Jemena Electricity Networks (Vic) Ltd

2016-20 Electricity Distribution Price Review Regulatory Proposal

Attachment 7-13

Jacobs - Real cost escalation indices forecast

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Real Cost Escalation Indices Forecast

JEMENA ELECTRICITY NETWORK

Real Cost Escalation Indices Forecast

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Real Cost Escalation Indices Forecast

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Document history and status

Revision	Date	Description	By	Review	Approved
0	18-09-2014	Draft version for JEN comments	A Malla	J Butler	R Dudley
1	26-11-2014	Final version based on draft version	A Malla	K Lui (JEN)	J Butler

Contents

Executive Summary

In previous decisions for electricity network service providers, the Australian Energy Regulator (AER) has allowed for costs related to capital and operational expenditure provisions to be escalated in real terms. Prior to these decisions the Australian Consumer Price Index (CPI) was used by the AER to represent cost escalation in relation to network asset costs. The method currently accepted by the AER involves the modelling of the change in equipment prices through combining independent forecast movements in the real price of input commodities and manufacturing activity, with weightings for relative contribution of each cost driver to the final material or equipment cost. The material or equipment is then further combined with independent forecast movements in the real price of engineering, construction and management labour to make-up or represent the complete installed and functioning asset classes in the electricity network. This in turn generates real cost forecasts for the regulatory control period under review.

Jacobs was engaged by Jemena Electricity Network (JEN) in July 2014 to undertake the development of real cost escalation annual indices for various common electricity network asset classes from January 2011 to December 2020 to be used in the forthcoming regulatory period.

JEN has provided Jacobs with the underlying real historical and forecast annual price indices of all the cost drivers developed by BIS Shrapnel. These inputs are shown in Table 1.

- Table 1 Average annual real cost escalation year-on-year % change of the underlying network cost drivers

Cost Drivers	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australian CPI	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Copper	0.61%	-11.83%	-3.86%	-3.36%	1.04%	3.71%	7.68%	2.13%	-9.99%	-6.09%
Aluminium	-5.11%	-16.91%	-5.76%	1.32%	10.12%	8.23%	8.23%	5.15%	-7.01%	-5.21%
Steel	-3.30%	-13.26%	-4.84%	-2.15%	5.41%	4.97%	2.99%	2.71%	-11.01%	-3.36%
Oil	3.28%	-3.94%	10.25%	5.63%	-1.31%	-0.86%	4.32%	2.54%	-7.66%	-4.97%
Wood	1.77%	1.49%	0.40%	3.20%	3.10%	2.40%	1.70%	0.90%	2.20%	3.90%
Engineering Construction Index	-0.90%	0.77%	-1.35%	-1.23%	-0.89%	-0.55%	-0.33%	-0.11%	0.22%	0.65%
Australian TWI	3.54%	-0.18%	-6.58%	-7.25%	-5.10%	-5.03%	-7.69%	-7.16%	6.99%	2.44%
Victorian utility labour: Int WPI	0.81%	2.12%	1.90%	0.74%	1.08%	1.13%	1.35%	1.76%	2.11%	1.81%
Victorian utility labour: Ext WPI	1.10%	1.37%	1.75%	1.06%	1.38%	1.44%	1.63%	1.49%	1.61%	1.92%

These input indices are aggregated to develop the real forecast cost escalation indices for various asset classes common to JEN's asset base in the preparation of its regulatory proposal. These outputs are shown in Table 2.

- Table 2 Average annual real complete cost escalation year-on-year indices aggregated to JEN's common asset classes

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wooden Pole	1.010	1.015	1.017	1.013	1.013	1.013	1.014	1.014	1.015	1.018
Concrete Pole	1.000	1.013	1.003	0.998	1.002	1.004	1.006	1.008	1.011	1.013
Steel Pole	1.004	0.998	1.012	1.006	1.014	1.014	1.016	1.017	0.999	1.008
Steel Cross Arms (incl. Insulators)	1.009	1.005	1.014	1.005	1.006	1.006	1.009	1.010	1.008	1.009
Wood Cross Arms (incl. Insulators)	1.011	1.013	1.016	1.007	1.007	1.007	1.010	1.011	1.015	1.014

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Bare Conductors (Al)	0.997	0.979	1.000	1.006	1.026	1.023	1.023	1.020	0.999	1.003
Insulated Conductors - LV	0.998	0.965	1.008	1.012	1.025	1.022	1.028	1.021	0.982	0.991
Bare conductors (steel)	1.005	1.005	1.011	1.004	1.014	1.014	1.014	1.016	1.008	1.013
Underground Cables and Cablehead - HV, XLPE	1.008	1.000	1.011	1.004	1.009	1.012	1.018	1.014	1.003	1.008
Underground Cables and Cablehead - LV, XLPE	1.007	1.006	1.014	1.008	1.013	1.013	1.016	1.015	1.011	1.013
Supervisory Cable - Fibre Optic	1.010	1.015	1.017	1.010	1.013	1.014	1.016	1.015	1.016	1.019
Capacitor Banks	1.006	1.002	1.012	1.006	1.014	1.014	1.016	1.016	1.006	1.011
Power Transformers - Zone Substation	1.003	0.986	1.006	1.003	1.015	1.016	1.018	1.015	0.993	1.003
Power Transformers - Distribution	1.002	0.982	1.004	1.002	1.016	1.016	1.018	1.015	0.990	1.000
Circuit Breakers - Indoor	1.009	1.000	1.005	0.998	1.006	1.007	1.007	1.007	1.010	1.010
Circuit Breakers - Outdoor	1.008	1.003	1.006	0.999	1.006	1.007	1.007	1.008	1.012	1.011
Outdoor Buses	1.000	1.014	1.002	0.998	1.001	1.003	1.005	1.008	1.011	1.012
CT's and VT's - Zone Substation	1.009	1.003	1.007	1.000	1.007	1.008	1.008	1.008	1.012	1.012
Neutral Earthing Resistor	1.007	1.014	1.016	1.006	1.012	1.012	1.014	1.017	1.015	1.014
Earth Grid Conductors	1.008	0.994	1.008	1.001	1.011	1.016	1.023	1.016	0.998	1.005
Zone Substation Batteries	1.009	0.993	1.010	1.001	1.006	1.007	1.008	1.008	0.999	1.005
Zone Substation Battery Chargers	1.009	0.993	1.010	1.001	1.006	1.007	1.008	1.008	0.999	1.005
HV Disconnectors / Isolators	1.008	1.000	1.004	0.997	1.006	1.006	1.006	1.006	1.011	1.010
LV Disconnectors / Isolators	1.008	0.999	1.003	0.996	1.005	1.005	1.005	1.006	1.010	1.009
Reclosers / Gas Switches	1.009	0.996	1.001	0.995	1.004	1.005	1.004	1.004	1.008	1.008
Surge Diverters	1.009	0.981	0.990	0.987	1.000	1.001	0.998	0.996	1.001	1.002
Fault Indicators	1.008	1.000	1.004	0.997	1.005	1.006	1.006	1.006	1.011	1.010
Pillars / Pits	1.006	1.016	1.012	1.004	1.008	1.009	1.011	1.013	1.016	1.016

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Public lighting luminaries	1.008	1.011	1.014	1.008	1.010	1.011	1.012	1.012	1.013	1.015
Relays - Digital / Microprocessor	1.010	1.011	1.011	1.002	1.005	1.006	1.007	1.008	1.016	1.013
SCADA - RTU	1.007	1.014	1.014	1.006	1.009	1.009	1.011	1.012	1.015	1.014
Fence	1.002	1.013	1.005	1.001	1.004	1.006	1.008	1.009	1.011	1.014
Ring Main Unit	1.009	0.980	0.990	0.987	1.000	1.001	0.998	0.996	1.001	1.001

The historic and forecast annual time period referenced in all the tables in this report runs from January month to December month, i.e. calendar year.

In developing the real cost escalation indices forecast, Jacobs has applied a methodology consistent with the accepted approach for the AER's most recent electricity utility regulatory decisions including the following:

- SA Power Networks (http://www.sapowernetworks.com.au/ centric/ corporate/ corporate_information/ regulatory_proposal_20152020.jsp);
- ActewAGL (https://www.aer.gov.au/node/11482);
- TransGrid (https://www.aer.gov.au/node/23137);
- SP AusNet (https://www.aer.gov.au/node/19819);
- Energex (https://www.aer.gov.au/node/20187);
- Ergon (https://www.aer.gov.au/node/20186); and
- Powerlink (https://www.aer.gov.au/node/7945).

The real cost escalation indices forecast presented in this report are specific to the operating environment faced by JEN, and are based on the most recent input information available and provided to Jacobs.

Important note about your report

The sole purpose of this service by Jacobs is to develop real cost escalation factors aggregated to asset classes common to the electricity utilities asset base, using various cost drivers data provided by a third party, in accordance with the scope of services set out in the contract between Jacobs and JEN. That scope of services, as described in this report, was developed with JEN and documented in Jacobs' proposal.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by JEN and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate, outdated or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information provided by JEN at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of JEN, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and JEN. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Limitation Statement

Forecasts are by nature uncertain. Jacobs has prepared these projections as an indication of what it considers the most likely outcome in a range of possible scenarios. These forecasts represent the author's opinion on what is considered to be reasonable forecasts, as at the time of production of this document and based on the information set out in this report.

Jacobs has used forecasts it believes to be credible, and its own judgement and estimates as the basis for developing the cost escalators contained in this report. There are a variety of factors that could cause actual results to differ materially from forecasts. The actual outcomes will depend on complex interactions of policy, technology, international markets, and behaviour of multiple suppliers and end users, all subject to uncertainty and beyond the control of Jacobs, and hence Jacobs cannot warrant the projections contained in this report.

Expert Witness Compliance Statement

In providing cost escalators, Jacobs has read and agreed to be bound by the guidelines for expert witnesses in proceedings in the Federal Court of Australia, as published by Chief Justice M.E.J. Black on 4 June 2013[1].

In providing consultation service in other assignments, Jacobs acknowledges a pre-existing relationship with the Client, but is confident such relationships do not compromise Jacobs' objectivity in defending its professional opinion based on specialised knowledge and capabilities held in the area of developing cost escalation rates for the Australian Energy Industry.

[1] Available to download from http://www.fedcourt.gov.au/law-and-practice/practice-documents/practice-notes/cm7

1. Introduction

1.1 Background

Regulatory proposals are required to be developed according to a building block methodology, requiring annual predictions of JEN's forecast capital and operational expenditure over the next regulatory period. An integral part of developing suitable forecasts of annual capital and operational expenditure is the production of a set of reasonable assumptions with respect to the likely rate of annual cost escalation. Jacobs has been actively researching the capital costs of electricity network infrastructure works for some time. It has developed a material cost escalation modelling process which captures the likely impact of expected movements of specific input cost drivers on future electricity networks infrastructure material or equipment pricing, providing robust material cost escalation indices. The material cost escalation indices are then further combined or aggregated with the respective labour cost escalation indices corresponding to the labour requirement to install or make those materials or equipment functioning in the electricity network infrastructure.

Jacobs was engaged by JEN in July 2014 to forecast the annual real cost escalation indices of its common asset classes over the period January 2011 to December 2020 for JEN's forthcoming electricity regulatory reset submission. For this engagement, the forecast of all the underlying cost driver escalation indices has been provided to Jacobs by JEN. BIS Shrapnel produced this information for JEN. Jacobs aggregated these forecast escalation indices up to asset classes common to JEN's network asset base.

The annual real escalation indices forecast presented in this report represents Jacobs' calculated best estimate of likely cost escalation components to account for the predicted movement in underlying drivers affecting the cost of undertaking capital and operating expenditure. Statements in this report that are not based on historical fact are forward looking statements. Although such statements are based on Jacobs' current estimates and expectations, and currently available competitive market economic data, forward looking statements are inherently uncertain. Jacobs, therefore, cautions the reader that there are a variety of factors that could cause business conditions and results to differ materially from what is contained in forward looking statements in this report.

1.2 Objective and Scope of Work

The scope of this engagement is to:

- Aggregate the provided average annual real escalation indices forecast of various cost drivers and relevant macroeconomics metrics to material asset classes common to JEN's network asset base. This is to be performed by referring to the standard production make-up profile of common individual asset classes using the Jacobs' Material Cost Escalation Model; and
- Further aggregate these material asset class escalation indices forecast with the respective provided labour cost escalation indices forecast to account for engineering, management, installation and commissioning of these materials or equipment to represent a complete functioning asset class. This is to be performed by referring to JEN's actual capital project cost structure of the respective asset classes from recent period.

Jacobs understands that JEN has undertaken a separate assignment by engaging BIS Shrapnel to determine the annual real escalation indices forecast for various cost drivers including commodities (aluminium, copper, steel and crude oil) price based in Australian dollar terms. The resulting forecast indices have been provided to Jacobs by JEN. It is understood that the commodities escalation inputs provided by JEN take account of the effect of foreign exchange rate as international commodities forecast price are not quoted in AUD. Jacobs is not privy to the methodology followed by BIS Shrapnel in producing its forecasts. Jacobs' scope of work excludes reviewing and commenting on the provided inputs from JEN. All the information provided to Jacobs is taken at face value.

The delivery of this objective will assist JEN in the preparation of their forthcoming regulatory period reset submission. This delivery will be provided through the production of an independent consultant's report (this report), which can be submitted to the AER and published in the public domain.

1.3 Deliverables

The primary deliverable for this assignment is a clear and concise independent consultancy report which supports the resulting escalation factors including an explanation of the approach adopted in developing the annual real cost escalation indices and how this approach is consistent with recent regulatory electricity network decisions.

2. Methodology

In past regulatory decisions for electricity network service providers, the AER has allowed the costs related to capital and operational expenditure provisions to be escalated in real terms. Prior to these decisions, the Australian CPI was generally used as a proxy to account for the escalation expected in relation to these network costs.

The methods more recently accepted by the AER sought to better characterise the likely escalation in price of equipment/project costs through combining independent forecast movements in the price of input components, with 'weightings' for the relative contribution of each of the components to final equipment/project costs. This in turn generates real cost forecasts for the regulatory control period under review.

In its 2009 final decision for the NSW Electricity Distribution Businesses, the AER stated:

> *In light of these external factors, it was considered that cost escalation at CPI no longer reasonably reflected a realistic expectation of the movement in some of the equipment and labour costs faced by electricity network service providers (NSPs). It was also communicated by the AER at the time of allowing real cost escalations that the regime should systematically allow for real cost decreases. This was to allow end users to receive the benefit of real cost reductions as well as facing the cost of real increases.*[2]

2.1 Material

Jacobs confirms that its method for modelling the forecast changes in the real costs of materials used in JEN's expenditure forecasts is consistent with the approach recently accepted by the AER.

This section of the report provides a step-by-step description of the method employed by Jacobs in modelling real material cost escalation forecast.

The opportunity to develop an enhanced understanding of the drivers of network asset costs originally presented itself to Jacobs during a 2006 multi-utility strategic procurement assignment. It was from this study that Jacobs was able to demonstrate that prices were increasing with rates higher than Australian CPI, and was able to develop and calibrate a model that described this escalation.

As part of this strategic procurement study a number of network asset equipment manufacturers and/or suppliers were surveyed to provide a greater understanding of the cost drivers underlying equipment pricing.

Jacobs also drew on information within studies undertaken on contract cost information for a number of turnkey and contracted construction projects (including plant equipment, materials, construction, testing, and commissioning). Jacobs' knowledge base of network management, operation, and asset procurement experience was also drawn upon during this establishment of cost drivers.

The results of Jacobs' research indicated that there are a number of common factors driving the changes in networks' capital infrastructure costs.

The primary factors (in no particular order) influencing material cost movements are considered to be changes in the market pricing position for:

- Metals – copper, aluminium and steel;
- Oil – as a material in itself, as a proxy for energy costs, and as a proxy for plastics (primarily High Density Polyethylene HDPE, Cross Linked Polyethylene XLPE);
- Wood – as material in itself;
- Construction material costs;

[2] AER, *NSW DNSP Final Decision 2009*, p. 478. http://www.aer.gov.au/content/index.phtml/itemId/728076

- Foreign exchange rates – primarily the USD to AUD relationship to convert commodities in international market quoted in USD;
- Foreign price inflation index – primarily the US Consumer Price Index (CPI) to convert price quoted in nominal USD terms into real USD term (and vice versa);
- Australian Trade Weighted Index (TWI) – as weighted average purchasing power of Australian dollar in overseas market and as a proxy for imported manufactured goods; and
- Australian Consumer Price Index (CPI) – as a general price inflation index in itself to convert nominal AUD quotes into real AUD term (and vice versa) and as a proxy for local manufacturing costs.

Having identified these key cost drivers, Jacobs examined each of the main items of plant equipment and materials within its database, in order to establish a suitable percentage contribution, or weighting, by which each of these underlying cost drivers were considered to influence the total price of each produced item.

In its determination and application of final cost driver weightings for these network assets, Jacobs drew on a wide range of information such as its knowledge of commercial rise and fall clauses contained within confidential network procurement contracts sighted by Jacobs during market price surveys, information passed on during its interviews with equipment suppliers and manufacturers; as well as industry knowledge held within its large internal pool of professional estimators, EPCM project managers, economists, engineers and operational personnel.

With appropriate weightings developed and assigned to each component, the key cost drivers thus provided a means by which changes in the forecast price of each underlying cost driver might be foreseen to affect the overall material cost of the network asset itself.

While there are benefits in maintaining consistency, particularly with past precedents, Jacobs has incorporated improvements[3] to its modelling method when there was a clear need, particularly in response to regulatory precedents and as improved cost information becomes available. The information and modelling method was further updated during the 2010 multi-utility strategic procurement assignment.

The cost drivers or the relevant economic indicators used in the Jacobs' Material Cost Escalation Model, their major application, and their reference sources are shown in Table 3.

- Table 3 Underlying information for material asset class aggregation

Cost Drivers	Application (mostly used for)	Sources
Aluminium, Steel, Copper and Oil prices	Primary equipment, structures, overhead conductors, cables etc.	Provided by JEN for this engagement
Wood	Wood poles.	Provided by JEN for this engagement
US CPI	All forecast commodities price data quoted in international market in nominal USD term (to convert nominal USD to real USD and vice versa).	Incorporated in forecast indices provided by JEN for this engagement
Foreign exchange rates	All forecast commodities price data quoted in international market in USD (to convert USD to AUD).	Incorporated in forecast indices provided by JEN for this engagement
Australian CPI	To convert nominal AUD to real AUD (and vice versa), various non-metallic and non-oil based items, and local manufacturing.	0.00% pa in real term (also provided by JEN in nominal term)
Australian Engineering Construction index	Civil, foundation, building, establishment etc. materials.	Provided by JEN for this engagement
Australian TWI	Overseas manufacturing component in the imported goods, various imported non-metallic and non-oil based items.	Provided by JEN for this engagement

[3] This involves the following elements:
- Addition of few new items in its asset database;
- Identification of 'mostly' overseas vs. 'mostly' locally manufactured items and incorporation of Australian TWI; and
- Incorporation of assessing carbon price mechanism and its impact to certain material cost items (NA from July 2014 onwards).

The output from the Jacobs' Material Cost Escalation Model provided the real escalation indices forecast at material asset class level. The escalation index at this level corresponds to the material asset procurement by JEN.

2.2 Material + Labour

Jacobs confirms that its method for aggregating the real material asset class escalation indices forecast with the real labour escalation indices forecast to build-up complete installed and functional asset classes is consistent with the approach recently accepted by the AER[4].

The output from Section 2.1 (i.e. Jacobs' Material Cost Escalation Model output) is combined in this step with the labour indices forecast which are exclusive to Victorian labour market environment and to electricity utility type labour force. Therefore, the applications of these labour indices are specific to the cost environment faced by JEN in operating and building its electricity network infrastructure. This is achieved by applying the same proportional weightings to the material asset class index and to the labour indices as the cost breakdown structure of the respective asset class. The cost breakdown structure was provided to Jacobs and is based on JEN's actual project delivery cost information from recent period. This actual cost breakdown structure information is shown in Table 4.

- Table 4 JEN's actual project cost breakdown structure

JEN Asset Classes	Material Cost	Labour Cost		Total (Check 100%)
		Internal	External	
Wooden Pole	30%	48%	22%	100%
Concrete Pole	49%	35%	16%	100%
Steel Pole	25%	52%	23%	100%
Steel Cross Arms (incl. Insulators)	33%	47%	20%	100%
Wood Cross Arms (incl. Insulators)	25%	53%	22%	100%
Bare Conductors (Al)	34%	48%	18%	100%
Insulated Conductors - LV	53%	38%	9%	100%
Bare conductors (steel)	15%	68%	17%	100%
Underground Cables and Cablehead - HV, XLPE	26%	30%	44%	100%
Underground Cables and Cablehead - LV, XLPE	17%	33%	50%	100%
Supervisory Cable - Fibre Optic	2%	15%	83%	100%
Capacitor Banks	19%	46%	35%	100%
Power Transformers - Zone Substation	38%	33%	29%	100%
Power Transformers - Distribution	44%	40%	16%	100%
Circuit Breakers - Indoor	32%	42%	26%	100%
Circuit Breakers - Outdoor	29%	64%	7%	100%
Outdoor Buses	52%	40%	9%	100%
CT's and VT's - Zone Substation	26%	44%	30%	100%
Neutral Earthing Resistor	9%	91%	0%	100%
Earth Grid Conductors	22%	42%	36%	100%
Zone Substation Batteries	41%	30%	29%	100%
Zone Substation Battery Chargers	41%	30%	29%	100%
HV Disconnectors / Isolators	34%	57%	9%	100%
LV Disconnectors / Isolators	36%	62%	2%	100%

[4] ActewAGL's 2014 regulatory submission to the AER.

JEN Asset Classes	Material Cost	Labour Cost		Total (Check 100%)
		Internal	External	
Reclosers / Gas Switches	41%	47%	12%	100%
Surge Diverters	66%	24%	10%	100%
Fault Indicators	34%	59%	7%	100%
Pillars / Pits	20%	52%	28%	100%
Public lighting luminaries	23%	9%	68%	100%
Relays - Digital / Microprocessor	26%	53%	21%	100%
SCADA - RTU	26%	53%	21%	100%
Fence	41%	21%	38%	100%
Ring Main Unit	67%	24%	9%	100%

The material cost component denotes all the equipment and tangible material assets procurement cost of that asset class. The internal labour cost component denotes all the engineering, management, installation and commissioning costs of those equipment and tangible material assets into a complete functioning asset class allocated to or incurred by JEN's employees. The external labour cost component denotes all the engineering, management, installation and commissioning costs of those equipment and tangible material assets into a complete functioning asset class allocated to or incurred by JEN's contractors and consultants.

3. Movement in Key Cost Drivers

In order to ensure all forecasts incorporate current and recent market information, Jacobs updates key cost drivers and economic indicators within its Material Cost Escalation Model for each assignment. This ensures the most practical recent/current date information is used. For this assignment, Jacobs has been provided with forecast data of all the cost drivers (inputs to its Material Cost Escalation Model) by JEN. Jacobs has also been provided with forecast data for labour price indices specific to Victorian utility industry by JEN. It is understood that these forecast data are current market information as of September 2014. The following sections contain a summary of the input data provided to Jacobs.

3.1 Commodity prices

This section presents the real price escalation indices forecast of commodities supplied by JEN as inputs to Jacobs' Material Cost Escalation Model. The supplied real commodity price escalation indices forecasts are presented as percentage annual change.

3.1.1 Aluminium

The average annual aluminium real price index forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 5. Jacobs' modelling process requires the aluminium average annual real price forecast to be expressed in Australian dollar term as mentioned in Section 3.3, Section 3.4 and Section 3.5.

- Table 5 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aluminium	-5.11%	-16.91%	-5.76%	1.32%	10.12%	8.23%	8.23%	5.15%	-7.01%	-5.21%

3.1.2 Copper

The average annual copper real price index forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 6. Jacobs' modelling process requires the copper average annual real price forecast to be expressed in Australian dollar terms as mentioned in Section 3.3, Section 3.4 and Section 3.5.

- Table 6 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Copper	0.61%	-11.83%	-3.86%	-3.36%	1.04%	3.71%	7.68%	2.13%	-9.99%	-6.09%

3.1.3 Steel

The average annual steel real price index forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 7. Jacobs' modelling process requires the steel average annual real price forecast to be expressed in Australian dollar term as mentioned in Section 3.3, Section 3.4 and Section 3.5.

- Table 7 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Steel	-3.30%	-13.26%	-4.84%	-2.15%	5.41%	4.97%	2.99%	2.71%	-11.01%	-3.36%

3.1.4 Oil

The average annual oil real price index forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 8. Jacobs' modelling process requires the oil average annual real price forecast to be expressed in Australian dollar term as mentioned in Section 3.3, Section 3.4 and Section 3.5.

- Table 8 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Oil	3.28%	-3.94%	10.25%	5.63%	-1.31%	-0.86%	4.32%	2.54%	-7.66%	-4.97%

3.2 Wood

The average annual wood real price index forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 9. It is noted that this particular cost driver influence the cost of wood poles asset class only. Jacobs' modelling process requires the wood average annual real price forecast to be expressed in Australian dollar term as mentioned in Section 3.3, Section 3.4 and Section 3.5 if the input data was sourced from the international market quoted in foreign denomination.

- Table 9 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wood	1.77%	1.49%	0.40%	3.20%	3.10%	2.40%	1.70%	0.90%	2.20%	3.90%

3.3 USA Consumer Price Index

The Jacobs modelling process uses the USA CPI trend forecast, to restate the nominal USD based forecast market prices of commodities, namely aluminium, copper, steel and oil, into their comparable real USD pricing movements.

It was assumed that the average annual real price escalation indices forecast of the commodities provided by JEN was based on real US dollar terms by using this forecast information to convert the quoted nominal US dollar terms. Therefore Jacobs did not investigate the USA CPI forecast.

3.4 Australian Dollar to US Dollar exchange rate

The Jacobs modelling process uses the forecast USD/AUD exchange rates, to restate the USD based forecast market prices of commodities, namely aluminium, copper, steel and oil, into their comparable AUD pricing movements. This is undertaken in order to account for any potential movements of base currency commodity market price movements through a strengthening or weakening of the AUD.

It was assumed that the average annual real price escalation indices forecast of the commodities provided by JEN was expressed in Australian dollar terms by incorporating this foreign exchange rate forecast. Therefore Jacobs did not investigate the USD/AUD exchange rate forecast.

3.5 Australian Consumer Price Index

The Australian CPI is used as a proxy for the local manufacturing activities. Jacobs acknowledges that while the historical Australian Producer Price Index (PPI) for electrical equipment manufacturing is available[5], the

[5] Australian Bureau of Statistics, PPI Table 12.

forecast for such precise activity is not. More importantly, such Australian PPI provides composite price movement indication of the entire input (or output) mix of the manufacturing process, and as such is not an exact indicator of manufacturing activity (or manufacturing labour) only price movement. Jacobs has therefore relied on the Australian CPI, for which a credible forecast is readily available, to represent the forecast trend of the manufacturing activity (manufacturing labour) price index.

The Australian CPI is also used to account for those materials or cost items in equipment whose price trend cannot be rationally or conclusively explained by the movement of commodities price.

The average annual Australian CPI forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 10.

- Table 10 Average annual price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australian CPI	3.30%	1.76%	2.45%	2.60%	2.40%	2.50%	2.50%	2.50%	2.50%	2.50%
'Real' term, i.e. without inflation	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

3.6 Australian Engineering Construction Price Index

Australian Engineering Construction Price Index forecast is included in Jacobs' modelling as a key driver underlying network project construction costs, in order to account for price movements in materials elements of the civil works. The average annual Australian Engineering Construction real price index forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 11.

- Table 11 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Engineering Construction Index	-0.90%	0.77%	-1.35%	-1.23%	-0.89%	-0.55%	-0.33%	-0.11%	0.22%	0.65%

3.7 Australian Trade Weighted Index (TWI)

The Australian TWI is a multilateral weighted average exchange rate index. It is the weighted average of exchange rates of Australian dollar against currencies of its most important trading countries, weighted to reflect the importance or the volume of trade with those countries. Therefore, the movement in the currencies of those countries with greater share of Australian's trade has greater effect on the index. The weightings of the various foreign currencies which make up the Australian TWI is regularly updated or revised by the RBA based on the actual or new Australian-international trading data.

Jacobs uses the combination of Australian CPI and Australian TWI to describe the manufacturing activity for any imported good or equipment. The Australian TWI is also used to account for those materials or cost items in imported equipment whose price trend cannot be rationally or conclusively explained by the movement of commodities prices.

The average annual real Australian TWI forecast trend used during Jacobs' modelling was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 12.

- Table 12 Average annual real escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australian TWI	3.54%	-0.18%	-6.58%	-7.25%	-5.10%	-5.03%	-7.69%	-7.16%	6.99%	2.44%

3.8 Victorian electricity utility internal Labour Price Index

The average annual Victorian electricity utility internal real LPI forecast trend used during Jacobs' aggregation calculation was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 13.

- Table 13 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Victorian utility labour: Int WPI	0.81%	2.12%	1.90%	0.74%	1.08%	1.13%	1.35%	1.76%	2.11%	1.81%

3.9 Victorian electricity utility external Labour Price Index

The average annual Victorian electricity utility external real LPI forecast trend used during Jacobs' aggregation calculation was provided by JEN for this engagement and therefore Jacobs did not investigate it further. It is presented in Table 14.

- Table 14 Average annual real price escalation indices % change

Cost Driver	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Victorian utility labour: Ext WPI	1.10%	1.37%	1.75%	1.06%	1.38%	1.44%	1.63%	1.49%	1.61%	1.92%

4. Asset Class

The scope of costs in asset classes common to JEN is listed in Table 15. The cost driver real escalation indices forecast described in Section 3.1 to Section 3.7 are first aggregated up to these asset class levels based on the proportion of the materials in them using the Jacobs' Material Cost Escalation Model. The resulting outputs from the Jacobs' Material Cost Escalation Model are next combined or aggregated with the cost driver real escalation indices forecast described in Section 3.8 and Section 3.9 to include the labour cost components.

- Table 15 Scope of costs in JEN asset classes

JEN Asset Classes	Scope of costs
Wooden Pole	Wood pole procurement together with labour effort to make it fully functional and integrated to the electricity infrastructure asset base (pole erection).
Concrete Pole	Concrete pole procurement together with labour effort to make it fully functional and integrated to the electricity infrastructure asset base (pole erection).
Steel Pole	Steel pole procurement together with labour effort to make it fully functional and integrated to the electricity infrastructure asset base (pole erection).
Steel Cross Arms (incl. Insulators)	Steel cross arm and insulators procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base.
Wood Cross Arms (incl. Insulators)	Wood cross arm and insulators procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base.
Bare Conductors (Al)	Overhead aluminium conductors (for e.g. ACSR) procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (conductor stringing).
Insulated Conductors - LV	Overhead LV Ariel Bundled Conductor (ABC) procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (conductor stringing).
Bare conductors (steel)	Overhead steel conductors (for e.g. 3/2.75mm galvanised steel) procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (conductor stringing).
Underground Cables and Cablehead - HV, XLPE	Underground copper XLPE cable, joints, conduit, pit material, cable protection material, re-instatement material and other miscellaneous materials procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (trenching, cabling, pulling, HDD works).
Underground Cables and Cablehead - LV, XLPE	Underground aluminium XLPE cable, joints, conduit, pit material, cable protection material, re-instatement material and other miscellaneous materials procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (trenching, cabling, pulling, HDD works).
Supervisory Cable - Fibre Optic	Communication pilot wire procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (conductor stringing or cabling works).
Capacitor Banks	Capacitor banks procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Power Transformers - Zone Substation	Transformer procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Power Transformers - Distribution	Transformer procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Circuit Breakers - Indoor	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Circuit Breakers - Outdoor	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Outdoor Buses	Structure procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
CT's and VT's - Zone Substation	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).

JEN Asset Classes	Scope of costs
Neutral Earthing Resistor	Earthing transformer procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Earth Grid Conductors	Bare copper conductor procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (trenching, laying works)
Zone Substation Batteries	Miscellaneous material procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Zone Substation Battery Chargers	Miscellaneous material procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
HV Disconnectors / Isolators	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
LV Disconnectors / Isolators	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Reclosers / Gas Switches	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Surge Diverters	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Fault Indicators	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Pillars / Pits	Pillar/Pit material procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Public lighting luminaries	Luminaries procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Relays - Digital / Microprocessor	Secondary system protection and control items procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
SCADA - RTU	SCADA system procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).
Fence	Substation establishment material procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (building).
Ring Main Unit	Switchgear procurement together with labour effort to make them fully functional and integrated to the electricity infrastructure asset base (installation).

The proportional material make-up profile of each asset class into the underlying cost drivers that forms the basis for the first aggregation step is inbuilt in the Jacobs' Material Cost Escalation Model and its development is described in Section 2.1. The proportional weightings of material cost component, internal labour cost component, and external labour cost component that forms the basis of the next aggregation step is described in Section 2.2 and shown in Table 4.

5. Conclusion

The Jacobs cost escalation modelling methodology provides a rigourous and transparent process through which reasonable and appropriate real cost escalation indices are able to be developed.

Table 16 presents the average annual real material cost escalation year-on-year indices forecast aggregated to JEN's common asset classes. This is the first aggregation step and output from the Jacobs' Material Cost Escalation Model.

- Table 16 Average annual real material cost escalation year-on-year indices forecast aggregated to JEN's common asset classes

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wooden Pole	1.014	1.005	1.013	1.025	1.017	1.014	1.015	1.008	1.006	1.018
Concrete Pole	0.991	1.008	0.986	0.988	0.991	0.995	0.997	0.999	1.002	1.007
Steel Pole	0.990	0.934	0.994	0.999	1.022	1.021	1.020	1.016	0.939	0.977
Steel Cross Arms (incl. Insulators)	1.010	0.976	1.005	0.997	0.994	0.994	0.999	0.995	0.983	0.990
Wood Cross Arms (incl. Insulators)	1.016	0.994	1.010	1.003	0.992	0.992	0.997	0.993	1.000	1.000
Bare Conductors (Al)	0.973	0.902	0.963	1.001	1.053	1.044	1.040	1.025	0.957	0.972
Insulated Conductors - LV	0.988	0.917	0.998	1.015	1.037	1.031	1.041	1.025	0.949	0.966
Bare conductors (steel)	0.982	0.920	0.968	0.983	1.030	1.027	1.014	1.013	0.937	0.981
Underground Cables and Cablehead - HV, XLPE	1.004	0.954	0.991	0.989	1.001	1.010	1.027	1.008	0.959	0.976
Underground Cables and Cablehead - LV, XLPE	0.994	0.954	0.994	1.004	1.017	1.014	1.019	1.010	0.976	0.983
Supervisory Cable - Fibre Optic	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Capacitor Banks	0.992	0.934	0.985	0.995	1.021	1.021	1.024	1.013	0.951	0.977
Power Transformers - Zone Substation	0.992	0.934	0.985	0.995	1.021	1.021	1.024	1.013	0.951	0.977
Power Transformers - Distribution	0.992	0.934	0.985	0.995	1.021	1.021	1.024	1.013	0.951	0.977
Circuit Breakers - Indoor	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
Circuit Breakers - Outdoor	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
Outdoor Buses	0.991	1.008	0.986	0.988	0.991	0.995	0.997	0.999	1.002	1.007
CT's and VT's - Zone Substation	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Neutral Earthing Resistor	0.992	0.934	0.985	0.995	1.021	1.021	1.024	1.013	0.951	0.977
Earth Grid Conductors	1.003	0.911	0.969	0.974	1.009	1.027	1.054	1.015	0.926	0.956
Zone Substation Batteries	1.009	0.957	0.997	0.991	0.997	0.998	0.999	0.995	0.971	0.985
Zone Substation Battery Chargers	1.009	0.957	0.997	0.991	0.997	0.998	0.999	0.995	0.971	0.985
HV Disconnectors / Isolators	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
LV Disconnectors / Isolators	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
Reclosers / Gas Switches	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
Surge Diverters	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
Fault Indicators	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993
Pillars / Pits	0.991	1.008	0.986	0.988	0.991	0.995	0.997	0.999	1.002	1.007
Public lighting luminaries	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Relays - Digital / Microprocessor	1.013	0.988	0.988	0.982	0.985	0.987	0.984	0.983	1.007	1.000
SCADA - RTU	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Fence	0.991	1.008	0.986	0.988	0.991	0.995	0.997	0.999	1.002	1.007
Ring Main Unit	1.008	0.961	0.975	0.976	0.995	0.995	0.990	0.985	0.992	0.993

The underlying cost drivers for some materials such as Communication equipment (Fibre Optic Cable, SCADA) and Luminaries closely reflects the Australian CPI trend and as such no real cost escalation is implied.

Table 17 presents the average annual real complete (i.e. material component + labour components) cost escalation year-on-year indices forecast aggregated to JEN's common asset classes. This is the next aggregation step following JEN's actual project delivery cost structure breakdown.

- Table 17 Average annual real complete cost escalation year-on-year indices forecast aggregated to JEN's common asset classes

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wooden Pole	1.010	1.015	1.017	1.013	1.013	1.013	1.014	1.014	1.015	1.018
Concrete Pole	1.000	1.013	1.003	0.998	1.002	1.004	1.006	1.008	1.011	1.013
Steel Pole	1.004	0.998	1.012	1.006	1.014	1.014	1.016	1.017	0.999	1.008
Steel Cross Arms (incl. Insulators)	1.009	1.005	1.014	1.005	1.006	1.006	1.009	1.010	1.008	1.009
Wood Cross Arms (incl. Insulators)	1.011	1.013	1.016	1.007	1.007	1.007	1.010	1.011	1.015	1.014
Bare Conductors (Al)	0.997	0.979	1.000	1.006	1.026	1.023	1.023	1.020	0.999	1.003
Insulated	0.998	0.965	1.008	1.012	1.025	1.022	1.028	1.021	0.982	0.991

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Conductors - LV										
Bare conductors (steel)	1.005	1.005	1.011	1.004	1.014	1.014	1.014	1.016	1.008	1.013
Underground Cables and Cablehead - HV, XLPE	1.008	1.000	1.011	1.004	1.009	1.012	1.018	1.014	1.003	1.008
Underground Cables and Cablehead - LV, XLPE	1.007	1.006	1.014	1.008	1.013	1.013	1.016	1.015	1.011	1.013
Supervisory Cable - Fibre Optic	1.010	1.015	1.017	1.010	1.013	1.014	1.016	1.015	1.016	1.019
Capacitor Banks	1.006	1.002	1.012	1.006	1.014	1.014	1.016	1.016	1.006	1.011
Power Transformers - Zone Substation	1.003	0.986	1.006	1.003	1.015	1.016	1.018	1.015	0.993	1.003
Power Transformers - Distribution	1.002	0.982	1.004	1.002	1.016	1.016	1.018	1.015	0.990	1.000
Circuit Breakers - Indoor	1.009	1.000	1.005	0.998	1.006	1.007	1.007	1.007	1.010	1.010
Circuit Breakers - Outdoor	1.008	1.003	1.006	0.999	1.006	1.007	1.007	1.008	1.012	1.011
Outdoor Buses	1.000	1.014	1.002	0.998	1.001	1.003	1.005	1.008	1.011	1.012
CT's and VT's - Zone Substation	1.009	1.003	1.007	1.000	1.007	1.008	1.008	1.008	1.012	1.012
Neutral Earthing Resistor	1.007	1.014	1.016	1.006	1.012	1.012	1.014	1.017	1.015	1.014
Earth Grid Conductors	1.008	0.994	1.008	1.001	1.011	1.016	1.023	1.016	0.998	1.005
Zone Substation Batteries	1.009	0.993	1.010	1.001	1.006	1.007	1.008	1.008	0.999	1.005
Zone Substation Battery Chargers	1.009	0.993	1.010	1.001	1.006	1.007	1.008	1.008	0.999	1.005
HV Disconnectors / Isolators	1.008	1.000	1.004	0.997	1.006	1.006	1.006	1.006	1.011	1.010
LV Disconnectors / Isolators	1.008	0.999	1.003	0.996	1.005	1.005	1.005	1.006	1.010	1.009
Reclosers / Gas Switches	1.009	0.996	1.001	0.995	1.004	1.005	1.004	1.004	1.008	1.008
Surge Diverters	1.009	0.981	0.990	0.987	1.000	1.001	0.998	0.996	1.001	1.002
Fault Indicators	1.008	1.000	1.004	0.997	1.005	1.006	1.006	1.006	1.011	1.010
Pillars / Pits	1.006	1.016	1.012	1.004	1.008	1.009	1.011	1.013	1.016	1.016
Public lighting luminaries	1.008	1.011	1.014	1.008	1.010	1.011	1.012	1.012	1.013	1.015
Relays - Digital /	1.010	1.011	1.011	1.002	1.005	1.006	1.007	1.008	1.016	1.013

JEN Asset Classes	Historical Trend			Forecast Trend						
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Microprocessor										
SCADA - RTU	1.007	1.014	1.014	1.006	1.009	1.009	1.011	1.012	1.015	1.014
Fence	1.002	1.013	1.005	1.001	1.004	1.006	1.008	1.009	1.011	1.014
Ring Main Unit	1.009	0.980	0.990	0.987	1.000	1.001	0.998	0.996	1.001	1.001

The real cost escalation indices forecast established during this engagement were developed with specific consideration of the operating environment faced by JEN, and were based on the input information provided by JEN and on the most up-to-date information available at the time of compilation. These real escalation indices forecasts therefore constitute Jacobs' calculated opinion of appropriate real cost escalation indices that can reasonably be expected to affect JEN over the upcoming revenue regulation period.

In exerting the expected cost pressures on JEN, Jacobs concludes that these real escalation indices forecast form a component of efficient prices for an Australian electricity network business. Jacobs therefore recommends that JEN take account of these real cost escalation indices forecast within their forthcoming regulatory expenditure proposal.

Jeff Butler

SENIOR CONSULTANT

CURRENT POSITION

Senior Consultant

QUALIFICATIONS

Bachelor of Electrical Engineering (Electronics and Communications stream) with Second Class Honours - Division A, Queensland Institute of Technology

Graduate Diploma of Computer Science, Queensland Institute of Technology

PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

- Graduate Diploma of Computer Science, Queensland Institute of Technology
- Graduate Member, Institution of Engineers, Australia
- Jacobs/SKM Gold Corporate Member nominee, Asset Management Council

EXPERTISE

- Strategic consulting advice
- Asset management
- Asset valuation
- Auditing
- Electrical maintenance management
- Process control in food and beverage industry

Summary of competencies

Jeff Butler is a qualified and experienced electrical engineer with over 25 years of professional experience in the industrial and electrical contracting industry. Jeff has developed a good working knowledge of aspects of the Queensland and national electricity sectors, through a variety of strategic consulting assignments with both the electricity utilities, and regulatory and jurisdictional authorities. He has specialist skills in asset valuation and estimating, together with asset management and service standards for electricity utilities.

Recent project experience

Jacobs Group (Australia) [previously Sinclair Knight Merz], Brisbane

August 2000 - present

Senior Consultant - Power Consulting

- Project management and participation in providing support to ActewAGL Distribution in the development of their regulatory submission to the Australian Energy Regulator (AER), including audit of asset management system and asset management plans, expenditure review, unit rate review and cost escalation factors (2013-14).
- Participation in review of capital and operational expenditure forecasts and project governance implementation for Endeavour Energy in preparation for regulatory submission to the AER (2013).
- Project management and participation in development of cost escalation factors for multiple electricity and water utilities in Australia, including Ergon Energy, ENERGEX, ActewAGL, Power Water Corporation and SunWater
- Project management and participation in asset valuations, unit rate reviews, comparative estimates and developed asset valuation models for multiple transmission and distribution electricity utilities including Transend Networks, NGCP Philippines, Transpower NZ, ENERGEX, Ergon Energy, Country Energy and EnergyAustralia.
- Project management and participation in asset valuation of electricity transmission network assets for financial reporting requirements under Australian Accounting Standards for Transend Networks (2007 and 2012).
- Assessment of prudency and efficiency of operational expenditure forecasts for various water utilities for Queensland Competition Authority (2013).
- Establishment of service standards and incentive scheme for transmission electricity utilities in Australia for the ACCC (2002) and principal auditor of performance reporting for AER (2003-08).
- Development of service standards scheme including proposed measures and targets/caps/collars for Transend Networks as part of regulatory submission (2007-08).
- Development of framework for a reliability incentive scheme and regulated service standards performance incentive scheme for proposed CopperString transmission network (2011).
- Participated in electrical asset review for Rio Tinto Alcan in Weipa (Feb-Dec 2008) including maintenance strategy gap analysis, asset valuation for

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external distribution network and Humbug Power Station, development of an asset register for the distribution network and field visual condition assessments

- Project management and participation in review of implementation of consolidated maintenance procedures and business cases for Powercor Australia (2006).
- Review and refinement of 33kV outdoor substation program including failure rate analysis for Transpower NZ (2010).
- Due diligence review for Country Energy gas networks (Jun-Aug 2010).
- Technical due diligence of regulatory proposal to Australian Energy Regulator for Ergon Energy (2008).
- Participated in benchmarking study of market prices for construction and maintenance services for EnergyAustralia, including presentation to senior management (2001-2003).

Stork Electrical, Brisbane

December 1999 – August 2000

E&I Completions Engineer

- This position reported to the E & I Area Superintendent, with the main purpose to set priorities in instrumentation and electrical installation to meet pre-commissioning targets for the $435M Queensland Clean Fuels Project at BP Refinery, Bulwer Island, Brisbane

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CURRENT POSITION

Senior Consultant

QUALIFICATIONS

Bachelor of Electrical & Electronics Engineering, 1996-2000

MBA (Management of Technology), 2004-2006

MiM (International Business & Project Development), 2005-2006

PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS

Member, Engineers Australia, Australia

Member, Nepal Engineering Council, Nepal

EXPERTISE

- Regulatory advices to electricity utilities;
- Electricity demand and energy consumption forecasting;
- Review network capex justification and benchmarking cost KPIs;
- Electricity network asset valuation (ODRC, ODV);
- Auditing electricity utilities on their License Conditions, RINs, STPIS and other operational performance reporting;
- Project financial modelling including developing profit loss, balance sheet & cash flow models; and
- Due diligence (asset replacement modelling) of electricity networks.

Summary of Competencies

Anuraag provides strategic consulting and advisory services to the power delivery sector, mainly involving utility and associated stakeholders. He works in Jacobs Power Consulting business unit and is based in Sydney. In this role, he regularly undertakes frontend planning, feasibility studies, forecasting, auditing, quantitative modelling and regulatory review works. He has successfully delivered a number of consulting and advisory projects requiring multidisciplinary resources as Project Manager. He is a reliable Consultant and a dependable team member having experience in working with a diverse range of clients. He has worked in a number of key and challenging projects with full ownership, individual responsibilities and deliverables in demanding environments. Anuraag is an Electrical Engineer with 11 years' professional experience.

Recent Project Experience

PROJECTS | Regulatory advices to electricity utilities

- Project Manager for forecasting the replacement expenditure using the AER Repex Model for the 2016-2020 EDPR submission, Client CitiPower and Powercor, Nov 2014.
- Project Manager for forecasting the augmentation expenditure using the AER Augex Model (Stage 3 Augex Modelling) for the 2016-2020 EDPR submission, Client CitiPower and Powercor, Oct 2014.
- Project Manager and developed the material asset cost escalation indices forecast for various electricity network utilities for the use in their respective revenue reset submission to the AER, Clients CitiPower & Powercor, Nov 2014, JEN Sep 2014, SAPN Aug 2014, ActewAGL Jan 2014, TransGrid Dec 2013, SPAusNet Jan 2014, P&W Corp Jun 2013.
- Review network (area plans) and non-network project business cases included in 2014-19 regulatory reset submission proposal for Ausgrid Program Director for Reset, Client Ausgrid, Mar 2014.
- Review capex and opex proposal, justification and setting up of DNSP STPIS targets for Endeavour Energy 2014-19 regulatory reset submission to the AER. Client Endeavour Energy, 2013.
- Project Manager/developer of range of price escalation indices to forecast generation and transmission capex and opex components to determine the annual Maximum Reserve Capacity Price in SWIS region in WA. Client IMO WA 2014, 2012, 2011, 2010, 2009, 2008 and 2007.
- Provision of assistance and advice to various Australian TNSPs and DNSPs for their regulatory reset submission process to the AER (capex reviews, asset risk criticality model, transformer replacement analysis). Clients TransGrid, ElectraNet, Country Energy, ActewAGL and EnergyAustralia, 2007 and 2008.

PROJECTS | Electricity demand and energy consumption forecasting

- Maximum electricity power demand forecast in the capital Honiara in Solomon Islands from 2013 to 2020 for planning and development purpose, Client SIEA, Jun 2014, Jun 2013, and Dec 2010 (for World Bank)
- Maximum demand forecast of eight outstations (islands) in Solomon Islands from 2013 to 2018 for the electricity infrastructure development option study, Client SIEA, Dec 2012.

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PROJECTS | Review network capex and benchmarking cost KPIs

- Revised/updated TransGrid's greenfield-brownfield cost factor model to address limitations and to include more transparency, consistency, functionality and controllability to the model users, Client TransGrid, March 2013.
- Project Manager for distribution capex unit cost review (estimate vs. actual cost structure). Client Essential Energy, Aug 2011.
- Project manager for reviewing and independent estimation of Ausgrid's overflow alliance program works (2009 to 2013) consisting of number of capital projects involving substations and underground cable assets, Client Ausgrid, Aug 2010 to Nov 2011.
- Connection options study for Dundas Wind Farm. Investigated the connection options and preparing capital cost estimates for the proposed 1500MW wind farm. Client Origin Energy, Australia, May 2010.
- Connection options study for Lexton Wind Farm. Investigated the connection options and preparing capital cost estimates for the proposed 38MW wind farm. Client Origin Energy, Australia, Nov 2009.
- Review of the Capex Estimating Database and Asset Valuation Algorithm. Client TranGrid, Dec 2013, May 2009, and Jun 2008.

PROJECTS | Electricity network asset valuation

- Asset valuation (ODRC) of electricity transmission network, Client GMCP Philippines, Oct 2014.
- Roll forward asset re-valuation of the electricity network, Client Solomon Island Electricity Authority (SIEA), Jan 2014.
- Asset valuation (ODRC) of electricity network business, Client Power & Water Corp, May 2013.
- Asset valuation (ODRC) of Integral Energy, Integral Energy, Feb 2011.
- Asset valuation (ODRC and ODV) of Horizon Power to determine the network access tariff, Client Horizon Power, Nov 2009.
- Asset valuation of six DNSPs in the Philippines (DAVAO, VECO, IEEC, CELCOR, TARLAC and LUECO) for their regulatory submission process to the office of the ERC. Client ERC, Philippines, Mar 2009.

PROJECTS | Auditing

- Non-Financial auditor of Endeavour Energy's 2013/14 Annual RIN, 2013/14 Category Analysis RIN, and 2013/14 Economic Benchmarking RIN reporting to the AER, Client Endeavour Energy, Sep 2014.
- Project Manager and auditor for 2013/14 and 2010/11 Design, Reliability and Performance Licence Conditions Audit of Essential Energy reporting to the IPART, Client Essential Energy, Aug 2014, Aug 2011.
- Non-Financial auditor of Ausgrid's 2008/09–2012/13 Reset RIN and 2008/09–2012/13 Economic Benchmarking RIN reporting to the AER, Client Ausgrid, May 2014.
- Non-Financial auditor of SAPN's 2008/09–2012/13 Economic Benchmarking RIN reporting to AER, Client SA Power Network, Jan 2014.
- Project Manager and Non-Financial auditor of Ausgrid's 2012/13 and 2009/10 Annual RINs reporting to the AER, Client Ausgrid, Sept 2013, mar 2011.
- Project Manager and Non-Financial auditor of Essential Energy's 2012/13, 2011/12 Annual RINs reporting to the AER, Client Essential Energy, Sept 2013, Nov 2012.
- Audit to assess the adequacy of the compliance programs, processes and supporting systems to achieve the NER Generator Performance Standard obligations, Client Snowy Hydro Limited, Jun 2012.
- Project Manager and auditor for 2010/11 Design, Reliability and Performance Licence Conditions Audit of EnergyAustralia reporting to

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IPART, Client EnergyAustralia Aug 2011.

- Auditor of 2009/10 annual TransGrid service component performance reporting to the AER under the Service Target Performance Incentive Scheme STPIS, Client TransGrid, Mar 2010
- Auditor of 2009/10 and 2008/09 Electricity Network Performance Report Appraisal; Design, Reliability and Performance Licence Conditions Audit; and Operating Statistics Audit of EnergyAustralia. Client EnergyAustralia, reporting to IPART and NSW DWE, Aug 2010 and Aug 2009.
- Auditor of 2009/10 and 2008/09 Electricity Network Performance Report Appraisal; Design, Reliability and Performance Licence Conditions Audit; and Operating Statistics Audit of Country Energy. Client Country Energy, reporting to IPART and NSW DWE, Aug 2010 and Aug 2009.

PROJECTS | Project financial modelling

- Financial Modelling and development of project framework to determine the tariff range for nine geothermal power generation projects in eight locations in Indonesia, Clients Pertamina and PLN, Indonesia, Jul-Aug 2013.
- Developer of a 'standard' option appraisal NPV Model that includes tool to conduct sensitivity analysis and Guideline for internal TransGrid use. Conducted a series of training sessions to various internal groups to roll-out this tool business wide, Client TransGrid, April 2013.
- Co-developer of the financial model for the 55MW Cibuni geothermal power project in West Java, Indonesia. Client GreenEarth Energy, Feb 2010.
- Financial modelling for San Jacinto Tizate Geothermal Power Project with new lender agreement for Phase I with Fuji options. Conducted comparison between Phase I MCT and Fuji options. Client Polaris Energy Nicaragua S.A., Nicaragua, Nov 2009.
- Development of the Power Generation Financial Model and its User Manual for SKM to be internally used in various power generation projects. Client Sinclair Knight Merz, Apr 2009.
- Developed the financial model for San Jacinto Tizate Geothermal Power Project. Client Polaris Energy Nicaragua S.A., Nicaragua, Aug 2008.
- Preliminary feasibility study (financial analysis) for renewable energy (solar) generation in RailCorp's noise corridor. Client RailCorp, Oct 2007

PROJECTS | Due diligence

- Asset replacement modelling for the due diligence of Powerco (NZ electricity distribution utility) to forecast the expenditure requirements and profile the asset age, Client AMP Capital, May 2013.
- Asset replacement modelling for the due diligence of SPN, EPN and LPN (UK electricity distribution utilities) to forecast the expenditure requirements and profile the asset age, Client CKI Holdings, May 2010.

PROJECTS | Others (Feasibility studies, Engineering design, Analytical modelling, Risk assessment, Reviews)

- Project Manager for independent review of variation claimed by Ausgrid's Alliance partner pertaining to asbestos contaminated spoil disposal on the Bankstown to Punchbowl 33kV cable replacement project, Client Ausgrid, June 2013.
- Project Manager for the review of various underground cabling (mostly 132kV) projects delivery models and presentation to the executive board on project delivery strategy, Client Ausgrid, Mar 2012.
- Development of the Fire Risk Inspection Checklist for Oil Filled Distribution Substation Transformers and its User Manual for EnergyAustralia's own assessment process. Client EnergyAustralia, May 2009.
- Conducted fire risk assessments of 65 distribution substation sites in Sydney. Client EnergyAustralia, Feb 2009.

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- Zone substation supply capacity options study for various locations using ELDOW model. Client Western Power Corp, Western Australia, Oct 2008.
- Analyse the quarries production and supply to demand centres in South East Queensland region to demonstrate the viability of the proposed expansion and capital works at Ormeau Quarry. Client Boral, Feb 2008.
- Project Manager and electrical engineer for the Liverpool transmission substation earthing design, Client Integral Energy, Nov 2007.
- Preliminary feasibility study of network assets augmentation involving HV transmission line and substation switchyard, Client TransGrid, Australia, Aug 2007.
- Feasibility study and concept designing of distribution network for the Solomon Island's rural electrification/extension project, Client World Bank, Aug 2007