Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	Obsolete IGBTs – IGBTs Staged Upgrade Engineering and Implementation + Ongoing IGBT Spares		
Project Type:	*Capex:*	*Refurbishment/Replacement $17.3m*	
Prepared:	*Allison N. Smith*	*Electrical Engineer*	
Endorsed:	*Noel Powell*	*Reliability Engineer*	
Approved:	*Stuart Dodds*	*Asset Manager Renewables and Transmission*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal covering the years 2020 to 2025.

BACKGROUND

There are 5,328 insulated-gate bipolar transistors (IGBT) in service at Directlink. IGBTs have a failure rate above that of other electrical High Voltage equipment. There is an on-going need to maintain a level of spare IGBTs .

One of the Converter stations, Mullumbimby System One (M1), has already been upgraded to Generation 3 Technology after the fire in 2012 caused irreparable damage and the converter station had to be re-built, works completed in 2015.

The obsolescence of generation 1 IGBTs will be subject to a Regulatory Investment Test – Transmission where possible solutions will be identified then assessed. This business case is for the purposes of considering solutions that Directlink has currently identified for the revenue proposal to address a problem that requires a solution for the ongoing operation of Directlink.

IDENTIFICATION OF NEED

APA have been advised by ABB that the Generation 1 technology, installed at five (5) of the six (6) convertor stations is now obsolete. APA have found it increasing difficult to order critical parts for the Generation 1 technology. ABB have advised that there are only 91 Generation 1 IGBTs left in the world. This number represents around 2 years of spares at Directlink at the current failure rate, which is not enough to even see through the current period from 2015-2019.

ABB will not be manufacturing any more Generation 1 IGBTs and have withdrawn the original quote to supply all of the Generation 1 IGBT spares required for the period of 2020-2025 (refer to Reference Documents). The expected failure rate for the 2020-2025 period is 45-50 per year for Generation 1. The expected failure rate for the 2020-2025 period is 6-9 per year for Generation 3. If the upgrade works are not undertaken then one of the links (60MW) will be mothballed in 2022 if failure rates continue at the current rate.

The valve control unit is the smarts behind the coordinated control and protection of the insulated gate bi-polar transistors control and protection. The valve control unit communicates to each IGBT using two dedicated optic fibres for each insulated gate bi-polar transistors position. The on /off signals are sent to the insulated gate bi-polar transistors from the valve control unit via a 'red' fibre optic cable. The information about the insulated gate bi-polar transistors performance and health is sent back to the valve control unit via the 'blue' fibre optic cable. The failure IGBTs within a valve, increases the voltage stress over the remaining IGBTs in the valve. To protect the IGBTs, the VCU monitors their operations will trip the converter when 5 or more IGBTs are detected within one valve.

Valve control units must be compatible with the IGBTs used. For the sake of clarity in this document the Valve Control Unit will be referred to in terms of their IGBT compatibility. Generation one valve control units are only compatible with generation one IGBTs. Generation three valve control units are compatible with generation one, two and three IGBTs.

EVALUATION OF ALTERNATIVES

The IGBTs are specialised items developed by the original equipment manufacturer ABB. Economic alternative suppliers are not a realistic proposition, as this would involve a complete redesign of the whole converter station. The alternatives explored are around how the upgrade works are undertaken:

1. Long term Capex Replacement Contract (LTCRC) between ABB & APA to manage the ongoing operation of Generation 1 IGBTs and where no longer possible to upgrade to Generation 3 . $3.3m per year first 10 years then $1.65m for the remainder of the contract
2. Replace one Valve room as a standalone project. $10m per valve room
3. Replace one entire converter building as a standalone project.
4. Replace all GEN1 IGBTs ancillary equipment with Gen3 as a single project
5. Cannibalise two entire converter buildings as a standalone project (do not replace with Generation 3 IGBTs)

Projects 2-4 are traditional capital expenditure projects where the existing asset is removed and the new asset is put in place. Project 5 the existing asset is removed and the IGBT are used as spares for the remainder of the systems, however this will take one of Directlink's three systems offline permanently – reducing Directlink's capacity by 60MW.

Project 1 is a long term contract where responsibility for the technical risk of operating Gen1 IGBTs, VCUs and the Control and Protection system is assumed by ABB. This contract will also cover spares management, 24/7 support and cyber security updates for these assets.

Priority in a staged upgrade would be given to one phase/valve room of the converter station Bungalora System One (B1). This would also allow the associated technology: fibre optic/lightguides, proms and VCUs to be upgraded during the same outages thus limiting the effect on the reliability and availability of Directlink to support its function in the NEM.

While enough spares should be able to be scavenged to maintain the remaining Generation 1 converter stations: B1 (2 phases) M2, B2, M3 and B3 during the period

2020-2025, these will not be supported by an original equipment manufacturer warranty nor is the failure rate of re-using the IGBTs known.

Generation 3 spares are required for Generation 3 Stations.

Valve Control Unit Upgrade Options:

1. Upgrade all Valve Control Units as a standalone project *$2m+*

2. Upgrade Valve Control Unit required for the staged upgrade only – *included in the $3.3 per year LTCRC*

3. Nil Action – do not upgrade valve control units (as the current VCUs support Gen 1 this option would suggest Option 5 above, Cannibalisation of two converter buildings is preferred and of most value. – current modelling suggests Option 5 not to be of most economic value

Directlink has conducted NPV economic analysis that demonstrates that the most efficient cost approach is to contract with a long term capex replacement service contract with ABB. The scope of the contract under discussion with ABB also includes the VCUs and control and protection system as well as spares management and maintaining cyber security on all assets they replace. When all this is considered the LTCRS provides the best value for money. In addition the LTCRS provides a much lower risk profile for customers and the risk of early obsolescence or technical disruption lies with ABB under the proposed scope of the contract.

This is provided in the Forecast Capital Expenditure Model supplied with this business case.

ESTIMATED COST

The proposed works outlined below:

1. Management of the replacement of IGBTs including liaising with AEMO and Essential Energy
2. Engineering
3. Design
4. Equipment and Materials including IGBTs.
5. Installation and Commissioning including switching remotely and locally.
6. Sundry costs associated with travel, accommodation, local transport of staff, plant and materials.

The replacement IGBTs will meet the original design specification for the Directlink system.

Total Cost **$ 9,660,000 (or LTCRC $16.5m 2020-2025 + APA Costs)**

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

Key activities include:

- Procurement at the start of reset period, with 20 months leadtime for the design to be completed and IGBTs to be delivered to site.
- Site Works sheduled from March to October 2022 to avoid the Summer Lockout period when no non-essential work is to be be done.

JUSTIFICATION

The upgrade of the IGBTs for "Directlink" is required to meet the requirements set out in the National Electricity Rules, in particular the capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) being required to maintain the efficient operability of the plant. The project will ensure that stock of spare IGBTs is maintained to minimise the risk of long term outages should when units need to be replaced.

The Directlink IGBTs are essential spares and should a problem occur in the period leading up to the replacement significant outages will be experienced.

RECOMMENDATION

Our recommendation is that the Long Term Capex Replacement contract be undertaken to maintain critical spares for the Directlink assets and ensure:

- adequate stock of critical components are maintained to ensure the ongoing reliable operation of Directlink

The estimated costs have been included in the capital expenditure forecasts for the Directlink Regulatory submissions.

REFERENCE DOCUMENTS

Forecast Capital Expenditure Model 31 January 2019 - MAllen

OPP-17-749637 (A) –APA HVDC Care LTSA Scope Overview

OPP-18-2477210 (2) – ABB quote to supply IGBTs WITHDRAWN

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APA Group

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Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	**Cable Protection** *$4.8m*		
Project Type:	*Capex/Opex*	Capex Replacement/Refurbishment	
Prepared:	*Kimberley Saunders*	*Project Manager*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset and Renewables Manager*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the years 2020 to 2025.

BACKGROUND

The Directlink Transmission System is a 59km underground and above ground (in galvanized steel troughing), bipolar HVDC cable route between Terranora and Mullumbimby in New South Wales. To minimise its environmental, community, aesthetic and land impacts, Directlink was installed along already existing rights of way for its entire 59 km route.

Cable Protection consists of two projects and seeks to maintain reliability, security of supply and safety to the community by limiting the cable's exposure to increased traffic (foot, cycle, vehicle) caused by organic region growth as well as protection from construction equipment as a result of the increasing development expected near the easement.

The two projects are:

1. Cable Signage and Protection

2. Cable Protection – Partial Relocation (Underground)

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PROJECTS

1. Cable Signage and Protection

1.1 Background

Directlink was commissioned in 2000. In it's original design and construction, the Directlink cable was bored underground where community exposure *was* anticipated and constructed above ground where exposure was considered to be minimal and infrequent. The cable was originally signed and labelled utilising the same logic. The purpose of the signage is to make the public aware of the presence of the cable to avoid accidental contact.

On an increasingly regular basis, existing signage is found damaged or removed. Due to the somewhat isolated locations and original sporadic placement of signage along the 59km route, this is difficult to track. The region is also prone to weather events which have also resulted in damaged signage requiring replacement.

The Northern Rivers Rail trail project imposes a significant change of use in the shared corridor and impacts 14-20km of cable, mostly in the above ground sections of galvanised steel tray (GST).

1.2 Identification of Need

Public safety is a key issue for Directlink. Clear signage in the right locations is critical to the ongoing safety of the general public, local community and landholders. Maintenance of signage and community awareness of the cable is an ongoing operating expenditure task.

As a result of the change in the cables surrounding environment and regional growth context, Directlink is reviewing, replacing, upgrading or adding to the signage and protection measures on the entire cable.

This project seeks to increase our protection work and have budget for new measures that may be required in certain locations. An example of these may be fencing, screen planting, and customised signage.

The Cable Signage and Protection project proposes a base case signage and cable protection measure program suitable for the cable environment as it is today, and an additional budget allowance in response to the rail trail as a minimal response and pending the outcome of further measures inclusive of partial relocation (see *2. Cable Protection – Partial Relocation (Undergrounding)*.

1.3 Evaluation of Alternatives

- Nil Action
- Signage and cable protection ($0.8m)
- Additional Physical barriers around the cable ($25-30m)

The base component of the Cable Protection – Awareness project is appropriate in the context of a mid-life cycle review. Given the modest cost of the signage program and the legal requirements on Directlink to maintain a safe operating environment this is the preferred option.

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While putting additional physical barriers underground to prevent contact with the cable is possible, the additional safety provided by these barriers on top of the existing safety aspects of the underground cable means that the cost of this approach is disproportionate to the benefit obtained.

1.4 Recommendation

A Signage and Cable Protection project is recommended.

1.5 Estimated Cost

The project estimate is $830,000.00.

The estimate has two components, allocating $500,000.00 to the 'base case' measures and $320,000.00 proposed as the response to the Northern Rivers Rail trail project in those locations where the underground cable is near the proposed rail trail.

The estimate has a 20% labour component including project management and additional contractor resource required to implement the protection measures.

The estimate has a 80% procurement component associated with the purchase of signage and protection measure equipment and items.

	Base Case	*Base Case + Rail trail response*	
Labour – Project Management, Supervision,	$100,000.00	$64,000.00	$164,000.00
Procurement	$400,000.00	$256,000.00	$656,000.00
	$500,000.00	$320,000.00	**$820,000.00**

The projects and expenditure will occur in FY21 and FY22, with a portion of expenditure forecast for FY24.

The estimated cost has been formed by requesting quotes from multiple suppliers of procurement items and forecasting an appropriate labour allocation to the scale of project.

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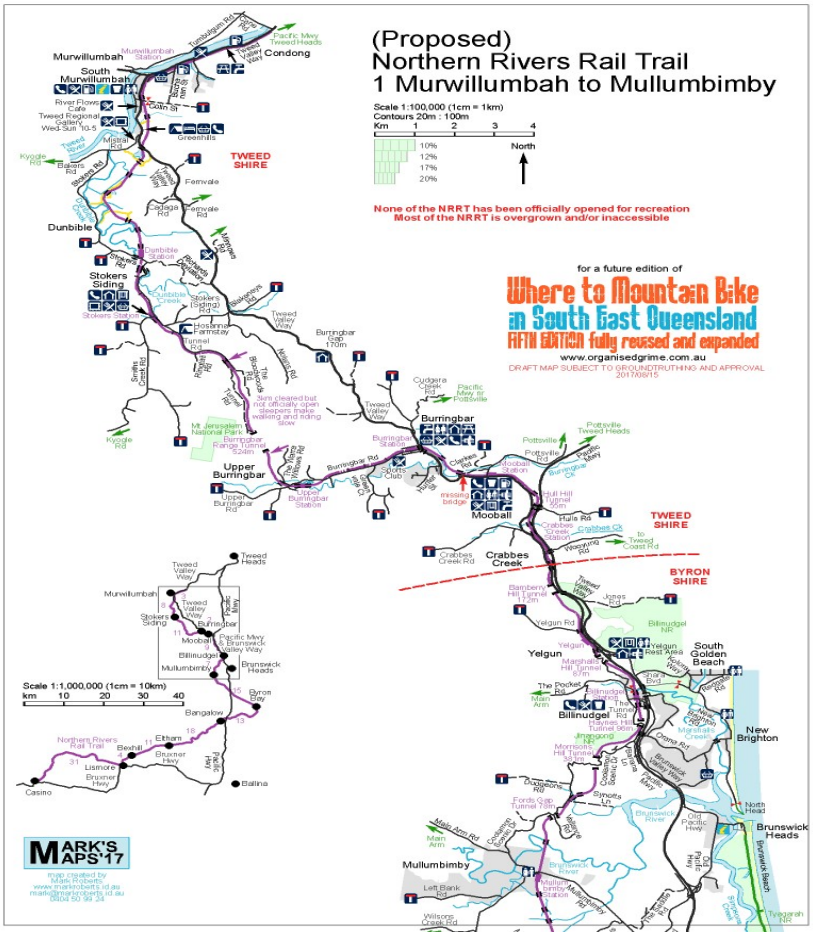
2. Cable Protection – Partial Relocation (Underground)

2.1 Background

Directlink was commissioned in 2000. In it's original design and construction, the Directlink cable was bored underground where community exposure *was* anticipated and constructed above ground where exposure was considered to be minimal and infrequent.

The Northern Rivers Rail trail project imposes a significant change of use in the shared corridor and impacts between 14-20km of cable of which the majority is the above ground sections in galvanised steel tray (GST). Towns impacted by the rail trail and where the GST and rail trail would run adjacent include Stokers Siding, Burringbar, and Mooball.

Figure 2.1.1 Norther Rivers Rail Trail Public Concept Design



The land of, or near, the rail trail is to be converted to a multiuse recreational path. This work will involve the construction of a trail and construction, or reinstatement of, bridges to facilitate pedestrian, cycling and equestrian use of the trail. The trail itself currently has two design options, with the trail being on the formation of the existing train tracks or off formation parallel to the train tracks. Initial funding for the project

has been obtained from both the federal and state governments and is expected to increase.

The construction of the trail, based on either design option, will be a significant program forecast to exceed 12 months including early works. Tweed Council are currently targeting a September 2019 construction commencement however there are multiple schedule difficulties in regards to legislative and other challenges that the council must overcome to achieve this target.

Directlink have been assessing concept designs for the rail trail (provided by Tweed Council) and propose an investigation in to the partial relocation (via undergrounding) of the cable ***most impacted*** by the rail trail design in the long term, and rail trail construction activity in the nearer term.

When it does occur, rail trail construction activity (including personnel and equipment) will be in close proximity with the Directlink interconnector assets. The three cables run through a galvanised steel tray (GST) that runs adjacent to the current railway line. The construction activity and significant change of use of the corridor in to a recreational area represents real changes to the current risk profile of cable interference probability. The tray is designed to enclose and protect the cables but has limited capacity to withstand accidental or deliberate physical damage from construction activity.

Given that risks are envisaged for the scale and type of construction activity near Directlink's high voltage cable, but are yet to be assessed on a final design option, it is essential that Directlink conduct an appropriate scale of risk assessment which will include ALARP.

In addition to construction risk, it is appropriate for Directlink to consider if the shared corridor use and recreational change of the environment is compatible with the current cable design and future maintenance and whether there are a combination of factors that give merit to design changes in addition to third party development.

2.2 Evaluation of Alternatives

Relocation of the above ground Directlink cable impacted by the rail trail is possible by undergrounding the cable in the current corridor and using the existing alignment, or by relocating the cable out of the corridor and in to an alternate easement. A project of this scale, relocation by removal, would exceed $30m. EII takes the view that in the context of Directlink's age and project life, in addition to the multiple challenges in the feasibility and safe execution of a relocation by removal project, this is not justified on a best value basis. On the same basis, undergrounding of the entire above ground cable, a project that would exceed $15m, has been eliminated at this time.

2.3 Recommendation

The EII propose to commence a Cable Protection – Partial Relocation (Underground) project, commencing in FY21. The project assumes that whilst undergrounding the above ground sections of cable in their entirety *(approx 14km)* would have merit – the

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scale of the project would not present best value at a mid cycle point of Directlink's project life.

Further, there are multiple sections where undergrounding may not be possible due to bridges, creek crossings, tunnels, and the general alignment – making a full underground project unfeasible.

It is recognised by Directlink that as the Northern Rivers Rail project is suggested as the dominant driver for relocation, Directlink should continue engagement with Tweed Council and establish the rail trail final design in order to identify and prioritise which sections would benefit from undergrounding.

The cost estimate is based on an initial consideration of the high level proposals being considered by the Tweed Shire Council being used to prioritise one third of the affected area equating to 4.1km (33% of 12.5km cable of the rail trail impacted sections) being relocated underground.

Consistent with accepted industry practice and community expectation, Directlink will seek to reduce risk associated with the location and operation of its assets to "As Low As Reasonably Practical". This requires that Directlink undertake mitigation action up to the point that it is disproportionate to the risk. Directlink will undertake a detailed ALARP study. ALARP is conducted by assigning a likelihood to a risk and determining the consequences of the event. These two factors form a matrix and the conjunction of the two concepts determine the risk.

Directlink is operated based on the APA risk matrix which is set out in *Figure 2.4.1*.

Figure 2.4.1 – APA Risk Matrix

ERM Risk Tables – Projects MAY 2018 – APPROVED

1. **Enterprise Risk Matrix – Project Likelihood table**

Level	Descriptor	Description
5	Frequent	Expected to occur on a regular basis and many times
4	Occasional	May occur occasionally or in many circumstances
3	Unlikely	Unlikely to occur but possible when certain circumstances prevail
2	Remote	Not anticipated but may occur if certain abnormal circumstances prevail
1	Rare	Conceivable, but has not been known to arise previously

2. **Enterprise Risk Matrix – Project Impacts (Consequence Ratings)**

Consequence Category	Impact (Consequence) Ratings				
	1. Minimal	2. Minor	3. Significant	4. Major	5. Catastrophic
1. Health & Safety Injuries, illness or death of employees, contractors or members of the public	Injuries or illness requiring first aid treatment only i.e. able to return to work immediately or the next day	- Injury / illness resulting in time lost from work of one day / one shift or more (LTI) - Member of the public requiring medical treatment	- Injury / illness resulting in permanent or partial disability to employees - Member of the Public requiring hospitalisation	Fatality or life threatening injuries or illness or permanent total disability of employees and contractors or members of the public	Fatality arising from systemic failure of APA safety or multiple fatalities of employees and contractors or members of the public
2. Environment (including heritage) Environmental harm or adverse effect on ecosystem i.e. the surroundings in which APA operates, including natural, built and Aboriginal cultural heritage, soil, water, vegetation, fauna, air and their interrelationships	One or a combination of the following consequences: - onsite and impacting < 1 ha - no remediation needed - impact continues for < 1 wk	One or a combination of the following consequences: - onsite and impacting > 1 ha - able to be remediated easily - impact continues for <1 yr	One or a combination of the following consequences: - offsite and impacting < 1 ha - able to be remediated with some difficulty - impact continues for <5 yrs	One or a combination of the following consequences: - offsite and impacting > 1 ha - able to be remediated with difficulty - impact continues for <10 yrs	One or a combination of the following consequences: - offsite and impact is widespread (> 1ha) - unable to be remediated - impact is irreversible or lasts >10 yrs
	Impact that causes negligible or no damage to heritage	Temporary and repairable impact or infringement to heritage	Permanent but repairable impact or infringement to heritage	Temporary but irreparable impact or infringement to heritage	Permanent and irreparable impact or infringement to heritage
3. Schedule Impact on delivery schedule	The higher of: - < 1 month; or - 1% - 10% of the approved schedule	The higher of: - 1 - 3 months; or - 10% - 25% of the approved schedule	The higher of: - 3 - 6 months; or - 25% - 40% of the approved schedule	The higher of: - 6 - 12 months; or - 40% - 50% of the approved schedule	The higher of: - more than 12 months; or - More than 50% of the approved schedule
4. People Impact size, engagement, capability of our Staff	Little or no impact on individual or team engagement	Some impact on team or site engagement / minor site level complaints or breaches	Some impact on Business unit engagement / rising complaints or breach levels / some staff turnover	Some serious complaints or breaches / Staff turnover rising	Increasing serious complaints and breaches/ High staff turnover

The consequence of the cable interaction is easily determined and any harmful contact is likely to result in a single or few deaths. The definition of 'harmful' contact however would be explored as the rail trail design and construction activity details (including personnel and equipment interaction) progresses.

In the event that harmful interaction potential is substantiated, further information about ALARP including definitions of consequence has been provided in *Directlink submission document* and is available from Safe Work Australia .

Subject to the results of a detailed ALARP study, Directlink's current best forecast is that efficiently meeting the standard of ALARP ***will*** involve either moving the cable underground in, or close to, its current location.

2.5 Estimated Cost

The project estimate is $4,000,000.00.

The estimate has a 10% labour component including project management and additional contractor resource required to scope and plan the project.

The estimate has a 90% construction component.

The project, if approved, has an $160,000.00 offset from the Project 1. Cable Protection- Awareness which represents 50% of the rail trail response measures that would be addressed by undergrounding.

		Cable Protection – Awareness Offset
Labour – Project Management, Supervision,	$400,000.00	*-$160,000.00*
Relocation Construction Indicative - *(min 4.1km cable)*	$3,600,000.00	
	$4,000,000.00	*$3,840,000.00*

The projects and expenditure will occur in FY21-FY25, with relocation construction occuring in FY22-FY24.

The estimated cost is a preliminary budget estimate and will require formal quotation in 2019 as part of the regulatory submission process. It is anticipated by Directlink that an updated budget, when the rail trail design has been finalised and the priority relocation sections established, will be presented in final submission to the AER.

The forecast capital expenditure assumes the entire cost for relocation is borne by EII.

The forecast includes the Risk Assessment and ALARP studies in FY19 and FY20 to inform final submission.

The estimated costs for the recommendation detailed have been included in the capital expenditure forecasts for the Directlink Regulatory submissions.

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JUSTIFICATION

The Cable Protection projects for "Directlink" is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (2) on the basis that the Cable Protection projects will be required to maintain compatibility with the Australian Standard.

Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	**Cable Modification**		
Project Type:	*Capex/Opex :*	Capex *$2.1m*	
Prepared:	*Kimberley Saunders*	*Project Manager*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset and Renewables Manager*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the years 2020 to 2025.

BACKGROUND

Directlink seeks to invest in regular analysis of cable fault data, to assist with any improvement strategies that could be implemented to maintain reliability. Cable faults cause downtime to the network and are a disruption to productivity in the business. Fault repairs can be a strain on resources and our normal operations. Cable faults cause system outages and impact the availability of Directlink.

IDENTIFICATION OF NEED

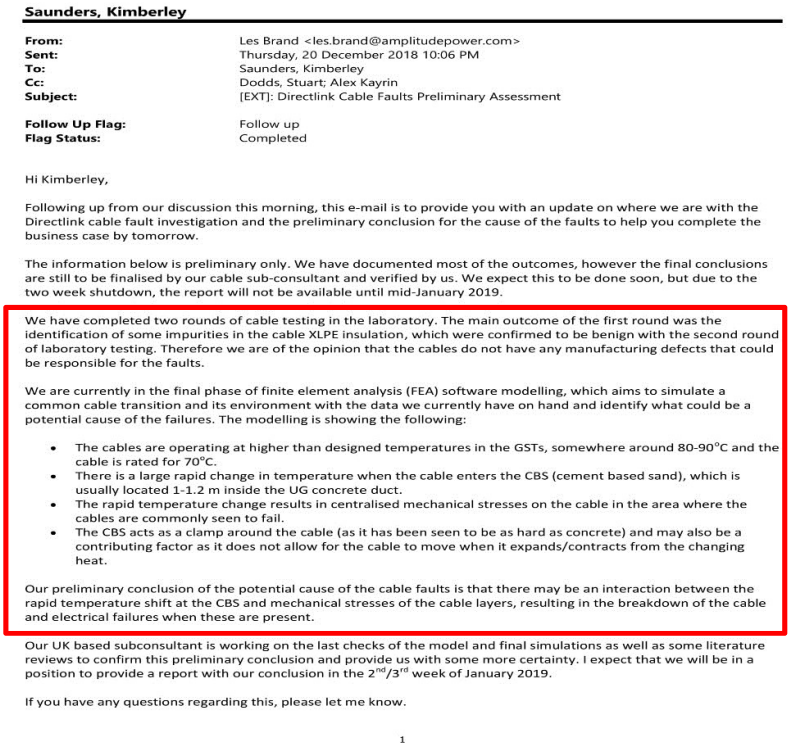
The Directlink cable is 59km and approximately 14km is above ground in galvanised steel tray (GST). There are approximately 76 cable transition points between below and above ground.

In 2018, Amplitude Consultants (a Brisbane based consultancy specialising in HVDC assets), were commissioned to conduct a cable fault analysis and study.

In partnership with the Directlink operations team, Amplitude were able to identify that a significant number of cable faults appear to be occuring at, or near, cable transitions.

An early recommendation from the ongoing cable analysis is to replace cable transitions with the objective of removing a mechanical stress identified impacting the cable's integrity.

Figure 1.1 *Extract Cable Fault Analysis Update*, *December 2018*



Saunders, Kimberley

From: Les Brand <les.brand@amplitudepower.com>
Sent: Thursday, 20 December 2018 10:06 PM
To: Saunders, Kimberley
Cc: Dodds, Stuart; Alex Kayrin
Subject: [EXT]: Directlink Cable Faults Preliminary Assessment

Follow Up Flag: Follow up
Flag Status: Completed

Hi Kimberley,

Following up from our discussion this morning, this e-mail is to provide you with an update on where we are with the Directlink cable fault investigation and the preliminary conclusion for the cause of the faults to help you complete the business case by tomorrow.

The information below is preliminary only. We have documented most of the outcomes, however the final conclusions are still to be finalised by our cable sub-consultant and verified by us. We expect this to be done soon, but due to the two week shutdown, the report will not be available until mid-January 2019.

We have completed two rounds of cable testing in the laboratory. The main outcome of the first round was the identification of some impurities in the cable XLPE insulation, which were confirmed to be benign with the second round of laboratory testing. Therefore we are of the opinion that the cables do not have any manufacturing defects that could be responsible for the faults.

We are currently in the final phase of finite element analysis (FEA) software modelling, which aims to simulate a common cable transition and its environment with the data we currently have on hand and identify what could be a potential cause of the failures. The modelling is showing the following:

- The cables are operating at higher than designed temperatures in the GSTs, somewhere around 80-90°C and the cable is rated for 70°C.
- There is a large rapid change in temperature when the cable enters the CBS (cement based sand), which is usually located 1-1.2 m inside the UG concrete duct.
- The rapid temperature change results in centralised mechanical stresses on the cable in the area where the cables are commonly seen to fail.
- The CBS acts as a clamp around the cable (as it has been seen to be as hard as concrete) and may also be a contributing factor as it does not allow for the cable to move when it expands/contracts from the changing heat.

Our preliminary conclusion of the potential cause of the cable faults is that there may be an interaction between the rapid temperature shift at the CBS and mechanical stresses of the cable layers, resulting in the breakdown of the cable and electrical failures when these are present.

Our UK based subconsultant is working on the last checks of the model and final simulations as well as some literature reviews to confirm this preliminary conclusion and provide us with some more certainty. I expect that we will be in a position to provide a report with our conclusion in the 2nd/3rd week of January 2019.

If you have any questions regarding this, please let me know.

1

Whilst the findings are preliminary it is evident that cable faults continue to occur and are more frequent at or near the transitions. The current study will continue in FY19 and FY20 with conclusive findings and study performed on proposed solutions.

Previous budget requested in relation to cable fault analysis has been study based only. A project is required that will move cable fault analysis and study through to pre feasibility and execution.

EVALUATION OF ALTERNATIVES

As the project identifies that the cable fault analysis results are inconclusive at this time, alternative options in regards to fault rectification will be presented to AER through the regulatory submission process throughout 2019. Further, if the cable transitions remain the priority – the project includes feasibility study and risk assessment to ascertain if the transitions do require placing or if alternative solutions such as additional insulation protection layers added to the surrounding transition points will be of the most value.

RECOMMENDATION

The Cable Modification project includes budget allocated to progress current technical analysis and study to a feasibility investigation and execution phase.

The evidence, whilst preliminary, is sufficient to justify a project to proceed in an attempt to cease the recurring trend identified.

This project is critical in Directlink's ability to be a reliable network provider. Without this scope of work there is no ability to understand why and how cable faults occuring and to stop it continuing into the future.

The project has two components however is presented and discussed as one project on the basis that EII understands action *will* be required in the new determination period if Directlink is to improve it's performance.

The feasibility study will include project management and third party consultancy engagement. A tender process in accordance with APA procurement policy is forecast as part of the feasibility study.

Probable items in the execution project will include cable replacement and the associated procurement for construction and redesign of the transitions zone by reducing the temperature gradient. Effective ways of reducing the temperatures within the GST as a result of solar heating will also be implemented.

ESTIMATE OF COST

The total estimate for the Cable Modification project is $2,100,000.00

The estimate proposes $300,000.00 allocated to feasibility study *(3-6 months)* and an interim project execution budget of $1,800,000.00 *(30-33 months)*.

The AER and stakeholders will be updated as this cost estimate develops.
This project is forecast to be executed in FY21-FY23.

The estimated costs for the recommendation detailed have been included in the capital expenditure forecasts for the Directlink Regulatory submissions.

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The delivery of the project has been scheduled as detailed in the Estimate sections above, occurring in FY21-F23.

JUSTIFICATION

The Cable Modification Program for "Directlink" is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) on the basis that the transition modification project and continued cable analysis via a fault improvement program will assist to maintain the quality, reliability and security of supply of prescribed transmission service

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Australian Pipeline Ltd
ACN 091 344 704

Australian Pipeline Trust
ARSN 091 678 778

APT Investment Trust
ARSN 115 585 441

Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	**Reliability**		
Project Type:	*Capex/Opex :*	Capex $4.4m refurbishment/replacement	
Prepared:	*Kimberley Saunders*	*Project Manager*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset and Renewables Manager*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the years 2020 to 2025.

BACKGROUND

Reliability maintenance projects seek to maintain Directlink's availability by ensuring key components and equipment that contribute to reliability are in optimum working order and utilising advanced technologies and products available to high-voltage direct current assets.

Directlink continues to make an integral contribution to the Queensland and New South Wales transmission markets. The demand on the network continues to increase as these regions grow. However, Directlink currently experiences reliability issues. The full 180MW of Directlink capacity is available 70 percent of the time.

IDENTIFICATION OF NEED

In order to avoid further deterioration of Directlink's availability EII has identified a number of projects that have an affect on Directlink's reliability performance. The projects are detailed below and include:

1. Power Supply Upgrade
2. Cyber Security
3. Variable Speed Drive (VSD) for Phase Reactors

PROJECTS

1. Power Supply Upgrade

1.1 Background

Directlink requires auxilary power from the local distribution network to power pumps and fans (essential equipment).

During weather events in the region, the local distribution network is interrupted. The interruption to power supply causes the converter to trip (fault). The trips can be for prolonged periods (12hours+). Current UPS units provide standby power for approximately of 5- 8 hours only and are battery operated.

1.2 Identification of Need

Directlink must receive power at all times to be run and achieve security of supply. Each interruption to supply via a trip results in downtime, and time to revert to online and available as equipment must first be restarted and monitored. Further, repeated trips can have negative consequences on equipment leading to damages – and in the event the equipment is critical, extended outage times awaiting repair or replacement.

The reliance solely on the local distribution network is a risk to the business. The existing UPS units at Directlink are aged and UPS capability including standby times have advanced.

1.3 Evaluation of Alternatives

The available options are

- Nil Action
- Replace with like for like
- Upgrade UPS

For the reasons outlined in the background section doing nothing will result in further deterioration of Directlink's reliability both in terms of frequency and duration with the flow on consequences to other equipment within Directlink.
As the current duration of UPS at the Directlink sites (5-8 hours) is proving to be inadequate to the duration of outages this will prove to be an ongoing problem for Directlink's reliability when the UPS runs out of power.

The falling price of back up power has meant that compared to when the UPS was insta

1.4 Recommendation

For Directlink to ensure reliability continues upgrading of our UPS capability is required via the purchase of new units to replace existing, and also to investigate the purchase of diesel run generators that may support a longer standby power capability.

3.5 Estimated Cost

The project estimate is $800,000.00 and the purchase will occur in FY21 and FY22.

The estimated cost has been formed by requesting quotes from multiple suppliers. The project will be executed via a formal Request for Quote or Tender process available to the open market and assessed for best value, taking in to consideration both price and the suitability of products to Directlink specific requirements.

2. Cyber Security

2.1 Background

Directlink was commissioned in 2000 with Information Technology and Security capabilities available at the time of construction for High-Voltage Direct Current assets.

2.2 Identification of Need

In 2019, Information Technology continues to evolve globally across all industries. With the benefits of continuous increased capabilities – the challenge to the business is to ensure the consequential associated risks are identified and mitigated.
Any disruption or breach to the IT infrastructure Directlink operates on has the potential of serious consequences for the market and end customers. Directlink's operations have multiple interfaces with third parties (Essential Energy Connection Agreement etc) where information is both dispatched and received on a daily basis. This data often includes market sensitive information and requires protection.
Failure to upgrade the cybersecurity increases the risk of cyberattack and the consequent impact on the Directlink transmission service.

2.3 Evaluation of Alternatives

- Nil Action
- Cyber Security Strategy

The Cyber Security Strategy recommended project commences with the engagement of a third party independent specialist to perform an analysis on Directlink's communications and network. The scope of the analysis will include physical security

of communications hardware, robust wide area communications, upgrading of computer systems, system back ups, change management and exposure to attacks on our network. The preferred supplier will be provided with past Cyber Security audit data that identifies key areas of security concern and proposed actions.

For Directlink to align with APA policies and industry standard, it is essential that we invest in Cyber Security and perform study to understand our risks and implement appropriate protection strategies.

If Directlink does not invest in Cyber Security, exposure increases year on year to attacks on our network and physical data that are likely to cause major disruption.

2.4 Recommendation

Cyber Security Strategy

3.5 Estimated Cost

The project estimate is $550,000.00 and will occur in FY21 and FY22.

The estimated cost has been formed by a preliminary project scale based internal estimate. The project will be executed via a formal Request for Quote or Tender process available to the open market and assessed for best value, taking in to consideration both price and the suitability of products to Directlink specific requirements.

3.**Variable Speed Drive (VSD) for Phase Reactor and Cooling Pumps**

3.1 Background

The phase reactor provides a large reactance that allows the valves to control the active and reactive power flow with AC network. They also help to reduce the high frequency harmonic content of the AC currents created by the valves.

3.2 Identification of Need

In operation, phase reactors heat up, and must be cooled. The motors on the phase reactors currently run only in on/off mode. When the temperature rise above the recommended operating temperatures the phase reactor cooling switches on at maximum capacity. This temperature cycling creates additional wear and tear on the phase reactors shortening their operation life. A phase reactor can cost $3.5m to replace.

A variable speed drive provides greater flexibility to the temperature control function, increasing and decreasing cooling air flow to manage phase reactor temperatures.

This has the impact of reducing wear and tear on the phase reactor and also reducing overall operation noise from the convertor station, a concern for local residents (see section Noise Monitoring Equipment).

3.3 Evaluation of Alternatives

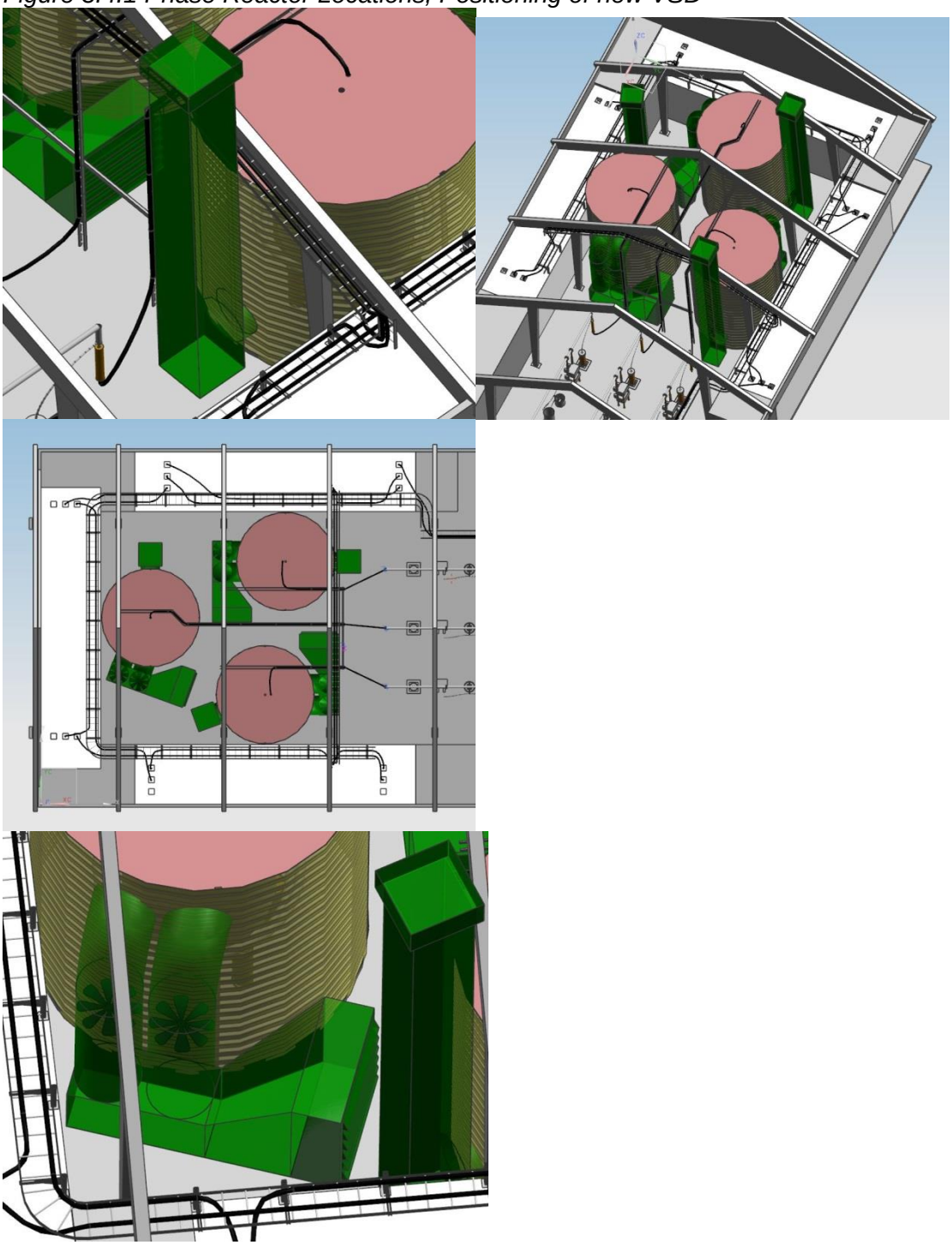
- Nil Action
- Install variable speed drive

Directlink propose the engagement of ABB to execute a project including the relocation of the phase reactor fans, and the addition of variable speed drives with integration into the MACH Control System (Control System Upgrade completion FY19). The scope of work includes the re-positioning of the phase reactor cooling fans for B1,B2,B3,M2 & M3 with the addition of variable speed drives and integration into the MACH System and involves the following key stages:

- Cooling fans will be moved from the side of the phase reactor and positioned together close to the floor enclosed within a re-fabricated air intake. (see fig.3.4.1 below)
- Two separate intakes and two separate fans are required for each reactor to achieve redundancy. In total this equals 6 fans per converter station.
- Addition of Variable Speed Drives including integration into the control system

- All intakes will be directed towards the center which means that they will be counteracting each other. This also causes a significant air flow in between the reactor cages.

Figure 3.4.1 Phase Reactor Locations, Positioning of new VSD



3.4 Recommendation

To avoid the consequences to phase reactor longevity it is proposed to install a variable speed drive.

3.5 Estimated Cost
ABB have been the exclusive supplier of Phase Reactor design related projects since the commissioning of Directlink in 2000. As the Control System is a product of ABB, it is suitable for ABB to manage the integration.

The project estimate is $3.1m and will occur in FY21 and FY22.

The estimated cost has been formed by a budgetary quote and technical scope provided by exclusive supplier, ABB. The budget proposal includes:

Space Simulation & Studies, Thermal Modelling, Design & Engineering

Frequency Converter for Phase Reactor Fans, Salt Filters,

New Air Intakes + Noise Baffler Box, Supervision and Project Management

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The delivery of the projects has been scheduled as detailed in the Estimate sections above, occurring in FY21-F24.

JUSTIFICATION

The Reliability projects for “Directlink” is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (4) on the basis that addressing Reliability Improvement Initiatives is required to maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission service

Reference Documents

Supplier Quotes Power Supply Upgrade

Cyber Security past audit data – Directlink (Confidential)

Cyber Security Industry guidelines, APA policy

ABB VSD Phase Reactor Budget Proposal inc technical scope

Business Case

Service Provider:	APA Group	Date:	January 2019
Asset:	Directlink		
Project:	Fibre/Lightguides		
Project Type:	Capex:	$ 3.8 million Refurbishment/Replacement	
Prepared:	Allison N. Smith	Electrical Engineer	
Endorsed:	Noel Powell	Reliability Engineer	
Approved:	Stuart Dodds	Asset Manager Renewables and Transmission	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal covering the years 2020 to 2025.

BACKGROUND

IGBTs are both the workhorse and basic building block of the VSC (Voltage Source Controlled) HVDC station. Each convertor station at Directlink contains three valve rooms. Each valve room contains two valves, each made up of 148 individually controlled IGBTs connected in series that must switch together in a fraction of a microsecond. To successfully handle these series-connected IGBTs, they all need to be switched (on or off) at the same time so each IGBT experiences the same voltage stress. Each time an IGBT fails the voltage stress on the remaining IGBTs increases. If more than 5 IGBT positions report as faulty the system will trip to prevent a cascading IGBT failure event.

Fibre optics transmit information between the VCU (valve control unit) and the IGBT. The VCU is the smarts behind the coordinated IGBT control and protection. The VCU communicates to each IGBT using two dedicated optic fibres for each IGBT position. The on /off signals are sent to the IGBTs from the VCU via a ‘red’ fibre optic cable. Information about the IGBTs performance and health is sent back to the VCU via the ‘blue’ fibre optic cable.

IDENTIFICATION OF NEED

There are two issues that are currently having a negative impact on Directlink availability as a direct result of the fibre degradation. The primary issue is fibre optic degradation leading to an increase in IGBT failures resulting and the secondary issue is the inability to unblock a convertor when it has cooled down. Both issues will be explained in more detail in the following paragraphs.

The loss of either a red or blue fibre will result in an IGBT position being reported as failing. The failure of the red fibre has the greatest impact as it will prevent the IGBT from switching correctly. While there is some self-protection built into the IGBT the IGBT is not designed to run in self-protection mode indefinitely and will generally be subject to a higher voltage stress due to a delayed switching speed in comparison with the other IGBTs. This will lead to premature failure of the IGBT. The failure of

the blue fibre will prevent the IGBT from reporting as healthy. While the voltage stress on the IGBT is not increased, the system will still count the position as failed and therefor increase the frequency of outage requirements to reduce the number of failed positions.

The current state of continual degradation of the fibres makes it impossible to energise a system without heating the valve rooms to operating temperature (40 degrees). Heating of the valve room is achieved via the valve cooling system and is currently a manual process, which involves turning on heaters and closing certain valves. As the heaters are only there to prevent the water from freezing during winter they are not designed to heat the water rapidly. Heating of the valve cooling water can take anywhere from 6 hours to 30 hours depending on the original water temperature and the ambient temperatures. As the heating process is manual is cannot be done until personnel are on site. The heating can only be removed upon energisation when the system is producing its own heat. Removing the heating also requires personnel to be on site. Replacement of all the degraded fibres is the only option to remedy this issue.

A project in 2017 to replace the worse performing fibres was conducted in which 650 of the worst fibres (8% of the total installed fibres) were replaced to increase the reliability of the systems. This was successful and improved the alibility to energise at lower than operating temperatures (37-38 degrees) with less protection failures. While more fibres could have been replaced there was no room in the existing cable route to run fibres without a design change to add an additional fibre route. A design change of the nature would require extensive testing by the OEM.

In December 2018 a trial project was conducted to replace all the fibres in one system convertor (1776 fibres in total). The system was energised without the need to heat valve rooms and now meets the original design functional specification. The failure rates for this system will continue to be monitored for improvement.

Replacements are occurrring in the current transmission determination period and at the time of 2020, it is System 2 and System 3 that will require replacement as opposed to all converters.

EVALUATION OF ALTERNATIVES

The fibre terminations are an OEM ABB proprietary fitting and long lead time items, which take approximately 26 weeks to deliver. No alternative suppliers considered. The alternatives explored are around how the fibre replacement/upgrade works are undertaken:

- Current pace continued $400k per annum- Replacing as singular fibres or small groups of 10 and does not have a tangible improvement to the failure rate. The heating is still required as multiple fibres remain degraded in staged replacements and cause failures. It is difficult to assess which fibres should be targeted in continued staged upgrades as opposed to a complete system.

- Accelerated Program / Targeted Project $3.2m – Replace System 2 and System 3 in a single project, supports the critical function of replacement fibres supporting IGBT communication and resolves the issue of delay in restoring the operation of the IGBTs due to heating as all fibres will be in equal condition at the time of energising.

- Nil Action

RECOMMENDATION

An Accelerated Program via a targeted project to replace all fibres on System 2 and System 3 is recommended.

Directlink considers it a priority to get all of the Fibre Lightguides at Bungalora System One (B1), Bungalora System Two (B2), Bungalora System Three (B3), Mullumbimby System Two (M2) and Mullumbimby System Three (M3) upgraded. Mullumbimby System One (M1) received new fibre optics when the whole station was rebuilt after the fire.

Our recommendation is that the project to replace fibres at System 2 and 3 be undertaken as a matter of urgency to maintain critical spares for the Directlink assets and ensure:

- The program of replacements is at a sufficient pace to address the two issues – support of the IGBT and ceasing the rapid degradation currently contingent on the heating mechanism
- adequate stock of critical components are maintained for the longer term maintenance and availability of the system;
- timely response to any future faults with the IGBTs allowing effective repair and minimised outages; and
- Good industry practice by maintaining stock of critical components for the long term sustainability / availability of the plant.

The estimated costs have been included in the capital expenditure forecasts for the Directlink Regulatory submissions.

ESTIMATED COST

The proposed works outlined below:

1. Management of the replacement of Fibre/Lightguides including liaising with AEMO and Essential Energy
2. Engineering
3. Design
4. Equipment and Materials including Fibre/Lightguides.
5. Installation and Commissioning including switching remotely and locally.
6. Sundry costs associated with travel, accommodation, local transport of staff, plant and materials.

The replacement Fibre/Lightguides will meet the original design specification for the Directlink system.

Total Cost $ 3,800,000.00

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently,

and represent a realistic expectation of the costs to achieve the requirement. It is efficient because ABB are the sole provider of this equipment.

The following schedule represents the key activities for APA to upgrade the Fibre/Lightguides (FY 2020-2025 regulatory period).

Essential Spares															
Fibre/Lightguides Upgrade															
Schedule															
Year	Q3 2020			Q4 2020			Q1 2021			Q2 2021			Q3 2021		
Month	J *	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Key Activities															
Approval Secured															
Procurement	$418,901								$1,675,604						
Eng & Design				$48,369											
Summer Lockout					No non-essential site work										
Site Works										$ 514,638		$ 514,638			
Documentation														$ 32,561	
* Start of RR period															
** End of RR period															

Key activities include:

- Procurement at the start of revenue period, with 9 months leadtime for the design to be completed and Fibres/Lightguides to be delivered to site.
- Site Works sheduled from March to October 2021 to avoid the Summer Lockout period when no non-essential work is to be be done.

JUSTIFICATION

The upgrade of the Fibres/Lightguides for “Directlink” is required to meet the following capital and operating expenditure objectives, in particular, set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) being required to maintain the efficient operability of the plant. The project will ensure that stock is maintained of a critical, long lead time item. This minimises the risk of long term outages should fibres need to be replaced and spares not be available.

The Directlink fibres/lightguides are essential spares and should a problem occur in the period leading up to the replacement significant outages are expected.

REFERENCE DOCUMENTS

OPP-17-749637 (A) –APA HVDC Care LTSA Scope Overview

OPP-17-837900, OPP-17-837905 – ABB quotes to Upgrade system 2 & system 3

APA Technical Summary for Fibre Optic Replacements.

Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	Essential Spares – Capacitors		
Project Type:	*Capex:*	*$0.385 million*	
Prepared:	*Allison N. Smith*	*Electrical Engineer*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset Manager Renewables and Transmission*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal covering the years 2020 to 2025.

BACKGROUND

Capacitors improve the quality of the electricity converted from AC to DC and from DC to AC. This reduces heat losses and minimises voltage stress on equipment. Poorly performing capacitors increase equipment failures and system losses. There are 724 capacitors installed at Directlink. Ten different types with a number of different functions including AC Harmonic Filter banks, PLC Noise (Coupling Capacitor), DC Filter banks and Valve Capacitors.

IDENTIFICATION OF NEED

Historically there has been a higher than expected level of degradation observed in the DC Capacitors, with the failure rate around 6% so there is an on-going need to maintain a level of spares.

The expected failure rate for the 2020-2025 period is 5-6 per year. A replacement program in response to the capacitor faults is proposed and this will require maintaining a level of stock on-site capable of addressing the failures as they occur. Capacitors are a long leadtime item, which take approximately 32 weeks to deliver to site.

EVALUATION OF ALTERNATIVES

The Capacitors are specialised items developed by the OEM ABB. Alternative pricing sought from another supplier, Siemens, who declined to quote due to lack of suitable equipment, additional design cost would have also made this alternative less attractive.

Experimenting with repair of the failed capacitors, the failed capacitors would need to be removed from service, shipped to the nearest ABB test facility and diagnosed before a failure mode can be determined and whether they are suitable to repair. The whole facility would be out of service until the replacement capacitors are installed. This alternative is discounted due to the extended outage and potential warranty issues.

ESTIMATED COST

The proposed works outlined below:

1. Management of the replacement of capacitors including liaising with AEMO and Essential Energy
2. Engineering
3. Design
4. Equipment and Materials including Capacitors, Lifting and removal equipment.
5. Installation and Commissioning including switching remotely and locally.
6. Sundry costs associated with travel, accommodation, local transport of staff, plant and materials.

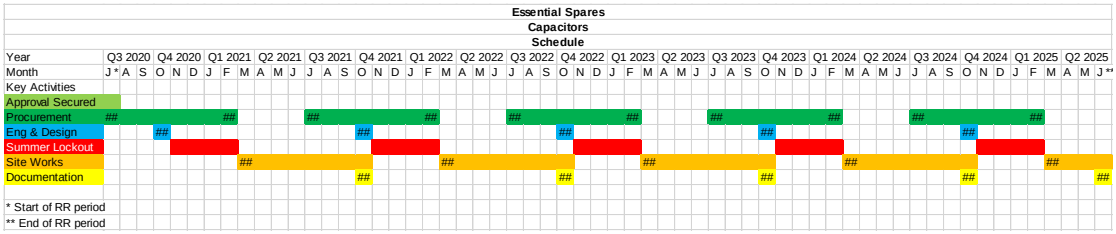
The replacement capacitors will meet the original design specification for the Directlink system.

Total ABB Cost **$ 314,000**

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The following schedule represents the key activities for APA to replace the capacitors as they fail (FY 2020-2025 regulatory period).



Key activities include:

- Procurement at the start of each financial year, with 8 months leadtime for the capcitors to be delivered to site.
- Site Works sheduled from March to October each year to avoid the Summer Lockout period when no non-essential work is to be be done.

JUSTIFICATION

The replacement of the capacitors for “Directlink” is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) being required to maintain the efficient operability of the plant. The project will ensure that stock is maintained of a critical, long lead time, spare capacitors to minimise the risk of long term outages should when units need to be replaced.

The Directlink Zero capacitors are essential spares and should a problem occur in the period leading up to the replacement significant outages will be experienced whilst the replacement capacitors are sourced.

RECOMMENDATION

It is recommended that the repair of the capacitors be undertaken as a matter of urgency and to maintain critical spares for the Directlink assets and ensure:

- adequate stock of critical components are maintained for the longer term maintenance and availability of the system;
- timely response to any future faults with the capacitors allowing effective repair and minimised outages; and
- Good industry practice by maintaining stock of critical components for the long term sustainability / availability of the plant.

The estimated costs have been included in the capital expenditure forecasts for the Directlink Regulatory submissions.

REFERENCE DOCUMENTS

OPP-16-97782 (5) – ABB quote to supply capacitors.

DL-RR – Capacitor Program Cost Estimate

Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	**Noise Monitoring Equipment**		
Project Type:	*Capex/Opex :* Capex *$0.5*		
Prepared:	*Kimberley Saunders*	*Project Manager*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset and Renewables Manager*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the years 2020 to 2025.

BACKGROUND

There have been multiple complaints about noise levels at the Bungalora and Mullumbimby Convertor stations, with a notable recent increase at Mullumbimby. These communities and the region is forecast for increased growth and development. In addition to national population increase trends, projects such as the Northern Rivers Rail Trail project *(see Cable Protection)* suggest more attention on converter station noise outputs is probable.

EII will be increasing Stakeholder Engagement activity in the communities concerned commencing 2019 (see section **Error! Reference source not found.** of Directlink Submission, Stakeholder Engagement) and there is an expectation that the local community will wish to engage in relation to a noise improvement strategy.

IDENTIFICATION OF NEED

NSW Industrial Noise Policy set the level of acceptable or unacceptable noise (nuisance noise) under the legislation (*Noise Policy for Industry (2017)*. Where the noise is found to be a nuisance this can lead to both corporate and personal fines and the resulting damage to corporate reputation in the area where EII operates its asset. EII needs to be confident that it is meeting its legal obligations with regards to noise pollution.

In June 2018 'Wood' group were engaged by Directlink to monitor noise at Mullumbimby in response to a neighbouring residential property complaint. The conclusion of the monitoring analysis stated that whilst it was likely (but not definitive) Directlink was compliant at the time of the complaint, there were variables in the

monitoring that would warrant further investigation and monitoring being commissioned.

Figure 1.1 *Mullumbimby Substation Noise Assessment Extract - Conclusion*

6. CONCLUSIONS

Attended monitoring of the Mullumbimby substation was undertaken on the 26th June 2018. Measurements were undertaken at the noise sensitive receptor, an intermediate location, and on the loudest noise sources on site. The results and observations of the surveyor demonstrate that with respect to the NSW Environmental Protection Authority (EPA) – Noise Policy for Industry (2017), the Mullumbimby substation was likely compliant on the night of 26th June 2018.

The monitoring was not able to positively identify the source of the noise that is the subject of the complaint.

Any additional monitoring would ideally include further measurements at the sensitive receptor, potentially including noise measurements inside the home, and further measurements of equipment on-site focussing on elevated noise sources for which measurements were not possible in this campaign. Ideally, measurements would also seek to identify noise source signatures from the adjacent site to allow separation of the contributions. Due to the environment at the receiver any further monitoring should look to avoid periods of wind, even with low wind speeds, as these have been demonstrated to obscure the potential source of interest.

Figure 1.2 Mullumbimby Substation Nosie Assessment Extract – Sample of Interference Issues with short term ad-hoc monitoring

Measurement Number	Measurement Start	Measurement Length (mins)	Total LAeq	Total LCeq	LCeq - LAeq	Tonal Noise?	Low Frequency Noise?	Assessed Industrial Contribution (dBA)	Adjusted Industrial Level (dBA)	Compliance?	Comment
											below 30dBA when there is no extraneous noise influence.
5	11:30:00 PM	12:01	33.8	48.1	14.3	No	No	<30	<30	N/A	Measurement period is less than the 15-minute assessment period. Extraneous bird and wind noise present during period. Extraneous traffic noise contributes significantly to overall. Level sits below 30dBA when there is no extraneous noise influence.
6	11:45:00 PM	15:00	42.4	55.7	13.2	Yes	Yes	<30	N/A	N/A	Extraneous bird, wind and traffic noise present during the assessment period. Extraneous traffic noise contributes significantly to overall levels. Two cars pass the receptor during the period, one proceeds to perform burnouts, significantly affected overall levels during the period. Tonality (250 Hz and 315 Hz bands) and low frequency noise (100 Hz, 125 Hz and 160 Hz bands) are present during the assessment period, this is likely due to the significant contribution from traffic noise. Level sits at approximately 30dBA when there is no extraneous noise influence.
7	12:00:00 AM	01:12	32.7	47.4	14.7	No	No	<30	32.7	N/A	Measurement period is less than the 15-minute assessment period. Extraneous traffic noise is present for the majority of the measured period.

EVALUATION OF ALTERNATIVES

The options are

- Nil Action
- Capital Project Reducing Noise - *$8m*

  The current cooling fans at both Bungalora and Mullumbimby are a significant source of our noise output in our operations. Whilst the fans are in sound enclosures, these were constructed 20 years ago and there are now improvements that could be made by utilising variable speed drive technologies, changing the type of fan (including size and number of fans) or replacing the existing enclosure with a new design.

  A project of this scale was investigated as an alternative and is in excess of $8m. The option has been eliminated due to insufficient evidence of value.

- Noise Monitoring Equipment to collate definitive data - *$500k*

RECOMMENDATION

A single project has been identified that would benefit Directlink's objective to ensure operations are as efficient as possible in noise related outputs. Noise Monitoring Equipment project proposes to install noise monitoring equipment and further engage external noise experts for data analysis as required. The monitoring equipment will have the benefit of providing data for analysis to identify sources of unacceptable noise, if they exist, or to enable Directlink to respond to concerns about noise levels demonstrating it is not the source of noise. As a priority the Noise Monitoring Equipment project will seek to establish a baseline of noise output *per section* and function of the converter station by using versatile monitoring equipment, to achieve an understanding of operations impact to overall noise levels. With landowner permission we would also have the ability, utilising the equipment, to consider monitoring from the source of complaint.

An example of equipment types for more permanent monitoring solutions is provided in *Figure 1.3 Noise Monitoring Equipment*.

Figure 1.3 Noise Monitoring Equipment and Solution Product Samples

EMS Brüel & Kjær

PRODUCT INFORMATION:

NOISE MONITORING TERMINALS TYPES 3639 AND 3655

Our family of Noise Monitoring Terminals (NMTs) is ideal for anyone who needs to continuously monitor noise levels in order to demonstrate compliance with regulations, manage their activities, limit noise impact or measure to improve their noise maps. Each NMT provides noise information you can trust, enabling you to make real-time decisions to avoid breaching noise restrictions and maintain noise compliance.

Unlike other instruments that are not specifically designed for continuous unattended outdoor monitoring, Brüel & Kjær NMTs accurately and reliably capture noise data. Each unit runs with little user attention, reducing your total monitoring cost and the demands on your valuable time.

The family of Noise Monitoring Terminals (NMTs) is made up of intelligent units designed to work unattended as part of a complete environmental noise monitoring system for permanent, mobile or portable monitoring operations. EMS Brüel & Kjær's system gives you maximum flexibility, ensuring that precious capital is not tied up in equipment that is only needed for short periods.

Using Brüel & Kjær noise management software, the NMTs can be controlled by a remote PC enabling them to measure, record, process, store and transmit noise information. Accurate noise data will assist you in making informed decisions and planning for the future.

USE AND FEATURES

Uses

- Permanent, mobile and portable monitoring of any application requiring unattended outdoor noise measurement

Features

- Specifically designed for permanent, continuous outdoor monitoring
- A wide range of solutions for all applications, needs and budgets
- Type approved to IEC 61672 Class 1 specifications; uniquely, including windscreen effects
- 120 dB dynamic range
- Self-monitoring capabilities for increased uptime
- Built-in facilities to minimise gaps in data
- Charge Injection Calibration (CIC) or a built in actuator for remote verification of the entire measurement chain
- Safe and reliable live data streaming
- LAN, WLAN, 3G and CDMA communication capabilities for remote operation
- Industry-standard Internet and security protocols for safe and reliable data transfer
- Wide range of integrated peripherals for communications, powering, mounting, weather, GPS, camera, etc.

EMS Brüel & Kjær

PHYSCIAL CONFIGURATIONS

The NMTs are modular both in hardware and software, making them suitable for a wide range of applications, needs and budgets. They come in a wide range of standard and customised configurations and with a wide range of accessories, peripherals and services, so whatever professional noise monitoring solution you need, Brüel & Kjær can deliver a solution. NMTs are available in permanent, mobile and portable variants with two microphone options for either general or specialist use. A wide range of peripherals covering communications, integrated weather monitoring, power, physical mounting and additional inputs such as GPS modules, cameras, etc., are available.

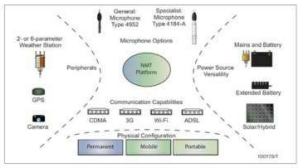


Fig. 1 *Overview of the Noise Monitoring Terminal and its accessories*

PERMANENT NOISE MONITORING

Suitable for permanent continuous monitoring at the same location for periods of several months to several years, EMS Brüel & Kjær's Permanent NMTs (Fig. 2) have been specifically designed to operate unattended in harsh environments, protecting the contents from weather, tampering, vandalism, theft, etc.

The durable, weatherproof cabinet includes a mounting kit for fastening the cabinet to a wall or pole. The cabinet is well protected by a weatherproof locking mechanism, and padlocks can be mounted. Protection is also provided for the cabling to reduce the risk of tampering or accidental damage. Permanent NMTs send a signal to the remote PC when the door is open, allowing unauthorised intrusion to be immediately detected and recorded.

The NMTs work according to specifications even in winter conditions, operating on mains down to –30°C. If required, a low-temperature protection kit is available for continuous operation under even more extreme weather conditions. Contact your local EMS Brüel & Kjær representative for more information.Permanent NMTs can be battery operated so that they can function even when there is no usable local power source or mains power has been disrupted. They can be powered from a variety of sources, such as solar panels, through the DC supply input.

A 10 m microphone cable is included to ensure that the outdoor microphone can be positioned in the correct acoustical position while the cabinet is conveniently and securely mounted. It is easy to add new accessories, like a GPS unit or weather station, to the NMT even after the installation of the NMT on a wall or a pole, easing installation and configuration.

Fig. 2 *Permanent NMT mounted on a pole*

EMS Brüel & Kjær

MOBILE NOISE MONITORING

For continuous monitoring for periods of one week or more, mobile configurations (Fig. 3) are available as special orders enabling independent operation either with on-line communication to and from the central control software or completely off-line. Mobile NMTs are typically trailer mounted and, like permanent NMTs, offer remote system health monitoring capabilities including alarms, which reduce down-time by ensuring timely manual intervention. The full range of NMT peripherals and options, including power and communication accessories, are available with mobile configurations. Contact your local Brüel & Kjær representative for more information.

Fig. 3 *Example of mobile NMT, which offers months of independent operation*

PORTABLE NOISE MONITORING

Fig. 4 *Portable NMT on location*

Compact and lightweight hand-carry portable units (Fig. 4) for periods of a few hours to several days, with the possibility of mains power connection, are available. A light and robust case protects the same analyzer as used in the permanent or mobile configurations, ensuring the same high-quality system interface. The contents are protected by high-density machined foam inlays, from weather damage and unauthorised access.

The case also enables the provision of power, remote control capability and data retrieval for truly independent operation. Battery power for extended measurement durations is provided by two hot-swap Li-Ion batteries. Li-Ion batteries are renowned for their excellent charge retention and very high energy efficiency (5 times better power-to-weight ratio than traditional lead-acid batteries).

These lightweight batteries make the NMT compact and completely portable. For reliable long-life operation, the batteries have internal circuitry to protect against shorts and over discharge. Chargers for the batteries, included in the case, enable the system to be powered from the mains or from external DC power, ensuring a very flexible solution. The case's power panel directs power from the source with the highest voltage to supply the entire unit, thus enabling you to change power sources, including hot-swapping batteries without disturbance at any time during measurement as long as one power source is available. During measurements any cables exiting the case, such as the microphone extension cable and a mains power cable (if used), are strain-relieved inside the case and protected by a rain shield mounted on the lid.

For all configurations, noise monitoring and analysis is performed by the included analyzer protected inside the cabinet. The analyzer measures data coming from the outdoor microphone and logs it onto its removeable memory, including broadband and spectral Leqs or SPLs* with one or two frequency weightings, continuously at half- or one-second intervals. The NMT can also identify, record and analyse noise events. Analyses produced include:

- **Hourly reports:** Information each whole hour including Total Leq and statistical distribution. Total, Background and Noise Event Leq and Effective Perceived Noise Level (EPN) of all events according to ICAO Annex 16
- **Short reports:** Information during a period of time between 1 and 30 minutes, calculating minimum, maximum, Leq and five user-defined LN values. Short reports can include sound recordings†
- **Calibration Check reports:** Results of the Charge Injection Calibration or Actuator tests, which can be performed automatically four times a day
- **Noise events:** Information on noise events detected based on hourly varying trigger and duration values. For each event, SPL or Leq values, spectra, Perceived Noise Level (PNL), and Perceived Noise Level Tone Corrected (PNLT) values according to ICAO Annex 16, are stored at half- or one-second intervals. Sound recordings of events can also be stored
- **Instrument Health reports:** Information on the NMTs internal temperature, battery voltage, mains voltage and external voltage

Fig. 7 *View the results and status of the NMT remotely from a web browser*

Data can be streamed over LAN-based communication or via 3G, with a maximum deviation of two seconds from the NMT to the central control server with Brüel & Kjær noise management solutions. Once on the server, Brüel & Kjær's central control software client can access and analyse the data. In addition, the NMT's user interface can be viewed directly in a web browser allowing simple remote access to data and the status of the NMT from any PC.‡ The NMT can be upgraded through its software licensing to interface to third party software for noise monitoring with batch data transfer.

Alarms

Permanent NMTs have a number of alarms** that are triggered as soon as the related condition is detected so users can quickly respond to issues. Alarms cover:

- Door Open/ Close
- Mains Power Off/On
- Battery Low/OK
- Temperature High/OK
- Communications power off/on

* Two frequency weightings are not available with Types 3639-E and -G

† Sound recording quality, duration and level is user-defined. Recording low-quality files reduces the time and bandwidth required to download the files from the NMT, often reducing operating costs. High-quality files enable post-processing, for example, tone analysis to determine noise limit compliance based on rating levels, using Brüel & Kjær's PULSE Multi-analyzer system or other application.

‡ Currently not available for Types 3639-E and -G

** Not all alarms are available for Type 3655 portable noise monitoring units

ESTIMATED COST

The project estimate is $500,000.00 and the purchases will occur in FY21-FY25.

The estimated cost has been a budget estimate formed on the basis of previous monitoring programs and commencing initial enquiries with suitable. There is no preferred supplier for Noise Monitoring Equipment project and procurement will be via a competitive process that may include tender, in accordance with APA Procurement policy.

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

JUSTIFICATION

The Noise Monitoring Equipment project for "Directlink" is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (2) on the basis that the program will support future compliance with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission service

Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	**Testing Equipment**		
Project Type:	*Capex/Opex :*	Capex $0.8m	
Prepared:	*Kimberley Saunders*	*Project Manager*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset and Renewables Manager*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the years 2020 to 2025.

BACKGROUND

Testing Equipment projects seek to ensure systems and tools are operating and in alignment with future needs, that obsolescence is managed proactively, and that new testing capabilities available to High-Voltage Direct Current assets are accessible to Directlink.

IDENTIFICATION OF NEED

To ensure the original design life of a hardware item or software is reached, and subsequently it's value fully utilised, the ability to test key components of the converter at all times is critical. A series of three items have been identified, and are discussed as projects with subsequent background, investigation and recommendation as follows.

1. Thumper Unit (Thumper, Hi-Pot tester + Trailer)
2. Insulated gate bi-polar transistor (IGBT) Tester
3. Power Quality Metering

PROJECTS

1. Thumper Unit (Thumper, Hi-Pot tester + Trailer)

1.1 Background

The Hi-Pot and Thumper are equipment used to locate cable faults and test repairs on the Directlink cable. The existing Thumper unit at Directlink had located 170+ cable faults at the end of 2018. The Thumper Unit is showing signs of deterioration. The Hi-Pot unit is used to test the Directlink cable is ready for service, after a cable fault repair. For the purposes of this project, Hi-Pot and Thumper unit includes the trailer that transports the Hi-Pot and Thumper to faults.

1.2 Identification of Need

The tester is approaching the end of its life and needs to be replaced.
This equipment is critical in the identification of cable fault locations and improves the repair time to ensure downtime is limited. The current poor condition of the existing trailer has raised transport concerns and the testing equipment is producing discharge at 20kv, normal capacity should be 25kV. This equipment is necessary to maintain the reliable and safe operation of the Directlink cables by ensuring faults are repaired.

1.3 Evaluation of Alternatives

If nil action is taken and the existing thumper unit's condition deteriorates further and becomes unusable, Directlink Operations have no way of refining a fault location to perform a repair. This has a direct impact on extended system outage times. Due to the nature of equipment, a refurbishment ie replacing the unit in parts would be significant in cost. The Thumper in particular, having performed 170+ cable faults at the end of 2018, can not be refurbished.

1.4 Recommendation

The project proposes a new purchase of the Thumper, Hi-Pot tester and the transport trailer. The critical functions of the equipment and the poor condition identified justify a capital replacement. A new purchase will also offer technology improvements – currently data is collected via floppy disks and unable to be uploaded automatically, it is expected that the new purchase items will have automatic data dispatch capabilities.

1.5 Estimated Cost

The project estimate is $330,000.00 and the purchase will occur in FY21.

The estimated cost has been formed by requesting quotes from multiple suppliers of the three components. The project will be executed via a formal Request for Quote process available to the open market and assessed for best value, taking in to consideration both price and the suitability of products to Directlink specific requirements.

2. Insulated gate bi-polar transistor (IGBT) Tester

2.1 Background

The insulated-gate bipolar transistor (IGBT) is essentially a three-terminal power semiconductor device typically used as an electronic switch in a wide range of applications. There are several thousand IGBTs in service at any one time at Directlink. Directlink utilises ABB's Generation One IGBTs on 5 systems[1] (Mullumbimby System 1 was reconstructed using Generation three IGBTs following the fire). IGBTs switch power from AC/DC to DC. ABB, the exclusive sole source supplier for IGBTs at Directlink, supplies bespoke IGBT testers for Generation One IGBTs to test the proper operation of IGBTs before energising after maintenance. .

2.2 Identification of Need

A Generation One IGBT tester is essential to ensure the thousands of installed IGBTs are safe for energise after maintenance. Operating a converter station without proper testing of IGBTs risks significant consequential damage to a valve from arc flash or fire.

2.3 Evaluation of Alternatives

As the Insulated Gate Bi-Polar (IGBT) technology is exclusive to ABB, there are no market alternatives to testing equipment designed for Directlink IGBTs at this time. To take nil action and not purchase testing equipment, would be detrimental to the interim strategy of maximising all available IGBTs whilst a longer term solution is investigated*).*

2.4 Estimated Cost

The project estimate is $71,500.00 and the purchase will occur in FY21.

The estimate includes a budgetary quote from supplier ABB and allows for the purchase of x 1 unit.

3. Power Quality Metering

3.1 Background

Directlink must comply with power quality expectations, of its connection agreements and the NER. In the past power quality was monitored on a periodic basis. Predictable quality meant that periodic measurement was reasonable forecast for the future and power quality management could be undertaken in a gradual manner. Power quality metering with logging software will enable ongoing, real time power quality monitoring. When operational this will permit the analysis of power quality data to inform key stakeholder assessments of the power quality impact of Directlink.

3.2 Identification of Need

Widespread investment in Queensland and New South Wales solar and wind projects means that there is increased presence of power electronic inverter connected generation and an periodic assessment is no longer consistent with good industry practice or the NER requirements for Transmission Networks.

3.3 Evaluation of Alternatives

Power Quality Metering is not exclusive to a sole supplier and a short form tender process will have the framework to assess alternative options based on tailored solution packages (see 3.4 Recommendation). An alternative of nil action is not in accordance with industry best practice.

3.4 Recommendation

Power Quality will be achieved by investing in power quality metering equipment and software. Purchase of this equipment is necessary to maintain the quality of the prescribed transmission services. Directlink will assess the value and suitability of tailored packaged solutions for HVDC.

3.5 Estimated Cost

The project estimate is $330,000.00 and the purchase will occur in FY23 and FY24.

The estimated cost has been formed by requesting quotes from multiple suppliers. The project will be executed via a formal Request for Quote or Tender process available to the open market and assessed for best value, taking in to consideration both price and the suitability of products to Directlink specific requirements.

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The delivery of the projects has been scheduled as detailed in the Estimate sections above, occurring in FY21 and FY23-F24.

JUSTIFICATION

The Testing Equipment project for "Directlink" is required to meet the following capital and operating expenditure objectives set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) on the basis that addressing Testing Equipment is required to maintain the quality, reliability and security of supply of prescribed transmission services.

Reference Documents

Thumper Unit Supplier Quotes
ABB IGBT Tester proposal
Siemens HVDC Metering Solution

Sydney NSW 2000
PO Box R41
Royal Exchange NSW 1225

Australian Pipeline Ltd
ACN 091 344 704

Australian Pipeline Trust
ARSN 091 678 778

APT Investment Trust
ARSN 115 585 441

Business Case

Service Provider:	APA Group	**Date:**	January 2019
Asset:	Directlink		
Project:	**Stay in Business**		
Project Type:	*Capex/Opex :*	Capex *$0.8m*	
Prepared:	*Kimberley Saunders*	*Project Manager*	
Endorsed:	Noel Powell	*Reliability Engineer*	
Approved:	Stuart Dodds	*Asset and Renewables Manager*	

PURPOSE

To present a project recommendation and expenditure forecast for inclusion in the Directlink Regulatory Proposal for the years 2020 to 2025.

BACKGROUND

Stay in Business (SIB) projects are generally ad-hoc and discrete packages of work, with a low to medium cost associated as opposed to major projects. Essentially SIB is a group of projects that may be unrelated but have been identified as beneficial to business operation.

Over a determination period it is probable that stay in business projects arise that cannot be forecast. In response to this, the category requests an allowance for these items in the determination period. Notably, the budget requested is a decrease from prior determinations as Directlink has sought to identify specific Stay in Business items where possible at this time.

This category proposes ad-hoc projects or items of purchase in relation to:

1. The concreting of switchyard areas
2. The Motorisation and Relocation of Isolation switches
3. Improved Security Surveillance
4. Essential Tools and Equipment

PROJECTS

1. Concreting of Switchyard at Bungalora and Mullumbimby

1.1 Background

The PLC filter yard (switchyard) at Bungalora and Mullumbimby converter stations is fenced to maintain safe approach distances, with the high voltage equipment mounted on the ground and an insulating layer of rock. Weeds regularly grow through the rock and cannot be safely controlled without a complete outage of Directlink.

1.2 Identification of Need

The weeds can grow at a rapid pace and cause high voltage electrical discharge if allowed to get too tall.

1.3 Evaluation of Alternatives

Raising the switchyard equipment off the ground was considered as an alternative to allow maintenance of the weeds while the equipment is energised. This alternative has significant cost, operational impact, and increases the safety risk from working at heights during maintenance. An alternative of nil action will not improve the functionality of the switchyard and incur recurring costs and maintenance.

1.4 Recommendation

The concreting of the PLC filter yard at Bungalora and Mullumbimby will prevent weeds growth and decrease outage time for recurring maintenance.

1.5 Estimated Cost

The project estimate is $30,000.00 and will occur in FY21.

The budget requested is a preliminary estimate based on discussions with local suppliers. The project will be formally quoted in February 2019 and an updated estimate presented in the final submission.

2. Motorisation of Directlink AC Isolators including MACH Integration and Relocation

2.1 Background

Currently the AC Disconnectors and earth switches at Bungalora and Mullumbimby are manually operated.

2.2 Identification of Need

Motorising the AC disconnectors and earth switches would engineer out the arc flash risk to switching operators enabling switching actions to be conducted in all weather conditions. It also means that a system could be isolated and earthed remotely via the control room removing the need to have switching operators on site for those actions.

2.3 Evaluation of Alternatives

ABB is the supplier of the Control System including Mach 3 technology and there would be cost and schedule implications of having another supplier complete the motorisation project that will integrate with the existing control system.

2.4 Recommendation

- The project recommendation ensures we are abstracting maximum value from the control system upgrade by integrating the key components in switching. To align with good engineering and operations practice, it is appropriate to move to the motorisation of isolation and earthing switches. The scope will include:
- Disconnection & removal of old hand drive mechanism
- Design, Supply & Installation of SM800 Units for all six Directlink Converter Stations
- Integration into MACH Control System
    - Modification to HMI
    - Control System Updates
    - Additional IO (Hardware and terminals)
    - Cabling & Materials

1.5 Estimated Cost

The project estimate is $500,000.00 and will occur in FY22.

The budget requested includes a formal budgetary quote provided by ABB ($360) and an allowance ($140) for the relocation scope of work which will be open to market. The budget includes Directlink costs associated and project management.

3. Improved Security Surveillance

3.1 Background

The security at Directlink substations is paramount in protection of the asset and, and most importantly a protection of personnel. Any interference with a High-Voltage Direct Current asset, including the substations, is a significant risk to the business. Directlink seeks to increase surveillance to address this risk. In addition, having further transparency on our internal equipment will support our maintenance program. Following recent break-ins, including at Bungalora substation in 2018 where property was stolen, it is apparent that increased camera surveillance would be appropriate.

3.2 Identification of Need

Bungalora and Mullimbimby substations are High Voltage Direct Current converter stations suitable for the entry of inducted, trained and appropriately qualified personnel. Whilst the equipment with high risk from interference is generally protected, there is a real possibility of harm from trespassers accessing the station. In addition to safety risk, Directlink have experienced property loss from past break-ins with subsequent operations time impacted by investigating the break-in with limited surveillance data.

3.3 Evaluation of Alternatives

Physical entry barriers are being constructed in FY19 to help reduce break-ins and unwanted entry however it is difficult to stop determined tresspassers/thieves using barriers alone.
From time to time Directlink will engage security guard contractor supervision for a specific project. Directlink takes the view that full-time security guard supervision at the Bungalora and Mullimbimby converter stations would be too expensive.

3.4 Recommendation

In increasing Directlink's security surveillance with the purchase of additional cameras, there are multiple benefits to the business, security of supply and to the community. These items of purchase increase safety measures whilst providing a general maintenance initiative through the monitoring of equipment inside the station. Increased surveillance supports the objective of Directlink being a sufficiently secured and protected asset.

1.5 Estimated Cost

The project estimate is $22,000.00 and will occur in FY22.

The budget requested includes a budget quotes provided by security camera suppliers and is purchase cost based.

4. Essential Equipment and Tooling

4.1 Background

Directlink personnel perform a series of rectification and maintenance duties on both the High-Voltage Direct Current (HVDC) cable and the converter stations on a daily basis to ensure the optimum performance capability is achieved at all times. These activities, including cable fault repairs, require tools specific to HVDC operations and maintenance. Periodically our essential tools and equipment require replacing due to age, an item requiring repair, or a new technology coming to market.

4.2 Identification of Need (per item)

Please refer to Table 4.2.1 Essential Equipment and Tooling provided below, which identifies a Background, Recommendation and Estimate per item. The items have been tabled due to the specific multiple purchase items within the project.

4.3 Evaluation of Alternatives

All items identified in Essential Equipment and Tooling are able to be purchased from multiple suppliers. The items are stock standard purchases unless a customisation is notified in Table 4.2.1 . A competitive request for quote process is suitable for these purchases and will be conducted by Directlink in accordance with APA Procurement policy. Nil Action as an alternative option in relation to Essential Equipment and Tooling would be in appropriate in that it is definite the need for these items will be

required and that the nature of these items do incur aging and infrequent breakage or loss.

Table 4.2.1 Essential Equipment and Tooling

IDENTIFICATION OF NEED (per item)	RECOMMENDATION (per item)	ESTIMATE
Directlink Operations Trailer The current Directlink Operations trailer is 20 years of age. It frequently travels between Bungalora and Mullimbimby stations. The trailer is aging and having issues, and is no longer reliable.	Renewing of existing essential equipment by replacement. The Directlink Operations trailer is an essential vehicle, storing and transporting fault repair equipment and tools and signage, safety barricading, items for repair on a daily basis. Directlink operates with 1 operations trailer – this is sufficient only on the basis that the trailer is reliable.	$26 FY21
Cable Handling Equipment (Stands, Winches) Stands hold the cable in place for the cable cutting process. This is important for safety, as well as efficient use of spare cable as cable cutting can be more accurate in specific length required for the activity.	Renewing of existing essential equipment by replacement. Stands are an existing item used however with their high use and constant revision of models on offer to the market, it is appropriate to have allowance to purchase new stands. For Directlink to respond to a cable fault in a timely manner and mitigate downtime associated with a repair, operations must have access to cable handling equipment including stands and winches.	$3 FY21
HV Cable Cutter/Earthing Spike The cutting of cable is a frequent requirement in Directlink's operations. Tools that can improve the manual handling and labour associatted with the cutting process should be considered periodically for what has come available to market, it's suitability and benefits included improved safety measures.	Renewing of existing essential equipment by replacement. A Hydraulic Drive Unit offered by companies such as The Energy Network (TEN) is a mobile and battery operated versatile tool with attachments available for cable cutting and general handling. This item allows for the purchase of a Hydraulic Drive Unit with customised additional cable cutting attachments.	$14 FY21

Cable Repair Tents Renewing of existing essential equipment by replacement. Repair tents provide protection to the cable fault repair process with shade and shelter for personnel and the cable itself. The tent also creates an isolated work space from the community.	Renewing of existing essential equipment by replacement. For Directlink to perform cable faults in a safe manner and protect the open trench from external factors including weather events, repair tents are required. This item allows for the purchase of stock standard Gazebo tents (frame + sides) from suppliers such as Boat Camping and Fishing.	$3 FY21
SF6 Handling Gear Sulfur hexafluoride (SF6), is a heavy, inert, nontoxic and incombustible gas. Its main uses are as an insulation medium in electrical transmittance systems and electrical distributing devices, making an inert cover, or simply for displacing the gas mixtures in metals smelting. The contacts of the breaker are opened in a high-pressure flow of sulphur hexafluoride gas, and an arc is struck between them. ... Sulfur hexafluoride is generally used in high-voltage circuit breakers and is used at Directlink.	Renewing of existing equipment and additional purchase. SF6 requires specific handling gear for the safe use of the gas. In addition, the properties of SF6 gas can cause leak detection delays and issues in identifying leak location and cause. A signficant leak has the potentail to cause a fault and subsequent outage. This item allows for the purchase of a SF6 handling kit and allowance for a leak detection device.	$24 FY21
Essential Tools Renewing of existing equipment or new purchases of new equipment available to HVDC market.	Renewing of existing equipment and additional purchases on an ad-hoc basis.	$61 FY21

4.5 Estimated Cost

The project estimate is $243,000.00 and the purchases will occur in FY21.

A competitive request for quote process is suitable for these purchases and will be conducted by Directlink in accordance with APA Procurement policy.

The estimated costs for the recommendations detailed have been included in the capital expenditure forecasts for the Directlink Regulatory submissions

PLAN FOR EFFECTIVE EXECUTION

The requirement for AER acceptance of capital and operating expenditure specified in 6A.6.7(c) and 6A.6.6(c) of the National Electricity Rules is that the expenditure must be such as would be incurred by a prudent service provider acting efficiently, and represent a realistic expectation of the costs to achieve the requirement.

The delivery of the projects has been scheduled as detailed in the Estimate sections above, occurring in FY21 and FY23-F24.

JUSTIFICATION

The Stay in Business project for “Directlink” is required to meet the following capital and operating expenditure objectives, in particular, set out in clause 6A.6.7(a) and 6A.6.6(a) of the National Electricity Rules (the Rules):

(1) meet the expected demand for prescribed transmission services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

(3) maintain the quality, reliability and security of supply of prescribed transmission services; and

(4) maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The project is justified under clauses (3) on the basis that addressing Stay in Business is required to maintain the quality, reliability and security of supply of prescribed transmission services

Reference Documents

Record of Enquiries with local concrete suppliers
ABB Budgetary Quote Motorisation project
ABB Technical Scope Motorisation project
Supplier Quotes Security Camera Surveillance