powerlink's capex forecast under low demand scenarios.

30. In advice contained in Annex A, we have recommended that each of these uncommitted projects is excluded from the forecast capex, but that they could be included as contingent projects. We observe that if any of these lines is required within the RCP, its inclusion in the forecast capex (on a probabilistic basis) would be insufficient to cover Powerlink's costs within the RCP. On the other hand, if the lines were not required, Powerlink would be materially over-compensated by revenues earned within the RCP.

31. In accordance with our advice in Annex A, the revised alternative capex forecast therefore excludes the two 500kV-capable proposed uncommitted augmentations.

3.3 Committed 500kV–capable project (Halys – Blackwall)

32. In our advice in Annex A, we recommended that the AER reject inclusion of the Halys-Blackwall line as proposed by Powerlink as a 500kV-capable line. We recommended that the AER consider either including an equivalent 275kV line cost (with the incremental cost treated as contingent and a deferred commissioning date reflecting the lower demand forecast) or that it should not include any of the proposed expenditure in the forecast capex, but consider the whole project as a contingent project. The AER has advised that it wishes to include this line in the forecast capex at an equivalent 275kV cost and we have calculated the forecast capex on this basis.

3.4 Carbon reduction assumption

33. The AER has advised that it wishes to consider only the low carbon scenarios proposed by Powerlink. Powerlink's RRP includes nine such scenarios, two of which also have low demand.

34. To calculate this adjustment, we re-weighted the scenarios proposed by Powerlink such that the relative weightings for the subset of low carbon reduction scenarios being considered remained the same.

3.5 Efficiency

35. EMCa provided further advice to the AER with regards to allowance for efficiency in Powerlink's capex budget. This advice is contained in annex B.

36. The AER has advised that it wishes to retain this allowance, as per its Draft Decision, in the revised alternative capex forecast.

3.6 Revised escalators

37. In its uncommitted project budgeting model, Powerlink uses a set of cost escalators which vary according to different materials (e.g. steel, copper, labour), to produce nominal dollar forecasts from real dollar cost inputs ($2010 base).

38. The AER has advised an alternative set of cost escalators for the revised alternative forecast. We have applied these cost escalators directly in Powerlink's uncommitted project budgeting model.

3.7 Replacement capex smoothing

39. Compared with its initial RP, Powerlink's RRP proposed expenditure on replacement capex is relatively similar year-on-year. EMCa considers this reasonable and has not applied any "smoothing" adjustment to this expenditure.

Glossary

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
DNSP	Distribution Network Service Provider
EMCa	Energy Market Consulting associates
IDM	IDM Partners
NER	National Electricity Rules
NPV	Net Present Value
NZIER	NZIER Consulting
RCP	Regulatory Control Period
RIT-T	Regulatory Investment Test for Transmission
RRP	Revised Revenue Proposal
RP	Revenue Proposal
ROAM	ROAM Consulting
SEQ	South East Queensland
SWQ	South West Queensland
Strata	Strata Energy Consulting
NEM	National Electricity Market

A. Annexures

Annexure A: Treatment of proposed expenditure on 500kV-capable projects

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A.1 Introduction and background to consideration of 500kV-capable projects

A.1.1 Purpose and scope of this review

Background to this review

40. Powerlink provided its Revenue Proposal (RP) for the period 2013-17 to the AER on 31 May 2011[1]. The RP included four projects initially operated at 275kV but constructed for future operation at 500kV[2] .

Table A.1: *500kV projects proposed by Powerlink in its initial Revenue Proposal*

Project No	Project Name
CP01875	Halys - Blackwall 500kV Operating at 275kV
CP01477.2	Western Downs - Halys 3rd-4th 500kV Operating at 275kV
CP01470	Halys to Greenbank 500kV DCST operating at 275kV
CP02477.3	Western Downs - Halys 5th-6th 500kV Operating at 275kV

Source: Powerlink

41. EMCa reviewed these projects and provided advice to the AER in its Technical Review report in September 2011[3]. The AER incorporated this advice in its draft decision.

42. Following the publication of the AER's draft decision Powerlink has submitted a Revised Revenue Proposal (RRP). The first three of the above projects are included in the RRP, with some changes to the assumed commissioning dates.

43. The AER has engaged EMCa and Strata Energy Consulting (Strata) as a Technical Consultant to review and provide advice on specific aspects of Powerlink's RRP relating to the 500kV-capable projects.

What the AER has asked EMCa to review

44. AER has asked EMCa to

i. test the requirement for, and reasonableness of, Powerlink's proposed expenditure relating to the four proposed projects constructed at 500kV capability; and

[1] 2013-17 Powerlink Queensland Revenue Proposal (to AER), and including associated supporting information

[2] While recognising that they may not be operated at 500kV for a number of years, for simplicity, we will refer to these projects as the 500kV projects

[3] Technical Review: *Forecast capital expenditure and service targets*, Report to AER, 6th September 2011

ii. focus specifically on those projects that have expenditure falling within the next RCP.

45. The AER did not require EMCa to provide more general advice on the RRP or to respond to matters raised by Powerlink in its RRP, nor to provide further advice on matters that EMCa covered in its first report.

A.1.2 Background information

Relevant aspects of Powerlink's Initial Revenue Proposal

46. In our 2011 Technical Review report, EMCa set out its view that the four 275kV (500kV-capable) augmentation projects had not been assessed appropriately by Powerlink in accordance with its capital governance framework and/or the requirements of the NER. EMCa took this view because:

a. *"Powerlink had not, in EMCa's opinion provided (and appeared not to have undertaken) a study which demonstrates any limitation in continuing to augment its 275kV system;*

b. *The proposed 500kV capability would not be required within the next RCP;*

c. *The strategic implications of a "move to 500kV" have not been articulated in accordance with the level of capital governance that would be expected of a proposed program of such significance and with implications for future expenditure that are well in excess of the projects proposed thus far;*

d. *Rigorous and pro-active evaluation of non-transmission options that may obviate the eventual need for 500kV, has not been undertaken; and*

e. *The supporting documentation provided by Powerlink suggested that the costs of 500kV-capable construction are uncertain; and that cost uncertainty and associated risks have not been sufficiently articulated in accordance with good capital governance."*

47. EMCa concluded that, based on the information it had sighted and reviewed, Powerlink had not;

> *"justified the need for the considerable incremental spend that would provide "500 kV capability" for a notional future upgrade that Powerlink estimates may be required by around 2023 and which we would expect would be further deferred by lower demand forecasts. We propose accepting capex for these projects consistent with the proposed 275kV operational voltage and disallowing the proposed incremental spend to provide future 500kV capability."*

Relevant aspects of the AER's draft decision

48. The AER's draft decision on Powerlink's initial revenue proposal was to amend the capex budget as follows:

a. Defer CP 01875 (Halys – Blackwall) by 1 year to 2015;

b. Disallow CP 02477.3 (Western Downs – Halys 5th and 6th) and CP 01470 (Halys – Greenbank) because under the AER's revised demand forecast, both would be delayed such that no expenditure would be required within the RCP;

c. De-rate CP 01875 (Halys - Blackwall) and CP 01477.2 (Western Downs – Halys 3rd and 4th) to 275kV construction.

49. The following adjustments to the 500kV project expenditure resulted from the AER's draft decision.

Table A.2: *AER draft decision adjustments to capex*

$million (real 2011/12)

	Total
Powerlink "500 kV" Project Forecast (Weighted) Capex	931
Less Easements	52
Forecast construction Capex during RCP	**879**
Less	
Disallow CP01470 Halys to Greenbank & CP02477.3 Western Downs to Halys	234
500/275kV Cost adjustment calculated in CAM for Uncommitted CP01477.2	141
500/275kV Cost adjustment for Committed CP01875	174
Total Reduction on Construction Costs	**549**
Residual Construction Capex on '500'kV Projects	330
Total Adjusted capex including Easements	**383**

Source: AER (from EMCa TR report, 6 September 2011)

Relevant aspects of Powerlink's Revised Revenue Proposal

500kV project costs

50. Powerlink's RRP, submitted to the AER, includes a prescribed transmission services capex forecast of $3,319million (real $2011) for the 5 years of the next RCP. In the RRP Powerlink state that:

" in comparison to the current regulatory period, the next regulatory period:

- *continues to have high demand growth, growing from an even higher base;*
- *has a similar ongoing need to replace assets;*
- *includes extending the transmission network into the Surat Basin; and*
- *establishes a 500kV transmission network into South East Queensland."*

51. The RRP includes three of the previously-proposed four projects. Powerlink states in its RRP that the commissioning dates for the two uncommitted projects are outside of the RCP. Analysis of the RRP indicates that, while some commissioning dates have been pushed back, there is nevertheless significant expenditure on these projects assumed with the RCP[4]. Movements in commissioning dates and RCP forecast expenditure between the RP and RRP are shown in the following table.

[4] Under Powerlink's probabilistic planning model, the expenditure shown in the RRP results from weighting the expenditures for 20 scenarios, with different project timings.

Table A.3: *Movements between RP and RRP*

Project	Status	Commissioning date[5]		Expenditure in RCP[6] ($000)	
		RP	RRP	RP	RRP
CP01875 Halys-Blackwall	Committed	October 2014	October 2015	357,815	379,941
CP01477.2 Western Downs-Halys 3rd-4th	Uncommitted	October 2015	October 2016	288,397	261,382
CP01470 Halys to Greenbank	Uncommitted	October 2018	October 2018	202,328	149153
CP02477.3 Western Downs-Halys 5th-6th	Uncommitted	October 2017	Not included (2021)	31,793	-
			Total	**880,333**	**790,476**

Source: Powerlink data.

Powerlink's options analysis

52. Included in the RRP package were the results of Powerlink's analysis of options that it considered were in line with the AER's Draft Decision and the 275 kV build options that EMCa considered Powerlink should have assessed. Powerlink evaluated the following options which it presented in the RRP.

[5] From Powerlink pro-forma information which represents the median date. Assumed commissioning dates vary in Powerlink's probabilistic planning model, according to scenario

[6] $real 2011/12 mid-year. The RRP capex budget results from Powerlink's weightings of 20 scenarios. Expenditures exclude expenditure on easements.

Table A.4: *RRP options analysed by Powerlink for 500kV development*

Option 1	**Full 500kV upfront:** construct and operate future transmission between South West (SWQ)[7] and South East Queensland (SEQ) at 500kV.
Option 2	**275kV then replace with 500kV on existing easements:** construct the next double circuit at 275kV from Halys to Blackwall and then Western Downs to Halys. This is followed by a double circuit constructed at 500kV initially operated at 275kV between Halys and Greenbank and then Western Downs to Halys allowing for the demolition and replacement of the first double circuit to 500kV initially operated at 275kV.
Option 3	**275kV provision for 500kV towers:** construct the next double circuit from Halys to Blackwall and then Western Downs to Halys with 500kV towers but string with 275kV insulation (and conductor). This is followed by a double circuit constructed at 500kV initially operated at 275kV between Halys and Greenbank and then Western Downs to Halys allowing for the restringing of the first double circuit to 500kV initially operated at 275kV.
Option 4	**275kV provision for 500kV towers and conductors:** construct future augmentations into SEQ at 500kV but initially operate at 275kV.

Source: Powerlink.

53. The above options, including the sequencing of transmission line commissioning, are described in more detail in section A.4.

54. Powerlink also assessed an option based on the construction of a 275kV network that would deliver the equivalent capacity of the combined 500kV projects (once operated at 500kV). Powerlink considered that this option was "infeasible "due to the number of additional easements required and the environmental impact of the increased number of transmission lines. Powerlink provided copies of advice from IDM Partners[8] and Norton Rose Australia[9] in support of its view.

55. EMCa agrees with Powerlink that this additional 275kV "equivalent capacity" option is likely to be unfeasible, therefore we have not considered it further in this subsequent review.

56. EMCa considers that easement options that would allow continued extension of the 275kV network closer to the time when 500kV would be required have not been fully explored. EMCa considers that Powerlink should have asked its advisors to consider the feasibility of easements that would be required to allow for deferment of the proposed 500kV build beyond the RCP. This issue is discussed further in section A.3 of this report.

57. As noted by Powerlink:

[7] In this report South West Queensland is the Bulli region referred to in Powerlink's power flow analysis diagrams and data.

[8] IDM Partners Powerlink Transmission Line Easement: South West to South East Queensland.

[9] Norton Rose AER Transmission Determination – 500kV Corridor Options

> *"Option 2 is most aligned with the AER alternative allowed in its Draft Decision (mainly 275kV builds in the period)."* [10]

58. The results of Powerlink's net present value (NPV) calculations revealed that, for a SEQ demand growth that was 1,500MW lower than Powerlink's central forecast, the NPV 'gap' between option 2, option 3 and option 4 closed considerably. This being the case, the AER considered that further refinement and testing of option 2 was warranted. The further testing was to include deferring 500kV construction and the utilisation of further easements, as a counterfactual in order to test the robustness of Powerlink's proposed 500kV development path (i.e. option 4).

59. EMCa also considered that there was uncertainty regarding Powerlink's assumed SEQ demand growth and Powerlink's proposition that all such growth would be met by SWQ generation. On this basis the AER requested further analysis to assess the sensitivity of the NPV analysis to lower demand and increased generation in SEQ.

A.1.3 Approach taken and structure of this annexure report

60. The approach taken in this review is described in three parts:

    i. Issues definition – Defining the issues including the relevance of demand and generation planting forecasts, options tested, technical feasibility, NPV analysis and easement requirements.

    ii. Supporting analysis - Consideration of strategic development options and implications of these options for the RCP capex budget for "500kV" projects;

    iii. Proposed treatment of these projects, including capex allowances for the RCP, contingent project triggers (if relevant) and other matters addressed such that AER can draft these aspects of its Final Decision.

61. This report provides a summary of the analysis we have undertaken and our findings.

62. The report is structured to provide the headline findings and recommended proposed treatment of the projects at the outset of the report. Subsequent sections provide information and supporting analysis.

A.1.4 Data sources

63. In the course of this review we have examined a large quantity of documents. This includes documents that Powerlink provided to the AER with its RRP and a number of other significant documents that were provided in the course of an on-site meeting and in response to our requests for information[11] .

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[10] RRP Appendix M Economic Analysis SEQ Reliability of Supply 275kV Alternatives

[11] Key information provided was in Response EMCa024 – 500kV Options Analysis – 2 March 2012 (and associated attachments); Response AER067 – 500kV generation in SEQ assumption – 8 March 2012 (and associated attachments). We met with Powerlink on 27th and 28th February 2012

A.2 Findings and proposed treatment of the 500kV-capable projects

A.2.1 Headline findings

Services provided by the proposed 500kV augmentations

64. As proposed by Powerlink, when the four 500kV capable projects are eventually operated at 500kV, they will form a direct connection between SWQ and SEQ with no connection along the route to the 275kV shared network. At this time, the 500kV assets can be considered to provide a dedicated energy transport service that would allow new SWQ generators to supply the SEQ market.

65. In the transition path proposed by Powerlink, the 500kV assets will be operated at 275kV for what could be a significant length of time. During this time, Powerlink proposes that the assets will be connected to the existing 275kV network at Halys. The network to the west of Halys (i.e. to Western Downs) would provide an energy transport service for new SWQ generators, albeit to a lesser capacity than when operated at 500kV. The assets from Halys to SEQ (i.e. to Blackwall and Greenbank) are also being built primarily to facilitate this assumed new generation, but would have greater flexibility in being able to support flows into or from Central Queensland in the transition period while they are operated at 275kV. However this flexibility is lost once the assets are moved to 500kV operation[12].

Risks and market efficiency incentives

66. As electricity transmission is not the sole option for transporting energy, the risks associated with Powerlink's proposed 500kV network development schedule must be fully considered, along with the dynamic efficiency economic objectives of the NEM. These include the following significant aspects:

   i. To the extent that Queensland consumers are required to pay for these assets to be built at 500kV, through charges for prescribed services, they will bear the significant carrying cost for the period until operation at 500kV is required. They would also effectively be underwriting the risk of any stranded transmission investments to the extent that the anticipated demand growth does not eventuate, if generation is built in another location and/or if alternative energy transportation systems, such as gas pipelines, enable SEQ demand to be met at a lower cost;

   ii. Building a 500kV link between SWQ and SEQ at this time may predetermine that future generation development will predominately locate in SWQ and this may represent an economically inefficient siting of such generation, relative to other options. If so, then this would be inconsistent with the NEM Objective.

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[12] This flexibility could be retained, but at the considerable costs of a 500kV/275kV substation at Halys. Powerlink has not proposed such a substation.

Findings on Powerlink's supporting analysis

67. We consider that the existence of these risks should have led Powerlink to undertake a thorough options analysis that properly assessed the factors driving the need for the proposed investment, with particular focus on uncertainty, the levels of commitment by the parties who would use these investments and contingency options if those commitments or needs were to change significantly over the planning horizon. While Powerlink properly sought to defer some expenditure by deferring operation at 500kV, this strategy could be further pursued to consider options to defer the high cost of building at 500kV too far in advance of need. In EMCa's opinion, thorough options analysis would have identified that 275kV build for the next RCP was a technically feasible and credible option that warranted such assessment.

68. EMCa considers that Powerlink's analysis of the options as submitted in the RRP was not reasonable because:

    i. It is based on an expected demand growth (at 4%/year) that we consider is not reasonable;

    ii. It is based on an expectation, that we consider not reasonable, that there will be no new SEQ generation; and

    iii. the analysis was predicated on an untested assumption that any options not involving initial 500kV build would be infeasible due to the unavailability of further easements.

69. EMCa's opinion on these matters is informed by our review of Powerlink's RRP analyses of the NPV of different development options, further analyses provided in response to information requests and by our review of the expert opinions on easements that Powerlink provided. We consider that Powerlink's NPV analysis does not reasonably demonstrate the superiority of a move to 500kV build at this time, and that Powerlink's brief to its advisers on easements limited its ability to explore the appropriate options.

Implications for Powerlink's 2009 Regulatory Test for Halys - Blackwall

70. While we accept as reasonable Powerlink's analysis that a line from Halys to Blackwall operating at 275kV is required within the RCP, EMCa considers that the Regulatory Test that Powerlink completed in June 2009[13] for this line to be built with 500kV capability has deficiencies that should be rectified, if it is intended to be used as a current justification for this project.

71. As commissioning for this project is now moved to at least late 2015 (and under EMCa's demand assessment, at least 2016, as below) there appears to be time for Powerlink to undertake a further assessment that could lead to a significantly improved outcome for Queensland consumers. This would include re-assessment of the project's proposed classification as a prescribed service when operating at 500kV and (if so), preparation

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[13] The Final Report prepared by Powerlink as part of the prescribed National Electricity Rules (NER) process for the approval of proposed new large network assets.

of a RIT-T that would replace the original Regulatory Test. EMCa's expectation is that, consistent with the NER requirements[14], the RIT-T would include revised demand forecasts which better account for long-term demand growth uncertainty, an analysis of generation projects that would drive the need for the investment, a full range of options analyses, a risk assessment that includes recognition of any risk allocation and a proactive process for non-transmission solution identification.

A.2.2 Headline recommendations

72. Following consideration of technical matters, EMCa recommends that the AER applies the following treatment of the 500kV project capex proposed by Powerlink, within the RCP:

[14] Regulatory investment test for transmission application guidelines Version 01 2010

Project	Recommendation	Reasoning	Contingent project triggers
CP 01875 Halys - Blackwall 500kV Operating at 275kV	Reject inclusion in the RCP capex forecast of the "committed" project cost as proposed by Powerlink for a 500kV build: AND, EITHER: 1) include (as part of an alternative forecast) an equivalent uncommitted project costed for a 275kV build; and Defer the commissioning date for this project from 2015 to 2016; and Re-classify the **incremental** costs of building at 500kV as contingent expenditure. OR 2) Reclassify the whole project and associated cost proposed by Powerlink as a contingent project.	This is a committed project for which it is considered that the Regulatory Test undertaken by Powerlink was deficient and failed to demonstrate the need to commit expenditure to construct at 500kV during the RCP. Neither a Regulatory Test nor a RIT-T has been conducted for a 275kV equivalent to this project. It is recognised that there is a need to address voltage stability constraints during the RCP and that a line operating at 275kV is required, but Powerlink's proposal shows that 500kV construction is not necessary to achieve this within the RCP. Relative to its initial RP, Powerlink has deferred this project to 2015 in its RRP and has estimated that, with a demand forecast equivalent to that proposed by EMCa in its current advice, it could be further deferred to 2016. On this basis there is sufficient time for Powerlink to undertake a RIT-T for this project (including consideration of the required voltage) and to review the project against contingent project triggers.	For 275kV operation during the RCP (whether 275 or 500kV construction): • Justification for the categorisation of the expenditure as a Prescribed Service consistent with Part 6A of the NER. • Power flow analysis taking into account committed and advanced proposals for generation outside SEQ demonstrates that forecast peak loadings on transmission circuits operated at 275kV will exceed voltage stability and/or thermal capacity limits. • If the expenditure is justified as a Prescribed Service, the completion of an NER-compliant RIT-T.

Project	Recommendation	Reasoning	Contingent project triggers
CP 01477.2 Western Downs - Halys 3rd-4th 500kV Operating at 275kV (Uncommitted)	Reject inclusion in the RCP capex forecast of the uncommitted project cost as proposed by Powerlink, and treat as a contingent project.	This is an uncommitted project and the likelihood of its requirement within the RCP can be seen to be linked with the development of sufficient levels of committed new SWQ generation. SWQ committed generation can be considered to be a unique driver for the purposes of establishing a contingent project trigger.	For 275kV operation during the RCP (whether 275 or 500kV construction) • Justification for the categorisation of the expenditure as a Prescribed Service consistent with Part 6A of the NER. • Power flow analysis taking into account committed and advanced proposals for generation in SWQ demonstrates that forecast peak loadings on the existing transmission circuits will exceed voltage stability and/or thermal capacity limits. • If the expenditure is justified as a Prescribed Service, the completion of an NER-compliant RIT-T.
CP 01470 Halys to Greenbank 500kV DCST operating at 275kV (Uncommitted)	Reject inclusion in the RCP capex forecast of the uncommitted project cost as proposed by Powerlink and consider whether treatment as a contingent project is consistent with the NER.	The project is uncommitted. All expenditure will fall considerably outside the next RCP under the revised alternative medium demand scenario and commissioning would fall outside the RCP under the revised alternative high demand scenario proposed by EMCa/NZIER (though some minor initial expenditure may fall within the last year of the RCP in this case).	If the AER wishes to include this as a contingent project in the next RCP, then the same triggers as proposed for CP 01477.2 could be applied.

73. These recommendations, which are based on our review of technical matters, should be subject to regulatory legal review by the AER to ensure that these or equivalent decisions are consistent with the NER.

74. We note that the triggers specified above do not explicitly distinguish between these projects as proposed for 275kV or 500kV construction. Once a project is triggered, then it is understood that the AER is required under the NER to assess and approve the contingent project expenditures to be included in the revised revenue cap. As part of this process, we assume that the AER would therefore have the opportunity to assess the justification for any of the above lines to be built at 500kV as opposed to 275kV. The need for consideration of the projects would therefore be triggered by the need for (at a minimum) lines operated at 275kV and consideration of the appropriate build voltage would then follow as part of the contingent project review.

A.3 Definition of issues

A.3.1 Basis for Powerlink's proposed requirement for the 500kV-capable assets

75. The need for and timing of the 500kV related project expenditure included in the RRP (i.e. to be incurred in the next RCP) is established on the basis of significant and continuing rates of growth in demand in South East Queensland (SEQ) being met by generation plant located outside the SEQ region, as described in the following table.

Table A.5: *Basis for requirement for proposed 500kV assets*

Halys - Blackwall and Halys - Greenbank	Is required if generation to meet forecast SEQ demand growth is supplied from regions outside SEQ (e.g. South West, Central or North Queensland) provided there is interconnection to these regions at Halys[15]. If there is not interconnection, then these are required solely to facilitate new generation in SWQ
Western Downs - Halys 3rd-4th and Western Downs - Halys 5th-6th	Is required if generation to meet SEQ demand growth is supplied from SWQ.

76. Importantly, the requirement to invest in 500kV-capable assets well ahead of the time that they will be needed to operate at that voltage has been attributed by Powerlink to the need to utilise the available easements strategically in a manner that avoids the securing of additional easements for later construction and operation of 500kV assets.

77. Based on Powerlink's initial and revised revenue proposal documentation and discussions during onsite meetings EMCa has formed the following understanding of why Powerlink considers that the four 500kV network augmentation projects are required:

   i. Increasing development of gas resources in SWQ will lead to increased demand growth in the region (due to gas compression plant) and the construction of gas fired electricity generation plant in SWQ;

   ii. Electricity demand growth in SWQ will be met by new generation capacity in SWQ;

   iii. Peak demand in SEQ is forecast to continue to grow from 6,253MW in 2014/15 to 14,226MW in 2035/36.[16]

   iv. Available SWQ generation capacity at SEQ peak demand times is forecast to increase massively in excess of SWQ demand growth, as the sole means of meeting assumed SEQ demand requirements. Specifically, Powerlink has assumed that SWQ generation will increase from 3,337MW in 2014/15 to

[15] Powerlink's proposed development path would provide interconnection only for the transitional period while these assets are operated at 275kV
[16] Powerlink analysis

15,796MW in 2035/36[17] while over the same period there is assumed to be zero additional generation capacity in SEQ.

78. Powerlink has based its views on the 'majority' of scenarios provided by ROAM Consulting for general planning, and on its revised and extrapolated demand forecasts.

79. Powerlink has concluded from power flow analysis that the development of a 500kV network is required in the longer term due to the predicted very large increase in the transfer of electrical energy between new SWQ generation and the continually growing SEQ demand. With these assumptions, Powerlink's analysis indicates that problems with voltage stability at 275kV operation for its interpretation of the planning standard will arise progressively on the sections of the Western Downs – Halys – Springdale – Blackwall and Western Downs – Halys – Springdale – Greenbank electricity transmission corridors.

A.3.2 Powerlink's proposed network development path

80. Powerlink's proposed build sequence[18] for the transmission line construction projects is provided in the table below.

Table A.6: *500kV build sequence proposed by Powerlink in its RRP*

Date required	Project
Oct 2015	Halys - Blackwall 500kV Operating at 275kV
Oct 2017	Western Downs - Halys 3rd-4th 500kV Operating at 275kV
Oct 2019	Halys to Greenbank 500kV DCST operating at 275kV
Oct 2021	Western Downs - Halys 5th-6th 500kV Operating at 275kV

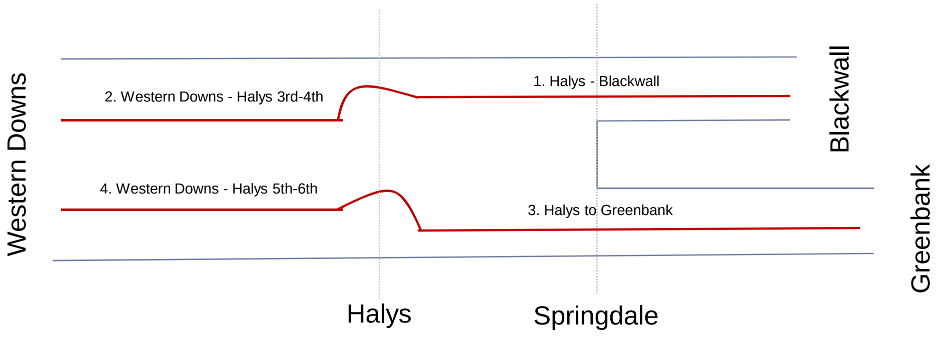
Source: Powerlink

81. The diagram below provides a conceptual view of the proposed 500kV interconnections between Western Downs/ Blackwall and Western Downs/ Greenback. The red lines represent the 500kV transmission lines and the grey lines provide a view of the easement corridors (not to scale). It is important to note that, at the intended date for operating at 500kV, the circuits will be connected in a 'solid' unswitched manner at Halys substation. This means that the 500kV circuits will form a continuous dedicated link between Western Downs and Brisbane with no connection to the shared Powerlink transmission network at any points along the circuit routes. This is an important point that we shall return to later.

[17] Powerlink inter region power flow analysis Scenario A 10% PoE SEQ Peak

[18] Option 4 in Appendix M Economic Analysis SEQ Reliability of Supply 275kV Alternatives of Powerlink's RRP documentation. It is noted that some of these dates are pushed back by one year, relative to the pro-forma dates quoted in the RRP (i.e. cf table A.3)

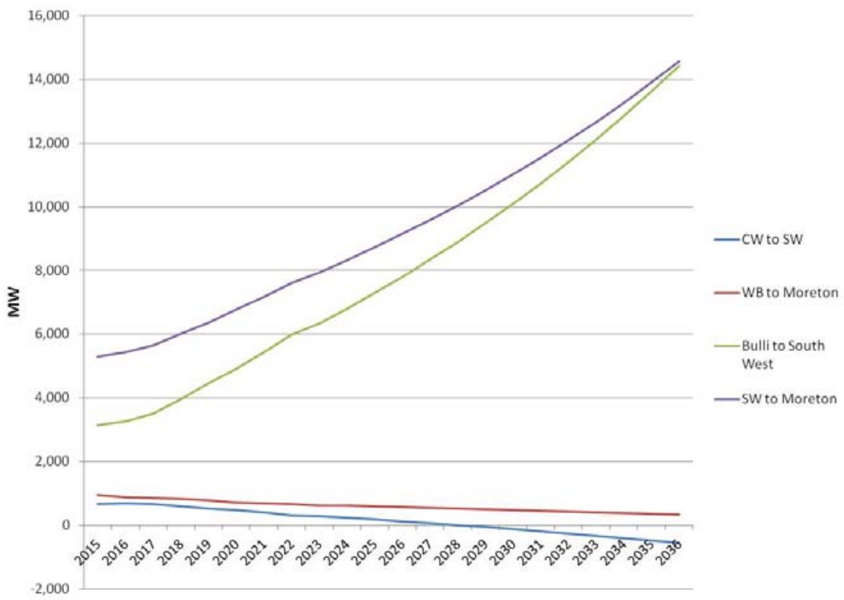
Figure A.1: *Illustrative transmission line and easement structure at 500kV operation*



Source: EMCa

82. The following chart shows Powerlink's modelled energy flows between the four Central and South Queensland regions between 2015 and 2036.

Figure A.2: *Example of chart of inter zone transfers for Powerlink's Option 4 analysis*



Source: EMCa based on inter region energy transfer data provided by Powerlink

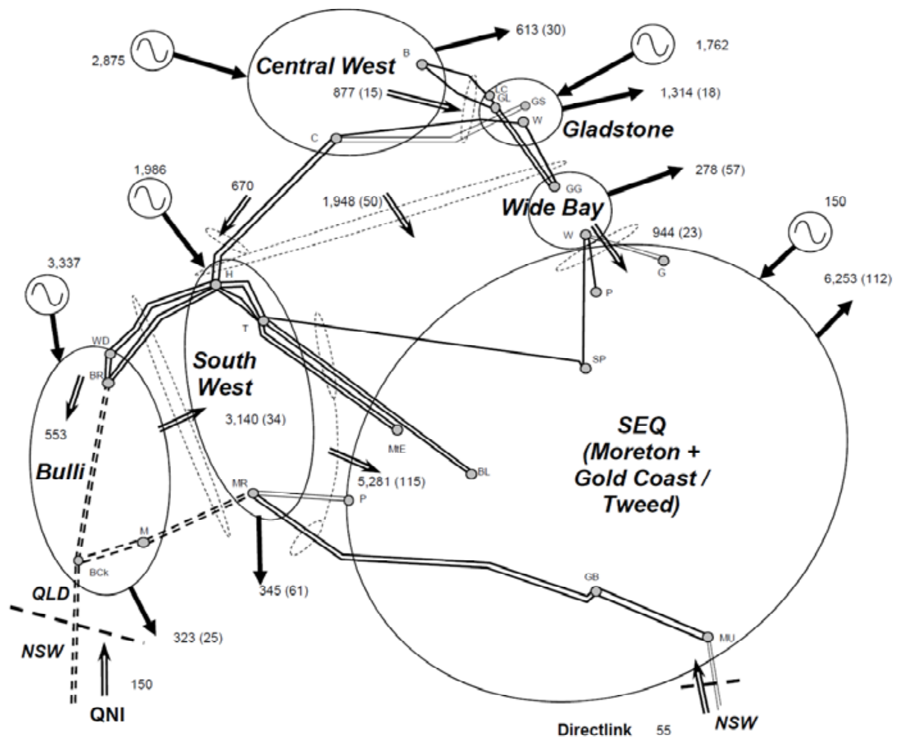
83. The above curves clearly indicate Powerlink's expectation of increasing SEQ demand being met by SWQ new generation. It can also be seen that Powerlink is expecting that inbound energy transfers from the North into SEQ will reduce.

84. Powerlink has undertaken voltage stability analysis for its network and using the above transfer forecasts has determined a build sequence required to ensure that the network remains within its operating limits for these assumptions.

85. The regions defined by Powerlink in its power flow analysis are shown in the diagram below. The values shown in this diagram are for a specific year, specific generation planting and demand scenario and a specific network development option. The increases in transfers between the regions over time are compared with the inter zone voltage stability and thermal operating limits in order to establish the trigger point for new line construction to be required.

86. It is important to note that Powerlink's analysis has identified that the triggers for all four projects are primarily voltage stability and not thermal capacity related. The voltage stability issues are mainly due to the transportation of electrical energy over longer distances of transmission lines. Generation located closer to demand centres reduces energy flows and reactive energy requirements in a.c. transmission lines and is likely to be able to provide additional voltage support. As Powerlink's Scenario A does not forecast increases in generation in SEQ these benefits are not seen in the options assessed by Powerlink in the RRP.

Figure A.3: *Example of output from Powerlink's inter zone transfer power flow analysis*



Source: Powerlink: Option 4 Scenario A OnTime 2014/15 10% PoE SEQ Peak

87. Throughout this report, SWQ generation and demand refers to the Bulli region in Powerlink's inter zone power flow diagrams and data.

A.3.3 Issues identified

Assumptions regarding location of new generation in SWQ

88. EMCa considers that there is uncertainty regarding Powerlink's assumptions that SEQ demand growth will be met exclusively by new SWQ generation capacity. We take this view because there is:

i. a material possibility that some generation may locate in SEQ and that this may be significant to the nature and timing of the investment triggers;

ii. a material possibility of generation being built in Central or Northern Queensland meaning that lower than expected energy transfers will occur on at least part of the SWQ to SEQ transmission corridors and increased transfer from the North.

89. One of several feasible scenarios under which this could occur, is the potential for construction of a further gas pipeline/s from SWQ to, or closer to, the SEQ region

enabling generation to be constructed closer to the SEQ demand. Major initiatives are under way to pipe gas out of SWQ.

Assumptions regarding demand in SEQ

90. EMCa notes that demand assumptions are uncertain, especially for analysis over 20 to 40 years or more. Powerlink's assumptions on forecast demand in SEQ therefore warrant scrutiny, since they drive the assumed generation need that is assumed to be met from SWQ and thus drive the power transfer assumptions in Powerlink's analysis.

91. Demand forecasting issues for the period to 2016/17 are covered in EMCa's report to the AER on Powerlink's revised demand forecast and are therefore not discussed in detail in this report. However we have used this analysis to form our views on the realistic range for longer term forecasts for SEQ that would support the reasonableness of commencing a 500kV augmentation program.

92. EMCa considers that Powerlink's assumed annual demand growth of 4% is unlikely and that a more realistic forecast would be in the range of 2.5% to 3%. We have formed this view because:

    i. While the 11-year historical peak demand growth for SEQ has been 4.4%, a key driver to this is the significant decline in the load factor over this period. Once this effect is taken out, the underlying growth rate (which is effectively the energy (kWh) growth) is approximately 3.0%. This observation is significant because Powerlink is forecasting that, in Queensland, load factor will not decline further from 2016. Powerlink's 4% peak demand growth extrapolation would therefore require either an increase in the energy growth rate in SEQ or for the load factor to continue to decline over the period of its analysis (which is to 2055).

    ii. Queensland DNSPs provided a 10-year connection point forecast to 2021, which for the SEQ connection points we calculate to be a 2.9%[19] growth rate overall, and 2.5% pa by the final year (i.e. 2021).

    iii. Powerlink's low demand forecast (for Queensland overall) is close to the revised EMCa/NZIER medium forecast. Powerlink's low forecast for underlying demand[20] represents a growth rate for these 5 years of around 2.7%.

93. Given these concerns, we consider that a reasonable view of long term peak demand growth would be somewhat less than 4%. Therefore, we have reached the view that:

    i. Powerlink's use of a 4% growth rate as the basis for analysis was excessive, and

    ii. Powerlink should have tested the sensitivity of its 500kV analysis to significantly lower demand growth rates, such as in the range of 2.5% to 3.0%.

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[19] The DNSP forecast rate for the first 5 years is 3.2% and the final 5 years 2.6%. The final year is 2.5% - the average to 2021 is 2.9%

[20] The Powerlink low forecast used for this purpose is the underlying load, which excludes large new demand loads such as LNG compression and coal mines, and which are projected outside of SEQ.

Assessment of risk, services provided and market incentives

94. Our concerns regarding Powerlink's assumptions as to the future levels and location of generation and in regards to the long-term increase in peak demand, together with the absolute reliance of the viability of the investment on these assumptions, leads to a conclusion that there is a significant risk that the proposed investments may not be needed and may become stranded. An assessment which does not adequately assess such risk may also lead to assets being built in the wrong location or alternative solutions that could have been provided at lower cost, not being developed.

95. If the investments are to be classified as Prescribed Services then, to the extent that consumers are required to pay for them, the financial risks associated with uncertainties discussed above will be underwritten by Queensland electricity consumers. It is considered an important part of the regulatory process to examine whether reasonable opportunities to minimise and manage these risks have been properly explored prior to committing expenditure or allowing its inclusion in revenue recovery from consumers.

96. During the course of this review Powerlink provided EMCa with information that shows us that the currently proposed final 500kV operational configuration is dedicated to the transfer of power from assumed new SWQ generation, to SEQ. This information is highly relevant to the issue as to whether the 500kV assets should be considered to provide a "Prescribed Service" under the NER, a point raised by AEMO in its submission to the AER[21].

97. From a market efficiency perspective, the development of what can be considered to be a continuous 500kV interconnector, dedicated to the export of energy from a single specific region, and ahead of the firm commitment of generation in that region, may have the effect of stifling or undermining other market initiatives that may deliver more efficient outcomes for consumers and for the Queensland economy. This would not be consistent with the objectives of the NEM[22]. One obvious alternative is the transmission of energy closer to load centres through gas pipelines as a lower cost non-transmission alternative[23].

98. In the NEM, the marketplace is intended to provide for generation to be sized, timed and located where and when it is most economic, and this includes considerations of siting where it can provide greatest support and least constraint risk. Commitment to the commencement of a 500kV construction program during the RCP may have an

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[21] AEMO submission letter to the AER 12 September 2011 Re: Powerlink Revenue Proposal 2012/13 - 2016/17

[22] Section 7 of the NEL states that "The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to

(a) price, quality, safety, reliability and security of supply of electricity; and

(b) the reliability, safety and security of the national electricity system."

[23] Other examples of non-transmission alternatives include improved peak load management particularly through the expansion of smart grid technologies, small scale distributed generation (e.g. solar PV) and emerging technologies such as energy storage.

impact on the operation of the market to deliver the most economically efficient location of future generation capacity.

99. The classification of the 500kV investments as a Prescribed Service has problematic implications in relation to the NEL objective, because ultimately it will be run as a directly connected circuit between generators in SWQ and the SEQ demand. Prescribed Service classification of these assets is likely in our view to produce economic barriers to investors in plant outside SWQ particularly if electricity consumers pay directly for those investments.

100. Notwithstanding the above views, EMCa acknowledges that unless future generation is built in the SEQ region, or a combination of future growth within the region and technological changes moderate the predicted load growth, there is likely to be a need for 500kV transmission from the Tarong (Halys) area into the SEQ region at some stage. If the SEQ demand growth needs to be met almost exclusively from SWQ generation then there is likely to be a need at some stage to construct 500kV transmission between Western Downs and Halys. The issues that we raise are largely in regards the timing and sequence of construction of the assets, and the risks of commitment too far in advance of their need.

Strategic use of easements

101. In the RRP, and at the on-site workshop, Powerlink has maintained its assumption that further extension of the 275kV network would not be possible due to an inability to secure additional easements. Powerlink cites advice it received from IDM and Morton Rose to support this assumption.

102. Unfortunately, much of the advice obtained by Powerlink relates only to the requirement for an expansion of 260m to the initial 120m easement corridors, over all assumed route requirements. A range of development options exist, with less intrusive easement requirements. For example, it would appear that approximately a 50m easement expansion would be required for a further single 275kV DC space that would allow further extension of the 275kV network, and there are development paths where such expansions might be required for only part of a line route and for a limited time.

103. In discussions on-site, Powerlink has advised that it considers that it is very unlikely that a single easement extension for overhead construction could be obtained on the Halys to Blackwall and/or Halys to Greenbank routes due to the need to traverse urban environments. However, IDM's advice[24] on the Halys to Springdale section of both routes suggests that difficulties would relate to a 260m easement and (consistent with IDM's brief) no opinion was provided on the feasibility of a 50m extension. The lack of proximity to urban landscape on this section of the route suggests that it would be reasonable to have investigated the option to extend the easement by 50m, which would enable at least this section to be built initially at 275kV.

[24] Section 8

104. EMCa remains unconvinced that options that utilise limited easement extensions for 275kV line construction are not possible. We also note that easements are yet to be acquired or proclaimed for much of the proposed 500kV development route.

A.3.4 Implications from issues identified for assessment of Powerlink's proposal

105. Powerlink's proposed 500kV network build programme is based on assumed SEQ demand growth being met exclusively by new SWQ generating capacity. We consider that the transfer assumptions on which Powerlink has based its assumed 500kV development needs and timings is not reasonable because it is predicated on a set of assumptions which, in aggregate, we consider not to be reasonable. These are:

i. A high assumed demand growth rate in SEQ;

ii. An assumption that none of this additional demand will be met from within SEQ

iii. An assumption that all of this additional demand will be met from SWQ;

iv. An assumption that all 500kV easements in the required corridors can be obtained, but that no other easements are possible.

106. Deferment of the construction of 500kV-capable assets is attractive because risks of making the wrong investments are reduced. This is because investment decisions can be made at a time when the trigger point for 500kV operation is closer and therefore planning assumptions are likely to be more accurate.

107. Given the above observations from the RRP, it was considered necessary to undertake further analysis to test the extent to which Powerlink's RRP (in regards 500kV projects) appropriately accounted for risks arising from uncertainty in the location of generation and SEQ demand growth rates, and to explore the possibility that there might be strategic development options that could materially reduce risk and defer the need for construction of significant assets at 500kV in the next RCP.

A.4 Supporting analysis

A.4.1 Problem definition and analysis objectives

108. With the lower demand forecast that EMCa has separately recommended to the AER, Powerlink's own assessment indicates that expenditure on only one of the original four 500kV projects (Halys – Blackwall) would be required within the RCP[25]. As proposed by Powerlink in its NPV analysis, this would be constructed at 500kV for commissioning at 275kV in 2015, and converted to 500kV operation in 2022.

109. The focus of the analysis we have conducted for this revenue determination is to test the justification for the "carrying cost' of building this line at 500kV against the assumed need for 500kV capacity at some future time. From Powerlink's NPV analysis, this carrying cost (that is, the difference between constructing this line at 500kV or at 275kV) is assessed at $135m[26]. Within the RCP, Powerlink has assessed that it needs 275kV operational capacity and, for clarity, our assessment is not of the need for this 275kV capability, which we accept.

110. To assess the reasonableness of the additional cost of constructing at 500kV within the RCP, we have therefore explored some development pathways that Powerlink could take if it were to initially construct this line at 275kV. Any one of a set of development pathways that is technically feasible and economically viable could be followed over the next 20 to 30 years, as the needs arise and as options evolve to meet those needs. The assumed timing and nature of augmentations beyond the RCP is therefore relevant only insofar as it assists in reaching a view as to whether it is reasonable to assume that constructing Halys – Blackwall at 500kV is justified because to construct it at 275kV would force Powerlink down a subsequent development path with limited and less viable options.

A.4.2 Establishing the analysis

Use of options analysis

111. The analysis of a range of options is valuable because it tests core assumptions and identifies the boundaries where alternative options become more favourable. In the case of the four 500kV projects, options analysis is particularly valuable for highlighting the costs and risks associated with the choice of various options.

112. In its report to the AER on the RP, EMCa discussed concerns regarding the omission of the assessment of an appropriate 275kV counterfactual to Powerlink's proposed 500kV investments.

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[25] At the 80% probability level inherent in the medium growth forecast

[26] In $2011/12

113. In the RRP documentation Powerlink subsequently provided extended options analysis that included two 275kV options:

i. Option 2 provided for a technically feasible construction programme with Halys - Blackwall and Western Downs - Halys lines initially constructed at 275kV[27], then demolished and rebuilt at 500kV in the same corridor once that capability was required;

ii. An option which Powerlink designated as "infeasible" based on the construction of the equivalent capacity of the entire proposed 500kV grid, in 275kV construction.

114. As discussed in section one, EMCa agrees with Powerlink that the 'infeasible' option is not environmentally feasible as it would require excessive easement extensions that, on the basis of the expert advice provided to Powerlink, are likely to be impossible to achieve. It is also accepted that such a solution is likely to be at a higher economic cost. Accordingly, further assessment of this option was considered to be pointless.

115. As Powerlink pointed out[28] , option 2 is more "*aligned with the AER alternative allowed in its Draft Decision (mainly 275kV builds in the period)".* EMCa agrees and considers option 2 (or variants) is an option that Powerlink should have identified and assessed in its project development documentation as an option in its own right or as a counterfactual in quantifying the carrying cost of its preferred option. Following review of Powerlink's analysis of this option, prepared in response to the AER's draft decision, our view is that a broader range of initial 275kV build options should be considered.

116. Accordingly, EMCa has put forward further development options and assumptions in order to test Powerlink's proposition that its proposal for all construction at 500kV (option 4) is based on a reasonable assessment that this provides the best technical and economic outcome. With Powerlink's assistance, EMCa:

i. identified a limited number of additional options to be tested;

ii. assessed each option for

- Technical feasibility
- Economic value (NPV);

iii. identified a range of SEQ demand growth rates to be used to test the boundary where options changed the economic value position; and

iv. engaged with the AER to develop revised generation planting scenarios that tested the sensitivity of Powerlink's proposed 500kV projects to increased generation in SEQ.

Key assumptions tested

Revised demand forecast

[27] Powerlink assumed that the Halys – Greenbank line would be constructed at 500kV on the basis that it would be essential to make maximum use of this easement corridor

[28] RRP Appendix M Economic Analysis SEQ Reliability of Supply 275kV Alternatives

117. For the analysis undertaken in the RRP package (appendix M) Powerlink used its Revised Revenue Proposal medium economic outlook demand forecast up to 2021 followed by 4% p.a. demand growth for SEQ and a net 2% demand growth for the remainder of the state.

118. As discussed in Section 3 EMCa considers that Powerlink's extrapolated forecast demand growth rate of 4% per year is not reasonable, and that more reliance should be placed on analysis at lower growth rates.

119. Revised demand growth assumptions were provided to Powerlink to enable these to be assessed on the same basis as Powerlink's analysis of previously-presented options, as follows:

i. Powerlink's low demand growth scenario to 2017 (and which is materially the same as EMCa/NZIER's medium growth scenario to that time);

ii. DNSPs' medium demand growth for SEQ, as provided by DNSPs to Powerlink in 2011, for the period from 2017 to 2021;

iii. DNSPs' projected 2021 growth rate (2.5%) extrapolated to the end of Powerlink's analysis period.

120. Further analysis was also sought for an extrapolation of demand growth at 3.0%, in conjunction with a further generation scenario (see below).

Alternative generation planting

121. As discussed in section 3, Powerlink's analysis has been undertaken on the basis that SEQ demand growth will be solely met from new SWQ generation. There is potential, and some evidence[29], that SEQ demand growth will to some extent be met either by generation within SEQ or from regions other than SWQ, or a combination of both.

122. As discussed and described in the EMCa report to the AER on the RP, Powerlink has developed its proposals for load driven reliability augmentations and connection works for the RCP (and to a limited extent, beyond this time) on the basis of studies undertaken for it by ROAM Consulting[30]. These studies identify twenty plausible market development scenarios, each with an ascribed probability, associated load growth assumptions and levels and locations of generation development.

123. We have reviewed the ROAM studies that Powerlink has relied on and we make the following observations:

i. In Table 5.7 (Committed, advanced and proposed Generation options for installation) in the ROAM studies, there is the following footnote:

> *"Investment in South East Queensland locations is considered unlikely, as there is limited land available for the purpose, and there is no local fuel source for any fuel type. Significant investment due to the LNG sector (and*

[29] For example TRUenergy publically announced plans to operate Blackstone Power Station in South East Queensland.

[30] Roam Consulting Report (PLK00028) to Powerlink Generation Scenarios for 2012 Revenue Reset Application 7th May 2010.

the prevalence of LNG ramp gas) will reduce the opportunity for new entrant gas plant in SEQ, and it will reduce the need for government-owned corporations (GOCs) to fund the development of additional capacity (funds which ROAM understands may be difficult to obtain in the current fiscal and political climate)"

124. In light of publically announced and potential generation proposals in SEQ, this assumption could now be updated so as not to provide an undue bias to SWQ generation in the planting schedules of plausible market development scenarios. We would expect Powerlink to take account of recent developments in proposed generation and to test the impact of these in network modelling, particularly for such large network augmentations as the proposed 500kV network.

125. The ROAM studies are for a 10 year period. The ROAM report, provided as Appendix E in Powerlink's original RP, identifies that developments in Queensland in the next decade are highly uncertain and in Section 9 of the ROAM report (Discussion) states the following:

"The energy sector is facing considerable changes over the next decade throughout the National Electricity Market. The rapid emergence of the LNG industry in Queensland will utilise the considerable coal seam methane resources located in the Surat Basin in South West Queensland, and this will significantly influence the trends in power station development over the period of interest. Ramp gas in the first half of the decade will provide an abundance of low cost fuel for high capacity factor gas fired plant, which will put pressure on the existing generating fleet. Greenhouse policies, including the expansion of the Renewable Energy Target and the possible introduction of a carbon price trajectory, will significantly change the fundamental economic competitiveness of traditional thermal generators. Coal fired generators, such a large component of the existing generating landscape in Queensland, will become significantly disadvantaged by both of these potential developments, and over time could revert to an intermediate role with combined cycle gas fired generators becoming major base load providers of electricity. However, this trend could be reversed later in the decade if the value of gas for export exceeds that for domestic usage."

and

"Emerging technologies, such as carbon capture and storage for coal fired generators and integrated gasification combined cycle (IGCC) may begin to mature at the end of the forecast period, and provide an alternative to gas and renewable generators in a carbon constrained future. Government incentives may hasten the emergence of this technology."

126. It is notable that Powerlink in its analysis has interpreted the ROAM report to project, for a period significantly beyond the ROAM 10 year study period[31], that all new generation

[31] Some Powerlink NPV analysis provided to us extends to 43 years and extrapolates the same assumptions

to meet rising SEQ demand will be met by generation development in SWQ. We consider this to be a limited and erroneous interpretation and projection of the market development scenarios provided in the ROAM report and consider that a wider set of scenarios should have been used for sensitivity analysis.

127. Accordingly, the AER asked Powerlink to undertake analysis of generation options including the following:

i. To establish the additional SEQ generation capacity that is required to produce a cross-over of NPV positioning between options 2 and 4; and

ii. To identify transmission augmentation requirements (and associated NPVs) for incremental SEQ generation of 500MW, 750MW, 1500MW and finally 2500MW with time phasing consistent with TRUenergy's proposed Blackstone development programme as a working assumption, with the final increment to 2500MW timed such that it meets demand growth requirements.

128. The timings that Powerlink established for these generation increments was as follows:

i. Oct-2019: 500MW

ii. Oct-2021: 750MW

iii. Oct-2022: 1,500MW

iv. Oct-2026: 2,500MW

129. We noted that Powerlink's analysis appeared to effectively treat the assumed generation as "negative load" and thus not incorporate voltage support benefits that could be provided by generators located closer to demand. We investigated if voltage support benefits should have been included in the options analysis. Powerlink informed us that, given the complexity, they had not undertaken voltage stability analysis for all the options, but had assumed that the benefits of generator voltage support would be cancelled by the reactive loading due to the generation being at a single point of connection that was located at a distance from the centre of demand. We accept Powerlink's reasoning and conclusions on this point.

130. The AER has subsequently requested further analysis of the options with the 3.0% demand growth extrapolation referred to above.

Assessment method

131. EMCa concluded that it would be most productive to focus on variations to option 2 and compare these with option 4 (Powerlink's proposed build sequence).

132. Each option 2 variation was defined and assessed using the following method:

i. Powerlink undertook power flow analysis which produced annual inter-regional energy transfers outputs;

ii. Powerlink identified investment trigger points using power flow outputs and voltage stability limits, and this information was also provided to EMCa for use in our review;

iii. Powerlink developed build sequences for the options, for each of the development paths provided by EMCa;

iv. Powerlink's cost estimates were used as inputs into the NPV modelling;

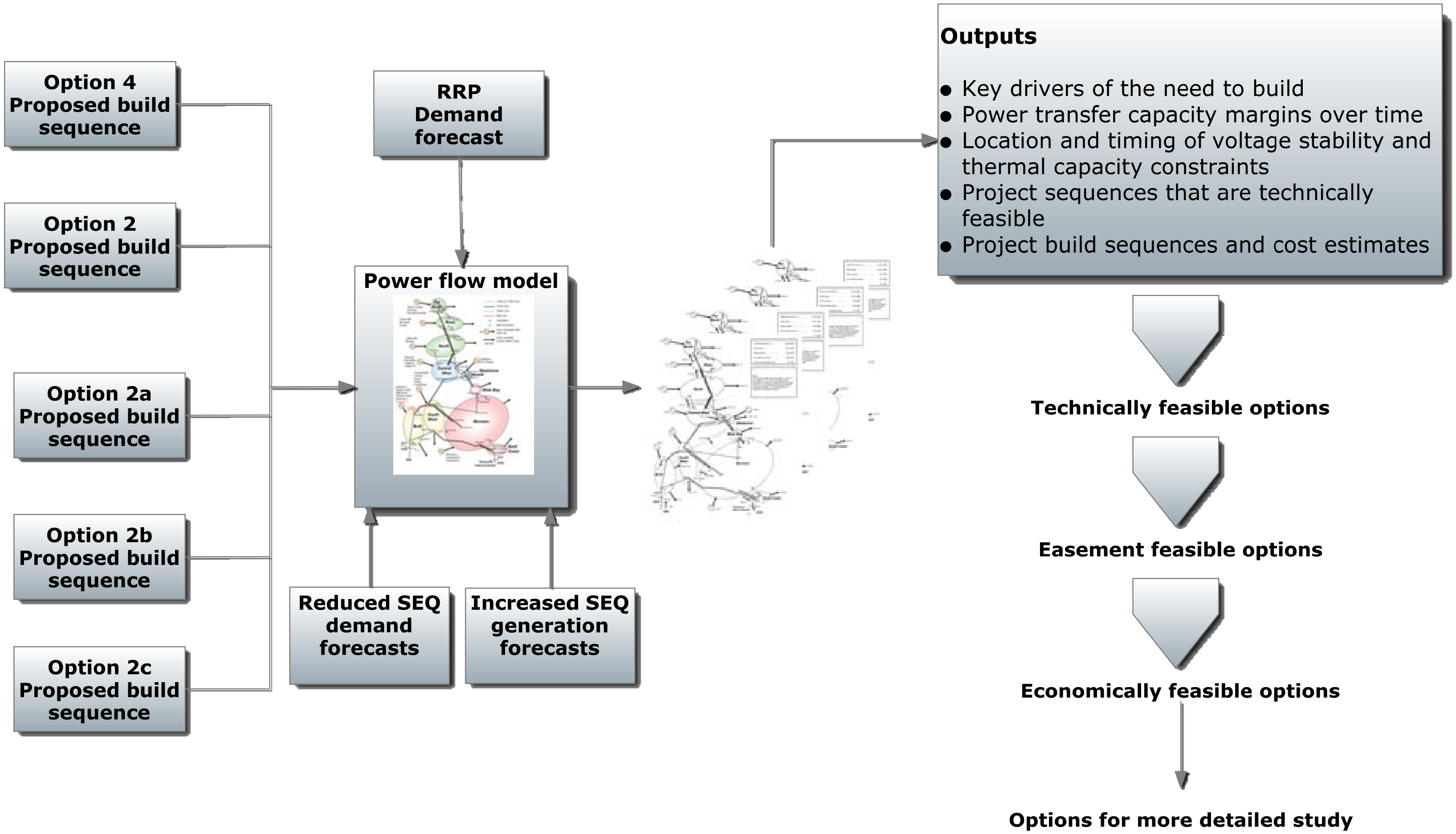
v. Powerlink completed NPV comparison (using Powerlink's model) for each option.

133. Each of the option 2 variations and option 4 was assessed using the revised demand forecast and alternative generation planting scenarios described above. It should be noted that options 2a, b and c differ from the "option 2" development sequence that Powerlink analysed in Appendix M of the RP document package, and that options 2a, 2b and 2c were not analysed using the demand and generation planting assumptions used by Powerlink in Appendix M of the RP document package[32].

134. The following diagram provides a view of the approach adopted to complete the above assessment.

[32] The option 2 build sequence analysed initially by Powerlink and presented in Appendix M of the RP involved in some cases building lines at 275kV and then dismantling them within two years and rebuilding them at 500kV. Clearly such a strategy would never be viable.

Figure A.4: *Options analysis approach*



Source: EMCa

Development options tested

135. We undertook some preliminary NPV analysis, which suggested that it would not be economic to "carry" the incremental cost of building at 500kV, if a 275kV line could meet the need for around 13 years or more. This led us to test build sequences that would allow a 275kV initial build, with maximum utilisation of that line before eventually replacing it with a 500kV line.

136. Powerlink's "option 2" was adopted as the basis for the development of further sub-options (Options 2a, 2b, 2c), and compared with Powerlink's option 4 (sequential 500kV developments). These options are described below.

Table A.7: *Description of options studied*

	Build Sequence			
	Option 4	Option 2a: Initial 275kV build, no additional easement	Option 2b: Initial 275kV build, H-GB strategic easement	Option 2c: Initial 275 kV build, H-B strategic easement
H-B line (for 275kV operation)	500kV build, op at 275	275kV build	275kV build	275kV build on strategic easement
WD-H line (1)	500kV build, op at 275	500kV build, op at 275	500kV build, op at 275	500kV build, op at 275
H-GB line for 275kV operation	500kV build, op at 275	500kV build, op at 275	275kV build on strategic easement	500kV build, op at 275
H-B stage 2 - Demolish	N/A	Demolish 275kV	Demolish 275kV	N/A
H-B stage 2 – Build (for 500kV operation)	N/A	500kV build	500kV build	500kV build
H-GB stage 2 (Build for 500kV operation)	N/A	N/A	500kV build	N/A
Strategic easement reversion	N/A	N/A	Demolish H-GB 275kV and hand back easement (optional)	Demolish H-B 275kV and hand back easement (optional)
WD-H line (2)	500kV build, op at 275	500kV build, op at 275	500kV build, op at 275	500kV build, op at 275
WD-B substations 500kV	Operate at 500	Operate at 500	Operate at 500	Operate at 500
WD-GB substations 500kV	Operate at 500	Operate at 500	Operate at 500	Operate at 500

Source: EMCa. Note that the differences between the build sequences all relate to the Halys-Blackwall and Halys-Greenbank lines, which we have colour-coded for clarity

137. Option 2a is an option that is designed not to require any additional easements. It would involve building first in the Halys – Blackwall corridor at 275kV and then, once the Halys – Greenbank line is built and can provide adequate support into SEQ, demolish the initial 275kV Halys – Blackwall line and rebuild at 500kV in the same corridor.

138. The strategic easement included in options 2b and 2c is conceived as a widening of the existing easement route either held or to be acquired by Powerlink. The easement widening would need to be sufficient to construct a double circuit single tower (DCST) 275kV transmission line. This would require an additional approximately 50m width[33]. The expanded easement would be used to allow parallel construction of transmission lines to allow the sequence of deconstruction of a 275kV line and replacement with

[33] Powerlink advised IDM that the required width for a singlle500kV line tower is 70m and that three 275kV line towers would require 140m (46m each)

500kV when the need arises. It is important to note that this would only require the limited widening of an easement and would mean that towers of significantly lower height would be operated for a number of years. Following the future construction of 500kV assets the easement extension could be relinquished.

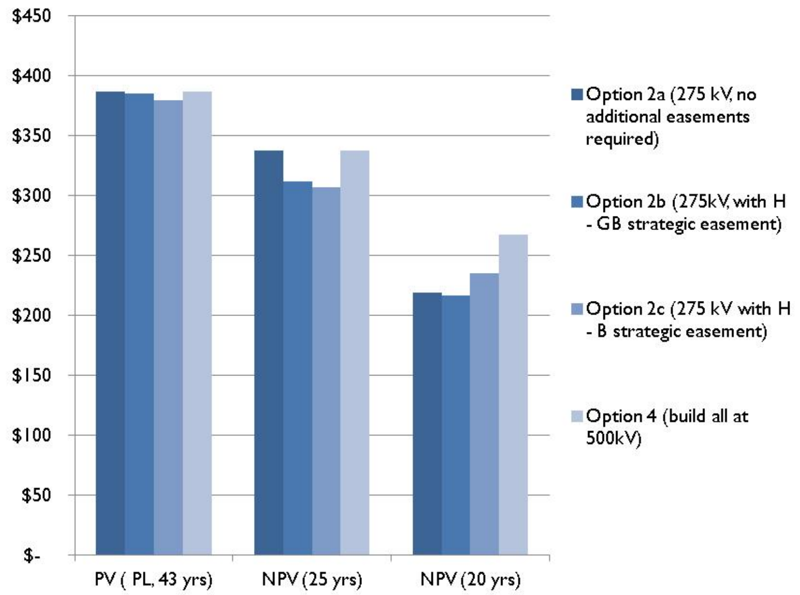
A.4.3 Analysis results

Results of main option analysis

139. Powerlink's RRP NPV analysis was conducted using an analysis horizon to 2035. In the requested options analysis, some significant construction is deferred beyond this period and, in presenting the results, Powerlink lengthened the analysis horizon to the year 2055 (43 years). To assess the significance of this, we present the NPV results to this time, and also NPVs to shorter horizons of 20 and 25 years that would be considered acceptable for such analysis.[34]

140. It can be seen from the results in Figure A.5 and Table A.8 that, for the given demand and generation assumptions that we requested, option 4 is not a clearly identifiable choice in terms of NPV rating when compared with the option 2 variations for 20 and 25 year analysis horizons, and is similar on a 43-year basis (which was the basis that Powerlink presented).

Figure A.5: *Analysis results and impact of analysis horizons (with lower demand and SEQ generation)*



Source: EMCa (from Powerlink analysis)

[34] The AER's RIT-T guidelines (section 3.9) state that "In the case of very long-lived and high-cost investments, it may be necessary to adopt a modelling period of 20 years or more" and that the period should be set such that "…by the end of the modeling period, the network is in a 'similar state' in relation to needing to meet a similar identified need to where it is at the time of the investment."

Table A.8: *NPV of 500kV development options, with alternative demand and SEQ*

	PV (per PL, 43 years)	PV (25 years to 2037)	PV (20 years to 2032)
Option 2a (275 kV, no additional easements required)	$387	$338	$219
Option 2b (275kV, with H - GB strategic easement)	$385	$311	$217
Option 2c (275 kV with H - B strategic easement)	$379	$307	$235
Option 4 (build all at 500kV)	$386	$337	$267

Source: EMCa[35] (from Powerlink analysis)

141. In addition to considering scenario NPV results, consideration should be given to the option value of implementing any of options 2a, 2b or 2c relative to Powerlink's proposed option 4. We have not sought to quantify this option value using formal options analysis. However in simple terms, based on the assumptions in the preceding sections, option 2a (for example) presents a reduced expenditure of the order of $130m within the period of the RCP, and no additional expenditure (i.e. over and above the expenditure proposed by Powerlink for option 4) until preparation for its assumed replacement in 2034. In other words, the initial "carrying cost" under Powerlink's proposed option 4 build sequence of the 500kV increment for the Halys-Blackwall line, is made against an assumed cost saving in 2034.

142. The corollary to this is that the quantum of stranded asset risk is considerably reduced by not having "carried" the $135m cost, against an uncertain future need for it, for around 18 years.

143. In its RRP submission, Powerlink notes that the transmission entity in Victoria had effectively carried a similar cost, that of the Hazelwood – South Morang line that was built at 500kV in 1985 and not operated at 500kV until 20 years later,[36]

Sensitivity of 500kV operation to demand and generation assumptions

144. Figure A.6 and table A.9 show the dates when, under the various demand (and demand / generation) scenarios, Powerlink assesses that 500kV operation is required. The top (blue) line and 500kV operation point shows the demand that Powerlink assumed in the primary analysis presented in the RRP, together with the assumed date of commencement of 500kV operation. The two "EMCa medium" demand plot lines on figure A.7 show 2.5% and 3.0% extrapolations of SEQ growth, with the red and green diamonds showing respectively the required commencement-points for 500kV operation without additional SEQ generation, and with up to 2,500MW of SEQ generation as described in previous sections. The combination of lower demand growth and SEQ

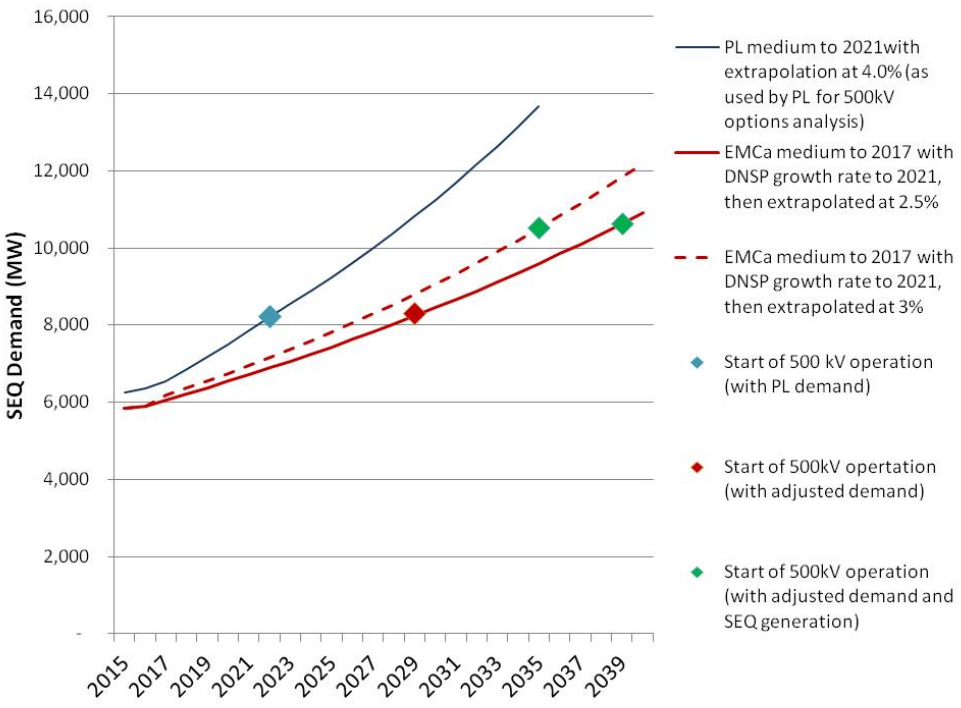
[35] In line with the AER's RIT-T guidelines, and as a simple mechanism for dealing with "end-effects", a one-year deferral has been assumed for Halys-Greenbank in option 2 from 2032 to 2033, consistent with Powerlink's option 4.

[36] RRP, page 95

generation is found to extend the point at which 500kV operation is required, by up to 17 years, from 2022 to 2039.

145. Figure A.6 demonstrates the sensitivity of eventual 500kV operation to demand growth and generation location assumptions. Powerlink's medium demand forecast with a 4%p.a. extrapolation produces a relatively dramatic demand growth curve when compared to the EMCa medium demand growth rate (and extrapolations as previously described).

Figure A.6: *SEQ demand growth and generation assumptions - implications for required commencement of 500kV operation*



Source: EMCa, from analysis provided by Powerlink

Table A.9: *Commencement of 500 kV operation - results of Powerlink analysis*

	PL demand projection	Adjusted demand projection	Adjusted demand with SEQ generation
Year for first operation at 500kV	2022	2029	2039
SEQ demand at time of trigger for 500kV operation	8,544 MW	8,511 MW	10,629 MW
SEQ generation at time of trigger for 500kV operation	150 MW	150 MW	2,650 MW
SWQ (Bulli) generation at time of trigger for 500kV operation	7,140 MW	7,152 MW	7,174 MW

Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

Sensitivity of NPV to demand and generation assumptions

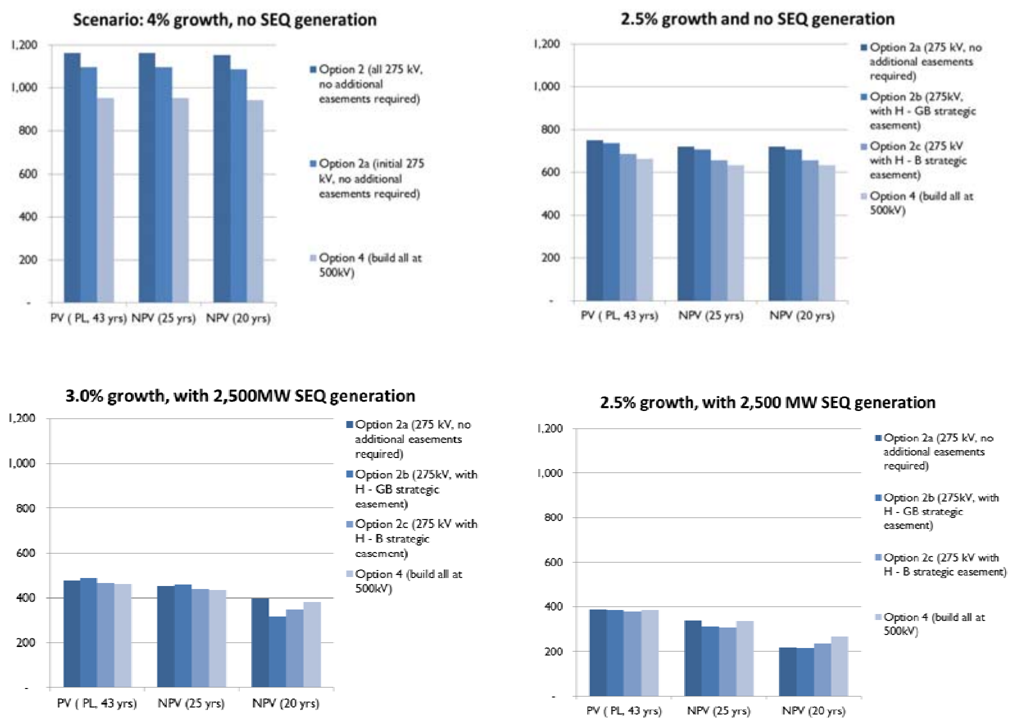
146. The four graphs in figure A.7 indicate the sensitivity of the NPV rankings of the options, to SEQ demand growth and generation assumptions.

147. The NPV of the whole development plan reduces with lower demand and SEQ generation (regardless of the development option) as the successive developments can be considerably deferred, as was shown in table A.9.

148. Importantly, the NPV differences between the different development paths contract considerably. With Powerlink's base assumptions of long-term growth of 4.0% p.a. and no new SEQ generation, the results tend to support Powerlink's proposition of an immediate start to 500kV build. With less aggressive demand growth and the assumption of some SEQ generation to meet that growth, the results become considerably more neutral and in some instances favour deferral. Bearing in mind that these are future estimates for periods up to 43 years, and the range of assumptions inherent in such a long-term analysis, we consider that these results are best interpreted as indicating almost equivalent NPVs for the different development options, for scenarios involving lower demand growth and some SEQ generation.

149. It can also be seen that the analysis period can affect rankings. This is due to "end effects" in which some developments fall just inside or just outside analysis period boundaries, as indicated in a previous subsection. This would require further consideration in a definitive analysis, but is shown here solely to illustrate the issue.

Figure A.7: *NPV comparisons of development path options: Sensitivities to assumed SEQ demand growth, SEQ generation and different analysis horizons*



Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

Regrets analysis

150. A useful technique for analysing decision options with significant future external uncertainties, is to consider the regrets if, having made a particular initial strategic decision, different external outcomes occur. In this case, the immediate strategic decision for Powerlink is whether to commence 500kV build "now" (by building Halys-Blackwall at 500kV) or whether to defer the first 500kV build, specifically, by building Halys-Blackwall at 275kV. Note that future decisions (regarding future lines) will be made at the time they are required, whenever that may be, and there is no need to determine those future decisions at this time.

151. Our regrets analysis hypothesis is that:

a. If Powerlink was to make a decision to defer initial 500kV construction on an assumption of lower demand and SEQ generation, but then high demand growth occurs and/or no SEQ generation is built, then there may be some 'regret' in terms of a higher lifecycle cost of having to bring forward the time when the initial 275kV line has to be replaced by a 500kV line;

b. Conversely, if a higher-cost 500kV line is built on an assumption of high demand growth and no SEQ generation, but demand growth is less and/or significant SEQ generation capacity is built, then there will be a regret cost to having 'over-invested' in the first place.

Figure A.8: *Regrets analysis table for Powerlink's "initial build" decisions*[37]

Cost ($m) (NPVs are over 20 years)

Powerlink's RCP option:		External environment - possible scenario outcomes: 4.0% growth, no SEQ generation (*)	2.5% growth, no SEQ generation	2.5% growth, with SEQ generation	3.0% growth, with SEQ generation
275 kV RCP Development Path (500kV build deferred)	RCP cost (undiscounted)	1,000	245	233	233
	Lifecycle NPV (20 years)	*1,087*	*721*	*219*	*400*
500 kV build commences within RCP	RCP cost (undiscounted)	680	374	362	362
	Lifecycle NPV (20 years)	*943*	*634*	*267*	*382*
RCP cost saving		-321 *see footnote*	129	129	129
NPV lifecycle difference (= "regrets" from following 275 kV initial RCP Development Path)		*-144*	*-87*	*48*	*-17*

Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

[37] In table A.8, the high differential in RCP costs for the 4.0% growth scenario results from Powerlink's assumption that the Halys-Greenbank line would need to be brought forward by 2 years under a 275kV initial build option for Halys-Blackwall, to be just within the RCP, but lies outside the RCP under the alternative option. Given our lower demand forecast, we consider this to be a most unlikely outcome.

152. The regrets table shows first that there is an initial saving of $129m within the RCP, from building Halys-Blackwall at 275kV. Under a 2.5% SEQ demand growth assumption together with 2,500 MW of SEQ generation, there would be a benefit to having done so (i.e. no regrets). There is a cross-over somewhere between this point and a 3.0% demand growth outcome (with SEQ generation) in which case the estimate indicates a $17m regret from having followed the lower cost path. As an interpretation of this outcome, we consider such a regret cost relatively immaterial given the up-front cost saving, the reduced risk and the option value of being able to defer investment decisions so as to make use of better information on a range of factors including peak demand growth rates, generation commitments and technology changes. A more definitive interpretation would result from more in-depth assessment of the assumptions and an exploration of risks, development flexibility and associated option values.

153. We have prepared similar regrets tables for other development options and other time periods, and these are shown in section A.5.

Powerlink's views on feasibility of options

154. In its response, Powerlink states that it considers options 2b and 2c to be infeasible, because they would require strategic easements to be acquired. Powerlink refers to the two expert studies it commissioned to support this view. As we discussed in section 3, the scope of the two studies was to review much larger easement requirements and they do not address the ability to obtain limited easement requirements for a defined period. Powerlink provided further sub-options which would involve undergrounding the "strategic line" routes over part of their length. However these are expensive options and Powerlink's analysis shows them to be not viable.

155. The analysis showed that option 2a, which requires no additional easement, has a similar or better NPV to the strategic easement options 2b and 2c as defined for this analysis. Therefore we rely primarily on this result in forming our view on the reasonableness of the proposed 500kV build for Halys - Blackwall. However we consider that strategic easement options could be further refined (for example, over parts of the route) and that their feasibility and viability should be explored in any options analysis conducted for project decision-making purposes.

275kV line cost assumption

156. For our analysis of the initial RP, Powerlink provided us an estimate that a 275kV line cost would be 51% of the cost of an equivalent 500kV line. In the NPV analysis provided for the RRP, Powerlink has estimated the costs for 275kV and 500kV builds, for each line. The ratios are from 52% to 56%, except for the main subject of this analysis, the Halys Blackwall 275kV line, for which Powerlink estimates a cost ratio for 275kV of 62%. This represents an additional NPV cost for the option 2 counterfactuals of the order of $30m. This suggests the need, in any further options analysis, to explore the reasons for this cost and to ensure that it is correctly applied in comparing the difference between factual and counterfactual costs.

A.4.4 Conclusions on options studied

157. The results of this review for revenue determination purposes indicates that continued construction at 275kV and delayed 500kV construction is a technically feasible and legitimate counterfactual to Powerlink's 500kV build option (option 4) and remains, in

our view, one that should have been included in the Regulatory Test for the Halys to Blackwall transmission line.

158. Using Powerlink's demand forecast and its generation plantings exclusively in SWQ (Powerlink's scenario A)[38], Powerlink's proposed 500kV build program (Powerlink's 'option 4') appears to deliver the lowest NPV of the development options that Powerlink selected for study in the RRP. However, under less dramatic demand forecasts, a better-specified build sequence and with some generation planting in SEQ, we find that this result reverses.

159. In addition, taking an option 2a, b or c pathway would provide greater future development flexibility and reduced exposure to the risks identified in our problem definition, and consequently a lower exposure to stranded asset risk for Queensland consumers.

160. EMCa considers that Powerlink's NPV analysis does not demonstrate the reasonableness of a move to 500kV build at this time, and specifically, for the additional costs of building the Halys – Blackwall line at 500kV within the RCP. Our reasons for forming this view are as follows:

a. EMCa considers that Powerlink's medium demand forecast and its long term extrapolation of this is unreasonably high and that some generation planting within SEQ has a reasonable probability of occurring over the period to 2029 when, absent such generation or any other alternative, a need for 500kV operation is indicated.

b. With what we consider to be more realistic demand and generation scenarios (based on current information), the NPV outcomes at extended NPV analysis periods are essentially neutral for the options analysed and, with shorter but still reasonable analysis horizons, are lower for the 275kV build options 2a, 2b and 2c;

c. We consider that there is a reasonable likelihood of additional benefits for these options if more properly explored (including further variants of option 2[39]) and the option benefit of deferring additional expenditure (even assuming it is required) for 18 years, further enhances the analysis outcome for 275kV options.

[38] Revised Revenue Proposal medium economic outlook demand forecast up to 2021/22 followed by 4% p.a. demand growth for SEQ10 and a net 2% demand growth for the remainder of the state

[39] For example the use of a Halys to Springdale easement extension

A.5 Additional analysis tables

Table A.10: *Regrets Analysis: Comparison of 275kV versus 500 kV initial build strategies, under different scenario outcomes (20 yrs)*

Cost ($m) (NPVs are over 20 years)

		External environment - possible scenario outcomes			
Powerlink's RCP option:		**4.0% growth, no SEQ generation (*)**	**2.5% growth, no SEQ generation**	**2.5% growth, with SEQ generation**	**3.0% growth, with SEQ generation**
275 kV RCP Development Path (500kV build deferred, Option 2a)	RCP cost (undiscounted)	1,000	245	233	233
	Lifecycle NPV (20 years)	*1,087*	*721*	*219*	*400*
500 kV build commences within RCP	RCP cost (undiscounted)	680	374	362	362
	Lifecycle NPV (20 years)	*943*	*634*	*267*	*382*
RCP cost saving		**-321** *see footnote*	**129**	**129**	**129**
NPV lifecycle difference (= "regrets" from following 275 kV initial RCP Development Path)		***-144***	***-87***	***48***	***-17***

Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

Table A.11: *Regrets Analysis: Comparison of 275kV versus 500 kV initial build strategies, under different scenario outcomes (25 yrs)*

Cost ($m) (NPVs are over 25 years)

		External environment - possible scenario outcomes			
Powerlink's RCP option:		**4.0% growth, no SEQ generation (*)**	**2.5% growth, no SEQ generation**	**2.5% growth, with SEQ generation**	**3.0% growth, with SEQ generation**
275 kV RCP Development Path (500kV build deferred, option 2a)	RCP cost (undiscounted)	1,000	245	233	233
	Lifecycle NPV (25 years)	*1,096*	*721*	*338*	*454*
500 kV build commences within RCP	RCP cost (undiscounted)	680	374	362	362
	Lifecycle NPV (25 years)	*953*	*634*	*337*	*436*
RCP cost saving		**-321** *see footnote*	**129**	**129**	**129**
NPV lifecycle difference (= "regrets" from following 275 kV initial RCP Development Path)		***-144***	***-87***	***-0***	***-17***

Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

Table A.12: *Regrets Analysis:(20 years) with option 2b compared to option 4*

Cost ($m) (NPVs are over 20 years)

		External environment - possible scenario outcomes			
Powerlink's RCP option:		**4.0% growth, no SEQ generation (*)**	**2.5% growth, no SEQ generation**	**2.5% growth, with SEQ generation**	**3.0% growth, with SEQ generation**
275 kV RCP Development Path (500kV build deferred, option 2b)	RCP cost (undiscounted)	N/A	245	233	233
	Lifecycle NPV (20 years)	*N/A*	*707*	*217*	*314*
500 kV build commences within RCP	RCP cost (undiscounted)	680	374	362	362
	Lifecycle NPV (20 years)	*943*	*634*	*267*	*382*
RCP cost saving		**N/A**	**129**	**129**	**129**
NPV lifecycle difference (= "regrets" from following 275 kV initial RCP Development Path)		***N/A***	***-73***	***51***	***68***

Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

Table A.13: *Regrets Analysis:(20 years) with option 2b compared to option 4*

Cost ($m) (NPVs are over 20 years)

		External environment - possible scenario outcomes			
Powerlink's RCP option:		**4.0% growth, no SEQ generation (*)**	**2.5% growth, no SEQ generation**	**2.5% growth, with SEQ generation**	**3.0% growth, with SEQ generation**
275 kV RCP Development Path (500kV build deferred, option 2c)	RCP cost (undiscounted)	N/A	245	233	233
	Lifecycle NPV (20 years)	*N/A*	*657*	*235*	*350*
500 kV build commences within RCP	RCP cost (undiscounted)	680	374	362	362
	Lifecycle NPV (20 years)	*943*	*634*	*267*	*382*
RCP cost saving		**N/A**	**129**	**129**	**129**
NPV lifecycle difference (= "regrets" from following 275 kV initial RCP Development Path)		***N/A***	***-23***	***32***	***33***

Source: EMCa, from analysis results provided by Powerlink (RRP and subsequent information requests)

Annexure B: Allowance for efficiency in capital expenditure forecasts

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B.1 Scope of efficiency allowance evaluation

161. The AER has asked for examples of efficiency gains that the EMCa team are able to provide to support quantification of the proposed efficiency adjustment included in EMCa's report on Powerlink's 2012 - 2017 revenue proposal. The efficiency adjustments recommended in that report are:

- a 1% reduction in forecast expenditure in the second year of the RCP; and
- a 2% reduction in subsequent years.

162. From the senior utility management, Board-level and senior consulting experience of members of our team, we identified a number of areas where we would expect efficiency gains to arise (see paragraph 196 of our 2011 report).

163. This annex provides further information in support of these findings and draws on our direct experience in order to scope what in our opinion is a conservative estimate of the gains that a well-managed utility should expect to make over a five-year period. We consider it unlikely that Powerlink would not be able to achieve gains of the level indicated; however the Powerlink-specific ongoing improvements and their quantum will become known only once Powerlink embraces such utility capex management practices.

B.2 Why we consider that efficiency gains can be allowed for in Powerlink's capex forecast

164. A key point EMCa's makes in its September 2011 report to the AER was that *we have found it notable that Powerlink does not have a formally managed focus on continuous improvement and cost management.* During the course of the review we observed that Powerlink had difficulty in identifying where efficiency gains had been made in the past and where potential efficiency gains could be achieved in the future. Where past efficiency initiatives were identified, we did not see evidence that the gains had been quantified, reported and communicated within the organisation.

165. Based on the management experience of the EMCa team it was concluded that the absence of a formal continuous improvement structure in Powerlink was likely to lead to potential opportunities to identify and secure efficiency and improvement gains being missed. In particular, the team considered that formal direction and support from senior management for an organisational efficiency and improvement programme was likely to yield results. In an efficient organisation we would expect to see formal efficiency and improvement management with widely communicated reporting on the achievement of targeted gains. We would also expect to see clearly defined lines of responsibility to an individual manager/s regarding efficiency and improvement. Given Powerlink's large capex programme we would have expected to have seen formal efficiency and improvement

management practices that have become standard practice in efficient organisations.

166. The following efficiency and improvement examples are based on cases that our team have either been directly involved in, or have close knowledge of. We do not suggest that all the approaches taken by the organisations in the examples would be applicable to Powerlink; our intention is to highlight how efficiency and improvement gains have been made in other organisations known to the EMCa team members.

B.3 Examples of efficiency gains achieved

B.3.1 Example 1: Variable and dynamic line rating

167. Variable and Dynamic Line Rating (DLR) is being used on some networks to release significant additional existing network capacity. EMCa understands that between 10 and 20% additional transmission capacity during specific time periods has been gained in Tasmania since the introduction of DLR on a proportion of its high voltage transmission circuits[1]. This is also supported by recent information presented by Transpower NZ[2].

168. The Transpower Line Rating Project is one initiative that falls under the organisation's Technology and Innovation Strategies. In this project Transpower is investigating where quick gains can be made. Bill Heaps of EMCa has knowledge of the VLR and DLR technology and how it is applied. As a previous Commercial Manager at Transpower and, as the Chair of the New Zealand Electricity Commission's Transmission Advisory Group, Bill gained an understanding of the reasons for lack of past progress made on VLR/DLR in New Zealand. In his opinion the lack of a formal framework for innovation contributed to the lack of progress.

169. Importantly, Transpower has now recognised and publically commented that this project will be different from previous studies because this time it has it has *management support*. The initiative is also part of a broader Technology and Innovation Strategy and progress is being publicised. The motivation within Transpower to fully investigate the potential of VLR/DLR can now clearly be seen in the approach being taken and the level of engagement with stakeholders. EMCa considers that the improved focus and motivation to progress this project is

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[1] Advanced Grid Reliability Standards, Workshop on Transmission Network Security Standards Imperial College London 9th March 2009, Gleadow, Todd, Smith, http://www.nationalgrid.com/NR/rdonlyres/8B8287EC-4976-4051-B690-4BD5D789C911/33402/2GridReliabilityStandardsNewZealand.pdf

[2] Transpower New Zealand http://www.gridnewzealand.co.nz/innovative-technology

likely to be attributable, at least in part, to the introduction of a formal Technology and Innovation Strategies programme, supported by senior management.

170. Transpower has estimated that the potential benefits of VLR will include potentially significant deferral benefits arising from extra capacity made available during peak demand times. The overall benefits identified by Transpower are estimated to be up to $55m[3]. If it is assumed that 50% of this benefit would be realised in deferral of capital costs, it would represent approximately 5% of Transpower's normal state annual capital expenditure.

171. This example demonstrates that efficiency and improvement gains benefit from a formal management supported framework where gains are identified, developed and in the case of Tasmania, realised.

B.3.2 Example 2: Bay of Plenty transmission deferral

172. Bill Heaps was Commercial Manager at Transpower NZ during the period where significant pressure was placed on Transpower to construct an additional 220kV transmission line into the Bay of Plenty on the East Coast of New Zealand's North Island. The approximate capital cost of this project was $40m (approximately 6%[4] of Transpower's recent annual capital expenditure). The need for the investment was based on projected demand increases arising from industrial load development and the avoidance of high regional wholesale electricity prices during planned outages on specific sections of the transmission line.

173. Senior management at Transpower led a project to establish how the capital investment could be avoided whilst maintaining service to grid operating standards. At the time, laser line surveys by helicopter were an emerging innovative technology that provided very detailed information on the condition of towers and lines and their local environment. Through this knowledge, opportunities for low cost solutions to realise additional transmission capacity could be identified.

174. Undertaking line surveys in the Bay of Plenty led to the identification of low cost management actions that when taken deferred the need for the construction of an additional 220kV line for an indefinite period. Subsequently, generation has been commissioned in the region which means that if the 220kV line had been constructed the investment would have been stranded.

175. This example is provided to demonstrate how emerging technologies can be adopted by transmission companies to reveal low cost solutions and reduce

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[3] http://www.gridnewzealand.co.nz/f2937,62763321/line-rating-project-update.pdf

[4] Transpower's annual average total capex for the three years 2008/09 to 2010/11 was $627m.

capital expenditure and that deferral sometimes obviates the need for what had been considered a necessary investment because of changing circumstances.

176. During our review of Powerlink's revenue proposal we have seen how changes to asset monitoring and management have led to more efficient asset life cycle cost management. An example of this is the change in condition monitoring and maintenance of assets in the wet tropical areas of Queensland.

177. In EMCa's September report to the AER it was observed that:

> *"The level and quality of condition monitors appears to have seen significant improvement. Evidence of this can be seen through the development, analysis and implementation of the 132kV refurbishment/replacement programme in North Queensland.*
>
> *Powerlink has found, through condition monitoring, that the assets are deteriorating and, to maintain reliable electricity supplies in North Queensland must be improved. The fact that the condition of the assets was not previously known suggests that an improvement in condition monitoring has been implemented."*

178. The improvements in condition monitoring and asset life cycle management are likely to reduce the overall life cycle costs of assets.

B.3.3 Implications from these examples

179. The above examples are provided to demonstrate how emerging technologies and asset management methodologies can, and are, being adopted by transmission companies to reduce capital expenditure. In the Revenue Proposal Powerlink failed to convince us as to how the benefits of past and future innovative approaches, that the organisation had adopted, had been included in the capital expenditure forecast. During our review, Powerlink did not identify initiatives that they were undertaking that would realise benefits during the RCP. EMCa considers that it is unlikely that such opportunities do not exist and that Powerlink would not be able to identity and secure gains from at least a proportion of the opportunities.

B.4 Gains from Smart Grids

180. One example of an emerging technology that is being actively studied by transmission companies the world over is Smart Grid. EMCa has suggested that current and emerging Smart Grid technologies may provide opportunities for transmission companies to better manage power flows on their networks and, in particular, reduce loadings during peak demand times. In its RRP Powerlink has said that it considered Smart Grid was a distribution based technology and any expected gains from reduced demand would have been included in the DNSP demand forecasts.

181. Whilst Powerlink is correct that some smart grid components such as smart meters are more relevant to distribution networks, the benefits that they can provide can be realised along the whole supply chain. Transpower NZ, for

example has recently provided information on how it intends to use smart grid technology to defer investment and improve reliability.

> "***Transpower behind smart grid project***
>
> *A new initiative between national grid operator Transpower and businesses will help ease electricity demand pressures in the upper North Island at crucial times, says Energy Minister Gerry Brownlee. Transpower said yesterday that it had started discussions with interested parties on a multimillion-dollar smart grid initiative in the upper North Island to help defer investment in new assets*[5]"

182. It is also important to consider non-network solutions such as those provided by the relatively recent emergence of organisations known as demand aggregators. These organisations contract to reduce demand for payments during peak demand or periods of stress on the network. It is normal for demand aggregators to contract with transmission companies. In New Zealand, one demand aggregator ENERNOC[6] is now able to offer 100MW of interruptible demand to the electricity market and to Transpower. ENERNOC is a global company active in Australia. EMCa considers that it is likely that opportunities from further development of demand aggregation will become available in Queensland during the RCP and develop further under a proactive approach from Powerlink.

183. This example is provided to demonstrate one potential smart grid technology that may provide opportunities for Powerlink to reduce costs during the RCP.

B.5 Capital project management

184. A common aspect of continuous improvement methodologies for capital intensive organisations arises from improved project management practices. In an efficient organisation it is normal for this aspect of management to be undertaken through a formal programme supported by senior management with reporting on the opportunities identified and the benefits realised.

185. David Frow, Stephen Lewis and Bill Heaps[7] have been senior managers and Board members of electricity network organisations that have adopted continuous improvement methodologies for project management. It is our opinion that Powerlink's practice of adding a generic one line contingency percentage for

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[5] http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=10670455

[6] http://www www.enernoc.com

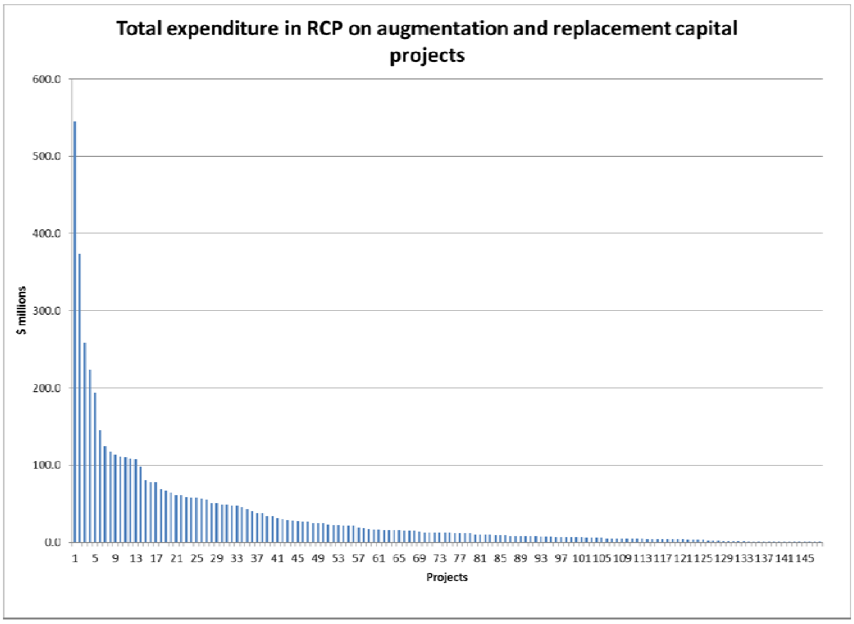
[7] Bill Heaps General Manager Geothermal ECNZ and Contact Energy, Commercial Manager at Transpower NZ and Director of Orion Networks; Dave Frow was Chief Executive of ECNZ and Director of Unison Networks; Stephen Lewis was Senior Manager of National Grid operations in UK, USA, Australia and South America and is a Director of MainPower NZ

capital projects was likely to lead to suboptimal project management outcomes. Mr Lewis' experience at National Grid UK is that, moving from generic contingency allowances to separate contingencies applied to major areas of work or equipment items, leads to overall lower approved project capex levels and improved cost management of projects.

186. A major driver behind the gains that can be made through targeted contingencies is that the vast majority of project costs are in equipment and materials that can be tied down quite tightly. The major risks and uncertainties in capital projects are normally associated with the onsite works and are mainly the civil or establishment works. It is therefore good management practice to encourage tight controls of these areas.

187. Also, EMCa considers that generic application of contingencies does not take into consideration the relative sizes of projects and differing components of the projects. The following chart shows the profile of the augmentation and replacement capex contained in the RRP. The wide range of project value can clearly be seen.

Figure B.1: Powerlink Revenue Proposal - Capex project expenditure profile



Source: EMCa analysis from Powerlink RP data

188. Based on project estimates in the RRP, if Powerlink applies a generic [C-I-C] contingency allowance to the estimated augmentation and replacement project estimates, 13 projects (9% of total 149 projects) will account for 50% of the total contingency allowance applied to all projects. Clearly relatively small efficiency and improvement gains made on the high cost projects will have a large impact on the overall capex expenditure. The application of more specific contingency allowances would be likely to tighten project management and improve focus on key cost drivers.

189. Whilst the basis of establishing the capex component of the revenue allowance is undertaken on a zero contingency basis, the actual expenditure within the RCP will in practice include any project management inefficiencies. Therefore, the project management efficiency gains that a well-managed utility can expect to make through its ongoing cost reduction and efficiency programs will result in an overall reduction in capital expenditure requirement. It is therefore appropriate to take such expected project management efficiency gains into consideration when setting the capex forecast.

190. Capturing the learnings from project overruns and underspends was an approach taken by Mr Frow when he was Chief Executive of the Electricity Corporation of New Zealand. Mr Lewis has also been a senior manager in organisations that have monitored project outcomes to identify where project management improvements are possible. During the review of Powerlink we observed that Evans and Peck had identified a relatively large differential between budget estimates and actual project outcomes.

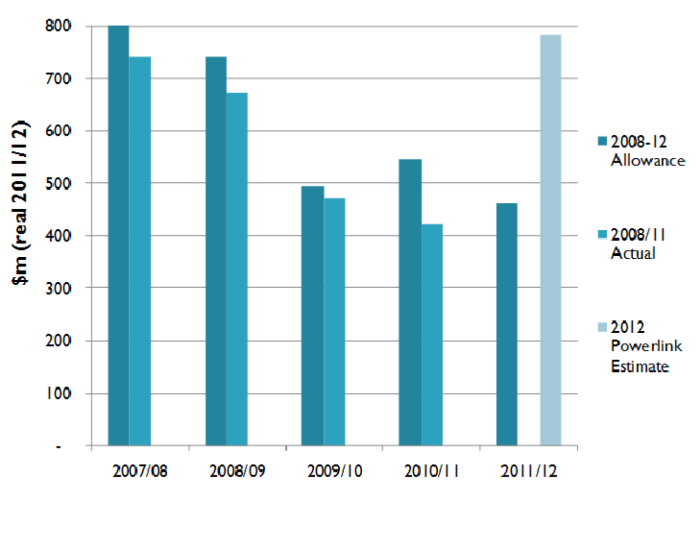
191. In appendix G of the RP Capital Program Estimating Risk Analysis, Evans and Peck analysed 50 capex projects which included 8 easement projects, 16 line projects and 26 substation projects. Evans and Peck found that there had been significant cost overruns (see confidential annex D for details). Powerlink has reported to us that its unit cost estimates used in preparing its capex forecast for the RRP are based on its actual costs from past capex projects, therefore it would appear that these over-runs are now inherent in its forecast spend.

192. Whilst EMCa agrees with Evans and Peck that estimating issues are likely to contribute to a proportion of the overruns, in our experience, given the attention Powerlink has applied to its estimating process and the credibility and integrity that it clearly holds for its base planning object (BPO) database, it is likely that estimation inaccuracy will not be the sole reason for the cost overruns. It is more likely that project management efficiency gains could be identified and implemented that would reduce at least a proportion of capital cost over runs and therefore the cost of projects.

B.6 Historical gains made by Powerlink

193. We observed that Powerlink had made reductions against predicted levels of capital expenditure during the 2007/08 to 2011/12 RCP. The chart below shows the differences between the allowance and actual/estimated capex.

Figure B.2: Current RCP actual capex spend



Source: EMCa Strata (from Powerlink Data)

194. The gains made in the first four years of the previous RCP were 9%, 9%, 5% and 22% respectively. However, the expenditure in the final year brought the total for the full five years close to the allowance.

195. Powerlink has explained that it considered the reduced capex in the first four years of the previous RCP to be due to lower than expected demand with the large increase projected for the final year due to a small number of envisaged major high cost projects. Whilst this may be the case, Powerlink responded appropriately to the changes in circumstances by deferring capex and spending less money.

196. We consider that, during the RCP opportunities will arise for Powerlink to respond in a similar manner and lock in gains from deferral and/or amendment of projects to realise efficiency gains.

B.7 Establishing the basis for an adjustment

197. Taking into account the above findings and examples, EMCa considered that Powerlink had not taken into account in its capital budgeting for the RCP, the realistic expectation of efficiency gains that a well-managed utility would expect to make. As the specifics have by definition not yet been identified and quantified, EMCa proposed an adjustment on the following basis.

	Proposed adjustment	Reasoning for the adjustment
Year 1	None	Whilst improvements implemented by Powerlink during the previous RCP would continue to produce gains during the RCP it was considered that these gains were likely to have been incorporated into the proposed capex. Therefore no adjustment was made to account for gains that are derived from historical improvement initiatives. As Powerlink did not identify initiatives they intended to explore during the RCP that were likely to produce material gains EMCa considered that it was unlikely that such gains would materialise during the first year of the RCP. It is expected that a formal management-driven focus on efficiency and improvement gains could be commenced in the first year but that benefits would only begin to be seen in subsequent years.
Year 2	1% of unadjusted capex for year	It is expected that gains will be identified and the benefits of improved capex performance will begin to be realised. Initially it is expected that gains in project management improvements will be seen in this period of the RCP. Whilst gains from deferral of capital investment may be seen in the period it is considered likely that, due to the longer lead time for these initiatives to take effect, the gains available during this period may not be material.
Year 3	2% of unadjusted capex for year	By year three it is expected that the gains arising from project management improvements will be consolidated and continue at 1%. It is expected that this level of gain will continue for each of the remaining years of the RCP. Note that the expected 1% gains are not cumulative but do increase in value as capex increases in each year. It is expected that gains arising from the introduction of a formal improvement programme would have been identified and implemented for a number of initiatives. Taking into account the examples discussed and the broader experience of the EMCa team it was considered that by year 3 a formal improvement programme is likely to have identified and implemented initiatives that would provide the equivalent benefit of a one year deferral of at least 1.5 projects per year out of the 149 capital projects identified in the RP. In years 3, 4 and 5 the deferral of 1.5 * average augmentation and refurbishment projects has a value in dollars = 1% of the proposed capex on augmentation and refurbishment for the relevant year. It was therefore considered that a 1% adjustment from project management and 1% from other efficiency and improvement initiatives is reasonably achievable and likely to occur in the final three years of the RCP.

Annexure C: Resumes of Authors

Paul Sell

Paul Sell is an energy economist, specialising in energy markets and market reforms. He has over 30 years' experience, which includes providing major advice on restructuring, on deregulation, on the design and implementation of electricity and gas markets and on network regulatory arrangements in Australasia. He has worked extensively with energy utilities, governments, energy regulators and energy market agencies.

Career summary

- Managing Director of Energy Market Consulting associates (EMCa), Sydney, NSW
- Vice President of Cap Gemini Ernst & Young, Global Services Unit (GSU), Sydney, NSW
- Partner of Ernst & Young Consulting, based in Sydney, NSW
- Consultant/Manager/Senior Manager/Principal of Ernst & Young Consulting , Wellington, New Zealand
- Economist in NZ Ministry of Energy, Planning and Forecasting Division Wellington, New Zealand

Expertise

- Electricity and gas utility network pricing, regulation and associated cost analysis
- Energy utility analyses including investment decisions and investment justification processes, energy forecasting and planning studies, and business modelling
- Electricity and gas wholesale markets design and operations
- Energy utility sector reform, restructuring and deregulation policies
- Retail competition in energy markets

Bill Heaps

Bill Heaps is Managing Director of Strata Energy Consulting and Director of Energy Impact and the Sustainable Capital Company. He has over 30 years' experience in electricity utility engineering, management and consulting roles.

Bill is an electrical engineer with senior management experience in energy utilisation, distribution, retail, transmission and power generation. He has recently held three advisory group chairmanship roles for the New Zealand Electricity Commission and currently chairs the Investment Advisory Group. Bill has also been Director of Orion Group Limited, one of New Zealand's largest electricity distribution businesses.

Career summary

- Managing director of Strata Energy Consulting
- General Manager (Commercial Services) at Transpower, New Zealand's electricity transmission and system operating company
- General Manager (Geothermal) of the Electricity Corporation of New Zealand (ECNZ)

Expertise

- **Wholesale electricity market** – Expertise in the design, governance, regulation and operation of electricity markets
- **Electricity Generation** – experienced in power generation plant management and investment planning
- **Electricity transmission networks** – experienced in the provision of transmission services, including pricing and revenue, contracts, asset management systems and performance
- **Electricity distribution** – Experienced in distribution company governance, strategy and policy development and distribution business processes
- **Retail electricity markets** – Expertise in retail market design and operation, including market processes, price risk management, metering, reconciliation and information systems regulation, rules and governance
- **Electricity Utilisation –** experienced in the use of load management techniques in major industrial manufacturing plants and commercial buildings

Stephen Lewis

Stephen Lewis is an electrical engineer who has over 30 years of electricity supply industry experience. His previous career with National Grid plc spanned the UK, the USA, Australia and South America.

Stephen is currently a Director of MainPower New Zealand Ltd., and a Trustee and Chair of Community Energy Action.

Up until August 2006, Stephen was the Commercial Director for National Grid Australia during the final stages of the Basslink HVDC interconnector project between Tasmania and Victoria. Prior to this, Stephen was a Vice President of National Grid USA and headed the transmission business covering the New England and New York states.

Career summary

- Associate consultant with Strata Energy Consulting
- Director of MainPower New Zealand Ltd
- Trustee and Chair of Community Energy Action
- Commercial Director for National Grid Australia
- Vice President of National Grid USA

Expertise

- **Electricity transmission** – Experienced in transmission governance, business management systems and operations, mergers and acquisitions, asset management and integration of processes and systems
- **Electricity distribution** – Experienced in distribution company governance, strategy and policy development and distribution business processes