Business Case: Spares Management

Directlink Joint Venture
2025-2030 Revenue Proposal

Energy
Infrastructure
Investments

Document control

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Table 1.1: Revision Record

Version	Date	Updated By	Changes Made
0.1	*10/11/2023*	*James Brandt*	*Initial draft*
0.2			*Feedback received from group discussions*

Table 1.2: Review and Distribution

Name	Role	Action	Sections
Noel Power	Senior HV Power Engineer	*Input*	*All*
James Brandt	Asset Performance & Lifecycle Specialist	*Input*	*All*
Eric Kocaj	Head of Infrastructure Projects	*Input*	*All*
Mark Allen	Regulatory Manager	*Review*	*All*

Table 4: Approvals

Name	Role	Approval	Date Approved
Annie Martyn	Asset Manager	Approved	*19/01/24*
Paul Alexander	GM Asset Management	Approved	*19/01/24*

Contents

1. Purpose

To present project recommendations and expenditure forecast for inclusion in the Directlink Regulatory Proposal for FY26 to FY30.

This business case includes an estimate for forecast capital expenditure of $12.5 million on a portfolio of projects within the Strategic Spares Management program for Directlink.

2. Scope of the Business Case

The Strategic Spares Management project:

- Identified all assets critical to the ongoing safe and reliable operation of the Directlink Interconnector (Asset criticality assessment)
- Analysed the nature of any spares that could be held for those assets (Spares Assessment)
- Assessed what is the optimal spares strategy for each of those assets that minimises the cost to customers for operating Directlink in the longer term (Economic assessment)
- Procured the efficient level of spares (Procurement)

The spare parts inventory covers all Directlink sub-systems.

This Business Case includes a high-level estimate of the cost of acquiring all the spares. All cost estimates of project expenditure in the 2025-30 regulatory control period are provided in FY25 dollars unless stated otherwise.

Note the strategic spares management does not include the acquisition of generation one IGBTs as they are no longer available to Directlink in the forthcoming regulatory period.

2.1. Regulatory context

The Spares Management program for Directlink is designed to meet the following capital expenditure objectives set out in clause 6A.6.7(a) of the National Electricity Rules:

- maintain the quality, reliability and security of supply of prescribed transmission services; and
- maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

The Spares Management Program will maintain the reliability of Directlink over the life of the asset. It will utilise an assessment system to ensure the expenditure incurred would reflect a prudent service provider acting efficiently and represent a realistic expectation of the costs to achieve the requirement.

The delivery of this project will be consistent with APA's project management policies and procurement standard (see Attachments 04b and 04c).

3. Strategic Spares Management Program

Spares management is a critical component of Directlink's operational resilience and efficiency. Spares management is essential for minimising downtime, optimising costs, and ensuring the continuity of operations.

The objective of the strategic spares management project is to design a spares management program that ensures the ongoing reliable operation of Directlink at the lowest long-term cost to customers.

The spares management strategy involves the systematic identification, procurement, storage, and utilisation of spare parts to support equipment maintenance and address unforeseen breakdowns.

As the key functions of the converter system are manufactured by Hitachi, it is not possible to source many spares from an alternative supplier. Due to factors beyond Hitachi's control, such as global supply chain constraints; there have been occasions where notification of the withdrawal of support has been issued with very limited notice.

These challenges have resulted in Directlink reconsidering the most prudent and efficient strategy for spares management over the long term to the expected end of economic life, to ensure that the Directlink interconnector will achieve its life expectancy at the lowest cost.

3.1. Framework and Methodology for Spares Management

As noted above the framework for developing the spares management strategy is structured around three components:

- Identify all assets critical to the ongoing safe and reliable operation of the Directlink Interconnector (Asset criticality assessment)
- Analyse the nature of any spares that could be held for those assets (Spares Assessment)
- Assess what is the optimal spares strategy for each of those assets that minimises the cost to customers for operating Directlink in the longer term (Economic assessment)

3.2. Asset criticality assessment

Refreshing the critical assets assessment is a critical step in developing the spares management strategy for Directlink. This required refreshing due to the age of Directlink and the transfer of asset OEM from ABB to Hitachi resulting in changing OEM support.

This involved an assessment of each sub system and each asset within the subsystem to determine its criticality to the operational capability of Directlink. The criteria for determining the criticality of sub-assets / components are as follows:

- failure of the sub-asset / component would result in an outage of the Directlink Interconnector or a Directlink Interconnector System (Directlink is made up of 3 x 60MW systems)
- failure of the sub-asset / component poses a high risk of an outage of the Directlink Interconnector or a Directlink Interconnector System due to limited redundancy. That is, assets with limited redundancy for continued operation; such as IGBTs.

Directlink has completed a criticality assessment. This assessment identified 68 critical spare types on Directlink.

Consistent with good industry practice Directlink will procure spares for all critical assets where this is the lowest long term practical cost outcome.

3.3. Spares Assessment

For each of the critical assets, the failure and replacement characteristics for each was considered. The failure and replacement characteristics considered are:

- Expected failure rates
- Cost of acquisition of spares
- Shelf life
- Risk of obsolescence
- Procurement lead times
- Cost of storage
- Procurement limitations
- Replacement cost for operating system

The following table provides a description of each of the characteristics considered.

Characteristic	Description
Expected Failure Rate	The estimated frequency at which failures are expected to occur under normal operating conditions. This is a forecast of failure rates.
Cost of acquisition of spares	Cost of the spares including any costs associated with procurement, contracting, legal advice etc.
Shelf Life	Period that a spare can be stored, under suitable conditions, and retain its quality. If the spare has a limited shelf life, then Directlink will maintain a sufficient quantity of the subcomponent at all times to ensure the ongoing operation of the Directlink Interconnector System, whilst minimising wastage based on forecast of failure rates. We have not identified any spares in the spares assessment that have a finite shelf life less than the expected remaining life of Directlink.
Risk of Obsolescence	The risk that a subcomponent will become unobtainable in the future. If there is no material risk of obsolescence, then the approach will be to acquire the prudent and efficient number of spares in the most prudent and efficient profile. If there is a risk of obsolescence then the procure the number of spares that maximises the NPV to customers, recognising the cost of the spare, cost of storage and the cost of replacing the operating equipment based on a range of realistic forecast failure rates.
Procurement Lead times	The lead time is the length of time from putting in a purchase to having the spare in storage. The procurement lead times can be expected to influence the prudent purchase quantity. The longer the lead time the harder it is to adjust for unexpected failures. This would require a higher level of spares in the first order to behave as insurance for all subsequent orders. Where

	part of the contingency is utilised, it would need to be rebuilt at the earliest opportunity (next order).
Cost of Storage	This is the cost of building (or acquiring) additional storage that meets the necessary conditions to store spares and the cost of maintaining that storage for the duration of the Directlink Interconnector. Our assessment of the number and type of spares indicates that there is currently sufficient storage available for the additional spares.
Procurement Conditions	Manufacturers of some items like cable and IGBTs require minimum purchases. In some cases, this minimum may be above the efficient procurement for Directlink but on PV (present value) analysis may still be prudent (if the counterfactual is operating system replacement). There are also costs associated with the project of procurement (project management, contract negotiation etc) that could influence the frequency of purchases.
Replacement cost for operating system	Cost of replacing the operating system as spares cannot be acquired.

This data collection and assessment was conducted following the Asset criticality assessment and all relevant data based on Directlink experience or international data such as CIGRE data. CIGRE is the internation industry body for large electric systems.

3.4. Economic Assessment

The data is then analysed for each category of critical spares to determine the frequency and quantity of purchases. This analysis has been completed.

The spares fall into one of two categories.

1) Business as usual

2) Obsolescence risk

The assessment of prudency and efficiency is whether the procurement of the spares is the lowest cost alternative, and that the procurement of spares is less than the cost of outages.

Directlink has constructed a model to calculate the lowest economic cost approach to determining the level of spares to procure for each of the 68 identified critical asset spares (see attachment 03). A document explaining the operation of the model is provided (see attachment 02)

Business as usual

This is for critical spares where there are multiple sources for the asset and the obsolescence risk is low.

The procurement approach forecasts failure rates and optimise procurement volumes. This optimises for:

- costs of procurement;
- limitations placed by vendors;
- Storage costs; and
- Time value of money

The economic assessment determines whether the procurement of sufficient spares in advance to avoid an outage is lower than the economic cost of the ongoing outage while the spares are replaced after a failure occurs. Where that criteria is satisfied the expenditure for acquiring the spares in included in the forecast capital expenditure.

Long or growing lead times

The electricity network industry, in particular High Voltage Direct Current, businesses are experiencing rapid increases in the lead times for some critical components.

Given the long lead times, even when higher failure rates are identified, it could take over 5 years to increase sparing, resulting in exhaustion of the available spares before more can be sourced.

However, in the first procurement an additional number of spares would be acquired to act as an insurance against the possibility that failure rates could rise before the procurement approach could be adjusted.

There is a probability associated with the likelihood of an increase in failure rates based on the age profile of the asset and historic experience with the asset in other networks. This means there is a risk that future actual failure rates could be systematically higher than forecast. As it is a factor of aging it is less likely that future failure rates will be systematically lower than forecast.

Previously Directlink had identified long or growing lead times as a separate category from business as usual. However, the assessment is the same regardless of whether the procurement lead time has grown in recent years.

Obsolescence Risk

Where a sub-system contains assets that are provided by a sole source supplier then there is a risk of obsolescence of the sub-system created by having one of those assets fail and having no replacement.

The analysis determining the scope and scale of spares acquisitions reflects the following:

- Obsolescence can happen at short notice;
- The present value of the cost of spares vs the present value cost of sub-system replacement;
- The forecast of failure rate for the assets.

Customers are better off acquiring the required number of spares to enable the sub component to last until the end of Directlink's life in 2042 where the present value of the cost of spares is less than the present value of the replacement cost of the sub-system or alternative solution.

Given the risk of obsolescence it is proposed to procure spares as soon as possible to avoid the risk that spares currently available are not available in the future and Directlink having no choice but to implement the higher cost alternative. This approach has been accounted for in the NPV analysis.

Further analysis has identified 2 different types of failure rates that affects the nature of the analysis to determine the timing and likelihood of failures and the nature of timing of the alternative to acquisition of spares.

The two different types of failure rates that needed to be considered were:

- Stable failure rates
- Mean time to failure

Stable failure rates are where an asset does not have a known mean time to failure. The only asset identified in this category is Generation 3 IGBTs.

The analysis of all other assets with an obsolescence risk was based on the mean time to failure. The mean time to failure is where, based on industry and APA data, 50% of assets are expected to last a particular duration. A mean time to failure and failure rates having a normal distribution this enables the calculation of a failure rate profile.

The failure rate profile informs two aspects of the analysis:

- the timing of the alternate course of action if no spares are acquired and
- the cost of the acquisition of spares.

This is then used to identify which is the lowest cost in present value terms the acquisition of the spares or the alternate.

3.5. Overall Risk

If the above issues are not addressed there are two key impacts on the future operability of Directlink;

a) If insufficient spares are procured and stored (due to long lead times, obsolescence or increase failure rates), extended outages to Directlink will occur whilst spares are sourced. This is can lead to outages of greater than 12 months based on current sparing challenges. Outages of this duration will have a significant negative market impact and risk reliability of supply to customers.

   Consequence: 5, Likelihood 3. Untreated Risk: Extreme

b) If insufficient spares are procured before parts become obsolete; major capital upgrades will be required to Directlink to facilitate continued operation. This will result in significant capital cost and extended (>1 month) outages to implement upgrades. These outages will have a negative impact on the market and risk reliability of supply to customers. As these have already been multiple cases of parts becoming obsolete, this is viewed as a likely outcome.

   Consequence: 4, Likelihood 4 Untreated Risk: Extreme.

3.6. Procurement

Procurement will take place in line with the identified strategy for the asset and will be undertaken in accordance with the APA procurement standard.

This approach will address immediate procurement needs for Directlink for the 2025-2030 regulatory period and contribute to the long-term reliability and performance of the asset.

This will be a multi-year procurement strategy.

4. Proposed Project Expenditure

Directlink identified 68 different types of spares for critical subcomponents.

A risk of obsolescence was identified for 37 types of spares. The analysis demonstrated that the acquisition of sufficient spares to the end of the asset life was cheaper than the expected cost of replacing the subcomponent for 29 of those spares.

The 8 projects where it was determined that the acquisition of spares to the end of life was not warranted were also assessed on a business-as-usual basis. It was determined that no spares were necessary to acquire for one of these assets. For the other 7 projects it was determined acquiring sufficient spares to cover the lead time was the lowest cost option.

The results for the overall assessment are set out below.

Outcome	Types of Spares
Critical Spares identified	68
Spares to extend to end of life	29
Spares for lead time	30
No additional spares required	9

The forecast expenditure for Spares Management for the 2025-30 regulatory period comprises of all spares for critical equipment to support the asset until end of life in 2042.

The amount included is the best available forecast.

The forecast of expenditure is as below for the regulatory period FY26-FY30 ($m).

Activity	FY26	FY27	FY28	FY29	FY30	Total
Business as usual	1.5	1.5	1.5	1.5	1.5	**7.7**
Obsolescence risk Mitigation	1.0	1.0	1.0	1.0	1.0	**5.2**
Total Capital expenditure	**2.6**	**2.6**	**2.6**	**2.6**	**2.6**	**12.9**

The proposed expenditure is based on information available at time of the revised proposal. Final expenditures over the regulatory period will ultimately be shaped by stock availability and any restrictions and conditions imposed by vendors, such as minimum purchasing requirements.

5. Recommendation

The proposed solution is to maintain the inventory of spare equipment. The capital cost to complete the spares management program is $12.9 million over the FY26 – 30 period.