# Regulatory Revenue Decision

NETWORKS NSW JV

## Reliability Impact Assessment

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# Regulatory Revenue Decision

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# Executive Summary

Networks NSW (NNSW) refers to a cooperative operating model across Ausgrid, Endeavour Energy and Essential Energy. The objective of NNSW is to contain the costs of building, maintaining and operating the NSW electricity networks in a safe, reliable and sustainable manner. The economic regulator for NNSW, the Australian Energy Regulator (AER) has proposed a significant reduction in revenue to the NNSW businesses in its draft decision for the regulatory period commencing 2015 – 2019 and a retrospective application of the decision for the transitional regulatory period 2014/15. Application of the draft revenue allowance and the reduced expenditure categories reduces the operating and capital expenditure significantly over regulatory period 2015 – 2019.

The quantum of reduction in estimated capital (capex) and operational expenditure (opex) is material and is expected by NNSW to lead to reliability impacts for the three network companies. Jacobs has undertaken a high level analysis to determine the reliability and network performance impact due to reduced investment in Capital refurbishment and Operational Expenditure.

**Opex – Impact on Reliability**

Jacobs approach was to identify high impact asset categories (based on data available) for the HV network, and to model the reliability impact of reduction to the opex on these categories by assuming an increased failure rate over time directly as a result of reduced resourcing. The impact of reduced opex was modelled with a time lag allowing for the effects of the longer maintenance cycles to gradually materialise as increased failure rates in the network elements after maintenance would otherwise have fallen due.

Failure Mode Effects and Criticality Analysis (FMECA) and Reliability Centred Maintenance (RCM) strategies are mathematically robust, well accepted methodologies and have been used in Ausgrid and other industries for many years. This technique has been used to optimise the inspection cycle to reduce total life-cycle costs for a variety of assets employed in the electrical network. Where FMECA/RCM based failure rates were available for major equipment failures in the HV network, we modelled the increased failure rate expected from longer maintenance periods to extrapolate the impact on reliability (SAIDI & SAIFI & CAIDI indices). This was done for a limited sub-set of distribution assets – poles, cross-arms and conductor.

Reduced opex is also expected to impact on the response times and repair times for major system outages. Reduced manning levels, equipment and depot sites will contribute to increased outage durations. Jacobs's modelling also includes this impact.

Another major contribution to SAIDI arises from distribution network equipment (wires, insulators) contacting with vegetation. However we have assumed that the vegetation maintenance is not compromised, thus the outcome being modelled is likely to under estimate the impact of the reduced operational expenditure.

Preliminary analysis of modelling results, using equipment failure on the HV network modelling, shows an increase in average interruptions and an increase in system average duration of outages. The modelling demonstrates that there will be a significant impact as a result of the reduction in maintenance expenditure, particularly over a 10 year period (two regulatory cycles). The modelled results with respect to reliability indices - SAIFI, SAIDI and CAIDI are shown below:

Table 1 - Relative average increase in reliability indices from the base year (2014/15) as a percentage

| | Ausgrid | | Endeavour Energy | | Essential Energy | |
|---|---|---|---|---|---|---|
| Year | 2020 | 2025 | 2020 | 2025 | 2020 | 2025 |
| SAIFI | 7.3% | 14.7% | 1.3% | 2.7% | 14.8% | 29.5% |
| SAIDI | 25.0% | 33.6% | 11.6% | 13.1% | 33.2% | 50.3% |
| CAIDI | 16.5% | 16.5% | 10.1% | 10.1% | 16% | 16% |

The table above shows that on a conservative basis:

- Ausgrid's average annual SAIDI performance can be expected to worsen by about 25% over the next 5 years, relative to the base year (2014/15).
- Endeavour Energy's average annual SAIDI performance can be expected to worsen by about 11.6% over the next 5 years, relative to the base year (2014/15).
- Essential Energy's average annual SAIDI performance can be expected to worsen by about 33% over the next 5 years, relative to the base year (2014/15).

Our high level analysis of the impacts of the proposed reductions in opex demonstrates that expenditure decisions cannot be made in isolation without consideration of the possible network performance consequences and provides an indication of the type of impacts that might be expected.

**Capex – Impact on Reliability**

NNSW's objective is to maintain the existing level of reliability with a large portion of the proposed capital projects being either asset refurbishment to replace ageing assets or augmentation/ customer initiated projects to meet load growth where alternative supply points are not available. Improving reliability from existing levels other than for compliance is not a focus of the DNSPs, which is reflected in the current regulatory submission with only a small fraction of projects being driven by reliability.

The DNSPs' proposed expenditure for the reliability driven capex programs for the 2014-19 regulatory period was targeted to meet the requirements of the NSW Reliability and Performance Licence Conditions, i.e. to maintain reliability performance at the feeder segment level to ensure persistent known poor performance for individual customers are addressed. Specific cuts to reliability capex will prejudice NNSW's ability to meet Schedule 2, 3 and 5 of licence conditions even if not making a large impact on STPIS. Cuts to augmentation and refurbishment capex will have secondary impact on overall system reliability over the longer term.

Without some degree of compensating expenditure on existing assets, there will be a slow, but inevitable, decline in network reliability as the assets in service age, deteriorate, and customer numbers grow, resulting in increased negative customer impact due to the increasing frequency of outages. Often the compensating expenditure is not primarily reliability driven but will result from augmentation for growth or other similar primary drivers. While the reliability benefits that flow from augmentation and refurbishment are secondary project justifications, these works contribute to maintaining acceptable reliability performance. The overall cuts proposed for the capital projects will have a longer term impact on reliability and hence an impact on the STPIS performance in a similar manner to the proposed cuts in opex, even if not fully analysed in this report.

**STPIS Incentive Target Levels and Reliability**

The AER targets were set constant for the regulatory period suggesting that the proposed large reductions in historical capex and opex will have no impact on the reliability of the network in subsequent years. The STPIS impact on revenue will result in a penalty across all three DNSPs, with the impact on Essential Energy being significantly higher than the other two.

Table 2 - STPIS Penalties / Incentives (% of revenue) under reduced opex

| % of revenue (capped at ±2.5%) | Ausgrid | | | Endeavour Energy | | | Essential Energy | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2015/16 | 2018/19 | 2022/23 | 2015/16 | 2018/19 | 2022/23 | 2015/16 | 2018/19 | 2022/23 |
| STPIS | -0.85 | -1.39 | -2.20 | -0.56 | -0.67 | -0.89 | -1.52 | -3.61 | -7.79 |

This report has produced overall global indices for impact on reliability only, however this is consistent with the AER's use of global organisational level modelling of reliability indices. In addition, when the retrospective reduction for 2014/15 is carried over the next 4 years, the annual reduction over the remaining four year period is higher (for example, the annual opex reduction will be 48.75% for Ausgrid, 28.8% for Endeavour Energy and 47.5% reduction for Essential Energy). Further refinement of modelling identifying other categories of asset failure and applying the retrospective 2014/15 expenditure reduction will likely result in an estimate of impact on reliability that is higher than stated in this report.

## Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to assess the likely impact on reliability that can result from AER's revenue determination for NNSW in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client 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 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 sourced from the Client (if any) and/or available in the public domain 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.

The project is limited to data provided by the client, some analysis methods and extrapolation were driven by available data, and the time restriction on the project makes it viable only to explore reliability impact conceptually with the intention to refine the approach and data, if further work is to be undertaken by the client.

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

To the extent possible within the limited timeframe available, the author(s) has made all the inquiries that the author(s) believes are desirable and appropriate in producing the report and that no matters of significance that the author(s) regards as relevant have, to the author(s) knowledge, been withheld from the report.

# 1. Introduction

Networks NSW (NNSW) refers to a cooperative operating model across Ausgrid, Endeavour Energy and Essential Energy. The objective of NNSW is to contain the costs of building, maintaining and operating the NSW electricity networks in a safe, reliable and sustainable manner.

The economic regulator for NNSW, the Australian Energy Regulator (AER) has proposed a significant reduction in revenue to Networks NSW (comprising of Endeavour Energy, Essential Energy and Ausgrid) in its draft decision. The quantum of reduction in estimated capital (capex) and operational expenditure (opex) is expected by NNSW to lead to reliability impacts for the three network companies. Jacobs has undertaken a high level analysis to estimate the reliability and network performance impact due to reduced investment in Capital expenditure and Operational Expenditure.

The purpose of the project is to examine and comment on the AER's draft decision, whilst considering the NNSW business' ability to meet reliability licence conditions, with a view to providing supporting argument to areas of the DNSPs response to the draft decision where Networks NSW considers that the AER may have made inappropriate reductions.

The intention of this report is to present our conceptual approach to estimating the impact on overall DNSP reliability indices arising from the expenditure reduction in capex and opex. We understand that, based on the findings of this preliminary report, NNSW will review its approach to responding to the AER's draft decision and assess potential merit in pursuing further work to refine the modelling and approach used in this report.

**Networks NSW**

The NNSW companies are responsible for transmitting electricity across the State of NSW and parts of southern Queensland. In FY12 they had annual revenue of $2.45 billion and 12,692 employees. The objective of NNSW is to contain the future costs of building, maintaining and operating the electricity network in a safe, reliable and sustainable manner. The combined network has over 800 major substations, 2.2 million poles and 190,000 smaller substations bound together by 279,000 kilometres of underground or overhead cable.

***Ausgrid*** - supplies electricity to more than 1.6 million customers in Sydney, the Central Coast and the Hunter Region in New South Wales. In FY12 its network supplied electricity to more than 1,637,000 network customers and generated revenue of $1.12 billion. It has 5,868 full-time equivalent employees.

***Endeavour Energy*** - manages an electricity distribution network for 883,658 customers or 2.1 million people across a network spanning Sydney's Greater West, the Illawarra and South Coast, the Blue Mountains and the Southern Highlands. In FY12 this network generated revenue of $0.76 billion and had 2,824 employees.

***Essential Energy*** - is responsible for building, operating and maintaining Australia's largest electricity network delivering essential services to more than 800,000 homes and businesses across 95 per cent of NSW and parts of southern Queensland. It also has water services with its Essential Water business which delivers water services to around 20,000 people in Broken Hill, Menindee, Sunset Strip and Silverton, and sewerage services to Broken Hill.

**AER Decision**

The AER regulates the revenues of the distribution network service providers in eastern and southern Australia under the National Electricity Law (NEL) and National Electricity Rules (NER). The AER is required to determine the revenue allowance for the distribution network service providers under the National Electricity Rules (NER). The regulatory period for NSW is 5 years, from 1 July 2014 to 30 June 2019.

The AER's draft determinations for the 5 year period were published on 27 November 2014 for NSW distribution network service providers. The AER has indicated that Networks NSW must submit a revised proposal by 20 January 2015 responding to issues raised in the AER's draft determination. The AER will take submissions from stakeholders and make a final decision by 30 April 2015.

The AER's draft decision impacts the revenue allowable to be earned by the businesses, and proposes significant reductions to operating expenditure and capital expenditure program budgets submitted to the AER by the NSW distributors. The NSW DNSPs are permitted to recover approved revenue through prices for distribution network services. The tables included below provide an overview of the AER's draft decision and the significance of the proposed reductions to forecast operating and capital expenditure allowances.

We are assisting NNSW in undertaking a preliminary analysis to assess the implications of the AER's draft decision, whereby the AER has proposed that the operating and capital expenditure of the three NSW distribution network service providers be materially reduced relative to recent actual expenditure levels. From our modelling work, we are of the opinion that the reductions proposed by the AER will not, if adopted, enable the DNSPs to provide adequate resources for sustainable asset management, leading to a degradation of asset performance and unfavourable outcomes in terms of safety & reliability over time.

This preliminary report specifically examines the implications on reliability outcomes of the AER's draft determination, in terms of:

- Reductions by the AER to proposed network capex and maintenance opex
- Reductions by the AER to proposed reliability capex programs
- Service Target Performance Incentive Scheme (STPIS) parameters & implications if the AER's reductions are implemented.

Table 3 Draft Decision– Capital Programs

| **capex (**$M 2013/14) | NNSW Submission | AER Draft Determination | Difference ($) | Difference (%) |
|---|---|---|---|---|
| Ausgrid | $4,421 | $2,256 | -$1,875 | -42% |
| Endeavour | $1,746 | $1,070 | -$676 | -39% |
| Essential | $2,619 | $1,934 | -$684 | -26% |
| **Total** | **$8,786** | **$5,551** | **-$3,235** | **-37%** |

Table 4 Draft Decision– Operating Expenditure

| **opex ($M 2013/14)** | NNSW Submission | AER Draft Determination | Difference ($) | Difference (%) |
|---|---|---|---|---|
| Ausgrid | $2,888 | $1,759 | -$1,130 | -39% |
| Endeavour | $1,381 | $1,068 | -$313 | -23% |
| Essential | $2,332 | $1,437 | -$895 | -38% |
| **Total** | **$6,601** | **$4,263** | **-$2,338** | **-35%** |

# 2. Impact of capex reductions on Reliability Performance

## 2.1 Licence Compliance Obligations

The NSW Government through IPART (Independent Pricing and Regulatory Tribunal), the jurisdictional regulator issues the Distribution Licence for NNSW and monitors the delivery of safe and reliable electricity supply within that licence. NNSW must meet licence conditions which, until recently, explicitly mandated 'N-1' redundancy for its design planning criteria for networks under Schedule 1. Effective 1 July 2014, Schedule 1 of the NSW Licence condition was repealed. Although the mandated design standard was repealed, corresponding network performance compliance obligations under Schedule 2 (network overall reliability standards), Schedule 3 (Individual feeder standards) & Schedule 5 (customer service standards) of the NSW Government Licence Conditions are unchanged. Under these compliance obligations NNSW is required to report on performance measures for overall network reliability, at individual feeder level and in meeting customer performance standards. NNSW is also required to undertake remedial reliability rectification programs to address shortfalls in performance. These compliance obligations are enforceable under the Electricity Supply Act 1995 by IPART and the Minister.

The capex proposed for the 2014 -19 regulatory period is significantly lower than the previous regulatory period where almost twice the investment was proposed for core grid reliability investments (primarily supply security related) under previous licence obligations. The proposed expenditure for the reliability driven capex programs for the 2014-19 regulatory period is to meet the requirements of the NSW Reliability and Performance Licence Conditions , ie to maintain reliability performance at the feeder segment level to ensure persistent known poor performance for individual customers are addressed. Projects that are specifically categorised to improve reliability ('Remedial Reliability Projects') for the 2014-19 regulatory period are limited to approximately 6.6% for Endeavour Energy, 0.6% for Ausgrid and 6% for Essential Energy of the total proposed expenditure.

Specific cuts to reliability capex will prejudice NNSW's ability to meet Schedule 2, 3 and 5 of licence conditions even if not making a large impact on STPIS. Reduction of programmes targeting poorly performing feeders will have a direct negative impact on supply reliability. However, due to the small proportion of these programs within the overall capital program and also due to the focus of these programs on individual poorly performing feeders, rather than overall system reliability, the STPIS will not generate savings or penalties equivalent to the cost of the works. Therefore, these programs must be funded in addition to any STPIS benefits/penalty.

## 2.2 Maintaining Reliability

NNSW's objective is to maintain the existing level of reliability; the bulk of the proposed capital investment program submitted to the AER is focused on the expenditure categories of refurbishment and augmentation.

Each component of the network has specific degradation rates and points beyond which failure is imminent. The actual failure mechanism itself can vary from explosive through to unnoticeable and the consequences of those failures can range from loss of supply through to the creation of high risk events such as electrocution and injury or property damage due to explosion. Ongoing asset condition assessment helps determine the trigger point for refurbishment expenditure to replace the aged equipment. There is a degree of judgement in determining when the refurbishment expenditure needs to take place. Refurbishment too early will not improve reliability. Leaving refurbishment expenditure too late can cause the negative consequences outlined above and that almost certainly impact reliability.

Augmentation is required to increase the capacity of the network to meet load growth which may well be very local. Often in distribution networks, there are no alternative sources of supply available for customers and augmentation is the only option if there is growth in load requirements of the customers. This augmentation tends to be quite lumpy in nature such that augmentation of a particular network bottleneck often will not just address the immediate issue but provide additional capacity for growth over a number of years. There is judgement involved in determining when that augmentation is required. Augmentation expenditure too early will not improve reliability. Not committing augmentation expenditure can result in network equipment damage, electricity supply unreliability for consumers and even damage to consumer equipment.

The NNSW expenditure program does not focus on the achievement of the N-1 security requirement that was previously a requirement of the Distribution Licence (repealed Schedule 1 licence condition obligation) and has a small percentage only focused on the reliability to address known feeder reliability issues. AER's proposed reductions will largely impact the refurbishment and augmentation expenditure. While the impact of these programs on system reliability is a secondary benefit, it is likely that the current levels of reliability cannot be maintained in the longer term with the restricted capital works program likely to result from the proposed capex reductions.

## 2.3 Planning Criteria

It is to be noted that repealing of Schedule 1 of the Design, Reliability and Performance Licence conditions for DNSPs does not prohibit the Network Service provider from catering for N-1 level of security. There is no specific mandated requirement to use probabilistic planning or energy at risk model in the NEL, NER or the Electricity Supply Act. Under The Rules (Chapter 5.17) there is a requirement that a Regulatory Investment Test – Distribution (RIT-D) is undertaken for all capital projects above a nominated expenditure threshold. The AER has published RIT-D Guidelines as required under The Rules. These guidelines require an economic assessment for capital projects that may include modelling involuntary load shedding amongst other factors. The Value of Customer Reliability (VCR) is one approach to estimating the economic value of lost load. However, in very few instances does the application of VCR provide economic justification for capital works outside of major substations with broad system impact.

The Victorian DNSPs have used probabilistic methods to drive capital investment with the use of the value of customer reliability (VCR). However, we note that the Victorian distributors have recently published a joint letter expressing their concern over the reduced value of the VCR (as determined by AEMO) and the volatility of the VCR. The latest VCR published by AEMO is approximately 40% lower than in the past. The volatility of the VCR brings into question the usefulness of VCR in driving capital projects and whether planning can be reliably carried out using a volatile index.

If the AER required a probabilistic planning approach to be taken up by all DNSPs and the mandated application of the VCR approach, NNSW expects that this would be made clear well in advance of the DNSPs' submission of their regulatory proposals.

## 2.4 Capital Rationing and Impact on Reliability

Capital rationing will impact the higher volume refurbishment and augmentation categories. It is expected that all of the identified augmentation and refurbishment projects will need to take place either as scoped with timing being the only variable with flexibility. Capital rationing will therefore cause augmentation and refurbishment projects to be deferred beyond the regulatory period. The consequences of that deferral may be explosive equipment failure resulting in loss of supply, injury, electrocution or property damage or may be equipment damage resulting in supply unreliability and network or customer plant damage. A 40% reduction in capex in these categories will effectively push two years of a five year refurbishment or augmentation program into the next regulatory period and require the remaining three years of the five year program to be addressed over a five year period. Such a deferral will require ongoing very close monitoring of the network elements at risk to prioritise expenditure and attempt to limit the high risk consequences outlined in this report.

In order to understand the reliability impact of significant capital rationing, the NNSW capital works program has been prioritised based on their drivers, benefits, positive and negative consequences with the view to prioritising safety, reliability and customer service. A significant proportion of excluded projects are to replace failing assets or condition deteriorated assets and to meet compliance and safety obligations.

The consequences of projects not being undertaken at the right time can lead to 'high risk consequences' such as electrocution due to contact with electrical assets, bushfire risk causing damage to people and property, loss of supply, collision of motor vehicles with poles etc. Examples of excluded programs include replacement of relays, VTs, CTs which are aged or deteriorated. The failure of these assets can result in loss of supply or cause safety incidents such as explosions and arc flash. Frequency of outages generally increases with increasing age and utilisation (loading) of network assets. The consequences of not undertaking refurbishment projects will impact network reliability negatively and increase the level of risk exposure of NNSW.

Refurbishment/ and replacement of aged assets should be targeted to replace assets just before reaching a minimum acceptable performance condition. An informed approach to extend refurbishment periods requires a high confidence degradation model as a basis without which industry tested standards should be accepted. As a result of significant reduction in capital expenditure, overall network reliability performance is likely to decrease, if the assets are not replaced/refurbished at an appropriate time. Current levels of reliability cannot be maintained and the frequency of outages is likely to cause an increase in system SAIFI with the effect being compounded over a few regulatory cycles. Reduction to capex allowance will have a negative impact on overall reliability and hence STPIS, in a similar manner to the opex cuts even if not analysed to the same extent.

# 3. Impact of opex reductions on Reliability Performance

## 3.1 Proposed reductions in opex Allowance

The AER's Draft Decision has proposed a significant reduction in the DNSP's opex allowance for all three of the NSW networks. The reduction in opex expenditure spans the full regulatory period including the current year, 2014/15. If the proposed opex cuts are to be implemented, the expenditure reduction for the full five year period would need to be delivered over the final four years.

### 3.1.1 Ausgrid

The AER's Draft Decision reduces the operating expenditure allowance by 39% or 49% per year over the last four years of the regulatory period.

### 3.1.2 Endeavour Energy

The AER's Draft Decision reduces the operating expenditure allowance for Endeavour Energy by 23% or 29% per year over the last four years of the regulatory period.

### 3.1.3 Essential Energy

The AER's Draft Decision reduces the operating expenditure allowance for Essential Energy by 38% or 47% per year over the last four years of the regulatory period.

## 3.2 Potential Impacts

Whilst it is difficult to quantify the potential impact of the proposed reductions in opex allowance on network reliability before the DNSPs have developed a corporate response to the Draft Decision, a reduction of the magnitude envisaged in the Draft Decision and the assumptions provided by NNSW using prioritisation tools indicate that this would result in reduced reliability for the networks. There are many strategies open to the DNSP management teams to attempt to prepare the organisations for the reduced opex expenditures. The high level analysis undertaken by us and reported here is not intended to portray the absolute expected reliability reductions flowing from the Draft Decision but to provide an indication of the type and quantum of impacts that might be expected. Our analysis demonstrates that expenditure decisions cannot be made in isolation without consideration of the possible network performance consequences.

### 3.2.1 General Assumptions

It has been assumed that any reductions in opex allowance will require a step reduction in expenditure, consistent with the AER's draft determination. Corporate responses such as workplace reforms, restructures, renegotiation of contracts etc. will take time to implement. We consider that the initial response is likely to consist of reductions in expenditure across the whole portfolio of opex expenditures until more sophisticated responses can be developed by the DNSPs. For this analysis the general assumption adopted is that the proposed cuts in opex expenditure will be applied equally across most opex expenditure items with the exception of the vegetation management programme. No cuts have been included for the vegetation management program under the assumption that this is a public safety initiative to reduce network induced bush fire incidences. In our analysis, the AER's nominal reductions have been applied to annual expenditure rather than the adjusted reduction required to deliver the Decision over four years.

For this analysis, the system wide SAIDI and SAIFI forecast for 2014/15 has been provided to Jacobs by the individual DNSPs and is consistent with each network's STPIS Response to the AER Draft Decision. This figure has been used as the starting level in estimating the expected impact of the proposed expenditure reductions on these parameters.

## Outage Frequency

The potential impact of reducing operating expenditure on the frequency of equipment outages has been modelled by assuming that preventive maintenance expenditure reductions include an extension of inspections cycles to accommodate the reduced availability of funds. An extension of the inspection period will result in more assets failing within the inspection cycle than is currently the case.

Distribution networks consist of a large number of asset types. Our analysis focuses on a selected limited number of asset categories within the high voltage distribution feeder network. The high voltage network contributes approximately 85% of the system SAIDI. The assets considered here cover poles, cross-arms and conductors. No attempt has been made to extrapolate the expected outcomes for these assets across the broader equipment base. The impact of reduced inspections on network reliability will be somewhat lower for assets that typically are run to failure or that are configured to meet a full N-1 security criteria.

Failure Mode Effects and Criticality Analysis (FMECA) and Reliability Centred Maintenance (RCM) strategies have been in use in Ausgrid for many years and have been rolled out across the other NSW networks over recent years. It is a mathematically robust, well accepted methodology used across many industries. It has been used by NNSW DNSPs to optimise the inspection cycle to reduce total life-cycle costs for a variety of assets employed in the electrical network. A representative curve illustrating the output from application of FMECA and RCM strategies is included below (Figure 2). Any move away from this optimum asset maintenance planning will result in increased failure rates and overall costs. These tools (FMECA and RCM) can be used to estimate the impact of any changes to the inspection cycles. This element of work was undertaken by [1]Networks NSW and the modelled change in equipment failures (and failure rate) was used as an input to our impact assessment study.

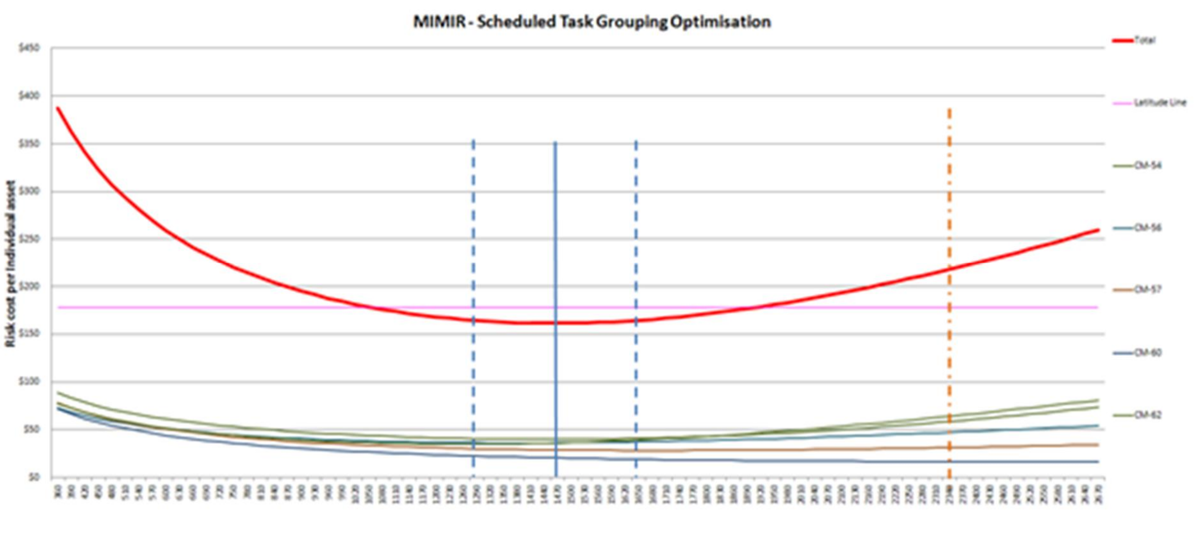


Figure 1 Typical Total Cost vs Inspection Cycle from FMECA modelling tool

In applying the results of the FMECA analysis, we have assumed that there will be a degree of inertia so that the first negative impacts of extended inspection cycles will not be seen for approximately two years and the full impact of the reduced opex (reduced inspection and maintenance cycles) will not be apparent for up to eight years. This is because most assets will still be functionally operational even if not inspected in the optimal cycle time. Some of the small percentage of assets that would have been identified for corrective maintenance will gradually begin to fail in service as they fall outside the optimum inspection cycle. For an extension from a typical cycle time of 4 to 5 years to (say) an 8 year cycle, it is expected that a full cycle under the new regime would be required before the new failure rates would become “business as usual”.

[1] AER Opex reduction implications – Mimir Modelling – Manager Network Performance, Network Strategy, NNSW (undated)

From data provided by NNSW equipment failures account for approximately 30 to 50% of recorded outages and the limited asset list considered here for approximately 4% of the total. These are typical figures but they will vary across the three networks. Whilst the impact on asset condition due to extended inspection cycles is expected to also lead to increased outages under storm/weather conditions, this secondary impact has not been modelled in our preliminary method.

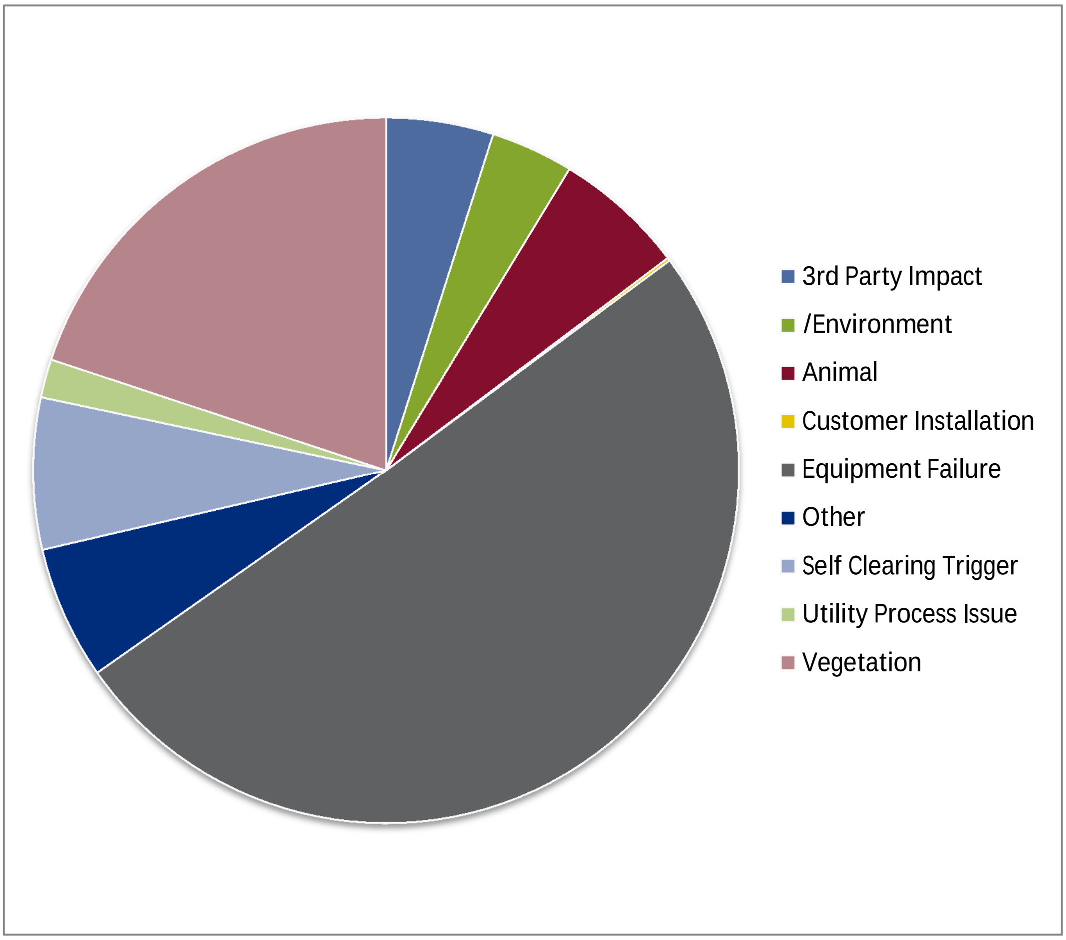


Figure 2 – Typical chart of SAIDI contribution by Cause

For the various reasons discussed, it is believed that this analysis of the impact of the Draft Decision underestimates the negative impact (increased frequency) of the impact of outages on the network.

### Outage Duration

Any reduction to the numbers of response and repair personnel, or the number of depots in operation will have a detrimental impact on the duration of any given outage. It is considered unlikely that there would be much increase in CAIDI for smaller network incidents having limited labour requirement. A more significant impact would be expected for incidents and days when there is a large labour requirement. Based on recorded [2]SAIDI data for each day, we selected a threshold value to represent those days which would require significantly increased labour resources when compared with a typical day. These would be days when initial response, switching and repair times may be compromised by labour constraints. The daily threshold used to define these atypical days was consistently around the 90$^{th}$ percentile but the daily SAIDI threshold varied across the three DNSPs. The sensitivity of the calculated increase in expected SAIDI to this variable (definition of these high labour resource days) was investigated and this is considered further in Section 4.4.

[2] Recorded daily SAIDI / SAIF I were analysed over the last regulatory period (5 years), for organisations where this data was available.

## NNSW

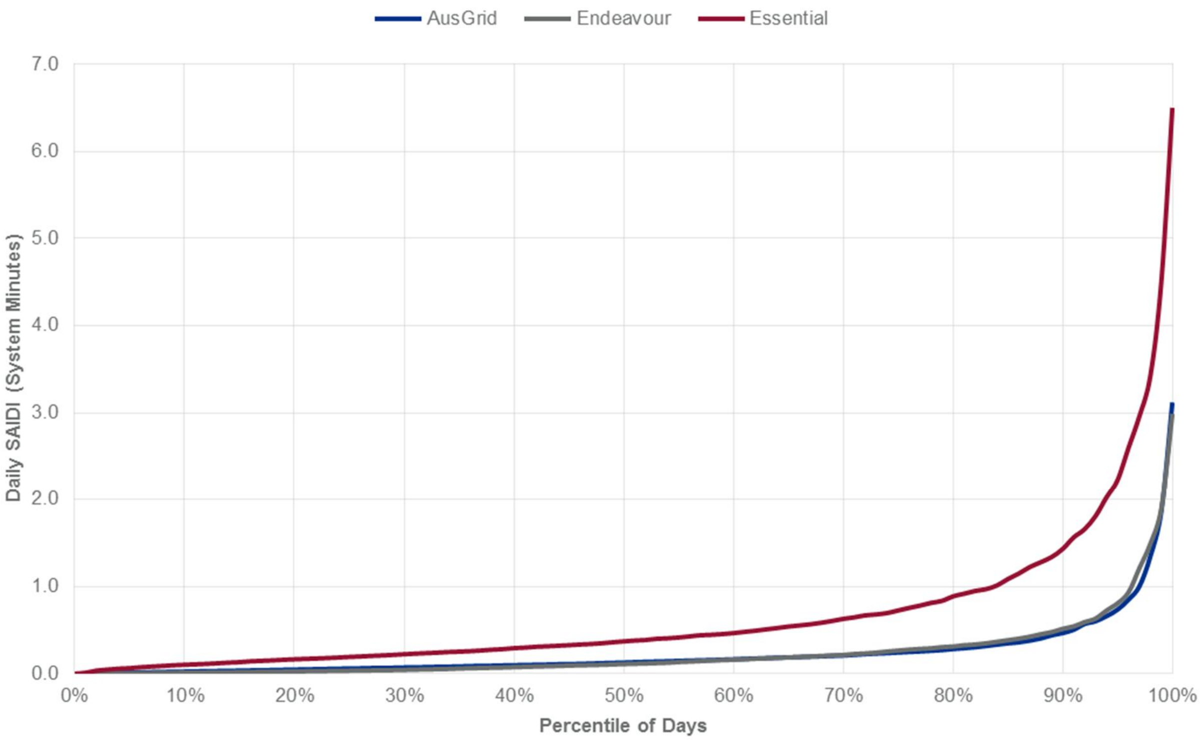


Figure 3 – Graph of Daily SAIDI for each Network

### 3.2.2 Ausgrid

Outage Frequency

A starting SAIDI and SAIFI as provided by Ausgrid has been used – 80.8 minutes SAIDI and 0.85 SAIFI.

Outage Duration

An average system CAIDI of 95.15 minutes has been used as the "business as usual" average customer outage duration, consistent with the parameters used above.

An analysis of outages in the Ausgrid network over the last 5 years indicated that 42% of normalised system SAIDI resulted from the worst 9% of days. These days corresponded to a threshold of approximately 0.5 system minutes of SAIDI. This worst 9% have been classed as high labour resource days. We expected that the proposed opex reductions will impact most heavily on these days. No adjustment has been made to CAIDI for any outage days below the threshold.

### 3.2.3 Endeavour Energy

#### Outage Frequency

A starting SAIDI and SAIFI as provided by Endeavour Energy has been used – 81 minutes SAIDI and 0.98 SAIFI.

#### Outage Duration

An average system CAIDI of 83.1 minutes has been used as the “business as usual” average customer outage duration, consistent with the parameters used above.

An analysis of outages in the Endeavour network over the last 5 years indicates that 44% of normalised system SAIDI resulted from the worst 9% of days. These days corresponded to a threshold of approximately 0.55 system minutes of SAIDI. These days have been classed as high labour resource days. We expect that the proposed opex reductions will impact most heavily on these days. No adjustment has been made to CAIDI for any outage days below the threshold.

### 3.2.4 Essential Energy

#### Outage Frequency

A starting SAIDI and SAIFI as provided by Essential Energy has been assumed – 225.3 minutes of SAIDI and 2.01 SAIFI.

#### Outage Duration

An average system CAIDI of 112.1 minutes has been used as the “business as usual” average customer outage duration, consistent with the parameters used above.

An analysis of outages in the Essential network over a 5 year period indicates that 42% of normalised system SAIDI resulted from the worst 10% of days. These days corresponded to a threshold of approximately 1.4 system minutes of SAIDI. These days have been classed as high labour resource days. We expect that that the proposed opex reductions will impact most heavily on these days. This is a much higher threshold than for the other two networks. There are a number of factors contributing to this. Because of the configuration of Essential Energy’s predominantly rural network, the system SAIDI on a typical day is higher than that of the urban networks. Also, given the wide geographic supply area, several unrelated outages could occur concurrently in different parts of the state affecting quite separate work groups without imposing undue load on a constrained workforce. The ability of Essential Energy to respond under this scenario will be reduced if depot closures result from proposed opex reductions.

No adjustment has been made to CAIDI for any outage days below the daily SAIDI threshold nominated above.

# 4. Modelling the impact on Reliability Indices

The spreadsheet models used to estimate the impact of the proposed reductions in opex on reliability indices are included in Appendix A.

## 4.1 Ausgrid

### 4.1.1 Outage Frequency

The expected impact of extended inspection cycles for the selected asset types on the frequency of outages for network as a whole is shown below.

Table 5 – Expected impact on Ausgrid system SAIFI

| | Baseline | 20015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|---|
| SAIFI | 0.85 | 0.85 | 0.85 | 0.87 | 0.89 | 0.91 | 0.93 | 0.95 | 0.97 |
| % change | | 0.0% | 0.0% | 2.4% | 4.9% | 7.3% | 9.8% | 12.2% | 14.7% |

### 4.1.2 SAIDI Impact

The combined impact of the expected changes to the frequency of outages and duration of outages on the overall system SAIDI is shown below.

Table 6 - Expected impact on Ausgrid system SAIDI

| | Baseline | 20015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|---|
| SAIDI | 80.78 | 94.07 | 94.07 | 96.38 | 98.68 | 100.98 | 103.29 | 105.59 | 107.89 |
| % change | | 16.5% | 16.5% | 19.3% | 22.2% | 25.0% | 27.9% | 30.7% | 33.6% |

## 4.2 Endeavour Energy

### 4.2.1 Outage Frequency

The expected impact of extended inspection cycles for the selected asset types on the frequency of outages for the Endeavour Energy network as a whole is shown below.

Table 7 – Expected impact on Endeavour Energy's system SAIFI

| | Baseline | 20015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|---|
| SAIFI | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 | 0.99 | 1.00 | 1.00 | 1.01 |
| % change | | 0.0% | 0.0% | 0.4% | 0.9% | 1.3% | 1.8% | 2.2% | 2.7% |

### 4.2.2 SAIDI Impact

The combined impact of the expected changes to the frequency of outages and duration of outages on the overall system SAIDI is shown below.

Table 8 - Expected impact on Endeavour Energy's system SAIDI

| | Baseline | 20015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|---|
| SAIDI | 81.4 | 89.66 | 89.66 | 90.06 | 90.46 | 90.85 | 91.25 | 91.65 | 92.04 |
| % change | | 10.1% | 10.1% | 10.6% | 11.1% | 11.6% | 12.1% | 12.6% | 13.1% |

## 4.3 Essential Energy

### 4.3.1 Outage Frequency

The expected impact of extended inspection cycles for the selected asset types on the frequency of outages for the Essential Energy network as a whole is shown below.

Table 9 – Expected impact on Essential Energy's system SAIFI

| | Baseline | 20015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|---|
| SAIFI | 2.01 | 2.01 | 2.01 | 2.11 | 2.21 | 2.31 | 2.41 | 2.50 | 2.60 |
| % change | | 0.0% | 0.0% | 4.9% | 9.8% | 14.8% | 19.7% | 24.6% | 29.5% |

### 4.3.2 SAIDI Impact

The combined impact of the expected changes to the frequency of outages and duration of outages on the overall system SAIDI is shown below.

Table 10 - Expected impact on Essential Energy's system SAIDI

| | Baseline | 20015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|---|
| SAIDI | 225.3 | 261.43 | 261.43 | 274.30 | 287.17 | 300.05 | 312.92 | 325.80 | 338.67 |
| % change | | 16.0% | 16.0% | 21.7% | 27.5% | 33.2% | 38.9% | 44.6% | 50.3% |

## 4.4 Sensitivity to definition of High Labour Resource Days

The calculated increase in SAIDI due to the proposed reductions in opex shows some sensitivity to the definition adopted for an atypical day with respect to labour resource requirements. The impact of a variation of 5% around the chosen percentile used to set the daily SAIDI threshold for an atypical day was modelled. The impact is detailed in the relevant spreadsheet model and is shown graphically for each network in the following charts.

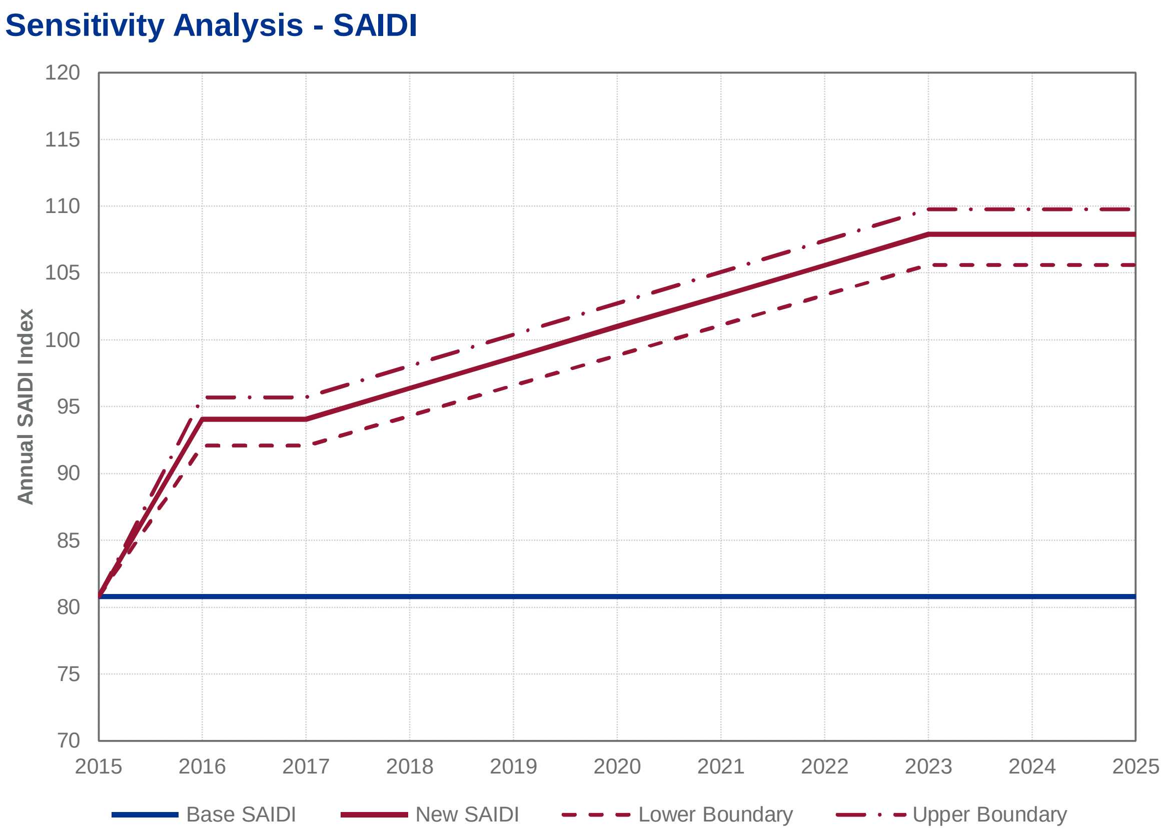


Figure 4 – Ausgrid - Sensitivity of SAIDI increase to definition of High Labour Resource day

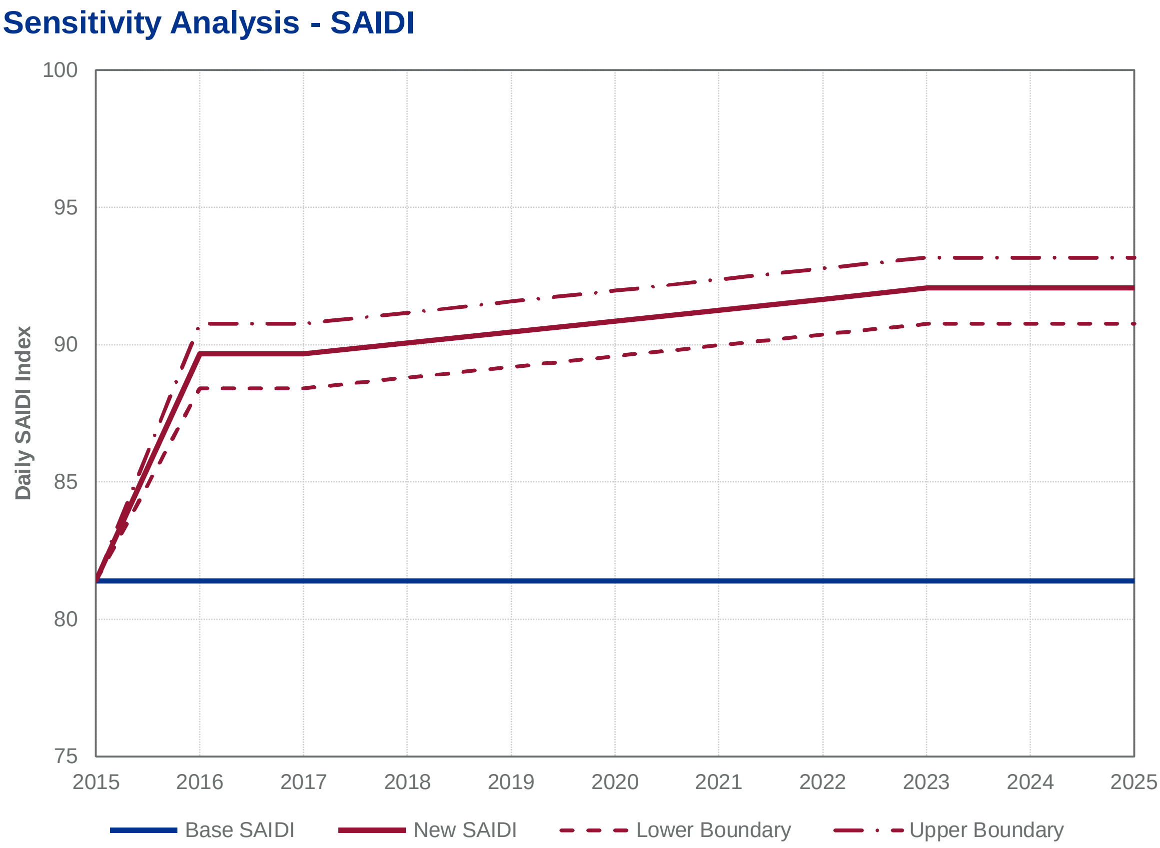


Figure 5 – Endeavour Energy - Sensitivity of SAIDI increase to definition of High Labour Resource day

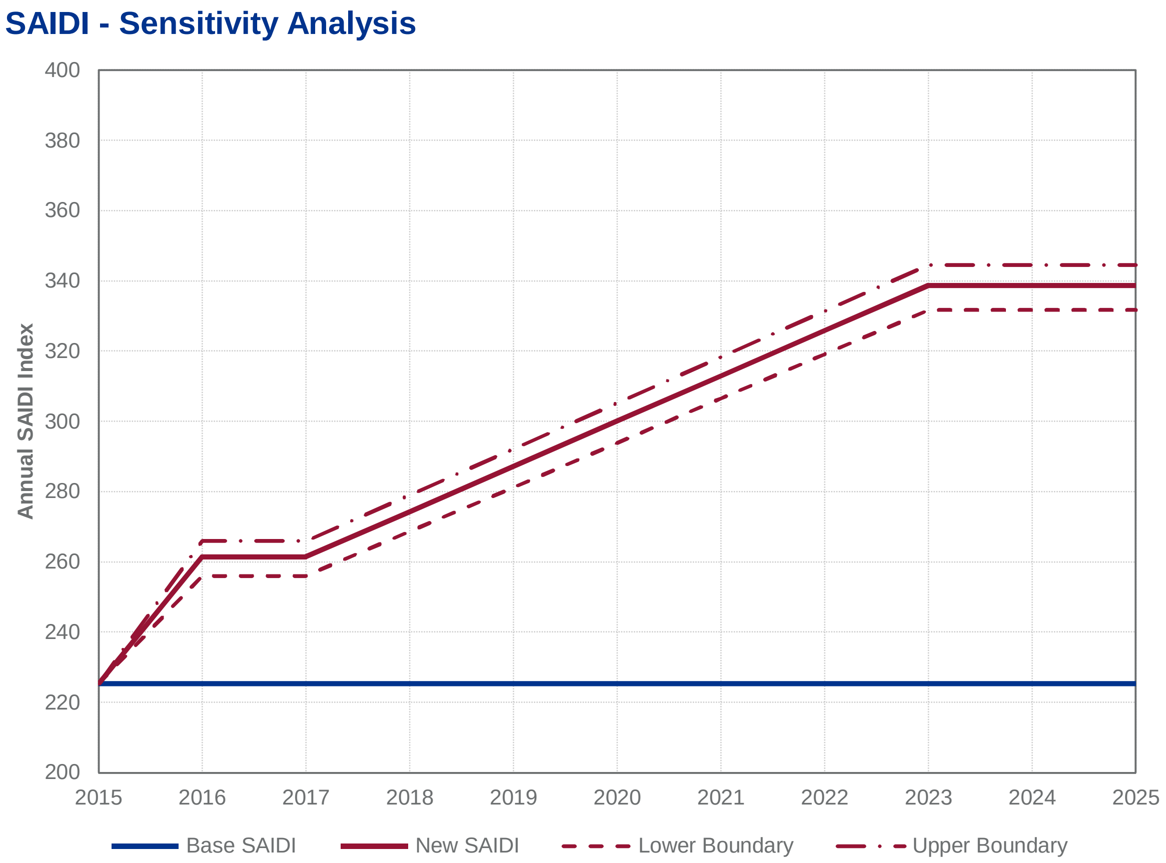


Figure 6 – Essential Energy - Sensitivity of SAIDI increase to definition of High Labour Resource day

The variation considered in this sensitivity test did not result in any significant change to the expected trend in SAIDI due to the proposed opex reductions.

# 5. STPIS Implications

The Service Target Performance Incentive scheme (STPIS) is designed and set to provide DNSPs with an incentive to improve the reliability of their network and a penalty is applied if the reliability falls below target figures.

Without some degree of compensating expenditure, there will be a slow, but inevitable, decline in reliability as the assets in service age, condition declines and customer growth increases the customer impact of the increasing frequency of outages. Often the compensating expenditure is not primarily reliability driven but will result from augmentation for growth or other similar primary drivers. Therefore the proposed reductions in the capital expenditure will also impact on reliability performance and the consequential STPIS penalties. This capex impact has not been modelled and included in the following results.

In this section, we analyse the impact of the proposed reduction in opex on system reliability and on consequential impacts on the STPIS incentive/penalty.

We note that the proposed STPIS targets included in the AER Draft Decision for Ausgrid were developed by examining the recent trend in total system SAIFI and SAIDI and calculating the apparent difference between the actual 2013/14 outputs and the trend figure for this year. This difference was then used by the AER to adjust the measured performance by feeder category to arrive at a target SAIDI and SAIFI for each feeder category. Similar adjustments were made to the performance targets for Endeavour and Essential based on the observed trends for Ausgrid (rather than the specific DNSPs). Given the significant differences in network configurations, the validity of this approach seems somewhat questionable.

The improving trend in historical reliability is identified by the AER as a result of high capital investments and operating budgets in previous regulatory periods. More recently the NNSW DNSPs have generally been targeting maintenance of existing reliability levels rather than improving reliability. It was on this basis that the DNSP’s Regulatory Proposals were submitted. Detailed responses to the Draft Decision regarding STPIS will be the subjects of other documents.

The AER targets were set constant for the regulatory period suggesting that the proposed large reductions in historical capex and opex expenditure will have no impact on the reliability of the network in subsequent years.

To facilitate consideration of the AER’s Draft Decision, a consistent approach to that taken by the AER has been used here to allocate the estimated movement in SAIDI and SAIFI for the total system across the feeder categories.

For this analysis, the SAIDI and SAIFI targets and the STPIS Incentive Rates for each relevant feeder category expected to apply over the regulatory period have been provided to Jacobs by the individual DNSPs and are consistent with the parameters put forward in each network’s STPIS Response to the AER Draft Decision as calculated based on the AER’s draft determinations revenue.

## 5.1 Ausgrid

We have not applied a system wide increase in SAIFI to the CBD feeders since these are predominantly underground and are replaced using age and utilisation conditions and do not have high maintenance works. This aspect represents another conservative assumption by us in the calculation of the impact of reduced expenditure on STPIS outcomes.

We have calculated the expected STPIS penalties for Ausgrid and our results are presented in the table below.

Table 11 – Expected Ausgrid STPIS Penalty

| % of Revenue | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|
| Penalty/Incentive (%) | -0.85 | -0.85 | -1.12 | -1.39 | -1.66 | -1.93 | -2.20 | -2.47 |

In addition to the reductions in opex proposed in the Draft Decision, Ausgrid will be exposed to an on-going and growing STPIS penalty.

## 5.2 Endeavour Energy

The expected STPIS penalty for Endeavour Energy has been calculated in a spreadsheet and is presented in the table below.

Table 12 – Expected Endeavour Energy STPIS Penalty

| % of Revenue | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|
| Penalty/Incentive (%) | -0.56 | -0.56 | -0.62 | -0.67 | -0.73 | -0.78 | -0.84 | -0.89 |

In addition to the reductions in opex proposed in the Draft Decision, Endeavour Energy will be exposed to an on-going and growing STPIS penalty. This STPIS penalty has been based on the reliability targets proposed by Endeavour Energy in their STPIS Response to the AER's Draft Decision. These proposed targets are less onerous than those proposed by the AER in their Draft Decision. Application of the AER targets would result in higher penalties than those calculated here.

## 5.3 Essential Energy

The expected STPIS penalty for Essential Energy has been calculated in a spreadsheet model and is presented in the table below.

Table 13 – Expected Essential Energy STPIS Penalty

| % of Revenue | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 |
|---|---|---|---|---|---|---|---|---|
| Penalty/Incentive (%) | -1.52 | -1.52 | -2.56 | -3.61 | -4.65 | -5.70 | -6.74 | -7.79 |

If the proposed opex reductions are implemented without modification to the reliability targets, then, based on our analysis, Essential Energy will face the maximum STPIS reliability penalty (currently 2.25% of revenue) by approximately 2017/18.

This STPIS penalty calculation has been based on the reliability targets proposed by Essential Energy in their STPIS Response to the AER's Draft Decision. These proposed targets are less onerous than those proposed by the AER in their Draft Decision. Application of the AER targets would result in higher penalties than those calculated here.

# Appendix A. Reliability Impact Assessment model

- RO008301 - Reliability Impact Assessment Model – AusGrid v1.5
- RO008301 - Reliability Impact Assessment Model – Endeavour Energy v1.5
- RO008301 - Reliability Impact Assessment Model – Essential Energy v1.4
- RO008301 – High Daily SAIDI Charts v1.2

*The attached zip file (RO008301 – Model Package (Version 1.4; Endeavour, AG update).zip) contains the spreadsheet models above.*

# Soruby Bharathy

## CONSULTING ENGINEER – REGULATION & NETWORKS

### CURRENT POSITION

Strategic Consultant - Regulation & Networks

### QUALIFICATIONS

Chartered Professional Engineer (since 2007)

Finance for Executives, 2013, INSEAD

Master's degree, Engineering Management, 2002 – 2003, University of Canterbury

Bachelor of Engineering (BE) (Hons), Electrical and Electronics Engineering, 1997 – 2001, University of Canterbury

### EXPERTISE

- Transmission & Distribution Planning
- Assisting Utilities develop Grid vision and transmission planning capability
- Assessing Impact of regulatory changes
- Assessing Prudency and Efficiency of capital expenditure
- Negotiation of long term customer connections and access agreements.

Soruby is an experienced Chartered Engineer having worked in energy regulation, transmission and distribution areas for the past 10 years in technical and commercially focussed roles. Soruby has been involved in the **due diligence** of major capital augmentation projects for the Victorian networks on behalf of the **Australian Energy Regulator**. Through Soruby's direct engagement in the utilities as a planning engineer and consulting, she has worked extensively with Queensland networks and has deep knowledge of commercial, regulatory, asset portfolios and network developments. Soruby has been instrumental in developing the **Transend's 2020 vision** to support subsequent regulatory submission. Her work with Transend included **network planning studies**, undertaking **power system stabiliser setting studies** for the refurbished Gordon generators and **developing limit equations** for Tasmania's entry to the NEM. Her recent engagement with ActewAGL (ACT) is to assist in the development of CAPEX projects, OPEX step up changes and formulate responses to the Australian Energy Regulator for the current revenue determination.

### Significant Work:

- Development of business cases for major CAPEX projects, step up OPEX projects and responses to the AER on behalf of ActewAGL Distribution.
- Connection negotiations for Peabody's ($200Million) mine development in the Bowen Basin; identification of investment opportunities for BHP; feasibility studies for Xstrata's Wandoan Coal mine.
- Copper String Feasibility Study: Instrumental in identifying drivers and capital structures required to support investment in regulated transmission networks through the feasibility for a merchant transmission investment ($1.7 Billion) for the mining region in Mt Isa, Queensland.
- Assessing prudency and efficiency of capital investment of the Victorian utilities for the Australian Energy Regulator.
- Contribution to an investor review for privatisation of the OEDAS distribution network (a Turkish distribution company).
- Contribution to AEMC assessment of Optional Firm Transmission Rights for Generators in the NEM.
- Scoping, management and delivery of projects for large mining clients to support investment decisions and negotiating long term power supply agreements with regulated entities.
- **Basslink integration project**: This project was to integrate the world's longest HVDC merchant link ($780 Million) between Tasmania and the Australian mainland. Developed network constraint equations for implementation in the Australian National Electricity Market to integrate Tasmania to the Australian mainland.
- **Gordon Power Station**: Instrumental in undertaking excitation system settings and power system stabilizer tuning studies for hydro generators. Witnessing of commissioning and testing. Advanced exposure to system dynamics and controls in the grid.
- **Grid vision planning:** Developed a 30 year vision for Transend working with external management consultants. Integrating stakeholder input into long term transmission planning.

# Greg Edwards

SENIOR CONSULTANT

**CURRENT POSITION**

Senior consultant – power delivery

**QUALIFICATIONS**

Bachelor of Engineering (Electrical) (2A Hon), University of Queensland, 1974

Bachelor of Arts (Economics), University of Queensland, 1985

Graduate Diploma of Management, Central Queensland University, 1991

Diploma Australian Institute of Company Directors, University of Sydney, 1998

**PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS**

Graduate Member, Institution of Engineers, Australia

**EXPERTISE**

- Distribution and transmission electricity network planning and reliability
- Customer connections, supply offer conditions and policy
- Distribution network pricing and Regulatory management
- Distribution asset management

## Summary of competencies

Greg has over 30 years' experience in electricity utilities; Powerlink (QEGB), Mackay Electricity Board, and Ergon Energy; in network planning, capital works programming, asset management, customer connections, regulatory and general engineering management roles before joining SKM in 2002.

## Recent project experience

### Network regulatory

**Valuation of isolated generation assets – 2005, 2007, 2012**

**Client:** Ergon Energy

**Role:** Consultant

**Engineering due diligence review of regulatory reset submission**

**Client:** Ergon Energy

**Role:** Consultant

**Key achievements:**

- Review of Ergon Energy's regulatory reset submission to the Australian Energy Regulator – 2009.

**Valuation of the Queensland DNSPs**

**Client:** Queensland Competition Authority

**Role:** Consultant

**Audit of transmission companies' reliability performance**

**Client:** ACCC

**Role:** Consultant

**Key achievements:**

- Audit of transmission companies' reliability performance against service standards.

**Review of operating expenditure forecast**

**Client:** Energy Australia, ElectraNet

**Role:** Consultant

**Key achievements:**

- Review of operating expenditure forecast as part of the clients' regulatory reset submissions.

**Valuation of the Philippine transmission network**

**Client:** Electricity Regulation Commission (Philippines)

**Role:** Consultant

**Key achievements:**

- Valuation of the Philippine transmission network for regulatory purposes.

**Review of operating and capital budget forecasts**

**Client:** LECG Consulting

**Role:** Consultant

**Key achievements:**

- Review of operating and capital budget forecasts for TransCo, Philippines, as part of submission to the Electricity Regulator.

**Assist ActewAGL to prepare its price re-set proposal**

**Client:** ActewAGL

**Role:** Consultant

**Key achievements:**

- Price reset proposal project.

**Audit of compliance to license conditions**

**Clients:** IPART and the Department of Water and Energy

**Role:** Consultant

**Key achievements:**

- Audit of compliance to license conditions.

**Review of transmission unit**

**Client:** Transpower (NZ)

**Role:** Consultant

**Key achievements:**

- Review of escalation in the cost of capital works, procurement and construction.

**Advice regarding performance incentive regulation**

**Client:** Price Waterhouse Coopers (India)

**Role:** Consultant

**Key achievements:**

- Advice to Andhra Pradesh Electricity Regulatory Commission regarding performance incentive regulation.

**Review of electricity demand forecasting**

**Client:** Western Power

**Role:** Consultant

**Key achievements:**

- Review of electricity demand forecasting methodology.

## Asset Management

**Incident investigations**

**Client:** Ergon Energy

**Role:** Lead Investigator

**Key achievements:**

- Investigated a range of major system outages and incidents – 2006-2011.

**Review of response to Cyclone Larry**

**Client:** Ergon Energy

**Role:** Reviewer

**Key achievements:**

- Review of Ergon Energy's response to Cyclone Larry.

**Benchmarking of fault rate data**

**Client:** Ergon Energy

**Key achievements:**

- Research and analysis of Australian and international fault rate data to allow benchmarking of fault rate data for network elements.

**Review of security of supply criteria**

**Clients:** Ergon Energy and ENERGEX

**Role:** Consultant

**Key achievements:**

- Review of existing Security of Supply criteria, recommending alternate criteria.

**Asset refurbishment/replacement modelling**

**Client:** ENERGEX

**Key achievements:**

- Asset Refurbishment/Replacement modelling, preparation of replacement strategies and CAPEX forecasts.

**Review of Annual Network Management Plan – 2005, 2006**

**Client:** ENERGEX

**Role:** Consultant

**PROJECT | Review of distribution network**

**Client:** Rio Tinto Alcan

**Role:** Consultant

**Key achievements:**

- Review of distribution network supplying Rio Tinto Alcan's Weipa mining, processing and township – reliability, maintenance strategies, costs and future development options.

**Review of asset management plan**

**Client:** Unison Networks (NZ)

**Role:** Consultant

**Key achievements:**

- Peer review of asset management plan.

## Greg Edwards

SENIOR CONSULTANT

**Reliability improvement**

**Client:** TXU (now SP AusNet)

**Role:** Consultant

**Key achievements:**

- Study of reliability improvement strategies.

**Vegetation compliance costs**

**Client:** Powercorp

**Role:** Consultant

**Key achievements:**

- Study of vegetation compliance costs.

**Independent review of state of the electricity network**

**Client:** Vector Limited

**Role:** Consultant

**CURRENT POSITION**

Manager Strategic Consulting

**QUALIFICATIONS**

Master of Engineering (1st Class Honours) Electrical and Electronic, Loughborough University of Technology, UK

Doctor of Philosophy, Power Electronics, Loughborough University of Technology

Master of Business Administration, Heriot Watt University, UK

Master of Law (Commercial), Glasgow University, UK

**PROFESSIONAL MEMBERSHIPS**

Chartered Engineer, Engineering Council, UK

Fellow of Institution of Engineering and Technology, UK

Registered Professional Engineer of Queensland

**EXPERTISE**

- utility regulatory support: CAPEX OPEX reviews, demand forecasting
- Project Governance
- Benchmarking
- Transaction technical advisory
- asset valuation
- CAPEX option studies

# Stephen Hinchliffe

PRINCIPAL CONSULTANT

## Summary of Competencies

Stephen holds Master's degrees in Electronic and Electrical Engineering, Business Administration and Commercial Law. He is a Chartered Professional Engineer, a Fellow of the Institution of Engineering and Technology (UK) and a Registered Professional Engineer of Queensland.

Stephen has 20 years' experience in the delivery of strategic consulting services to the utility sectors of power generation, power networks, rail, gas and water.

Stephen's specialisations include: regulatory price reset review, utility CAPEX, OPEX prudency and efficiency reviews and good practice benchmarking; capital project governance reviews; utility asset management planning; asset sale transaction due diligence; asset valuation (optimised depreciated replacement cost method among others); preparation of business plans and Board papers; scheme technical and commercial feasibility analysis; options analysis and financial modelling; demand forecasting and business process analysis.

## Recent Project Experience

Utility Regulation and Project Governance Experience

PROJECT | Stage 3 Regulatory Submission Support

Client: ActewAGL

Role: Project director for provision of support to ActewAGL in respect of stage 3 of its regulatory submission to the AER. Work included governance review, asset management documentation, demand forecasting, capex project and program justification and CAPEX/OPEX trade-off and business case development.

PROJECT | ENERGEX Cost Escalation Factors

Client: Energex

Role: Project director for an assignment to provide capital works cost escalation factors based on the ENERGEX asset classes, including electricity industry labour, commodity and asset price indices. The cost escalation factors were provided in both nominal and real terms. Upon request by ENERGEX, these cost escalation factors were updated during the life of the project (with fees captured under sub-numbers) prior to submission to the AER as part of the ENERGEX regulatory proposal in 2015.

PROJECT | Independent Review of Cost Forecasts

Client: Ergon Energy

Role: Project director for an assignment to provide capital works cost escalation factors based on the Ergon Energy asset classes, including electricity industry labour, commodity and asset price indices. The cost escalation factors were provided in both nominal and real terms. Upon request by Ergon Energy, these cost escalation factors were updated during the life of the project (with fees captured under sub-numbers) prior to submission to the AER as part of the Ergon Energy regulatory proposal in 2015.

PROJECT | Benchmarking of distribution capital expenditure costs

Client: Western Power

Role: Project director for an assignment to undertake independent benchmarking of capital expenditure items for distribution assets against Jacobs' internal databases and recent project example costs in Australia, New Zealand and the UK applying appropriate normalisation factors for location, remoteness, terrain, market conditions.

PROJECT | Stage 2 Regulatory Submission support

Client: ActewAGL

Role: Technical specialist advising on review of CAPEX and OPEX forecasts against regulatory prudency and efficiency tests and capital project governance processes

PROJECT | Capital Project Governance Review

Client: Jemena Gas Networks

Role: Project manager for a review of Jemena Gas Networks capital project governance processes against industry good practice and development of recommendation to transition to international good practice in project governance.

PROJECT | Audit of RIT-T process

Client: ELECTRANET SA

Role: Project Director for an internal audit of ElectraNet's RIT-T processes covering details of overall objectives, stakeholder requirements (internal and external), method adopted and resources utilised.

PROJECT | Manning Level Benchmarking and Shift Rostering Review

Client: Power and Water Corporation (Generation)

Role: Review of manning levels and shift rostering arrangements at Owen Springs and Ron Goodin power stations, NT, including benchmarking against public sector and private sector power station manning levels

PROJECT | Regulatory Submission

Client: Endeavour Energy

Role: Technical specialist advising on review of CAPEX and OPEX forecasts against regulatory prudency and efficiency tests.

PROJECT | Gladstone Area Water Board price monitoring 2015-2020

Client: Queensland Competition Authority

Role: Project Manager for the review of the prudency and efficiency of capital and operating expenditure of Gladstone Area Water Board on a sample basis on behalf of the Queensland Competition Authority.

PROJECT | Aurizon Rail CAPEX post commissioning review

Client: Queensland Competition Authority

Role: Project Director for a review of Aurizon Network's capital expenditure (Post commissioning) for FY 2012/2013 financial year. This covered a prudency review of the $1.4bn GAPE (Goonyella to Abbot Point) project and Blackwater Electrification (feeder stations) CAPEX post commissioning

PROJECT | Seqwater Irrigation Price Review 2013-2017

Client: Queensland Competition Authority

Role: Project Director for the review of the prudency and efficiency of capital and operating expenditure of Seqwater's irrigation services on behalf of the Queensland Competition

Authority. Plus review of procedures for establishing and authorising expenditure

PROJECT | Aurizon Rail Network 2013 Draft Access Undertaking

Client: Queensland Competition Authority

Role: Project Director for a review of Aurizon's access undertaking agreement from 2013-2017.

PROJECT | SunWater Price Reset Price Capital Project Review

Client: Queensland Competition Authority

Role: Project Manager for the review of the prudency and efficiency of SunWater's proposed capital expenditure programme over a 5 year regulatory review period in support of the QCA's decision making process on allowable costs for water supplies to irrigators following SunWater's response to initial ruling) including review of operational staff manning levels and costs against Australian and international benchmarks.

PROJECT | Aurizon Rail flood damage assessment

Client: Queensland Competition Authority

Role: Project Director for a development of a high level assessment of works and +/-50% cost estimate of works necessary due to the flooding damage on Aurizon Network's Blackwater and Moura systems during the 2013 floods. The QCA used SKM's review to benchmark Aurizon Network's own claim expected in May 2013.

PROJECT | Queensland Rail Network Engineering Assessment and Cost Review

Client: Queensland Competition Authority

Role: Project Manager for the provision of technical advice on the prudency of QRN's scope, standard and cost of the works. In assessing the prudency and efficiency of the capital expenditure, the consultant will be expected to focus on material matters in terms of value and matters of regulatory principle, reviewing most major projects and adopting a sampling approach to the assessment of the minor projects submitted by QR Network

PROJECT | Review of SunWater's Asset Management Plans

Client: Queensland Competition Authority

Role: Project Manager for the review of SunWater's asset management plans, and asset management planning methods as part of a CAPEX review of SunWater's 25 year forward capital expenditure program for asset replacement and refurbishments.

PROJECT | South East Queensland Water Distribution and Retail Price review 2013-15

Client: Queensland Competition Authority

Role: Project Director for the review of the prudency and efficiency of capital and operating expenditure of the monopoly distribution and retail water and wastewater activities of Unitywater, Queensland Urban Utilities (QUU), Logan City Council, Redland City Council and Gold Coast City Council (the entities).

PROJECT | South East Queensland Water Grid Service Charge Review 2012-13

Client: Queensland Competition Authority

Role: Project Manager for the review of the prudency and efficiency capital and operational expenditure put forward by the SEQ water grid providers on behalf of the regulator as in support of a regulatory price monitoring activity).

PROJECT | South East Queensland Water and Wastewater Price Monitoring

Client: Queensland Competition Authority

Role: Project Manager for the regulatory review of capital and operating expenditure and an assessment of projected demand for the three distribution and retail entities in SEQ:

Queensland Urban Utilities, Allconnex Water and Unitywater.

PROJECT | SunWater CAPEX Review

Client: Queensland Competition Authority

Role: Project Manager for the review of the prudency and efficiency of SunWater's proposed capital expenditure programme over a 5 year regulatory review period in support of the QCA's decision making process on allowable costs for water supplies to irrigators.

PROJECT | South East Queensland Water Grid Service Charge Review 2011-12

Client: Queensland Competition Authority

Role: Project Manager for the review of the prudency and efficiency capital and operational expenditure put forward by the SEQ water grid providers on behalf of the regulator as in support of a regulatory price monitoring activity).

PROJECT | South East Queensland Water and Wastewater Price Monitoring 2010-11

Client: Queensland Competition Authority

Role: Project Manager for the review of the prudency and efficiency capital and operational expenditure put forward by the SEQ water distributers and retailers on behalf of the regulator as in support of a regulatory price monitoring activity)

Client: Seqwater

Role: Project Director for an independent technical review of five separate budget proposals relating to the Western Corridor Recycled Water (WCRW) and Gold Coast Desalination Project (GCDP). This included reviewing the process by which the forecasts were developed to gain confidence in the cost estimates.

<u>Asset Management Experience</u>

PROJECT | Development of Strategic Asset Plans

Client: Power and Water Corporation, NT

Role: Project Manager and principal advisor for the development of strategic asset plans for the generation business, including a readiness review of the business in terms of existing plans and capability of management team to develop required plans.

PROJECT | Review of SunWater’s Asset Management Plans

Client: Queensland Competition Authority

Role: Project Manager for the review of SunWater’s asset management plans, and asset management planning methods as part of a CAPEX review of SunWater’s 25 year forward capital expenditure program for asset replacement and refurbishments.

PROJECT | Regulatory Readiness and Asset Management Planning Review

Client: Power and Water Corporation

Role: Project Manager for the review of Power and Water’s capital expenditure approval documentation, including supporting asset management plans for their Water and Wastewater, Generation, Power Networks businesses as part of a regulatory submission readiness review.

PROJECT | Assessment of Application of Fossil Fuel Power Plant Condition Monitoring Systems to Wind Farms

Client: Intermediate Technology Institution (Scotland)

Role: Project Manager for advice on merit, including cost benefit analysis, of applying fossil fuel power station asset condition monitoring systems to wind farms to support a reliability centred maintenance approach to wind farm operation.

PROJECT | Operational Management of Wind Farms

Client: ScottishPower and Celt Power (UK)

Role: Asset Manager for the independent operation and asset management of a portfolio of wind farms in the UK.

PROJECT | Outage Management for 2400MW Coal Fired Power Station

Client: ScottishPower (UK)

Role: Manager responsible for the development of an outage management business (Incorporated JV between ScottishPower Technology and Mitsui Babcock) for the outage management and overhaul of turbines of ScottishPower's 2400MW Longannet Power Station.

Asset Transaction Due Diligence

PROJECT | SunWater Irrigation Asset Transaction Engineering Due Diligence

Client: Department of Energy and Water Supply, Queensland Government

Role: Project Manager for undertaking engineering due diligence for the transfer of circa $1bn of SunWater's irrigation assets to Interim Independent Irrigation Boards. This includes the development of a 30 year capital asset replacement and expenditure profile (CAPEX and timing) including review of asset condition and review of development of options studies, together with analysis and recommendation of business structure models and systems to be used by new Irrigation Boards.

PROJECT | Turkish Distribution Utility Transaction Technical Due Diligence

Client: Confidential

Role: Project manager for technical due diligence on acquisition of Turkish distribution utility covering, *inter alia,* capital asset plans, operation and maintenance systems, asset condition, energy market mechanisms, regulation and staff transfer/employment aspects.

PROJECT | Transaction Due Diligence: Vector Distribution (NZ)

Client: Confidential

Role: Project manager for Jacobs (formerly SKM (AUS)) support of the due diligence on sale of Vector network. Jacobs (AU) lead on capital expenditure, including growth and replacement of aged assets.

PROJECT | Wind farm sale technical due diligence

Client: International Power

Role: Project Manager for technical due diligence re purchase of five of Queensland Treasury's operating wind farm sites and wind farm development portfolio.

PROJECT | Transaction Due Diligence: Powerco (NZ)

Client: AMP Capital

Role: Project Director for Jacobs AU (formerly SKM (AUS)) technical due diligence contribution to a successful acquisition of a Powerco's power and gas network and retail utility business.

PROJECT | Chemical Laboratory and Forensic Company Acquisition Due Diligence

Client: Gold Coast Council

Role: Project Manager for the valuation and asset and business acquisition due diligence, including market analysis and development of business plan for future integration of a joint chemical lab facility with forward projection of revenue streams, return on investment and business structure development.

PROJECT | Wind farm sale technical due diligence

Client: AGL Energy Limited

Role: Project Manager for technical advisor support in preparation of technical documentation for sale of wind farm assets including answering prospective acquirer questions during sale due diligence.

PROJECT | Wind farm sale technical due diligence

Client: Transfield Infrastructure fund

Role: Project Manager for development of technical sale documentation for sale of a portfolio of wind farms in Australia previously owned by Queensland Treasury.

PROJECT | Wind farm sale technical due diligence

Client: International Power

Role: Project Manager for development of technical sale documentation for sale of a portfolio of wind farms in Australia owned by Queensland Treasury.

PROJECT | MANWEB (UK) Power Distribution Transaction Due Diligence

Client: ScottishPower

Role: Power network and retail utility acquisition technical adviser for the acquisition of MANWEB distributor and retailer by ScottishPower. Following acquisition, led an element of the energy services integration activities.

PROJECT | Transaction support of Cogeneration Plant

Client: RSM Robson Rhodes

Role: Project Manager for the valuation and asset sale technical due diligence and support for a liquidator on behalf of BHF bank of cogeneration assets used to supply electricity, heat and $CO_2$ to the market gardening industry on the Isle of Wight.

Asset Valuation Experience

PROJECT | Power Distribution and Transmission Network Valuation

Client: Power and Water Corporation

Role: Valuation technical adviser for the optimised, depreciated replacement cost valuation of all of Power and Water Corporation's power transmission and distribution assets including office blocks and land.

PROJECT | Valuation of Power and Water Corporation's $2.4bn Assets

Client: Power and Water Corporation

Role: Project Manager for the valuation of all of Power and Water Corporation's assets: Generation, Transmission, Distribution, Water, Wastewater, Gas, Remote Community and Corporate Assets. Included optimised depreciated replacement cost valuation of utility assets and fair market value valuation of commercial buildings and land.

PROJECT | Geothermal Project Valuation and Tariff Study

Client: PLN and PERTAMINA, Indonesia

Role: Project Manager for development of a mechanism and financial model to calculate the required power purchase agreement tariff for geothermal projects in Indonesia to achieve an agreed project internal rate of return. This included valuation of existing assets and the determination of future CAPEX and OPEX and development of a Monte Carlo financial model.

PROJECT | Generation Business Asset Valuation

Client: Power and Water Corporation

Role: Technical advisor for optimised depreciated replacement cost and financial valuation of Power and Water Corporation's generation business.

**CURRENT POSITION**

Graduate Engineer

**QUALIFICATIONS**

University of Adelaide, 2008-2013 – Bachelor of International Finance

University of Adelaide, 2008-2013 – Honours Bachelor of Engineering (Mechanical and Sustainable Energy Engineering), 1st Class Honours

University of Birmingham, 2011-2012 – Study Abroad Program, Mechanical Engineering and Economics, Banking and Finance

**PROFESSIONAL MEMBERSHIPS AND AFFILIATIONS**

StudIEAust

Australian Institute of Energy (AIE)

**EXPERTISE**

- Financial Modelling
- Model development (VBA, Matlab, C++)

# Steve Ingham

## FINANCIAL AND ECONOMIC MODELLER

### Summary of Competencies

Steve's background in conventional and renewable power generation and international finance has positioned him at the cross-road between technical and commercial project factors. His core competencies include financial analysis of power projects, environmental economics, energy management, renewable energy technology design and commercialisation and regulatory framework consultation.

He has attained an Honours Bachelor of Engineering in Mechanical and Sustainable Energy Engineering and a Bachelor of Finance in International Finance and Economics, from the University of Adelaide, Australia. Steve's Engineering Honours Project was the design, manufacture, testing and commercialisation of a free-stream tidal generation turbine, utilising tubercles on the leading-edge of the blades for improved performance. A key role within this project was investigating the sustainability of the technology including the environmental, economic and social impact of full commercial implementation.

In addition to his engineering background, he has completed placements and internships within boutique business advisory firms in the fields of corporate recovery, strategic advisory and private business sales.

### Recent Project Experience

**Jacobs (formerly Sinclair Knight Merz)**

*Strategic Consulting for Power and Energy, Graduate Engineer – London, UK*

**Consultancy Support for Electricity Transmission and Distribution Revenue Controls (2016-2020), 2014**

**Client:** Commission for Energy Regulation

**Role:** Consultant

**Key Achievements:**

- Acting as Technical Consultant for Price Review 4 (PR4) 2016 – 2020 on behalf of the Commission for Energy Regulation (CER) in the Republic of Ireland.
- Included assessment of historic expenditure against PR3 allowances and advised on allowed expenditure in PR4 for EirGrid and ESBN.
- Full ownership of benchmarking study against GB DNOs and international transmission system operators.

**Technical Assessor AADC Annual Information Submission, 2014**

**Client:** TRANSCO / Al Ain Distribution Company

**Role:** Consultant

**Key Achievements:**

- Technical Assessor undertaking the Technical Assessment of the Annual

Information Submission (AIS) of Al Ain Distribution Company (AADC) in the Emirate of Abu Dhabi. This includes assessment of the outturns and forecasts of the companies' opex, capex, revenue, assets, customers, volumes and projects for water and electricity distribution in the region.

**Carbon Capture and Storage Economic Feasibility Study for UK CCGT Plant**

**Client:** Confidential

**Role:** Economic and Financial Consultant

**Key Achievements:**

- Techno-economic assessment of market conditions required to incentivise the retrofitting of carbon capture and storage (CCS) to a proposed CCGT plant in the UK.
- Cost-benefit analysis based on lifetime cost of investment and carbon price projection modelling

**Energy transfer between DERL and Michelin, UK**

**Client:** Zero Waste Scotland

**Role:** Power and Energy Consultant

**Key Achievements:**

- Business case analysis of proposed energy transfer between Dundee Energy Recycling Limited (DERL) and Michelin's Dundee tyre factory
- Energy use profiling and cost-benefit analysis

**CCE Renewables Tool, EU**

**Client:** Coca Cola Enterprises

**Role:** Market Analyst

**Key Achievements:**

- Renewable energy market progression and forecasting analysis
- Excel tool development

**Cost-benefit Analysis for Proposed HVDC link, UK**

**Client:** Confidential

**Role:** Economic and Financial Modeller

**Key Achievements**

- Long range economic modelling under dynamic conditions including detailed dispatch and energy constraint modelling
- Scenario development and sensitivity analysis within high uncertainty market
- Based on work done by Jacobs, Ofgem approved the £1.1 billion investment plan

Steve Ingham

FINANCIAL AND ECONOMIC MODELLER

**UK Energy Market Reform (EMR) Analysis and Advice, UK**

**Client:** Various

**Role:** Techno-economic Consultant

**Key Achievements**

- Provided capacity mechanism, balancing market and contract for difference advice for clients within the UK energy and utilities industry
- Development of in-house models into bespoke tools

**Connection Charge Methodology, Oman**

**Client:** Muscat Electricity Distribution Company

**Role:** Research Analyst

**Key Achievements**

- Connection charges, TUoS and DUoS research in multiple jurisdictions across Western Europe and the Middle East
- Used in the development of a connection charge methodology submission to regulator

**Evaluation and Negotiation Support for Attarat Oil Shale Project, Jordan**

**Client:** National Electric Power Company (NEPCO), Jordan

**Role:** Financial Modelling Consultant

**Key Achievements**

- Audit of proposed PPA with respect to financial model for 460MW oil shale mine and power plant
- Technical and financial comparison of alternative technologies for negotiation support

**Calla Wind Farm Extension, Scotland**

**Client:** WilloWind

**Role:** Financial Modelling Consultant

**Key Achievements**

- NPV analysis of wind farm extension for planning permission request

## Past Experience

**University of Adelaide, Sustainable Marine Current Energy Project**

*Project Engineer – Adelaide, Australia*

December 2012 – November 2013

- Honours project investigating the effects of tubercles on marine hydrokinetic turbines
- Involved the design, manufacture, testing and analysis of a renewable power generation technology.

**Sinclair Knight Merz,**

*Power Generation, Intern – Manchester, UK*

November 2012 – January 2013

- Key tasks included proposal development, technical alignment and commercial strategy and analysis
- Owner's Engineer services for CCGT, OCGT and thermal generation plant.
- Engaged in the full bid process (pursuit to submission) for a large--scale IWPP in the Middle East region.

**McGrathNicol**

*Vacationer – Adelaide, Australia*

Worked on a diverse range of projects within the corporate recovery, corporate advisory, forensic and transaction services business units.

**Dale Woods Sales Consultancy**

*Intern – Adelaide, Australia*

August – October 2010

Worked in a small dynamic team with selected undergraduate and MBA Students to extract data and compile a digital database.