Directlink Transmission Annual Planning Report 2024

Contents

1. Introduction **5**
1.1. Purpose of this Transmission Annual Planning Report 5
1.3. APA Group and Related Entities 6
1.4. Registration Status and NER Obligations 7
2. EII's Transmission Assets **7**
2.1. VSC HVDC Technology 8
2.1.1. Summary of VSC HVDC Technology and Capabilities 8
2.1.2. HVDC vs. AC Transmission Interconnection 8
2.2. Directlink 10
3. Directlink Utilisation **10**
4. The Changing Energy Landscape **11**
4.1. Role of the Directlink Interconnector 12
5. Looking After Our Assets **13**
6. Asset Availability and Reliability **14**
7. Completed Projects **17**
7.1. Major Completed Projects over 2020-24 Regulatory Period 17
7.1.1. Directlink Control and Protection Replacement 17
7.1.2. Fibre Optic Cable Refurbishment 17
7.1.3. Zero Sequence Reactor 17
7.1.4. Cooling Tower Sound Enclosure Panel Replacement 17
7.1.5. Refurbishment/Replacement 18
7.2. Other Minor Completed Projects 17
8. Committed Projects **18**
8.1. Major Committed Projects 18
8.1.1. Directlink Valve Replacement 19
8.1.2. Directlink DC Cable Reliability Improvement 19
8.1.3. Fire System Upgrades 20
8.1.4. SCADA Hardware Lifecycle Management 19
8.2. Other Minor Committed Projects 21
9. Proposed Projects **21**
9.1. Reliability Improvement and Lifecycle Replacement Works 21
9.1.1. IGBT Water Cooling System Midlife Refurbishment 22

9.1.2. Cable Tray Install and Cable Relocation 22
9.1.3. Directlink Circuit Breaker Replacement 22
9.1.4. Cooling Tower Fans 23
9.1.5. Cooling Tower Sound Enclosure and Roofing Corrosion Management 23
9.1.6. DC Disconnector Replacement 23
9.1.7. Physical Site Security and Public Protection 24
9.1.8. Reactor Cooling Enhancements 24
9.1.9. PLC Capacitors 25
9.1.10. Spares Management 25
9.1.11. HVDC Spare Cable Management 25
9.2. Other Proposed Projects 25
References 23
Appendix A – Abbreviations and Definitions 24

Executive Summary

Energy Infrastructure Investments (EII) owns and operates the Directlink transmission asset. Directlink Transmission Company Pty Ltd is wholly owned by EII and is a registered Transmission Network Service Provider (TNSP) in the National Electricity Market (NEM) as prescribed by the National Electricity Rules (NER). EII has prepared this Transmission Annual Planning Report (TAPR) in accordance with the requirements of section 5.12 of the NER.

The TAPR provides some key information on the Directlink transmission asset, which is a high voltage direct current (HVDC) system serving the purpose of interconnection of the Queensland and New South Wales regional electricity transmission systems. The asset consists of two converter stations located remotely from each other which are interconnected by six HVDC cables.

This report also discusses the factors relating to the capability of the asset to provide a reliable service that facilitates electrical interconnection between QLD and NSW. A summary of projects is presented which aim to maintain the quality, reliability or security of supply in line with the EII Asset Management Plan and NER requirements.

This report is written with consideration of the Australian Energy Market Operator's Integrated System Plan (ISP) published in June 2024. The ISP forecasts an increase in the connection of new renewable generation as the reliance on the fossil-fuelled power is scaled down which in turn requires development of the transmission and distribution infrastructure as well as efficient utilisation of the existing assets, which includes the Directlink interconnector.

1. Introduction

1.1. Purpose of this Transmission Annual Planning Report

This Transmission Annual Planning Report (TAPR) is prepared as in accordance with the requirements of the National Electricity Rules (NER). Given the nature of the assets and the absence of any directly connected customers, this report covers those aspects of the prescribed TAPR content required by the NER[1] where specific comment is possible.

Specifically, the following content of the NER section 5.12 is not applicable to Directlink:

- Clause 5.12.2 (c)(1) – information pertaining to the review and analysis of load forecasts; and
- Clause 5.12.2 (c)(2) – information pertaining to planning proposals for future customer or generator connection points.

The purpose of this report is to present key factors impacting the Directlink high voltage direct current (HVDC) transmission asset and define a level of asset capital investment considered by EII for the next 10-year period. In turn, this report looks to identify the need and opportunity for improvements in efficiency, reliability, general functionality and potential capacity expansion of these assets in order to efficiently deliver the required services.

This TAPR also seeks to provide broader stakeholders with an overview of the planning processes and decision making on future capital investment applied to these assets. The aim is to provide information that helps stakeholders to understand Directlink's capability to transfer bulk electrical power and contribute to the future development of the transmission network.

1.2. Disclaimer

This TAPR is developed and made available entirely for information purposes. The information in this document reflects the forecasts, proposals and opinions adopted by EII and its subsidiaries as at the date of this report other than where otherwise specifically stated and may change at any time. At any date, the reader should independently obtain the latest forecasts, proposals and opinions for their use.

Any information in this document that has been obtained from the Australian Energy Market Operator (AEMO), other Network Service Providers (NSPs) and other relevant sources has been adopted in good faith without further investigation or verification.

In all cases, anyone proposing to rely on or use the information in this document should:

[1] NER Clause 5.12 – Transmission Annual Planning Process

- Seek to independently validate the accuracy, completeness, and suitability of the information pertained within;
- Seek to independently validate the accuracy, completeness and suitability of the reports and source information used by EII for the development of this document; and
- Obtain independent and specific advice from appropriate experts or other sources.

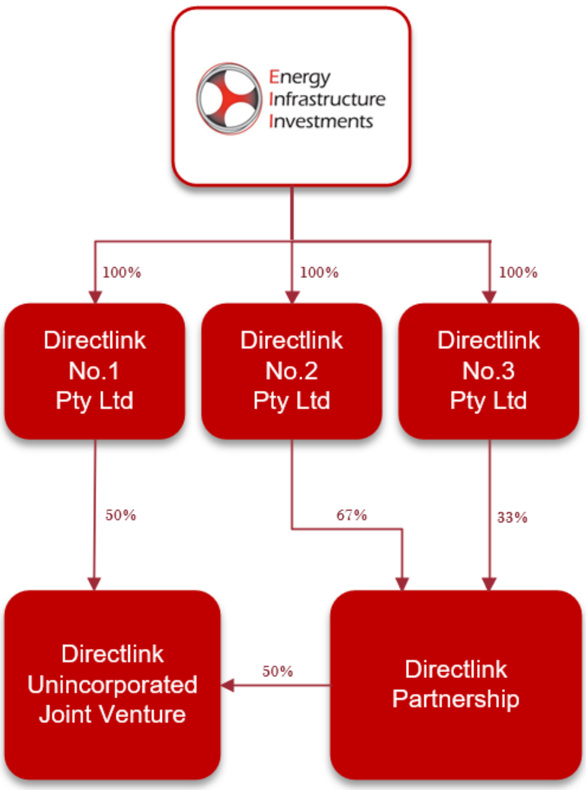
While care is taken in the preparation of the information presented in this report, EII accepts no responsibility or liability for any loss or damage that may be incurred by persons acting in reliance on this information or assumptions drawn from it.

1.3. APA Group and Related Entities

EII is an energy infrastructure investment company that owns and operates the Directlink transmission asset. The asset is maintained and operated by APA Group under a Management, Operations, Maintenance and Commercial Services Agreement (MOMSCA). The Directlink transmission asset provides transmission services to the NEM as prescribed by the NER.

The overview of ownership and management structure of the Directlink interconnector is shown in Figure 1.

Figure 1: Directlink Ownership and Management Structure



1.4. Registration Status and NER Obligations

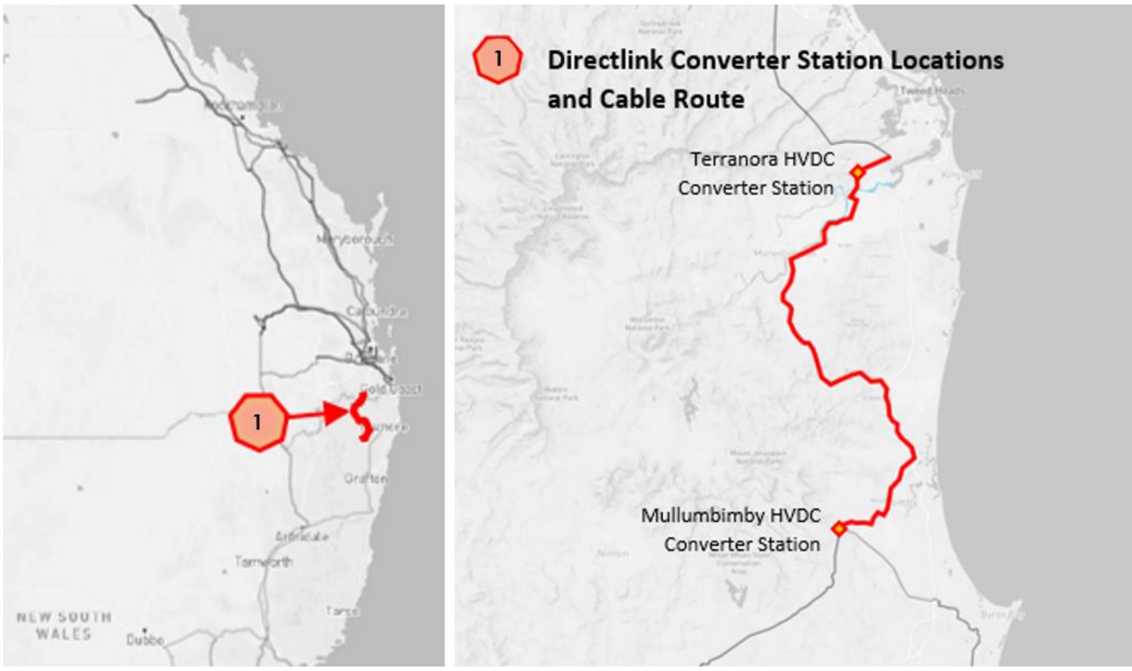
The Directlink proprietary limited company shown in Figure 1 is wholly owned by EII and is a registered Transmission Network Service Provider (TNSP).

The NER sets out the required processes for developing networks as well as minimum performance requirements of the network, which subjects the interconnector to the application of the Australian Energy Regulator's (AER's) Regulatory Investment Test for Transmission (RIT-T) where required.

2. EII's Transmission Assets

The Directlink transmission asset is a HVDC facility owned by EII, which serves the purpose of connecting regional electricity transmission systems. The asset consists of two HVDC converter stations (which convert electrical power between AC and DC) located remotely from each other and are connected by a HVDC cable system. The approximate Directlink converter station locations and cable routes are shown in Figure 2.

Figure 2: Directlink Cable Routes and Converter Station Locations [1]



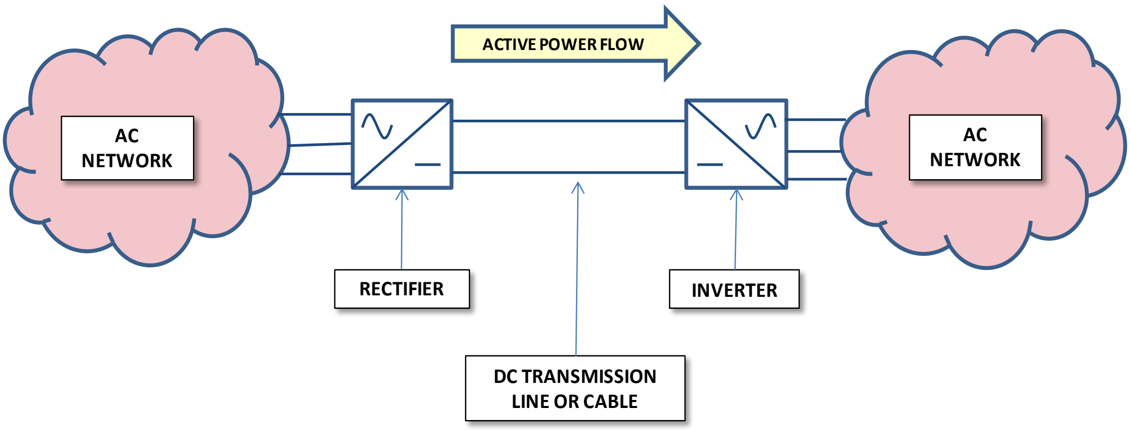
Directlink was commissioned in the year 2000 and connects the regional electricity markets of New South Wales (NSW) and Queensland (QLD) in Australia. Directlink was Australia's first HVDC interconnector. Directlink utilises voltage source converter (VSC) HVDC technology.

2.1. VSC HVDC Technology

2.1.1. Summary of VSC HVDC Technology and Capabilities

At the most basic level, HVDC power transmission is the point-to-point transmission of power by first converting it from AC to DC at the rectifier converter station, transmitting in DC to the inverter converter station and then converting back to AC at the inverter converter station. This is represented in Figure 3. The HVDC converter stations can operate in either rectifier or inverter mode depending on the direction of power dispatch.

Figure 3 - HVDC Power Transmission - Basic Representation



VSC HVDC technology uses the switching of insulated gate bipolar transistors (IGBTs) to develop an AC voltage waveform of sufficient amplitude and phase angle difference to cause both active power and reactive power to flow in either direction. The same IGBTs are used to create a DC voltage to allow active power to flow to or from the other converter. Consequently, VSC systems are capable of bi-directional, independent real and reactive power transfer. At each converter station, active and reactive power can be controlled independently within defined power limits. Reactive power at each end can be controlled independent of the converter at the other end.

VSC technology can connect to relatively weak[2] networks. VSC converters have no requirement to absorb reactive power and the filtering requirements are minimal, considerably reducing footprint area compared to other HVDC technologies. VSC technology can also provide other benefits at the connection point, including AC voltage control or frequency control where specified.

2.1.2. HVDC vs. AC Transmission Interconnection

There are pros and cons with the use of either AC or VSC HVDC technology for high power transmission interconnection. Table 1 provides a high-level comparison of AC and HVDC technologies for the purpose of transmission interconnection.

[2] System strength is an inherent characteristic of a power system, which is a measure of stability of a system under all reasonably possible operating conditions.

Table 1 – Comparison of AC and VSC HVDC Technology for Power Transmission Interconnection

Parameter	AC	VSC HVDC
Controllability	N/A	High
Losses – substation/converters	Lower	Higher
Losses – lines/cables	Higher	Lower
Voltage support capability	N/A	Available where specified
Frequency control capability	Yes, through synchronisation. Can only connect networks of same frequency.	Available where specified. Can connect networks with different frequency.
Damping control capability	N/A	Available where specified
Overhead line	Larger conductors, more conductors, larger towers	Smaller conductors, fewer conductors, smaller towers
Underground cable capability	More and larger cables, distance limited by cable capacitance.	No practical limit on distance, fewer and smaller cables.
Transfer of issues of one region to next	Managed via dispatch and external special protection schemes.	Controllable and inherently flexible.
Tap off points along route	Unlimited, low cost	Limited to a few and preferably known in advance, high cost
Substation/converter station footprint	Smaller	Larger
Easement width for overhead lines	Larger	Smaller
Visual amenity of overhead lines	Greater	Lesser
Contribution to short circuit current	High	Low

VSC HVDC transmission has a number of technical advantages over AC transmission, including controllability of active and reactive power, lower losses on the transmission lines, voltage support and damping control capability. Conversely, AC transmission will have lower losses in the terminals (substations). For the same power transfer level, VSC HVDC transmission will be superior in terms of environmental impact and aesthetics – where underground cables are more viable, overhead towers are smaller, easement requirements are lesser and fewer conductors per bundle in the DC transmission lines may be achievable.

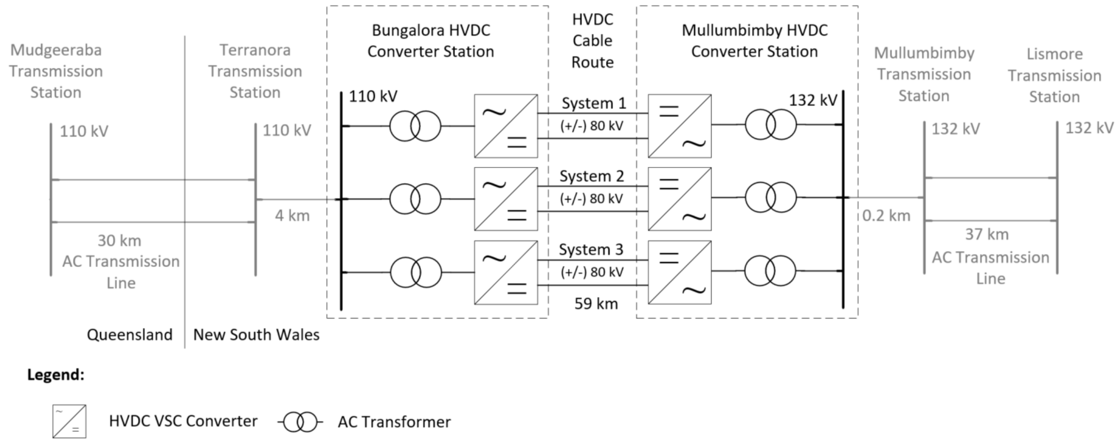
2.2. Directlink

Directlink is a 59 km high voltage DC transmission system in New South Wales between Bungalora and Mullumbimby. Directlink transfers up to 180MW of power, between the Queensland (QLD) and New South Wales (NSW) transmission networks.

Directlink consists of three independent DC transmission lines each consisting of a pair of high voltage DC cables, buried in some areas and in others installed in steel troughs. Each cable pair is connected to a single converter station at both Bungalora and Mullumbimby. The converter stations interface to the existing high voltage, AC transmission systems via relatively short lengths of underground, high voltage AC cable at Bungalora (110kV) and overhead high voltage AC cable at Mullumbimby (132kV).

A simplified single line diagram for Directlink is shown in Figure 4.

Figure 4: Directlink Simplified Single Line Diagram



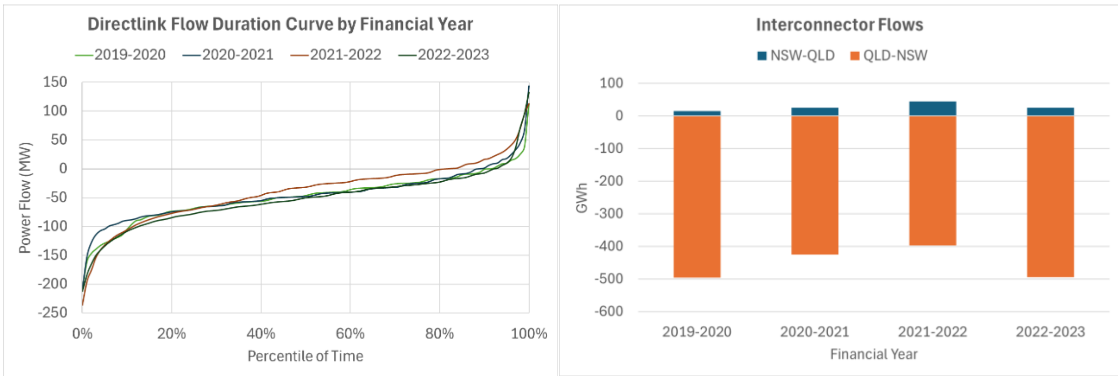
The Australian Energy Market Operator (AEMO) determines the power transfer as a part of their central dispatch process.

3. Directlink Utilisation

The demand for Directlink's services arises from the need for energy to be supplied to customers in the North Coast NSW area as well as supporting dispatch between the QLD and NSW regions through the Directlink interconnector.

The historic flows across the interconnector are presented in Figure 5, which shows that the flows are predominantly southerly (i.e. from QLD to NSW) for approximately 80-90% of the time.

Figure 5: Directlink Historic Utilisation



Approximately 520 GWh of electricity flowed across the Directlink transmission asset during the 2022/23 financial year. This is an increase from the 2019/20 financial year, which saw an overall transfer of approximately 511 GWh.

Electricity flows across the interconnector are driven by price variation between regions or to address network constraints.

4. The Changing Energy Landscape

In June 2024, AEMO published an Integrated System Plan (ISP) [2] which forecasts changes to the power system as a result of retiring thermal generation and an increase in connection of renewable energy generation and energy storage.

To further understand changes to the electricity transmission system, Directlink has engaged in planning discussions that also considered emergency control and protection system design with AEMO, TransGrid and Essential Energy over the preceding year. No material outcomes have resulted from these discussions.

Further need for investment in the transmission network is anticipated to support the development and connection of the projected portfolio of geographically dispersed renewable generation. The ISP has identified that increasing the interconnection of the grid will provide various benefits including flexibility and security as well as being able to take full advantage of the new and existing generation throughout the NEM.

Interconnectors provide a range of benefits, in particular:

- Enabling the lowest cost generation in the NEM to reach more consumers;
- Mitigating the risk of supply shortfall through imports from other regions;
- Sharing system stability support services, such as frequency and voltage control; and
- Improving system resilience to high impact, low probability events (such as interconnector failures) through a more interconnected NEM.

— Directlink's asset management process does not forecast any new asset de-ratings, constraints or inability to meet network performance requirements over the next 5-years.

4.1. Role of the Directlink Interconnector

Directlink's primary role in the National Electricity Market is that it enables the transfer of electricity between Queensland and New South Wales. Additionally, the characteristics of Directlink being an HVDC interconnector, means that it provides greater flexibility in operation than traditional AC systems.

"Based on our studies for the Draft 2024 ISP, we have observed ongoing value in maintaining the Directlink interconnector, including:

- ***Resource firming** – As the proportion of variable renewable energy (VRE) increases across the NEM, Directlink will play a role in sharing firm generation and surplus resources between regions. Throughout the duration of our modelling horizon to 2050, including following a potential major upgrade to the Queensland to New South Wales interconnector (QNI), we project that the full capacity of Directlink will generally be utilised in every year*
- ***Supporting peak demand** – At times of peak demand, our modelling shows that Directlink improves the capability to deliver a reliable supply of electricity to consumers. This role is particularly clear during periods of high demand, low VRE, network outages or generator outages, and continues following a potential QNI upgrade. Without Directlink, additional capital investment (e.g. battery storage) may be required to meet the NEM reliability standard.*
- ***Network controllability** – The dispatchability of Directlink is projected to improve network utilisation and reduce congestion by actively controlling flows parallel to QNI. Directlink can actively follow a precise dispatch target, which helps to balance flows on the network between Queensland and New South Wales.*
- ***Outage management** – During both planned and unplanned outages of other assets in this area of the NEM, Directlink improves the capability of the grid to provide consumers with reliable and secure electricity supply. Importantly, the presence of Directlink is expected to increase the duration of outage windows that are critically needed to maintain the surrounding network.*
- ***Voltage management** – The reactive plant at both ends of Directlink improve voltage management at Mullumbimby and Terranora. This improves the resilience of the grid in these areas.*

Importantly, our studies have found that QNI and Directlink will be able to simultaneously import or export near their combined maximum transfer levels during some conditions. Amongst other factors, the actual dispatch of Directlink and QNI will be optimised in combination with bids from local generation and storage."

5. Looking After Our Assets

EII has an Asset Management Plan (AMP) that identifies the actions required for optimal management of its assets. A long-term consideration of the integrity of assets is necessary to ensure that they continue to provide the required services.

The purpose of the AMP is to:

- Provide a comprehensive understanding of the current management approach relating to the asset, its condition and utilisation;
- Identify strategic recommendations for future utilisation;
- Provide a platform for approval of work programs; and
- Identify specific issues affecting the assets and the proposed remediation for budget consideration.

The objective of the AMP is to ensure that a strong focus on safety and reliability is maintained in relation to the operation and management of Directlink. In developing the operating and maintenance procedures incorporated within the AMP, APA Operations EII Pty Limited (as Operator) has considered the approved policies and procedures of APA Group.

Suitable safety management systems are in place and operating to ensure that the risks relating to the operation of all EII assets are effectively managed to keep risks as low as reasonably possible. The APA Group HSE management system is called 'Safeguard' and provides a framework by which the processes relating to EII's HSE activities are written, approved, issued, communicated, implemented and controlled. Additionally, the management system is also subject to review and improvement to ensure objectives and obligations are continually satisfied.

The Operators' management systems are subject to review and improvement to ensure objectives and obligations are continually satisfied. The AMP is reviewed each year to ensure that the content is current.

The AMP describes the applied asset management processes, which requires the asset maintenance history, condition and service performance of each component to be monitored.

Functionally, the equipment at Directlink can be divided into two groups:

- Main circuit equipment – These include power transformers, phase reactors, IGBTs, filtering equipment and underground cables. These have a standard design life of 40 years or more with some of these now beyond the midpoint of their useful service lives; and
- Ancillary equipment – Equipment necessary for the operation of the converters, notably uninterruptable power supplies, building ventilation, air conditioning, cooling water pumping and treatment systems and control and protection systems. The ancillary equipment generally have shorter service lives (between

15 and 25 years) with elements of the equipment currently at various stages in their service life.

The principal challenges associated with the interconnector relate to maintaining the electrical installation, with its many components, to meet high reliability and availability standards. Even so, components need to be replaced or refurbished when:

- The service performance of the equipment deteriorates, to the point where it jeopardises the reliability and availability performance of the link;
- Maintenance costs escalate, to the point where it becomes economic to replace or refurbish the equipment; or
- Equipment associated with auxiliary systems become obsolete, with the potential to jeopardise the availability performance of the link due to unavailability of spare parts.

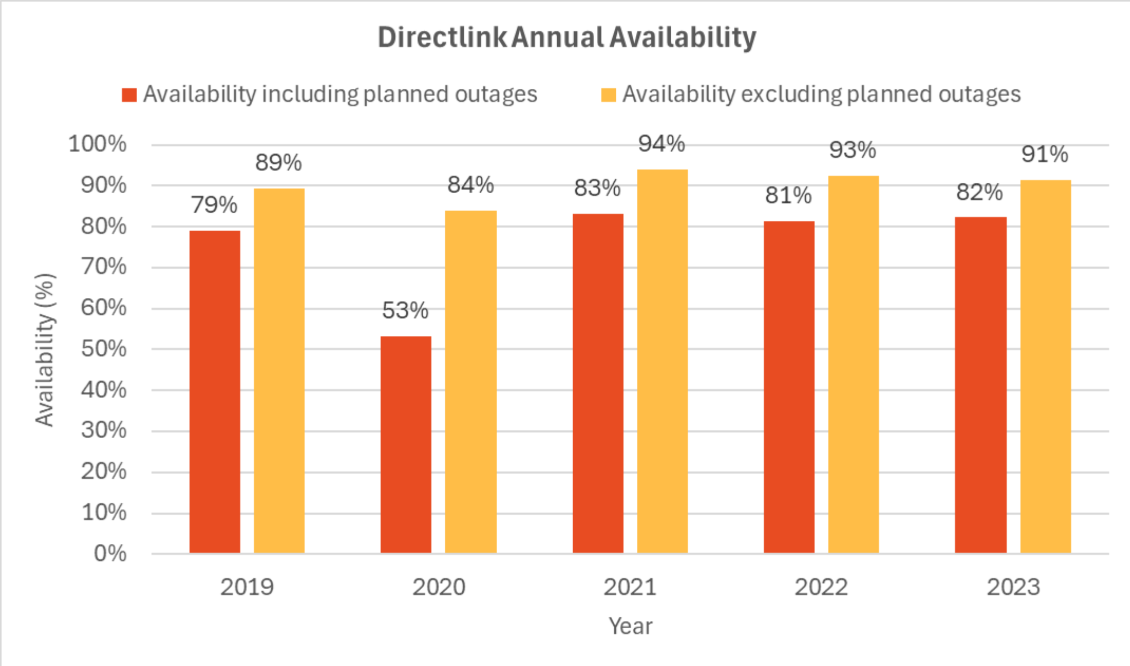
Some of the equipment will require refurbishment or replacement during the 2025-2030 [4] regulatory period. Section 8 and 9 or this TAPR provides a summary of the projects that are either underway or have been proposed.

6. Asset Availability and Reliability

This section provides a high-level summary of Directlink's availability based on historic data over the last five-year period of operation. This data is used by EII to review the asset performance and for the development of strategies for maintenance or improvement of the interconnector in accordance with the EII AMP.

Directlink is now in its 24th year of operation. The asset has displayed an annual average of 89.9% circuit availability over the last five-year period excluding planned outages and approximately 75.5% with the planned outages included, as shown in Figure 6.

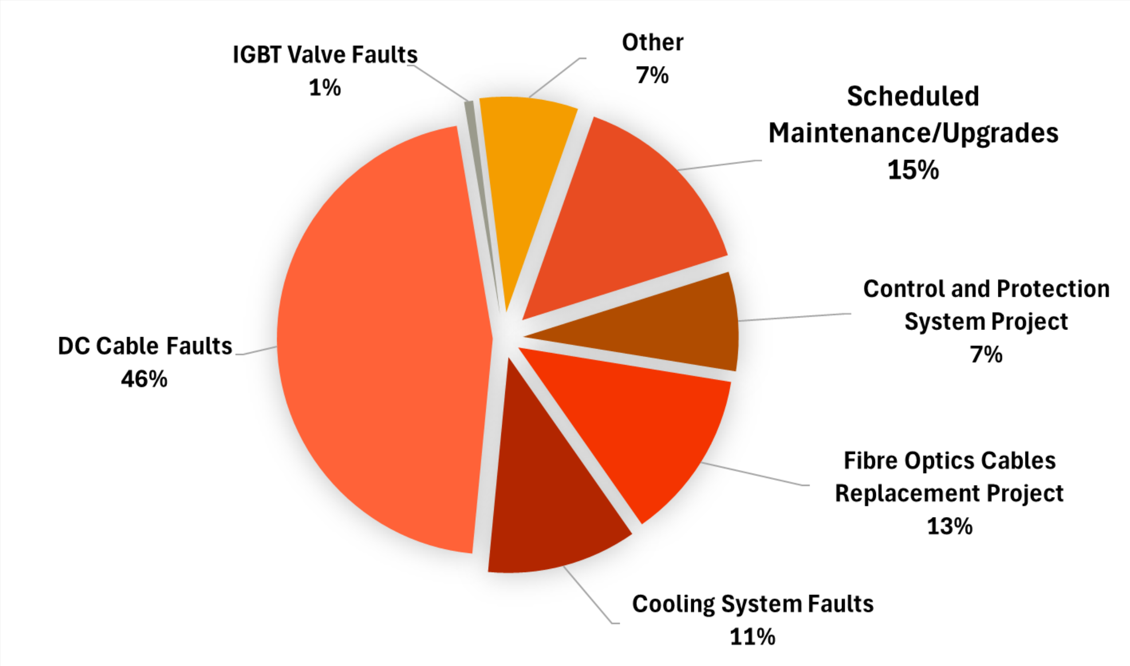
Figure 6 – Directlink Annual Availability



Historically, Directlink's availability has been significantly below international benchmarks for HVDC cable systems. Activities and improvements undertaken by EII since 2015 has seen the overall availability rise each year to just below 80% in 2019. In the following years leading up to 2024, Directlink has marginally exceeded these availability figures with the exception of year 2020. In this year, Directlink experienced significant outage durations due to DC cable and cooling system faults as well as executing a fibre optic cable replacement project. These three drivers accounted for approximately 90% of the overall outages in 2020.

The major causes of outages, in terms of overall outage hours of all systems over the five-year period since 2019 to 2023, are shown in Figure 7.

Figure 7: Directlink Major Outage Cause Breakdown 2019-2023



The majority of non-scheduled outage causes have already been addressed since 2019 due to reliability improvement projects having been implemented or are currently underway. As can be seen in Figure 7, DC cable faults have accounted for almost half of the outage durations. A major cause of the cable faults in recent history has been determined to be due to the heating of the cable at the cable transition points, where the cables pass between the underground sections and the above ground cable steel tray installations. A solution has been developed to address this issue and is in the early stages of being implemented across the asset which aims to reduce this failure rate for the 2025-30 regulatory control period.

Further possibilities for improvement of availability of Directlink have been identified, as either corrective or preventative measures, and are detailed in Section 8 of this TAPR.

While the main circuit equipment has a long-life span, ancillary equipment necessary for Directlink operation have shorter life spans. Some of this equipment is currently or will be undergoing replacement or refurbishment during the 2025-30 regulatory control period in order to make sure that the link remains in a reliable state of operation as detailed in the EII Asset Management Plan. A number of projects that aim at supporting the availability and reliability of Directlink are presented in Sections 8 and 9 of this TAPR across various categories including asset monitoring, major maintenance, safety and protection and spares management.

7. Completed Projects

This section presents the major projects recently completed for the Directlink HVDC interconnector.

7.1. Major Completed Projects over 2020-24 Regulatory Period

7.1.1. Directlink Control and Protection Replacement

The Directlink control and protection system was designed and manufactured in 1999 and some of the control system hardware utilised (processors, electronic chipsets, circuit boards) would have become obsolete circa year 2020. Due to the unavailability of hardware spare parts and manufacturer support for the hardware and software, a replacement of these systems and equipment was carried out.

The project activities started in early 2018 which included the replacement of the main control computer, control cards and operator Human Machine Interfaces (HMI), as the hardware and software reached the end of its serviceable life cycle. The replacement of the obsolete hardware and software is expected to extend the serviceable life of these components by a further 20 years from when it was commissioned in FY2019/2020 with a capital expenditure of approximately $14m.

7.1.2. Fibre Optic Cable Refurbishment

Fibre optic cables are installed within the IGBT valves to communicate information from the valve control unit (VCU) to each IGBT. A gradual deterioration over time in the performance of these fibre optic cables was identified which has had an impact on the availability of Directlink. A program of work was carried out to replace the fibre optic cables with new cables.

7.2. Other Minor Completed Projects

In order to keep the Directlink interconnector operating in a reliable and secure state, a number of minor projects were also carried out, which are listed below:

- Zero Sequencer Reactor
- Cooling Tower Sound Enclosure Panel Replacement
- Procurement of cable testing and other specialised testing equipment
- Power supply upgrade.
- Refurbishments and replacement of ancillary equipment
- IGBT cooling pipework repairs.
- UPS system upgrade.
- Converter station facilities improvements.
- Cable transition modifications, cable protection and cable tray installation and relocation works.

- Oxygen deficiency monitors.
- Industrial computer control system upgrade.
- Arc flash study and mitigation.
- Satellite and microwave link upgrade.
- Replacement of various equipment and procurement of spares (capacitors, fibre optic cables, etc.).
- Other various minor expenditures, such as IT upgrades, office supplies and studies/investigation works.
- Procurement of spare ACDC capacitors.

8. Committed Projects

This section presents the major projects which are currently underway for the Directlink asset.

8.1. Major Committed Projects

8.1.1. IGBT Generation 3 Upgrade

Directlink utilises the first generation of ABB's (now Hitachi's) IGBT "valves" on five of the six converters that make up the facility (Mullumbimby System 1 was reconstructed using "generation three" IGBTs following a re-build in 2015).

In October 2018 Hitachi, the original equipment manufacturer (OEM), notified EII that due to the cessation of the manufacture and supply of crucial components it is unable to continue support for these first generation IGBTs units and will no longer be producing them. This means that the only available spare IGBT units (referred to as "positions") are those currently held by EII. IGBT positions can fail and when this happens, they need to be replaced to continue operation of the converter. With the short supply of spare IGBT positions, the Directlink systems will eventually be unable to operate.

The IGBT positions can be replaced with newer, later generation positions. The overall functionality of the IGBT valves will remain the same, however VCUs will need to also be replaced to be compatible.

On the basis of discussions with Hitachi and the analysis conducted, the proposal for the current determination period includes capital expenditure for replacement of the IGBT positions for $14.9m (FY20) over the 5-year period. EII completed a RIT-T and published a Project Assessment Conclusions Report (PSCR) in April 2022. This outlined that the replacement of the IGBT positions as the optimal approach and for the project to upgrade the IGBT positions of two phases of the Bungalora system one converter to 'Generation 3' IGBT positions. This includes all required supporting hardware including newer versions of VCUs and DC capacitors. The control system will not be upgraded as the current version is compatible with the new IGBT positions. The recovered 'Generation 1'

IGBTs and VCUs will be used to replenish spares stocks for the remaining converters and phases that will continue to have the generation one IGBT positions installed.

The project is expected to be completed in FY2025/26 with a capital expenditure of approximately $26m.

8.1.2. Cable Modifications

The Directlink HVDC cables were designed and manufactured in 1999. The DC transmission system consists of six HVDC cables split evenly across three parallel converter systems, with two cables per system. The Directlink cable is 59 km in length, of which approximately 14 km is above ground in galvanised steel troughing (GST). There are approximately 74 cable transition points between below and above ground.

Cable faults cause downtime to the HVDC system and reduce the availability of the Directlink system. Fault repairs can be a strain on resources and can impact normal operations.

In 2018, EII commenced a cable fault investigation project including data analysis, software modelling and laboratory testing of faulted cable samples aimed at identifying the likely root causes of failure. Raised temperature differences across the insulation and a sharp rise in volumetric strain were identified by subsequent field testing and examination to exist at the cable transitions. These factors are known electrical stress enhancers and are believed to significant contributing factors of the cable failures.

A new thermally enhanced cable transition design was developed and tested across two different sites and showed positive results in reducing the effects of the above described factors. The solution is expected to reduce the temperature difference across the cable insulation and mechanical strain of the Directlink HVDC cables at the transitions and lower the rate of transition cable failures.

This work is expected to be delivered in FY2025/26 with a capital cost of approximately $0.8m.

8.1.3. SCADA Hardware Lifecycle Management

A number of dispatch and communication failures were revealed by a recent investigation conducted between March 2021 and February 2023 to be due to the SCADA system. These failures resulted in dispatch of Directlink not meeting AEMO dispatch targets.

APA has committed to improve its capability and alarming of the SCADA systems to better aid the operators in selecting the correct responses. This is expected to remove the pressure on after hours on-call staff.

The key scope items of this project include:

- Migration of the MS Excel based dispatch system and the existing SCADA system to GeoSCADA.

- New communications driver configured to link the control system and GeoSCADA.
- GeoSCADA design and configuration (Overviews, popups, alarms, status, commands, and analogue signals).
- Procurement, configuration and installation of four rack mount servers located onsite.
- Alarm redesign, explanation, and response building of each alarm.

The project is expected to be complete in FY2024/25 with a capital expenditure of circa $1.6m.

8.1.4. HVDC Spare Cable Order

The Directlink interconnector has a transmission line of approximately 59km in length which consists of six 80 kV cables which are buried direct and installed in galvanised steel troughs above ground. It is essential to have spare cable on hand in order to be able to quickly respond to cable faults and to perform timely repairs to bring the link back to full operation in a timely manner.

EII have put in an order with Hitachi to procure 2 km of the 80 kV HVDC Light cable at a cost of $1.5m in the FY2024/25.

8.1.5. Environmental Damage from Landslips

Due to extreme weather events, there were erosion of alluvial watercourse banks and rotational landslip of residual material at a number of identified locations putting the asset at risk of being exposed and unsupported with further rainfall/flooding events.

Remediation works will be carried out as a long-term solution at these sites to significantly reduce the risk of further erosions.

The remedial works is to address the erosional damages on flood-affected sites will be at the cost of approximately $ $1.3m and is expected to be delivered in FY2024/25.

8.2. Remaining Revenue Determination Project Commitments

To ensure the Directlink interconnector operates in a reliable and secure state, the Asset Operator is in the process of commencing the following projects:

- Barn door and rust damage removal
- Fire system upgrades.
- Painting of the PLC reactors.
- Fire suppression deluge system modifications.
- Power supply upgrade
- Procurement of new testing and cable locator equipment.
- Rectification of environmental damage from land slips.

- Procurement of spares.

These various projects have a cumulative cost of approximately $2m.

9. Proposed Projects

This section presents the major projects which are proposed for the Directlink HVDC transmission assets over the next 10-year period. There are no proposed or planned augmentation works to enlarge the system or to increase its capacity.

9.1. Reliability Improvement and Lifecycle Replacement Works

The following projects have been identified for Directlink based on a need to either increase the reliability of the asset, maintain emergency controls or to replace the identified component(s) to maintain reliability and/or for lifecycle replacement reasons.

9.1.1. Other Proposed Projects

To ensure Directlink's ongoing, reliable operation and to reduce possible outage times, EII plans to perform the projects listed below as major capitalisable maintenance:

- IGBT water cooling system midlife refurbishment.
- Cable tray install and cable relocation.
- Directlink circuit breaker replacement.
- Cooling tower fans.
- Cooling tower sound enclosure and roofing corrosion management.
- DC disconnector replacement.
- Physical site security and public protection.
- Reactor cooling enhancements.
- PLC capacitors.
- Spares and obsolescence management.
- HVDC spare cable management.
- Major capitalisable maintenance.
    - Cooling water pump major overhauls.
    - Fire water pump major overhauls.
    - Corrosion prevention.
    - General facility major maintenance (gutter replacements, roof sections etc.).
    - Regular converter site vegetation management.
    - Vehicle upgrades.
    - Pressure vessel inspections and repairs.
    - Dehumidifying major overhaul.
- PLC reactor filter spares management.

- RTU Upgrade - communications interface to AEMO.
- Versiondog software upgrade and expansion.
- CMMS upgrade
- AC isolators / earth switches.
- Bungalora facilities improvements.
- Bungalora storage facilities.
- Cameras for inspections.
- Transmission cable route land grading.
- Master controller upgrade.
- Reposition nitrogen tanks.
- Sound wall earthing installation.
- Vehicle procurement for easement inspections and management.
- Power quality metering.

This work is expected to be delivered by FY2030/31 with a capital cost of approximately $28.4m.

References

[1] AEMO Network Visualisation Tool, [Online]. Available: http://www.aemo.com.au/aemo/apps/visualisations/map.html. [Accessed 2024].

[2] AEMO, "Integrated System Plan," AEMO, 2024.

[3] AEMO Communication, *The future role of Directlink in the NEM - December 2023,* AEMO, 2023.

[4] EII, "2025-2030 Revenue Proposal Overview – January 2024," EII, 2024.

Appendix A – Abbreviations and Definitions

Abbreviations

Table – Abbreviations

AEMO	Australian Energy Market Operator
Hitachi	Company and supplier of the asset HVDC equipment (originally ABB) - main Contractor and OEM for this asset
AC	Alternating Current
APA	APA Group company and operator of Directlink
DC	Direct Current
AC	Alternating Current
HVDC	High Voltage Direct Current
IGBT	Insulated Gate Bipolar Transistor
NER	National Electricity Rules
OEM	Original Equipment Manufacturer
VCU	Valve Control Unit VCA – Valve Control Phase A VCB – Valve Control Phase B VCC – Valve Control Phase C
AEMO	Australian Energy Market Operator

Definitions

In this document, unless the context requires otherwise, capitalised terms have the meanings set out in the engineering, procurement and construction contract, any contract schedules and this Technical Specification. If there is a conflict among any definitions then the definitions in a contract document take precedence, followed by those listed below.

a. **Converter** means the special equipment needed to convert electricity between AC and DC, and utilising power electronic devices and associated electrical and auxiliary equipment.

b. **Converter Building** means the structure housing the Converter and associated electrical and auxiliary equipment. The Converter Building consists of a control room, a valve cooling room, a reactor cooling room, valve enclosures, a reactor room, an indoor AC yard and an indoor DC yard.

c. **Converter Station** means the site where the Converters and associated high voltage switchgear are installed.

d. **Directlink** means the HVDC Transmission System that connects the high voltage power transmission networks at Mullumbimby and Terranora (both in New South Wales) via HVDC cables.

e. **Bungalora Converter Station** means the Directlink Converter Station located at Terranora Rd, Bungalora NSW, and consisting of one Directlink Converter Station.

f. **Mullumbimby Converter Station** means the Directlink Converter Station located at Wilsons Creek Road, Mullumbimby NSW, and consisting of one Directlink Converter Station.

g. **Site** means either or both of the Bungalora Converter Station and/or the Mullumbimby Converter Station.