Transmission lines uprating (NMP21)

Regulatory Business Case (RBC) 2024-29

PowerWater

Contents

1 Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need and identified a full suite of credible options that will resolve the need, to ensure that Power and Water continues to meet the National Electricity Objectives and manage the network prudently and efficiently.

The project/program identified in this business case will undergo further assessment and scrutiny through Power and Waters normal governance processes prior to implementation.

This business case addresses the ratings and mechanical strength of some 66kV transmission lines in the Darwin area.

1.1 Business need

A review of line clearances on the 66kV transmission network has shown that some line sections do not maintain statutory clearances to the ground and that some poles have insufficient mechanical strength to meet cyclone ratings. These issues present risks to public safety and to the reliability of the network.

As the lines in question are required for the foreseeable future and do not meet design standards during foreseeable loading conditions, Power and Water is obligated to take action to comply and, by extension, mitigate the risks.

1.2 Options analysis

The options considered to resolve this need are shown in Table 1

Table 1 Summary of credible options

Option No.	Option Name	Description	Recommended
1	Do Nothing	This option defers work to address transmission line compliance issues until the 2029-2034 regulatory control period	No
2	Rectify all non-compliant line sections by 2028/29	This option addresses all identified risks during the 2024-29 Regulatory Control Period	Yes

As part of a holistic assessment, we considered non-network solutions, capex/opex trade-offs and retirement or derating, but found that none of these options addressed the underlying network issues.

1.3 Recommendation

The recommended option is Option 2, a program to rectify all non-compliant line sections by 2028/29. Option 2 addresses the risks adequately and the scope of work is deliverable - the proposed volume of work is similar to what will be delivered during the current regulatory control period (RCP) to address similar transmission line compliance issues.

The scope for this project is to upgrade the remaining 66kV transmission lines which have been identified as being unable to maintain statutory clearances under normal and contingency conditions to ensure they are sufficiently rated to supply expected loads. The project will also ensure that these lines can meet required cyclone wind loading forces.

The scope of the project includes the following:

- Increase the contingency rating of both Hudson Creek – Palmerston (HC-PA) and Hudson Creek – Archer (HC-AR) 66 kV lines to at least 83 MVA
- Rectify clearance and structural strength non-compliant conditions on the double-circuit Hudson Creek – Woolner (HC-WN) 66 kV line.

The table below summarises the expenditure requirements for the next RCP.

Table 2 Lines compliance work - annual capital and operational expenditure ($m, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	0.96	0.96	0.96	0.96	0.96	4.80
Opex	-	-	-	-	-	-
Total	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**4.80**

2 Identified need

This section provides the background and context to this business case, identifies the issues that are posing increasing risks to Power and Water and its customers, describes the current management program, highlights challenges and emerging issues, and provides a risk assessment of the inherent risk if no investment is undertaken.

2.1 Background

The 132kV and 66kV transmission lines in the Darwin system were largely designed and built in the late 1970s to early 1980s. The 66kV lines are critical for reliability of supply as they transport power from the Channel Island and Weddell power stations to bulk supply points. For the foreseeable future, the 66kV network will continue to be required for the distribution of power within the Darwin/Palmerston area.

The rating of a transmission line is usually determined by two factors, the conductor temperature, which rises and falls with the ambient temperature and the line current flow (loading), and the safety clearance of the conductors. Operating beyond a temperature specified for each conductor may result in irreversible conductor annealing and deformation reducing the lifetime of the conductor and potentially causing a safety hazard:

- The higher the conductor temperature, the more the line section between supporting poles/towers sags due to conductor expansion, reducing the clearance of the conductor to ground along the line section
- An annealed line is brittle and may break under load.

Australian Standard/New Zealand Standard (AS/NZS) 7000:2016 Overhead Line Design specifies the required safety clearance distance of overhead power lines of various voltages to ground, buildings, and other circuits.

Therefore, Power and Water's transmission line conductors are required to operate at or below a certain temperature that is specified according to the materials and construction of the line. This in turn limits the rating of the transmission lines.

2.2 Line Surveying

Power and Water commissioned Connell Wagner to survey and model the Darwin and rural area 66kV transmission network in 2007.

Since that time, the Darwin-Katherine system has expanded with additional generation at Channel Island Power Station and a power station built at Weddell, new industrial areas, and more roads and infrastructure. Due to various developments since the Connell Wagner report, multiple projects have been completed to increase ground clearances, such as at the Tiger Brennan Drive extension, Palmerston Hospital intake road, and Hidden Valley Motorsport Complex.

More recently, aerial LiDAR surveys of each 132kV and 66kV transmission line and as-installed conditions have been completed. The information has been incorporated into a capacity model using PLS CADD to

identify clearance issues and to calculate nominal and contingency line ratings. In keeping with good electricity industry practice, Power and Water aims to design and maintain its overhead power lines to meet the requirements of AS/NZS 7000:2016.

By simulating a range of system and weather conditions, sections of transmission lines that do not comply with the required AS/NZS 7000:2016 safety clearances due to excessive sag have been identified. Upgrading the non-compliant spans to meet minimum required safety clearances may also increase line transfer capacity and may provide opportunities to defer capital expenditure that would otherwise be required to overcome capacity constraints.

2.3 Work completed or to be completed in the current RCP

During the current RCP, expenditure on upgrading transmission lines in order of priority is expected to total $5.1 million (real 2021/22). Works have been completed on two lines to rectify identified clearance risks:

- Berrimah – Leanyer 66kV line
- Weddell – Strangways 66kV line.

Engineering design has commenced for the following lines to assist with forecasting expenditure requirements in the next RCP:[1]

- Hudson Creek – Woolner 66kV
- Hudson Creek – Palmerston 66kV.

The expenditure profile for the current RCP is shown in the table and figure below.

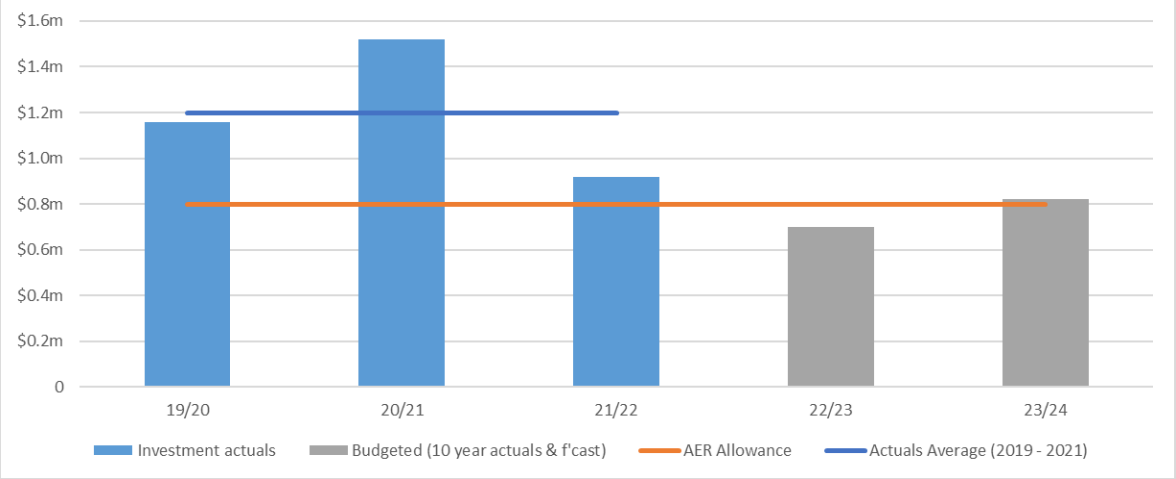
Table 3: Historical and expected expenditure on transmission line upgrades – current RCP ($m, real 2022)

Item	FY20	FY21	FY22	FY23	FY24	Total
Original forecast	0.80	0.80	0.80	0.80	0.80	4.00
Actual/estimate	1.16	1.52	0.92	0.70	0.82	5.12

The estimated cost is 27.5% higher than the original forecast (included in the AER allowance), due primarily to the refinement of scope following detailed design and higher than expected input costs.

Figure 1: Expenditure profile actual/forecast capex on transmission line upgrades ($m, real 2022)

[1] The non-compliances are not due to be resolved until late in the next RCP



2.4 Identified remaining strength issues and forecast clearance violations

The lines with identified structural strength issues and lines expected to violate minimum clearance requirements in the next RCP due to increased loading are listed in the table below.

Table 4: Expected lines with strength and/or clearance non-compliance

Line	Current design rating	Year when clearances violated	Maximum utilisation during outage [1]	Critical Issue
Hudson Creek – Woolner 1 & 2	64MVA	2024/25	73% / 77%	Cyclone rating and clearance issues
Hudson Creek - Palmerston	64MVA	2028/29	100%[2]	Clearance issues following Hudson Creek – Archer line outage
Hudson Creek - Archer	64MVA	2028/29	100%[3]	Clearance issues following Hudson Creek – Palmerston line outage

[2] D2022/288166 - NPR2203 Darwin-Katherine Transmission Line Upgrades
[3] D2022/288166 - NPR2203 Darwin-Katherine Transmission Line Upgrades

[1] Based on design rating

The double-circuit 66kV Hudson Creek to Woolner line is important component of the transmission network as it supplies the Darwin CBD and surrounding suburbs. There are no prospects for retiring this line in the foreseeable future. It is designed to only withstand a Category 3 cyclone, whereas the current AS/NZS 7000:2016 design standard requires 66kV lines to be able to withstand Category 4 cyclones.[4]

Figure 2 shows the Darwin-Katherine system and the 66kV lines earmarked for uprating in the next RCP.

2.5 Prioritisation of work

The prioritisation criteria used to rank the non-compliant line sections for remedial action are:

- Safety - line sections in proximity of people (pedestrians) typically pose a greater safety risk than rural line sections with low clearance, however vehicular traffic (e.g. high loads, including farm equipment) can also pose significant safety hazards depending on the frequency with which vehicles etc. come close to/traverse the line section. Power and Water's Safety Management Corporate Policy states that:

  'The Corporation is committed to complying with relevant WHS legislation and other requirements placed on the Corporation by other bodies, including the Utilities Commission by being:

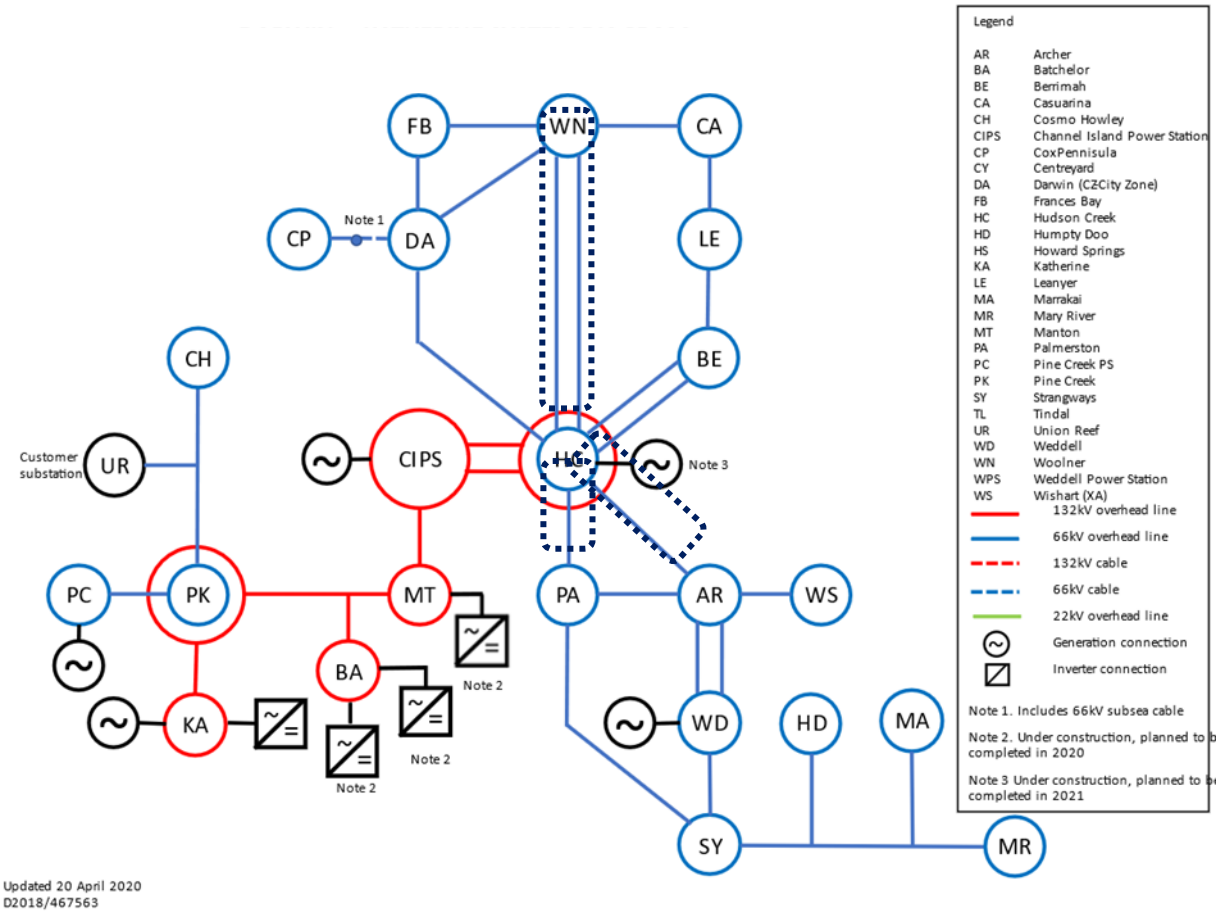
  (i) consistent with the intent of relevant Australian and international Standards on safety management'

  In keeping with good electricity industry practice, Power and Water aims to design and maintain its overhead power lines to meet the requirements of AS/NZS 7000:2016.

- Extent of non-compliance – including factors such as the length of offending spans, the difference between the design rating and the contingency rating and also the anticipated duration of the non-compliance

[4] AZ/NZS 7000, 2016, Table 6.1, Table 3.1; for 66kV transmission lines, the Line security level is 200 (Level II, 100 years); this results in a wind speed of 61 m/s (Region C) vs superseded design wind speed rating of 39m/s

Figure 2: Darwin-Katherine system diagram



- Criticality – for example if line rating non-compliance in turn constrains-off generation or would lead to significant supply outages
- Improving maintenance access - assisting to reduce the risk of supply outages
- Whether or not other projects provide an opportunity to rectify clearance issues - including, for example, customer-driven line relocations.

The risk reduction can then be balanced against the cost and complexity of the work to determine the order and timing of the rectification work. Works to address line non-compliance have been prioritised using these criteria during the current RCP and for the next RCP.

2.6 Timing Constraints

Due to the annual load profile, work on the Power and Water transmission network is limited to Northern Australia's shoulder season (May - September), when the peak loads are lower than in the wet season and there is less risk from taking lines out of service for construction work.

2.7 Summary

The solution selected must resolve non-compliant pole strength and span clearance violations on the transmission network identified in the line survey. The line upgrades will appropriately reduce the risk of injury to the public and Power and Water staff under normal and contingency scenarios.

3 Options analysis

This section describes the various options that were analysed to address the non-compliant pole mechanical strength and line clearances to identify the recommended option. The options are analysed based on ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

Credible options are identified that address the identified need, are technically feasible and can be implemented within the required timeframe. The following options have been identified:

- Option 1 - Do Nothing. This option involves deferring any work to address the non-compliant line spans until the following regulatory period.
- Option 2 - Rectify all non-compliant line sections by 2028/29. This option will address 66kV line poles and spans that are expected to be non-compliant in the next RCP.

A comparison of the two identified credible options and the issues they address is summarised in the table below. A discussion of each option is provided below.

Table 5: Summary of options analysis

Assessment metrics	Option 1	Option 2
NPV ($m, real 2022)	0.00	-4.19
Capex ($m, real 2022)	0.00	4.80
Opex ($m, real 2022)	0.00	0.00
Meets customer expectations	○	●
Aligns with Asset Objectives	○	●
Technical Viability	○	●
Deliverability	○	●
Preferred	✗	✓

● Fully addresses the issue ◕ Adequately addresses the issue ◑ Partially addresses the issue ○ Does not address the issue

3.1.1 Option 1 – Do Nothing (Base Case)

This option involves deferring any work to address the non-compliant line spans until the following regulatory period. This is not a technically acceptable option as Power and Water is required to take reasonable and prudent action to ensure compliance with safety standards, including complying with the specified minimum clearances in AS/NZS 7000.

This option does not impose any additional costs on Power and Water but does not address the non-compliant poles and line spans and would therefore not address the inherent safety risk nor the reliability risk associated with loading constraints during contingency conditions.

This option would not meet the expectations of customers and other stakeholders who expect Power and Water to act prudently, particularly with respect to addressing compliance issues involving threats to public safety.

Similarly this option does not align with Power and Water's asset management objectives.

This option is not recommended.

3.1.2 Option 2 – Rectify all non-compliant line sections by 2028/29

This option will address 66kV line poles and spans that are expected to be non-compliant in the next RCP at an estimated cost of $4.8 million (real 2021/22). This option best fulfils the project objectives of resolving the clearance violations at a prudent and efficient cost. It will address the safety risks to the public and will also allow the network to operate without restriction in normal and contingency scenarios.

The cost estimate has been derived from a bottom-up analysis of the work required, leveraging off the recent experience with similar work in the current RCP.

The advantage of this option is that all spans that are non-compliant with clearance standards would be eliminated by 2028/29 and that any spans unable to meet cyclone ratings will also be addressed.

The design of the rectification works will be to the existing Power and Water Standards. This will maximise constructability and reduce design cost risk. There is little risk of public opposition to the rectification works as it will occur within existing line easements. Works near public roads will be carefully managed with the use of traffic control around work sites. There will be minimal clearing of the site as there is no significant native vegetation within existing Power and Water easements.

This is the recommended option. It will satisfy customers' and other stakeholders' expectations that Power and Water act prudently to remove conditions that are non-compliant with the relevant Australian Standards within a reasonable timeframe.

3.2 Non-Credible Options

The following options were identified but are considered to be non-credible and were not subject to detailed analysis for the reasons provided.

3.2.1 Non-Network alternatives

The are no suitable non-network options available to address the identified issues with these lines. It is not practicable to replace the transmission lines with a non-network alternative such as by establishing generation at targeted points in the network to reduce the load that the transmission lines need to carry. Aside from the relatively high capital and/or operating cost of this approach, because the line sections involved supply areas within the CBD and suburbs of Darwin, there are no suitable locations for such facilities to be constructed.

3.2.2 New transmission line

Construction of new lines to reduce the load carried on the existing network and to improve redundancy in during periods of high wind. Any project to construct a new feeder (including easement acquisition) would be significantly more expensive than modifying the existing lines as recommended in this report.

4 Recommendation

The recommended option is Option 2 - Rectify all non-compliant line sections by 2028/29 as the prudent option to address the identified needs. The estimated cost is $4.8 million (real 2021/22).

The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the transmission system.

4.1 Strategic alignment

This project aligns with the Corporations' key result areas of operational performance and customer centricity, where the goals are to be an efficient provider of services and delivering on customers' expectations. This project will assist Power and Water to meet current and future safety, reliability, and capacity requirements on the transmission system.

4.2 Dependencies

There are no known projects or other network issues that are dependent on the resolution of this network issue.

4.3 Deliverability

The proposed works are equivalent to the similar activities to be completed in the current RCP. No delivery risks have been identified.

The rectification construction work will take place during the northern 'dry' season as this is the only time the electrical demand is low enough to enable transmission lines to be de-energised:

- Temperatures and humidity levels are low enough to allow live-line work to be undertaken
- The reduced prevalence of thunderstorms allows for safe pole and conductor access
- The workforce can work reasonable hours without unacceptable heat stroke risk.
- During the northern 'Wet' season, access to some areas is limited due to flooding and soft ground.

4.4 Customer considerations

As required by the AER's Better Resets Handbook, in developing this program Power Services has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this business case, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure continued reliability, maintainability, and safety of supply.

4.5 Expenditure profile

This cost estimate is based on rectifying the remaining clearance and strength issues in the 66kV transmission network. The table below shows a smoothed expenditure profile over the next RCP. A smoothed profile is likely to be close to the actual expenditure profile because the need to manage planned outages of the critical lines involved is likely to require work over more than one year for each of the three identified lines.

Table 6: Forecast Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	0.96	0.96	0.96	0.96	0.96	4.80
Opex	-	-	-	-	-	-
Total	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**4.80**

4.6 Benefits

The table below summarises the benefits from undertaking the proposed line uprate work.

Table 7: Benefits from the proposed line uprate projects

Driver/Objective	Benefit	Current State	Future State
Safety / Compliance	Reduction of the risk of a fatality through contact with non-compliant power lines	Low line clearances to ground present a safety hazard to the public and are non-compliant with AS/NZS 7000 and Power and Water Standards	No high risk noncompliant line sections in the Darwin-Katherine system under normal or N-1 conditions.
Reliability	Improved reliability of supply for customers	Loss of a single 66kV line in the meshed network may require load shedding to ensure ratings are not exceeded	Loss of a single 66kV line in the meshed network will not result in loss of supply to customers.

4.7 High-level scope

This project will implement required upgrades of the 66kV transmission line spans expected to be non-compliant in the next RCP. The scope of the project includes the following:

- Hudson Creek – Woolner (HC-WN) 66 kV line to rectify remaining clearance and structural strength issues. The estimated cost is $5.0 million with the work expected to be undertaken by FY25[5]
- Increase the contingency rating of both Hudson Creek – Palmerston (HC-PA) and Hudson Creek – Archer (HC-AR) 66 kV lines to at least 83 MVA. Both lines presently have a contingency rating of 64 MVA. The estimated cost is $2.5 million with the work to be completed by FY29.[6]

To achieve this aim, it will be necessary to:

- Update the relevant load, generation, and weather assumptions used in the calculation of normal and contingency line sag closer to the time to confirm the timing and scope of work
- Undertake the detailed engineering design work
- Procure the contract resources to undertake the work
- Schedule the work to account for access limitations – this may involve spreading the work over more than one year.

While the quality and accuracy of the data collected by Aerial LiDAR Surveying is now very good, the same cannot be said about the knowledge of all the transmission line towers and poles structural capacities. While compiling the costings for upgrade options, it has been assumed that the structures can withstand the loads that would be applied to them after rectification works and comply with the requirements of AS/NZS 7000:2016. The true state of the structural capacities of the poles and towers in question will only be realised when detailed engineering studies are undertaken. There is a possibility that some structures may not be capable of being modified to comply with the requirements of AS/NZS 7000:2016 resulting in a more expensive upgrade option being selected, which may impact on the number of spans rectified or the project's budget.

[5] Depending on work scheduling limitations, the work may need to be completed over FY25 and FY26
[6] Depending on work scheduling limitations, the work may need to be undertaken over several years (i.e. FY27-FY29)

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