Distribution Feeder Backup Protection

Business Case

19 November 2024

ERGON ENERGY NETWORK
Part of Energy Queensland

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DOCUMENT VERSION

Version Number	Change Detail	Date	Updated by
1	Approved Version	15/11/2024	General Manager Grid Technology

RELATED DOCUMENTS

Document Date	Document Name	Document Type
05/12/2023	National Electricity Rules Version 204	Rules

1 SUMMARY

<table>
<tr><th>Title</th><th>Distribution Feeder Backup Protection</th></tr>
<tr><td>DNSP</td><td>Ergon Energy</td></tr>
<tr><td>Expenditure category</td><td>☐ Replacement ☒ Augmentation ☐ Connections ☐ Tools and Equipment
☐ ICT ☐ Property ☐ Fleet</td></tr>
<tr><td>Identified need
(select all applicable)</td><td>☐ Legislation ☒ Regulatory compliance ☐ Reliability ☐ CECV ☒ Safety ☐ Environment ☐ Financial
☐ Other
The identified need for the Distribution Feeder Backup Protection program in Ergon Energy is to ensure that all credible faults on the distribution feeders are reliably detected and cleared without causing consequential damage. Distribution Feeder Backup protection ensures network faults are able to be detected in the event that any single component of the safety system fails or is unavailable.</td></tr>
<tr><td>Summary of preferred option</td><td>The proposed option is that, in addition to works associated with planning activities, 30 protection schemes and 90 line reclosers be installed in the 2025-2030 regulatory control period to address compliance issues with the National Electricity Rules.</td></tr>
<tr><td>Expenditure</td><td>
<table>
<tr><th>Year</th><th>2025-26</th><th>2026-27</th><th>2027-28</th><th>2028-29</th><th>2029-30</th><th>2025-30</th></tr>
<tr><td>$m, direct 2022-23</td><td>-</td><td>-</td><td>3.2</td><td>3.2</td><td>3.2</td><td>9.6</td></tr>
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2 PURPOSE AND SCOPE

The purpose of this business case is to evaluate the benefits of the proposed Distribution Protection Backup Protection program.

The scope of the program is to deploy protection devices to the network to ensure that the performance of the network protection systems meets the requirements of the National Electricity Rules specifically in relation to backup protection. All financial references in this document are based on real $2022-23 and exclude overheads.

3 AER FEEDBACK AND OUR RESPONSE

In its Draft Decision, the AER gave the below reasoning for not accepting our proposed investment in *ensuring* we have backup protection for faults on our 11kV and 22kV network:

> *"Ergon Energy submitted that it needs to install new protection systems components to detect network faults to comply with clause S5.1.9(f) of the NER, which cite specific fault clearing times. Ergon Energy states that having no backup protection during a fault current would damage upstream plants and result in a breach. However, we found that Ergon Energy's business case did not clearly demonstrate how the installed assets would contribute to its compliance with clause S5.1.9(f) of the NER.*
>
> *We consider that this project misinterprets the clause and should not apply to low voltage circuits. Investments to address fault clearance times for low voltage circuits is not a sustainable practice and would result in short life assets with significant depreciation costs.*
>
> *Without strong supporting evidence to demonstrate the need for the new components, we do not accept Ergon Energy's proposed total of $11.1 million for this program."*[1]

The AER appear to have four key concerns, with a brief summary of our response to each outlined below:

- **Low voltage networks** – the AER appears to have interpreted that our program is for the low voltage network. We have clarified in this revised business case that our program only treats a lack of backup protection reach issues on the 11kV and 22kV network, which would typically be considered as a high voltage network. We have sought to clarify this in this business case by explicitly referring to our 11kV and 22kV network.
- **Addressing clearance times** – this investment is to address parts of our 11kV and 22kV that do not have any backup protection. That is, if our primary protection device doesn't clear a fault, no other device is capable of clearing a fault. Our intention is not to "address fault clearance times" but rather provide a secondary form of protection to clear a fault. Section S5.1.9(f) does not state a specific clearing time, rather a requirement for operation of a backup protection system to prevent consequential damage. Without backup protection this would not be able to be met.

[1] AER *Attachment 5 Capital Expenditure*, pg.71

- **Rules interpretation** – we acknowledge we didn't make the reasoning for this business case as clear as we could have. The National Electricity Rules (NER) requirement is, at lower voltages, for backup protection to be provided such that the fault current would not "*damage any part of the power system (other than the faulted element)*". The basis of this business case has been to identify those parts of the network where there is no backup protection provided and where the fault current is high enough that left uncleared it would damage upstream conductor.
- **Short life assets** – our proposed investment has a weighted average asset life of 41 years in the AERs standardised capex model, which we do not consider as a short-life asset.

4 BACKGROUND

Clause S5.1.9 of the National Electricity Rules (NER) outlines the requirements for a Network Service Provider's protection systems and fault clearance times. Crucially, clause S5.1.9(c) states:

> *"Subject to clauses S5.1.9(k) and S5.1.9(l), a Network Service Provider must provide sufficient primary protection systems and **back-up protection systems** (including breaker fail protection systems) to ensure that a fault of any fault type anywhere on its transmission system or distribution system is automatically disconnected in accordance with clause S5.1.9(e) or clause S5.1.9(f)."*

This clause requires Ergon Energy Network to provide sufficient back-up protection system on the distribution network to clear a fault in time that would prevent damage to other parts of the network. In the context of our network, short circuit faults can be of the order of 200 to 2,000 Amps. Conductors within a distribution network have thermal ratings below 500A before damage to the conductor occurs. For instance:

- **Raisin** – maximum rating of 128A before damage
- **Moon** – maximum rating of 436A before damage

We have undertaken an assessment of our network, focusing on identifying backup protection issues. This analysis utilises actual field data in our source systems, such as:

- **Protective devices** – we have included our network protective devices in our PowerFactory modelling software to understand where and what would isolate a fault.
- **Protection settings database** – we have utilised the actual protection settings captured in our Protection settings database (IPS). This includes both the primary and backup protection settings of every device used to protect our 11kV and 22kV networks.
- **Conductor type** – this is modelled from our Geographical Information System (GIS) to identify the impedance under fault conditions
- **Fault level** – this is the result of utilising PowerFactory to determine the maximum fault level that a particular network will see following a fault.

We then compared the resultant fault level to the protection setting to determine whether the backup protective device would be able to determine there was a fault on the network and be able to clear that fault. From this we identified inadequate backup protection, which is where the protection system cannot reliably and dependably detect a power system fault.

In simple terms, to do this we have compared the protection setting, which is the current that the protection device is set to be able to clear for any single section of line, and the fault level at that

section of line, which is the current that runs through the section of line. This simple ratio is the protection each factor. As an example, if the protection setting is 200A, while the fault current is 100A, the reach factor is 0.5.

We have captured the reach factor for each segment of feeder in the study area. The results from this study were summarised by area, with each project in Appendix 4 representing a geographical region. 24% of our network was identified as having inadequate backup protection.

Throughout the current regulatory period distribution feeder backup protection projects were included in other network projects where they could be efficiently delivered. This has not resulted in a significant improvement in our distribution feeder backup protection coverage and only met the requirement of the National Electricity Rules in locations where network projects were being undertaken. These projects also did not specifically address high risk areas. This process of addressing distribution feeder backup protection as part of network planning activities will be continued in the first two years of the regulatory period with specific projects to be delivered in the last three years of the next regulatory control period.

5 IDENTIFIED NEED

The identified need for this business case is compliance with the NER. Specifically, NER clause S5.1.9(c) outlines that we must provide back-up protection to ensure that the fault current "*would not damage any part of the power system (other than the faulted element)*". To identify those sections of our network that would be damaged if we were to rely on our backup protection, we undertook a two-step process:

- identify those parts of the with a backup reach factor below 1
- fault level is above 500A

As outlined in Section 4, conductors in the distribution network are not rated to withstand current higher than 500A. As such, if the fault current is above 500A then it follows that this will cause damage to the upstream conductor, breaching S5.1.9(f) by causing damage to the network. Having undertaken this analysis, we have identified that:

- **Reach factor of 1.00** – 185 feeders have a reach factor of below 1.0 and a fault level on sections of feeder beyond the protection reach of greater than 500A
- **Reach factor of 0.75** – 121 feeders have a reach factor of below 0.75 and a fault level on sections of feeder beyond the protection reach of greater than 500A.

To ensure deliverability, we have used the results from the reach factor of 0.75 to prioritise 120 feeders.

It should be noted that there will also be a safety benefit that will result from the improvement of backup reach on our network. Where a fault was to occur and our primary protection fails to operate, without backup protection reach there would be a potential live fault that will not be cleared and would pose a community safety risk. While we have not sought to quantify the risk reduction or provide a positive cost benefit analysis, the community will benefit from improved backup protection reach on more of our assets. The outcome of this assessment is shown in

Table 1 – Number of Feeders with Backup Protection Reach Limitations

Region	Feeders exceeding 0.5kA Fault Level	Average Fault Level (kA)	Maximum Fault Level (kA)	Minimum Fault Level (kA)
Toowoomba	13	2.14	2.70	0.52
Hinchinbrook	2	2.18	2.37	1.99
Maryborough	8	4.07	4.13	3.82
Rockhampton	12	1.57	2.15	0.58
Stanthorpe	3	0.91	0.93	0.87
Cairns	17	2.96	3.38	0.71
Bundaberg	15	1.43	2.00	0.59
Proserpine	10	1.15	1.80	0.78
Bowen	5	0.74	1.00	0.51
Burdekin	4	0.66	0.72	0.59
Callide South	2	1.00	1.00	1.00
Charters Towers	2	0.83	0.82	0.82
Dalby	5	1.37	1.56	0.76
Gladstone	13	1.50	2.40	0.53
Hervey Bay	2	1.42	2.16	0.67
Childers	5	1.29	1.78	0.60
Mackay	18	0.73	1.74	0.50
Mt Isa	9	2.64	2.75	2.41
North Burnett	7	1.26	1.57	0.70
Tablelands	6	0.80	0.86	0.65
Townsville	15	1.66	2.45	0.74
Warwick	2	0.75	0.79	0.70
Yarranlea	10	1.75	3.16	0.58
Total Number of Feeders	**185**			

6 OPTIONS ANALYSIS

In the process of determining the most cost-effective solution to address the identified network limitations, Ergon Energy has sought to identify a practicable range of technically feasible, alternative options that could satisfy the network requirements in a timely and efficient manner.

This program specifically identifies and action high risk sites with a backup protection reach factor below 0.75 and a fault level above 500A. The funding requested as part of this proposal does not address all backup protection reach issues on the Ergon Energy network. Network issues that are unresolved as part of this program will have a plan to be remediate in the next regulatory period.

6.1 Option 1

6.1.1 Summary

Option 1 for this investment is to continue to review backup protection and initiate works to rectify the network backup protection deficiencies as part of network augmentation and operational projects.

6.1.2 Assumptions

It is assumed that no unexpected load increases occur or operational changes occur on the distribution network that trigger a stand-alone protection project to be initiated in years 1 and 2 of the regulatory period.

6.1.3 Costs

Protection scheme installation costs are:

- Protection relay replacement $113,386
- Installation of a line recloser $64,782

It is expected that this program will require the replacement of 10 substation protection schemes per year as well as installation of 30 overhead line reclosers per year to continue to address the backup protection deficiencies in the Ergon Energy network.

6.1.4 Risks

Given that the remediation of backup protection defects is a compliance obligation under the NER, there is no alternative other than to rectify the breach. Failing to do so would place Ergon and its officers at risk of breach of this legislation, particularly in circumstances where there has been a failure to address a known risk. In addition to our regulatory obligation, failing to act creates a potential risk to public safety.

Table 2 Cost overview for Option 1

2025-26	2026-27	2027-28	2028-29	2029-30
$-	$-	$3.2m	$3.2m	$3.2m

7 RECOMMENDATION

It is recommended that, in addition to works associated with planning activities, 30 protection schemes and 90 line reclosers be installed as per Option 1. This program is forecast to cost $9.6M and ensures that the distribution protection on the feeders that are part of these works will comply with National Electricity Rules requirements.

APPENDICES

APPENDIX 1: ALIGNMENT WITH THE NATIONAL ELECTRICITY RULES

Table 2 – Recommended Option's Alignment with the National Electricity Rules

NER capital expenditure objectives	Rationale
A building block proposal must include the total forecast capital expenditure which the DNSP considers is required in order to achieve each of the following (the capital expenditure objectives):	
6.5.7 (a) (2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;	Subject to clauses S5.1.9(k) and S5.1.9(l), a Network Service Provider must provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any fault type anywhere on its transmission system or distribution system is automatically disconnected in accordance with clause S5.1.9(e) or clause S5.1.9(f).
6.5.7 (a) (3) to the extent that there is no applicable regulatory obligation or requirement in relation to: (i) the quality, reliability or security of supply of standard control services; or (ii) the reliability or security of the distribution system through the supply of standard control services, to the relevant extent: (iii) maintain the quality, reliability and security of supply of standard control services; and (iv) maintain the reliability and security of the distribution system through the supply of standard control services	While the primary purpose of this program is compliance with the NER, this program delivers a safety network and addresses some reliability issues associated with network failures.
6.5.7 (a) (4) maintain the safety of the distribution system through the supply of standard control services.	Subject to clauses S5.1.9(k) and S5.1.9(l), a Network Service Provider must provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any fault type anywhere on its transmission system or distribution system is automatically disconnected in accordance with clause S5.1.9(e) or clause S5.1.9(f).
NER capital expenditure criteria	**Rationale**
The AER must be satisfied that the forecast capital expenditure reflects each of the following:	
6.5.7 (c) (1) (i) the efficient costs of achieving the capital expenditure objectives	The consistent use of the estimation system is essential in producing an efficient CAPEX forecast by enabling: • Option analysis to determine preferred solutions to network constraints • Strategic forecasting of material, labour and contract resources to ensure deliverability • Effective management of project costs throughout the program and project lifecycle, and • Effective performance monitoring to ensure the program of work is being delivered effectively.

APPENDIX 2: RECONCILIATION TABLE

Table 3 – Reconciliation

Expenditure	DNSP	2025-26	2026-27	2027-28	2028-29	2029-30	2025-30
Expenditure in business case $m, direct 2022-23 in AER capex model input page	Ergon			**3.2**	**3.2**	**3.2**	**9.6**

APPENDIX 3: STRATEGIC ALIGNMENT

Alignment to Energy Queensland's Strategic Framework

This investment aligns with the following Energy Queensland 'Enable' Building Blocks:

Table 4 – Alignment to 'Enable' Building Blocks

'Enable' Building Blocks	How this investment contributes	Impact
1. Safety The safety of our people, customers and communities is our first priority	*This investment ensures that network faults are reliably detected and disconnected, reducing the risk of fatality, fire and environmental damage*	High
2. Keep the lights on We will design, build and maintain a safe and reliable electricity network	This investment helps to minimise consequential damage to power systems, allowing faster repairs and return to service. Where line reclosers are used as a solution, smaller sections of the network will be exposed to outages.	Medium
3. Financial sustainability We will ensure funds spent are done so prudently and we will grow our revenue streams	Each activity under this investment will be based on specific engineering analysis and will be the most prudent way of meeting the requirement.	Low
4. People & Culture Continue to build a capable & productive workforce to ensure we deliver EQL's electric life ambition.	This program does not have a specific impact on people and culture.	NA

APPENDIX 4: NETWORK STUDY RESULTS

Table 5 – Studied Network

			Absolute values line lengths		
Project	**Lines Segments**	**Modelled line length (m)**	**Line length studied (m)**	**Back-up issue (m)**	**% Backup deficiency**
Cairns	6,814	998,956	876,836	265,900	30%
Cook-Douglas	1,278	687,636	683,083	41,658	6%
Gulf	1,533	3,321,916	3,321,736	406,799	12%
Mt Isa	2,209	1,415,141	1,414,165	271,853	19%
Tablelands	5,988	1,706,915	1,551,061	429,589	28%
Bowen	2,548	925,789	908,287	149,359	16%
Burdekin	7,598	1,974,098	1,521,953	391,023	26%
Charters Towers	3,189	2,773,736	2,180,623	218,916	10%
Mackay	18,052	3,962,504	3,201,690	824,929	26%
Townsville	11,550	1,980,210	1,765,364	258,870	15%
Hinchinbrook	1,089	221,249	221,055	71,143	32%
Ingham	905	715,616	704,554	12,442	2%
Sun Water	14	3,536	3,536	-	0%
North West	180	423,611	423,611	-	0%
Moranbah-Newlands	1,437	1,558,280	335,916	3,696	1%
Maryborough	3,970	955,844	912,549	239,257	26%
North Burnett	3,730	2,217,372	2,215,159	606,185	27%
Roma	5,195	5,205,991	163,757	34,414	21%
Toowoomba	8,556	1,774,989	1,603,606	541,745	34%
Warwick	7,073	2,649,215	2,649,112	863,757	33%
Yarranlea-Oakey	6,957	3,332,422	3,196,788	1,445,281	45%
Dalby	10,893	5,073,359	3,565,927	1,334,364	37%
Gympie	3,124	1,084,439	1,004,301	259,842	26%
Bundaberg-GinGin	12,297	3,533,317	1,232,595	358,468	29%
Callide South	3,114	1,257,434	865,904	279,382	32%
Hervey Bay	3,785	766,910	752,412	35,563	5%
Rockhampton	11,236	3,622,401	1,020,133	270,936	27%
Gladstone	12,870	6,067,105	4,272,208	857,568	20%
Isis-Childers	2,525	702,384	680,611	115,064	17%
Stanthorpe	3,952	1,302,172	1,301,047	439,492	34%
Blackwater	1,644	1,383,075	1,371,730	165,759	12%
			45,921,311	11,193,257	24%