APPENDIX M

Economic Analysis
SEQ Reliability of Supply 275kV Alternatives

January 2012

Powerlink Queensland 2013–2017 Revised Revenue Proposal

Table of Contents

1 Introduction

In its Draft Decision, the AER did not accept Powerlink's proposed capital expenditure forecast for the 500kV suite of projects. The AER was "not satisfied that Powerlink has demonstrated the need for, and efficient costs of, such strategic expenditure"[1]. The AER instead substituted Powerlink's forecast costs for the 500kV suite of projects with the costs that the AER considered would be associated with typical 275kV builds[2] and indicated that further material would need to be provided to demonstrate the need for, and efficient costs of, the incremental cost of developing a 500kV network which is to be initially operated as a 275kV network. The Regulatory Test performed in 2009 did not include a 275kV option. The Final Report stated:

> All of the network augmentation options also involve the construction of 500kV double circuit lines between Halys and Blackwall substations. Easements have been strategically acquired since the 1980's and reserved for this purpose, in recognition of diminishing land availability and increasing land development in the South East Queensland corner[3].

When developing the options for the Regulatory Test, in 2009, Powerlink only presented technically feasible alternatives which result in similar net present value costs. For example, HVDC options were considered in preliminary planning assessment but excluded from the detailed analysis phase due to their much higher cost. Similarly, 275kV options were also assessed but excluded from the public consultation phase due to the external constraints of existing land use and environmental factors.

In the AER's Draft Decision, the AER observes that "Powerlink has assumed it will be unable to acquire 275kV easements for the project in the future and therefore needed to build on existing easements. The AER considers this should have been tested rather than assumed."[4]

Powerlink has further tested this assumption by obtaining independent expert advice from IDM Partners and Norton Rose (provided to the AER on a confidential basis). Powerlink conclude from this independent advice that it would be unrealistic and unreasonable to expect that Powerlink would be able to secure the necessary approvals to build 275kV on the existing 500kV easements and acquire additional easements to preserve the necessary further development at 275kV. Notwithstanding this Powerlink has taken the step to perform economic analysis on this non-feasible 275kV development option to further demonstrate the merits of the preferred option (building 500kV capable assets).

In light of the matters raised in the AER's Draft Decision, Powerlink has re-assessed 275kV alternatives and updated the option analysis to take account of changes in the external environment (demand forecast, project estimates and new generation outlook) since the 2009 Regulatory Test. This appendix summarises the economic analysis performed.

Although this appendix does not constitute a Regulatory Investment Test for Transmission (RIT-T) consultation process, the analysis is presented consistent with a RIT-T assessment.

---

[1] Draft Decision, Powerlink Transmission Determination 2012-13 to 2016-17, p.29, AER, November 2011.

[2] In estimating the capex adjustment as a result of this substitution, EMCa and the AER underestimated the costs in the 2013-17 regulatory period associated with a 275kV alternative. These are discussed in Appendix N.

[3] Final Report, Maintaining a reliable electricity supply to Southern (South West and South East) Queensland, p.23, Powerlink, 5 June 2009.

[4] Draft Decision, Powerlink Transmission Determination 2012-13 to 2016-17, p.131, AER, November 2011.

2 Options Assessed

Powerlink has developed five options consistent with the three generic credible options described in the AER's Regulatory Investment Test for Transmission application guidelines, when dealing with uncertain future demand growth:

> For example, where future demand growth is uncertain, the following may all be legitimate credible options:
>
> Option (a): fully upgrade a transmission line in the immediate term to accommodate all likely demand growth over the next 15–20 years.
>
> Option (b): upgrade a transmission line to the minimum extent necessary to cover likely demand growth in the next five years (without any further consideration of the potential for further growth in the future).
>
> Option (c): upgrade a transmission line to the minimum extent necessary in the immediate term, but allow for sufficient extra space to (perhaps by installing larger towers than necessary) to allow for a relatively low-cost expansion of the network if generation growth materialises in the future[5].

The five options are:

- **Option 1 Full 500kV upfront**: construct and operate future transmission between South West (SWQ) 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.

For clarity, Option 2 is most aligned with the AER alternative allowed in its Draft Decision (mainly 275kV builds in the period). However Option 2 includes a 500kV build between Halys and Greenbank acknowledging that this line cannot be taken out of service for an extended time in the future. This circuit must be advanced to ensure Powerlink maintains its mandated reliability obligations during the double circuit outage of the Halys to Blackwall line to rebuild for 500kV capability. All other options contain 500kV at varying stages within the development of the option. Option 4 is the preferred option included in Powerlink's Revenue Proposal and this Revised Revenue Proposal.

Powerlink has provided the AER with supporting material (IDM Partners' report and Norton Rose letter) to satisfy the AER's need for a 'test' that Powerlink will be unable to acquire 275kV easements for the project in the future. Powerlink conclude from this independent advice that it would be unrealistic and unreasonable to expect that Powerlink would be able to secure the necessary approvals to build 275kV on the existing 500kV easements and acquire additional easements to preserve the necessary further development at 275kV. IDM Partners identified ecological impediments to this strategy. Visual amenity constraints through high impact areas may be addressed by constructing transmission underground. However, this would not address the

[5] Regulatory investment test for transmission application guidelines, p.9, AER, June 2010.

significant ecological impacts and (in their opinion) render this 275kV development option non-feasible.

Notwithstanding this Powerlink has included this non-feasible 275kV option in the economic analysis. Its inclusion is to assist the AER to form a view of the relative merits of 275kV and 500kV options. The non-credible option is described as:

- **Infeasible Option 275kV new easements**: continue to construct transmission into SEQ at 275kV. This option will entail acquisition of significantly more new easements than other options. In developing this option, allowance has been made for undergrounding specific sections of some additional future lines.

These options have been evaluated in detail, to establish the technical triggers and appropriate augmentations. The study assumes all currently committed transmission projects proceed as planned with the exception of 'CP.01875 Halys to Blackwall 500kV operating at 275kV'.

In performing analysis for the Infeasible Option, an important consideration is the length of underground cable which will be necessary to address visual amenity impacts. The underground lengths allowed in these developments are consistent with the minimum cable lengths developed through a comprehensive desktop corridor selection process undertaken by IDM Partners and provided to the AER on a confidential basis. Specifically:

- Western Downs – Halys: a maximum of 2 additional double circuits can be built overhead, subsequent circuits require [redacted] of underground;
- Halys – Blackwall: a maximum of 1 additional double circuit can be built overhead, subsequent circuits require [redacted] of underground; and
- Halys – Greenbank: a maximum of 1 additional double circuit can be built overhead, subsequent circuits require [redacted] of underground.

Scenarios analysed consider the advent of significant levels of generation in SEQ (see Section 5). For the purposes of this analysis it has been assumed that this generation will support the transmission system without network support payments. This assumption favours options which defer the larger amounts of capital expenditure following the generator's commissioning (i.e. it should favour, in order, the infeasible option, options 3 and 2).

3 Market Benefits

The Rules[6] requires a TNSP to include all classes of market benefits when applying the RIT-T that it considers to be material. A TNSP must consider all classes of market benefit as material unless:

- It can provide reasons why a particular class of market benefit is not likely to materially affect the outcome of the assessment of the credible options; or
- The estimated cost of undertaking the analysis to quantify the market benefit is likely to be disproportionate to the scale, size and potential benefits of each credible option being considered.

Due to the significant cost differences of the preferred alternative (Option 4) and the Infeasible Option and closest AER Draft Decision aligned 275kV feasible option (Option 2), Powerlink has taken the pragmatic approach of **excluding market benefits which favour the preferred credible option** (Option 4) where these are uncertain or difficult to ascertain.

When assessing the impact of the alternatives to market benefits it should be noted that:

- Option 4 will result in higher network transfer limits for longer periods of time than the Infeasible Option and Option 2. This Option 4 establishes larger infrastructure up front with correspondingly higher transfer limits up front.
- Option 4 transfers power more efficiently than the Infeasible Option and Option 2. For a given power transfer, transmission at higher voltage is accomplished at a lower current flow. Transmission losses are a function of current flow. Further, due to the higher number of conductors per bundle (more specifically the cross sectional area of the conductor bundle), Option 4 has significantly lower resistance per circuit than the Infeasible Option and Option 2. This further assists to lower transmission losses and producing more favourable marginal loss factors for South West Queensland generators.

[6] National Electricity Rules, Chapter 6A, Clauses 5.6.5B(c)(5) and (6), AEMC.

RIT-T guidelines summarises the classes of market benefits as:

Class of market benefit	Consideration in economic analysis presented
Variable Operating Costs	Considered only for network assets – conservative assumption. Option 4 having the higher limits will result in lower congestion allowing more periods of lower fuel cost dispatch, however these benefits have not been captured.
Voluntary Load Curtailment	Excluded – conservative assumption. Voluntary load curtailment is dependant on the spot price. Lower congestion will result in lower spot prices.
Involuntary Load Shedding	Excluded – conservative assumption. Option 4 having the higher limits is more favourable under High Impact Low Probability (HILP) events associated with Involuntary Load Shedding.
Costs to other parties	Excluded – conservative assumption. Higher limits and more favourable loss factors to SWQ should result in more competitive market conditions for generators. Therefore the overall costs to the market of generation will favour Option 4.
Timing of Transmission Investment	Considered.
Network Losses	Considered.
Ancillary Services Costs	Excluded – options are not expected to impact ancillary services costs.
Competition Benefits	Excluded – conservative assumption. Higher limits associated with the preferred option mean that it will have greatest competition benefits.
Option Value	Excluded – conservative assumption. Construction of 275kV on existing 500kV easements has extensive impact on option value. The next build will require significant lengths of undergrounding making future 500kV alternatives excessively expensive.

It should therefore be noted that the outcomes of the economic analysis constitute a conservative assessment of the benefits of Option 4 over both the Infeasible Option and Option 2.

4 Assessment Methodology

The RIT-T guidelines advise 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.'[7] A 25 year planning period and 50 year financial modelling period has been selected for this study to capture the impact of expenditure following the last modelled build[8]. Losses are calculated using AC load flow analysis over the first 25 years, and the loss difference between options in the 25th year is continued for the remaining 25 years[9].

The following additional assumptions form the **base case** assumptions:

- Revised Revenue Proposal medium economic outlook demand forecast up to 2021/22 followed by 4% p.a. demand growth for SEQ[10] and a nett 2% demand growth for the remainder of the state.
- Scenario 5 generation developments (highest probability ROAM Consulting scenario), subsequent new entrants injecting to Western Downs (no new entrants in SEQ). New entrant generators are implicit in the nett 2% demand growth in CQ and NQ. That is, a significantly higher demand growth in central and northern Queensland (e.g. due to resource developments in the Northern Bowen Basin and/or Galilee Basin) is offset by new generation developments in those same areas.
- Powerlink's estimating methodology to establish network and easement costs (sensitivity analysis is conducted on each individual cost estimate to test this assumption).
- Cost of losses of $70/MWh (consistent AEMO's volume weighted average NEM spot price during the study period as derived in the 2010 NTNDP[11] – sensitivity analysis is conducted to test this assumption).
- Discount rate of 9% per annum (relevant commercial discount rate – sensitivity analysis is conducted to test this assumption).

---

[7] Regulatory investment test for transmission application guidelines, p.41, AER, June 2010.
[8] Last modelled build occurs on the 25th year.
[9] This assumption will favour the higher loss option (Option 3) since loss differences increase with increasing demand.
[10] Maximum native demands have grown at 4.6% p.a. in SEQ over the last 10 years.
[11] 2010 NTNDP: National Transmission Development Plan, Market Simulation Results, Scenario Comparisons, http://www.aemo.com.au/planning/2010ntndp_cd/downloads/NTNDPdatabase/NTNDPoutputinfo/Scenario%20Comparisons.zip, AEMO, December 2010.

5 Scenarios Considered

Consistent with the principles of the RIT-T Powerlink has considered scenarios that impact on the power transfer requirements into SEQ. As defined in Section 4, the scenarios considered are underpinned by the Revised Revenue Proposal medium economic outlook demand forecast.

A high economic outlook demand forecast has been deliberately excluded from this analysis as it advances the timing for future augmentations which clearly penalises the Infeasible Option relative to Option 4.

A low economic outlook demand forecast has not been explicitly modelled. A low economic scenario is associated with lower power transfers across the SWQ to SEQ transmission corridor. These lower power transfer scenarios are modelled by the inclusion of generation (up to 1,500MW) within the SEQ area. The new generation entrants are assumed to be multiple generating units so as to not introduce a new, more limiting, critical contingency. The scenarios are summarised in Table 5.1.

Table 5.1: Scenarios assessed

Scenario	Scenario description
Scenario A	No SEQ new generation
Scenario B	SEQ new generation in 2016, 500MW
Scenario C	SEQ new generation in 2018, 500MW
Scenario D	SEQ new generation in 2020, 500MW
Scenario E	SEQ new generation in 2016, 1,500MW
Scenario F	SEQ new generation in 2018, 1,500MW
Scenario G	SEQ new generation in 2020, 1,500MW

The inclusion of new entrants, both timing and magnitude, are testing the economic viability of the options that provide lower power transfer capabilities into SEQ and should not be confused with a statement about the probability of such occurrence.

6 Financial Analysis

6.1 Present value analysis

The net present values of the four credible options, across the seven scenarios, are compared in Table 6.1. Table 6.2, includes the same analysis for the non-credible alternative. These results are given for the baseline assumptions defined in Section 4 and clearly show that the least cost long-term development plan involves the establishment of the 275kV with provision for 500kV towers and conductor (Option 4) between South West and South East Queensland. Powerlink's recommended solution is the number 1 ranked option across all scenarios. The second best ranked is Option 3 that constructs 500kV towers but is strung with twin sulphur conductors and 275kV insulations until operation at 500kV is required. The 275kV alternative allowed for by the AER in its Draft Decision (Infeasible Option) is less economic than any of the four credible options considered across all scenarios.

Table 6.1: Summary of economic analysis of the seven scenarios for feasible options

Discount	Scenario A		Scenario B		Scenario C		Scenario D		Scenario E		Scenario F		Scenario G	
Rate 9%	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank
Option 1 Full 500kV upfront	1,056	3	968	3	974	3	1,031	3	837	4	849	3	998	3
Option 2 275kV then replace to 500kV on existing easements	1,162	4	1,007	4	1,060	4	1,103	4	765	3	901	4	1,011	4
Option 3 275kV provision for 500kV towers	982	2	862	2	888	2	920	2	674	2	741	2	823	2
Option 4 275kV provision for 500kV towers and conductor	953	1	837	1	864	1	894	1	658	1	726	1	802	1

Table 6.2: Summary of economic analysis of the seven scenarios for the infeasible option

Discount	Scenario A		Scenario B		Scenario C		Scenario D		Scenario E		Scenario F		Scenario G	
Rate 9%	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank	PV ($m)	Rank
Infeasible Option 275kV new easements	1,632	5	1,392	5	1,417	5	1,436	5	1,019	5	1,081	5	1,128	5

6.2 Sensitivity analysis

Table 6.3 investigates the robustness of the ranking against variation in a number of the input assumptions. Independently for the three discount rates of 7, 9 and 11%, the capital cost of the projects have been varied between plus/minus 15% and the cost of losses between $40/MWh and $100/MWh. In both cases the probability distribution has been assumed to be triangular. To ensure convergence of the Monte Carlo simulations 10,000 iterations for each discount rate were performed.

Table 6.3 demonstrates that Option 4 has the highest probability of being the number 1 ranked option for all scenarios and discount rates. It is pointed out that in all cases where Option 4 is not ranked number 1 in the sensitivity analysis, it is Option 3 which takes the number 1 ranking. In other words, construction of the line using 500kV capable towers always wins the net present value assessment under all sensitivities and scenarios analysed.

Table 6.3: Results of sensitivity analysis for varying discount rates

	Discount rate		
	7%	9%	11%
Scenario A No SEQ new generation	4 (92.72%)	4 (90.63%)	4 (88.15%)
Scenario B SEQ new generation in 2016, 500MW	4 (90.81%)	4 (87.51%)	4 (84.26%)
Scenario C SEQ new generation in 2018, 500MW	4 (90.31%)	4 (86.97%)	4 (83.10%)
Scenario D SEQ new generation in 2020, 500MW	4 (91.82%)	4 (89.00%)	4 (85.67%)
Scenario E SEQ new generation in 2016, 1,500MW	4 (84.48%)	4 (78.08%)	4 (71.73%)
Scenario F SEQ new generation in 2018, 1,500MW	4 (82.62%)	4 (76.22%)	4 (69.53%)
Scenario G SEQ new generation in 2020, 1,500MW	4 (88.86%)	4 (82.65%)	4 (77.09%)

It should be noted that Option 4 is the most economical option even without the consideration of losses (which further support it).

7 Conclusions

The analysis presented in this appendix clearly demonstrates the efficiency and prudency of continuing with the strategy of building Powerlink's transmission network from South West to the South East Queensland region with provision for 500kV towers and conductor. In light of the long life of the relevant assets, it is imperative that a long term view is taken of the development of the network. It has been shown that it is not efficient and prudent to adopt a strategy of 275kV to supply SEQ. The economic analysis shows that the preferred option is to build a 500kV network and to initially operate that network at 275kV.

In developing the technically feasible options for meeting the increasing power transfer requirements between South West and South East Queensland Powerlink has been cognisant of independent consultant advice but have included a non-feasible option which addresses the visual amenity issues. Notwithstanding the lower upfront cost of this 275kV option, when the long term needs of South East Queensland are considered the additional upfront cost of establishing a 500kV capable network is both:

- prudent with respect to the efficient use of land, ecological and social impact; and
- least net present value cost based on a 25 year planning horizon and 50 year financial analysis window.

The robustness of this conclusion was confirmed against key input assumptions, namely lower transfer scenarios modelled by generation in South East Queensland, variation in input costs and cost of transmission losses.

The cost benefit analysis has demonstrated that this strategy is robust against a background of significant new generation in South East Queensland. These generation scenarios are surrogates to lower load growth and/or non-network solutions such as contracting for demand side management or with new generators. In this context the cost benefit analysis provided is conservative to the preferred option as no cost has been allocated to the acquisition of these non-network services.

On the basis of the information provided in this appendix, the AER should be satisfied that the additional incremental cost of developing a 500kV network initially operated at 275kV is prudent and efficient and consistent with the requirements of the Rules.