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SAPN_PUBLIC_DGA_Revised ADMS and ZSS

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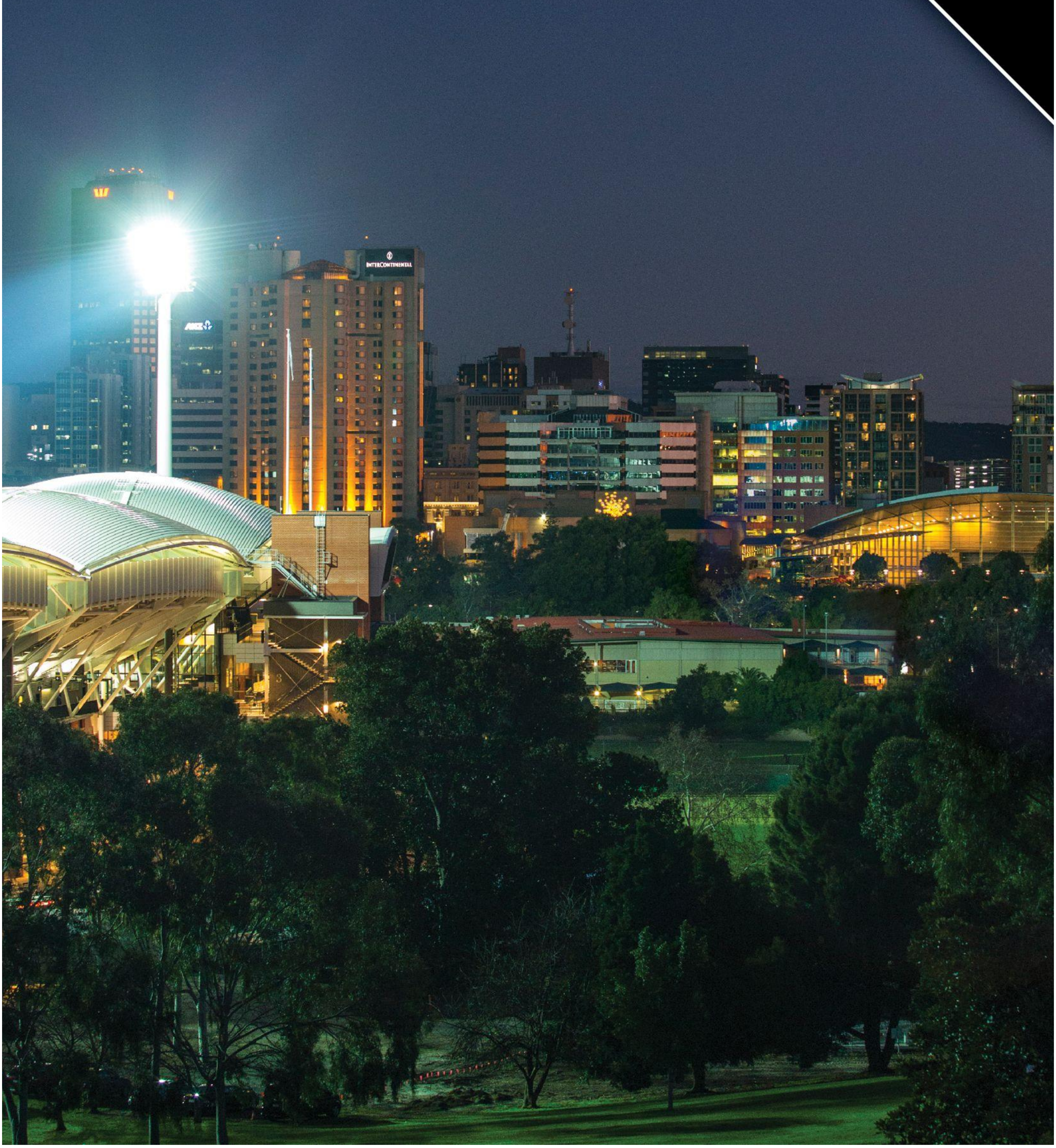

DGA Consulting

REVISED ADMS AND ZSS SCADA BUSINESS CASE

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CONTENTS

1 EXECUTIVE SUMMARY

DGA Consulting were requested to re-evaluate the business case for the ADMS Road Map projects to address the comments received from the AER in its preliminary determination. In doing so, it is believed that all of the AER's comments have been addressed.

The ADMS Road Map projects covered the Zone Substation (ZSS) SCADA Expansion programme and three ADMS initiatives ((Volt/Var Optimisation, Embedded Generation Management and Distribution Feeder Management).

As part of this review it was decided to re-focus these projects to the elements that had a clearer and more defined business case. This has resulted in the re-submitted business case covering:

- Expansion of SCADA Monitoring and Control to 75 Rural ZSS in high and medium bushfire risk areas; and
- Embedded Generation Management functionality in the ADMS

DGA Consulting has reviewed the project benefits for these revised projects to ensure that the presentation is straightforward and that all key assumptions are conservative, with a clear explanation of how the data has been derived. This more conservative approach has resulted in the conversion of a number of benefits into qualitative rather than quantitative benefits. The assessment has also removed a number of the small benefits to ensure that the business case focuses more on material items and therefore has greater clarity. However, SA Power Networks believes that the additional benefits that result from these non-quantified items should be noted in the AER's assessment of the projects.

DGA Consulting has applied these updated assumptions to the DNV-GL societal model. In both projects it should be noted that the main beneficiary is the customer of the network business rather than SA Power Networks with the main benefits consisting of:

i) Avoided Costs of Network Augmentation for Embedded Generation – The key benefit justifying this project is the avoided cost of augmenting the network for the connection of an embedded generator. This is avoided through customer consent to a connection agreement that allows SA Power Networks through the ADMS to analyse operations and exercise timely 'control' of generators. As the augmentation cost would be included in the connection agreement, the benefit of avoiding that cost accrues to generator.

ii) Unserved Energy Benefits for Customers – Two of the key model calculations exhibit benefits related to Unserved Energy but where benefits accrue solely to consumers, with no impact on SA Power Networks' measured SAIDI reliability performance and therefore no impact on STPIS payments. An NPV total of $9.6m of customer unserved energy benefits were identified of which only $1.1m would partly benefit SA Power Networks.

A summary of the results of the quantified benefits is shown in the table below. It should be noted that other benefits were identified for both projects, but in light of the comments from the AER, these have been presented as qualitative only.

Project	NPV Societal Cost Benefits	PV SAPN Costs	PV SAPN Benefits (excludes Unserved Energy)	PV Customer (Generator) Benefits
ZSS SCADA Expansion	$4.5m	$11.4m	$6.3m	$9.6m
ADMS Expansion Projects	$6.4m	$2.2m	$0m	$8.6m

Table 1 Summary of NPV Costs and Benefits

The business cases demonstrate a positive societal business case, but a negative return to SA Power Networks indicating they will not be funded without regulatory support. DGA Consulting has also undertaken sensitivity analysis using Monte Carlo simulation that shows the business cases are robust and have demonstrated that changing any key parameters within the ranges specified still maintains a positive societal benefit.

2 INTRODUCTION

2.1 Background

This document summarises the results of the cost benefit assessment grouped into two projects. These are:

- ZSS SCADA Expansion at 75 Rural ZSS
- ADMS Expansion to provide Embedded generation functionality

Further details on the scope of each of these individual projects are provided in the ADMS Technical Roadmap report. However, this cost benefit assessment represents only a subset of the originally proposed set of projects.

2.2 Structure of the Report

The remainder of this report is divided into the following sections:

Section 3 Response to the AER's Comments – This section details how the AER's comments have been handled within this revised benefit assessment.

Section 4 Approach to Modelling: DNV GL's approach to the project including modelling approach, key parameters and sensitivity modelling.

Section 5 Costs and Benefits for ZSS SCADA Expansion: A detailed breakdown of the individual costs and benefits for ZSS SCADA Expansion

Section 6 Costs and Benefits for ADMS Project: A detailed breakdown of the individual costs and benefits for the ADMS Project

Section 7 CBA Results for ZSS SCADA Expansion: A review of the CBA results for ZSS SCADA Expansion including sensitivity analysis, Monte Carlo analysis and cash flow projections. This analysis is undertaken separately with unserved energy excluded.

Section 8 CBA Results for ADMS Project: A review of the CBA results for the ADMS Project including sensitivity analysis, Monte Carlo analysis and cash flow projections.

Appendix A Model Data References – A complete list of data sources used in the modelling.

3 RESPONSE TO AER DRAFT DETERMINATION COMMENTS

3.1 Approach

DGA Consulting have reviewed the comments from the AER and where applicable re-evaluated the business case to address these comments. This section is structured as follows:

- Review and Rationalisation of the Proposed Projects
- Update of Key Parameters in the Model
- Clarification of the Generation Connection Benefit
- Unserved Energy Reductions that Benefit Consumers Only
- Industry Standards for ZSS SCADA

3.2 Review and Rationalisation of the Proposed Projects

One of the comments in the AER Preliminary Determination was that the benefits were overstated. In order to address the AER's concerns in SA Power Networks' Revised Proposal, DGA Consulting has reviewed the project benefits to ensure that the presentation is straightforward and that all key assumptions are conservative with a clear explanation of how the data has been derived.

This more conservative approach has resulted in the conversion of a number of benefits into qualitative rather than quantitative benefits. The assessment has also removed a number of the small benefits to ensure that the business case focuses more on material items and therefore has greater clarity. However, SA Power Networks believes that the additional benefits that result from these non-quantified items should be noted in the AER's assessment of the projects.

In order to focus on the delivery of positive overall societal benefits it was agreed with SA Power Networks to modify the forecast projects as follows:

- The original program proposed expansion of SCADA to all (203) of the remaining ZSS that exist on SA Power Networks' distribution network that are currently without SCADA. The revised project proposes expansion of SCADA to 75[1] of the highest risk country ZSS in bushfire risk areas. By addressing the highest risk ZSS, it presented the highest societal benefits. An additional benefit is that the project can be implemented within a shorter timeframe, reducing the number of loggers required to be deployed for RIN reporting purposes to meet AER requirements.
- The original program included ADMS projects to support Volt/VAr optimisation and Distribution Feeder Management. SA Power Networks have revised its scope and no longer propose to proceed with these projects as these projects required additional equipment to be deployed on the network, which the AER does not support. It was therefore decided to confine the ADMS expansion project to support Embedded Generation.

Ignoring discounting this has resulted in a reduction in the cost for the presented projects of 70% and 67% respectively.

- [1] *The substations selected for SCADA rollout (75) have been evaluated and selected based on bushfire risks and maximum customer benefit. We acknowledge projects such as capacity upgrades which are driven by network planning and have ensured there is no overlap between the work we propose and projects driven by capacity upgrades. We also acknowledge the bushfire mitigation project and SA Power Networks have confirmed there is no overlap. As these substations are in rural/country areas, they are more crucial from a network control perspective to ensure customers at rural substations receive consistent levels of service, in line with what has been provided to them historically.*

3.3 Updating of Key Parameters

The AER raised concerns that a number of the key assumptions were overstated, two specific examples were given. These were:

- Value of Customer Reliability (VCR) - The AER noted that the value of customer reliability used in the assessment was higher than the VCR published by the AEMO. This reflected the timing of production of the DNV GL report, with most of the analysis undertaken in mid-2014, prior to the release of the AEMO document. DGA Consulting have updated the modelling and the report to reflect the current VCR.
- Number of ZSS visits – The AER indicated they believed that the benefit associated with ZSS visits was overstated. A material part of this benefit was the travelling time associated with rural ZSS and the fact that an initial visit to modify the settings (e.g. to place reclosers in non-automatic mode) would be followed by a subsequent visit (to place reclosers back into automatic) - thus 2 visits for every occurrence. DGA Consulting have reviewed this assessment with SA Power Networks who agreed to adopt a more conservative approach to number of visits, hours taken and crew size, which materially reduces the overall benefit.

One other significant update to the key assumptions was the discount rate used in the assessment. SA Power Networks have now provided a revised real discount rate, which is set at 4.93%. This is materially below the number previously applied and does strengthen the business case for the projects where many of the benefits appear over the life of the project.

3.4 Clarification of the Generation Connection Benefit

A major customer benefit from the ADMS project is the ability to manage the operational connection for medium scale generation using ADMS analysis and control rather than opting for augmentation of the network. This customer benefit was not supported by the AER, but we believe this may reflect a failure on the behalf of the original submission to clearly explain how this benefit is derived. In our view this is best explained with an example of how generation proponents could benefit from the ADMS Control.

In this example a business proposes to invest in a 15MW generator to sell output to a retailer:

The Network Service Provider (NSP) (e.g. SA Power Networks) undertakes a technical assessment of the network and determines the majority of the time it can withstand the proposed level of generation under normal local load flow conditions. However, in certain circumstances (e.g. several nearby factories not operating) it may not be able to withstand the predicted level of power flow. The NSP has two options to connect the proponent:

- Augment the network back to the substation to ensure it can withstand the predicted exports at all times. Any connection agreement would need to reflect these costs. That is, the proponent would pay for the network augmentation as part of the connection agreement; or
- Have a connection agreement with the proponent that enables the NSP to turn off the generator, or reduce its output, when required. The proponent's connection charge in this case will be significantly lower.

Such an approach can only be reliably employed if the ADMS has direct SCADA monitoring and control of the generator and the additional analysis tools that allow it to model the network, look ahead and then react in real-time as the network approaches overload conditions. Action needs to be automatically and proactively taken before the load starts to damage network assets (e.g. assets operating outside of the prescribed ratings). "Control" can be achieved without the ADMS, but it would rely on rudimentary alarm processing and manually-initiated verbal communication and therefore brings an increased risk of a delay before the instruction to disconnect or reduce output, was sent to the generator. Given this manual approach presents a high risk to network assets, there is a greater likelihood the NSP would require the generator to pay for augmentation on a worst case scenario. This may impact the business case for development of the distributed generation.

In the modelling there is an assumption, based on historical connections requiring such augmentation, that a generator connection of this type would occur every 2 years. This is consistent with the SAPN Register of Completed Projects which has 4 generators commissioned in the last 5 years. However, it is feasible this number may grow as businesses start to invest in medium sized renewables to reduce their operating cost and, as part of this investment, sell power back through the network. Any growth in generator connections has not been built into the modelling estimates.

As stated previously, given the proponent does not have to contribute to network augmentation, this is regarded as a Customer (or generator) benefit.

There were additional benefits in the ability for generation that became part of non-networks solutions to be controlled more efficiently by the ADMS. The avoidance of augmentation using these non-network solutions could be a material benefit that the ADMS expansion could assist to deliver, but at this point has not been quantified in the modelling.

3.5 Unserved Energy Reductions that Benefit Consumers Only

Two of the key model calculations exhibit benefits based on Unserved Energy where benefits accrue to consumers, but there will be no impact on SA Power Networks' measured SAIDI reliability performance and therefore no impact on STPIS payments. These calculations are as follows:

- **Faster capture of faults in the OMS** – One of the benefits of ZSS SCADA is that it allows the dispatchers to be automatically notified of SCADA detected outages and begin the process of rectification. Without SCADA the dispatchers only become aware of an outage after customers contact SA Power Networks and evidence of the location of the outage can be confirmed. As SAIDI calculations only commence from the time faults are identified by the OMS, the shortened outage time will benefit the consumer but will not lead to any STPIS benefits to SA Power Networks.
- **Reduced Off-Supply Incidents During Bushfire Conditions** – SA Power Networks has the ability to turn off power under extreme bushfire weather conditions. Time off supply for these bushfire related events are excluded from SAIDI calculations. This means that the introduction of ZSS SCADA may result in less customers being needlessly disconnected during extreme bushfire weather events, however there will be no impact on the SAIDI calculations, or STPIS benefits to SA Power Networks.

This business case demonstrates strong societal benefits for this reduction of unserved energy to consumers. However, the lack of SA Power benefits means that this would not be funded separately by the business, as is typically the approach with many reliability improvements

3.6 Industry Standard Review

One of the AER comments relates to the degree to which ZSS SCADA is now the standard in most utilities. The concern was as follows:

We do not dispute that there are benefits to network automation and control, in particular for metropolitan networks, major feeders and critical assets. In this sense, the adoption of SCADA for these types of assets has become industry standard. However, the rollout of SCADA across the network is not necessarily industry standard unless it can be shown it has a positive incremental benefit to consumers.

DGA Consulting's personnel have worked on SCADA projects in most of the electricity network businesses over the last decade and more and have a strong understanding of the state of network control in each utility. Almost all mainland utilities have levels of ZSS automation well above that currently achieved by SA Power Networks and the deployment of ZSS SCADA, even in relatively rural sites, has previously been supported by the AER. Typically, metropolitan and urban distribution businesses have 95-100% SCADA coverage at ZSS level whilst urban and rural businesses have at least 85% ZSS SCADA coverage. In this sense we believe that SCADA at ZSS is an industry standard and that trends indicate that distribution utilities are now moving toward extending monitoring and control deeper into their networks below ZSS level.

SA Power Networks, with metropolitan, urban and rural network, has only 70% ZSS SCADA coverage and, if this is discounted for ZSS with rudimentary alarm systems (no control), that number falls to closer to 60%. SA Power Networks will be well behind other comparable utilities if they continue to have such a high percentage of ZSS without control and automation.

DGA Consulting agree that these deployments should have a net incremental benefit to consumers and believe the revised business case demonstrates this benefit. However, it is important to also recognise the large number of qualitative benefits that the introduction of SCADA at ZSS can deliver and these are detailed in section 5. The introduction of SCADA at ZSS also provides the foundation for many of the innovative projects that may develop over the next 20 years which will require, as a starting point, the access to SCADA data from key points in the network.

4 APPROACH TO MODELLING

4.1 Overview of Modelling Approach

4.1.1 Background to the Model

DNV GL's cost benefit model is built in Microsoft Excel and provides a central tool to assess the benefits of introducing new infrastructure and technologies. It breaks down all cost and benefits in fine detail, allowing the user to identify which variables drive the more significant elements. This in turn enables further validation of the key data.

The model has been applied in Australia for DMS, Smart Metering, Smart Grid, Substation Automation, Communications assessments and Generation business cases.

4.1.2 Stakeholders in the Model

The purpose of this benefit assessment is to consider the value to different stakeholders from the expansion of SCADA to additional ZSS and increasing the scope of the ADMS Project. The model has looked at net market benefits to all stakeholders with the major impacted parties being SA Power Networks', Customers and generators.

The model has not attempted at this stage to consider the STPIS impacts of the potential change as these really represent a wealth transfer between different stakeholders. However, it should be noted that the majority of the improvements in Unserved Energy will not be reflected in SAIDI or therefore STPIS improvements.

4.2 Business as Usual Approach

The modelling approach assesses changes in costs and benefits compared to the Business as Usual (BAU) provision of service. This assumes that without these projects there would be no expansion of SCADA to ZSS, or deployment of additional functionality to the ADMS.

4.3 Scenarios to Test

DNV GL's model is designed to allow the testing of a number of different scenarios as shown in the chart below.

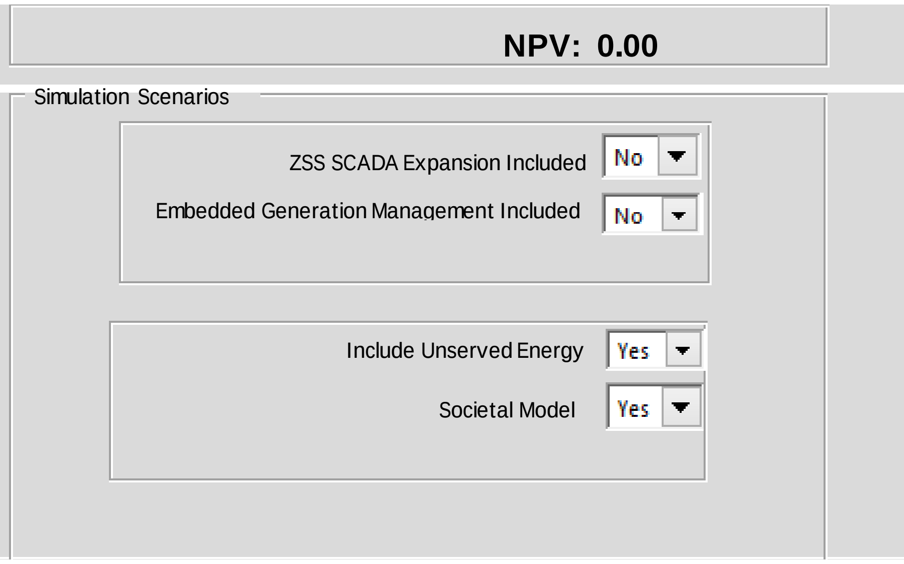

Figure 1 Scenario Choice in the Model

These scenarios allow the users to select which projects to be included in the NPV results and whether unserved energy should be included as a benefit. There is also the option to restrict costs and benefits to just SA Power Networks, or to include benefits to all stakeholders. This is important as the majority of the benefits are gained by external stakeholders.

4.4 Key Parameters of the Model

Within the model there are key parameters that either impact on a number of costs and benefits, or are significantly material in their impact for some range of values to be assessed. Each of these key parameters has a central (most likely), minimum and maximum values that can be individually switched to demonstrate the effect of value ranges, or to cover off differences of opinion that may need to be assessed. The use of this range of values within the model allows the testing of sensitivities, which are described later in this section.

A table of all the key parameters applied in the model is shown below. A number of these parameters are discussed in the assessment of the individual costs and benefit sections with the source for all parameters in Appendix A. In addition for some of the more important parameters an explanation is provided below on how they have been derived and are utilised in the model.

Parameter description	Value	Var-min	Var-nom	Var-max
Total Project Duration (years)	15	10	15	20
Real Discount Percentage (%)	5%	6.00%	4.93%	4.00%
Total Number of Substation Upgraded ()	75	100	75	50
Cost of CBD ZSS SCADA Expansion with M &C ($k)	245	270	245	200
Cost of Rural ZSS SCADA Expansion with M & C ($k)	136	150	136	120
Number of ZSS Upgraded each year ()	25.0	20.0	25.0	30.0
Contingency applied to Projects (%)	0%	10.00%	0.00%	0.00%
Value of a damaged Transformer ($k)	250	150.0	250.0	500.0
Number of outages per year per ZSS ()	2	1.0	1.5	2.0
Number of Customers Impacted by an Outage ()	500	300.0	500.0	700.0
Field Crew Cost per Hour ($/Hour)	88	80.0	87.5	100.0
Hourly cost of vehicle provision for Field Crew ($/Hr)	50	40	50	60
Value of Operator Time ($/Hour)	114	125	114	100
Number of major events causing damage at ZSS each year ()	1	1	1	2
Reduction in Time to get SCADA recorded faults to OMS (mins)	10	5	10	15
LRMC of capacity gained at ZSS ($/kVA)	438	350	438	500
Effective increase in capacity at the ZSS from SCADA M &C (%)	0.5%	0.0%	0.5%	1.0%
Number of Generators Avoiding Augmentation with ADMS Control ()	0.5	0.3	0.5	0.8
Average cost of generation augmentation required (AUD)	2,000,000	1,000,000	2,000,000	3,000,000
Average Consumption per customer per hour (kWh)	1.6	1.2	1.6	1.8
Number of ZSS visits per year that could be avoided ()	6	4	6	8
Value of Customer Reliability ($MWh)	38090	30000	38090	45000

Table 2 Key Parameters used in the Model

4.4.1 Duration of the Value Assessment Period

The model has been set up to cover a period of up to 20 years. In order to be conservative the modelling has developed a central figure of 15 years to value the costs and benefits. Any extension of this 15 year period will increase the benefits, but this will depend on the life that can be achieved with this type of solution.

4.4.2 Real Discount Rate

The model has applied a Real rather than Nominal discount rates for calculating the NPV. This allows the effect of inflation on other variable to be removed from the modelling. This has been set to 4.93% with a range of 6% and 4%. This allows testing of the impact of a high discount rate to confirm that the NPV will remain positive.

4.4.3 Labour Savings

The introduction of SCADA and expansion of the ADMS will result in time saving from a number of activities that can be achieved remotely or more efficiently. This includes operator time and field services time in the key parameters list with other types of personnel included as a single parameter.

These parameters include overheads and are the full cost of these personnel or an hourly basis.

4.4.4 Value of Customer Reliability

The AER in the draft determination indicated the business case should apply the VCR published by AEMO for South Australia of $38,090 per MWh and this has now been adopted. The model assigns this full value to customer outage time, rather than splitting between SAIDI and SAIFI incentives, which is the approach taken in calculation of STPIS.

4.4.5 Average Value of Customer Consumption

The benefits associated with customers have supply restored faster will depend on the consumption levels of customer. The model has taken SA Power figures for the number of metering points and consumption across the network to derive an average consumption per customer. This is divided by the annual number of hours (8760) to derive an average hourly consumption of 1.6 kWh per hour.

4.4.6 Total Number of Substations Upgraded with SCADA

The modelling assumes that 75 of the ZSS that don't currently have SCADA will gain this over the next 3 years with all sites assumed to be in rural area. The model consider the impact of changing this number on the business case as this could have a significant impacts on the investment and new benefits.

4.5 Time Periods in the Model and Transition of Benefits

The model has adopted the following approach to the realisation of benefits:

- ZSS SCADA Expansion establishment costs based on linear number of ZSS rolled out in first 3 years.
- ZSS SCADA Expansion operating costs and applicable benefits based on the mid-year number of ZSSs that have SCADA.
- The ADMS Expansion projects for Embedded Generation Management commences delivering benefits in year 3 with costs for establishment starting from the first year of the project.

4.6 Sensitivity of the Model

A key concern with cost benefit analysis is the sensitivity of the end results to changes in each parameter and the risk of one small alteration having a significant impact on the overall result. To demonstrate this sensitivity DNV GL's model assesses each key parameter for its impact on the NPV when the maximum and minimum values are tested.

As an example, the central value for the number of generators avoiding augmentation with ADMS Control was 0.5, reflecting an expectation that once every 2 years the need for augmentation could be avoided. The sensitivity test assesses the impact if this happened once every 4 years (0.25), or every 1.5 years (0.75). These changes increase or decrease the NPV by $4.3m.

4.6.1 Probability Distributions

The DNV GL model allows all key parameters which can influence the NPV to be defined by their expected minimum, maximum and nominal (most likely) value. The nominal values are used to calculate the expected NPV of the model, whilst the extreme values are used to analyse the sensitivity of the outcome (expected NPV) to the parameters.

In reality, not all parameters will be at their nominal value but will have an uncertainty and may vary between their minimum and maximum value according to a certain probability distribution. As a refinement to the model, DNV GL has implemented Crystal Ball, the statistical simulation tool from Oracle. Crystal Ball runs the model using a Monte Carlo simulation with a large number of trials with each run allowing different values of the parameters to be chosen given the defined probability distributions. As a result, the refined model will provide a statistically more accurate NPV, including the spread of possible outcomes.

Within this model all input parameters (assumptions in Crystal Ball) are varied according to a triangular distribution, defined with a minimum, likeliest and maximum value. In this example below the Number of ZSS Upgraded with

SCADA each year has a most likely value of 25. There is a minimum number of 20 and a maximum number of 30, which will speed up or slow down the deployment of SCADA and associated costs and benefits.

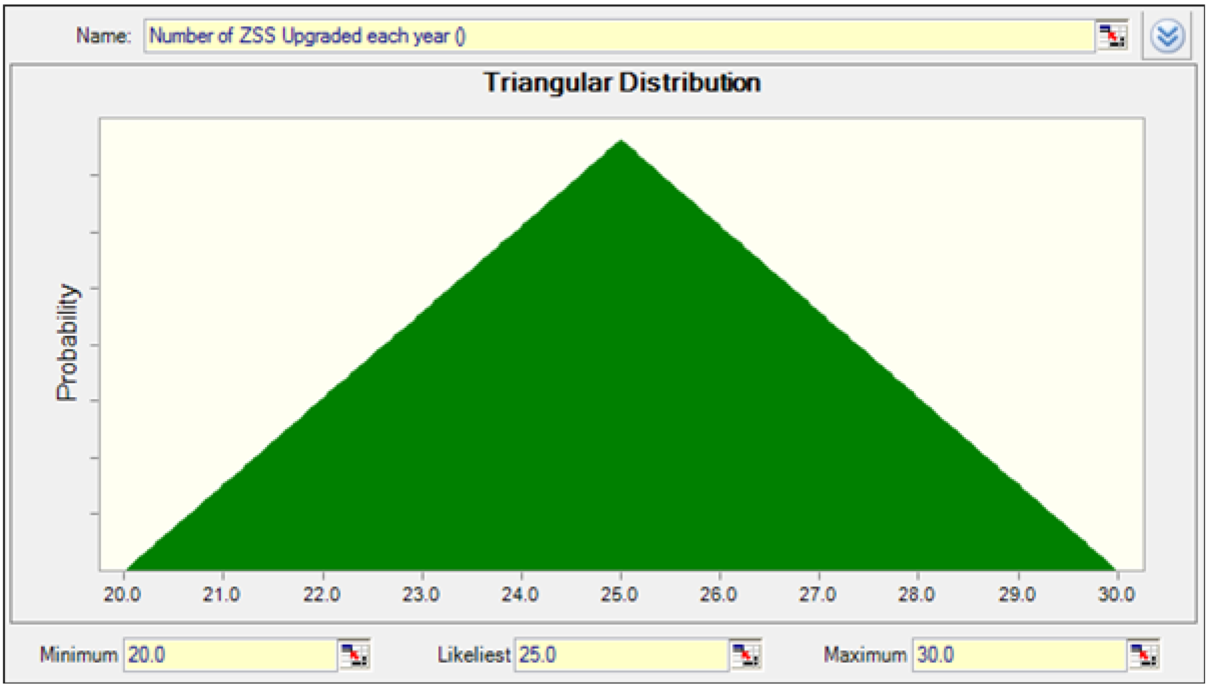

Figure 2 Example Triangular Distribution

Crystal Ball undertakes a Monte Carlo simulation of the forecast NPV using three steps

- For every assumption cell (our parameters), Crystal Ball generates a random number according to the probability distribution defined and places it into the spreadsheet.
- Crystal Ball recalculates the spreadsheet.
- Crystal Ball then retrieves a value from the forecast cell and adds it to the chart in the forecast windows.

The results for the Monte Carlo simulation are presented in sections 7 and 8.

5 COSTS AND BENEFITS FOR ZSS SCADA EXPANSION

5.1 Overview of Key Costs

The following table outlines the key costs associated with the ZSS SCADA Expansion.

Model Reference	Description	NPV	Comments
KB1.A	Capital Cost of ZSS SCADA Expansion	$9.3m	This is the cost for installing SCADA Monitoring and Control Equipment at the selected ZSS.
KB1.B	Capital Cost of Communications Infrastructure	$0.8m	This is the capital cost of getting communications infrastructure to the ZSS
KB1.C	Operational Costs for Expanded SCADA at ZSS	$1.3m	This is the incremental operating costs for the expanded SCADA at ZSS
Total		$11.4m	

Table 3 Summary of Costs for ZSS SCADA Expansion

A more complete explanation on each of these costs is provided in sections 5.2.1 to 5.2.3 below. A list of all data items used in the calculations is provided in Appendix A.

5.2 Review of Key Costs for ZSS SCADA Expansion

5.2.1 Capital Cost of ZSS SCADA Expansion

The most significant item is the capital cost of the control and monitoring equipment at the ZSS. The modelling assumes that all substations get both monitoring and a control capability installed and that the average costs for an installation is $136k for a rural ZSS. This cost was based on a recent implementation of SCADA at an existing substation.

5.2.2 Capital Costs of Communications Infrastructure

This is the capital cost of the communications infrastructure needed at the 75 ZSS that have SCADA enabled. The following assumptions are made:

- 70% of these rural ZSS will use a radio solution with an average cost of $16k including a contribution to the Master station
- 30% of rural ZSS will use a 3G/4G solution with an average cost of $2.5k.

5.2.3 Operational Costs for Expanded SCADA at ZSS

This is the incremental operational cost for maintaining SCADA at the ZSS. It is based on the current costs of maintaining SCADA at existing ZSS of around $1k per year, which is used as a proxy for the new ZSSs.

As well as the SCADA equipment there are also costs in maintaining the communications infrastructure, which is estimated at $1k per year for radio and $200 for 3G/4G. In addition for those sites using 3G/4G a monthly communication cost of $50 per month is used as an estimate of the charge from a telecommunications provider.

5.3 Overview of Benefits

The following table provides an overview of the key quantified benefits from ZSS SCADA Expansion

Model Ref	Description	NPV	Comments
KB1.D	Avoiding Major Equipment Problems from Better Monitoring	$2.2m	This is the benefit from monitoring major equipment (e.g.) transformers and taking action to avoid damage.
KB1.E	Improvements from Faster Identification of Faults and Entry into OMS	$5.2m	Reduced unserved energy from faster identification and therefore restoration of outages
KB1.F	Reduced Visits to ZSS to change settings	$1.8m	Avoided need to visit ZSS to change devices settings if this can be done remotely
KB1.G	Saving from Avoided Loggers for RIN Reporting	$1.1m	RIN requirements needs some form of monitoring at each ZSS. The introduction of SCADA avoids the need for loggers at each site.
KB1.H	Bushfire Benefits	$3.4m	Reduction in unserved energy from customers in bushfire areas
KB1.I	Deferred Augmentation through Enhanced Information for Planners	$2.2m	This is the benefit from reduced augmentation through better network knowledge
Total		**$15.9m**	

Table 4 Benefits from ZSS SCADA Expansion

5.4 Overview of Benefits

5.4.1 Avoiding Major Equipment Problems from Better Monitoring

This is the benefit of monitoring major equipment such as transformers and taking action before damage occurs. There was an estimate of 1 event per year of major equipment damage at the selected ZSS without monitoring with an expectation that 50% of these could be avoided with monitoring and control. These ZSS are relatively small with an estimate residual value for each transformer of $250k.

One of the benefits of avoiding damaged equipment is the outages and consequently unserved energy that would result from the damage. This benefit assumes that one outage every 2 years would be avoided and that this could last for 8 hours as it would require a transformer to be replaced.

The PV of the damage was estimated at $1.1m with the remaining part of the benefit ($1.1m) relating to Unserved Energy. This would benefit consumers and assist in improving SA Power Networks SAIDI performance.

5.4.2 Improvements from Faster Identification of Faults and Entry into OMS

When ZSS have SCADA then any faults detected can be automatically transferred to the OMS allowing the dispatch team to start the restoration activity. The current process requires customers to ring up to report the fault and the fault restoration process will only commence once a fault has registered sufficient calls. The time saving with SCADA is composed of 2 elements. Firstly, the detection by SCADA and secondly the ‘automatic’ link from the ADMS to the OMS so that these outages get responded on almost immediately.

The modelling assumes that this automatic transfer will save 10 minutes for each SCADA detected fault. This reflects the rural nature of these ZSS and the fact that these outages could occur at any time of the day. There will be an average of 500 customers impacted per fault with an expectation of 1.5 outages per ZSS per year.

Once all ZSS have SCADA installed this is expected to generate an annual benefit of over $0.5m per year.

It should be noted that this is only a consumer benefit and would not be captured in SA Power Networks SAIDI calculations, which commences when the fault is recognised and recorded in the OMS.

5.4.3 Reduced Visits to ZSS to change settings

A significant efficiency benefit from installation of SCADA at ZSS was the avoided cost of reduced visits to ZSSs to change settings. Once SCADA monitoring and control is installed at the ZSS these settings can be done remotely, which avoids a visit to the substations. The following assumptions were made in these calculations

- Average number of visit per year was 6 – This includes planned switching visits, unplanned switching events and changes due to bushfire. These activities can often involve two separate trips to initially change the settings and then revert back to the previous settings once the activity has been undertaken. This revised estimate may be conservative for high bushfire risk substations that may need additional visits to be placed into one-shot mode during bushfire risk periods and the returned to multi-shot mode afterwards.
- Hours per visit was 2 – A number of these ZSS are relatively rural and could involve considerable travel time to the ZSS
- Crew Size was 2 - This reflects SA Powers typical crew size for these types of activity.

Once all 75 ZSS had SCADA then this would result in an annual benefit of reduced field crew and vehicle use of $200k per year.

5.4.4 Saving from Avoided Loggers for RIN Reporting

The AER requires actual data reporting related to the performance of individual parts of the network (including actual load data) with the expectation of additional data being made available to users of the network. The expansion of the SCADA network would assist with the telecommunications to provide this information in a timely manner and avoid the costs of needing to deploy loggers (the lowest cost method for just collecting the data)

The avoided cost is estimated at $15k per ZSS and an annual costs of $100 per year for avoided communications costs.

5.4.5 Bushfire Benefits

This benefit is based on the ability to turn off customers in response to a bushfire risks to a finer level of delineation than is currently possible. It assumes that relatively infrequently there may be a need to turn off a complete area, whereas automation at the substation may allow some customers to stay on supply if it is deemed that they are not a bushfire risk for a particular set of circumstances.

The modelling assumes that all ZSS in high bushfire risk areas (36) and 39 ZSS in medium bushfire risk areas have SCADA in the first 3 years. The following assumption are then applied to calculate the amount of unserved energy

- A customer in a HBFRA would have an outage every 10 years with once every 15 years assumed for a MBFRA
- Only 25% of the time would have been possible for those customers to have remained on supply with greater delineation of controls
- Average outage duration of 8 hours.

These numbers can be translated into unserved energy. This results in an average annual benefit of close to $0.38m per year once these ZSS have SCADA.

It should be noted that this is only a consumer benefit and would not be captured in SA Power Networks SAIDI calculations as bushfire events are excluded.

5.4.6 Deferred Augmentation through Enhanced Information for Planners

This is the benefit of planners having more accurate information on the status of the network. This information can be used to more accurately determine the state of the network and allow network planners to be less conservative in their decisions on when to upgrade the network for growth reasons. This less conservative approach would also be assisted by the ability of the control room to have direct control and be able to intervene at a ZSS. This would give the planner increased confidence that they can operate the network closer to its limits and defer augmentation.

The modelling has assumed that this more accurate information is equivalent to a 0.5% increase in network capacity. It is assumed that most of the ZSS that are gaining SCADA are relatively small with a total network capacity of 112.5 MVA (based on a conservative average size of 1.5 MVA). The 0.5% saving of this network capacity represents a 0.6MVA. This has been multiplied by the LRMC of capacity at the rural substation level ($438/kVA/yr).

This provides an annual benefit once all the selected ZSS have SCADA of nearly $0.25m per year.

5.5 Qualitative Benefits from ZSS SCADA Expansion

In addition to the quantitative benefits outlined above there are a number of important qualitative benefits. Whilst some of these could be quantified, the assumptions for a number of these benefits are hard to robustly determine and it has therefore been decided to retain them as qualitative only.

Benefit	Description
Reduced Complaints and PV Impacts from Improved Voltage at ZSS	This is a combination of small benefits that emerge from the control room being able to improve the voltage profile at ZSS due to improved information on the network. It includes four separate elements: • Reduced customer damage of equipment due to voltage issues • Reduced SA Power cost of dealing with complaints about voltage • Increased PV generation (no longer are inverters tripping off due to voltage problems) • Reduced claims against SA Power Networks for damage to equipment
Reduced Cost of Manual Voltage Checking from ZSS measurements	The expansion of SCADA will avoid the need to regularly check voltage levels at each ZSS. Currently on average the ZSS have the voltage checked using a polylogger every 5 years.
Consistent with Standard Practice	Many other utilities already have, or are in the process of expanding, all ZSS to have SCADA. SA Power Networks does not wish to be perceived as a late adopter of this technology by their customers who may gain from its deployment.
Improved Losses	With more ZSS on SCADA there may be the option to transfer load across feeders so that losses can be reduced.
Improved Quality of Load Flow Solution	The additional input data from more ZSS with SCADA will improve the quality of the load flow solution and make for better operational and planning decisions
Availability of Additional Remote Reclosers	In some instances the reclosers on the feeders have SCADA, but the substation does not have SCADA. There may be additional benefits from these reclosers once the substations also has SCADA
Faster Outage Restoration from	This is the reduction in time off supply using the distance to fault indicators at the

Remote Access to Fault Information at ZSS	ZSS. Where the distance to fault indicator exists the introduction of SCADA at the ZSS will allow this to be reviewed remotely and reduce the time to resolve the outage (the operator can plan the restoration process during the field crews travelling time to the fault).
Faster Outage Restoration from Changing Settings Remotely	This is the reduction in time off supply by parts of the feeders that are not impacted by the fault being isolated remotely and put back on supply. This compares with the business as usual position where the feeders will be isolated, but only after the crew have arrived on site and made the adjustment. The unserved energy benefit relates to the reduction in travel time from being able to do this isolation remotely.
Reduction in Number of Customers Off Supply During a Forced Outage	During an outage it may be necessary to take a larger area of supply because there are no controls down at the ZSS level. This may result in more customers than necessary being taken off supply. Once mores ZSS had SCADA controls it will be possible to selectively disconnect a smaller amount of customers.
Avoided Outages from Wider Deployment of Contingency Analysis	Contingency Analysis provides the background tools to assess the state of the meshed network and to assess the network's state that would result from the occurrence of specified contingency events/failures. The ZSS SCADA expansion provided information that the power system will survive particular contingencies without the network entering an insecure or stressed state. Currently operating policies dictate that protective actions are taken in advance (e.g. radialising parts of the network) and these protective actions are based on off-line, worst-case analyses of the network. At times, after unnecessary protective actions are taken, such as radialising, subsequent plant outages lead to major loss of supply events.
Avoided Outages through better Load Management	In overload situations there may be an option to transfer load across feeders and avoid outages. It is not clear how often this will be an option so this has not been explicitly captured in the calculations.
Exploit the Full Value of Assets	There will be an enhanced ability to use circuit breakers/transformers to their fully operational potential once they can be remotely controlled.

Table 5 Qualitative Benefits from ZSS SCADA Expansion

6 COST AND BENEFITS OF ADMS EXPANSION PROJECTS

6.1 Overview of Key Costs

The following table outlines the key costs associated with the ADMS Expansion Projects:

Model Reference	Description	NPV	Comments
KB2.A	Costs of Upgrade for ADMS for Embedded Generation Management (First year costs)	$0.7m	Mixture of labour, software, hardware and specification costs to upgrade ADMS for embedded generation functionality
KB2.B	Annual Operating Cost of ADMS Embedded Generation Management	$1.5m	Primarily labour cost for adding Embedded Generation Management on the ADMS
Total		$2.2m	

Table 6 Costs of ADMS Expanison Projects

A more complete explanation on each of these costs is provided in sections 6.2.1 to 6.2.2 below and is included in the main report. A list of all data items used in the calculations is provided in Appendix A.

6.2 Review of Key Costs for ADMS Expansion Project

6.2.1 Cost to modify the ADMS for Embedded Generation Management (First year costs)

Within the modelling the costs are split between year one as implementation costs and operating costs after this date. A small part of the operating costs in year 2 relate to making the system operational. The first year costs are shown below:

- $0.22 for personnel
- $0.25 software
- $0.1m Hardware costs
- $0.2m for specification development and external testing

This gives a total of $0.77m.

6.2.2 Annual Operating Cost of ADMS Embedded Generation Management

The operating costs primarily relate to the configuration of generators in the ADMS over years 2 to 15 in the project. However, there is also a small amount of set up costs in year 2 as the ADMS functionality for generation control does not go-live until year 3 in the modelling.

The configuration costs are expected to reduce after year 6 once processes and procedures are available. As there were a low number of generators being configured the modelling has not made any allowance for a failure rate.

The costs start at just over $0.5m in year 2 and drop to just under $0.2 m in years 3-5. After year 5 the costs are just under $0.1m per year with all costs on an undiscounted basis.

6.3 Approach to ADMS Expansion Benefits

As discussed in section 3 the approach taken in this re-submission is to focus only on quantifying the key material items that demonstrate a positive business case and to discuss the other benefits in a qualitative manner. In this instance a single benefit, the reduced network connections costs for customers has an NPV of $9.9m, which strongly outweighs the cost and the approach to quantification of this is shown below. There are a number of other important qualitative benefits and they are discussed in the following sections.

6.4 Quantitative Benefits

6.4.1 Reduced Network Connection Costs for Customers

The avoided connection costs is best shown with an example. In this example a business wishes to invest in a 15MW generator either to sell output to a retailer, or more likely to support its own business needs and occasionally sell energy.

The Network Service Provider (NSP) (e.g. SA Power Networks) undertakes a technical assessment of the network and determines the majority of the time it can withstand the proposed level of generation under normal local load flow conditions. However, in certain circumstances (e.g. a couple of nearby factories not operating) it may not be able to withstand the predicted level of power flow. The NSP has two options to connect the proponent:

- Augment the network back to the substation to ensure it can withstand the predicted exports at all times. Any connection agreement would need to reflect these costs. That is, the proponent would pay for the network augmentation as part of the connection agreement; or
- Have a connection agreement with the proponent that enables the NSP to turn off the generator, or reduce its output, when required. The proponent's connection charge in this case will be significantly lower.

Such an approach can only be reliably employed if the ADMS has direct SCADA monitoring and control of the generator and the additional analysis tools that allow it to model the network and look ahead and then react in real-time as the network approaches overload conditions. Action needs to be automatically and proactively taken before the load starts to damage network assets (e.g. assets operating outside of the prescribed ratings). "Control" can be achieved without the ADMS, but it would rely on rudimentary processing and manually-initiated, verbal communication and therefore brings an increased risk of a delay before the instruction to disconnect or reduce output, was sent to the generator. Given this manual approach presents a high risk to network assets, there is a greater likelihood the NSP would require the generator to pay for augmentation on a worst case scenario. This may impact the business case for development of the distributed generation.

In the model this benefit starts from year 3 of the model and is based on 2 key assumptions that were derived with SA Power Networks. These were:

- Number of Generators Avoiding Augmentation with ADMS Control – This was estimated at 0.5 per year (i.e. one every 2 years). This is in line with recent experience from SA Power Networks. However, there could be a forecast that this number may grow as some businesses start to invest in medium sized renewables to help reduce their operating cost and, as part of this investment, also sell power back through the network. This growth has not been built into our modelling estimates.
- Average cost of generation augmentation required – This was estimated at $2m, which was seen as conservative compared with the connection cost that had been seen recently with some generation connections.

This has a value of $1m per year from year 3 of the model. As stated previously, it should be noted that, as they avoid being charged for the costs of connection, this is a Customer (or generator) benefit.

6.5 Qualitative Benefits

6.5.1 Encouragement to Utilise Non Network Solutions

A key benefit of the ADMS is the control it will give SA Power Networks to bring distributed generation on to support the network in time of heavy load. This will make it easier for SA Power Networks to implement non-network solutions rather than augmenting the network, which could be a material savings to network users.

Whilst these non-network solutions can be implemented without the ADMS, it will provide confidence that the generation scheme will be triggered in a timely manner. This reduces any risk associated with damaged assets or a potential outages from failure to initiate the generation and should increase the likely of the non-network solutions being selected.

6.5.2 Reduced Control Room Resourcing

The current generation schemes and the potential growth in non-network solutions will increase the requirement on control room resources to operate embedded generators. This can typically require a duplication of staff to be trained in the activity and could be challenging if it needs to be managed during a period of high activity in the control room.

6.5.3 Reduced Variable Payments to Generators for Control

Automatic monitoring and triggering of when generators are required should lead to a reduction in their operating time in response to SA Power Networks' instructions to provide stability to the network. This is also a reflection of the instant response to an automatic instructions, rather than the delay and risk that may arise from the current manual phone based process. A consequence of this improved process would be a reduction in the variable payments that need to be made to generators from SA Power Networks.

7 CBA RESULTS FOR ZSS SCADA EXPANSION

7.1 Review of Cost and benefits for ZSS SCADA Expansion

7.1.1 Key Cost and Benefits

The NPV of the model including Unserved Energy is $4.5m as shown in the table below. This includes costs of $11.4m with benefits of $15.9m.

The most significant benefits are:

- Faster transfer of outages to the OMS (32%)
- Bushfire benefits (21%)
- Deferred Augmentation through enhanced information for planners (14%)
- Avoiding major equipment problems from better monitoring (14%)

Cost/ benefit item	Description	Total per CB-item
		4.5
1.A	Capital Cost of ZSS Scada Expansion	-9.3
1.B	Capital Cost of Communications infrastructure	-0.8
1.C	Operational Costs for Expanded SCADA at ZSS	-1.3
1.D	Avoiding Major Equipment Problems from Better Monitoring	2.2
1.E	Improvements from faster identification of faults and entry into OMS	5.2
1.F	Reduced visits to ZSS to change settings	1.8
1.G	Saving from Avoided Loggers for RIN Reporting	1.1
1.H	Bushfire Benefits	3.4
1.I	Deferred Augmentation through Enhanced Information for Planners	2.2

Figure 3 ZSS SCADA Expansion Costs and Benefits

7.1.2 Sensitivity Analysis

It is important to note that whilst the central estimate of the NPV to society is estimated at $4.5m this is sensitive to a number of key parameters. The figure below indicates the impact on the NPV of moving a single parameter from its expected value to the high or low values that were considered feasible. The figure demonstrates the very high significance of the value of the product assessment period.

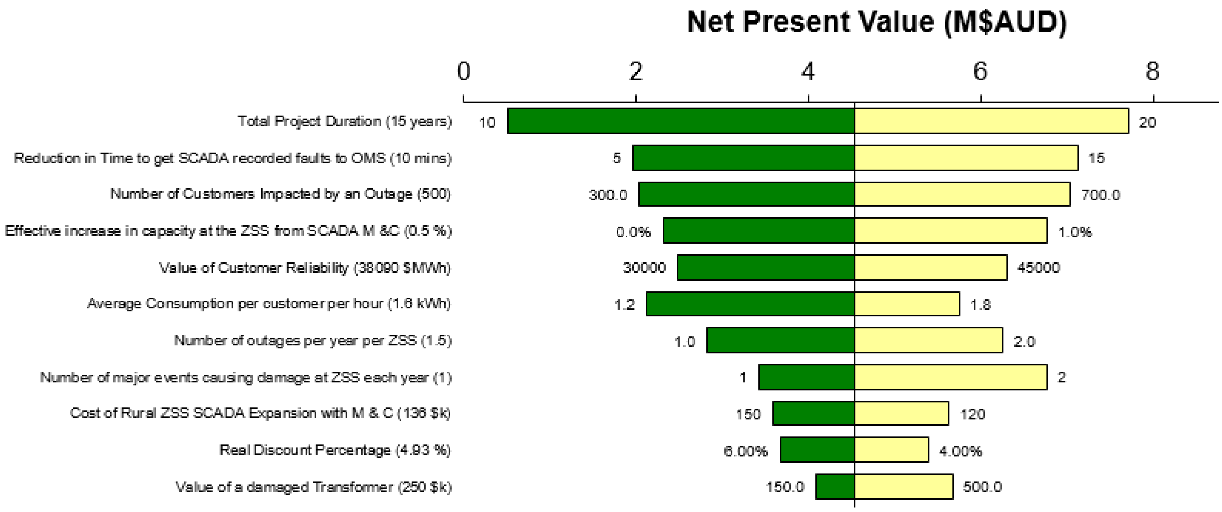

Figure 4 ZSS SCADA Expansion Sensitivity Analysis

The three most sensitive parameters are:

- Total Project Duration (range $7.2m) – If the project life was extended to 20 years then this could increase the NPV by $3.2m. A reduction to 10 years would decrease the NPV by a more significant $4.0m as this duration minimises the time to gain benefits.

- Reduction in Time to get SCADA recorded faults to OMS (range $5.2m) – This parameter is a symmetric range from 5 to 15 minutes. The benefit will increase or decrease by $2.6m if the upper or lower ends of the range are applied.

- Number of Customers Impacted by an Outage (range $5.0m) – This interacts with the value of customer reliability to calculate the value of energy that can now be consumed with reduced outage times. The range moves from 300 to 700 customers and will increase or decrease the NPV by a symmetric $2.5m.

7.1.3 Monte Carlo Analysis

The chart below shows the NPV forecast chart for the model based on 1000 runs with the parameters all set using a triangular distribution. The key observation from this Monte Carlo simulation is that the mean NPV using this approach ($4.2m) is slightly lower than the value using the most likely value. However, it still strongly positive. The trial runs showed less than 5% of outcomes with a negative NPV as is shown in the second diagram.

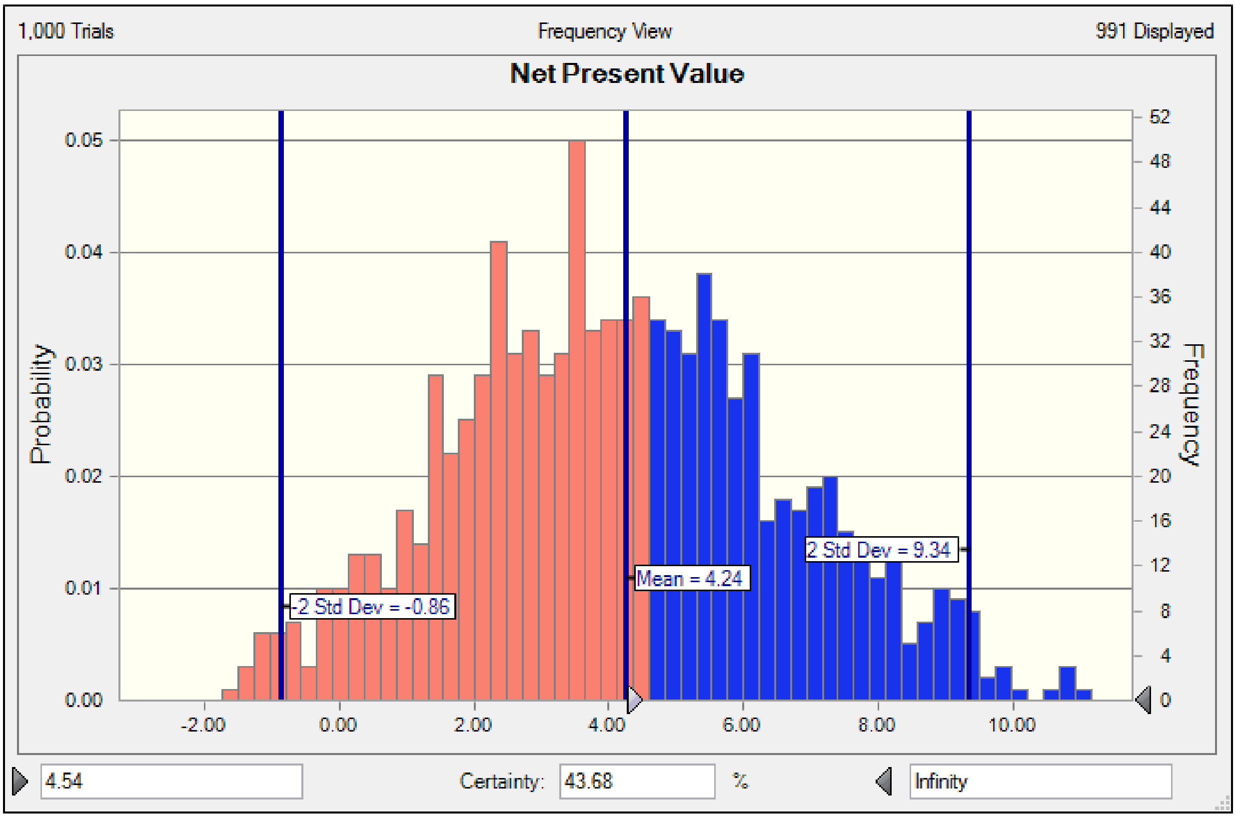

Figure 5 ZSS SCADA Expansion Monte Carlo Analysis

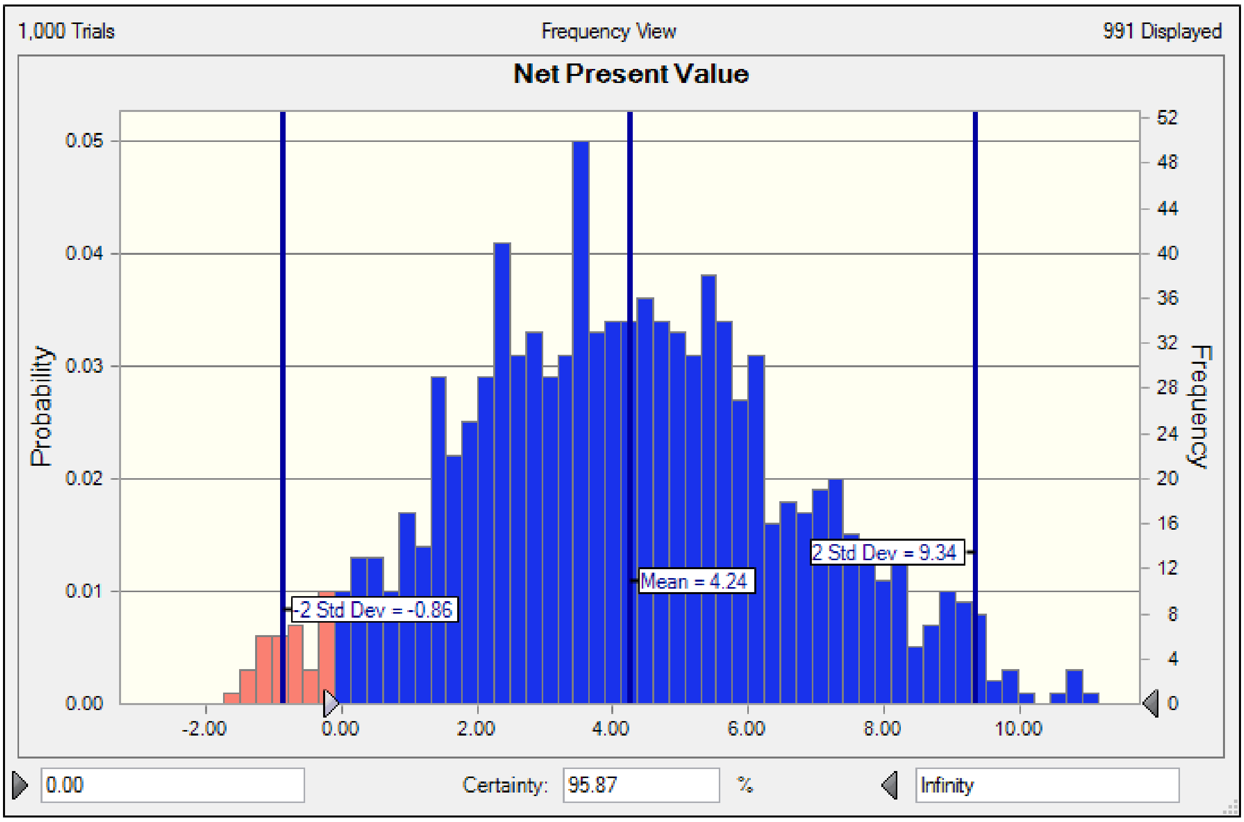

Figure 6 SCADA Expansion Monte Carlo Analysis showing NPV Positive Results

Key Statistics

The trial results gave the following statistics

- The mean of $4.24m and median of $4.12m are slightly below the most likely value produced by the model.
- The standard deviation is a relatively large $2.55m.
- There is a 4.1% chance that the NPV could be negative.

7.1.4 Cash Flow Analysis

The societal model for ZSS SCADA Expansion demonstrates a payback in year 10 of the model. Post implementation of SCADA at all ZSS the model generates net benefits (before discounting) of around $1.5m per year.

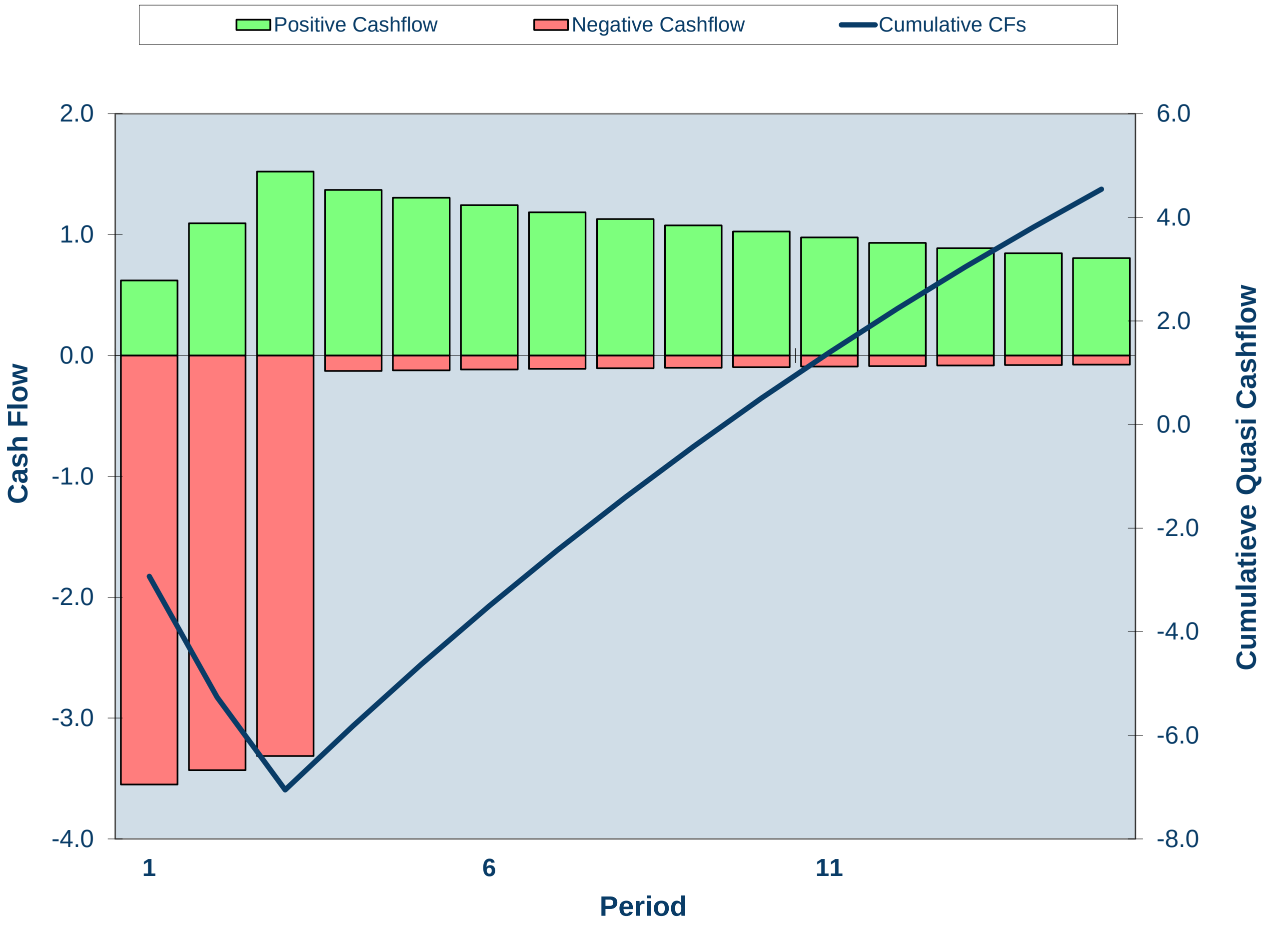

Figure 7 ZSS SCADA Expansion Cashflow Analysis

8 CBA RESULTS FOR ADMS PROJECTS

8.1 Review of Cost and benefits for ADMS Projects Expansion

8.1.1 Key Cost and Benefits

The NPV of the model is $6.4m as shown in the table below with the only quantified benefit relating to reduced costs of customer/generator connections. Other benefits have not been quantified at this stage.

Cost/ benefit item	Description	Total per CB-item
		6.4
2.A	Costs of Upgrade for ADMS for Embedded Generation Management (First year costs)	-0.7
2.B	Annual Operating Cost of ADMS Embedded Generation Management	-1.5
2.C	Reduced Network Connection costs for Customers	8.6

Figure 8 ADMS Project Costs and Benefits

8.1.2 Sensitivity Analysis

The key parameters impacting the NPV are shown in the chart below:

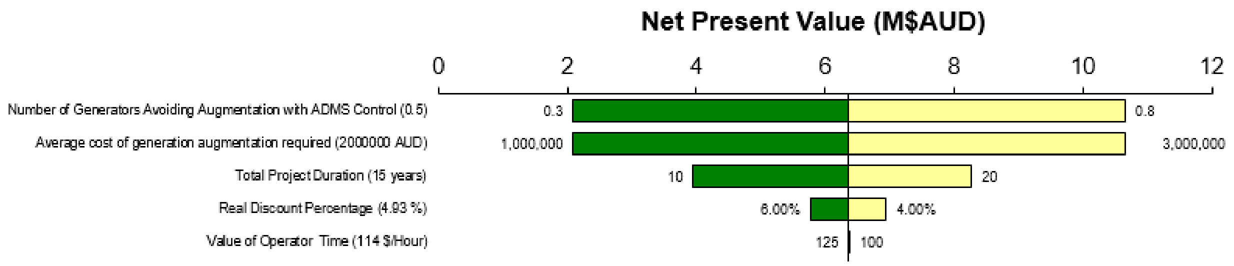

Figure 9 ADMS Projects Sensitivity Analysis

The three most highly sensitive parameters are:

- Number of Generators Avoiding Augmentation with ADMS Control (range $8.6m) – This was expected to be 1 every 2 years (0.5 per year). If this was reduced to one every 4 years (0.25 per year) it would decrease the NPV by $4.3m, whilst increase to one every 1.5 years (0.75 per year) would increase the NPV by $4.3m.

- Average cost of Generation Augmentation Required (range $8.6m) – The benefits of avoiding augmentation required for a new generation could be material. A range was tested between $1m and $3m with a symmetric increase/decrease on the NPV of $4.3m depending on the cost selected.

- Total Project Duration (range $4.3m) - If the project life was extended to 20 years then this could increase the NPV by $1.9m. A reduction to 10 years would decrease the NPV by a more significant $2.4m as this reduces the period after which the ADMS projects had been implemented and deliver benefits to 8 years.

No change to a single parameter was sufficient to make the NPV negative.

8.1.3 Monte Carlo Analysis

The chart below shows the NPV forecast chart for the model based on 1000 runs with the parameters all set using a triangular distribution.

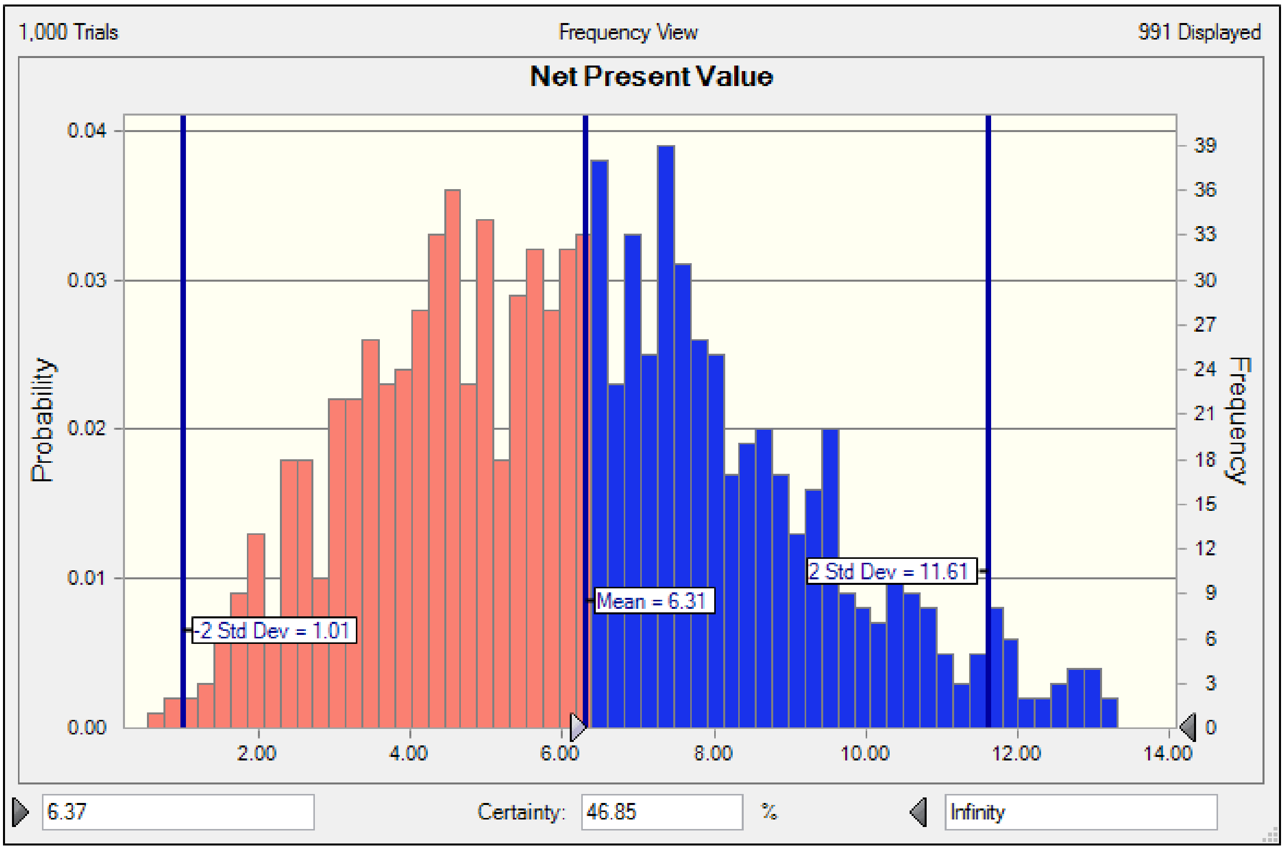

Figure 10 ADMS Projects Monte Carlo Analysis

The key observation from this Monte Carlo simulation is that the mean NPV using this approach ($6.31m) is similar to the value using the most likely value ($6.37m).

Key Statistics

The trial results gave the following statistics

- The mean of $6.3m and median of $6.2m are fairly close to the most likely value produced by the model.
- The standard deviation is $2.65M.
- None of the trial outcomes resulted in a negative NPV.

8.1.4 Cash Flow Analysis

The societal model for ZSS SCADA Expansion demonstrates a payback in year 4 of the model. After year 6 the model generates average net benefits (before discounting) of $0.9m per annum.

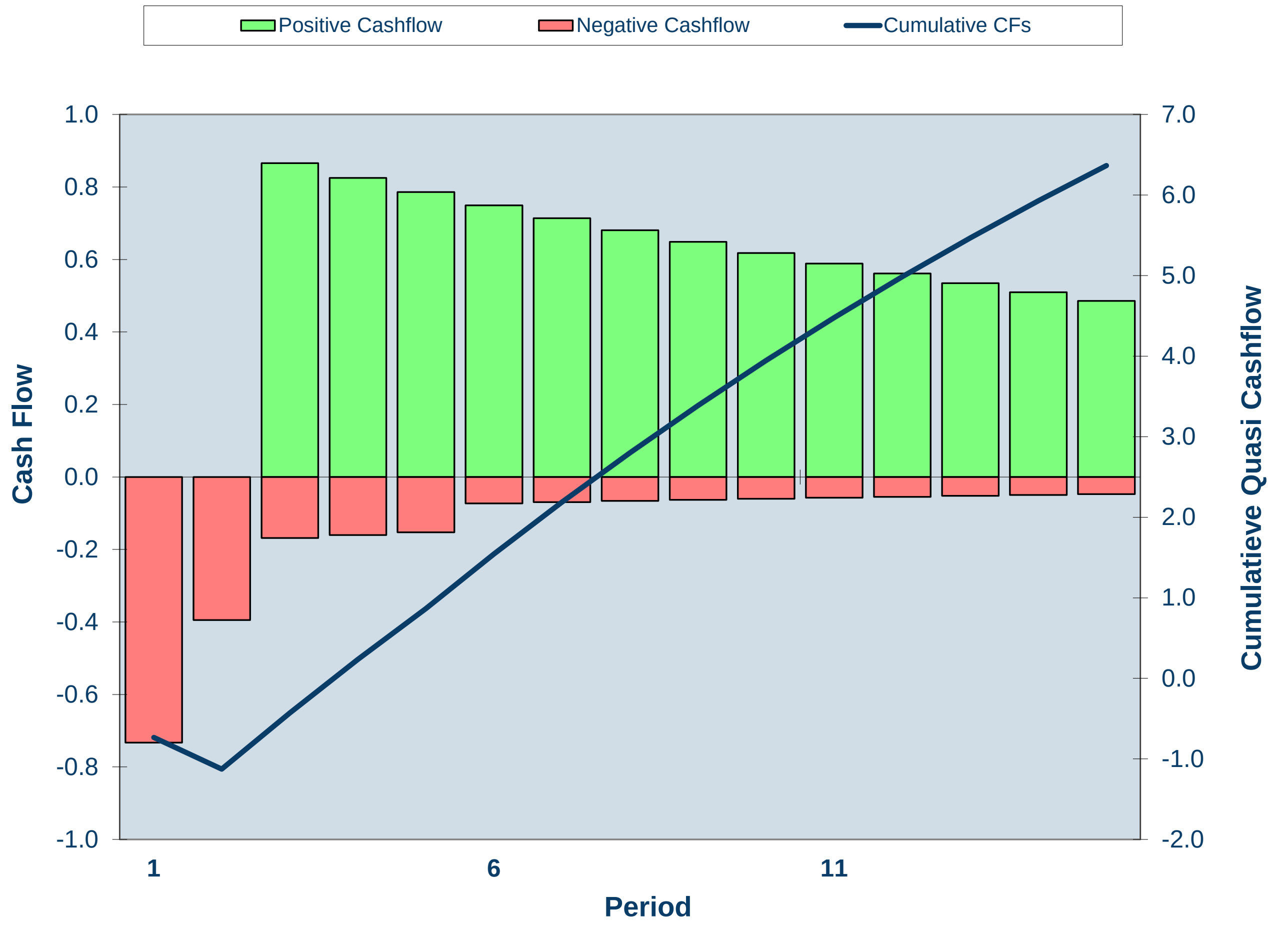

Figure 11 ADMS Project Cashflow Analysis

APPENDIX A MODEL DATA REFERENCES

Key Parameters

Parameter	Central	High	Low	Reason
Total Project Duration (years)	15	20	10	DNV GL estimate of likely life for this type of System
Real Discount Percentage (%)	4.93%	6%	4%	Percentage figures provided by Network Control Manager on 22nd June 2015
Total Number of Substation Upgraded ()	75	100	50	Based on schedule of completing 25 substation per year in 3 years and focused on high and medium bushfire areas – agreed with SA Power Networks at meeting on 20th May 2015
Cost of CBD ZSS SCADA Expansion with M & C ($k)	245	270	200	Cost estimate provided by Control System Engineer on e-mail of 17th June 2014 based on recent projects – no longer applied in the modelling as all ZSS rural
Cost of Rural ZSS SCADA Expansion with M & C ($k)	136	150	120	Cost estimate provided by Control System Engineer on e-mail of 17th June 2014 based on recent projects
Number of ZSS Upgraded each year ()	25	30	20	Schedule agreed with SA Power Networks on meeting of 20th May 2015
Value of a damaged Transformer at ZSS ($k)	250k	500k	150k	Estimate confirmed with SA Power (e-mail of 8th May 2014) – This should reflect the depreciated installed cost of the transformers as early replacement for failure avoids a cost that would have been incurred in the future. Suggest cost should reflect half the installed cost of the transformer assuming damage occurs half way through the asset life.
Number of outages per year per ZSS ()	1.5	2	1	DNV GL estimate based on previous calculations of the number of outages per year at major ZSS, but scaled down to reflect smaller size.
Number of Customers Impacted by an Outage ()	500	700	300	DNV GL estimate based on previous calculations of the number of outages per year at

				major ZSS, but scaled down to reflect smaller size.
Field Crew Cost per Hour ($/Hour)	87.5	100	80	E-mail from Control System Engineer of the 18th June 2014 includes overheads
Hourly cost of Vehicle Provision for Field Crew ($/hr.)	50	60	40	Estimate provided by Control System Engineer on the 8th May 2014 confirmed with estimating group
Value of Operator Time ($/Hour)	114	125	100	E-mail from Control System Engineer on the 18th June 2014 includes overheads
Number of major events causing damage at ZSS each year ()	1	2	0.5	Based on discussion with SA Power of number of events each year
Reduction it Time to get SCADA Recorded Faults to OMS (Mins)	10	15	5	This saving was agreed with SA Power Networks on the meeting of the 20th May 2015 and reflects their experience with rural customers. This saving covers 2 elements, the detection by SCADA and secondly the 'automatic' link from the ADMS to the OMS so that these outages get responded on almost immediately.
LRMC of capacity gained at Rural ZSS ($/kVA)	438	500	350	LRMC of capacity at rural ZSS. This was provided by SA Power Networks on the 28th May 2015.
Effective increase in capacity at the ZSS from SCADA Monitoring and Control (%)	0.5%	1%	0%	DNV GL estimate – will help planners but unclear exactly how much so this is a conservative figure agreed with SA Power Networks at the meeting of the 15th May 2015
Number of generators that require augmentation of the network before they can connect each year, which could be avoided with ADMS Control	0.5	0.75	0.25	Discussion with SA Power Networks indicated that one every 2 years would be a conservative estimate and is consistent with the four new embedded generators connecting in the last 5 years.
Average cost of connection	$2,000,000	$3,000,000	$1,000,000	Discussion with SA Power Networks on potential cost of connection for a typical generator
Average consumption per customer per hour (kWh)	1.6	1.8	1.4	SA Power Networks' annual consumption is around 12000 GWh with 850000 customer- Divided by 8760 to get

				consumption per hour
Number of ZSS Visits per year that could be avoided	6	8	4	Revised estimate discussed with SA Power Networks includes planned switching, bushfires changes and unplanned switching that may require changes in settings
Value of Customer Reliability ($MWh)	38090	50000	30000	Revised regional figures published by AEMO

Single Value Key Parameter

Parameter	Value	Reason
Average Working Hours per Week (hours)	37.5	DNV GL assumption
Working weeks per year (weeks)	48	DNV GL assumption
Cost of SCADA Engineer ($/hr)	96	DNV GL calculation based on data provided by Manager Network Control 7th May 2014 including overhead allowance
Cost of DMS Administrator/ Manager/Specialist ($/hr)	96	
Cost of Process Re-engineering Specialist ($/hr)	102	
Cost of Integration SME ($/hr)	102	
Cost of Project Manager ($/hr)	132	
Cost of Change Manager ($/hr)	102	

Individual Key Parameters

1.A Capital Cost of ZSS SCADA Expansion

Parameter	Value	Reason
Percentage of ZSS that just require monitoring equipment Capability (%)	0%	Discussions with Control System Engineer indicated minimal cost difference between monitoring and control capability
Reduction in cost where only monitoring is required	$10k	DNV GL Estimate - Discussion with Control System Engineer indicated only a small labour cost saving in not implementing a SCADA control capability – Not applied as all ZSS have monitoring
Percentage of ZSS to be upgraded that are urban (%)	0%	Based on revised approach to ZSS SCADA Expansion focussed on rural ZSS,
Planned Number of ZSS to Upgrade	75	Based on discussion with SA Power Networks on the 20th May 2015

1.B Capital Costs of Communications Infrastructure

Parameter	Value	Reason
Percentage of rural ZSS using radio	70%	DNV GL estimate discussed with SA Power Networks
Percentage of rural ZSS using 3G/4G	30%	DNV GL estimate discussed with SA Power Networks
Cost of radio solution	$16000	DNV GL estimate based on $8000 per base station and $8000 contribution towards the master
Cost of 3G/4G solution	$2500	SA Power Networks estimate
Percentage of urban ZSS using fibre	100%	DNV GL estimate discussed with SA Power Networks
Average cost for a fibre connection	$30000	DNV GL estimate – Could vary greatly depending on distance from Fibre network

1.C Operational Costs for Expanded SCADA at ZSS

Parameter	Value	Reason
Average annual cost to maintain each ZSS (AUD)	$1000	DNV GL estimate based on discussion with SA Power Networks that current annual maintenance costs was around $1000 per ZSS
Annual average cost to maintain fibre (AUD)	$1000	DNV GL estimate discussed with SA Power Networks
Annual average cost to maintain radio (AUD)	$1000	DNV GL estimate discussed with SA Power Networks
Average annual cost to maintain 3G/4G (AUD)	$200	DNV GL estimate discussed with SA Power Networks
Average monthly cost of Comms for 3G/4G (AUD)	$50	DNV GL estimate based on typical costs in other utilities – needs to be confirmed by SA Power Networks

1.D Avoiding Major Equipment Problems from Better Monitoring

Parameter	Value	Reason
Percentage of major events that can be avoided with increased ZSS monitoring	50%	Estimate discussed with SA Power Networks – only some of the damage could be avoided – agreed 20th

and control		May 2015
Time off Supply	8 hours	DNV GL estimate of time to restore after major outages – Agreed with SA Power Networks 20th May

1.F Reduced visits to ZSS to change settings

Parameter	Value	Reason
Hours per visit	2	Revised estimate discussed with SA Power Networks on 20th May 2015– some sites may have long travel time
Crew Size	2	Estimate discussed with SA Power Networks on 20th May 2015 - Normally at least 2 people in each visit

1.G Saving from Avoided Loggers for RIN Reporting

Parameter	Value	Reason
Avoided Capital Cost of Loggers per ZSS	$15000	Estimate agreed with SA Power Networks on 20th May 2015
Average Avoided Operational Cost per logger	$100	Estimate agreed with SA Power Networks on 20th May 2015

1.H Bushfire Benefits

Parameter	Value	Reason
Number of ZSS without SCADA or only with a TDU in HBFRA	36	Number of HRBFA ZSS without SCADA or with TDU or ElectraNet control from data provided by Tasnim on 1 May 2014
Frequency of HBFRA being cut-off (Years)	5.00	DGA Consulting estimate discussed with SA Power Networks. Combined with calculations below suggest customers face a one in ten year chance of a forced outage
Percentage of Customers on HBFRA that would be cut-off	50%	DGA Consulting estimate discussed with SA Power Networks
Percentage of Customers that could avoid being cut off	25%	DGA Consulting estimate discussed with SA Power Networks
Number of customers per HBFRA	500	DGA Consulting estimate discussed with SA Power Networks
Length of outage	8.00	DGA Consulting estimate discussed with SA Power Networks
Number of ZSS without SCADA or only with a TDU in MBFRA	39	Based on a total of 75 ZSS being implemented – This is a subset of 80 MRBFA ZSS without SCADA or with TDU or ElectraNet control from data provided by Control System Engineer on 1 May 2014
Frequency of MBFRA being cut off	7.5	DGA Consulting estimate discussed with SA Power Networks. Combined with calculations below suggest

		customers face a one in ten year chance of a forced outage
Percentage of Customers on MBFRA that would be cut off	50%	DGA Consulting estimate discussed with SA Power Networks
Percentage of Customers that could avoid being cut off	25%	DGA Consulting estimate discussed with SA Power Networks
Number of Customers per MBFRA	500	DGA Consulting estimate discussed with SA Power Networks
Length of outage	8.00	DGA Consulting estimate discussed with SA Power Networks

1.I Defer Augmentation through Enhanced Information for Planners

Parameter	Value	Reason
Network capacity of ZSS gaining SCADA with monitoring	112.5	Conservative estimate based on 1.5 MVA per ZSS. – Agreed with SA Power Networks on 20th May 2015

Embedded Generation Management

2.A Costs of Upgrades for ADMS (First year costs)

Parameter	Value	Reason
Number of DMS Administrators	0.125	DNV GL estimate of resource required
Number of DMS Specialists	0.5	DNV GL estimate of resource required
Number of Operators	0.25	DNV GL estimate of resource required
Number of Project Managers	0.25	DNV GL estimate of resource required
Specification Development	$100,000	DNV GL estimate of cost
External Testing	$100,000	DNV GL estimate of cost
Hardware	$100,000	DNV GL estimate of cost
Software	$250,000	DNV GL estimate of cost
Year when ADMS Functionality is added	1	DNV GL assumption that changes can be made in year one

2.B Annual Operating Cost of ADMS Embedded Generation Management

Parameter	Value	Reason
Number of SCADA Engineers	0.06	DNV GL estimate of resource required
Number of Data Managers	0.125	DNV GL estimate of resource required
Number of DMS Specialists	0.25	DNV GL estimate of resource required
Number of Project Managers	0.5	DNV GL estimate of resource required
Implementation cost saving after year 5	50%	DNV GL estimate that as procedure and requirement become defined the cost should be reduced. This cost saving may start to emerge before year 5, which is a conservative estimate
Year when Implementation cost savings begin	6	DNV GL estimate of when implementation cost savings should be incurred
Number of DMS Administrators in Year 2	0.25	DNV GL estimate of resource required
Number of Operators in Year 2	0.25	DNV GL estimate of resource required
Number of Process re-engineering staff in Year 2	0.125	DNV GL estimate of resource required
Number of Change Managers in Year 2	0.125	DNV GL estimate of resource required
Length of Implementation period (years)	19	Assume devices continue to get rolled out for the life of the model
Start period for implementation	2	DNV GL assumption that implementation starts from year 2
Software licensing cost in year 2	100000	DNV GL estimate of software licensing cost

Standing Data (used for Societal Unserved Energy Calculations)

Note – the value of these parameters makes only a very small impact on the model. The major driver of the societal model is the Value of Customer Reliability.

Parameter	**Value**	**Reason**
Number of Customers	850000	DNV GL estimate – Not currently used in the model
Average electricity used per customers (All customers)	14000	DNV GL estimate based on total consumption of around 12000 GWH with 850000 customers.
Peak Network Demand (MW)	2800	DNV GL estimate
Retail Cost of electricity (without GST)	0.34	In line with Origin tariffs, which varies for summer and winter – Depends on customers selected – Small reduction as carbon will come out
Average wholesale cost of electricity	0.1	Estimate of wholesale costs
Average variable production cost (to generators)	0.75	DNV GL estimate of average of costs – Gas fired generation that is reduced
Distribution cost	0.15	Based on network costs being around 50% of total costs
Transmission Cost	0.03	
Costs for Retailers	0.28	Based on other calculation – Difference between this and the retail price of electricity is the retailers' margin