13 Aug 2013

Installation of OPGW on 132kV Network - 7521157

1 Background

The existing ActewAGL communications network which is a mix of digital radios, pilot wires and Telstra cables is extremely limited in capacity. The reliability of this network presents a severe bottleneck to realising the benefits of the current SCADA system and thus the effective and reliable performance of the electricity network. Furthermore, the performance of some aspects of existing ActewAGL's 132kV network protection fault clearing times falls short of technical compliance with the current National Electricity Rules but is considered acceptable due to 'grandfathering' provisions in the Rules. However, a need for upgrade will arise, for example, every time a large scale generator is connected to the 132kV network[1] or when 132kV network upgrade, modification[2] or new investment takes place. ActewAGL network may not comply with the new performance standards in these instances depending on the nature of the load and the application of the relevant Rules to the particular installation.

2 Key Drivers

The key internal drivers are:

- Enhance SCADA and network protection functions and capability - to improve network operational effectiveness and reliability
- Enable future compliance to National Electricity Rules particularly where it is required to have primary and backup protection including breaker fail protection systems.
- Meet National Electricity Rules' new requirements for network performance in relation to protection systems and fault clearance times. These will become more pertinent and relevant to our network once we become a Transmission Network Service Provider (TNSP) or when a large scale embedded generator is connected to our sub-transmission network.
- Reduce operational costs and improve access and acquisition of operational data and asset performance data
- Improve security of the SCADA systems
- Provide communication infrastructure for distribution network monitoring and control and smart grid.

3 Link to ActewAGL's Strategy

In addition to the direct business needs outlined above, this project/initiative will also contribute to the achievement of objectives stated in ActewAGL Strategic Outlook: 2010 – 2020:

[1] A connection enquiry for a 20MW solar farm has been received and is expected to be completed by end 2013.

[2] With the completion of the Williamsdale supply point ActewAGL is now classified as a TNSP ActewAGL re-classification as a TNSP or the need for new work to meet TNSP obligations would most likely trigger the requirement to comply with the new performance standards.

- operate a modernised, automated (intelligent) distribution network better able to effectively manage distributed intermittent generation, distribution network assets and end use applications;

This objective is to be achieved by:

- existing business activities to be responsive to a new industry landscape and to be undertaken on the basis of continual improvement and improved efficiency
- modernisation of the networks
- successful implementation of major capital works programs
- growth through judicious investment in areas related to ActewAGL's core businesses

4 Project Objective

The objective of the project is to replace existing communication networks with a single communication network that provide the speed, security, reliability and functionality required for the electricity networks.

5 Project Management

The project will be managed by the Networks Division Major Projects branch utilising the Prince2 project methodology.

6 Options

6.1 Option 1 - Do Nothing

Several useful and desirable features of modern protection systems, SCADA and other standby network controls will not be obtained if nothing is done. The full benefit of investment made in zone substation protection and SCADA systems will not be realised. This could prevent Networks divisions from achieving its strategic intent to deliver a reliable and dependable modern network and retain a dominant share within the ACT and the surrounding region.

The option of leasing communication services from third parties was investigated but discounted as this would pose an unacceptable operational and security risk for network protection.

Doing nothing is not a viable option.

6.2 Option 2 - Redundant fibre optic network

Fibre optic cables can be installed on the entire 132kV sub-transmission network to form a redundant fibre optic network. A fibre optic network will be significantly cheaper over the asset life cycle and more reliable than the microwave network option discussed in Option 2. This network will also meet the technical requirements for NER system standards compliance.

The fibre optic network will:

- Ensure there is a robust network for protection and real time control operations for the Electricity Network;
- Provide a reliable and cost-effective means to achieve the fault clearing times specified in the National Electricity Rules for network performance standards;

- Introduce a robust and secure communications technology;
- Enable the future expansion of remote monitoring, control and protection functions of the distribution network, and collection of data from smart devices installed in the network and customer premises;
  Provide spare black fibres that can be used by the corporate communication network, reducing corporate service cost to the business.

6.2.1 Fibre optic network implementation methods

Two methods for installation of fibre optic on 132kV overhead network are available:

- OPGW Solution: Replace the existing overhead earth wire with Optic Fibre Composite Overhead Ground Wire (OPGW)

  ADSS Solution: Install self supporting fibre optic cables (All-Dielectric Self-Supporting – ADSS) in addition to the existing overhead earth wire.

6.2.2 Technical assessment of fibre optic installation options

The advantages and disadvantages of the two installation methods were investigated and examined. The table below summarises the pros and cons of the two installation methods:

Table 1: Comparison of fibre optic installation methods

Feature	OPGW	ADSS
Sheath erosion when exposed to electric fields	Not applicable	Yes
Lightning strike protection functionality	Yes	No
Communication functionality	Yes	Yes
Risk of damage from lightning strike	Yes	No
Risk of fire damage	Low	High
Risk of vegetation caused damage	Low	High
Resilience to physical impacts	High	Low
Ground clearance	Not a constraint	Constraint
Need for major structure modification	No	Yes
Constraint to line maintenance activities	No	Yes
Planning approval requirement	Possibly waived	Yes
Planning approval achievable	Very likely	Uncertain
Industry common practice	Common	Uncommon

The objective of the optic fibre installation on the 132kV overhead network is to provide the communication functionality without compromising existing infrastructure integrity and performance. This objective can be achieved with the OPGW method. The ADSS solution, however, would introduce an additional cable in the line structures. The combined weight of the existing overhead earth wire and ADSS cable is greater than the weight of OPGW conductor (Refer Table 2). This will cause greater wind loading on the structures. Structural modification or replacement may be needed, leading to substantial additional costs.

Unlike OPGW, the attachment point for ADSS cable on a structure is below the phase conductors at an approximate height of 8m. With sag allowances, the ground clearance requirements are difficult to achieve, especially over carriageways.

The table below provides cable technical specification for the different conductors:

Table 2: Comparison of Cable Specification

Property	Existing OHEW	OPGW	ADSS
Overall Diameter (mm)	9.8	12.1	13
Overall cross-section (mm^2)	58.1	82	approx 90
Cable Weight (kg/m)	3.9	5.1	1.4
Approx Sag (m) on a typical 150m span at 208C	3	3.5	3
Typical Attachment Height (m)	20	20	8

The replacement of the existing earth wires with OPGW would not result in any additional impact on land and it would have identical appearance and profile to the existing ground wires. Moreover, the replacement of existing earth wires with OPGW conductor may be considered as maintenance as it involves replacement of existing assets with a similar type of asset. For these reasons the planning approval is not expected to be an unduly onerous process.

The ADSS solution requires installation of an additional fibre optic cable. Its appearance will be significantly different from the existing line profile. Hence, the planning approval process is expected to be more involved than for OPGW. ActewAGL 132kV overhead network traverses through a large number of blocks across the ACT. Obtaining planning approval for each of these blocks can be a lengthy and very costly exercise.

The 132kV overhead lines between Belconnen and Bruce already have been upgraded with OPGW conductor. OPGW is also currently being implemented within the second supply to the ACT project. Future upgrade of Woden to Wanniassa lines will present another opportunity for OPGW installation. Continued implementation of the OPGW solution will ensure uniformity throughout the network and simplify maintenance and procurement activities.

OPGW solution is recommended over ADSS based on the above technical, constructability and operational considerations.

6.2.3 OPGW installation cost estimate

The cost estimate in Table 3 includes design, construction, material procurement and contract management.

Table 3: Project Costs

Description	ADSS	OPGW
Material		
Optic Fibre cable	[redacted]	[redacted]
Optic Fibre termination	[redacted]	[redacted]
Implementation Cost (Contractor)	[redacted]	[redacted]

The projected distribution of capital expenditure on the project is shown in the table below. All expenditure falls within the current regulatory period.

Table 4: Project expenditure forecast breakdown

	Forecast ($m)			
	2014/15	2015/16	2016/17	2017/18
Replacement Programme (OPGW Replacement)	1.5	1.5	2.2	2.6
IT Augmentation Programme (Optic Fibre termination) To be funded separately	0.3	0.5	0.5	-

6.2.4 OPGW installation project risks

- Adverse weather conditions could impede the project program. This risk can be managed through appropriate contract cost risk allocation mechanism.
- Lack of resources for operational and maintenance activities
- Potential difficulties in Development Approval (DA); although ACTPLA have advised that this work does not require a DA the NCA have yet to be approached in this matter.
- Limited in-house skills and resources for engineering design, construction, operation and maintenance. This can be addressed by either building up an internal skill base or establishing external contract support and services.

The risk assessment matrix for this project can be accessed at Reference [3].

6.2.5 OPGW installation project timeframe

The duration of each stage has been estimated based on time required for approvals, contracting, design and material procurement and construction. We have obtained formal response from ACTPLA that this work is exempt from DA requirement. We are seeking a similar exemption from NCA.

The roll out of OPGW on the rest of the 132kV network is estimated to take four financial years to complete.

The work will be carried out in several stages. These stages are sequenced to achieve the following priorities –

1. Establish a connection between the control centres at Fyshwick and Civic
2. Establish a connection between zone substations
3. Establish redundant loop to all zone substations

The first stage will establish the technical standard, a proper cost base and a realistic construction timetable for the remaining stages.

The scope of work is outlined in table 5. The program will be subject to fine tuning to align with other major substation works at Civic, East Lake, Molonglo and transmission line relocation works.

Table 5: Scope of work

Phase and Stages	Line		Length (km)	Scope of work	Timetable	Cost ($m)
	From	To				
Phase 1	**Establish initial connection between Belconnen, Bruce, Civic and City East**				**2014/15**	**$1.5**
1	Bruce	City East	11.9		July 2013 to Mar 2014	$0.8
2	Bruce	Civic	2.6		Feb 2014 to May 2014	$0.2
3	City East	East Lake	9.3	Through wetland in UG conduits	June 2014 to Apr 2015	$0.4
Phase 2	**Complete fibre connection to Fyshwick Control Centre**				**2015/16**	**$1.5**
4	East Lake	Fyshwick Control Centre	5		Jul 2015 to Dec 2015	$0.2
5	Bruce	East Lake	16.7	Through wetland in UG conduits	Jan 2015 to Dec 2015	$1.0
6	Canberra Zone	Latham	5.2		Nov 2015 to Apr 2016	$0.3
Phase 3	**Complete fibre connection across the network**				**2016/17**	**$2.2**
7	Gilmore	East Lake	13.1		Jul 2016 to Feb 2017	$0.8
8	Latham	Belconnen	4.6		Sep 2016 to Nov 2016	$0.3
9	Gold Creek	Bruce	13.2		Sep 2016 to Apr 2017	$0.8
10	Telopea Park	East Lake	2.5	Part of Causeway SS relocation	Feb 2017 to Jun 2017	$0.3
Phase 4	**Complete redundant connections and loops across the network**				**2017/18**	**$2.5**
11	Woden	Civic	12.4		Jul 2017 to Feb 2018	$0.7
12	Wanniassa	Gilmore	6.2		Jan 2018 to Jun 2018	$0.4
13	Canberra Zone	Woden	14.7		Aug 2017 to Apr 2018	$0.7
14	Canberra Zone	Gold Creek	14		Aug 2017 to Apr 2018	$0.7
15	Woden	Wanniassa	7.5	To be done with pole replacement	TBA	
Total			**131.4**		**2014/15 – 2017/18**	**$7.7**

OPGW installation programmed within Second Supply Point Line Project				
From	To	Length (km)	Scope of work	Timetable
Gilmore	Theodore	7.2	As part of second supply to the ACT project stage 2	Oct 2016 to Mar 2018
Theodore	Williamsdale	16	As part of second supply to the ACT project stage 1	Completed
Williamsdale	Gilmore	23	As part of second supply to the ACT project stage 1 & 2	Part Completed

The overhead earth wires on the existing network are a combination of 'All Aluminium' and 'Galvanised Steel' conductors, totalling up to an approximate length of 132kms. Details of the existing overhead earth wires on ActewAGL 132kV network and technical specification of the OPGW to replace the OHEW are given Item 8 - Refefences.
The duration of each stage has been estimated based on time required for approvals, contracting, design and material procurement and construction. We have obtained formal response from ACTPLA that this work is exempt from DA requirement. We are seeking a similar exemption from NCA.
The roll out of OPGW on the rest of the 132kV network is estimated to take four financial years to complete.

6.3 Option 3 - High speed microwave network

This option will meet the SCADA communication requirement. However it rates lower than fibre optic network on bandwidth, availability, reliability, maintainability, data integrity, security and expandability based criteria. In particular, microwave network would incur substantially higher operational and maintenance cost than fibre optic network by a factor of 10.

Microwave network operates on point-to-point communication through straight line of sight. The topography of the ACT includes substantial hilly terrain requiring repeaters. This implies higher cost and a lengthy planning approval process.

Microwave network alone would not be suitable for ActewAGL network protection functions due to its potentially lower availability and reliability. It can only be deployed as a back up redundant network but not as a primary communication network for protection functions.

This option will not be considered further.

7 Summary and Recommendation

This report investigates options to address speed, security and reliability issues on the existing communications network. A fibre optic network is the preferred solution. Two methods to implement the fibre network were investigated viz. OPGW and ADSS. The cost difference between the two methods is not

significant. OPGW is recommended over ADSS as it performs better based on technical, constructability and operational considerations.

8 References

1. Conductor Specifications: ACTEWAGL-#518383-OPGW Spec 9941.PDF
2. Typical construction timeframe for Bruce to City East line OPGW replacement: ACTEWAGL-#531739-BSS to CEZS Works Program
3. Project Risk Assessment: ACTEWAGL-#532552-Risk Assessment PN 7521157 & 7521245 OPGW & NPSI Project