



Powerlink Queensland

# Project Assessment Conclusions Report

9 January 2019

## Addressing the secondary systems condition risks at Abermain Substation

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## Document Purpose

For the benefit of those not familiar with the National Electricity Rules (the Rules) and the National Electricity Market (NEM), Powerlink offers the following clarifications on the purpose and intent of this document:

1. The Rules require Powerlink to carry out forward planning to identify future reliability of supply requirements and consult with interested parties on the proposed solution as part of the Regulatory Investment Test for Transmission (RIT-T). This includes replacement of network assets in addition to augmentations of the transmission network.
2. Powerlink must identify, evaluate and compare network and non-network options (including, but not limited to, generation and demand side management) to identify the '*preferred option*' which can address future network requirements at the lowest net cost to electricity consumers. This assessment compares the net present value (NPV) of all credible options to identify the option that provides the greatest economic benefits to the market.
3. This document contains the results of this evaluation, and a final recommended solution to address the secondary system condition risks at Abermain Substation from June 2021.

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## Executive Summary

Located in south-east Queensland, Abermain Substation is a major injection point into the Energex distribution network. Planning studies have confirmed there is an enduring need for the substation to maintain the supply of electricity in the Ipswich, Lockrose, Gatton and south western parts of Brisbane.

Most secondary systems at the Abermain Substation are reaching the end of their technical service life, and are no longer supported by the manufacturer, with few spares available.

Secondary systems are the control, protection and communications equipment that are necessary to operate the transmission network and prevent damage to primary systems when adverse events occur. Under the National Electricity Rules ('the Rules'), Transmission Network Service Providers (TNSPs) are required to provide sufficient secondary systems, including redundancies, to ensure the transmission system is protected.

The deteriorated condition and obsolescence issues associated with the Abermain secondary systems presents Powerlink with operational and compliance issues, requiring resolution. Since consideration for this investment is driven by an obligation in the National Electricity Rules (the Rules), it is a 'reliability corrective action' under the Regulatory Investment Test for Transmission (RIT-T).

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process prescribed under the Rules undertaken by Powerlink to address the condition risks arising from ageing and obsolete secondary systems at Abermain Substation. It contains the results of the planning investigation and cost-benefit analysis of credible options. In accordance with the RIT-T, the credible option that maximises the present value of net economic benefits is recommended for implementation.

### Credible options considered

Powerlink identified two credible network options to address the identified need, as presented in Table 1.

Table 1: Summary of credible options

Option	Description	Indicative capital cost (\$million, 2018/19)	Indicative average annual operating and maintenance costs (\$million, 2018/19)
Base Option: In-situ panel replacement by June 2021	Replacement of all secondary systems using pre-wired panels within an extended existing building by June 2021	6.91	0.04
Option 1: Full replacement in pre-fabricated building by June 2021	Replacement of all secondary systems using a modular prefabricated building with new secondary systems installed by June 2021	6.76	0.04

## Evaluation and conclusion

The RIT-T requires that the proposed preferred option maximises the present value of net economic benefit, or minimises the net cost, to all those who produce, consume and transport electricity in the market.

In accordance with the expedited process for this RIT-T, the Project Specification Consultation Report (PSCR) made a draft recommendation to implement Option 1, replacement of all ageing and obsolete secondary systems using a modular prefabricated building with new secondary systems installed by June 2021.

The estimated capital cost of the proposed preferred option is \$6.76 million in 2018/19 prices. Powerlink is the proponent of the proposed network project.

There were no submissions received in response to the PSCR.

As the outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR, the draft recommendation has been adopted without change as the final recommendation, and will now be implemented.

## 1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process<sup>1</sup> prescribed under the Rules undertaken by Powerlink to address the condition risks arising from the ageing and obsolete secondary systems at Abermain Substation. It follows the publication of the Project Specification Consultation Report (PSCR) in September 2018 that adopted the expedited process for this RIT-T, as allowed for under the Rules for investments of this nature.

The Project Specification Consultation Report (PSCR):

- described the identified need that Powerlink is seeking to address, together with the assumptions used in identifying this need
- set out the technical characteristics that a non-network option would be required to deliver in order to address the identified need
- described the credible options that Powerlink considered may address the identified need
- discussed specific categories of market benefit that in the case of this specific RIT-T assessment are unlikely to be material
- identified the preferred option and that Powerlink was claiming an exemption from producing a Project Assessment Draft Report (PADR).

Powerlink identified Option 1, replacement of all ageing and obsolete secondary systems using a modular prefabricated building with new secondary systems installed by June 2021, at a cost of \$6.76 million in 2018/19 prices, as the preferred option to address the identified need.

NER clause 5.16.4(z1) provides for a Transmission Network Service Provider (TNSP) to claim exemption from producing a PADR for a particular RIT-T application if all the following conditions are met:

- the estimated capital cost of the preferred option is less than \$41 million
- the preferred option has been identified in the PSCR noting exemption from publishing a PADR
- the preferred option, or other credible options, do not have a material market benefit
- submissions to the PSCR did not identify additional credible options that could deliver a material market benefit.

There were no submissions received in response to the PSCR that closed on 24 December 2018. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

As all of the conditions are now satisfied, Powerlink has not issued a PADR for this RIT-T and is now publishing this PACR, which:

- describes the identified need and the credible options that Powerlink considers may address the identified need
- provides a quantification of costs and reasons why specific classes of market benefit are not material for the purposes of this RIT-T assessment
- provides the results of the net present value (NPV) analysis for each credible option assessed, together with accompanying explanatory statements
- identifies the preferred option for investment by Powerlink and details the technical characteristics and estimated commissioning date of the preferred option
- describes the consultation process followed for this RIT-T together with the reasons why Powerlink is exempt from producing a PADR.

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<sup>1</sup> This RIT-T consultation has been prepared based on the following documents: *National Electricity Rules, Version 112*, 18 September 2018 and AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, September 2017.

Since this investment is driven by an obligation in the Rules, it is a 'reliability corrective action' under the RIT-T.

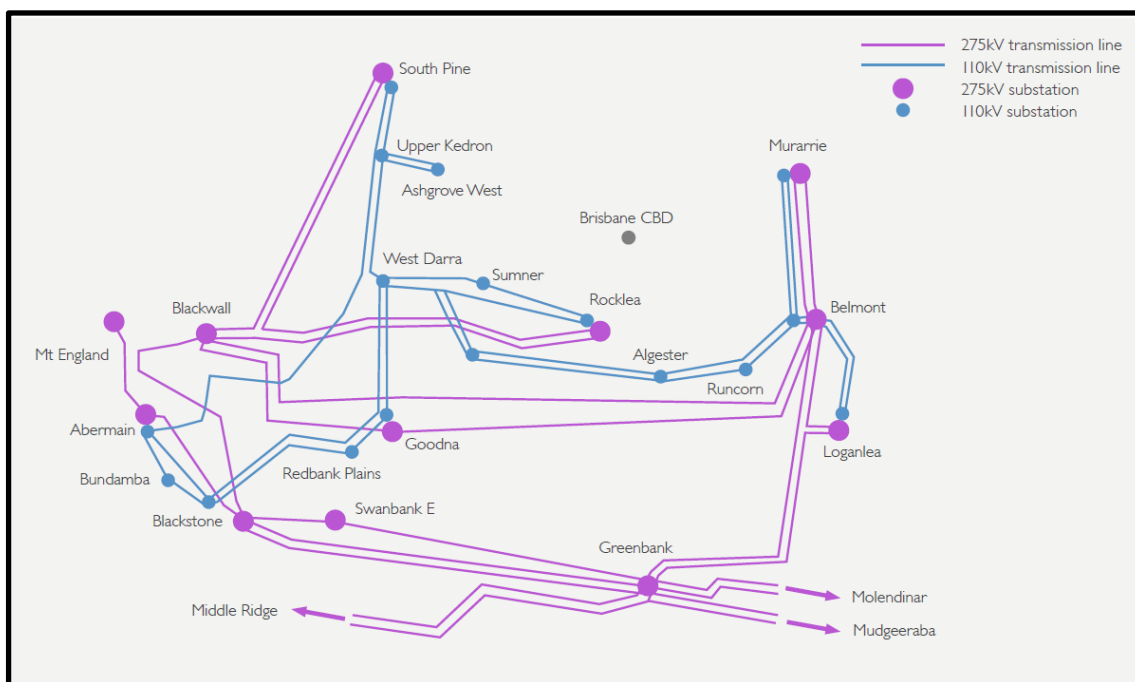
## 2. Identified need

### 2.1 Geographical and network overview

Abermain Substation is located approximately 40km south west of the Brisbane CBD and forms part of the Greater Brisbane transmission network, within the Moreton transmission zone. It was initially established in 1962 as a 110kV switchyard and operates as a bulk supply point to the Energex (part of the Energy Queensland Group) 33kV network. In 2009 a separate 275kV switchyard was established with connections to Mt England and Blackstone substations.

The Greater Brisbane transmission network is shown in Figure 2.1.

Figure 2.1: Greater Brisbane transmission network



### 2.2 Description of identified need

Planning studies indicate an enduring need for the substation as an injection point for the Energex distribution network in the Ipswich, Lockrose, Gatton and south-western parts of Brisbane<sup>2</sup>.

Powerlink's assessment of the condition of the ageing secondary systems assets at Abermain has highlighted that the majority are now obsolete and nearing the end of their technical service life. The majority of the substation's protection, control and supervisory systems are no longer supported by their respective manufacturers nor do they hold spare replacement units.

Under the Rules, TNSPs are required to provide sufficient secondary systems, including redundancies, to ensure the transmission system is adequately protected. This places an obligation on Powerlink to undertake actions that address the risks arising from obsolete and ageing secondary system assets at Abermain Substation, to maintain compliance with the Rules.

### 2.3 Assumptions underpinning the identified need

The need to invest is a direct result of the risks arising from ageing and increasingly obsolete secondary systems at Abermain Substation, for which Powerlink has legal compliance obligations under the Rules. If not addressed, these risks can extend the time taken to recover

<sup>2</sup> [Powerlink's Transmission Annual Planning Report](#),

(or even prevent recovery) from secondary system faults, due to a lack of support from manufacturers and a lack of spare parts.

Specifically, S5.1.9(c) of the Rules requires a TNSP to provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any type anywhere on its transmission system is automatically disconnected<sup>3</sup>. This requirement extends to any communications facilities on which protection systems depend<sup>4</sup>.

TNSPs must also ensure that all protection systems for lines at a voltage above 66kV are well maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of a protection system is being carried out<sup>5</sup>. The TNSP may need to take primary systems out of service if protection systems are not restored within the required eight hour timeframe for a planned outage. In the event of an unplanned outage, the Australian Energy Market Operator's (AEMO's) Power System Security Guidelines require that the primary network assets must be taken out of service within 24 hours<sup>6</sup>.

It follows that the increasing likelihood of faults arising from the condition of ageing secondary systems and their obsolescence compels Powerlink to undertake reliability corrective actions at Abermain Substation if it is to continue to meet the standards for protection system availability set out in the Rules, and to avoid the impacts of taking primary systems out of service.

## 2.4 Description of asset condition and risks

The Abermain 110kV switchyard was built in 1963.

The majority of the 110kV secondary system components at Abermain Substation are approaching the end of their technical service life. Many critical protection and control items are no longer supported by their manufacturers and have been superseded by new technologies. The diminishing availability of spares and the lack of manufactures' support for repairs place an obligation on Powerlink to address the obsolescence risks arising from these ageing assets remaining in service.

Powerlink has undertaken a comprehensive condition assessment of the at-risk equipment using an asset health index that evaluates:

- equipment functional failure rates (failure to operate as intended)
- environmental conditions where the assets are installed and
- equipment physical and effective age.

Health indices are modelled in the range from zero (0) to ten (10), where zero represents new assets and ten indicates that the asset requires immediate action to address its increasing risk of unreliable operation. The impact of equipment obsolescence is also considered when determining if remedial action is required.

A summary of health index scores and recommended actions for each group of 110kV secondary systems at Abermain is set out in Table 2.1.

<sup>3</sup> Clause S5.1.9(c) of the Rules requires that faults are automatically disconnected in accordance with clause S5.1.9 (e) or clause S5.1.9(f)

<sup>4</sup> Clause S5.2.5.9 (2) of the Rules

<sup>5</sup> Clause S5.1.2.1 (d) of the Rules

<sup>6</sup> AEMO Power System Operating Procedure SO\_OP\_3715 – *Power System Security Guidelines* (the Rules require AEMO to develop and publish Power System Operating Procedures pursuant to clause 4.10.1(b) of the Rules, which Powerlink must comply with per clause 4.10.2(b)).



Table 2.1: Summary of secondary system health index scores at Abermain Substation

Bay	Construction year	Health index (average)	Description
4x Feeder Bays Protection and Control	2002	6.0	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
3x Transformer Bays Protection and Control	2001-2002	8.0	Equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
1x Capacitor Bay Protection and Control	2002	7.2	Equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
2x Bus Zone Protection	2000	8.5	Equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
2x Bus Section Control and Circuit Breaker Fail	2000	8.0	Equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
2x Feeders 3x Transformers Metering Equipment	1999-2002	7.4	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
Non-bay secondary systems (includes OpsWAN, SCADA, fire protection, AC board, DC battery systems)	2001-2002	7.8	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required

Deteriorating asset condition increases the risk of secondary system faults, while obsolescence increases the time needed by Powerlink to address system faults, potentially up to several weeks as panel wiring and test plans are needed on an individual basis. The inability to repair, replace or otherwise resolve secondary system faults in a timely manner has operational consequences, as this reduces the overall resilience of the transmission network to subsequent forced outages.

### 3. Submissions received

Powerlink published a PSCR in September 2018 calling for submissions from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options that could address the risks arising from the ageing and obsolete secondary systems at Abermain Substation.

There were no submissions received in response to the PSCR that was open for consultation until 24 December 2018. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

#### 4. Credible options assessed in this RIT-T

Powerlink has developed two credible network options to address the identified need at Abermain Substation:

- Base Option: Single stage replacement of all secondary system components using new secondary system panels established within an extended existing building.
- Option 1: Single stage replacement of all secondary systems and associated panels, using a prefabricated building with new secondary systems equipment and wiring preinstalled.

A summary of the major components to be replaced under the two options is given in Table 4.1.

Table 4.1 Summary of components to be replaced

System/Location	Type
Protection and control systems	4x 110kV feeder system replacements – Abermain and remote ends 3x 110kV transformer system replacement 2x 110kV Bus Diameters 2x 110 kV Bus Sections 1x 110kV Capacitor
Metering	2x 110kV feeder revenue meter panels 3x 33kV transformer revenue meter panels
Ancillary systems and components	Master Station and Common RTU Panel OpsWAN terminal and port servers Marshalling kiosks and associated cabling Fire protection panel and fire system detectors AC distribution board – <i>Base Option only</i> Additional Y protection DC system – <i>Base Option only</i>

Both of the credible options address the identified need and are technically and economically feasible, and able to be implemented in sufficient time. This avoids a situation where corrective maintenance of ageing and obsolete assets is no longer practical. None of these options has been discussed by AEMO in its most recent National Transmission Network Development Plan (NTNDP).<sup>7</sup>

Indicative costs for each credible option are presented in Table 4.2, and are based on Powerlink estimates<sup>8</sup>.

<sup>7</sup> Clause 5.16.4(b)(4) of the Rules requires Powerlink to advise whether the identified need and or solutions are included in the most recent NTNDP. The 2016 NTNDP is currently the most recent NTNDP.

<sup>8</sup> Powerlink has a robust estimating process that takes into consideration construction costs of recently completed projects, exchange rates on equipment and current labor market trends.

Table 4.2 Summary of credible options and indicative costs

Option	Description	Indicative capital cost (\$million, 2018/19)	Indicative average annual operating and maintenance costs (\$million, 2018/19)
Base option: In-situ panel replacement by June 2021	Replacement of all secondary systems using pre-wired panels within an expanded existing building by June 2021	6.91	0.04
Option 1: Full replacement in pre-fabricated building by June 2021	Replacement of all secondary systems using a modular prefabricated building with new secondary systems installed by June 2021	6.76	0.04

#### 4.1 Base option: In-situ panel replacement by June 2021

Powerlink is the proponent of this option.

The Base Option involves the replacement of all ageing and obsolete 110kV secondary systems with new panels installed in the current building, retaining the infrastructure within the existing building. Due to space constraints this option requires on-site civil and construction works to extend the existing building in order to fully house the new secondary system panels.

Major cost components are shown in Table 4.3.

Table 4.3: Main project components for the Base Option

Components	Cost (\$k, real 2018/19)	Construction timetable and completion date
Replacement of obsolete protection and control systems within existing building (including building expansion) at Abermain and decommissioning of old systems	5,270	Design and procurement: 2019-2020 Completion: June 2021
Associated telecommunication works	270	
Other <i>Includes project management, design and commissioning coordination, network operations, compliance management and statutory costs (Qleave)</i>	1,372	
<b>TOTAL</b>	<b>6,912</b>	

## 4.2 Option 1: Full replacement in pre-fabricated building by June 2021

Powerlink is the proponent of this option.

Option 1 involves the replacement of all ageing and obsolete 110kV secondary system within a new prefabricated building. The building is constructed, fitted out and tested off-site, before being relocated to the substation for commissioning.

This approach provides for a more efficient installation and testing of panels compared to the Base Option. The panels can be tested at Powerlink by internal staff and any issues addressed before the building is shipped to site. The installation of a new building will require on-site civil works and provision of AC supplies.

Major cost components are shown in Table 4.4 below.

Table 4.4: Main project components for Option 1

Components	Cost (\$k, real 2018/19)	Construction timetable and completion date
Replacement of all obsolete protection and control systems within new prefabricated building at Abermain and decommissioning of old systems	5,120	Design and procurement: 2019 -2020 Completion: June 2021
Associated telecommunication works	270	
Other <i>Includes project management, design and commissioning coordination, network operations, compliance management and statutory costs (Qleave)</i>	1,372	
<b>TOTAL</b>	<b>6,762</b>	

## 4.3 Material inter-network impact

Powerlink does not consider that any of the credible options being considered will have a material inter-network impact, based on AEMO's screening criteria.<sup>9</sup>

## 5. Materiality of Market Benefits

Powerlink does not consider that the replacement of secondary systems at Abermain Substation will provide any market benefits due to the nature of the project.

### 5.1 Market benefits that are not material for this RIT-T assessment

None of the replacement options will have an impact on wholesale market outcomes. The Australian Energy Regulator (AER) has recognised that if the proposed investment will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment<sup>10</sup>. Consequently, no market benefits have been estimated as part of this RIT-T. More information on consideration of individual classes of market benefits can be found in the [PSCR](#).

<sup>9</sup> In accordance with Rules clause 5.16.4(b)(6)(ii). AEMO has published guidelines for assessing whether a credible option is expected to have a material inter-network impact.

<sup>10</sup> AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, September 2017, version 2, page 13 in place at the commencement of this RIT-T consultation.

## 6. General modelling approach adopted to assess net benefits

### 6.1 Analysis period

The RIT-T analysis has been undertaken over a 15-year period, from 2020 to 2034. A 15-year period takes into account the size and complexity of the secondary systems.

Works on the secondary systems replacement under both options are expected to begin in 2019 and to be completed by June 2021. As the new secondary system has a technical service life of 20 years, there will be some remaining asset life by 2034 under each option, at which point a terminal value is calculated to correctly account for capital costs under each credible option.

### 6.2 Discount rate

Under the RIT-T, a commercial discount rate is applied to calculate the net present value (NPV) of costs and benefits of credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 7.04%<sup>11</sup> as the central assumption for the NPV analysis presented in this report.

Powerlink has tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound discount rate of 3.47%<sup>12</sup> and an upper bound discount rate of 10.61% (i.e. a symmetrical upwards adjustment).

### 6.3 Description of reasonable scenarios

The RIT-T analysis is required to incorporate a number of different reasonable scenarios, which are used to estimate market benefits. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration.

The choice of reasonable scenarios must reflect any variables or parameters that<sup>13</sup>:

- are likely to affect the ranking of the credible options, where the identified need is reliability corrective action and
- are likely to affect the ranking of the credible options, or the sign of the net economic benefits of any of the credible options, for all other identified needs.

Powerlink has considered capital costs and discount rate sensitivities individually and in combination and found that these variables do not affect the relative rankings of credible options or identification of the preferred option. As sensitivities (both individually and in combination) do not affect ranking results, Powerlink has elected to present one central scenario in Table 6.1 below.

Table 6.1: Reasonable scenario assumed

Key variable/parameter	Central scenario
Capital costs	100% of central capital cost estimate
Discount rate	7.04%

<sup>11</sup> This indicative commercial discount rate has been calculated on the assumptions that a private investment in the electricity sector would hold an investment grade credit rating and have a return on equity equal to an average firm on the Australian stock exchange, as well as a debt gearing ratio equal to an average firm on the Australian stock exchange.

<sup>12</sup> A discount rate of 3.47 per cent is based on the AER's Final Decision for Powerlink's 2017-2022 transmission determination, which allowed a nominal vanilla WACC of 6.0 per cent and forecast inflation of 2.45 per cent that implies a real discount rate of 3.47 per cent. See AER, *Final Decision: Powerlink transmission determination 2017-2022 | Attachment 3 – Rate of return*, April 2017, p 9.

<sup>13</sup> AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 16, p. 7

## 7. Cost-benefit analysis and identification of the preferred option

Table 7.1 outlines the net present value and the corresponding ranking of each credible option.

Table 7.1: NPV for each credible option (NPV, \$million 2018/19)

Option	Central Scenario NPV	Ranking
Base Option	-5.46	2
Option 1	-5.35	1

When comparing Option 1 to the Base Option, Option 1 cost is \$111,461 less in NPV terms.

### 7.1 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

- a 25% increase/decrease in capital costs
- a lower discount rate of 3.47% as well as a higher rate of 10.61%.

Given that the only difference between the options relates to the difference in their capital costs, these sensitivity tests show that Option 1 is the preferred option under all sensitivities (both considered individually and in combination).

### 7.2 Preferred option

Based on the conclusions drawn from the NPV analysis and the Rules' requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 1 be implemented to address the risks arising from the condition of ageing and obsolete secondary systems at Abermain Substation.

Option 1 involves replacement of all ageing and obsolete secondary systems using a modular prefabricated building with new secondary systems installed by June 2021.

Sensitivity testing shows the analysis is robust to variations in the capital cost and the discount rate assumptions. Option 1 is therefore considered to satisfy the requirements the RIT-T and is the preferred option.

## 8. Conclusions

The following conclusions have been drawn from the analysis presented in this report:

- Powerlink has identified condition risks arising from ageing and obsolete secondary systems at Abermain Substation requiring action.
- S5.1.9(c) of the Rules requires a TNSP to provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.
- TNSPs must also ensure that all protection systems for lines at a voltage above 66kV are well maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of a protection system is being carried out.
- The risks arising from the condition of ageing secondary systems and their obsolescence compels Powerlink to undertake reliability corrective actions at Abermain Substation to ensure ongoing compliance with the Rules' standards for protection system availability and avoid the impacts of taking primary systems out of service.
- Studies were undertaken to evaluate two credible options. Both credible options were evaluated in accordance with the AER's RIT-T.

- Powerlink published a PSCR in September 2018 requesting submissions from Registered Participants and interested parties on the credible options presented, including alternative credible non-network options which could address the secondary systems condition risks at Abermain Substation.
- The PSCR also identified the preferred option and that Powerlink was adopting the expedited process for this RIT-T, claiming exemption from producing a PADR as allowed for under NER clause 5.16.4(z1) for investments of this nature.
- There were no submissions received in response to the PSCR which was open for consultation until 24 December 2018. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. The conditions specified under the Rules for exemption have now been fulfilled.
- The result of the cost-benefit analysis under the RIT-T identified that Option 1 is the highest net benefit solution over the 15-year analysis period. Sensitivity testing showed the analysis is robust to variations in the capital cost and the discount rate assumption. As a result Option 1 is considered to satisfy the RIT-T.
- The outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR. Consequently, the draft recommendation has been adopted without change as the final recommendation and will now be implemented.

## 9. Final Recommendation

Based on the conclusions drawn from the NPV analysis and the Rules requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 1 be implemented to address the condition risks arising from ageing and obsolete secondary systems at Abermain Substation.

Option 1 involves replacement of all ageing and obsolete secondary systems using a modular prefabricated building with new secondary systems installed. The estimated capital cost is \$6.76 million (2018/19).

Powerlink is the proponent of the proposed option.

Construction activities would be expected to commence off-site in late 2019, with final commissioning on-site by June 2021.

Powerlink will now proceed with the necessary processes to implement this recommendation.



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