Evans and Peck: Review of Estimates and Portfolio Risk Calculation

Appendix 10

Tasmanian Networks Pty Ltd

Transend Networks Pty Ltd

EVANS & PECK

Transend

Estimating Risk Assessment

2014/19 Regulatory Submission

May 2014

Table of Contents

List of Appendices

List of Tables

Version Control

Revision	Date	Author	Reviewed by	Comments
0	12/5/2014	Tremayne Raper	Evan Mudge	Final
1	13/5/2014	-	Evan Mudge	Minor Amendments
2	27/5/2015	-	Evan Mudge	

1 Summary

Transend has engaged Evans & Peck to assist with the preparation of its 2014-19 revenue submission to the Australian Energy Regulator (AER). Evans & Peck's scope includes a qualitative assessment of Transend's estimation process, a quantitative assessment of the risk profile for forward projects and a historical assessment of the performance of Transend's estimate outcomes. This is detailed as follows:

- Review Transend's estimating system to substantiate the suitability of the project cost estimating approach applied for the regulatory submission and the likelihood that it will deliver estimates of the order of P50 – that is, an equal likelihood of overruns and underruns. This is the subject of Appendix 1
- On a 'look back' basis, review the historical performance of Transend's estimating and project delivery systems in terms of overall financial performance of the projects that have progressed to completion over the 2009-14 regulatory period. This is the subject of this Appendix 2
- On the basis of the foregoing analysis, provide recommendations in relation to the inclusion of an estimating risk allowance in the forthcoming revenue submission to the AER. This is in the form of recommended risk modelling parameters.

By utilising the specialist skills of Transend personnel involved in the estimation and delivery of those projects, Evans & Peck has structured a risk profile for each type of representative project by looking at the potential variance in individual cost elements in the project. Monte Carlo simulation was then used to develop a diversified risk profile applicable to each project type. The risk profiles are used by Transend to input into its 2014-19 capex forecasting model (capex model).

The historical analysis of completed projects predicts a "P50" portfolio overrun of 3.1% with a statistical bias towards overruns. When projects nearing completion are included, the overall network result changes to a 3.4% underrun, assuming that costs to complete are estimates only at this stage. The +3.1% / -3.4% outcome, at an overall level indicates that Transend has a relatively robust estimating practice in place.

On this basis, Evans & Peck considers that Transend's cost estimating processes, inclusive of the risk allowance, have historically produced reasonable forecasts. Therefore, we recommend that the forecast risk modelling parameters as outlined in Appendix 1, Tables 2 and 3, are updated by Transend in its capex model to reflect a more current view on the likely variance in project outcomes.

2 Overview

In preparing this report, Evans & Peck has completed an analysis of Transend's:

- historical project performance against estimate;
- estimating processes; and
- future project forecasts.

Our review has found that each of these areas is consistent with good practice both within the energy sector and the broader infrastructure sector (specifically the water and road sectors).

In summary:

1. Our quantitative assessment of capital expenditure on completed projects has demonstrated that outcomes across the portfolio are consistent with the forecast results arising from Transend's estimating processes;
2. Our qualitative assessment of Transend's estimating processes, which underpin the development of estimates, show these processes to be consistent with good practice; and
3. Our quantitative assessment of the 'look forward' estimates have then been analysed to establish the inherent risks in the cost components that make up Transend's estimates for individual projects. The outcome of this analysis is used to establish the input parameters to Transend's capex model.

The weighted average risk estimates across the representative projects is summarised in the table below and, with an indicative inherent risk of 1.95% the recommended risk modelling parameters are considered to be a reasonable basis for input into the capex model.

	Inherent	Inherent & Contingent
	P50	P50
Weighted average	**1.95%**	**4.36%**

3 Key Findings

This section summarises the key findings from the key components of our assessment. Further information is included in the two appendices.

3.1 Good Estimating Practice

Evans & Peck has undertaken a high-level comparison of Transend's Regulatory Proposal (RP) estimating process with the regulatory and strategic phase cost estimating process used by organisations in other industry sectors, particularly water and road sectors and with other electricity transmission businesses.

Similar to Transend, these organisations adopt deterministic approaches to preparing strategic cost estimates. There is generally a component of the estimate that is reliant on actual costs incurred on previous projects, but it is not a universal practice.

The key differences between Transend's RP estimating process and other organisation's strategic phase estimating process are as follows:

- Transend's projects are typically more "repetitive" in nature, i.e. there is less variance between the scope of work between projects, when compared against the projects delivered by the water and road agencies. Transend has been able to take advantage of this by developing and utilising templates which enables the production of estimates that have a much greater consistency when compared against similar organisations, despite the common issue of there being limited project definition information and design available at the time of strategic estimate; and
- The comparable organisations generally aim to determine strategic estimates which are more conservative than Transend's RP estimates, typically aiming for the equivalent of a P80 or P90 confidence level rather than the median P50.

Overall Transend's RP estimate process appears to be at least as detailed and robust as equivalent regulatory and strategic estimating processes observed in comparable organisations.

3.2 Risk Profile ('Look Forward')

For the upcoming regulatory period, Transend requested that Evans & Peck recalculate the risk modelling parameters that are applicable to their forecast portfolio of projects.

The portfolio of projects were categorised into 14 different project types. Evans & Peck reviewed five projects which were representative of the different types of projects. This risk factor for each of these five representative projects was then applied to the remaining nine types based on the similarity of the project risk types. Each of the five representative projects was analysed to determine the Inherent risk in the estimate of outturn cost for that project. The Inherent risk for each of the five representative projects was analysed, then the Inherent risks were analysed in conjunction with the Contingent risks which were outside of the control of Transend.

By utilising the specialist skills of Transend personnel involved in the estimation and delivery of those projects, Evans & Peck has structured a risk profile for each type of representative project by looking at the potential variance in individual cost elements in the project. Monte Carlo simulation was then used to develop a diversified risk profile applicable to each project type.

The risk profiles are provided to Transend to input into its capex model, however Evans & Peck were not generating a "global" risk adjustment as prepared in previous reports.

3.3 Project Analysis ('Look Back')

In this analysis, Evans & Peck has focussed on network projects. These have been divided into augmentation and renewal, and analysis has been completed for both completed projects and an expanded portfolio including projects nearing completion (based on Transend's estimate of the costs to complete). In consultation with Transend, a number of projects have been excluded due to significant changes in scope driven by such factors as declining load growth.

For completed projects, the analysis predicts a "p50" portfolio overrun of 3.1% with a statistical bias towards overruns. Augmentation projects tend to perform slightly worse than renewal projects, but overall there is not a large variation between all, augmentation and renewal. It should be noted that the regulatory base cost on which this analysis has been complete includes a risk allowance.

When projects nearing completion are included, the overall network result changes to a 3.4% underrun, subject to the caveat that costs to complete are estimates only at this stage and do not include for unexpected cost or time impacts arising during commissioning and project completion. This is primarily driven by a projected underrun on renewal projects that are nearing completion. Given that overruns have historically been experienced for both augmentation and renewal projects and that a significant bias towards a overrun remains for augmentation projects that are nearing completion, we consider that this result is most likely due to an understatement of the cost to complete or adjustment to scope rather than a systemic overstatement of the original cost.

The +3.1% / -3.4% outcomes, at an overall level this result indicates that Transend has relatively robust estimating practices in place, albeit acknowledging that at an individual project level a much wider variation occurs. These results point to a justification of the continued use of the existing estimating practices (including the risk approach introduced in the current regulatory period).

Appendix 1

Review of Project Estimating Process and Calculation of Project Risk Factors Report.

“Looking Forward”

EVANS & PECK

Transend

Estimating Process and Portfolio Risk

Appendix 1: Review of project estimating process and calculation of project risk factors report

May 2014

Table of Contents

List of Figures

List of Tables

Version Control

Revision	Date	Author	Reviewed by	Comments
0	11/4/14	Jason Hendricks/ Michael Quinnell	Michael Quinnell	Draft
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1 Introduction

Evans & Peck has been engaged by Transend to assess and quantify the risk associated with Transend's capital works portfolio of projects proposed for the five-year regulatory period from 1 July 2014 to 30 June 2019. This review is to support Transend in its preparation of its revenue proposal for the regulatory period.

In 2008 Transend engaged Evans & Peck to carry out a similar role for the 1 July 2009 to 20 June 2014 regulatory period.

For the upcoming regulatory period, Transend requested that Evans & Peck recalculate the risk factors applicable to their portfolio of projects.

The portfolio of projects were categorised into 14 different project types. Evans & Peck reviewed five projects which were representative of the different types of projects. This risk factor for each of these five representative projects was then applied to the remaining nine types based on the similarity of the project risk types. Each of the five representative projects was analysed to determine the *Inherent* risk in the estimate of outturn cost for that project. The *Inherent* risk for each of the five representative projects was analysed, then the *Inherent* risks were analysed in conjunction with the *Contingent* risks which were outside of the control of Transend.

By utilising the specialist skills of Transend personnel involved in the estimation and delivery of those projects, Evans & Peck has structured a risk profile for each type of representative project by looking at the potential variance in individual cost elements in the project. Monte Carlo simulation was then used to develop a diversified risk profile applicable to each project type.

The risk profiles are provided to Transend to input into its capex model, however Evans & Peck were not generating a "global" risk adjustment as prepared in previous reports.

Following calculation of the updated project risk profiles, Transend will input the new risk profiles into its capex model to calculate the risk adjusted capex cost of their portfolio of projects for the 2014 to 2019 regulatory period.

The update of the risk factors was required to reflect changed market conditions in Tasmania and to capture the experience and lessons learnt over the last regulatory period. Transend have also requested a qualitative review of their estimating process be undertaken and documented, to substantiate the suitability of the project cost estimating approach applied for the regulatory submission.

2 Methodology

Evans & Peck has both prepared updated project risk factors and undertaken a qualitative assessment of Transend's project estimating process for the development of regulatory proposal (RP) or strategic estimates. The qualitative review approach involves a high-level assessment of the process steps and inputs to the base estimates, including comparison with other similar organisations. The revision of the project risk factors built on the work carried out for the 2009 to 2014 regulatory period, essentially updating the risk factors utilised for the current period to reflect the changed market conditions in Tasmania and capture the experience gained relating to Transend's project delivery over the last five years.

2.1 Qualitative Assessment Methodology

As part of the qualitative assessment of Transend's project estimating process, Evans & Peck has undertaken the following:

1. Performed a high-level review of Transend's Project Estimating Manual (PEM) which provides the principles for all Transend's operational and capital projects, including non-network, connections, network augmentation and replacement, that are over $100,000 in total cost;
2. Provided commentary on the process steps and identified any shortcomings or areas of concern that may result in estimates that are not representative of a sound base cost (i.e excluding of risk);
3. Reviewed the estimated allowances for a sample of projects to assess whether:
    a. All allowance items are relevant to the project only; and
    b. The allowances for each item are based on reasonable assumptions. to develop a base cost estimate.
4. Compared Transend's Revenue Proposal (RP) estimating process with other similar organisations and their regulatory estimate preparation; and
5. Provided the Transend estimating team with the opportunity to discuss and provide further and better particulars of the process.

It was an important step to assess whether the base estimates prepared by the estimating team at Transend were sound as the risk modelling is undertaken in relation to the base estimate assumptions and contents. Further, the base estimate process dictates the size of the risk ranges assigned to the inherent risk of the models.

2.2 Update of project Risk Factors

2.2.1 Overview

The Evans & Peck 2008 report titled "*Risk Assessment of Transend Capital Works Program for 2009-2014 Regulatory Reset Period*" and dated 30 May 2008, stated that the long duration of a capital works project and their exposure to outside influences means that at any point in time until completion is achieved, the forecast final cost, or outturn cost, will contain a degree of uncertainty.

Therefore, while an initial (best) estimate of outturn cost may be made ("base cost"), the actual outturn cost will almost certainly differ from that initial (best) estimate. This is true during the feasibility, concept design, detailed design and construction phases of a project.

To quantify the extent of variation between the base cost estimate and the outturn cost on a look forward basis, rather than a reliance on historical information, it is proposed to utilise a risk based estimate process, including Monte Carlo simulation for project budgeting, as described in Section 3 below.

The methodology adopted to develop the risk factors for Transend's portfolio of projects relied upon the work undertaken in 2008 for the 2009 – 2014 regulatory period and followed a similar process. Accordingly, sections 5 to 7 of the 2008 report provide relevant background to the approach taken for this updating of the risk factors and this report should be read in conjunction with those sections.

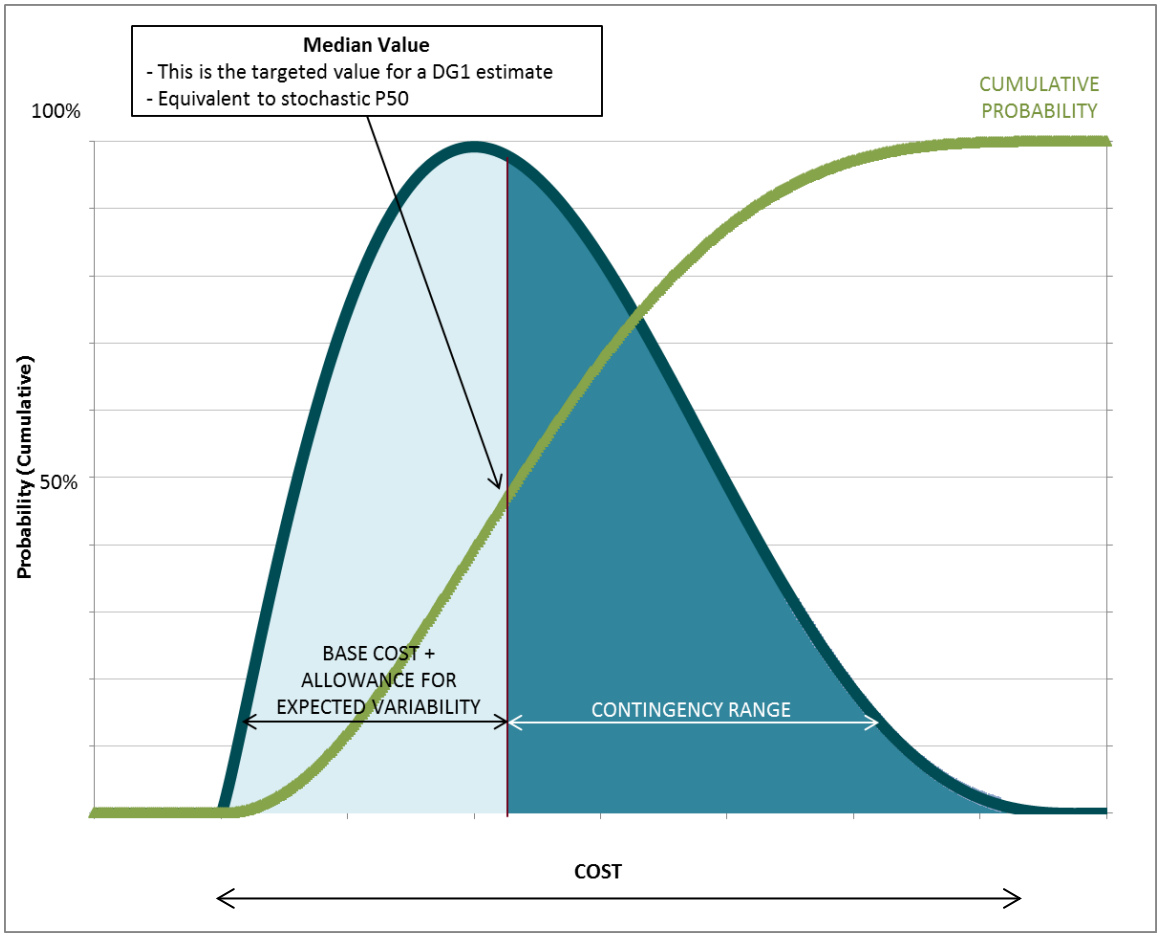
2.2.2 2014-2019 Regulatory Period Update

A sample of five projects were selected jointly by Transend and Evans & Peck from the portfolio of projects proposed for the 2014 to 2019 regulatory period to represent one of each of the project risk types identified in the 2008 work. Each of these project risk types was present in the 2014-2019 portfolio. The selected projects were assessed as representative of the identified project types for the future capital portfolio. Subsequently, Transend developed Level 1 and Level 2 estimates for each of the selected projects.

Starting with the risk models for each project risk type prepared during the 2008 work, the risk assessment was reviewed and revised by updating the risk ranges for the inherent risks and updating the likelihood and risk consequence distributions for contingent risk. The changes to the contingent risk models were derived from the project experiences gained over the 2009-14 regulatory period, the assessment of changing market conditions and changes to the operating model of Transend considering the (potential / proposed) merger with Aurora Energy.

The main output of the probabilistic risk assessment approach is a distribution of potential outcomes, from which values with associated confidence levels can be selected. The median value of the distribution, known as a P50 value, can be identified and compared to the base estimate forecast, with the variance being described in percentage terms of the base estimate.

An illustrative example of the output from a probabilistic model is provided in Figure 1 below. A cumulative probability curve (with left hand axis) has been overlaid on the probability density function in Figure 1 to clearly indicate the P50 value of the illustrative model output.



Range of Expected Outcomes

Figure 1 - Illustrative Example of Stochastic Model Output

For each sample project or risk profile type, a risk model was built using a stochastic approach by adopting the following procedure:

1. The cost items (Transend, Design, Procurement and Installation) from Transend's estimate was used to derive the "base cost" estimate;

2. For each cost item, an assessment was undertaken to capture the uncertainty around the base quantities and rates. This uncertainty was captured in an appropriate probability distribution and an estimate of the minimum, maximum and most likely (where required) value for the quantity and rate for each cost item based on:

    a. Uncertainty on quantities, based on the confidence of the estimating team regarding the assumed scope and past experience regarding observed actual variability of quantities of certain cost items from the base assumption; and

    b. Uncertainty on rates, based on the potential for deviation between the actual rates paid for cost items compared to the rate in Transend's estimating database;

3. For contingent allowances, the uncertainty was captured in terms of the potential range in treatment costs in the eventuality that the allowance is required to fund additional costs caused by the variability in site conditions, weather, productivity, design suitability and contractor performance i.e. what is the worst-case, best case and most likely (if known) treatment cost and the most appropriate probability distribution.

4. A Monte Carlo simulation (using 5,000 iterations) was performed to produce a distribution of potential outcomes. A risk factor was identifed, being the respective percentage difference between the P50 and P90 risk model results and the base estimate values. The @Risk distribution fitting tool was then applied to identify a best fit probability distribution for each project type.

5. The following qualifications should be noted for the development of the probabilistic models
   a. Where a cost estimate line item was not present in the 2008 estimates and not provided by Transend during the 2013 review, a default risk range of 90%, 100%, 120% was used for the risk modeling.

   b. Where a line item in the current estimates is similar to item from the 2008 model, the risk range from 2008 has been transferred across.

   c. The contingent risk consequences utilised in the 2008 models were scaled in proportion to the project base value for the current models to reflect the relative risk compared to the project base value.

3 Qualitative Assessment Findings

3.1 Review of Transend Estimating Process

Transend prepare Revenue Proposal (RP) project estimates using the following approach:

1. RP estimates are based on Level 1 estimates;
2. Forecast cashflow is presented on annual expenditure basis working back from nominated finish dates;
3. Base estimate is calculated in June 2012 dollar terms and input into the capex model (no allowance for Interest During Construction, accuracy (inherent) and contingent risk, escalation or foreign exchange variation as required for Level 1 estimates, but do include location adjustments);
4. Risk and escalation (to reflect the timing) factors are added by the capex model;
5. The output of the capex model is a project estimate in June 2014 dollar terms that includes inherent risk and annual escalation.

Table 1 – Qualitative Findings

Estimating Process	Evans & Peck Commentary
Base Estimate:	
Inputs • The primary inputs used to prepare Level 1 estimates are contained the Project Definition Form, which provides details of: a. the project objectives; b. description of scope of works; and c. overview of the implementation (project delivery) requirements. • Supporting information such as technical standards, planning documentation, existing site design drawings and preliminary schedule.	
Methodology – Preparing the Base Estimate • Level 1 estimates are prepared using a "top-down" approach.	• No detail is provided on how the quantities are derived for the estimates.
• Transend have prepared standard templates for 14 generic project types. These standard templates are used as the basis of the Level 1 estimate and typically comprises of: a. **individual resources** which are referred to in the Project Estimating Manual ("PEM") as base planning objects ("BPO") and base planning rates ("BPR"). • BPOs typically relate to discrete activities or assets *e.g. supply and installation of a transformer or switch bay*. • BPRs typically relate to assets or activities which are estimated using a unit rate *e.g. installation of transmission lines ($/km)*. • The rates for both BPO and BPR	• Use of Project Estimating Templates ("PET") allow for standardisation of estimates, ensure items are not forgotten and consistent formulas are utilised in calculations. • BPOs and BPRs are derived from actual rates obtained from past projects and updated as soon as new data is available. • These rates represent the "installed" cost for various types of conductor stringing or transmission line at different voltages and capacities. • The models include all

Estimating Process	Evans & Peck Commentary
represent "all-in" costs, including direct (supply and install), indirect (design, supervision and contractor's indirects). b. **cost items** which are a mix of appropriate individual BPOs and BPRs. Examples of cost items include: *switchgear bay, power transformers, capacitor banks*; and c. **asset items** which are a collection of relevant cost items. Examples of asset items include: *110 kV,220 kV, groundwork*.	Transend, design, procurement (material) and contractor(labour) costs associated with the functional object. • The PEM also stipulates that the "lowest" tender rate is not necessarily the rate to be utilised for updating the rates in the templates. • Overall this appears to be a very good approach, however there is potential areas of concern regarding the use of historical rates: • Historical rates are generally highly reliable for items which are not generally volatile (e.g. labour rates) • However, more volatile items (e.g. copper cabling) would require a more time specific forecast and understanding of the market than simply relying on historical data. Although there does appear to be evidence that this has been undertaken especially when considering the escalation section of the estimate. • Consideration should be given to the cyclical nature of the market, e.g. were the rates achieved in a quieter market with generally lower rates or in a very busy market where rates are higher than normal. This can be particularly relevant if the rates are over a year old. • The constant review of rates however, should limit these concerns.
d. Adjustments are made to the estimate to account for items not included in the standard template. • The standard templates are generally based on typical "greenfield" projects. • Adjustments are applied to the estimate to account for project or location specific issues that are not considered in the standard template *e.g. environment and planning approval conditions, site conditions,*	

Estimating Process	Evans & Peck Commentary
ground conditions, location etc. • These adjustments may be undertaken as a percentage factor markup for items such as locality (using locality factor specified in the PEM) and staging factors. • Alternatively, for certain elements of the estimate which may be unique to the project or no standard rate is available, a separate first principles estimate may be prepared	• Location adjustment is only made on contractor cost (i.e. labour) and not procurement (i.e. material). Where required specific rates are altered. An example would be where a remote location raises the cost of material e.g. concrete delivery rate.
Project Estimate Shelf Life:	
• Due to changes in technology, market conditions, improvements in productivity, etc. project estimates have a shelf life of 3 months.	
Project Estimate Template Review	
• Estimate templates are to be reviewed regularly to update escalation factor, unit costs and rates. In addition, reviews should follow: o Publishing of quarterly price indices by the ABS; o Publishing of the annual edition of Rawlinson's Australian Construction Handbook; o The receipt of contract award notification, utilising tender cost breakdown information; or o The capitalisation of assets during project finalisation, utilising contractor cost breakdown ("CBS") schedules. • Cost information entered in to equipment and material worksheets from tender cost breakdowns should not necessarily be the 'lowest' tendered cost.	• The PEM does not provide guidance on which cost should be utilised in the feedback loop.
Foreign Currency Exchange	
Consideration should be given to the impact of currency exchange variation on imported equipment or components of locally produced equipment and a specific contingency item included in the estimate. Alternatively, if the value of the item, the exchange variable component and the exchange rate are all known, then a forward adjustment factor may be applied specifically to the item.	

3.2 Comparison between Transend Project Estimating Process with other Organisations

Evans & Peck has undertaken a high-level, comparison of Transend's RP estimating process with the regulatory and strategic phase cost estimating process used by organisations in other industry sectors, particularly water and road sectors and with other electricity transmission agencies.

Similar to Transend, these organisations adopt deterministic approaches to preparing strategic cost estimates. There is generally a component of the estimate that is reliant on actual costs incurred on previous projects, but it is not a universal practice.

The key differences between Transend's RP estimating process and other organisation's strategic phase estimating process are as follows:

- Transend's projects are typically more "repetitive" in nature, i.e. there is less variance between scopes of work, when compared against the projects delivered by the water and road agencies. Transend has been able to take advantage of this by developing and utilising templates which enables the production of estimates that have a much greater consistency when compared against similar organisations, despite the common issue of there being limited project definition information and design available at the time of strategic estimate; and
- The comparable organisations generally aim to determine strategic estimates which are more conservative than Transend's RP estimates, typically aiming for the equivalent of a P80 or P90 confidence level rather than the median P50.

Overall Transend's RP estimate process appears to be at least as detailed and robust as equivalent regulatory and strategic estimating processes observed in comparable organisations.

4 Update of Project Risk Factors

4.1 Overview

Section 7.1 and Section 8 (excluding results of the risk modelling at that time) from the 2008 report are re-presented below in section 4.2 and 4.3 respectively, with updated values applicable for the 2014-2019 period.

4.2 Project Cost Inputs

Transend has a portfolio of 88 "future" projects for the 2014-2019 Revenue Reset period.

Transend has subdivided its total portfolio of projects into 14 different generic project types. Evans & Peck in conjunction with Transend has then analysed the risks associated with an individual project representative of 5 different network categories. These were assessed as being representative of the risks and opportunities for each of these project types and are:

- Type A Transmission line augmentation (small and medium);
- Type B Transmission line augmentation (large);
- Type C Transmission line renewal;
- Type D Substation augmentation;
- Type E Substation renewal.

For the purpose of this Revenue Reset submission, the types of projects and the specific projects selected as the representative sample are outlined in Table 2.

Each of the projects reviewed is a 'Level 3A' estimate.

Table 2 - Risk Assessed Projects

Type	Description	Project Size	Specific Project Assessed	Relationship	Network Category
1	Transline Development (existing easement and TL)	Small		Similar to type 2 Project Profile	**Type A** Transmission line augmentation (small and medium)
2	Transline Development (existing easement and TL)	Medium	Kingston area augmentation (Estimate 1- Transmission Line)		
3	Transline Development (existing easement and TL)	Large (Brownfield)	Waddamana – Palmerston 220kV security augmentation (Estimate 2 - Transmission Line)		**Type B** Transmission line augmentation (large)
4	Transline Development (new easement)	Large (Greenfield)		Similar to type 3 Project Profile	

Type	Description	Project Size	Specific Project Assessed	Relationship	Network Category
5	Transmission Cable (new easement)	Single / Multiple		Similar to type 3 Project Profile	
6	Transline Refurbishment (existing TL)		TL insulator assembly replacement		**Type C** Transmission line renewal
7	Substation Development (green field with transformers & civils)	Single Stage / Multiple Bay	Bridgewater Substation new 110/33kV connection point		**Type D** Substation augmentation
8	Substation Redevelopment (partial brownfield with P&C)	Single Stage / Bay		Similar to type 9 Project Profile	**Type E** Substation renewal
9	Substation Redevelopment (full brownfield with P&C)	Multiple Stage / Bay	Substation disconnector & ES replacement		
10	Network Transformer	Single / Multiple		Similar to type 9 Project Profile	
11	Supply Transformer	Single / Multiple		Similar to type 9 Project Profile	
12	Protection & Control Replacement	Single Stage / Bay		Similar to type 9 Project Profile	
13	Protection & Control Replacement	Multiple Stage / Bay		Similar to type 9 Project Profile	
14	Capacitor Banks (Bay & Cap Bank)			Similar to type 9 Project Profile	

For each generic project type, a specific example was reviewed. Where a specific example was not reviewed then a relationship to a similar generic project type was assigned. Each project was selected because it contributed a considerable forecast cost within the forecast program and was generally representative of the type. For each project Transend had a Level 2 estimate developed for the project, in addition to an initial Level 1.

In summary, the generic project type relationships could be grouped into 5 network categories comprising Transmission Line Augmentation (small & medium), Transmission Line Augmentation (Large), Transmission Line Renewal, Substation Augmentation and Substation Renewal.

4.3 Model Results

Transend's portfolio of future projects within the 2014-19 Capital Works program has been subdivided into 14 groups and individual projects. Representative projects for each group have then been analysed by Evans & Peck using a quantitative risk based approach that recognises the inherent risks in the cost components that make up Transend's estimate of the cost for the individual projects. These are the five identified risk and opportunity types from Table 2.

The results of the quantitative assessment for the representative projects are outlined in Table 3 below.

Table 3 - Summary of Stochastic Modelling Results

Network Category*	Project Risk Type	Base Estimate	Inherent		Inherent & Contingent	
			P50	P80	P50	P80
Type A	**2**	$12,229,648	2.07%	3.23%	3.57%	4.95%
Type B	**3**	$11,372,378	2.49%	3.71%	4.32%	5.73%
Type C	**6**	$11,889,875	1.72%	3.98%	3.50%	5.91%
Type D	**7**	$16,630,429	1.44%	2.50%	5.32%	7.32%
Type E	**9**	$7,804,522	2.46%	3.11%	4.95%	6.43%
	Weighted average		**1.95%**	**3.25%**	**4.36%**	**6.14%**

** Refer to Table 2 for Risk and Opportunity Type*

The weighted average was calculated by comparing the P50 and P80 values to the Base Estimate across the projects.

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Appendix 2

2014/19 Regulatory Submission

Review of Transend Project Estimating and Delivery

“Looking Back”

EVANS & PECK

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Estimating Risk Assessment

Appendix 2 – 2014/19 Regulatory Submission
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Table of Contents

List of Figures

List of Tables

Version Control

Revision	Date	Author	Reviewed by	Comments
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1 Introduction

As part of Transend's regulatory preparations for the 2014/15 to 2018/19 regulatory submission Evans & Peck was engaged to provide an assessment of the cost performance of Transend's estimating processes.

Our scope includes a historical analysis which reviews the performance of Transend's estimating and project delivery systems in terms of overall financial performance of the projects that have progressed to completion.

Consistent with the approach adopted by the AER's advisors in the recent ElectraNet review, we have adopted a non-parametric bootstrapping approach to inform the assessment. This is essentially a method to allow a richer data set to be generated in circumstances where there are a small number of actual data points. Effectively the 'gaps' in the distribution of project outcomes are filled through a process of randomly sampling actual project outcomes to determine the likely range of outcomes for a portfolio containing greater number of similar projects.

This approach is necessary because of the relatively small number of projects that remain where a comparable estimate is reflected in Transend's capex portfolio for the current regulatory control period. Whilst Transend has provided financial information on a total of 326 projects, only 1/3rd of these can be mapped to line items in Transend's 2009-2014 regulatory submission and approximately half of these are non-network projects. The remaining list of network projects has been reduced to:

- only include projects that were included in the 2009-14 proposal to the AER;
- commissioned within the 2009-2014 period; and
- exclude projects that are considered to be outliers as a result of significant changes in scope, often due to significant changes in load growth. The intent of this analysis is to test the robustness of Transend's estimating systems within reasonable bounds of comparability.

For each project, the following information has been provided by Transend:

- Project ID
- Project description
- Expected & revised commissioning date
- Project type
- The AER decision (in $m June 2009 and $m nominal)) for each of the periods:
  - 2009/10
  - 2010/11
  - 2011/12
  - 2012/13
  - 2013/14
- Actual expenditure(in $ nominal) for the periods:
  - Pre 2008/09
  - 2009/10
  - 2010/11

- 2011/12
- 2012/13

- Variance from AER Decision to the Actual

Adjustment from $ June 2009 to $ nominal was under taken by Transend. It is understood that the AER Decision values include an allocated risk allowance in accordance with the amount approved in the final determination.

Analysis has been performed in several ways. These include:

- Commissioned Projects (18 projects)
  - Overall portfolio of completed projects
  - Augmentation vs Replacement Projects
- Inclusion of projects nearing commissioning (an additional 14 projects)
  - Overall portfolio of completed projects
  - Augmentation vs Replacement Projects

2 Project Outturn to Budget Performance

In order to achieve a "like for like" comparison of outturn costs to regulatory forecasts, Evans & Peck has applied CPI escalation to bring figures to a constant ($2012/13) basis. In addition to a simple comparison between forecast and outturn costs on a project / portfolio basis, analysis has also been conducted using the non-parametric bootstrap methodology.

By way of regulatory precedent, in assessing Electranet's application for a risk allowance as part of its 2013/14 – 2017/18 regulatory determination, the AER (in conjunction with its consultants EMCa and MetServices) utilised a non-parametric bootstrap methodology to determine the probability that a portfolio of projects would have an outturn cost below, equal to, or above budget.

The bootstrap methodology utilises a technique of repeated sampling from a finite set of project outcomes within a portfolio to expand the set to the extent that statistical parameters can be inferred for the portfolio as a whole. In essence, it utilises a relatively sparse set of data to increase the richness of the data set to a point where overall statistical inferences can be made.

Given this precedent, Evans & Peck has applied this methodology to both the Commissioned and "to be" Commissioned projects to draw conclusions relating to the accuracy of Transend's estimating / delivery processes.

Analysis has also been expanded to include network projects that were included in the 2009-2014 submission but will be commissioned in the near future. This expands the list of network projects to 32 in total, representing a total of $142.45 million in expected expenditure compared to an equivalent AER budget of $147.54 million. This equates to an underrun of 3.4%, indicating Transend is significantly more optimistic in relation to their projects nearing completion than has been indicated by completed projects.

2.1 Overall Portfolio of Commissioned Network Projects

After removal of "outliers" (i.e projects that have changed significantly in scope or not progressed to completion) a total of 18 network projects (i.e Asset Renewal, Augmentation, Connection or Spares) remain in the analysis on commissioned / completed projects. These projects represent $110.6 million in expenditure ($nominal), the allocation for these projects from the AER was $107.43 million ($ nominal).

The range of project outcomes is demonstrated in Figure 1.

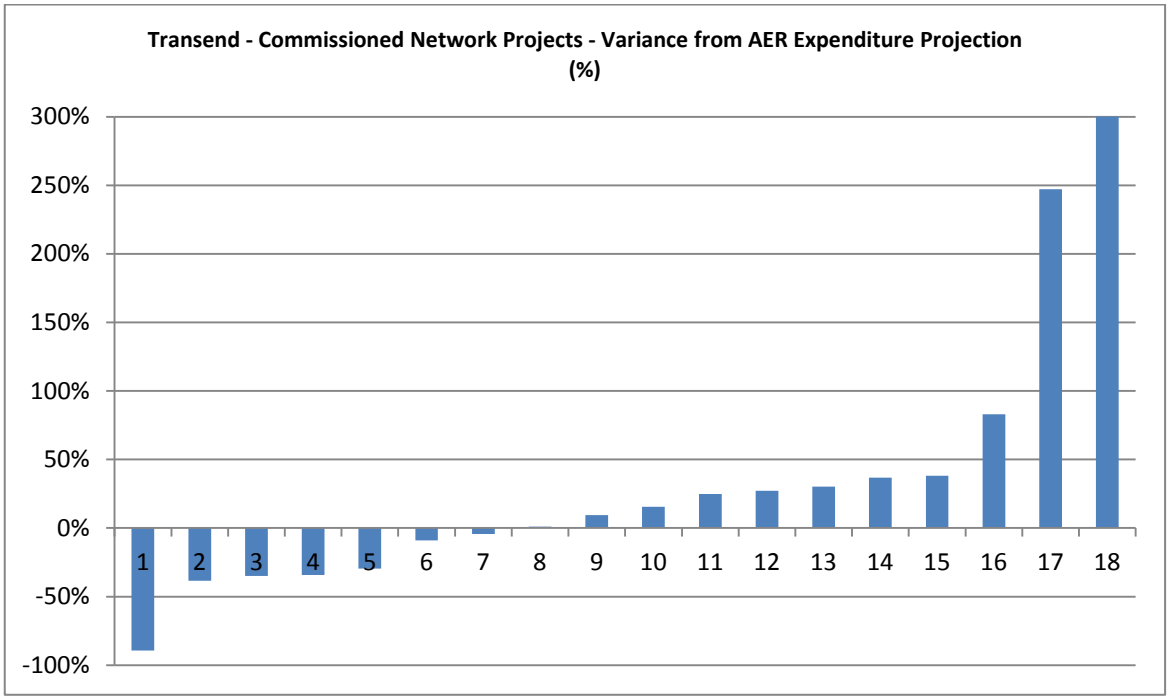

Figure 1 Network Project Performance – 2009/10 to 2014/15 Regulatory Period (Completed Projects)

Overall and after converting budgets and expenditure to a common $2012/13 base, the portfolio of selected projects incurred an overrun of approximately 3.6% ($3.2 million).

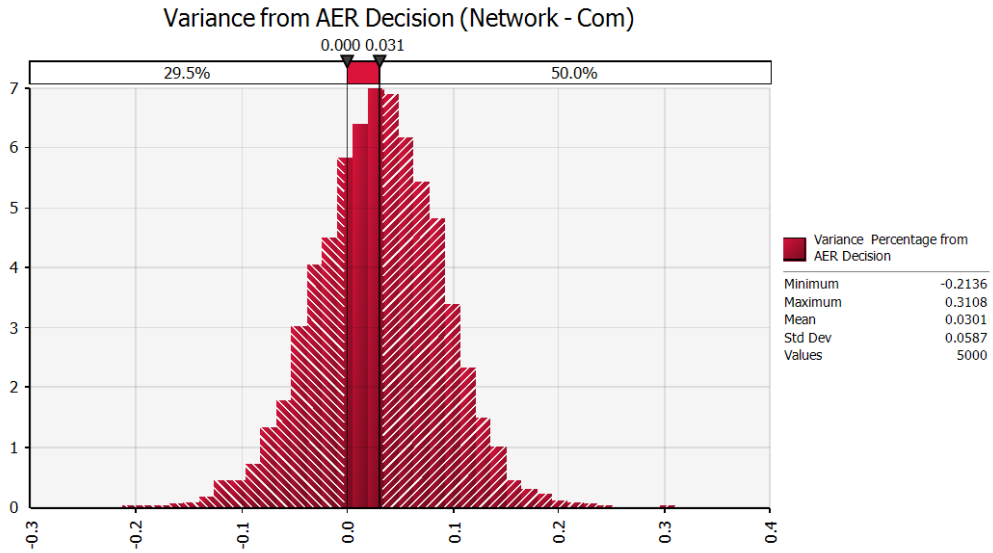

Figure 2 Bootstrapping analysis to portfolio of projects

Bootstrapping analysis has been applied to this portfolio of projects to determine the range that of outcomes that may occur in the overall outcome for an expanded portfolio of similar projects. The advantage of the "non-parametric bootstrap" technique is that it provides an estimate of not only the "mean" outcome (which can be calculated directly anyway), but also provides insight into the likely statistical spread of outcomes for a different set of projects with individual performance

similar to the ranges encountered for the 18 commissioned projects. The resultant analysis is shown in Figure 2.

The "x" axis shows statistical range of expected outcome for the portfolio as a whole. "0.00" represents outturn costs in line with budget, "-0.10" represents a 10% underrun and "0.10" represents a 10% overrun. The vertical axis represents the relative probability of each outcome.

Bootstrapping results in a ""p50" overrun of 3.1%, which is marginally less than the mean value of 3.6% that was calculated above. The results are also skewed toward an overrun, with a 70% chance of an overrun compared to a 29.5% chance of an underrun. In essence, based on this information, Transend's estimating system underestimates by around 3.1%.

In order to assess the performance of the estimating system on augmentation projects when compared to renewal projects, Evans & Peck has repeated the analysis on two separate subsets of projects.

2.1.1 Portfolio of Completed Augmentation Projects

Augmentation has been taken to include both "augmentation" and "connection" projects as these are broadly the type of projects that result in the construction of new assets. This subset consists of only 6 projects that have been completed, are identified in Transend's historical regulatory forecast, and are not considered (by Transend) to be outliers.

The resultant bootstrap analysis is shown in Figure 3.

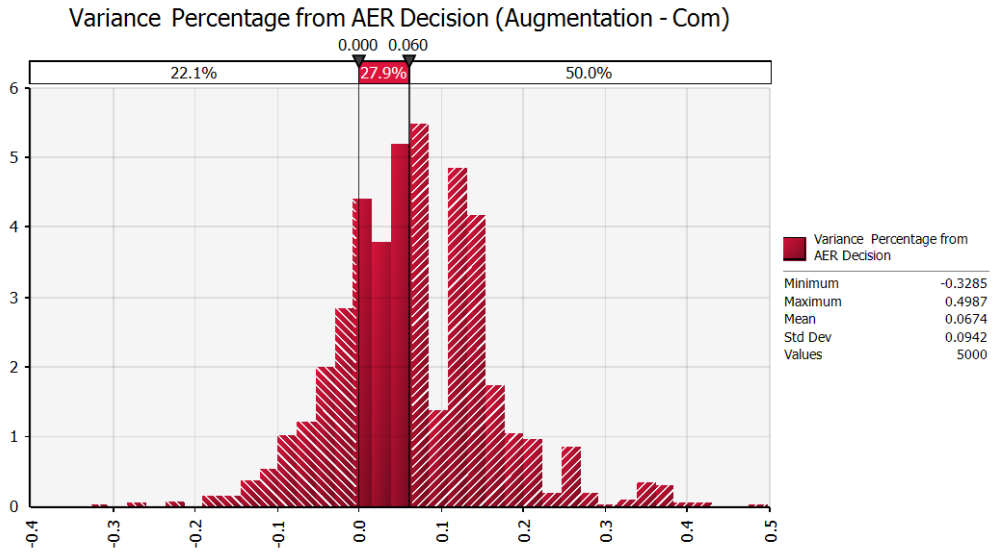

Figure 3 Bootstrap analysis of Augmentation projects

The "p50" overrun is 6%, with a 77.9%/22.1% assymetry towards an overrun.

2.1.2 Portfolio of Completed Renewal Projects

There were 11 completed "renewal" projects that are identified in Transend's historical regulatory forecast and are not considered (by Transend) to be outliers. The resultant bootstrap analysis for this group of projects is shown in Figure 4.

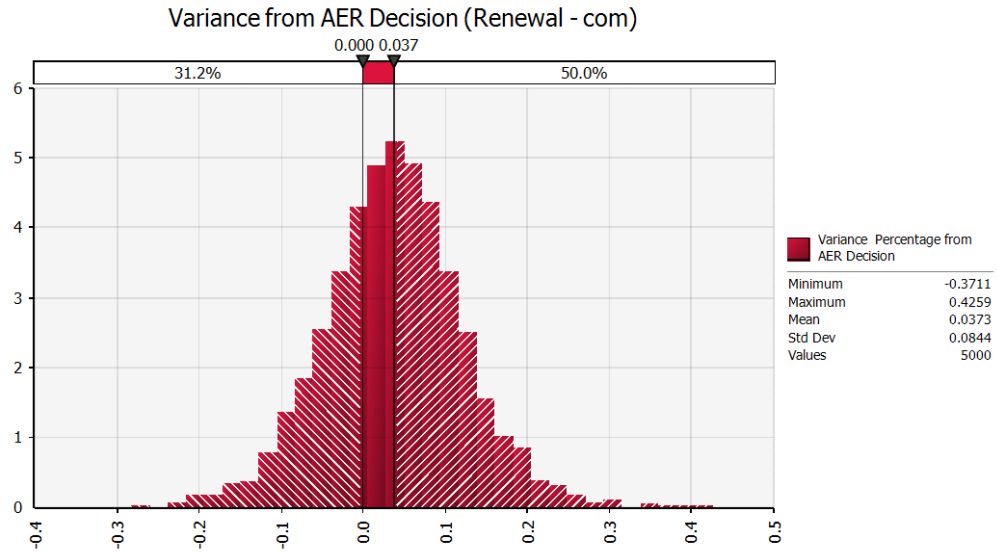

Figure 4 Bootstrap analysis of Renewal projects

Based on this analysis, the "P50" portfolio outcome is a 3.7% overrun, with an asymmetry of 78.8%/31.2% towards an overrun rather than an underrun.

The results for both augmentation and renewal result in a P50 (and mean) outcome above that shown in Figure 2 for network projects as a whole (6% and 3.7% vs 3.1%). One additional project, a primary plant spare, is included in the results for network as a whole. This project shows a 39% underrun, and has had a corresponding influence on the overall result.

2.2 Expanded Portfolio – Inclusion of Network Projects Nearing Completion

In order to increase the available sample size, the bootstrapping methodology has been expanded to include a number of projects that will be completed in 2014, 2015 or 2016, and Transend believes reasonable estimates of cost to complete can be made. This increases the overall number of network projects in the analysis to 32.

The result of the bootstrapping analysis for these projects is shown in Figure 5.

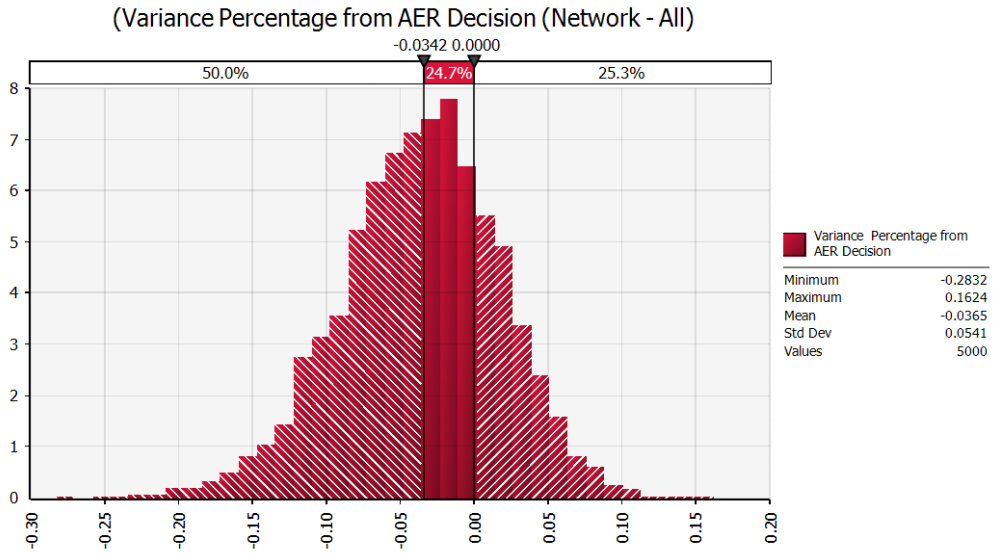

Figure 5 Bootstrapping analysis to include Network projects nearing completion

Whereas completed projects are showing a potential overrun of "P50" 3.1%, inclusion of the projects nearing completion reduces this to an expected "P50" underrun of 3.4%. We note that this reversal is not unexpected for projects that are still in progress as they remain exposed to cost uncertainties relating to commissioning and completion, where unexpected cost or time impacts are likely to occur. In order to further analyse this reversal, Evans & Peck has broken the analysis into "augmentation" and "renewal" projects.

2.2.1 Expanded Portfolio of Augmentation Projects

Inclusion of projects nearing completion into the augmentation sample increases the sample size from 6 to 8. The resultant bootstrap analysis is shown in Figure 6.

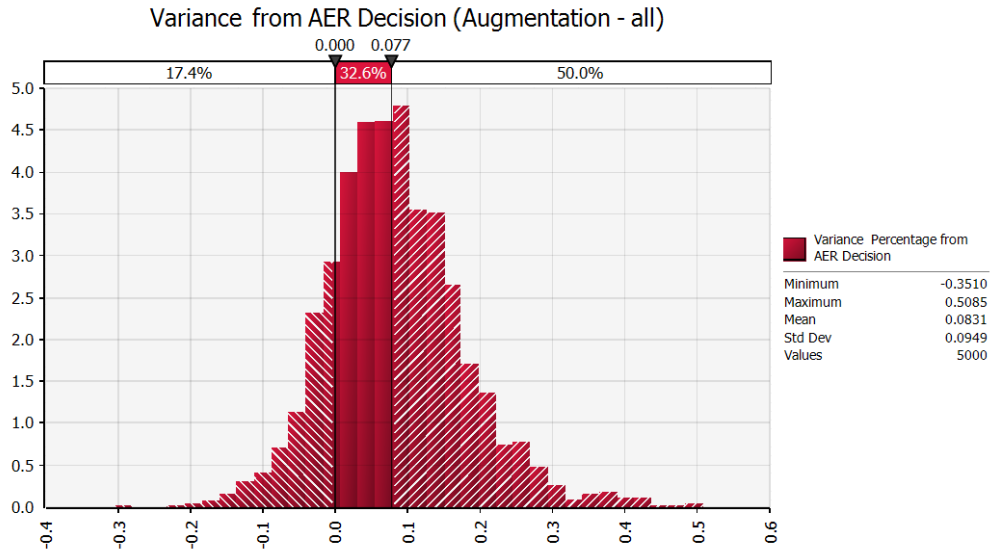

Figure 6 Bootstrap analysis of Augmentation projects including "to be completed" projects

Inclusion of the 2 additional projects increases the expected "P50" overrun from 6% to 7.7%, with increased asymmetry towards an overrun 82.6% / 17.4%. Renewal projects demonstrate the opposite effect as shown below 2.2.2.

2.2.2 Expanded Portfolio of Renewal Projects

Inclusion of "to be completed" renewal projects increases the portfolio size from 11 to 24 projects. The results of the bootstrapping analysis are shown in Figure 7.

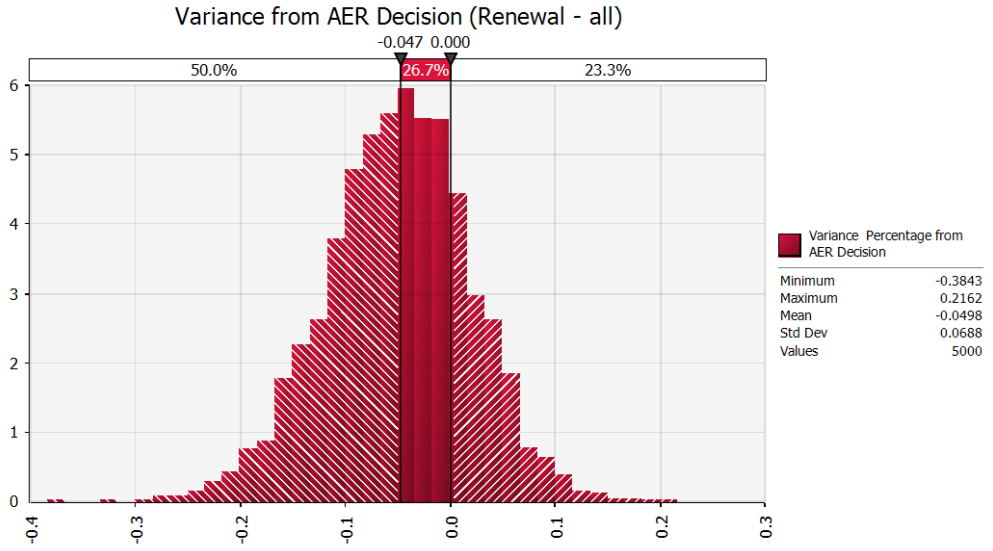

Figure 7 Bootstrapping analysis of Renewal projects including "to be completed" projects

Inclusion of these projects changes the expected portfolio outcome from an expected overrun of 3.7% to a "p50" underrun of 4.7%. In essence, this result implies that Transend is optimistic that its performance on yet to be completed projects will be better than those already completed. Given:

a) the historical overruns for both augmentation and renewal projects; and,

b) the significant bias towards cost overruns for augmentation projects that are nearing completion,

we consider that this result is more likely to arise from an understatement of project cost to complete forecasts or from scoping changes than from a systemic overstatement of the original project costs

3 Conclusions

As is often the case in analysis of this type, the availability of data on which to base meaningful comparisons is limited due to long project and regulatory lead times resulting in changes as projects proceed from planning to inception and implementation. The AER has implicitly recognised the challenges of data sparsity through the inclusion of the "non-parametric bootstrap methodology" in their ElectraNet 2013-14 to 2017-18 decision.

In this analysis, Evans & Peck has focussed on network projects. These have been divided into augmentation and renewal, and analysis has been conducted on both completed projects and an expanded portfolio including projects nearing completion (based on Transend's estimate of the costs to complete). In consultation with Transend, a number of projects have been excluded due to significant changes in scope driven by such factors as declining load growth.

For completed projects, the analysis predicts a "p50" portfolio overrun of 3.1% with a statistical bias towards overruns. Augmentation projects tend to perform slightly worse than renewal projects, but overall there is not a large variation between the 'all projects', 'augmentation only' and 'renewal only' categories. It should also be noted that the regulatory base cost on which this analysis has been complete includes a risk allowance.

When projects nearing completion are included, the overall network result changes to a 3.4% underrun, subject to the caveat that costs to complete are estimates only at this stage and do not include for unexpected cost or time impacts arising during commissioning and project completion. The overall result is primarily driven by a projected underrun on renewal projects that are nearing completion. Given that overruns have historically been experienced for both augmentation and renewal projects and that a significant bias towards a overrun remains for augmentation projects that are nearing completion, we consider that this result is most likely due to an understatement of the cost to complete or adjustment to scope rather than a systemic overstatement of the original cost.

The +3.1% / -3.4% outcomes, at an overall level this result indicates that Transend has relatively robust estimating practices in place, albeit acknowledging that at an individual project level a much wider variation occurs. These results point to a justification of the continued use of the existing estimating practices (including the risk approach introduced in the current regulatory period).

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