Cost Benefit Analysis Enhancement –

Ergon Energy Draft vs RRP Submission

David Wu & Jake Buckland

October 2024

Summary

Revised Cost Benefit Analysis (CBA):

- Revised based on EMCA / AER feedback from Draft submission
- Improved cost benefit analysis (compared to draft submission model) by introducing prioritisation using risk-based approach.
- Applied the benefit analysis periods based on asset expected life (50 years benefit for poles, 35 years benefit for pole top structures).
- Compared feasible interventions.
- Data quality validation.
- Validation of modelled risk value vs actual data such as outage history and disposed assets information.

Energy Queensland

Progression Between Models - Poles

Enhancements	Draft Submission	AER Visit Oct'24 Analysis	RRP Submission
Individual Pole	Calculated health index	Calculated health index, estimated optimised timing	Calculated health index, estimated optimised timing
Benefit Analysis Period	20 years	50 years benefit (based on expected life)	50 years (based on expected life)
Replacement Prioritisation	Based on health index (for model purpose)	Risk based (for model purpose)	Risk Based (for model purpose)
Data Quality Validation	Accepted given data	Validation against defect history	Validation against actual decommission, removed disposed poles (leads to reduction in optimised pole in first year from 50,000 to 22,248)
LV Feeder Reliability Cost	Based on upstream feeder - average load	Based on upstream feeder - average load	Based on average LV feeder load from 'Actual historical load information' (leads to more realistic risk value)
Degraded Reliability Cost	10% of feeder reliability cost	1% of feeder reliability cost	1% of feeder reliability cost
VCR Derivation	Average AER 2022: $47.27	Average AER 2022: $47.27	Weighted Average AER 2023: $53.47
Year 1 Total Risk Cost (16,600pa Defective Pole Replacement Volume)	$266,025,735	$106,871,224	$88,914,775
Risk Cost Validation	Compared intervention options	Sample checks on actual unassisted pole failure outage	3 year historical actual unassisted pole failure outage ($20.7m) vs year 1 modelled reliability risk cost ($18.2m)

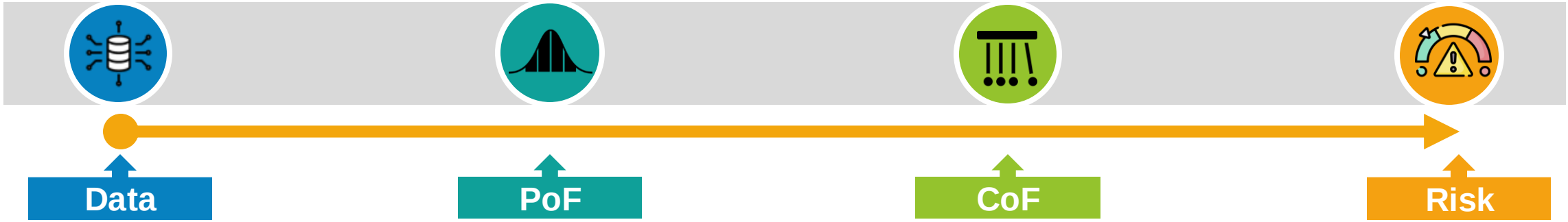
Energy Queensland

Progression Between Models – Pole Top Structure

Enhancements	Draft Submission	AER Visit Oct'24 Analysis	RRP Submission
Analysis Period	20 years	35 years	35 years
Replacement Prioritisation	Probability of failure	Highest risk	Highest risk
Risk Cost (Safety, Financial, Reliability & Bushfire)	Grouped by age	Cost for each individual pole top structure	Cost for each individual pole top structure
Degraded Safety Cost	5% of safety cost	Removed	Removed
Location Safety Factor	Not used	Yes	Yes
Degraded Reliability Cost	10% of feeder reliability cost	1% of feeder reliability cost	1% of feeder reliability cost
Degraded Bushfire Cost	10% of bushfire cost	Removed	Removed
VCR Derivation	Average AER 2022: $47.27	Average AER 2022: $47.27	Weighted Average AER 2023: $53.47
Year 1 Total Risk Cost (9,000pa Defective Pole Top Replacement Volume)	$188,026,162	$75,223,839	$52,141,280
Risk Cost Validation	Compared intervention options	Compared intervention options	3 year historical actual unassisted pole top failure outage vs year 1 modelled reliability cost ($11.6m vs $4.1m)

Energy Queensland

Optimised Pole Model: How It Works



Data

- Individual Asset
- Age
- Material
- Measured Data
- Observed Data
- Failures
- Defects

PoF

- CNAIM – PoF derived from measured and observed condition data
- K Factor (Actual failure data used to scale the PoF)

CoF

- Safety (Location, Fatality or Injury)
- Reliability (VCR)
- Financial (Asset Unit Cost)
- Bushfire

Risk

- CoF x PoF x Loc

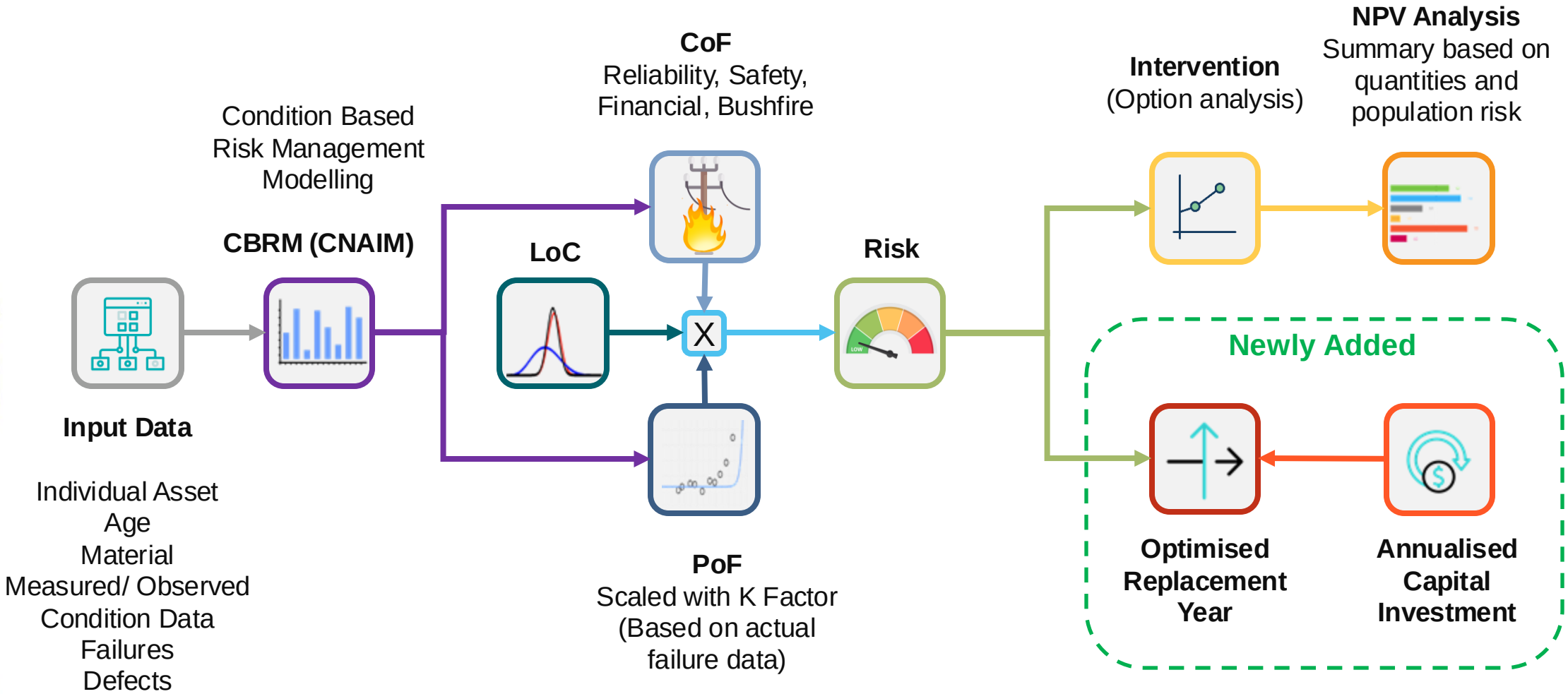
Intervention

- Set replacements volumes – 5 year investment
- **50-year analysis period – based on an average pole life expectancy**
- **Replace on highest risk** – reset HI to 0.5 – capital replacement cost only – no risk
- Catastrophic failures, degraded and nailed assets generated full monetised risk

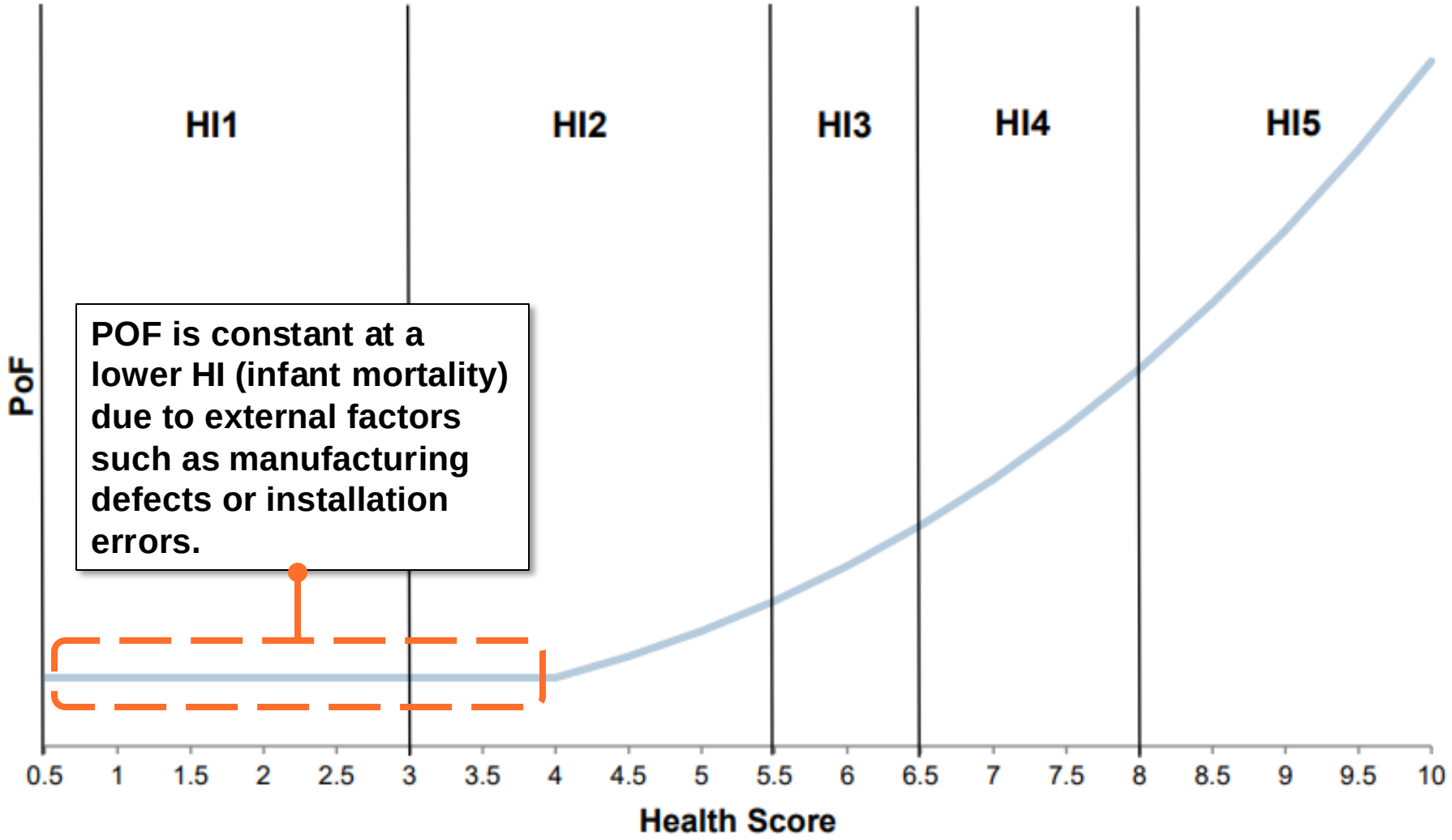
Optimised

Derived optimised replacement timing for individual poles

Predictive Modelling Process



Relationship Between PoF and HI



Optimised Pole Replacement (Annualised Capital investment)

The cost of the pole per year depending on how long the expected life is;

$$\textbf{Annualised Replacement Cost} = \textbf{Replacement Unit Cost} \times \frac{WACC}{1 - (1 + WACC)^{-\text{expected life}}}$$

Where;

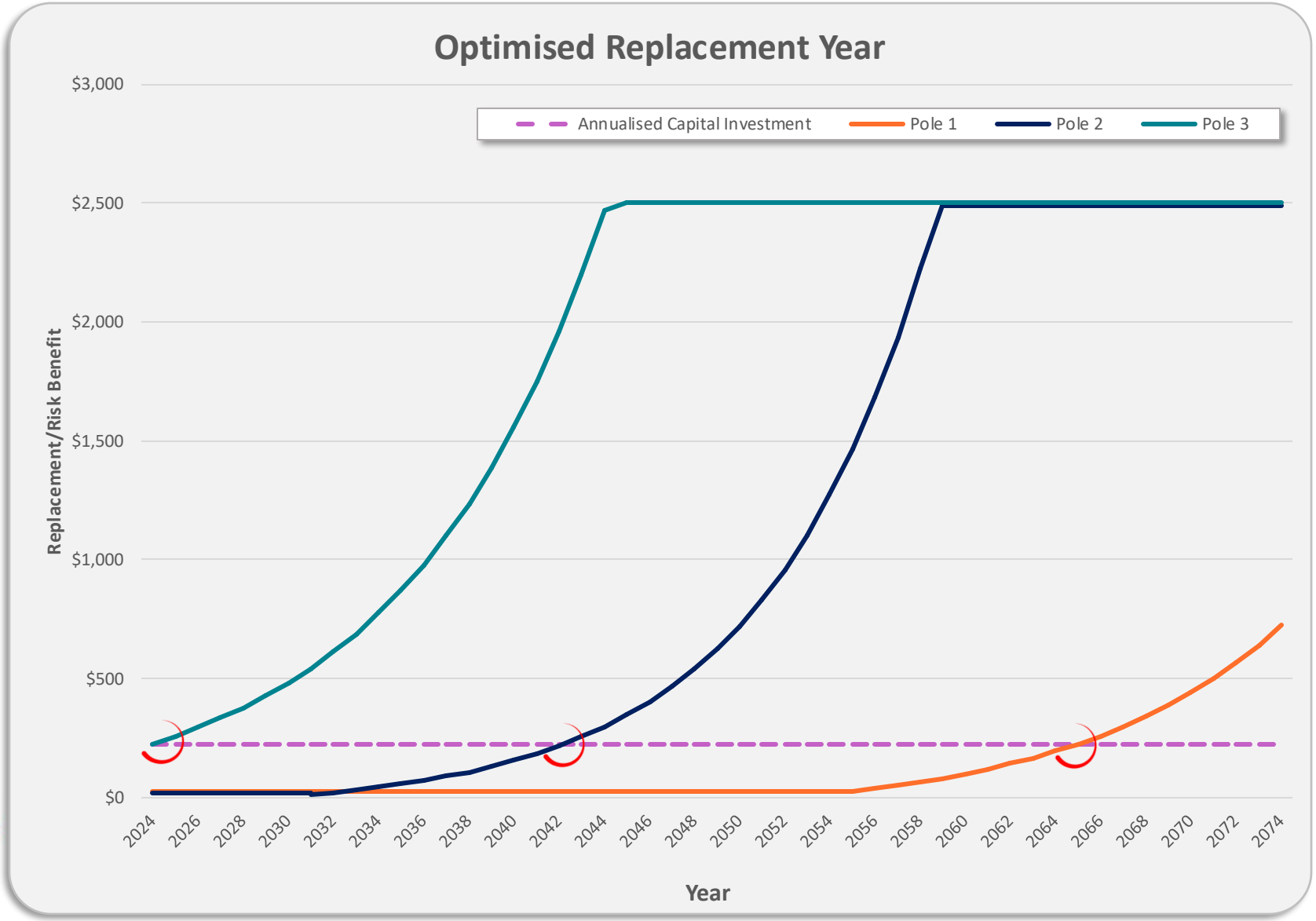
- *Replacement Unit Cost: The cost to replace one unit of asset*
- *WACC: Weighted Average Cost of Capital (3.5% used)*
- *Expected Life:* Years of useful asset life

Example : For a pole

Costs: $6,236 (Based on CoF)
with an expected life of 60 years

= $5,679 x 0.035 / 1-(1+0.035)$^{-60}$
= $227

Optimised Replacement Time



The crossing point between Replacement Benefit and Annualised Cost is the Optimised Timing.

optimum time for replacement

Net Present Value (NPV) Analysis

The process to calculate the net present value of the intervention options.

HI PoF Intervention CoF

Population Risk WACC Replacement Cost

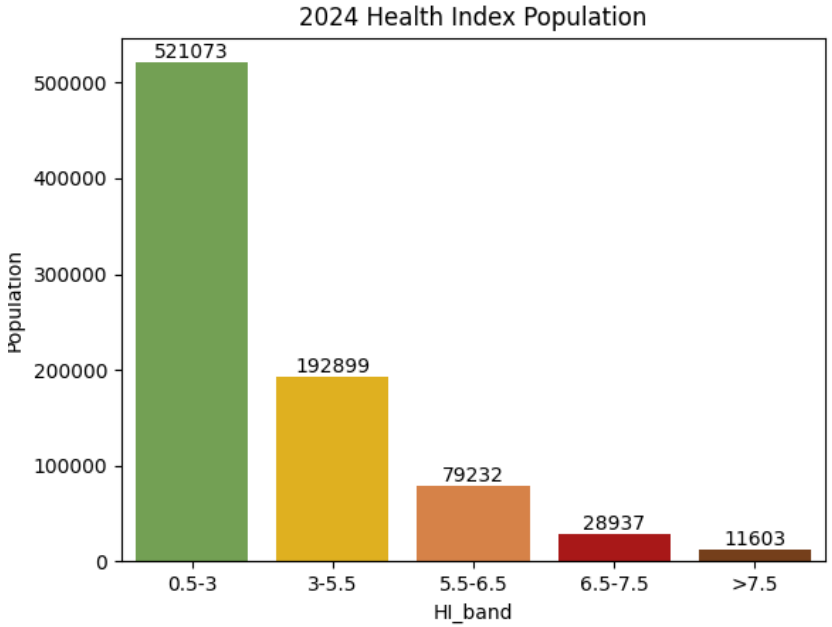
CAPEX (NPV) Benefit (NPV)

Net NPV

Energy Queensland

Ergon Energy - Poles

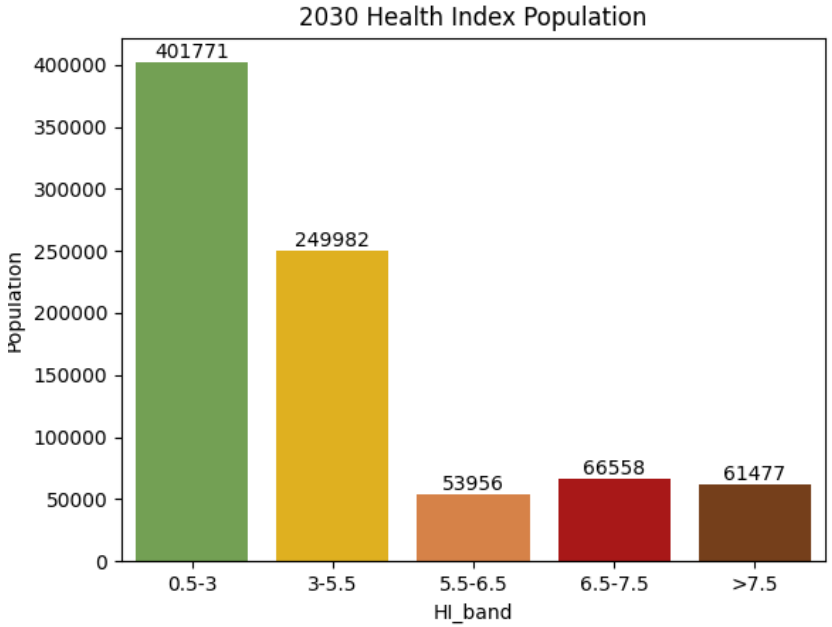
Health Index (HI) Profile in 2024



After detailed interrogation and data validation, the number of poles with HI greater than 7.5 is 11,603 as of year 2024.

Health Index Range	Draft Submission 2024	AER Visit Oct'24 Analysis 2024	RRP Submission 2024
0.5 – 3.0	560,889	560,737	521,073
3.0 – 5.5	183,817	205,600	192,899
5.5 – 6.5	40,115	48,977	79,232
6.5 – 7.5	46,475	29,179	28,937
7.5+	34,913	21,716	11,603

Health Index Profile in 2030 (with no intervention)



As of 2030, the number of poles beyond HI of 7.5 is 61,477 as predicted by the model using the 'below ground' condition monitoring measurements.

Health Index Range	Draft Submission 2030	AER Visit Oct'24 Analysis 2029	RRP Submission 2030
0.5 – 3.0	477,066	490,920	401,771
3.0 – 5.5	185,559	225,449	249,982
5.5 – 6.5	79,099	47,941	53,956
6.5 – 7.5	33,487	35,778	66,558
7.5+	90,998	66,121	61,477

Energy Queensland

Model Validation (HI) with Unserviceable Poles

- Unserviceable poles are driven by two types of degradation (see the table below):
  - Approximately 70% of defective poles replaced are based on “below ground” degradation
  - Approximately 30% of defective poles replaced are based on “above ground” degradation
- The model can ONLY estimate the “below ground” degradation using the condition monitoring measured data of the sound wood. There are no condition threshold available with “above ground” degradation to be used as a measured condition.
- It is anticipated that approximately 30% more unserviceable poles (due to “above ground” degradation) will not be captured by the predictive model, particularly those with an HI above 7.5.
  - By 2030, the model predicts 61,477 unserviceable poles due to “below ground” degradation. Accounting for an additional 30% (26,348 poles) with “above ground” degradation, which the model cannot predict, the total forecast for unserviceable poles in 2030 is estimated to be between 87,000 to 88,000.

Actual Unserviceable History	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
Below Ground Condition	68%	72%	71%	70%	71%
Above Ground Condition	32%	28%	29%	30%	29%

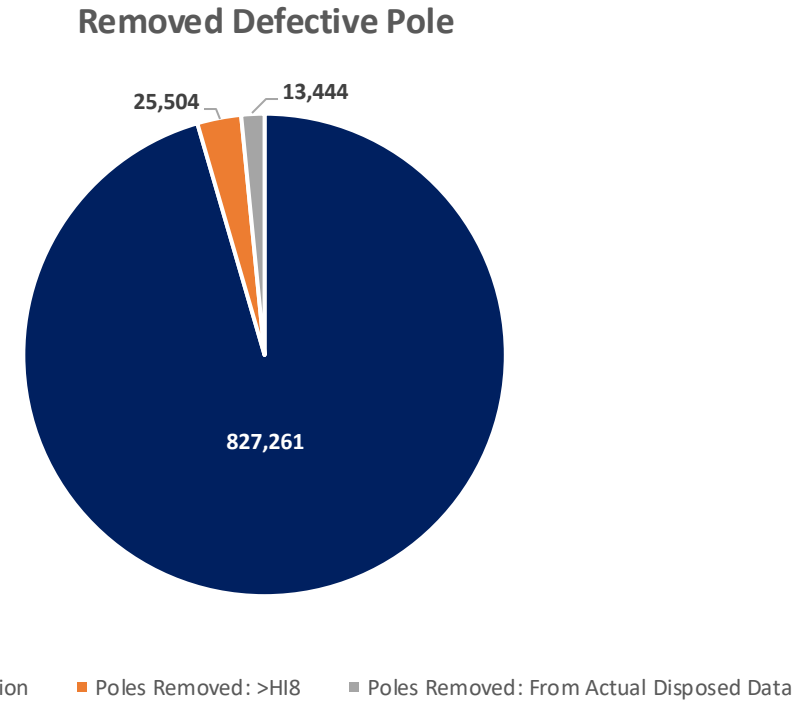
Energy Queensland

Model Validation (HI) with Disposed Defective Pole Data

A comparison of poles with a modelled HI greater than 8 against historical defect data showed that these poles had already been decommissioned, though this information was not promptly updated in the system due to delays in the decommissioning process.

This finding confirms the model's ability to consistently predict unserviceability for poles with an HI above 8, as expected.

Consequently, these decommissioned assets have been removed from the model to align it more closely with the actual network conditions.



Model Validation (HI) with Rapid Degradation

The model cannot predict poles that undergo rapid degradation between inspections (e.g., sound wood thickness declining from 100mm to 30mm within five years) because its aging degradation curve follows CBRM CNAIM principles, which may not account for such sudden changes.

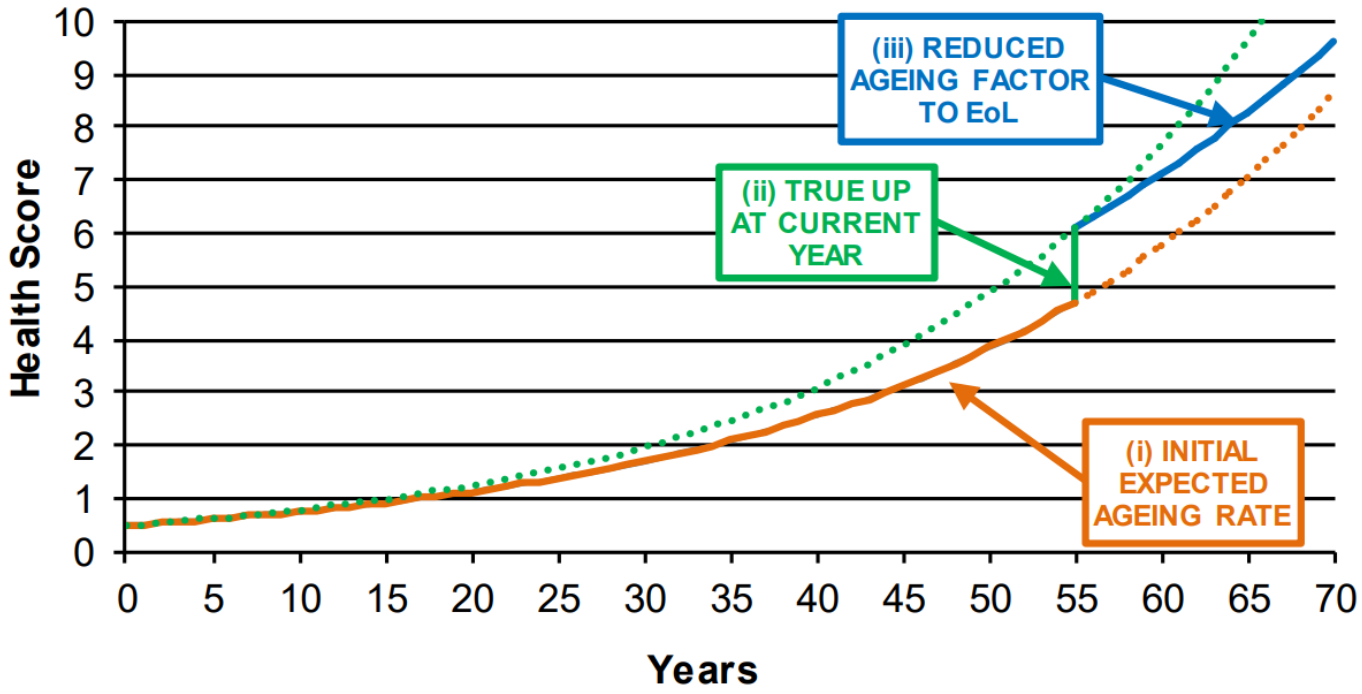


FIGURE 7: EFFECT OF AGEING REDUCTION FACTOR ON ASSET DETERIORATION

Source: DNO COMMON NETWORK ASSET INDICES METHODOLOGY V4

Total Risk Cost

Reduction in risk cost against previous draft determination submission model vs the revised regulatory proposal (matured) model.

Draft Submission	Year 1 Risk	Year 5 Risk	Year 20 Risk
Counterfactual (16622)	$ 266,025,735	$ 250,968,123	$ 528,865,973
REPEX Cost Scenario (10413)	$ 282,622,408	$ 280,882,791	$ 675,113,069
Health Index (13250)	$ 274,396,216	$ 265,117,605	$ 605,497,678
REPEX Live Scenario (5745)	$ 299,038,054	$ 323,105,525	$ 885,397,020
Counterfactual +2k Targeted (18622)	$ 261,058,113	$ 244,859,273	$ 494,488,547

AER Visit Oct'24 Analysis	Year 1 Risk	Year 5 Risk	Year 50 Risk
Counterfactual - Pre 2018-19 Volume (8000)	$ 109,672,741	$ 117,578,040	$ 1,461,783,749
1 - Replaced Failed Poles	$ 111,962,309	$ 135,609,650	$ 1,541,318,769
2 - Low Volume (5000)	$ 110,953,842	$ 122,317,094	$ 1,490,414,404
3 - Proposed Volume (16600)	$ 106,871,224	$ 105,179,583	$ 1,353,128,927
4 - Proposed + 10000 Low Strength (3kN) Poles	$ 104,912,869	$ 102,943,975	$ 1,248,044,862
5 - Proposed + 20000 Low Strength (3kN) Poles	$ 104,624,867	$ 102,923,196	$ 1,221,872,439

RRP Submission	Year 1 Risk	Year 5 Risk	Year 50 Risk
Counterfactual - Pre 2018-19 Volume (8000)	$ 90,854,594	$ 102,277,021	$ 1,421,217,027
1 - Replaced Failed Poles	$ 91,520,377	$ 111,016,947	$ 1,464,522,572
2 - Low Volume (5000)	$ 91,509,380	$ 105,365,778	$ 1,441,813,307
3 - Proposed Volume (16600)	$ 88,302,658	$ 92,046,153	$ 1,338,455,271
4 - Proposed + 10000 Low Strength (3kN) Poles	$ 86,932,376	$ 88,676,670	$ 1,231,826,041
5 - Proposed + 20000 Low Strength (3kN) Poles	$ 86,542,994	$ 88,660,488	$ 1,212,465,981

Energy Queensland

Model Validation (Risk Cost) with Actual Outage Data

The actual outage data was collected for each unassisted pole failure:

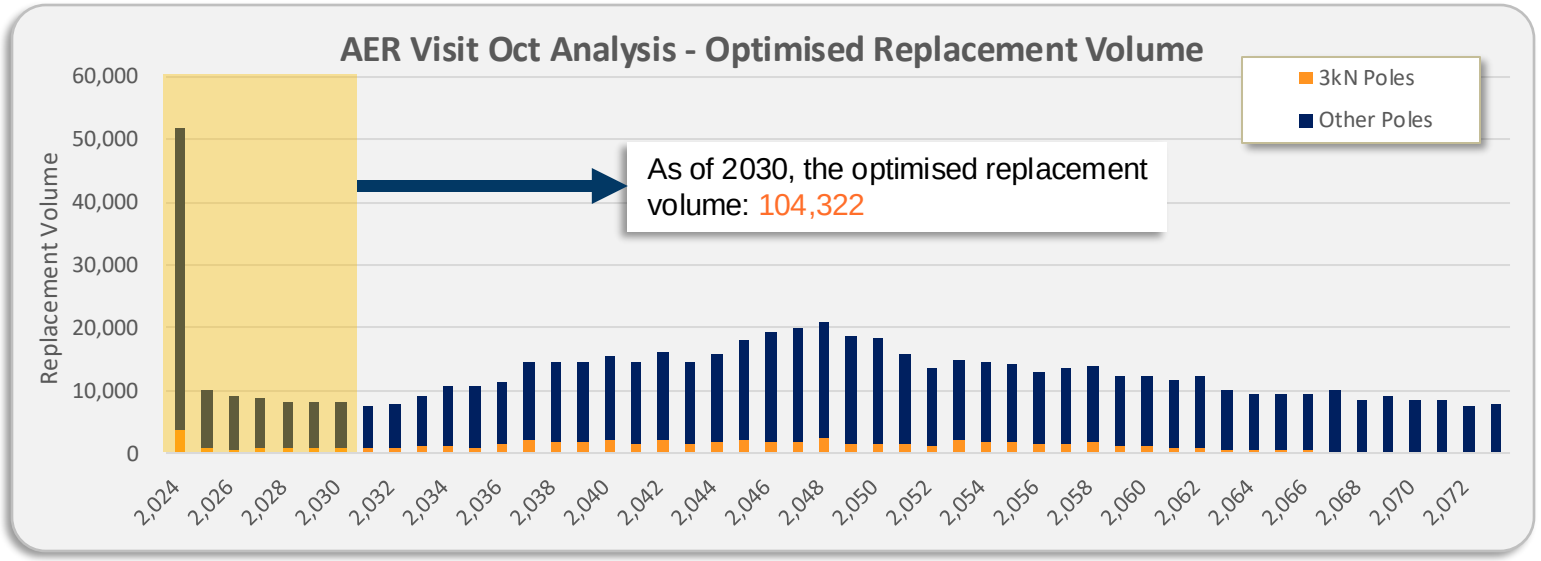
1. For all the outages, the unserved energy to the customer was obtained, including the restoration time.
2. The VCR $53.47/kWh value is derived from the weight average calculation based on the AER 2023 VCR publication.
3. Using the $53.47/kWh, the reliability cost is calculated for each unassisted failure.
4. This reliability cost is then compared with the predictive model's reliability risk cost output.
5. The same concept is applied to pole top structures.
6. In the FY2022-23, the **outage reliability cost** due to unassisted pole failures of $20.7m (shown in the table below) is comparable with the **year 1 predictive model output** of $18.2m.
7. In the FY2022-23, the **outage reliability cost** due to unassisted pole top structure failures of $11.6m (shown in the table below) is comparable with the **year 1 predictive model output** of 14.9m.

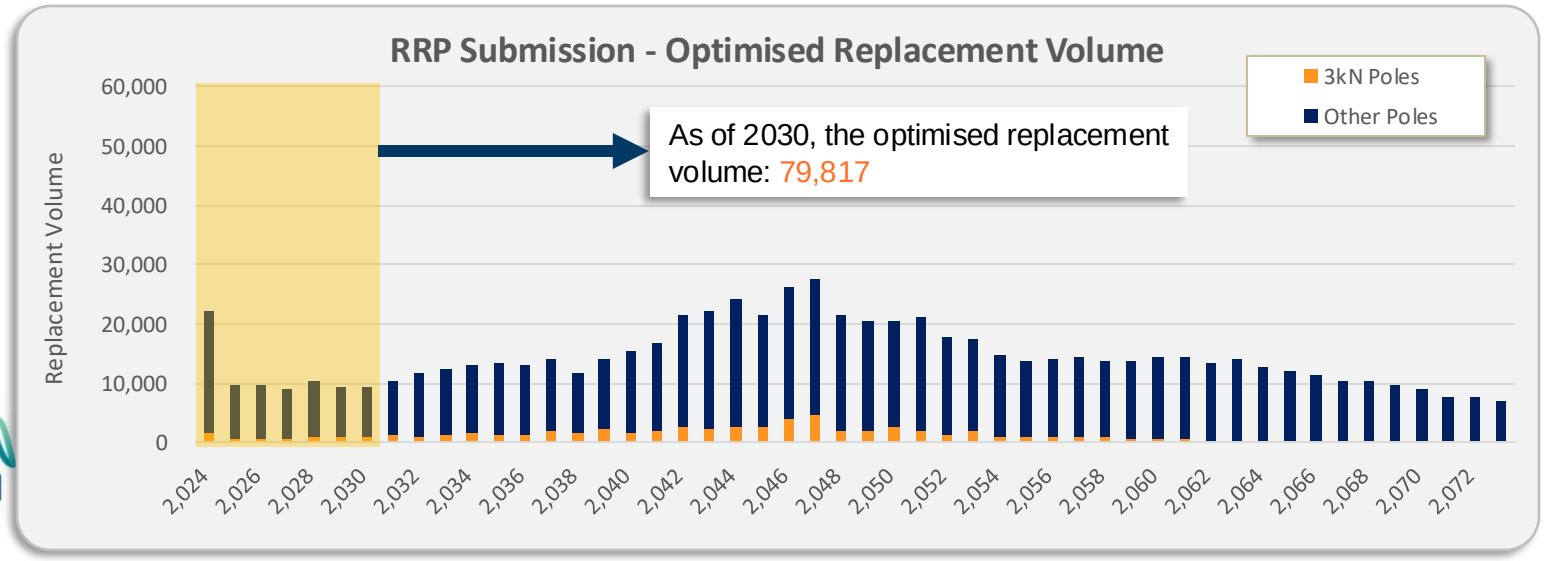
VCR Used **$53.47/kWh**

Asset : Poles			
Financial Year	**2021/22**	**2022/23**	**2023/24**
Reliability Cost (Unassisted Failures)	$ 11,294,252	$ 20,706,765	$ 19,548,900

Asset : Pole Top Structure			
Financial Year	**2021/22**	**2022/23**	**2023/24**
Reliability Cost (Unassisted Failures)	$ 13,223,025	$ 11,635,256	$ 3,000,398

Optimised Pole Replacement





- The discrepancy between the optimised models presented during the October AER visit and the RRP submission arises from data quality validation efforts.
- Following the data quality validation, the optimized volume for the initial year (2024) decreased from 50,000 to 22,200. This reduction reflects the replacement or reinforcement of most poles with an estimated Health Index (HI) above 10, leading to their removal from the model to better represent the current network.

Can Ergon consider the Optimum Investment Plan?

The answer is “yes” if:

- Change in QLD “Distribution Authority” asset management
- Electrical Safety Office - ESCOP limit removed
- Electrical Safety act change
- Change in policy requirement for rectification of defective pole timeline

NPV Analysis – Replacement with Wood Pole

After all the required changes to the model in the RRP Submission model, the NPV results shown the proposed volume (option 3) is NPV positive and benefit to our customers.

Please note: Option 3 Proposed volume is our Expost actual volume (2018/19 to 2022/23) and also this is the same volume we proposing for our forecast (2025-30)

Draft Submission (PIR)

	Rank	Net NPV incl CCPEX	CAPEX (NPV)	Benefit (NPV)	CCPEX NPV	CCPEX Benefits NPV
Counterfactual	5	0	0	0	$0	$0
Option 1 Historical Average	4	$98,387,777	-$18,685,033	$121,587,710	-$6,792,145	$2,277,244
Option 2 Health Index	2	$572,938,131	-$173,262,304	$785,651,889	-$55,517,083	$16,065,629
Option 3 AER REPEX Live Scenario	3	$460,587,755	-$114,172,656	$601,437,875	-$37,714,124	$11,036,659
Option 4 Actual Delivery	1	$575,523,301	-$184,382,291	$797,401,422	-$51,223,639	$13,727,809

AER Visit Oct'24 Analysis

Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR
Counterfactual - Pre 2018-19 Volume (8000)	4	$0	$0	$0	4
1 - Replaced Failed Poles	6	-$522,025,969	$284,846,392	-$806,872,361	5
2 - Low Volume (5000)	5	-$125,317,180	$116,500,006	-$241,817,186	6
3 - Proposed Volume (16600)	1	$439,161,629	-$285,884,761	$725,046,390	1
4 - Proposed + 10000 Low Strength (3kN) Poles	2	$437,788,192	-$564,605,171	$1,002,393,363	2
5 - Proposed + 20000 Low Strength (3kN) Poles	3	$366,054,292	-$664,791,078	$1,030,845,370	3

NPV Analysis to Counterfactual

Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR Rank
Counterfactual - Pre 2018-19 Volume (8000)	4	$0	$0	$0	4
1 - Replaced Failed Poles	6	-$187,889,627	$314,290,891	-$502,180,518	5
2 - Low Volume (5000)	5	-$86,177,397	$108,328,000	-$194,505,397	6
3 - Proposed Volume (16600)	3	$380,460,391	-$314,971,405	$695,431,796	1
4 - Proposed + 10000 Low Strength (3kN) Poles	1	$530,552,513	-$583,812,502	$1,114,365,015	2
5 - Proposed + 20000 Low Strength (3kN) Poles	2	$489,858,444	-$663,372,171	$1,153,230,616	3

NPV Analysis – Alternative Pole Material

NPV analysis were also conducted for alternative replacement pole materials – concrete and composite. The replacement expenditure of these alternative material is more than wood pole, but this did not impact the outcome for our proposed volume.

NPV Analysis - Concrete Poles					
Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR Rank
Counterfactual - Pre 2018-19 Volume (8000)	4	$0	$0	$0	4
1 - Replaced Failed Poles	6	-$540,388,347	$592,232,544	-$1,132,620,892	6
2 - Low Volume (5000)	5	-$111,586,789	$236,068,947	-$347,655,736	5
3 - Proposed Volume (16600)	2	$343,494,022	-$588,843,630	$932,337,653	1
4 - Proposed + 10000 Low Strength (3kN) Poles	1	$416,871,815	-$1,129,302,916	$1,546,174,731	2
5 - Proposed + 20000 Low Strength (3kN) Poles	3	$318,877,392	-$1,291,615,053	$1,610,492,445	3

NPV Analysis – Composite Poles					
Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR Rank
Counterfactual - Pre 2018-19 Volume (8000)	3	$0	$0	$0	4
1 - Replaced Failed Poles	6	-$1,248,910,077	$797,224,600	-$2,046,134,677	6
2 - Low Volume (5000)	5	-$359,155,184	$326,397,440	-$685,552,624	5
3 - Proposed Volume (16600)	1	$98,488,386	-$1,044,897,567	$1,143,385,953	1
4 - Proposed + 10000 Low Strength (3kN) Poles	2	$34,698,073	-$1,919,966,941	$1,954,665,014	2
5 - Proposed + 20000 Low Strength (3kN) Poles	4	-$128,003,576	-$2,172,212,730	$2,044,209,153	3

NPV Analysis – Wood vs Alternate Material

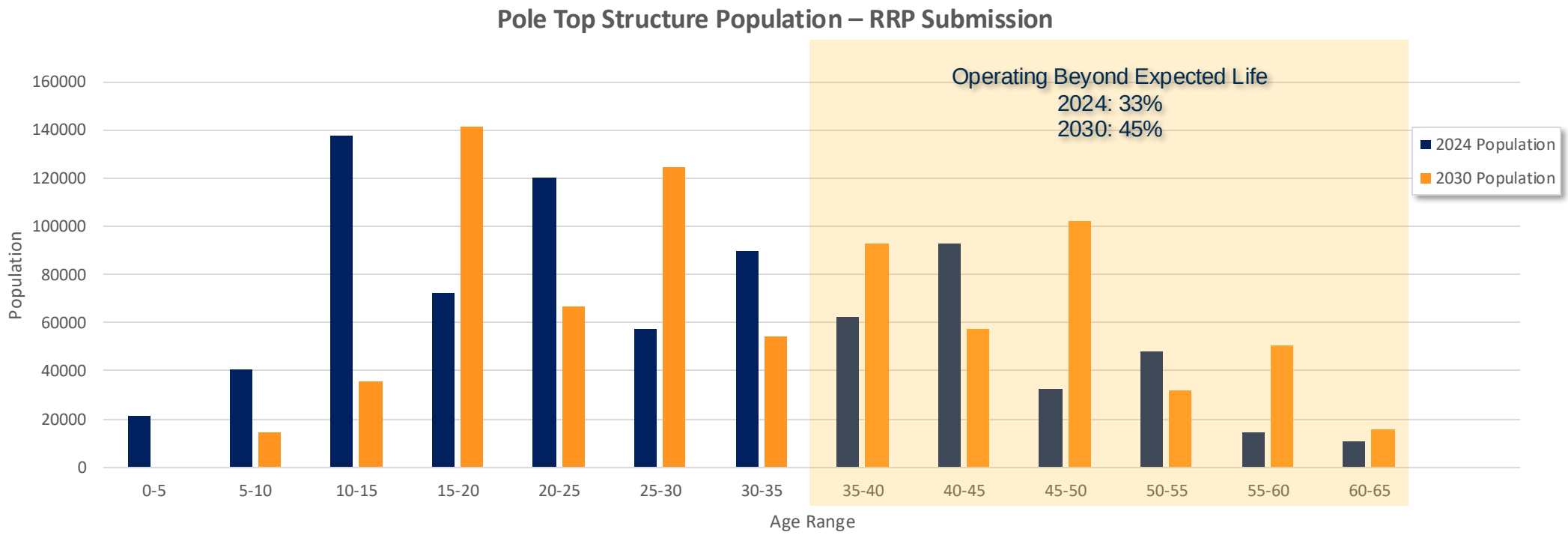
NPV analysis comparing the Replacement with wood pole option with concrete and composite options. The outcome reflects the wood pole option is the cost benefit solution to maintain the service level of our customers.

NPV Analysis to Counterfactual					
Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR Rank
Counterfactual - Pre 2018-19 Volume (8000) - **Wood**	3	$0	$0	$0	3
1 - Replaced Failed Poles - **Wood**	5	-$187,889,627	$314,290,891	-$502,180,518	4
2 - Low Volume (5000) - **Wood**	4	-$86,177,397	$108,328,000	-$194,505,397	5
3 - Proposed Volume (16600) - **Wood**	2	$380,460,391	-$314,971,405	$695,431,796	2
4 - Proposed Volume (16600) - **Concrete**	6	-$2,658,890,817	-$871,281,199	-$1,787,609,618	6
5 - Proposed Volume (16600) - **Composite**	7	-$5,810,001,467	-$1,535,380,707	-$4,274,620,760	7
6 - Proposed + 10000 Low Strength (3kN) Poles - **Wood**	1	$1,039,131,613	-$583,812,502	$1,622,944,115	1

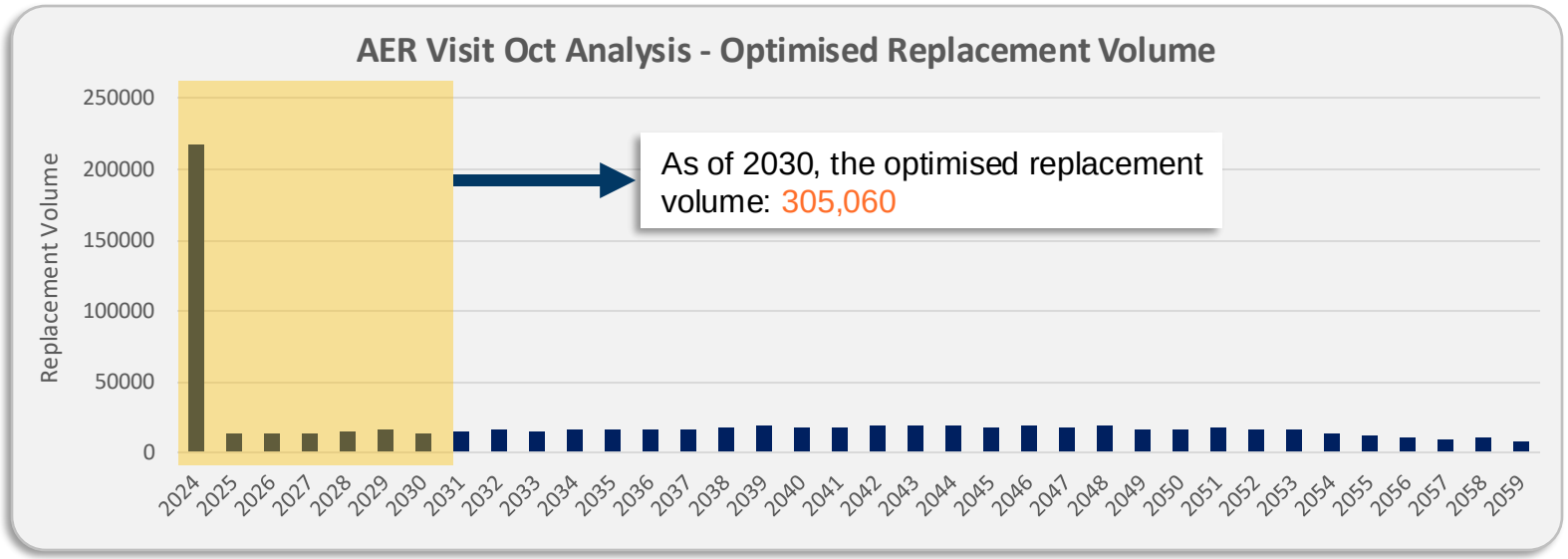
Ergon Energy – Pole Top Structure (Crossarm)

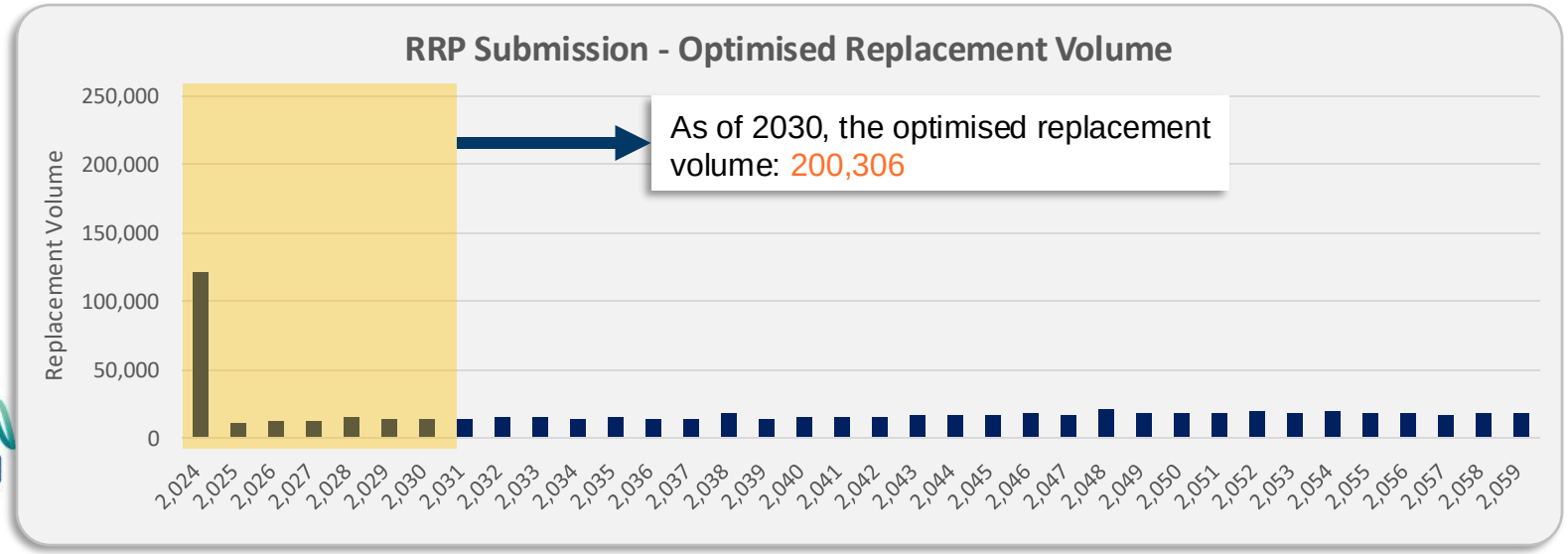
Age Profile

The age of pole top structures are inferred from poles. Currently, 33% of pole top structures are operating beyond it's expected life in the network.



Optimised Pole Top Structure Replacement





- Difference between optimised models during the October AER visit vs RRP submission due to data quality validation done to the pole (refer slide 9).
- As a result, the optimised pole top volume reduced from 218,000 to 121,000 in 2024.

Total Risk Cost

Reduction in risk cost against previous draft determination submission model vs the revised regulatory proposal (matured) model.

Draft Submission	Year 1 Risk	Year 5 Risk	Year 10 Risk	Year 20 Risk
Counterfactual	$ 188,026,162	$ 206,350,633	$ 334,889,569	$ 417,793,572
1. Counterfactual +50% Targeted	$ 188,026,162	$ 189,203,237	$ 324,218,630	$ 408,463,929
2. Counterfactual -50%	$ 131,173,633	$ 196,179,748	$ 419,401,675	$ 499,295,736
3. Counterfactual +7,000 Targeted	$ 188,026,162	$ 179,803,516	$ 318,363,108	$ 403,339,435

AER Visit Oct'24 Analysis	Year 1 Risk	Year 5 Risk	Year 10 Risk	Year 20 Risk	Year 35 Risk
Counterfactual: Historical Defect Average (8736)	$ 75,223,839	$ 80,004,097	$ 111,120,213	$ 196,606,817	$ 385,793,020
1 - Replaced Failed Pole Top Structure	$ 80,518,238	$ 103,690,204	$ 140,834,774	$ 239,581,017	$ 447,898,926
2 - Defect + Targeted (3500)	$ 73,315,670	$ 72,894,491	$ 102,146,810	$ 183,514,730	$ 366,737,299
3 - Defect + Targeted (7000)	$ 71,529,618	$ 66,555,771	$ 94,173,287	$ 171,958,751	$ 350,074,609
4 - Optimum Replacement Volume (51135)	$ 57,453,418	$ 26,716,541	$ 41,903,075	$ 90,978,781	$ 224,573,266

RRP Submission	Year 1 Risk	Year 5 Risk	Year 10 Risk	Year 20 Risk	Year 35 Risk
Counterfactual: Historical Defect Average (8736)	$ 52,141,280	$ 56,338,972	$ 78,139,932	$ 137,550,499	$ 267,223,491
1 - Replaced Failed Pole Top Structure	$ 55,385,816	$ 71,417,163	$ 96,882,694	$ 164,237,906	$ 305,098,696
2 - Defect + Targeted (3500)	$ 50,952,521	$ 51,551,714	$ 72,189,143	$ 129,092,536	$ 255,296,194
3 - Defect + Targeted (7000)	$ 49,831,284	$ 47,243,095	$ 66,769,164	$ 121,238,378	$ 243,979,738
4 - Optimum Replacement Volume (34528)	$ 44,528,985	$ 29,777,474	$ 44,259,376	$ 87,365,065	$ 193,186,480

Energy Queensland

NPV Analysis

Reduction in risk cost against previous draft determination submission model vs the revised regulatory proposal (matured) model.

Draft Submission				
Intervention	Rank	Net NPV	Additional Cost	Benefit
Counterfactual (8736)	3	$0	$0	$0
1. Counterfactual +50% Targeted (13255)	2	$127,940,476	-$30,972,316	$158,912,791
2. Counterfactual -50% (4368)	4	-$571,694,273	$27,229,463	-$598,923,736
3. Counterfactual +7,000 Targeted (15736)	1	$198,142,825	-$47,978,920	$246,121,745

AER Visit Oct Analysis					
Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR
Counterfactual: Historical Defect Average (8736)	4	$0	$0	$0	4
1 - Replaced Failed Pole Top Structure	5	-$558,159,449	$134,490,444	-$692,649,892	5
2 - Defect + Targeted (3500)	3	$158,941,932	-$52,570,397	$211,512,329	1
3 - Defect + Targeted (7000)	2	$295,625,618	-$103,021,711	$398,647,329	2
4 - Optimum Replacement Volume (51135)	1	$1,093,699,493	-$607,492,801	$1,701,192,295	3

RRP Submission					
Intervention	Rank	Net NPV	CAPEX (NPV)	Benefit (NPV)	BCR
Counterfactual: Historical Defect Average (8736)	4	$0	$0	$0	4
1 - Replaced Failed Pole Top Structure	5	-$293,117,179	$138,035,620	-$431,152,799	5
2 - Defect + Targeted (3500)	3	$86,416,767	-$50,749,551	$137,166,318	1
3 - Defect + Targeted (7000)	2	$163,090,376	-$101,037,845	$264,128,222	2
4 - Optimum Replacement Volume (34528)	1	$440,974,704	-$368,664,018	$809,638,722	3

Strategy is to replace wood crossarm with Composite.

Thank You

Energy Queensland