Australian Energy Regulator

Review of Essential Energy's past and forecast capital expenditure for the 2019/24 regulatory control period

Final draft report

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Contents

Executive summary

Arup has been engaged by the Australian Energy Regulator (AER) to review Essential Energy's network capital plans for the 2019/24 regulatory control period (RCP). The review has looked at information provided in Essential Energy's reset application and supporting documentation, and in the context of past expenditures, network performance and reliability, and its customer's expectations.

Essential Energy owns, maintains and operates the electrical distribution infrastructure to 95% of regional and rural NSW.

Essential Energy's proposed capex for the upcoming RCP reflects its general customer preference for affordability over increased reliability, and is marginally below that of the current RCP. While there is some customer support to improve reliability by 25% in the worst performing areas of the network, generally customers were "satisfied with the current reliability of the network" [1].

This indicates that Essential Energy should generally be able to maintain its current overall reliability profile, and should not need to invest (except in isolated pockets) to improve performance over the coming regulatory period.

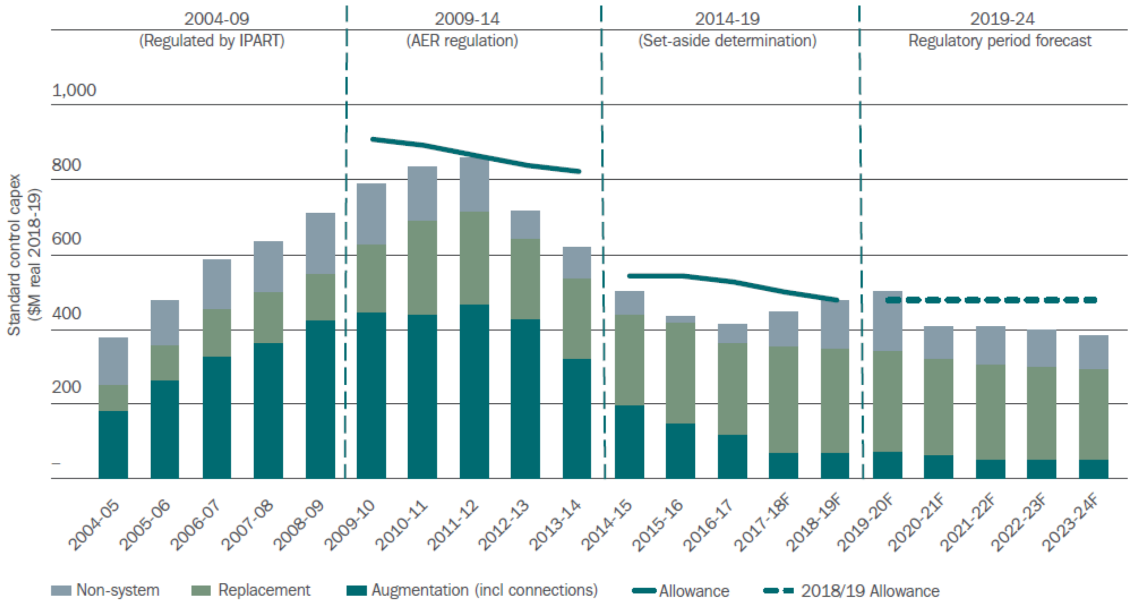

Figure ES 1 Capital expenditure for Standard Control Services[2]

Essential Energy was formed in 2011 following the merger and amalgamation of a number of smaller networks, which has resulted in a number of legacy issues particularly in standardisation of network planning and design, and in its ICT platform rationalisations.

Management is attempting to address these issues through significant investment in updating the strategies and processes that govern capex. Increasing Essential Energy's visibility of their network through better access and synthesis of data should benefit the manner in which

[1] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 67
[2] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 64

projects are optioned and prioritised, leading to more efficient expenditures and lower price pressure to the benefit of its customers.

The AER uses its repex model to forecast asset replacement expenditure in six major categories to inform its allowance decisions. Essential Energy has proposed a significant volume of capex that falls outside the repex model, the majority of which is in pole top structures. This is in part attributed to changes in business and accounting treatments, and in part an increase in replacement volumes driven by greater network visibility of conditional failures, and asset condition. While the process behind the investment appears generally robust, whether this program is impacting on overall risk beyond its customer's appetite is unclear and speaks to Essential Energy's prioritisation process.

The current capital investment framework, which adopts an optimisation program known as 'C55', prioritises projects by value but doesn't provide clear transparency on the impact on overall network risk. Essential Energy may be increasing or decreasing total risk outside of its own or its customer's appetite. For example, Essential Energy considered five options to replace laminated crossarms. Option 2 replaces 950 crossarms from 2020/24 at a cost of $2.8m, and Option 5 replaces 984 crossarms for $11.5m.[3] [4] Option 5 was the preferred option despite what appears to be significant diminishing returns.

Nonetheless, the limited change in proposed capex from the current RCP implies network risk levels for the forecast RCP are likely aimed to be comparable to the current RCP.

Overall, Essential Energy's approach to capex appears to be generally robust, with proposed expenditure approximately in line with historical levels. Essential Energy appears to have a well-structured approach to identifying key project drivers, and the development and prioritisation of options which allows a consideration of lowest cost delivery of outcomes. Updating legacy ICT systems and increasing the capability of project selection and prioritisation tools will be important in Essential Energy maintaining a reliable and affordable network for its customers.

[3] Essential Energy 2018, *ESS_4005 Distribution Pole Tops pg 37*
[4] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, pg 35-36

1 Introduction

1.1 Scope of works

Arup were engaged by the Australian Energy Regulator (AER) in April of 2018 to deliver analysis on TasNetworks' proposed capital expenditure (capex) for the 2019/24 regulatory control period.

The scope of works required Arup to provide technical engineering advice relevant to the AER's assessment under clause 6.5.7 and 6A.6.7 of the National Electricity Rules (NER).

Through consultation with the AER, the scope of works was refined to focus on particular areas identified by the AER, which in turn has been reflected throughout this report.

1.2 Assessment approach

The National Electricity Law states the National Electricity Objective to be:

> *To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:*
>
> - *price, quality, safety and reliability and security of supply of electricity*
> - *the reliability, safety and security of the national electricity system.* [5]

The current version of the National Electricity Rules also consistently refers throughout chapter 6 and 7 to the necessity of a transmission and distribution network operator to be both prudent and efficient.[6]

With this in mind, Arup reviewed Essential Energy's capex program in accordance with the scope of works.

The first formal step of the engagement was an inception meeting held between the AER and Arup on Friday 18 May. The AER provided the context and key risks of the project from their perspective, and project management practices, communications and key milestones were agreed upon.

The inception meeting also provided an opportunity to request additional documents that may not have been provided initially at time of engagement. Key documents at this stage of the engagement included:

- Essential Energy's proposal to the AER
- the AER's repex model
- the AER's presentation of Essential Energy's performance in its forecast capex against the repex model's findings
- Essential Energy's strategic asset management plans

[5] Australian Energy Market Commission, 2018, *National Electricity Rules Version 109*, various
[6] Australian Energy Market Commission, 2018, *National Electricity Rules Version 109*, various

- Essential Energy's various high level asset management plans, NPVs and investment summaries.

Key staff from Essential Energy met with the AER and Arup in Melbourne for a workshop in May 29. Both Arup and the AER had prepared questions for Essential Energy based on a preliminary review of the documents provided to Arup by the AER. The workshop, along with a follow up meeting in Port Macquarie in early June allowed staff from Essential Energy to respond to the questions put to them.

Essential Energy team's responses to the various questions put to them both at the interviews and in formal information requests, as well as discussions with the AER on areas for prioritised analysis, also form part of Arup's review.

Arup's review of these items, and the observations on the capex in reference back to the original scope and the NEO, form the analysis found in this report.

1.3 Report structure

The **Executive summary** is an overview of the engagement and the key observations contained in this report.

Section 1 - Introduction provides the background for this report in describing the scope of works, the assessment approach, and the report structure.

Section 2 – Essential Energy overview describes the context in which Essential Energy operates, in terms of its physical environment, its recent merger and its capex in the most recent regulatory period.

Section 3 - Strategic observations covers the key processes that impact on Essential Energy's proposed capex. Processes are assessed in terms of their prudency and efficiency in meeting Essential Energy's obligations while keeping prices in a reasonable range. This section covers the key processes and tools that underpin Essential Energy's capital budgeting, including Copperleaf C55, risk quantification and investment cases.

Section 4 – Replacement capital expenditure analyses Essential Energy's repex program, including an overview of repex that's modelled by the AER as well as a more detailed assessment into un-modelled pole top structures.

Section 5 – Augmentation capital expenditure assesses key elements of Essential Energy's distribution augex profile.

Section 6 – Non-network capital expenditure considers the prudency and efficiency of Essential Energy's ICT transformation program and capex proposal, as well as other non-network capex including fleet and property programs.

2 Essential Energy overview

This chapter provides a high-level overview of Essential Energy and its submission. This chapter has three parts:

- 2.1 describes the background to Essential Energy and associated legacy issues
- 2.2 outlines the network and its performance
- 2.3 summarises the capital expenditure submission.

2.1 Background

Essential Energy was formed in 2011 following the sale of Country Energy's brand and retail division to Origin Energy. Country Energy itself was established in 2001 following the merger of Great Southern Energy, Advance Energy and North Power.

Essential Energy faces many of the same challenges as its NEM counterparts including:

- reducing capex in response to lower than expected demand and consumer price preferences
- shifting expenditure from augex to repex
- an increasing requirement to be able to handle two-way networks with the increasing integration of renewables and storage.

Arup observation

Country Energy's amalgamation from smaller utilities has caused significant legacy issues for Essential Energy, such as:

- lack of asset standardisation
- outmoded ICT systems that do not integrate seamlessly
- fragmented AMS.

However, the history of Essential Energy is not unique in the NEM, with other distribution networks having formed as a result of merging smaller networks. The key challenges it faces are also shared by many of its counterparts, particularly those with a rural focus.

2.2 Network

Essential Energy is a government owned distribution network. It owns, maintains and operates the electrical distribution infrastructure to 95% of regional and rural NSW.

Essential Energy's key network metrics include:

- 1,381,578 power poles
- 377 zone substations
- 183,612km of overhead lines

- Average age of network assets is 36 years
- 840,000 customers.

Arup observation

The wide geographic distribution means Essential Energy's assets are subject to different climatic challenges. Dispersion of assets increases the unit rate for maintenance and inspection activities, as most of the cost is borne through mobilisation. However, this means there is opportunity to increase efficiency through ICT and asset management transformation that enables better coordination of works planning and proactive asset management.

2.3 Performance

Essential Energy's average availability of supply is currently around 99.96%. This has improved over the years. In 2005-2006, the average time per year that Essential Energy customers were affected by unplanned supply interruptions (SAIDI) was over five hours (300+ minutes). In 2016-17, their average time without supply reduced to just under four hours (233 minutes) – an improvement of over 20 per cent. Similarly, SAIFI has improved by over 30% to 1.8 unplanned outages in 2016-17. [7]

Essential Energy's network performance improved between 2005/06 to 2011/12. This stabilised over the following period where Essential Energy did not make further investment in network performance improvement.

[7] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 27

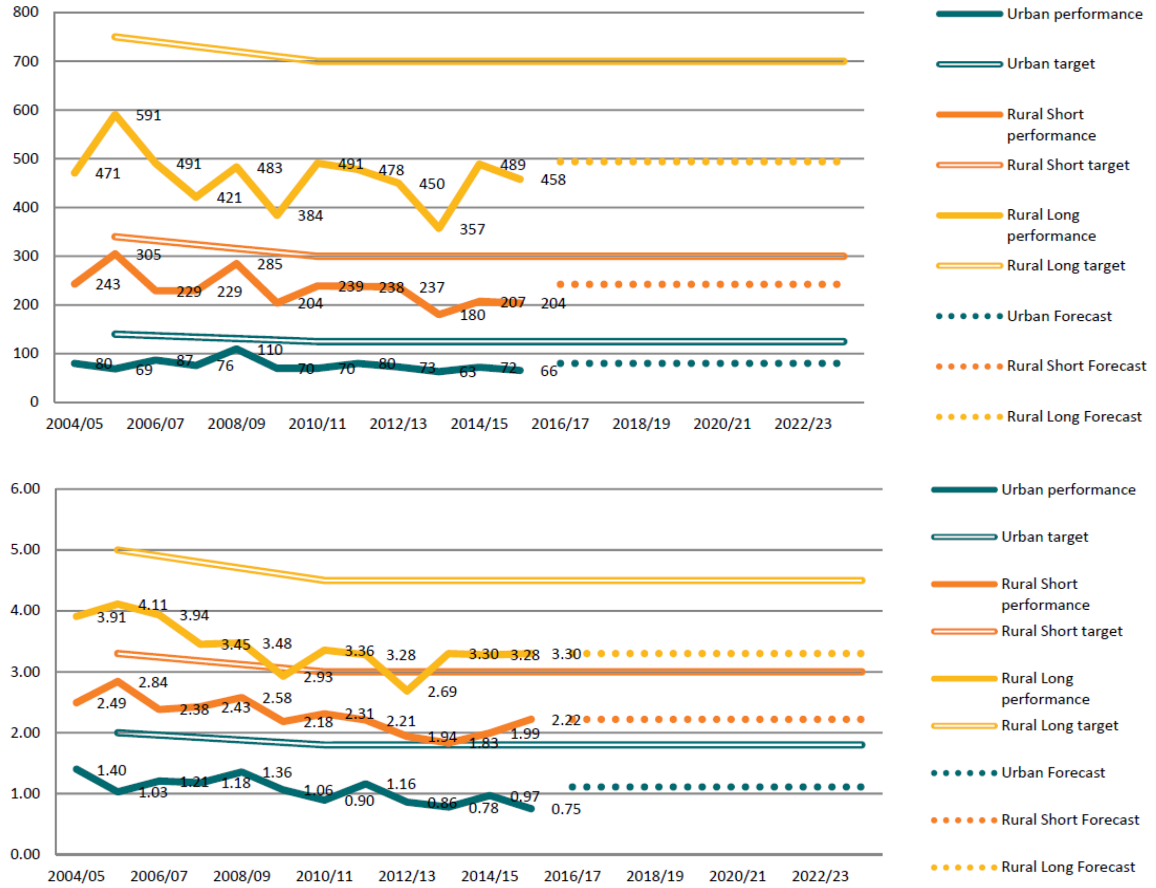

Figure 1 SAIDI (top graph) and SAIFI (bottom graph) performance compared to License Schedule 2 requirements[8]

Essential Energy states that the forecast SAIDI and SAIDI performance assumes:

- no network-wide reliability performance gains are realised from any previous programs of work
- as has been the case over the 2013/14 to 2018/19 period, programs of work from 2019 to 2024 are designed to maintain current network performance
- asset management practices will continue to target the management of current asset failure rates
- the impact of weather on underlying performance remains unchanged at current levels.

Essential Energy's 2017 customer engagement showed that customers are generally satisfied with this level of performance.

[8] Essential Energy, 2018, *Supporting Document 12.1.7 Reliability Strategy – COP2463 2019-24*, pg 17

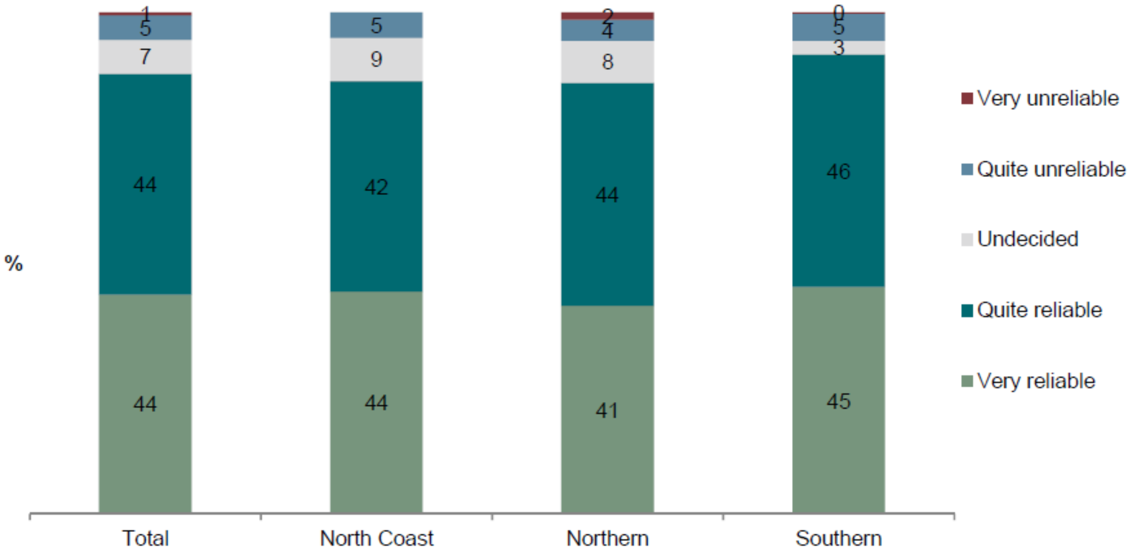

Figure 2 Customer perception of reliability[9]

Arup observation

Arup notes there is customer support to improve reliability by 25% in the worst performing areas of the network, though generally customers were satisfied with the current reliability of the network:

> *due to the current satisfaction with reliability, in the community deliberative forums, two thirds were willing to accept slightly lower levels of reliability for a lower cost. The online participants did not have the benefit of the information and discussion given in the forums and without this knowledge they slightly preferred maintaining the status quo.*[10]

This indicates that Essential Energy should generally be able to maintain its current overall risk profile, and should not need to invest (except in isolated pockets) to improve performance over the coming regulatory period.

Given the size and structure of Essential Energy's network (highly dispersed with long single lines to relatively small population centres), management should give serious consideration to new technologies such as microgrids and standalone power systems when assessing how to improve reliability in a cost efficient manner in rural areas.

2.4 Capital expenditure

Like other NSW DNSPs, Essential Energy's capital expenditure increased significantly between 2004 and 2014 due to regulatory changes, deterministic performance requirements and predicted growth in consumption. Expenditure has moderated in 2014/2019, and Essential Energy has spent below its capital allowance.

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[9] Essential Energy, 2018,*12.1.7 Reliability Strategy – COP2463 2019-24*, pg 11
[10] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 67

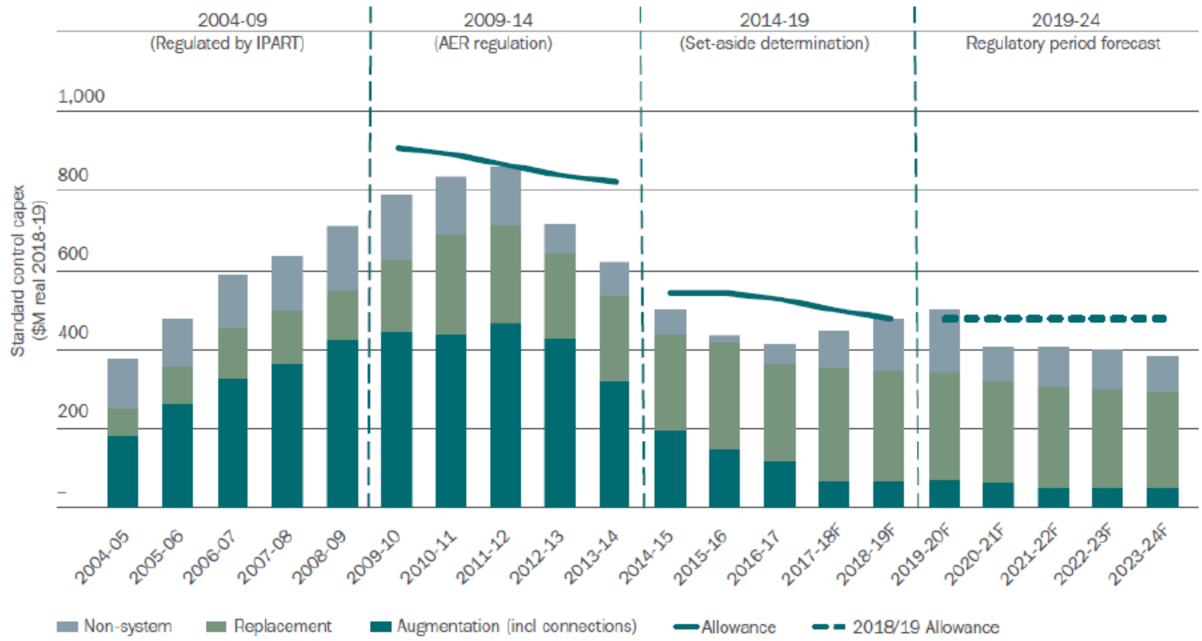

Figure 3 Capital expenditure for Standard Control Services[11]

Table 1 Proposed capex including overheads for the 2019/24 Regulatory Period ($M, Real 2018-19)

	2019/20	2020/21	2021/22	2022/23	2023/24	2019/24
Replacement	272	260	255	247	241	1,275
Connections	8	8	8	8	8	39
Augmentation	65	54	46	48	46	259
IT	59	29	34	21	21	164
Property	41	11	13	16	13	94
Fleet	31	30	34	40	34	169
Other non-system	24	19	19	16	22	100
Total	**499**	**411**	**409**	**396**	**384**	**2,100**

Arup observation

Essential Energy is proposing total capex marginally below the 2014/19 actual and predicted expenditure. This indicates management's general understanding of customer preferences in prioritising affordability over increased network performance, and suggests there should be minimal risks in resourcing and delivery in the upcoming RCP.

The proposed capex also reflects a NEM-wide shift from augex to repex (see Figure 4 Allocation of capex in current and forecast regulatory control periods), continuing the ramp down in augex from its peak in 2009/14. Our analysis follows the trend of this capex, focussing largely on repex and related governing strategies.

[11] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 64

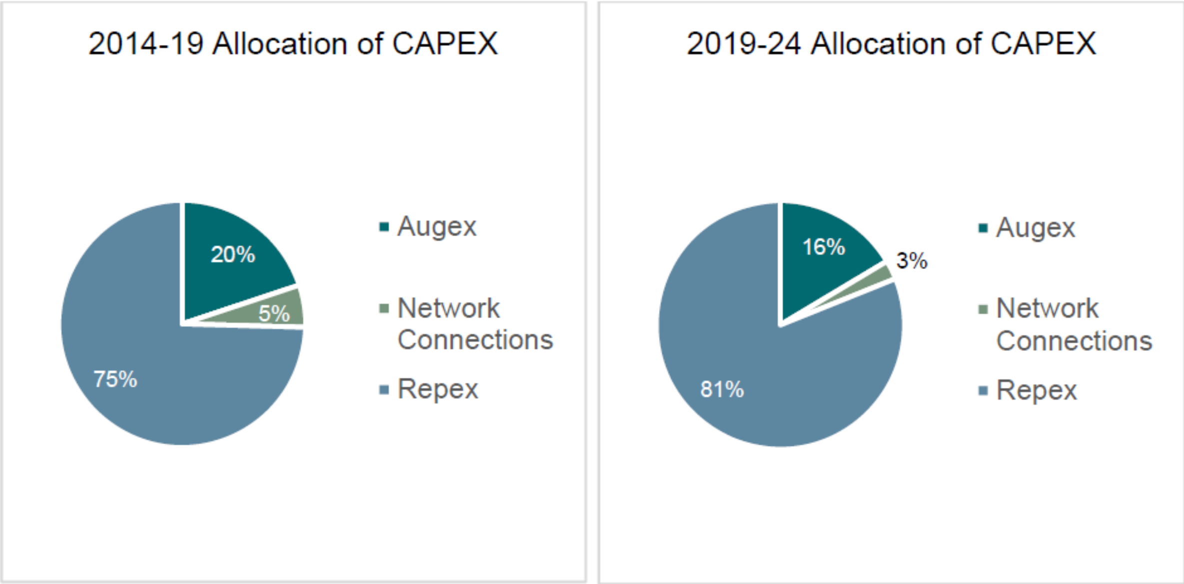

Figure 4 Allocation of capex in current and forecast regulatory control periods[12]

[12] Essential Energy, 2018, *Supporting Document 12.1.14: Essential Energy Network Delivery Plan*, pg 10

3 Strategic observations

3.1 System and business transformation

Essential Energy experiences significant legacy issues, stemming from its origination from the merger of a series of smaller distribution businesses. It has made positive steps towards risk quantification and risk-based asset management and planning, however legacy issues affecting its core IT systems constrain data availability and quality, as well as works planning and scheduling (Section 3.2.1 outlines that this was identified as an area requiring most improvement in the last Asset Management System maturity audit).

The business had some experience in delivering mid-sized ICT system renewals, however there have been no large-scale upgrades for more than a decade. As such, Essential Energy had a gap in this capability and therefore has recently hired an ICT transformation manager, established an Enterprise Delivery Office (EDO) in early 2017 and initiated a transformation program.

Essential Energy's plan for the coming period includes:

- renewing the Enterprise Asset Management (EAM) system and implement an as-a-service platform
- renewing the Enterprise Resource Planning (ERP) system and implement an as-a-service platform
- upgrading the Distribution Management System (DMS)
- renewing market systems and billing.

Its strategic aims for ICT transformation are to:

1. deploy best practice systems, technology and processes to drive business performance efficiency
2. rationalise infrastructure and applications to ensure a secure and sustainable operating environment
3. transition to innovative lower cost platforms for reduced total cost of ownership and future flexibility
4. utilise modern as-a-service solutions as an alternative to traditional long-cycle asset investments
5. continuous improvement of the ICT delivery group for ongoing efficiency and customer value[13].

Figure 5 summarises the alignment between Essential Energy's strategic goals and ICT transformation as an enabler.

[13] Essential Energy, 2018, *12.1.16s ICT Plan FY20-24*, p. 5

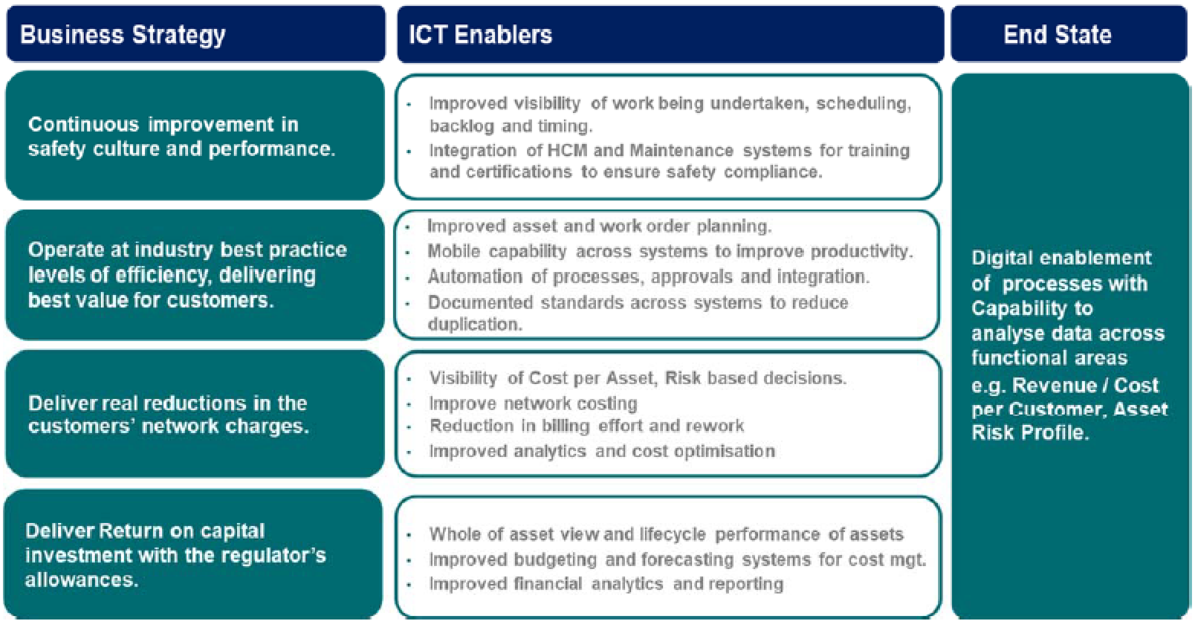

Figure 5 Alignment between corporate objectives and ICT strategy

Essential Energy proposes to spend c$177m in capex on ICT from FY20 to FY24. Its ICT Plan states that *the proposed short-term increase in ICT TotEx (FY18-FY19) enables substantial bottom-line operational savings across the business. Thereafter, it is planned to transition to a sustainable ongoing ICT investment profile*[14]. Section 6.1 covers Essential Energy's ICT plans in further detail.

Arup observation

Essential Energy's ICT transformation appears to be well-targeted to alleviate legacy constraints. Without these system upgrades, Essential Energy will not be able to achieve the improved risk management and planning processes it is moving toward. These will be key to achieving operational efficiency and prudent risk-optimised investment for the long term, which drive customer value. Opex is expected to decrease by 15% in the forward regulatory period relative to the current period. Essential Energy states that *these expenditures results have a positive net benefit to customers*[15], and has implemented an EDO with benefits realisation monitoring. However, given the transformation program will generate business efficiencies which reduce opex, the capex allowance needs to go hand-in-hand with a reasonable estimate of the forecast opex savings that are likely in the next regulatory period.

3.2 Asset management

3.2.1 Asset Management Planning

Essential Energy's AMS is shown in Figure 6. It *follows the ISO 55001:2014 top-down approach of integrating corporate objectives into Asset Management Objectives, which then filter through the rest of the system.* Essential Energy uses performance monitoring and

[14] Essential Energy, 2018, *12.1.16s ICT Plan FY20-24*, p. 6
[15] Essential Energy, 2018, *IR008*, p. 3

review to *identify and implement continual improvement activities that improve its asset management practices*[16].

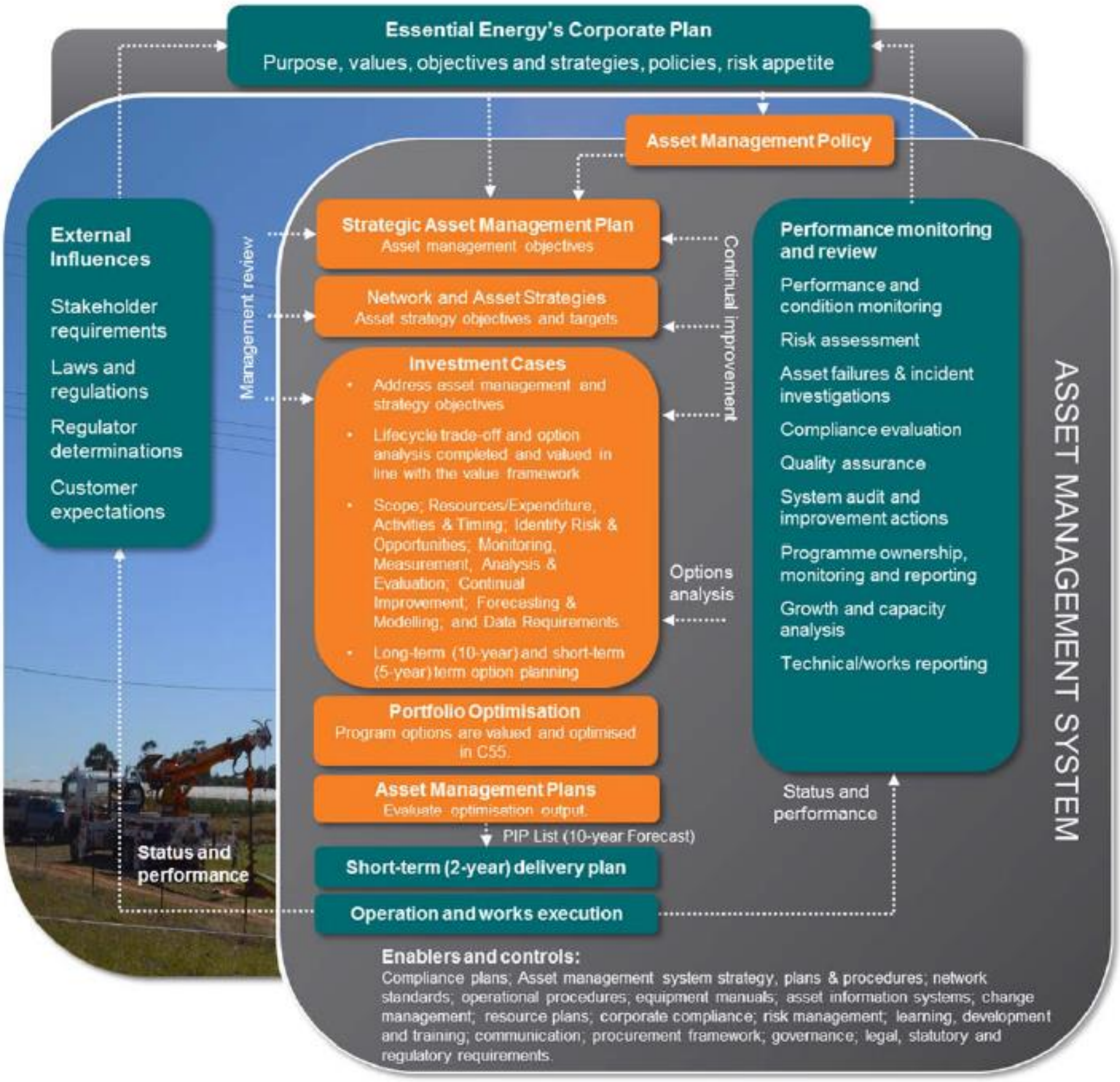

Figure 6 High Level Framework of Essential Energy's AMS[17]

The core documents for Essential Energy's AMS are:

- **Corporate Plan (Business Plan) –** published annually and sets objectives for the entire business. These are incorporated into Asset Management Objectives as per ISO 55001. These objectives are the responsibility of the Strategic Asset Management Committee (SAMC).
- **Asset Management Policy –** guides how Essential Energy manages network assets to meet corporate objectives. Sets the asset management principles under which it operates.
- **Strategic Asset Management Plan (SAMP)** - *aligns the strategic direction of Essential Energy's Asset Management System (AMS) with the needs of our business*

[16] 12.1 Strategic Asset Management Plan 20180430 - Public
[17] 12.1 Strategic Asset Management Plan 20180430 - Public

and our stakeholders. These stakeholders include: shareholders, customers, regulators, policy makers, industry groups, land owners, employees and the public. The SAMP aims to ensure we meet corporate requirements by developing detailed Asset Management Objectives that incorporate stakeholder requirements. This approach ensures our asset management approach delivers the value all stakeholders expect. The Plan meets the requirements of the ISO 55000 series of asset management standards and is part of a suite of documents that support Essential Energy's AMS. These ensure we distribute electricity in a way that meets our corporate objectives and stakeholder requirements, including present and future customers. The SAMP is also the responsibility of the SAMC.

- **Network Strategies -** *Essential Energy's Network Strategies expand on our Asset Management Objectives by applying a network focus. Each Network Strategy is assigned Asset Management Objectives to satisfy at a network level through relevant programs. Our Network Strategies also perform a gap analysis function, identifying any emerging issues outside routine asset lifecycle practices. The resulting issues are addressed in our Investment Cases. The strategies also support network performance through their performance monitoring plans. Most importantly, they identify relevant laws and regulations and set targets to comply*.

- **Investment Cases (ICs)** (covered in Section 3.3) – *focus on asset classes and programs of work. They aim to achieve the Asset Management Objectives identified by the SAMP and Network Strategies while being true to the Asset Management Policy. In each Investment Case, we analyse asset performance and condition before proposing multiple options for managing the asset class. These options are valued according to Essential Energy's Value Framework, which includes costing and risk assessment. We then enter them into our Asset Investment Planning System so a final network portfolio can be established.*

- **Asset Management Plans (AMPs)** – summarise the applicable Asset Management Objectives and provide a succinct summary of each subsystem's economic health and proposed expenditure programs over its lifecycle. The AMPs are arranged by subsystem: Zone Substation Assets, Underground Network Assets, Secondary System Assets, Overhead Network Assets, Network Metering Assets, and Public Lighting Assets. The AMPs have been simplified to reduce the barriers to updating them and sharing with stakeholders.

- **Delivery Plans –** th*ese have two components. The Portfolio Investment Plan (PIP) List is a high-level, 10-year outlook for expenditure requirements which is prepared by the Capital Works Program Manager. The rolling two-year statement of works, which is the interface between our Asset Management and Network Services functions, is prepared within Asset Management.*

- **Continuous Improvement Register –** The process for performance monitoring is *tailored for each document. Our Continuous Improvement Register captures the identified improvement items in an online database, which is to be governed by a committee that risk assesses each item for risk then delegates actions.* The Register is used to drive changes in approach and delivery of asset management initiatives.

The core system used for asset planning is WASP – the Works, Assets, Solutions and People Database. This Enterprise Asset Management System (EAMS) contains historical asset and failure data that is used to formulate asset management and replacement work tasks.

Essential Energy benchmarks its asset management system maturity against the ISO55001 standard. It engages an independent external assessor to assess its AMS against the ISO55001 and Global Forum On Maintenance & Asset Management (GFMAM) requirements. SAMP performance monitoring requirements stipulate that the AMS is to be independently audited for ISO55001 maturity every three years. However, *Information Request 012* states that it will be assessed every two years. These assessment results baseline current performance and inform Essential Energy's future improvement programs. Figure 7 shows Essential Energy's maturity for 2015. Assessments are planned for August 2018 and again in 2020.

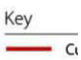

Figure 7 2015 Maturity Assessment[18]

As the figure shows, key areas for improvement at the last audit included:

- Asset Information Strategy;
- Asset Information Systems;
- Asset Management System Monitoring; and
- Reliability Engineering and Root Cause Analysis.

It is thus appropriate that Essential Energy's transformation plans are targeted at strengthening these capabilities.

Arup observation

Maturity assessment is the responsibility of the SAMC. Qualitatively, the structure of asset management planning and alignment with corporate objectives and risk appetite is aligned to expected industry standards. However, these structures and governance frameworks appear to

[18] Essential Energy, 2018, *IR012 – 012 AER Information Response*, p. 8

be more mature than the systems and processes that underpin them. In particular, quantitative investment evaluation has been improved but is not yet fully mature (see Section 3.3).

Essential Energy is working towards adopting a more risk-based culture and asset management business. The continued development of processes and tools such as Copperleaf C55 (see Section 3.4.5) will be instrumental – and this will be more effective if it can be implemented to its full functionality to optimise for risk at a project level.

3.2.2 Inspection practices and LiDAR

Essential Energy started using Light Detection and Ranging (LiDAR) to collect asset information at the beginning of the current regulatory period in 2014. Its Aerial Patrol & Analysis (AP&A) program is intended to improve understanding of overhead power line pole-top condition, line design profile, and vegetation clearance status. Aircraft perform high definition photography of assets and undertake LiDAR sensing.

Essential Energy has fully capitalised its LiDAR program, and proposes to fully capitalise LiDAR in the next period. It sets out its AP&A accounting principles, which are based on Australian Accounting Standards (AASBs)[19]. LiDAR is capitalised in that it creates a valuable but intangible asset - a data base model of the network. These criteria set out that a capital expenditure must result in an identifiable asset which is controlled by Essential Energy and generates probably future benefits, and which has a useful life.

LiDAR also creates efficiencies, in terms of business improvement to works scheduling and travel reduction, real savings in vegetation management and shifting inspection cycles. Moreover, it enables better asset management practices. A reduction in design field visits which is enabled by LiDAR as on-line information is available for reference as a design progresses. Further improvement depends on the investment in and rollout of a line design software package with the capability to make use of the large volume of LiDAR data, referred to as the 'point cloud'.

However, this better visualisation of its network assets is also identifying defects that would not have been detected from ground level inspections. This has allowed Essential Energy to reduce the frequency of ground line inspections from 4 to 4, 5, and 6 year cycles (based on pole types like natural round wood and relevant geography) – although defect classification has not changed, the timeframe for rectification has also been altered. This better understanding of asset condition from LiDAR surveys allows EE to increase the time between inspection cycles and offset opex as a benefit to the capex investment.

Arup observation

Essential Energy has assumed a limited useful life of the asset data created by LiDAR by drawing an analogy with software platforms. This enables the expenditure to be capitalised over a useful life of only 5 years in the case of vegetation data, or 5-10 years for engineering photography – short enough "*to warrant a substantially renewal of both the model and AP&A 'data' asset*"[20]. Essential Energy would be likely to draw on this asset data further into the future to assess historical network performance and defect rates.

However, LiDAR is not fully capitalised by other networks (such as TasNetworks and Ausgrid). Ergon Energy Network and Energex have carried out aerial LiDAR inspections of

[19] Essential Energy, 2018, *IR008 – LiDAR AC Principles*, p. 2
[20] Essential Energy, 2018, *IR008 – LiDAR AC Principles*, p. 6

their entire networks[21]. Ausgrid began using LiDAR in the last regulatory period. Ausgrid appears to classify the expense as a Network Maintenance operational expenditure.[22] Essential Energy's RIN lists LiDAR under 'Other' Non-Network Capex. RINs from Energex, Ergon and Ausgrid do not note LiDAR as opex or capex. However, neither does TasNetworks. Some of these network businesses include unspecified other non-network capex.

It may be reasonable to capitalise the first pass of network LiDAR scanning which creates the information asset. However, it may further be reasonable to consider ongoing maintenance of the asset information an operational expenditure. We suggest the AER engages with industry to arrive at a considered and collective view over how such investment shall be treated for regulatory purposes.

3.3 Risk assessment

Essential Energy has developed a framework for quantifying risks. This informs investment analysis. Risk calculation is set out in the *Risk Informed Optimisation* and *Asset Risk Management* documents.

3.3.1 Risk processes

Essential Energy has standardised its risk assessment processes. Defined processes and standard metrics are used to quantify the consequence of different risks.

Figure 8 Risk quantification[23]

Essential Energy uses more detailed risk analysis techniques where it sees that the level of risk is greater. Figure 9 illustrates that Essential Energy applies more quantitative risk analysis to high level risks. Where there is high uncertainty or complexity, multiple techniques are considered. The effort and methods used to calculate risk are proportionate to the level of spend associated with control of the risk, the level of uncertainty around the risk calculation, and the importance of this analysis for decision-making and investment governance.

[21] Energy Queensland Group, 2017, Summer Preparedness Plan 2017-18, p. 11
[22] Ausgrid, 2015, Strategic delivery and workforce plans for 2015-19, p. 24
[23] Essential Energy, 2018, *12.1.4 Asset Risk Management*, p. 14

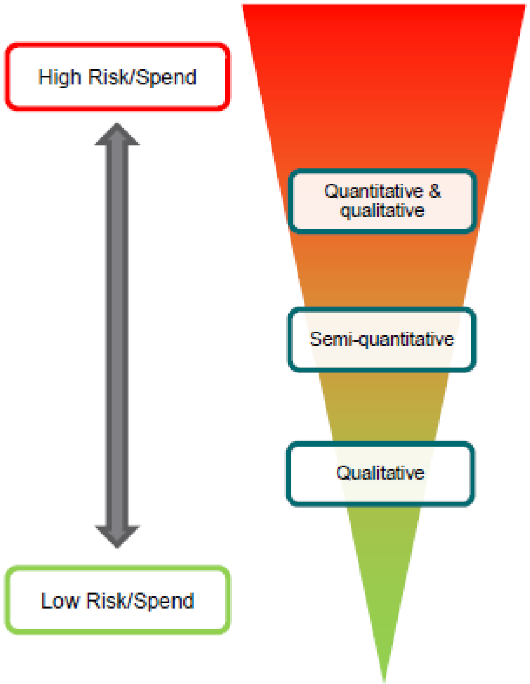

Figure 9 Expected application of alternative risk analysis methods

Essential Energy's general framework for modelling risk is set out in Figure 10. As well as specifying the components of the risk being analysed, this attempts to account for existing controls.

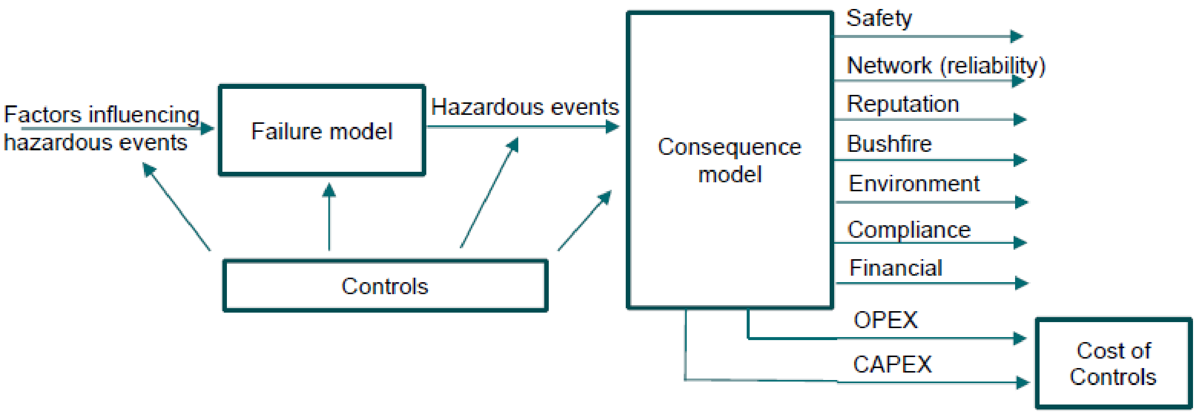

Figure 10 Conceptual risk model for asset risk management

Essential Energy assesses and quantifies risk across a number of categories shown in Table 2**Error! Reference source not found.**.

Table 2 Risk Categories

Risk Criteria	Risk Appetite[24]	Weighting[25]	Example Consequence Differentiators[26]
Safety	Very Low	3	Location in areas of high public exposure Presence of explosive failure mode
Network Reliability	Moderate	1	Number of customers affected Customer load affected Availability of redundant supply
Environment	Low	1	Proximity to heritage site Availability of containment measures
Compliance	Low	1	
Reputation	Low	1	Proximity to high visibility public sites
Financial	Moderate	1	High-value assets within radius Cost of fault and emergency replacement

Safety is weighted most heavily. This reflects Essential Energy's engagement with customers, as well as internal value statements. Section 3.3.4 discusses quantification of safety and reliability risks in detail.

Arup observation

These structures for quantifying risk through probability of failure, likelihood of failure and quantitative consequence are standard industry process.

Essential Energy's unit inputs for the risk of unserved energy are in line with accepted practice. Some assumptions used to quantify this risk across different asset classes (such as customer density multipliers in the investment case for distribution pole tops *ESS_4005 Distribution Pole Tops*[27]) appear to provide reasonable approximations given Essential Energy's current data issues. However, these methodologies would be expected to be strengthened as systems are transformed and these methodologies mature to accommodate better data. Given technology changes such as the adoption of microgrids that give rural communities energy independence may begin to reduce the risk of intermittency and failure that underpin rural feeder reliability standards, using constant values may overstate future risk and customer perceptions.

The weighting of safety as the highest priority risk category appears to be reasonable based on customer perceptions and risk appetite. Moreover, utilising the value of statistical life stipulated by the Department of the Prime Minister and Cabinet in risk quantification[28] is a valid industry standard assumption. However, reliability and financial risk are noted as 'moderate' risk appetite, yet are weighted the same as 'low' risk appetite categories such as compliance and reputation.

[24] Essential Energy, 2018, *12.1.4 Asset Risk Management*, p. 8
[25] Essential Energy, 2018, *IR008.4 Appraisal Value Framework*, p. 16
[26] Essential Energy, 2018, *12.1.4 Asset Risk Management*, p. 18
[27] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*
[28] Essential Energy, 2018, *IR008.4 Appraisal Value Framework*, p. 7

Overall the approaches adopted use existing data in a reasonable manner to achieve a balanced outcome. Improvements in data should allow adoption of stronger methodologies and more functionality and sophistication in the optimisation modelling, leading to further improvements in capex program analysis.

3.3.2 Risk analysis

Figure 11 illustrates how Essential Energy's risk processes fit into its overarching asset investment processes (which was discussed earlier).

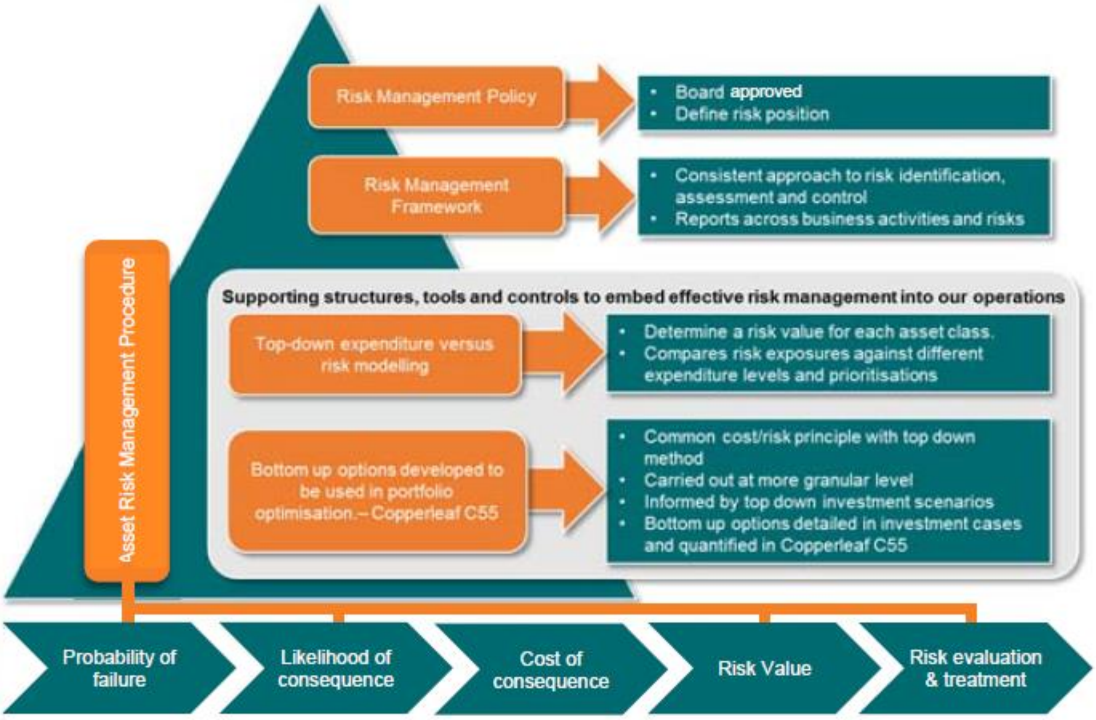

Figure 11 Asset Risk Management Procedure[29]

The Asset Risk Management procedure supports Essential Energy's overarching investment governance.

Figure 12 shows the range of risk assessment techniques Essential Energy employs.

[29] Essential Energy, 2018, *12.1.4 Asset Risk Management*

Technique	Risk Assessment Process						Risk Treatment
	Risk / Cause Identification	Control Environment/ Effectiveness/ Options	Risk Analysis: Consequence	Risk Analysis: Probability	Risk Analysis: Level of Risk	Risk Evaluation	
Brainstorming or SME Workshop	✓	✓	✓	✓	✓	✓	✓
Structured Interviews	✓	✓	✓	✓	✓	✓	✓
Delphi	✓	✓	✓	✓	✓	✓	✓
Checklists	✓	✓	×	×	×	×	×
Failure Mode Effects Analysis	✓	✓	✓	✓	✓	✓	✓
Failure Mode Effects & Criticality Analysis	✓	✓	✓	✓	✓	✓	✓
Event Tree Analysis	✓	✓	✓	✓	✓	×	×
Fault Tree Analysis	✓	✓	×	✓	✓	×	×
Bow-Tie Analysis/ Threat Barrier Diagram	✓	✓	✓	✓	✓	×	×
Reliability Centred Maintenance	✓	✓	✓	✓	✓	✓	✓
Consequence/ probability matrix	×	×	✓	✓	✓	✓	×
Risk Indices	×	×	✓	✓	✓	✓	×
Cost/benefit analysis	×	×	×	×	×	✓	✓
Multi-Criteria Decision Analysis	×	×	×	×	×	✓	✓

Figure 12 Asset Risk Analysis Techniques[30]

Arup observation

Essential Energy has assembled a robust toolkit of risk assessment and quantification techniques, and an appropriate value framework to guide their utilisation. At a high level, this approach to risk analysis appears prudent. However, problems with input data resulting from legacy issues may weaken the detailed risk quantification processes. Some input assumptions have therefore been based on estimates. This may weaken the risk quantification and investment optimisation process overall, although Essential Energy has clearly made significant progress and its planned ICT transformation will enable more detailed, rigorous and automated analysis.

It is unclear whether Essential Energy's proposal will maintain the current level of network risk which customers are satisfied with, or whether the proposal will reduce overall risk. That the proposal outperforms the top down Cutler Merz risk optimisation provides some confidence that, overall, risk is not being significantly targeted. However, some assumptions used in the risk quantification that underpins investment cases may overstate risk –

[30] Essential Energy, 2018, *12.1.4 Asset Risk Management*, p. 14

particularly the value of customer reliability where distributed energy resources are augmenting historically unreliable and expensive rural feeders, and the exposure probability assumptions that are used to quantify safety risks for remote assets that are unlikely to encounter pedestrians (see Section 3.4.4 for more detail on exposure assumptions). Moreover, the C55 process is optimising to maximise value up to the capital baseline, rather than optimising to maintain baseline risk at least cost (see Section 3.4.5 for more detailed discussion of this program selection methodology).

However, Essential Energy appears to understand that its customers are satisfied with current levels of risk and reliability, and is transforming its processes and systems such that in the future it will be able to achieve quantitative risk optimisation across the majority of its asset base.

3.4 Investment governance and evaluation

3.4.1 Introduction and overview

Essential Energy's capital rationing process involves three mains steps:

1. setting the capital expenditure constraint through a sequential process of:
    a. developing a bottom-up build;
    b. an independent top-down challenge based on risk optimisation; and
    c. incorporating compliance, capacity, and deliverability requirements;
2. developing project options and investment cases by:
    a. developing capex options by drawing on asset information and unit rates; and
    b. calculating option 'value' by quantifying avoided or reduced risk through standardised calculations for risk categories such as the value of customer reliability;
3. optimising the portfolio up to this capital line based on the 'value' ratio of options.

Capital budgeting applies top-down 'challenge' optimisation to a bottom-up engineering build. Adjustments like deliverability and compliance are incorporated manually to develop the portfolio. Figure 13 summarises the overall process.

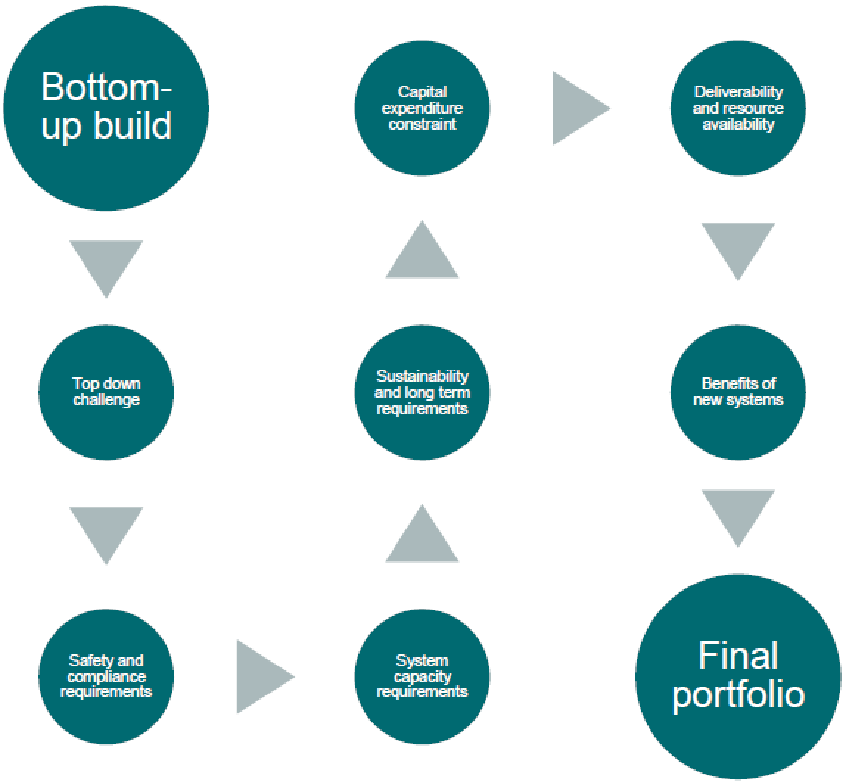

Figure 13 Portfolio development process[31]

Essential Energy's "proprietary algorithm" software takes risk value and capital cost inputs from options development to build a portfolio of projects. The portfolio is thus composed of a set of project options - one may be chosen out of each proposed program. To optimise capital rationing, Essential Energy draws a line at the capital budget constraint and employs the Copperleaf C55 software platform to fill the program with the most 'optimal' project options until this capital line is met.

The components of this process are covered in further detail in the following sections:

- 3.4.2 Capital budgeting
- 3.4.3 Appraisal evaluation
- 3.4.4 Value and risk quantification
- 3.4.5 Program selection using Copperleaf C55.

Arup observation

Essential Energy's capital optimisation process is a significant step forward from legacy procedures (some of which are still utilised by some networks). However, the process for capital rationing and portfolio optimisation does not provide a true 'bottom-up' risk prioritisation.

[31] Essential Energy, 2018, *12.1.1 Risk Informed Optimization*, p. 7

Rather, the top-down process produces a risk-optimised capital line which is then filled with the programs with the highest ration of value to cost. It is not targeted at maintaining an acceptable risk level at most efficient cost.

Where Essential Energy's proposed capex does not exceed the AER's modelling of repex allowances, the likelihood of materially inefficient investment is likely to be low. Given the significant progress for legacy procedures, and in conjunction with risk-informed methodologies like the independent top-down challenge this appears to provide a reasonable basis for investment. However, although risk is quantified within value measures, by optimising for value from the bottom up rather than risk at the option level, the proposed capital program may have an opaque impact on the overall level of risk in the network. This value-driven optimisation methodology should not be accepted as a precedent for other regulatory determinations. It should be expected that Essential Energy will determine future regulatory proposals with an incremental improvement in approach using an option-level risk quantification and optimisation methodology. Arup understands this should be supported by the C55 tool with further input data refinement. Section 3.4.5 discusses the current optimisation process in further detail.

3.4.2 Capital budgeting

The process for drawing the 'capital line' which sets Essential Energy's capital budget involves:

1. undertaking a bottom-up engineering build (investment on failure, rather than value)
2. applying repex / augex modelling as sanity checks (which is an ongoing process)
3. commissioning a consultant to undertake an independent 'top-down challenge' to the bottom up build:
    a. this is the Cutler Merz report, which only considers risk based on age (it is called an age risk-based model) with no consideration of compliance
4. interpreting the bottom up and top-down builds to factor in compliance and set the 'line' which Copperleaf C55 uses as the capital constraint:
    a. as well as compliance, Essential Energy considers sustainability and customer engagement on issues (Essential Energy's customer engagement shows that price is currently the most important customer driver).

Essential Energy engaged Cutler Merz to 'challenge' its bottom-up engineering build investment programme. Cutler Merz model used quantitative risk analysis techniques to model and evaluate alternative scenarios that could produce the same or improved risk outcomes for a lower expenditure. The objective was to establish the minimum level of investment required to maintain the existing level of network risk. However, this did not consider some compliance issues such as health and safety. Essential Energy thus had to consider the limitations of this analysis when setting the capital line. The table below sets out the outcome of Cutler Merz's top-down challenge. Cutler Merz recommended that targeted risk-based investment could reduce capex by over 20%.

Table 3 Adjustment to bottom-up build

	Final	Optimised top-down	Bottom-up build
Replacement Total	**$819.7M**	**$817.0M**	**$990.2M**
Poles	$201.4M	$160.6M	$221.9M
Pole top structures	$231.6M	$199.2M	$261.0M
Overhead Conductor	$94.1M	$164.5M	$134.6M
Underground Cables	$16.0M	$0.4M	$18.9M
Service Lines	$27.9M	$11.0M	$60.4M
Transformers	$68.1M	$78.4M	$85.1M
Switchgear	$117.4M	$116.5M	$138.7M
SCADA, Network Control & Protection	$19.0M	$18.2M	$18.2M
Other	$44.2M	$68.3M	$51.3M
Augmentation	**$166.1M**	**$174.3M**	**$276.3M**
Connections	**$25.1M**	**$25.2M**	**$25.2M**
LIDAR	**$56.7M**	**$60.8M**	**$60.8M**
Network Capital Expenditure Total	**$1,067.6**	**$1,077.4M**	**$1,352.5M**

Table 3 shows that the bottom-up build by Essential Energy suggests a capex program of $1,352.5m, but the Cutler Merz top-down analysis suggests an optimised capex program of $1,077.4m will be sufficient to sustain the network at current levels of risk adoption. Arup understands the 'Final' column provides Essential Energy's adjusted capex program proposed to the AER, taking into account both the bottom-up and top-down analyses, but seeking an outcome close to the top-down challenge value.

Arup observation

Risk-based optimisation is critical to maintaining the level of risk in the network at least cost. Cutler-Merz's top-down challenge demonstrates Essential Energy's approach to optimising for least-cost risk optimisation is not unreasonable from the top-down. Essential Energy is proposing to outperform the top-down optimisation bottom line. This provides some confidence that the capital program does not propose to significantly reduce overall network risk. However, Essential Energy proposes to exceed top-down optimised expenditure in poles and pole top structures based on its bottom-up risk quantification processes. These bottom-up processes and assumptions are relatively standardised and have matured significantly since the previous regulatory period. However, although the process and assumptions are relatively robust, some input assumptions may over-value risk. Moreover, Section 3.4.5 discusses how Essential Energy's optimisation processes appear to optimise for value rather than least-cost risk optimisation. However, while these effects can be improved in subsequent submissions to the AER it is felt these do not have a material impact on escalating the capex program sought for approval. Essential Energy's processes and assumptions are expected to mature as system transformation enables the business to move past legacy data and process issues.

The remainder of Section 3.3 discusses these bottom-up processes in more detail.

3.4.3 Appraisal evaluation

Figure 14 shows the relationship between the Appraisal Value Framework and the related procedures. It is a supporting document which sits under *the Risk Management Framework, Asset Risk Procedure and Investment Evaluation*. While the framework is designed to support all aspects of network investment decisions, its primary current use is to inform the 2019/24 portfolio optimisation performed within the Copperleaf C55 software optimisation tool.

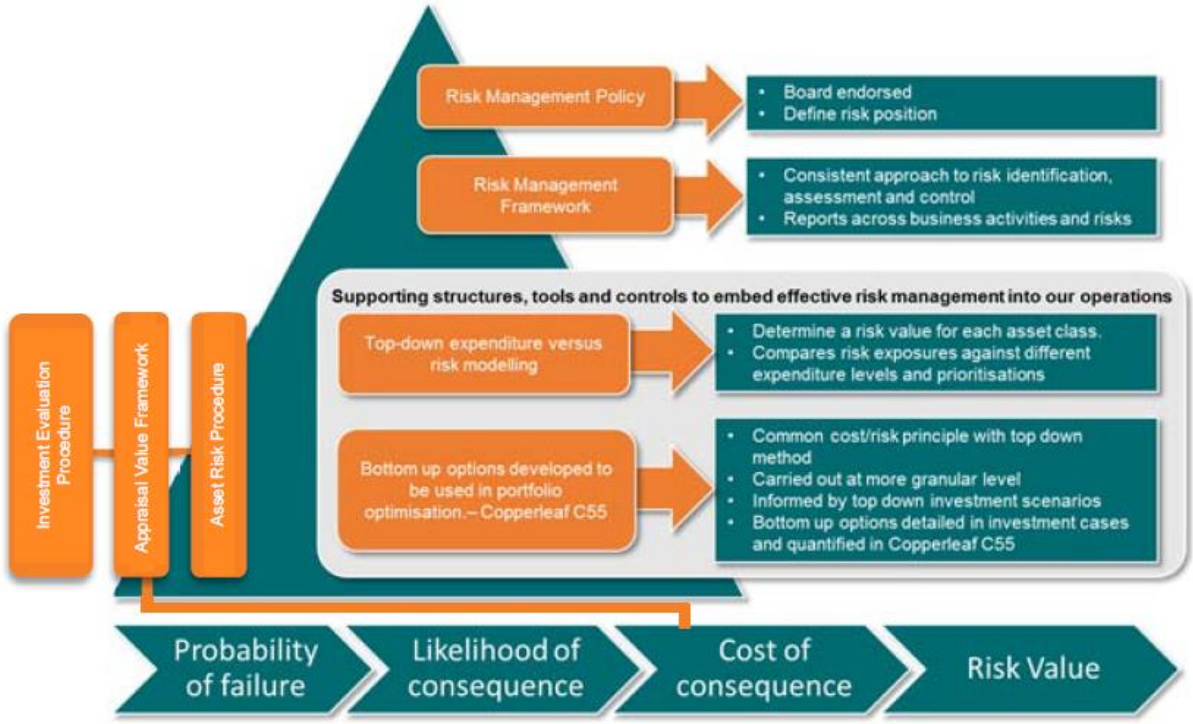

Figure 14 Appraisal value framework

Arup observation

Essential Energy has strengthened its quantitative risk valuation processes. The overarching structure for valuation appears to provide a good platform for prudent investment prioritisation. However, ICT and data limitations may hamstring this in some areas. Moreover, some components of the processes are not aligned to a risk-based ethos for efficient investment. C55, for example, maximises *value* rather than maintaining risk at most efficient cost. Over estimation of the capex program sought for approval is mitigated by the use of the top-down challenge process.

3.4.4 Value and risk quantification

Risk Informed Optimisation and the Appraisal Value Framework determine how to convert the assessment of risk into dollar values for all types of risk, including cost of consequence and the dollar value of risk classes. This output is used to quantify the value side of project and program options.

The risk of failure to deliver electricity is measured in the value of unserved energy. In the NEM, where networks are generally reliable by global standards, consumers are often unprepared for outages. Of the businesses affected by the South Australian blackouts, only 12% had back up generation and almost two thirds didn't have business interruption insurance.[32] The blackouts cost businesses $367m through loss of production, trading and

[32] Business South Australia survey, 2016

wages paid. Industry often bears these costs, with a third of the cost of the South Australian blackouts born by four major industrial users.

The value of unserved energy is determined across the NEM by AEMO's power system models, and is an approximation under varying scenarios of customer demand in MWh that can't be served due to a deficiency in generation or network delivery.

The risk of network assets causing serious injury or death can occur through a number of ways, including:

- contact with assets, through accidental collisions or from a fallen pole or line
- electrocution from a faulty asset, not necessarily through direct contact
- injury or death from fires originated by a network asset.

Unlike the value of unserved energy, there is currently no uniformly agreed approach across the NEM on how to measure these aspects of risk. However, Essential Energy utilises AEMO's value of unserved energy values.

Reliability

Essential Energy's reliability methodology is outlined in several documents:

- Appraisal Value Framework
- 12.1.4 Asset Risk Management
- Reliability Dataset Investment Case Reference Document
- Simple and Effective Assessment of Reliability for Network Programs using the Value of Customer Reliability Briefing.

This gives every investment case the same reliability valuation methodology, and only differs for large sub-transmission projects where the exact location is known and therefore a direct project outcome is known.

The costs of network reliability impacts are assessed using a combination of the following methods:

- Value of Customer Reliability (VCR); and
- costs to Essential Energy.

Both methods are aligned to AEMO's published Value of Customer Reliability.

Figure 15 Methodology for calculating duration and Flagfall risk values

Essential Energy has developed a simplified application of VCR to provide a consistent approach for defining financial impact. This reflects the fact that customers generally slightly for highly value 'avoiding' the initial interruption of supply above the 'duration' of the interruption.

The VCR is calculated via two alternative methods:

- 'Flagfall and duration' method, for general scenarios which are representative of average customers; and
- 'Energy interrupted' method, for specific scenarios where the energy interrupted is known, or the load contains major industrial loads which are not representative of average customers.

While Essential Energy has robust calculations behind these two methodologies that provide a basis for assessing average customer and major industrial load risk, it does not appear to differentiate by customer type.

The values of customer reliability per interruption and per minute shown in Figure 16 are developed by valuing Essential Energy's annual energy delivered.

Method	Value
Flagfall	$47.58 / customer
Duration	$0.375 / customer-minute
Energy Interrupted	$42,331 / MWh

Figure 16 Value of customer reliability values

When analysing equipment investment, Essential Energy draws on the customer impact figures in Figure 17 to apply the values in Figure 16. Despite some issues with data accuracy that informs this impact assessment, this provides a standardised procedure for quantifying the value of customer reliability for different equipment types.

GROUPED EQUIP	95% Conf. Lower	Average Duration (mins)	95% Conf. Upper	95% Conf. Lower	Average Number of Customers Affected	95% Con Upper
ABS / ISOLATOR	138	**150**	162	312	**404**	496
BUSBAR - ZONE	86	**111**	135	877	**1396**	1915
CAPACITOR / REACTOR	65	**170**	274	0	**911**	2532
CIRCUIT BREAKER FAILURE	84	**96**	108	71	**451**	832
CONDUCTOR-HV	193	**196**	199	216	**229**	241
CONDUCTOR-LV	146	**149**	152	57	**64**	70
CROSSARM	167	**170**	173	107	**118**	129
CT OR VT FAILURE	148	**225**	302	143	**850**	1556
DISTRIBUTION TRANSFORMERS	318	**326**	334	29	**36**	44
DROPPERS	139	**146**	153	17	**31**	45
ENCLOSED SWITCH	121	**137**	154	754	**1052**	1350
FI PLANT	110	**124**	138	2	**5**	8
INSULATOR	170	**177**	185	167	**202**	238
JOINT / CONNECTION - HV	154	**157**	160	94	**106**	118
JOINT / CONNECTION - LV	131	**135**	139	25	**30**	36
LINKS - ZONE SUBSTATION	97	**128**	158	242	**452**	661
LINKS HV DISTRIBUTION	128	**137**	147	173	**216**	258
LINKS LV DISTRIBUTION	123	**140**	157	48	**71**	95
METERING	106	**179**	251	0	**86**	250
PILLAR / PIT	111	**117**	124	53	**75**	98
POLES	237	**244**	250	158	**175**	192
RECLOSER	130	**135**	140	97	**107**	117
SERVICES	157	**160**	162	20	**24**	27
STAY	130	**142**	153	52	**119**	186
SURGE ARRESTER	147	**151**	154	44	**55**	66
TIES	127	**132**	136	66	**82**	98
UG - HV	207	**236**	265	590	**774**	958
UG - LV	186	**205**	223	40	**56**	73
UG HV JOINT / TERMINATION	106	**126**	146	640	**976**	1313
UG LV JOINT / TERMINATION	182	**223**	265	40	**54**	67
UG SWITCHGEAR	171	**235**	299	266	**516**	766
VOLTAGE REGULATOR	117	**153**	189	236	**437**	638
ZONE SUB TRANSFORMER	85	**106**	128	837	**1200**	1563

Figure 17 Customer impact by equipment type[33]

Safety

Safety is given the highest priority in Essential Energy's risk quantification methodology. As Table 3 shows, it is weighted by a factor of 3. The value [redacted] is taken from as defined by the Department of the Prime Minister and Cabinet, Office of Best Practice Regulation, and weighted three times higher than other risk criteria (as per the table above) to reflect customer perceptions. [redacted]

A Safety Event Tree methodology has been developed to ensure a consistent approach. Quantified risk outcomes are calculated using a standard formula shown below.

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[33] Essential Energy, 2016, Simple and Effective Assessment of Reliability for Network Programs using the Value of Customer Reliability, p. 3
[34] Essential Energy, 2018, *IR008.4 Appraisal Value Framework*, p. 7

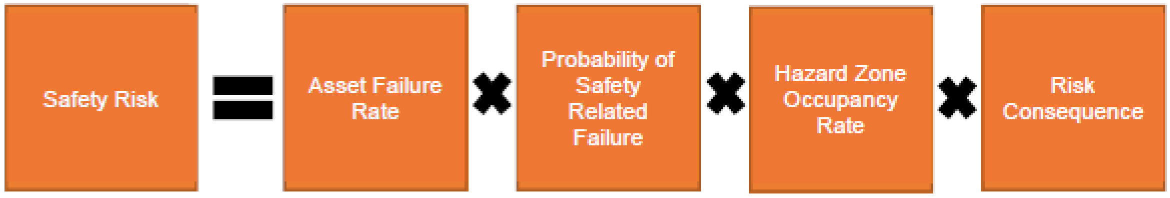


Figure 18 Safety risk calculation[35]

Essential Energy uses estimated parameters to quantify the likelihood of exposure to hazardous events, such as those shown below that quantify the likelihood of public exposure to a failure event.

Common Parameters	Parameter Value
Number of people entering exposure radius	0.1 pp / hr (Rural) 2 pp / hr (Urban)
Likelihood a person comes in contact with an energised asset	5%
Probability of producing a low span	5%

Figure 19 Exposure rates used in investment case ESS_4005[36]

Figure 20 shows Essential Energy's criteria for safety risk tolerance.

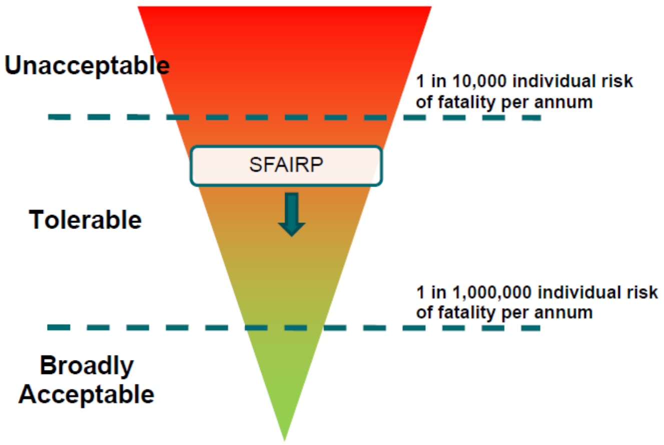


Figure 20 Safety risk tolerability and acceptance criteria[37]

Risks become tolerable if they are below the unacceptable threshold and managed 'so far as is reasonable possible'. This is aligned with relevant industry standards:

- AS/NZS 7000:2010 Overhead line design – Detailed procedures
- EG-0 Power system earthing guide Part 1: Management principles
- Institute of Asset Management SSG 31: Risk Assessment and Management.

[35] Essential Energy, 2018, *12.1.4 Asset Risk Management*, p. 18
[36] Essential Energy, 2018, *ESS_4005*
[37] Essential Energy, 2018, *12.1.4 Asset Risk Management*, p. 7

Arup observation

Essential Energy's utilisation of AEMO's risk values aligns with accepted practice. This is in accordance with the AER's communication to the NSPs in general that quantifying safety risks is a key step to robust network planning.

Despite some issues with asset data reliability Essential Energy has developed a robust and practical approach to valuing customer reliability. However, based on AEMO's VCR guidelines, Essential Energy would be expected to incorporate a process to differentiate by customer type rather than just factors such as customer density. Although Essential Energy's 'energy interrupted' methodology provides a process for assessing scenarios where the load contains major loads that aren't represented by the average customer calculation, it should move towards incorporation of AEMO's guideline for customer type differentiation into its existing framework.

Essential Energy's quantification of risk appears to have matured significantly from previous processes. Processes are in keeping with what could be expected in terms of industry standards and provide an appropriate governance process for investment prioritisation and portfolio development. However, the assumptions that underpin the individual processes may not be as mature as could be possible.

For example, C55 NPV input models for investment cases *ESS_45 Subtransmission Pole Top Refurbishment* and *ESS_4005 Distribution Pole Tops* assume that the opex associated with a failure is higher than planned replacement by 70% of the unit capex rate. Essential Energy states that these "figures have been derived from unit rate analysis of a number of similar works over a period of time"[38]. However, it is not clear how this analysis has been undertaken. Given the legacy data issues with Essential Energy's asset information, enterprise resource management and asset management systems, these input assumptions could introduce uncertainty to forecasting.

Moreover, these figures are taken as constant over the ten-year horizon of the analysis. The value of customer reliability is similarly taken as constant. Further consideration of these assumptions may be warranted. In addition, the value of unserved energy may be overstated – particularly where reliability is becoming less of a priority for rural feeders where customers are becoming more independent of the gird. This may overstate the avoided cost through risk quantification.

Essential Energy's customer engagement provides support for maintaining the current level of risk. Customers appear to be satisfied with the current level of reliability, and are not largely asking for an increase or decrease.

Section 4 assesses proposed repex programs in detail, including these assumptions.

3.4.5 Program selection using Copperleaf C55

Essential Energy uses a "proprietary algorithm" software called Copperleaf C55 to optimally ration capital based on project option value, not project value once an option is chosen. This is a subtle difference which seeks to capitalise on the inter-project option linkages and the by-

[38] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, p. 33

play with opex through consideration of opex benefits[39], and with further, more detailed consideration of options, should lead to better outcomes in economic efficiency terms.

C55 is a spreadsheet-based cloud platform. Program inputs cover:

1. Risk;
2. Capital cost; and
3. Options.

Essential Energy's investment optimisation platform has been in use for under 12 months. Essential Energy is running it as a simple capital rationing model:

- C55 simply maximises the value of program options within the capital constraint.
- The 'last' program that was selected before the proposed capital budget was allocated has a value-cost ratio of 2.4[40].
- Options include capex-opex trade-off over the 5 years, with opex savings included as value benefits. However, C55 only optimises within the one regulatory period. This includes company tax rates, as well as net present value-style trade-off.
- C55 optimises over the 5-year regulatory period. Essential Energy has stated that only the 5 year NPV value is included in the optimisation, however the NPV input sheets (for example in ESS_4005 and ESS_45) forecast cost and value over ten year timeframes. It is not clear whether the ten-year forecast is used as the input to C55.
- C55 does not include Non-Network expenditure. C55 optimises for projects, after which Essential Energy accounts for the flow of benefits of non-network capital into network capital by calculating a 5-year payback on those efficiency savings.

The figure below summarises this process.

Figure 21 A high level C55 process[41]

Arup observation

C55 optimises capital rationing only – i.e. the capital budget is set, and C55 selects the combination of program options with maximum value. This produces the best value from a set capital constraint. There is some interaction between capex and opex, through consideration of opex savings as a benefit. However, this is not optimising for the least cost portfolio that maintains network risk. This value-optimised approach may reduce the level of

[39] The opex-capex optimisation mechanism is not yet fully mature as C55 is only used to prepare the capex proposal, however opex reductions are included as benefits to the capex options.
[40] Essential Energy 2018, *IR008 Response*, Question 11
[41] Essential Energy, 2018, *IR012 – 012.9 C55 outputs to ROMO*

risk in the network. Given customers are satisfied with the current level of risk, this may not be prudent and efficient.

Essential Energy is planning to shift C55 to a project-level analysis that could optimise risk levels. However, it is not yet able to undertake this analysis due to system and data input constraints. If investment case input assumptions can be prudently challenged, if may be justifiable to run C55 optimisation with new inputs. However, this would simply optimise a potentially different set of projects into the existing capital line. Nonetheless, the C55 approach is an advance on other techniques, and its further development should be encouraged.

3.5 Microgrids

Essential Energy's management has identified three main options to remediate their worst-performing feeder segments[42]:

- replacing overhead conductor and pole top hardware
- new reclosers, sectionalisers, fuses, line fault indicators and fusesavers
- emerging options such as microgrids.

The first two options represent business as usual targeted replacement of existing assets, classed as repex. On emerging options, Essential Energy state[43]:

> *The current cost of installing and maintaining a stand-alone power system or microgrid that replicates the capacity of a typical rural grid connection is not yet a cost-effective replacement for an existing grid connection.*
>
> *However, it is often comparable in cost for new customers. This, along with the forecast rate of likely cost decreases in the sector, makes it likely that within the next regulatory control period, these systems will represent the least-cost approach for addressing some network reliability constraints.*

Microgrids are the key emerging technology under consideration, and may be central to Essential Energy's efforts to deliver cost effective, reliable electricity to fringe areas of its network in the coming years.

3.5.1 Overview

A microgrid is a distributed level energy system which includes all the necessary components to operate in isolation of the grid. It is a microcosm of the broader energy network, but at a distributed level. Due to the size of Essential Energy's network, and the number of remote communities serviced by its distribution lines, microgrids are currently being trialled and considered as an option to meet reliability targets while keeping network costs low.

[42] Essential Energy, 2018, *Supporting Document 12.17: Reliability Strategy 2019-2024*, pg 33
[43] Essential Energy, 2018, *Supporting Document 12.17: Reliability Strategy 2019-2024*, pg 33

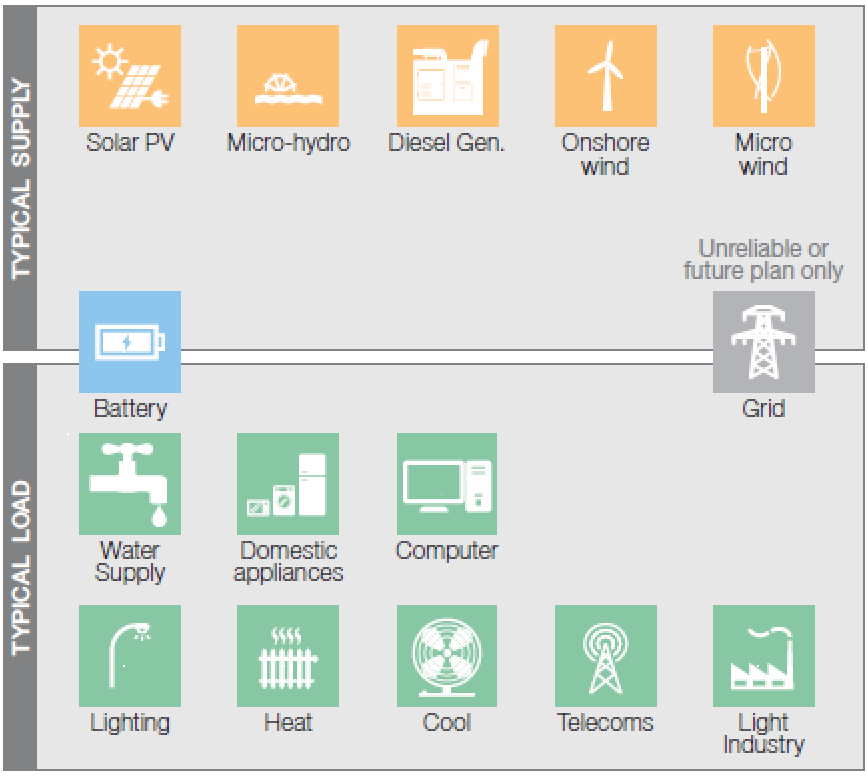


Figure 22 Typical microgrid structure for remote or off-grid applications[44]

3.5.2 Drivers

Whether microgrids are adopted by Essential Energy will depend on whether they prove to be a cost effective, environmentally sustainable, and reliable method of delivering electricity to more remote areas.

3.5.2.1 Cost effectiveness

Cost effectiveness will be determined by the capital inputs required for microgrids. Generation in a microgrid may be from a range of variable distributed energy resources, with an emphasis on renewables but also potentially including fossil fuelled back-up generators. Storage may include battery arrays, electric vehicles, liquid air among others. In this respect microgrids are becoming rapidly more affordable as unit costs of energy storage and embedded generation in the market decreases.

Demand is modulated through microgrid control systems incorporating demand response so that it can be matched to available supply in the safest, effective and controlled way. When operating independently of the grid in 'island' mode, a microgrid is a self-sustaining independent energy system. It can also be connected to the grid where practical, allowing it to import or export electricity as prevailing commercial or technical conditions dictate.

As such, efficient operation of a microgrid will involve some level of investment in localised system dispatch IT infrastructure, particularly given the relatively unpredictable nature of renewable generation compared to traditional baseload dispatch.

[44] Arup graphic, refer also "*5 Minute Guide Microgrids (uG)*", Arup.

A microgrid's cost effectiveness will also be driven by what alternatives are available to Essential Energy. Currently, the alternatives are represented by business as usual operations. Only when microgrids are cheaper than current practices over the life of the assets under replacement consideration, while delivering a similar level of safety and reliability, should they be considered by management.

3.5.2.2 Sustainability

Microgrid generation can come from fossil fuel or renewable dependent sources. Until recently, microgrids would only be feasible with a fossil fuel generator – likely small scale diesel – but the falling costs of renewables and storage now potentially present a viable alternative to long-lateral network greenfield or replacement investment.

Increasing penetration of renewable energy into the mix brings many benefits in terms of sustainable low-carbon sources. Other environmental benefits would accrue from reducing reliance on long-lateral networks and their associated material use and habitat clearing. However, whether a microgrid is considered more sustainable than alternative options – likely Essential Energy current BAU – would have to be considered on a case to case basis.

3.5.2.3 Reliability

By virtue of being a self-contained system, a microgrid is resilient to certain energy supply disruptions, such as failure on long-lateral feed lines.

Essential Energy is expecting a change in definition of a sustained outage to three minutes from the current one-minute standard. This is considered an 'emerging change' by management meaning that in some cases microgrids may become the lowest-cost solution to addressing individual feeder standard compliance[45].

3.5.3 Applications

Given the size and nature of Essential Energy's network, customer expectations on reliability in terms of SAIDI and SAFI vary across the network:

[45] Essential Energy, 2018, *Supporting Document 12.17: Reliability Strategy 2019-2024*, pg 32

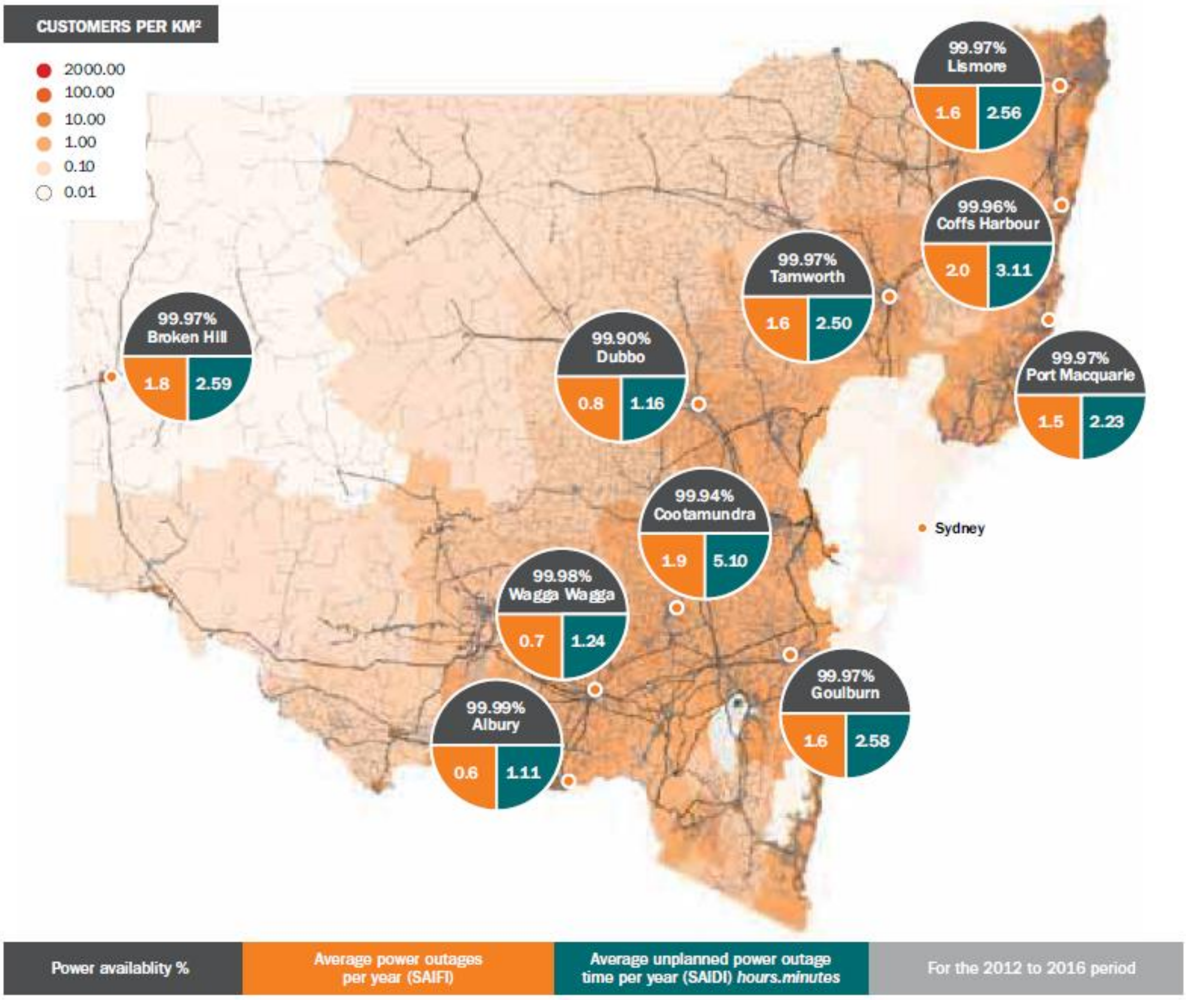


Figure 23 Regional reliability[46]

Typically, more remote communities or users can be characterised as having relatively modest energy demands serviced by unreliable single point grid connections or by inefficient and expensive fossil fuel generation equipment. These are the environments in which microgrids may be suitable.

Essential Energy's management should thus consider the expected changes in outage definition in the context of its rural network and customer's varying expectations on reliability, which would act as a key determinant to the suitability of microgrids.

Essential Energy has developed a business case to measure the suitability of microgrids in its network, allocating $2m of reliability capital expenditure in 2019/20 to a microgrid trial on a worst-served feeder segment. Management states[47]:

> *The approach details the rollout of a single microgrid site that we can use to work through the technical, legal and customer engagement components of microgrid application. This project will act as a pilot, de-risking the use of microgrids as a solution for Individual Feeder Standard compliance.*
>
> *This means that (pending the actual cost curve that the technology follows) a microgrid solution could offset several Individual Feeder Standard constraints from*

[46] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 28
[47] Essential Energy, 2018, *Supporting Document 12.17: Reliability Strategy 2019-2024*, pg 32

2021 onwards and we could deliver it as part of our Individual Feeder Standards Management program of works.

Arup observation

Alternative options to feeder maintenance such as microgrids may reduce the risk of unserved energy or manage risk at lower cost. It is not a panacea; it is relatively unproven at scale in the NEM, and its wide scale implementation relies on cost reductions in embedded generation and storage technologies, as well as integration of IT systems that can efficiently dispatch intermittent generation and storage.

However, there are a number of potential benefits to microgrids, both monetised and otherwise:

Benefits	
Monetised	Non-monetised
Conversion loss savings	Consistent secure power
Lower carbon cost	Protection of critical loads
Reduced peak power costs	Secure non-essential supply
Reduced capacity charges	Controlled power quality
Increased CHP balance	Reduced blackout risk
Network capex avoidance	Increased supply reliability
Lower network redundancy	Reduced CO_2 intensity
Energy price arbitrage	Continued productivity
Optimised own supply use	CSR and education benefits
Negawatt market	Consumer engagement
Operational reserve market	Employee engagement
Reduced fossil fuel use	Supply independence
Auxiliary market services	Reduced outage impact
Choose lowest cost energy	Optimised existing system
Power factor services	Remote site availability
	Absorption chiller level load
	Visibility of energy use

Figure 24 Potential benefits of microgrids[48]

Essential Energy's initial business case to be undertaken in 2019/20 is encouraging. Arup would expect to see the results of the business case, should they reveal microgrids are a viable option, to influence Essential Energy's remediation of poorly performing feeders and new connections in rural areas in the forecast RCP, rather than waiting until 2024/29 to implement the findings.

[48] Arup graphic.

4 Replacement capex observations

Essential Energy's forecast capital expenditure continues the NEM wide trend over the last two regulatory periods in concentrating their resources more on repex than augex. This shift is in part driven by consumption at lower levels than was expected in the 2009/14 regulatory period, and partly by the aging nature of network assets. In the 2019/24 regulatory period, 81% of the capex proposed by Essential Energy is repex[49].

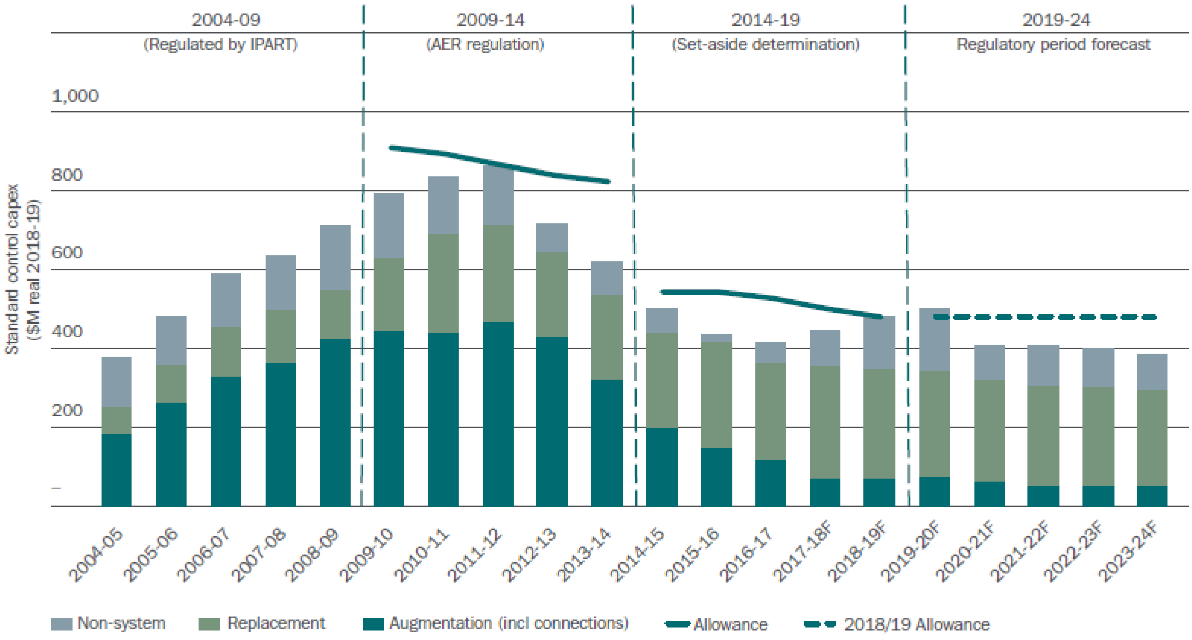


Figure 25 Historical, current and forecast breakdown of capex into repex, augex, and other[50]

4.1 AER repex model

The AER uses a sophisticated method of modelling to inform its repex decisions. As described by the AER:

> *The AER's repex model is a statistical tool used to conduct a top-down assessment of a distributor's replacement expenditure forecast. Discrete asset categories within six broader asset groups are analysed using the repex model. These six asset groups are poles, overhead conductors, underground cables, service lines, transformers and switchgear.*
>
> *The repex model forecasts the volume of assets in each category that a distributor would expect to replace over a 20-year period. The model analyses the age of assets already in commission and the time at which, on average, these assets would be expected to be replaced, based on historical replacement practices. A total replacement expenditure forecast is derived by multiplying the forecast replacement volumes for each asset category by an indicative unit cost.*
>
> *The repex model can be used to advise and inform the AER and its consultants where to target a more detailed bottom-up review, and define an alternate repex forecast if*

[49] Essential Energy, 2018, *Supporting Document 12.1.14: Essential Energy Network Delivery Plan*, pg 10
[50] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 64

necessary. The model can also be used to benchmark a distributor against other distributors in the National Electricity Market. [51]

The modelling forecasts expenditure in the following asset categories:

- underground cables
- transformers
- switchgear
- services lines
- poles
- overhead conductors.

These modelled categories generally constitute the majority of a NSP's repex, but in Essential Energy's case a significant volume of proposed capex fell outside the boundaries of the AER's modelling.

As such and in accordance with the AER, we have structured our analysis into modelled and un-modelled repex, the latter of which is predominately in pole tops and crossarms.

4.2 Modelled replacement capex

Essential Energy's allocation of expenditure between programs is expected to stay reasonably consistent, with a slight decrease, in the upcoming regulatory period.

[51] As described by the AER in email to Arup dated 25/06/2018 @ 3.52pm

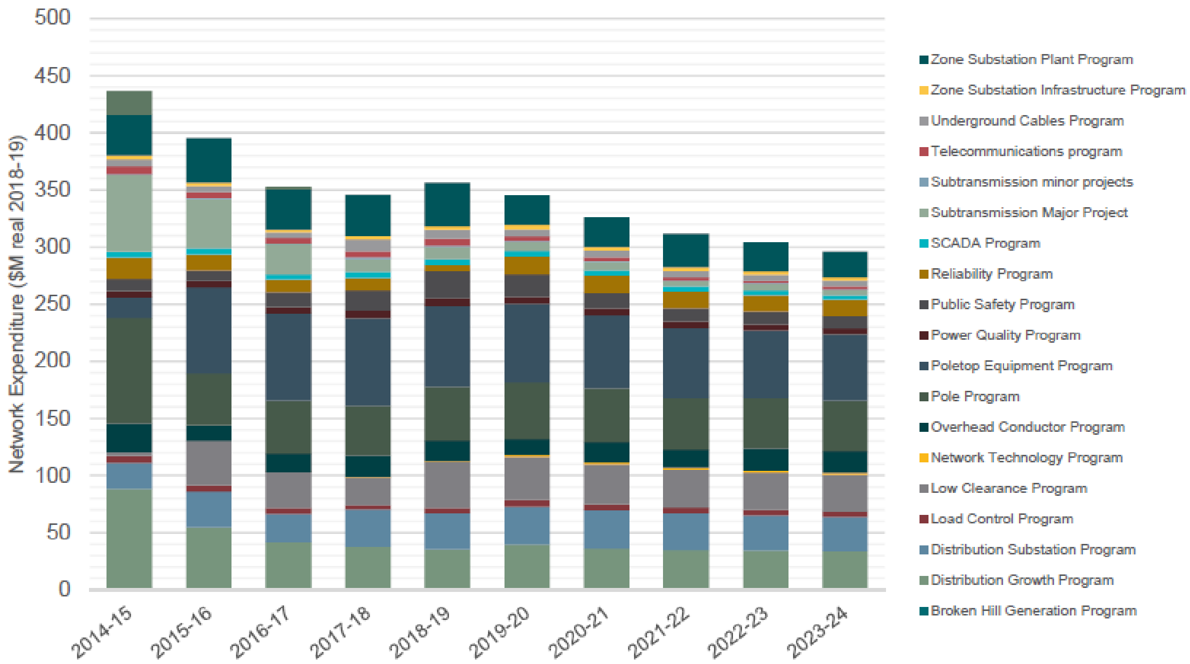


Figure 26 Capital expenditure by program 2014-2024[52]

Arup observation

The pole and rectification of low clearance programs are two of the largest in Essential Energy's capital portfolio. In addition to the observations on strategic investment evaluation in Section 3, Arup has reviewed these major programs in detail to assess the application and suitability of Essential Energy's frameworks in their program evaluations, particularly in regards to whether they result in prudent and efficient investments.

4.2.1 Investment case – low clearance rectification

Essential Energy has proposed $114.3m in capex in the upcoming regulatory period to rectify low clearance overhead conductors across its network.

[52] Essential Energy, 2018, *Supporting Document 12.1.14: Essential Energy Network Delivery Plan*, pg 10

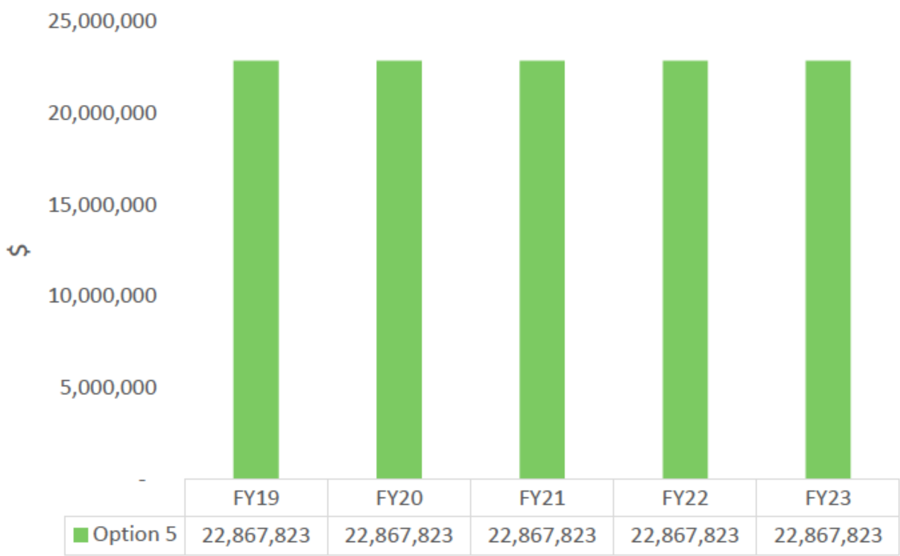


Figure 27 Essential Energy's proposed capex for Rectification of Low Clearance on Overhead Feeders[53]

In 2014 Essential Energy engaged LiDAR contractors to scan the rural portion of their network over a five-year cycle. After three years, 72% of spans had been scanned for ground clearance, revealing 7.63% or 57,199 potential defects. Essential Energy are expecting ~80,000 potential defects to be found by the end of the five-year cycle. These defects are investigated by a task force and thus far ~46% of identified spans ultimately require rectification[54].

Prior to 2014, a ground-line asset inspection team measured the height of each span to confirm conformance with statutory requirements. The volume of defects revealed by LiDAR is significantly higher than was revealed by the ground-line team, as seen in Table 4. This led Essential Energy to conclude that the approach prior to 2014 was inadequate in ensuring its network was compliant[55].

Table 4 Low ground clearance rectification expenditure[56]

	2014-15	2015-16	2016-17	2017-18	2018-19	Total
Replacement Quantity	427	4,837	4,432	4,432	4,432	18,560
Expenditure	$2.12m	$24.00m	$21.99m	$21.99m	$21.99m	$92.08m

4.2.1.1 Drivers for investment

The key driver for this project is compliance. Specifically, Essential Energy's overhead conductors are required to conform to overhead line design standard AS/NZS 7000:2016 and NSW Service and Installation Rules 2016.

[53] Y-axis units not clear from source
[54] Essential Energy, 2018, *Investment Case: Rectification of Low Clearance on Overhead Feeders*, pg 10
[55] Essential Energy, 2018, *Investment Case: Rectification of Low Clearance on Overhead Feeders*, pg 5
[56] Essential Energy, 2018, *Investment Case: Rectification of Low Clearance on Overhead Feeders*, pg 14

Conductors that fail to meet these design standards have a higher chance of coming into contact with a member of the general public. The Australian standard stipulates a minimum clearance of 4.6m, but in some cases conductor spans can fall to within reach of pedestrians.

Contact with conductors can result in serious injury or death, and as such safety concerns are largely what dictate compliance requirements. Secondary but not insignificant concerns also related to low spans include:

- network reliability, where in most cases the protection system will trip resulting in outages for downstream consumers
- expenditure, with unplanned capex to remediate the conductor generally more expensive than planned
- bushfire risk, where sparks resulting from contact with conductors could potentially lead to fire starts.

4.2.1.2 Options assessment

Essential Energy has developed a number of strategies to mitigate the risk of conductor strike, including:

1. design standards, tools and peer review
2. inspection programme
3. a prioritised risk-based rectification programme
4. a Public Electrical Safety Awareness Programme
5. other programmes designed to eliminate the risk of contact.

The options considered in this investment case represent variations of strategy 3, where Essential Energy has devised and ranked 14 priority categories for planned rectification.

Table 5 Priority Categories for Options Analysis[57]

Priority	Conductor Type	Land Groupings	FY20 to FY24 Projected Defects
1	HV	Production from irrigated agriculture and plantations	421
2	LV-Covered	Intensive uses	468
3	HV	Intensive uses	1,796
4	HV	Production from dryland agriculture and plantations	1,433
5	LV-Covered	Production from irrigated agriculture and plantations	22

[57] Essential Energy, 2018, *Investment Case: Rectification of Low Clearance on Overhead Feeders*, pg 21

Priority	Conductor Type	Land Groupings	FY20 to FY24 Projected Defects
6	HV	Grazing modified pastures	7,981
7	LV-Covered	Production from dryland agriculture and plantations	346
8	LV-Bare	Production from dryland agriculture and plantations	380
9	LV-Covered	Low Risk Land	50
10	HV	Low Risk Land	2,108
11	LV-Bare	Production from irrigated agriculture and plantations	141
12	LV-Bare	Intensive uses	695
13	LV-Bare	Medium Risk	4.889
14	LV-Bare	Low Risk Land	1,312

The options being considered by Essential Energy are:

- option 1: defer to future regulatory period
- option 2: priorities 1 to 5
- option 3: priorities 1 to 6
- option 4: priorities 1 to 12
- option 5: priorities 1 to 14.

Ultimately, Essential Energy has proceeded with option 5, the most comprehensive of the options considered under this investment case.

Arup observation

Essential Energy is required under AS/NZS 7000:2016 and NSW Service and Installation Rules 2016 to have minimum clearance for their overhead spans. In instances where spans have been defective and members of the general public have come into contact with overhead conductors, Essential Energy has been taken to court and on occasion been found liable for damages resulting from serious injury.

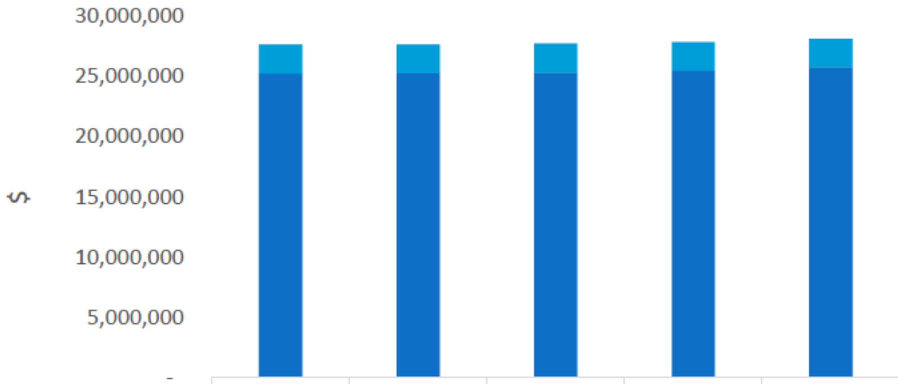
As such, both Essential Energy's intent to survey its network in a thorough manner through LiDAR, and the decision to proceed with the most comprehensive options for remediation, is understandable. Further, the process by which these options are developed, through quantifying condition and consequence risk factors and prioritising areas with the highest risk, appears to be robust.

However, the actual process through which Essential Energy select the preferred option – through C55 as discussed in Section 3 – means that the change in overall risk profile of the network as a result of this project is relatively opaque. As such, it is entirely possible that this project, though conforming with Essential Energy's statutory requirements, is lowering its overall network risk to a level beyond what is required by the AER and desired by its customers.

4.2.2 Investment case – distribution pole replacements and reinforcements

Essential Energy's network is comprised of 1.39 million structures, approximately a quarter of which were installed prior to 1970. Addressing the probability of pole failure has been Essential Energy's traditional focus for pole investment strategies. The current investment case "is to assess and quantify the differing levels of risk mitigation that can be achieved through different pole maintenance, replacement, and reinforcement strategies"[58].

Essential Energy's proposed capex for distribution pole replacements and reinforcements for the upcoming RCP is summarised in the following Figure 28.



	FY20	FY21	FY22	FY23	FY24
Distribution pole reinforcements	2,379,000	2,379,000	2,379,000	2,379,000	2,379,000
Distribution pole replacements	25,230,846	25,248,706	25,308,889	25,450,801	25,724,553

Figure 28 Essential Energy's proposed capex for distribution pole reinforcements and replacements

Both programs represent a reduction compared to the current regulatory period, though in distribution pole top replacements this difference may be in part explained by accounting changes as the "investment case scope reduced after financial year 2014/15 excluded poles replaced due to system alterations as well as distribution pole top investment case" [59].

[58] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 7
[59] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 23

Table 6 Previous program expenditure summary, actual (a) and forecast (f) [60]

	2014/15 (a)	2015/16 (a)	2016/17 (a)	2017/18 (f)	2018/19 (f)	Total
Pole staking / reinforcements		$2.12m	$4.87m	$2.39m	$3.12m	$12.5m
Pole replacement distribution	$51.16m	$23.81m	$25.15m	$21.46m	$21.46m	$143.04m

The number of reinforcements and replacements reported by Essential Energy in the Figure 29 below do not necessarily line up with the expenditure figures in the Table 6 above. Note it is not clear from the source text whether this represents total replacements and reinforcements or specifically in response to conditional failures.

Essential Energy did note in discussions that the size of its network increases the ratio of replacements to reinforcements above what might otherwise be expected. Given the distances often covered by technicians, travel time can be a major input into repex costs. This can skew the reinforcement/replacement decision in favour of replacement, the option that reduces travel time the most in the long term.

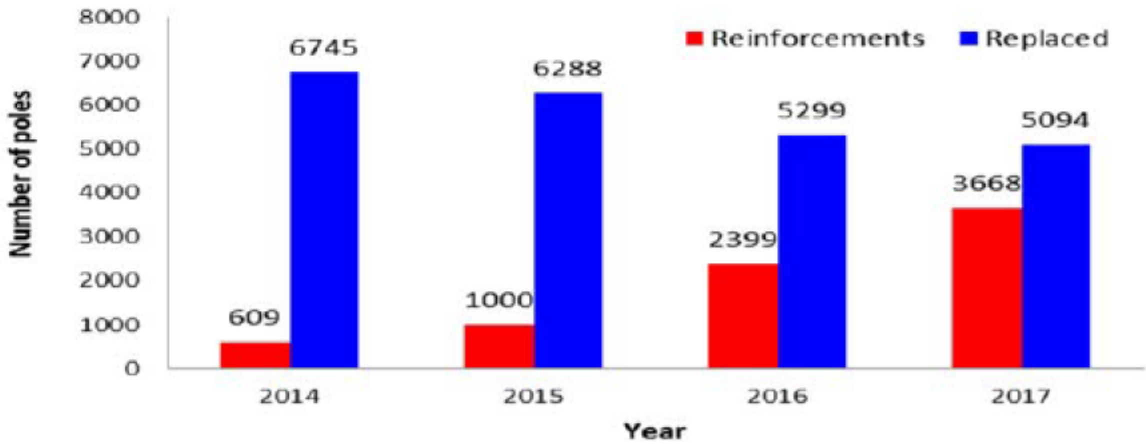


Figure 29 Replacements and reinforcements[61]

4.2.2.1 Drivers for investment

There are six drivers for investment in distribution pole replacement and reinforcements[62]:

- safety, including but not limited to:
  - damage to private property or livestock
  - damage to other assets and equipment
  - trauma injuries to public or workers

[60] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 23
[61] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 24
[62] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 12

    - ignition of fire
    - electrocution of livestock
    - electrocution of public or workers
- network reliability, indicated by licensing conditions and the value of customer reliability
- environmental factors, including bushfire risk mitigation and material pollution
- financial factors, with unplanned capex to remediate the conductor generally more expensive than planned
- reputation risk, with excessive rates of failure eroding community confidence
- compliance, in relation to the Electrical Supply (Safety and Network Management) Regulation 2014.

4.2.2.2 Options assessment

Essential Energy has devised a list of 14 and 15 priorities of condition and consequence differentiators for pole replacements and reinforcements respectively. Together, these differentiators capture:

- condition, measured by the category of defect
- consequence, measured by:
    - bushfire priority zone
    - reliability impact
    - urban / rural area.

As with the options assessment for the low clearance rectification investment case, the options are presented in terms of complete deferral or addressing priorities from 1 to *n* inclusive.

Essential Energy has proceeded with the options detailed in Table 7[63].

Table 7 Replacement and reinforcement option selection

	Total poles FY20 to FY24	**Defect severity extent**	**Bushfire extent**	**Reliability extent**	**Safety extent**
Replacement – option 3	26,145	CAT 3	P4	B80	Rural
Reinforcement – option 5	11,860	CAT 4	P4	B80	Rural

[63] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 28-30

Relevant definitions for Table 7[64]:

- CAT 3: Situations where the assets are considered a moderate risk to the safe or reliable operation of the network over the short term.
  Defects, faults, failures or situations that are assessed to be a moderate risk to the safe or reliable operation of the network.
  It is expected that tasks that fall in this category will progress to functional failure within 50% of the time till the next maintenance cycle.
- CAT 4: These are general maintenance tasks on assets which present a low risk but if left untreated can in the long term have the potential to affect the safety or reliability of the network.
  It is expected that tasks that fall in this category will not progress to a functional failure or present a very low risk if functionally failed before the next inspection.
- P4: Non-Bushfire Prone e.g. wetlands, riparian bushlands, urbanised
- B80: VCR cost bottom 80%.

Option 3 for replacement allows for replacement of all CAT 1, CAT 2 and CAT 3 defects.

Option 5 for reinforcement addresses all priorities, allowing for reinforcement of all CAT 3 and CAT 4 defects, noting that CAT 1 and CAT 2 defects (representing emergency and urgent situations respectively) are not considered for reinforcement as their condition warrants full replacement.

Both option 3 and 5 are "approximately congruent with the replacement program from the 2014/15 – 2018/19 period"[65].

Arup observation

Essential Energy's investment case for distribution pole replacement and reinforcement is well structured with reasoned discussion on drivers for investment, asset description and performance, and options development.

However, the manner in which the appropriate option is selected remains opaque as it is done through C55 as discussed previously.

In the case of pole reinforcement, the most comprehensive option was selected. This option remediates poles that are classed in the lowest prioritised category of condition and consequence, where "it is expected that tasks that fall in this category will not progress to a functional failure or present a very low risk if functionally failed before the next inspection" [66]. On the surface, this would appear to be overly conservative.

The merits of each options are assessed in C55 according to value, measured by the value ratio of total value divided by the total presented value of capex. For ESS_17N replacements, option 3 was selected with a value ratio of 2.2. For ESS_15N reinforcements, option 5 was selected with a value ratio of 11.6[67].

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[64] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 43-44
[65] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 29-30
[66] Essential Energy, 2018, *ESS_15, ESS_17 and ESS_46 – Poles and Towers: Investment Case*, pg 43-44
[67] Essential Energy, 2018, *IR012 – 012.9 C55 outputs to ROMO – 20180620 – Public.xlsx*, 'C55 Outputs' tab

The discrepancy in value ratio raises the question of whether the weighting of pole reinforcement to replacement should be revisited. This question does not appear to be addressed in the investment case.

4.3 Un-modelled replacement capex – pole top structures

Pole top structures include cross arms, insulators, fittings, braces, bolts, conductor ties and any other associated hardware. The function of the asset class is to ensure the security of overhead conductors to the pole head so that the conductors are isolated from each other and the ground.

Historically, detailed data on pole top components has been of limited quality, and therefore the age of pole has been used as a proxy for the condition of pole top assets. Essential Energy currently uses the following inspection and control monitoring techniques.

- Cyclic ground line asset inspection programme
- Annual bushfire patrol
- LiDAR Aerial Patrol and analysis.

Pole top components are replaced when a conditional or functional failure is detected from one of the inspection regimes.

4.3.1 Previous expenditure

The most significant change in the previous and forecast expenditure on pole tops can be somewhat attributed to the change in business and accounting treatment, and from the better understanding of pole and pole top structures condition. As a result, Essential Energy's expenditure on pole top structures appears to have increased significantly between FY15 and FY17 as shown in Figure 30.

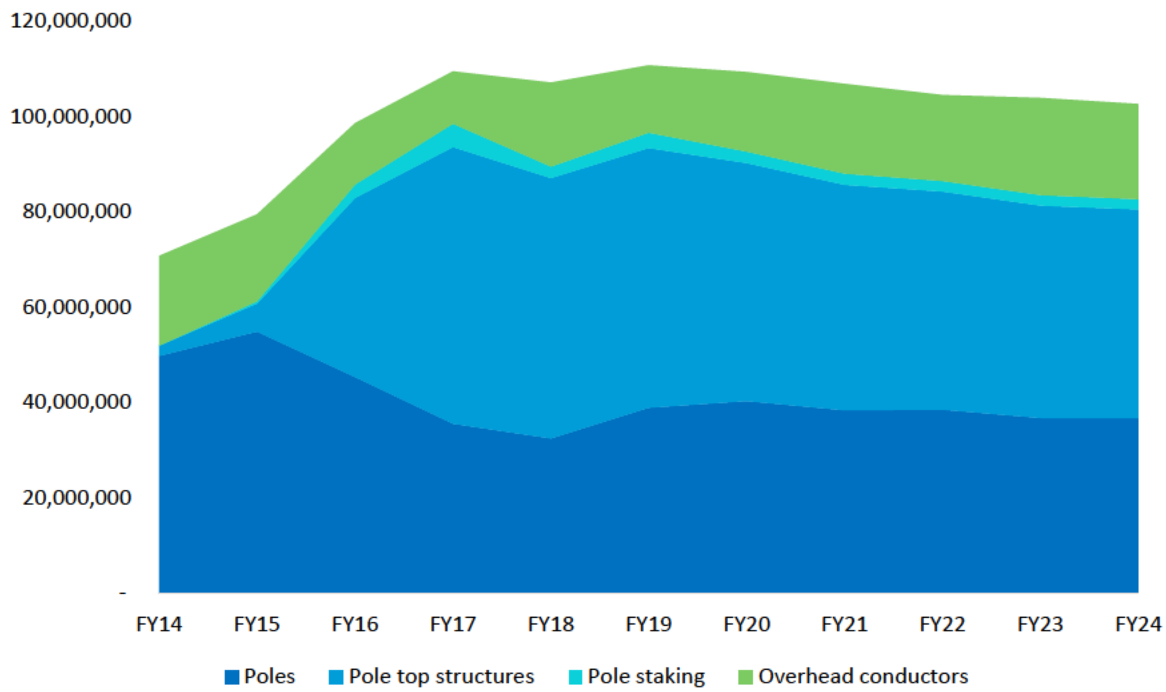

Figure 30 Pole, pole top and overhead conductor repex - historical and forecast

Essential Energy has provided two reasons that underpin the changes in the treatment of pole top repex:

- combining pole top expenditure with poles tended to overinflate pole expenditure. The current practice separates the expenditure more accurately.
- assigning to the broader AER RIN categories made it more difficult for EE to track expenditure and unit replacement costs[68].

The changes in the treatment of pole top repex has been compounded with a significant increase in pole top spend. Essential Energy reduced spend in poles, totalling $15m which is shown in the Table 8 below. This is outweighed by the $50m increased spend in pole top structures.

Table 8 Changes in repex spend in pole and pole top structures

Changes in treatment (FY15 to FY17)	**Value**
Reduction in the spend on poles	-$15 m
Increase in the spend on pole top structures	+50 m
Net change in repex	+$35 m

Essential Energy has provided the following reasoning within the pole and pole top expenditure explanation to the AER and Arup that outlines the increase in pole top expenditure between FY15 and FY17.

4.3.1.1 Reduction in the spend on poles

Essential Energy has made some internal changes in the way in which poles expenditure is considered. The following changes have been made to reduce pole repex by $15m.

- $10m of $15m decrease - Removal of pole top structure expenditure from poles
- $3m of $15m decrease - Improved inspection criteria and increased cycle length
- $2m of $15m decrease - Increases in the staking program.

4.3.1.2 Increase in the spend on pole top structures

$15m of $50m increase - All opex pole top replacements have been moved to repex as Essential Energy believe that this reflects a more accurate treatment of the asset.

[68] Essential Energy 2018, *Pole and Pole Top Expenditure – Explanation*

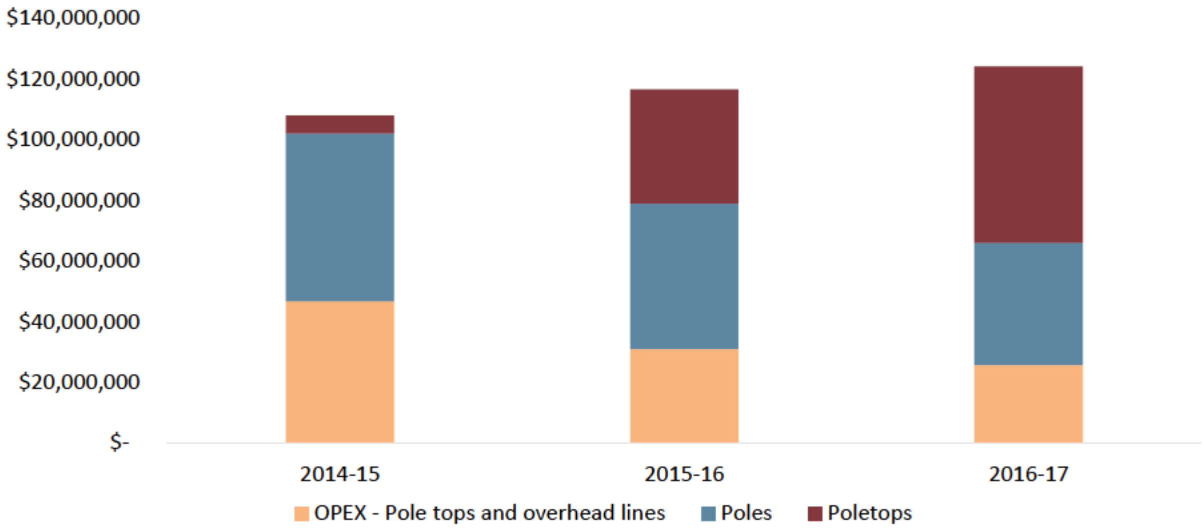

Figure 31 CA RIN pole & pole top repex w/ opex[69]

$15m of $50m increase - Essential Energy's introduction of LiDAR and aerial inspection technologies has highlighted previously unseen pole top and low ground clearance (LGC) conditional issues.

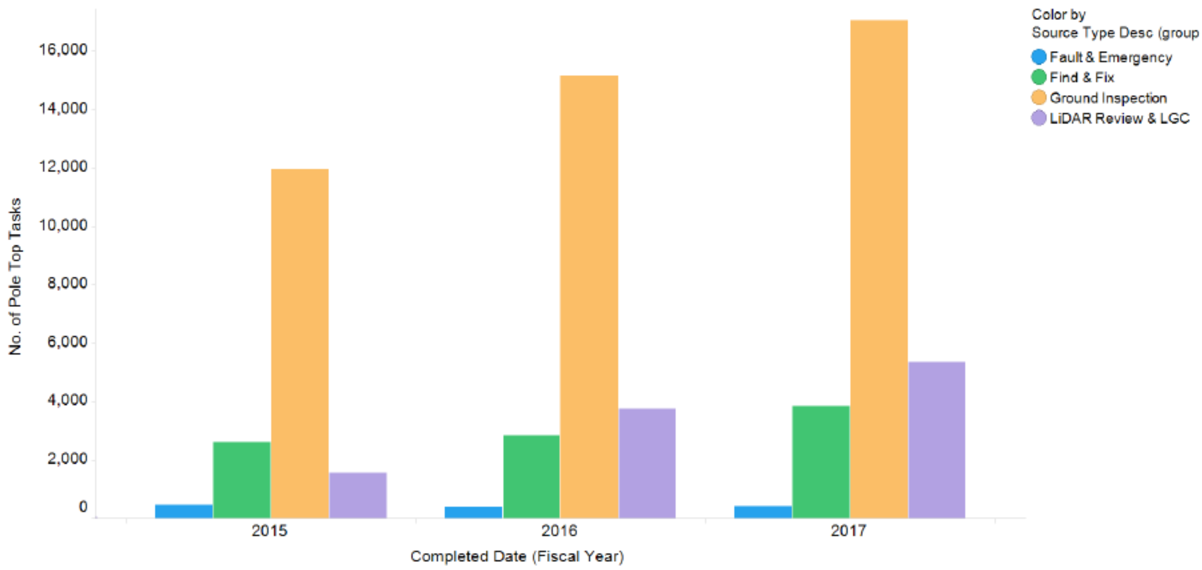

Figure 32 LiDAR and LGC technologies attributed spend (purple column)[70]

$10m of $50m increase - Essential Energy has reallocated pole top structures from pole repex as it suggests that this has overinflated expenditure on poles prior to FY15.

[69] Essential Energy 2018, *Pole and Pole Top Expenditure – Explanation,* pg 11
[70] Essential Energy, 2018, *Pole and Pole Top Expenditure – Explanation,* pg 12

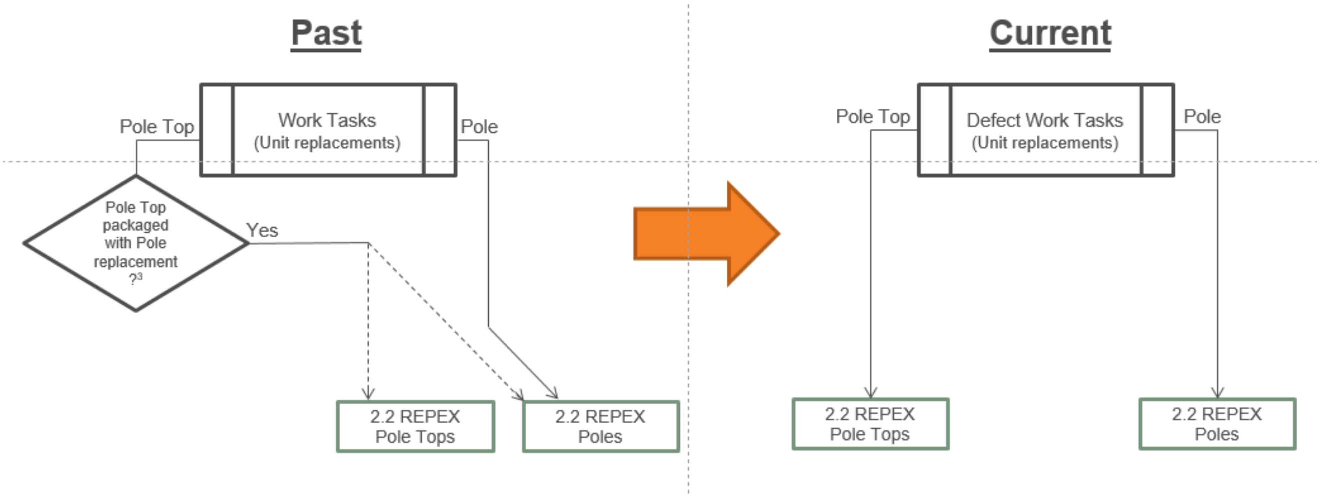

Figure 33 Schematic describing the reallocation and treatment of pole top structures[71]

$5m of $50m increase - Essential Energy introduced the PEC and laminated pole refurbishment program due to poor existing asset condition.

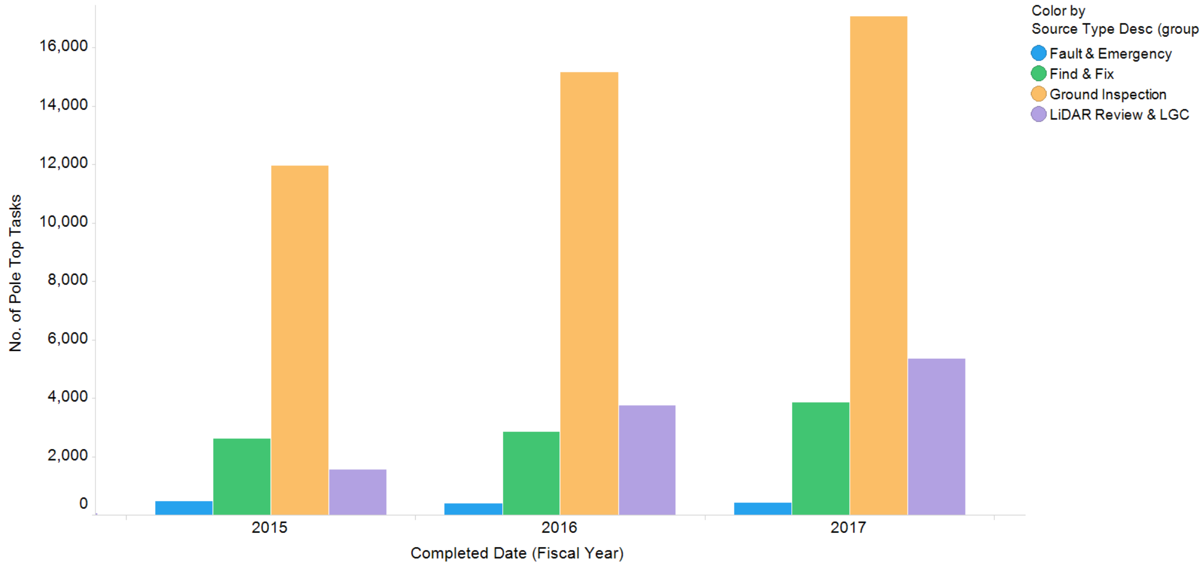

Figure 34 PEC and laminated pole top refurbishment programme (yellow column)[72]

$5m of $50m increase - The Prioritised Investment Programme (PIP) provides specific allocations for investment into asset groups which can be compared and prioritised to each other, and introduces work tasks to more accurately track conditional replacement vs augmentation.

Arup observation

Essential Energy's approach to accounting and asset categorisation of pole and pole top structures appears to be mature and reasonable, despite the increase in overall expenditure. The only area of concern is around efficiency gains around the introduction of the LiDAR and aerial inspection technologies. It would be expected that these technologies would be used to improve detection of high risk assets, as opposed to increasing overall replacement.

[71] Essential Energy, 2018, *Pole and Pole Top Expenditure – Explanation*, pg 7
[72] Essential Energy, 2018, *Pole and Pole Top Expenditure – Explanation*, pg 13

4.3.2 Investment driver

Essential Energy has suggested that there are a range of safety and operational issues associated with pole tops that can only be addressed through the replacement of the asset. Pole top assets are purportedly reaching the end of their usable life, increasing the likelihood of failure. There are two types of failures in pole tops: conditional and functional failure.

4.3.2.1 Conditional failure of pole top assets

Conditional failure is when a pole top component has reached the end of usable life, but functional failure has not taken place.[73] As such, an asset can be classed as having failed conditionally if visual inspection reveals poor condition, despite the asset continuing to function as designed.

Essential Energy's inspection programmes aim to find these cases and rectify them before functional failure occurs. Based on the inspection programs WASP data, crossarms and insulators have been identified as the main sources of failure. Historical data from WASP records of crossarm and insulator are shown in the figures below. As noted in ESS_4005, spikes in the FY15 and FY16 conditional failure rates and subsequent replacements are due to the introduction of the aerial photography inspections.

[73] Essential Energy, *ESS_4005 Distribution Pole Tops*, pg 23

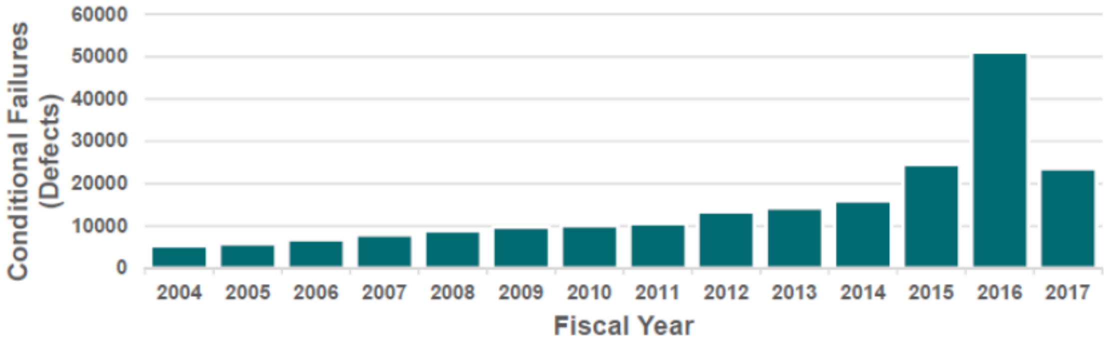

Figure 35 Conditional Failures – distribution crossarms[74]

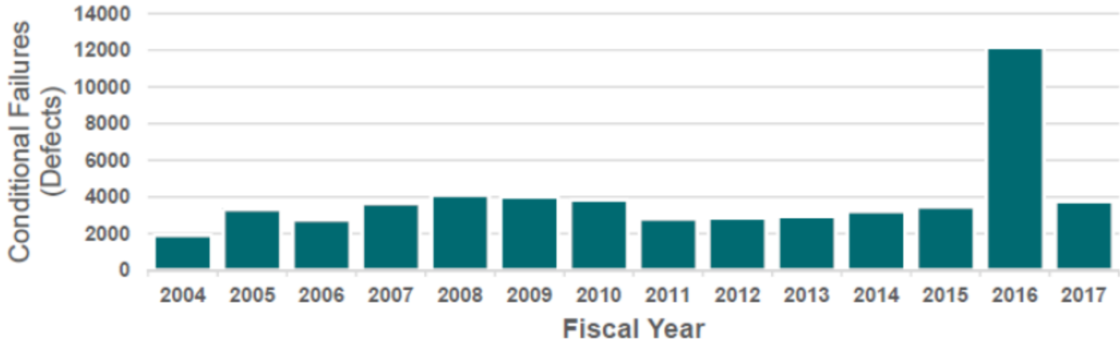

Figure 36 Conditional failures – distribution insulators[75]

4.3.2.2 Functional failure of pole top assets

Functional failures include snapped crossarms, broken insulators and conductors resting on the crossarm. These failures have the potential to increase risk to public safety, staff, bushfire, reliability and third-party damage.

The frequency of failure from 2013 to 2017 is shown in Table 9 and Figure 37. The failure rate does not appear to exhibit a consistent trend, with the rate peaking in FY15 at 0.0748% per annum.

Table 9 Distribution pole top failure frequency[76]

Fiscal year	Functional failure	Annual failure rate
2013	809	0.0622%
2014	650	0.500%
2015	972	0.0748%
2016	699	0.0538%

[74] Essential Energy, *ESS_4005 Distribution Pole Tops,* pg 24
[75] Essential Energy, *ESS_4005 Distribution Pole Tops,* pg 24
[76] Essential Energy, *ESS_4005 Distribution Pole Tops,* pg 25

Fiscal year	Functional failure	Annual failure rate
2017	699	0.0538%
Average	**766**	**0.0589%**

Crossarms are the main driver of functional failure in Essential Energy's pole top network. Based on the functional failure breakdown by component, crossarms represent 78.3% of failures in pole tops and insulators the remaining 21.6%.[77] Essential Energy's crossarm population is made of timber, steel or composite fibre material. After increasing the use of aerial inspection from FY15 onwards, there has been a decline in the rate of crossarm function failures, as can be seen in the figure below.

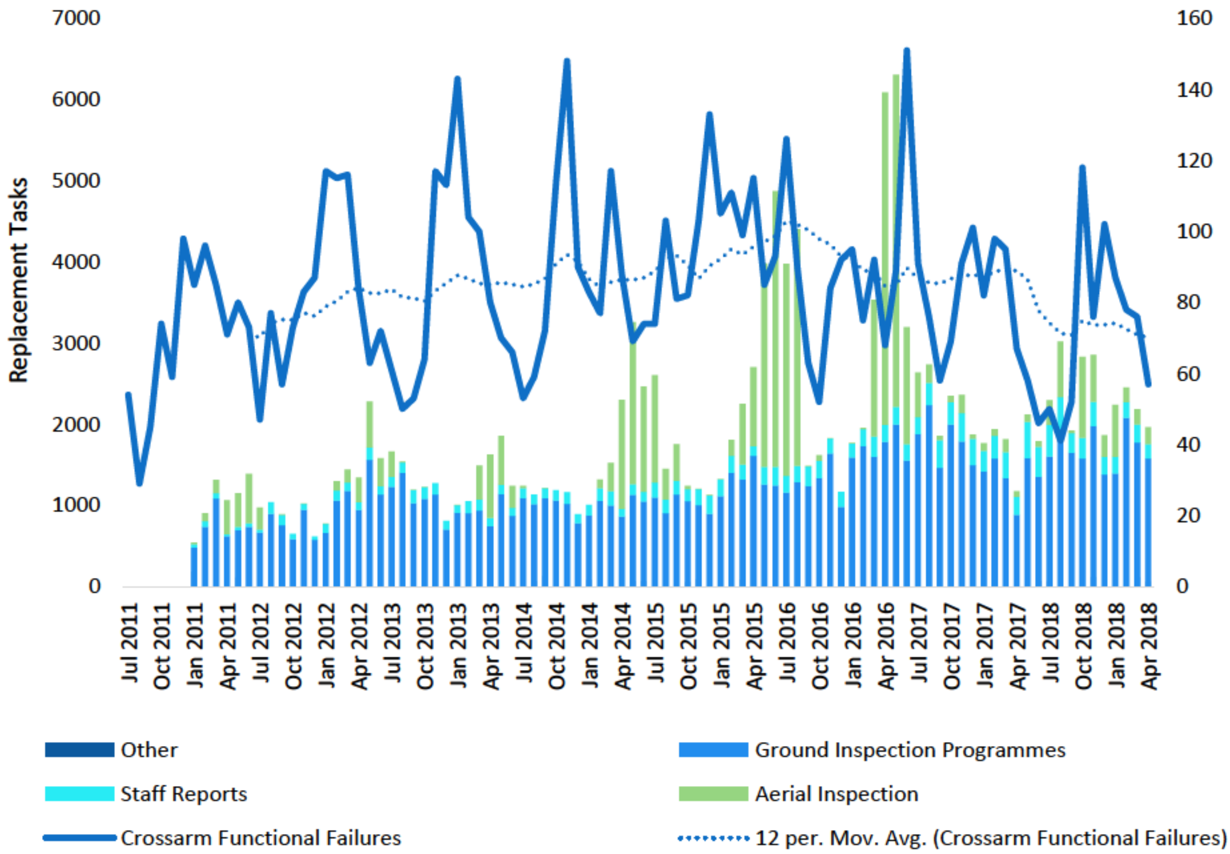

Figure 37 Historical crossarm functional failures and replacement tasks

Arup observation

Essential Energy has identified an increasing number of conditionally failed pole top assets. One might expect that taking a more proactive role in identifying and rectifying conditional failure assets that are assumed to be at high risk of functional failure would decrease the rate of functional failure seen across the network. Based on Figure 37 it appears that this is the case, and crossarm functional failures are reducing.

[77] Essential Energy, *ESS_4005 Distribution Pole Tops,* pg 26

Conditional failure can represent the perceived risk in the network. Condition and assessment systems such as aerial photography are increasing the visibility of conditional failures and as such, the perceived risk, is unlikely to have actually changed significantly since LiDAR's introduction. There is potential for LiDAR to be used to target high risk assets as opposed to increasing replacement levels to maintain the level of perceived network risk.

In this respect, one outcome of increased visibility and rectification of conditional failures appears to be an increase in investment with an outcome of overall reduction in network risk. It's not clear that Essential Energy's customer preference for affordability is being reflected in this approach.

4.3.3 Replacement approach

Essential Energy is replacing all crossarms with a composite material considered as the lowest lifecycle cost crossarm when compared to timber or steel. General replacement of defective pole tops, including crossarms will be undertaken under the allocations program, discussed in Section 4.3.4. Essential Energy is also planning to replace targeted assets, including pigment emulsified creosote (PEC) and laminated crossarms with a composite material, discussed in Section 4.3.5.

4.3.3.1 Composite crossarms

Essential Energy started trialling composite crossarms in the network in 2005, with the material type approved as the primary material type in 2008/09, and were continuing to use steel crossarms in areas that require high strength and timber in coastal (salt spray) environments. Essential Energy transitioned to composite crossarms in 2012 across the entire network, including both high strength and coastal environments.[78]

According to Essential Energy composite crossarms have been selected for installation due to high strength, fire resistance and corrosion resistance. The evidence provided in the Review of composite Crossarms document suggests that the material has reduced potential injuries and repeated handling through their lower weight in order to recognise the needs of the aging workforce. These are the suggested "hidden savings'" associated with the asset, in addition with the better network reliability and longer service life. In addition to this, the unit price of composite crossarms shows only a marginal cost difference compared to its counterparts. Essential Energy only has one approved supplier for composite crossarms, however are looking to expand the number of suppliers.[79]

Essential Energy's NPV that was used to compare the set of potential crossarm materials monetised the following factors:

- Decay and corrosion
- Reliability (VCR)
- Unloaded labour costs
- Estimation of F&E
- Manual injuries.

[78] Essential Energy 2018, *IR008- 008.5 Review of Composite Crossarms*, pg 3
[79] Essential Energy 2018, *IR008- 008.5 Review of Composite Crossarms*, pg 7

From the NPV results below, timber crossarms are the most cost-effective material in terms of total capital cost. However, they do not appear to be available in high volume for purchase as stated in the review of composite crossarms due to diminishing hardwood supplies. Additionally, when considering NPV timeframes of 20 years and beyond, composite fibreglass emerges as the most preferable option.[80]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Arup observation

The NPV results shown above highlight that fibreglass is the most preferable replacement option in the long term. The outputs of this NPV are based on a comparative model that details the life of each of the material types and the probability of failure. There appears to be consideration given to failures for both timber and steel crossarms: timber from decay and steel from corrosion. This is not the case for fibreglass crossarms, where the asset appears to have zero probability of failure assumed over its life.

Regardless of the quality of the material, there would be some probability of failure. To complete a robust analysis, we recommend that Essential Energy includes some consideration for the probability of failure in fibreglass crossarms in its analysis.

4.3.4 Pole top structures proposed capex

The 'allocations' portion of pole tops targets the replacement of pole tops on specific distribution feeders that are reaching the end of their useable life. Targeted replacement of specific crossarms materials does not appear to be included in Essential Energy's allocations methodology, and is instead discussed in Section 4.3.5.

This program targets the replacement of assets based on the level of risk it places on the network. Essential Energy uses condition and consequence differentiators to prioritise investment in assets in the allocation portion.

[80] Note: Composite and fibreglass crossarms are used interchangeably to describe the same material

[81] Essential Energy 2018, *IR008- 008.5 Review of Composite Crossarms,* pg 11

Condition differentiators for investment are based on the defect categorisation given by asset inspectors. This is linked to the window of time in which Essential Energy believe they must rectify the issue.[82]

- CAT1 (Emergency) = 48 hours
- CAT2 (Urgent) = 1 Month
- CAT3 (Risk) = 6 Months
- CAT4 (General Maintenance) = 4 Years.

Essential Energy has used three potential consequence differentiators in the modelling to determine the difference between the options, including:

- Bushfire priority zone
- Reliability impact categorisation
- Safety impact categorisation.

Allocation of the consequence and condition differentiators is shown in the following table. Each priority has been assigned to a forecast number of conditional replacements per year. Essential Energy has based these conditional failure rates on the organic decay model, which considers the age of the asset as well as the decay regions set out by the CSIRO for timber. Essential Energy deems an asset as conditionally failed once it reaches the failure point on the modelled curve.[83] The failure rates associated with each of the priorities have been used to compare the options.

Table 11 Essential Energy condition and consequence differentiator combinations and associated priority [84]

Priority	Defect severity	Bushfire	Reliability	Safety
1	CAT1-CAT2	-	-	-
2	CAT3	P1	-	-
3	CAT3	P2/P3/P4	T20%	Urban
4	CAT3	P2/P3/P4	T20%	Rural
5	CAT3	P2/P3/P4	B80%	Urban
6	CAT3	P2	B80%	Rural
7	CAT3	P3/P4	B80%	Rural
8	CAT4	P1	B80%	-

[82] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, pg 29
[83] Essential Energy 2018, *IR008 – 008 AER Information request response*, pg 7
[84] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, pg 30

Priority	Defect severity	Bushfire	Reliability	Safety
9	CAT4	P2/P3/P4	T20%	Urban
10	CAT4	P2/P3/P4	T20%	Rural
11	CAT4	P2/P3/P4	B80%	Urban
12	CAT4	P2/P3/P4	B80%	Rural

Table 12 Pole top replacements options analysis (preferred option bolded)[85]

Option	Relevant Priorities	Description	Total ($)
Option 1	-	Defer to future regulatory period. Only functionally failed assets will be replaced	54,401,066
Option 2	1-3	Involved the planned replacement of pole tops identified during inspections as having conditional defect of CAT1 or CAT2. As well as CAT3 defects in P1 areas and CAT3 defects in Urban Areas with a T20% reliability impact.	59,460,623
Option 3	1-6	Option 3 involves the planned replacement of pole tops identified during inspections as having a conditional defect severity of CAT1 or CAT2. As well as all CAT3 defects except CAT3 defects in Rural Areas with a bushfire rating of P3 or P4, and a reliability impact of B80%.	81,857,735
Option 4	1-7	Option 4 involves the planned replacement of pole tops identified during inspections as having a conditional defect severity of CAT1, CAT2, or CAT3.	102,546,078
Option 5	1-11	Option 5 involves the planned replacement of pole tops identified during inspections as having a conditional defect severity of CAT1, CAT2, or CAT3. As well as all CAT4 defects except CAT4 defects in Rural Areas with a bushfire rating of P2, P3 or P4, and a reliability impact of B80%.	107,232,094
Option 6	**1-12**	**Option 6 involves the planned replacement of pole tops identified during inspections as having a conditional defect severity of CAT1, CAT2, CAT3, or CAT4.**	**118,793,294**

[85] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, pg 29-30

Option 6 has been selected as the preferred option using the C55 model. C55 has been designed to select an option based on the optimisation of value and cost. Each option for the allocations portion was broken down based on net value derived from a number of factors including risk, cash flows and unserved energy.

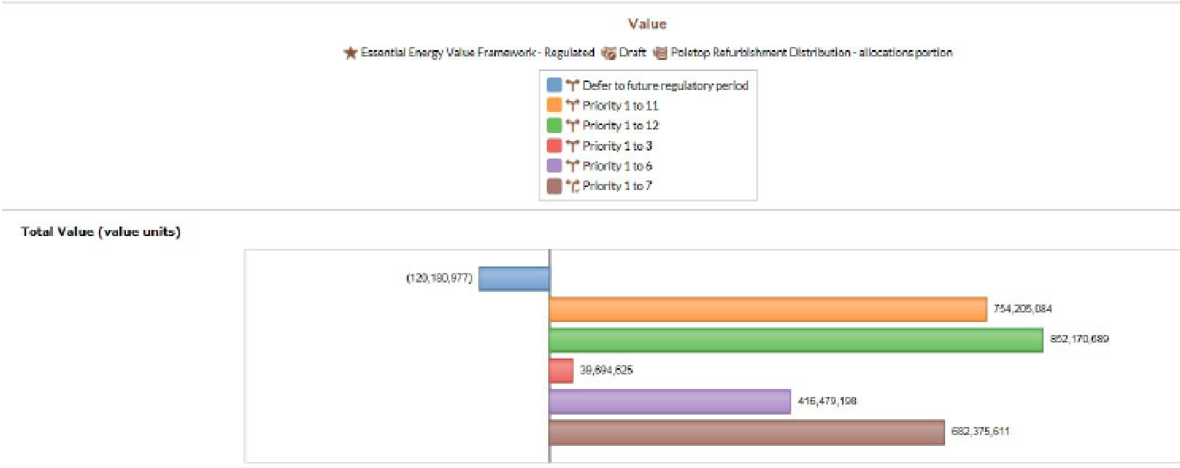

Figure 38 Breakdown of the total net value of each option[86]

As can be seen in the Figure 38 above each of the options range in value, with Option 6 having the highest value. Please refer to Section 3 for further details on the C55 model and how it quantifies value associated with projects as well as risk.

Arup observation

The allocations portion of the program is an example of the way in which Essential Energy classifies options with regards to value instead of risk. There does not appear to be an explicit method that shows Essential Energy maintaining the current network level of risk. As discussed in Section 3 this appears to be a value optimising approach, which may reduce the level of network risk instead of maintaining it.

Essential Energy has stated that it has used three consequence differentiators within the modelling to determine which option is preferrable. The Functional Failure Model used by Essential Energy appears to operate so that the total of defects for all three parameters is the same. Therefore, there does not appear to be a clear method in the model that shows that bushfire priority zone, relaibility and safety impact are taken into consideration.

4.3.4.1 Safety parameters

The safety risks assosiated with pole top allocations include a range of assumptions that summarise the liklihood of failure and individual exposure to a failed asset. The parameters are included in the safety event tree which was used to model safety risks.

Arup observation

The table below outlinese the safety risk parameters that appear to require further consideration.

[86] Essential Energy 2018, *IR008* pg 6

Table 13 Safety risk parameters[87]

Safety risk parameters used	Parameter value	Arup observation
During this time, how many people enter the exposure radius per hour?	2 pp / hour 0.1 pp / hr rural	Rural and urban pedestrian exposure may be overstated, considering the population density in rural areas and the number of hours that an individual is exposed to a pole is quite low. Based on the number of customers, Essential Energy has assumed exposures of 5 customer per km of route.
Assuming that no-one was standing within the exposure radius:		
What is the likelihood that a person comes in contact with energised asset?	5 %	This appears to be overstated. Considering that no-one is standing in the radius of exposure the likelihood of exposure would be expected to be lower, given: the reletively sparse population density, the fact that Essential Energy should be alerted to fallen assets, the network's breakers can de-energise fallen assets, and that there is a general awarness among the public that contact with energised network assets should be avoided.
What is the likelihood of a person or vehicle contacting a low span?	5 %	This appears to be high for the same reasons detailed above.

Essential Energy's estimation of the number of people entering the exposed radius may need further analysis. Catergorising Essential Energy's network into two zones, urban and rural may be too simplistc. Movements around a rural community such as the local store, post office or school within a local government area (LGA) varies significantly to the movements on the connecting roads to farms or large residential plots. It appears reasonable to assume that areas near built-up areas within LGAs could have two people per hour passing through the exposed radius, however the connecting roads and regions would most likely be more negligable.

4.3.4.2 Value of customer reliability

Essential Energy has used two key parameters to determine the for the Value of Customer Reliability (VCR). A base rate has been determined and then multiplied by 1.8 to provide the value for the top 20% of distribution feeders by customer density. For the bottom 80% of feeders by customer density this base value has been multiplied by 0.8.

[87] Essential Energy 2018, *ESS_4005 Consequence model*

Table 14 Parameters used for VCR – allocations[88]

Parameter	Value
VCR Cost Top 20% of Feeders (T20%)	$23,646.49
VCR Cost Bottom 80% of Feeders (B80%)	$10,509.55

Arup observation

It appears that Essential Energy has utilised a generally robust approach in determining the value for VCR. The value for VCR here is based on customer density, however it is unclear if customer type such as residential, commercial or industrial – estimates for which are available from AEMO guidance documents – has been taken into consideration. Arup recommends that Essential Energy review the value used for VCR to ensure that it incorporates customer type and distribution into calculations.

4.3.5 Targeted crossarms proposed capex

Essential Energy has proposed two programs in addition to the allocations portion. These target specific asset types in laminated[89] and PEC crossarms that have been identified as key drivers of failure.

4.3.5.1 Laminated Crossarms

Essential Energy has proposed five options to replace laminated crossarms which have reached end of life. The preferred option for the replacmenet of laminated crossarms has not been included in the C55 outputs provided by Essential Energy, and it is unclear if this is a subset of the allocations portion described above.

Table 15 Pole top replacements options analysis[90]

Option	Description	Total ($)
Option 1	Defer to the future regulatory period	1,598,523
Option 2	Replace only identified defects that have been identified as being a defect by the ground-line inspection team. Due to the accelerated nature of failures of these types of crosarms, it is expected that the degredation rate will be faster than the 4 year inspection cycle. This option is anticipated to decrease failure rates, however failures are still expected to occur.	2,814,866
Option 3	Replacement of laminated crossarms where there are identified defects, as well as all laminated crossarms installed on a termination style construction. This	7,459,719

[88] Essential Energy 2018, *ESS_4005 Distribution Pole Tops,* pg 32
[89] These are wood laminated crossarms, where hardwood crossarms have been difficult to source.
[90] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, pg 35-36

Option	Description	Total ($)
	replacement will aim to be completed over two regulaotry cycles.	
Option 4	The planned replacement of of lamianted crossarms with identified defects, as well as lamianted crossarms on a terminated style construction, strain style construction and operating constructions. This replacement will aim to be completed over two regulaotry cycles.	9,577,574
Option 5	The planned replacement of all laminated crossarms with identified defects in line with standard replacement timelines, as well as planned replacement of all laminated crossarms over two regulatory cycles.	11,535,325

Arup observation

Without visibility on which option was selected through C55, it is difficult to judge the prudency and efficiency of this investment. However, examining the table below on failure in conjunction with the above table on capex suggests that there is a significant element of diminishing returns for the capex investment. Option 2 costs $1m more than option 1, and reduces total expected failures by over 400 in FY24 alone. Option 5 is the most comprehensive option, costing ~8.7m more than option 2, while only reducing failures by 34 across the five years.

Table 16 Projected failure rates per option – laminated crossarms[91]

Option	2019/20	2020/21	2021/22	2022/23	2023/24	Reduction in failures compared to previous option
Option 1	34	80	184	325	447	-
Option 2	25	25	24	23	23	950
Option 3	24	22	20	19	17	18
Option 4	23	21	19	17	14	8
Option 5	22	20	17	15	12	8

4.3.5.2 PEC Crossarms

Five options have been proposed to address the increasing rate of PEC crossarm failure. The preferred options for the replacement of PEC crossarms have been included in the C55

[91] Essential Energy 2018, *ESS_4005 Distribution Pole Tops pg 37*

outputs as the "Defects + Term + Susp"option, with Option 3 as outlined below selected as the preferred option.

Table 17 Pole top replacements options analysis[92]

Option	Description	Total ($)
Option 1	Defer to the future regulatory period	6,493,763
Option 2	This option involves the replacement of PEC crossarms that have been identified as being a defect by the ground-line asset inspection team. Due to the hidden nature of the decay on these types of crossarms, it is anticipated that the asset inspection team will be unable to successfully detect all of the degraded PEC arms on the network. Thus, this option will decrease failure rates, as compared to completely deferring replacement, but it is anticipated that failures will still occur on the network.	12,099,591
Option 3	Option 3 involves the planned replacement of PEC crossarms with identified defects, as well as all PEC crossarms installed on a termination style construction, suspension style construction, or flying angle style construction. The replacement of targeted arms will be completed over two regulatory cycles.	20,081,256
Option 4	Option 4 involves the planned replacement of PEC crossarms with identified defects, as well as all PEC crossarms installed on a termination style construction, suspension style construction, flying angle style construction, or strain style construction. The replacement of targeted arms will be completed over two regulatory cycles.	23,717,548
Option 5	Option 5 involves the planned replacement of PEC crossarms with identified defects in line with standard replacement timelines, as well as the planned replacement of all PEC crossarms over two regulatory cycles.	32,929,084

Arup observation

The same concerns with regards to the common parameters used in the event tree modelling have been identified as that for laminated crossarms. It appears that the values used for the number of people entering the exposed radius and the likelihood of a person coming in contact with an energised asset may have been overstated.

[92] Essential Energy, 2018, *ESS_4005 Distribution Pole Tops*, pg 41-42

4.3.6 DNSP benchmarking

Essential Energy is the largest network in terms of route line-length across the Australian distribution networks. Therefore, when benchmarking with other DNSPs this was taken into consideration, as a network's performance metrics are highly dependent on size.

The figures below outline the variation in size and customer density across the networks. Ergon Energy is the most comparable network to Essential Energy in terms of network length and rural location. Comparing Ergon Energy's previous spend on pole top structures to Essential Energy shows the difference is quite significant, even when taking network length into consideration. Based on the technical specifications[93] Ergon Energy appears to be using only timber and composite fibre crossarms in the network, as opposed to Essential Energy who currently use timber, composite and steel and are fully transitioning to composite.

Table 18 Spend on pole top structures based on RIN data

Network	Route length (km)	2015-16		2016-17	
		Pole top structure capex	Capex per km route length	Pole top structure capex	Capex per km route length
Essential Energy	181,700	$37,604,560	$206.96	$58,097,304	$319.74
Ergon Energy	140,415	$16,557,570	$117.92	$19,308,728	$137.51
SA Power Networks (SAPN)	81,790	$23,585,772	$288.37	$19,785,940	$241.91
Powercor	67,581	$13,769,656	$203.75	$16,032,730	$237.24

It is important to note that when comparing to other distribution networks, the way in which pole top structures are treated varies considerably. Based on the Table 18 above it does appear that Essential Energy's total capex is materially higher than its closest counterparts in dollar terms. However, when accounting for network size, Essential Energy's expenditure on pole tops appears more reasonable in 2015/16. In 2016/17, Essential Energy's capex per km of route length was higher than all the other comparable networks by size.

[93] Ergon Energy, 2013, *Standard for Distribution Line Overhead*

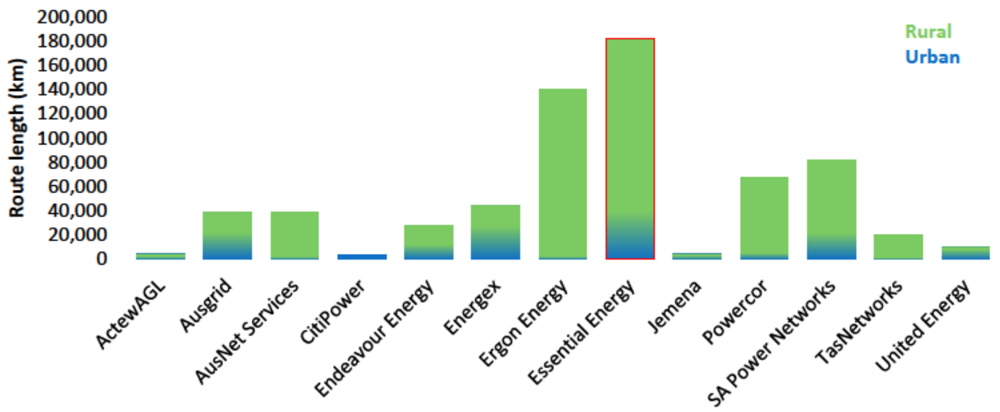

Figure 39 Network route length comparison based on RIN data

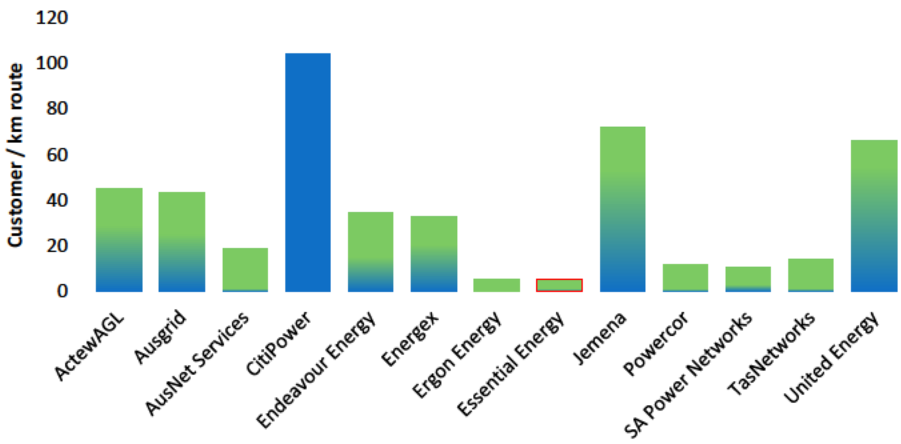

Figure 40 Network customer density based on RIN data

4.4 Modelled and un-modelled replacement capex summary

Arup observation

The approach to replacement expenditure appears to be generally robust, with proposed capex approximately in line with historical levels. Essential Energy appears to have a well-structured approach to identifying appropriate materials for replacement, and the development and prioritisation of options, though some assumptions regarding pedestrian interaction with network assets may need to be revisited. Essential Energy should also investigate whether its selection of options is reasonable in light of the diminishing marginal rates of return exhibited in some projects.

The introduction of LiDAR has provided Essential Energy the opportunity to increase visibility of its network and more thoroughly identify defects for better asset management. However, the result of the technology appears to be an increase in repex on low clearance rectification and pole top structures s as more defects are identified. No linkages between better defect identification and an increased risk of failure are provided and therefore the justification for increasing replacement rates is weakened. There may be some potential for

Essential Energy to utilise the LiDAR technology in a way that maintains the current level of risk in the network by using it to target the highest risk assets.

5 Augmentation capex observations

Essential Energy has proposed a total spend of $259m over the upcoming proposal period on network augmentation expenditure (augex).

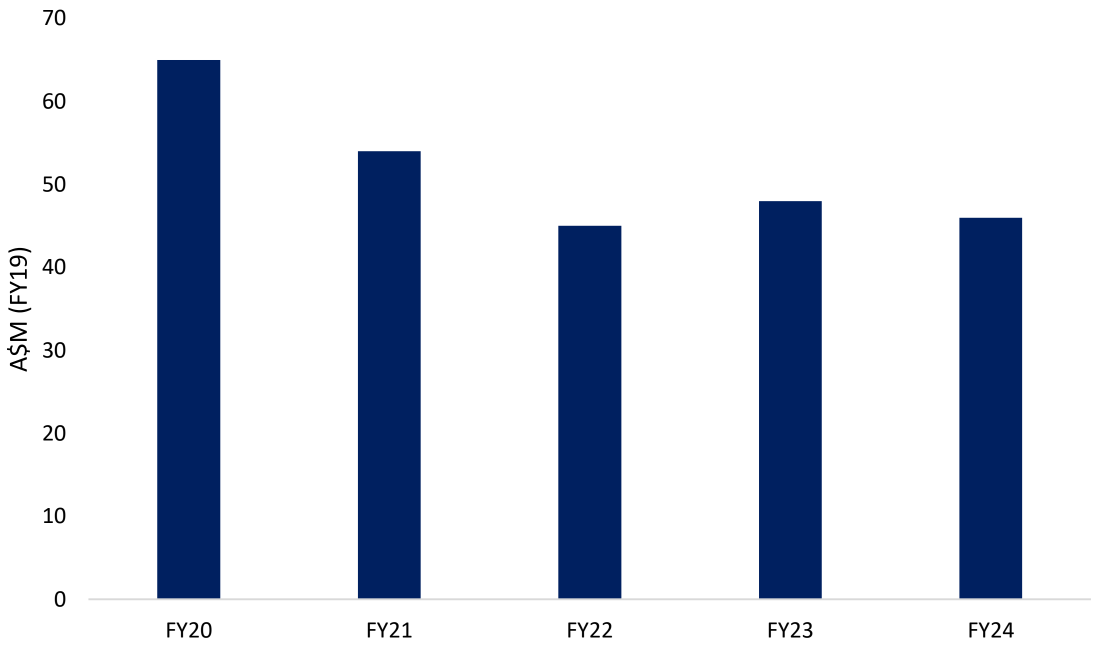

Figure 41 Proposed augex spend[94]

Arup has reviewed the portfolio of proposed major augmentation programs, and undertaken a detailed assessment of a sample of programs in order to determine the efficiency and prudency of the options analysis.

5.1 Tharbogang to Tabbita Lane 33kV Feeder

Essential Energy has proposed $7m in augex in the upcoming regulatory period to acquire an easement and construct a new 33kV feeder from Tharbogang Zone Substation to Tabbita Lane.

[94] Essential Energy 2018, *2019-24 Regulatory Proposal*, pg 64

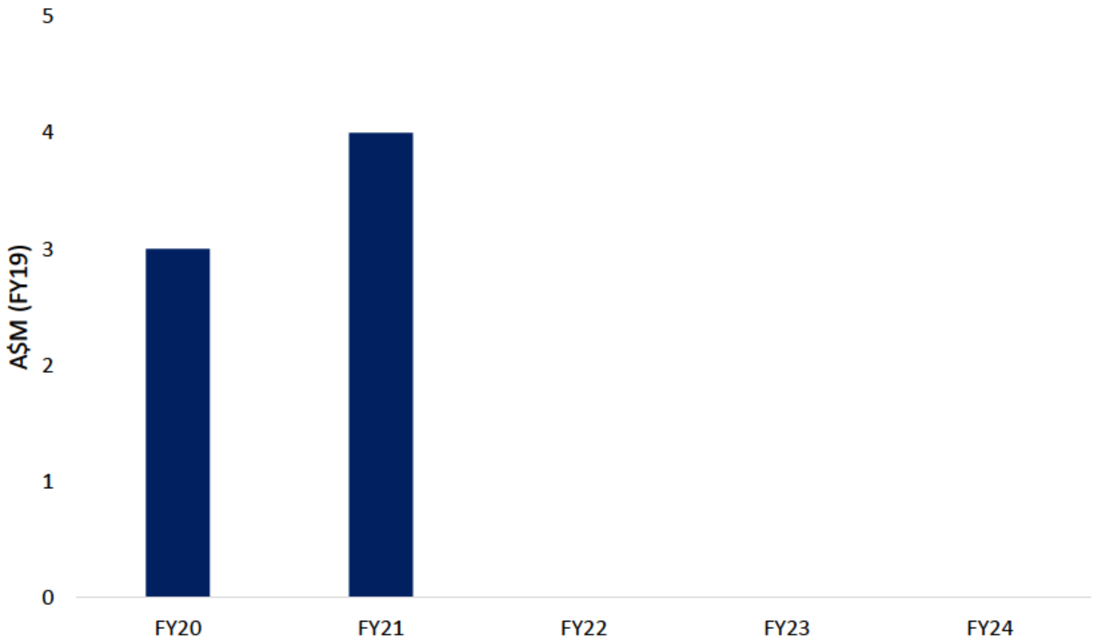

Figure 42 Proposed expenditure – Tharbogang to Tabbita Lane[95]

5.1.1 Drivers for investment

This major project is a response to the growth in the poultry and agricultural industries as well as general growth in the Tabbita/Goolgowi area in NSW. The network is currently constrained by the existing 33kV network capacity; therefore, Essential Energy has proposed the installation of a 33kV capacitator to meet the 2019/20 summer forecast demand.

Enquiries for approximately 300 new poultry sheds from developers in Tabbita Lane are outlined in the table below. Essential Energy's primary concern is network constraint due to the estimated load increase of 15MVA.

Table 19 Griffith poultry load applications[96]

Development	Demand MVA	Sheds (number)	Progress
[redacted]	1.0	[redacted]	Connected
[redacted]	2.0	[redacted]	Connected
[redacted]	2.2	[redacted]	Connected
[redacted]	0.4	[redacted]	Connected
[redacted]	3.0	[redacted]	2018/19

[95] Essential Energy 2018, *Major Project Options Report – ESS_4021 Tharbogang to Tabbita Lane 33kV Feeder*, pg 3
[96] Essential Energy 2018, *Major Project Options Report – ESS_4021 Tharbogang to Tabbita Lane 33kV Feeder*, pg 6

Development	Demand MVA	Sheds (number)	Progress
[redacted]	3.6	[redacted]	2019/20
[redacted]	5.0	[redacted]	2019/20
Summated Total	**17.2**	n/a	n/a
Diversified Total	**13.7**	n/a	n/a

When combining the agricultural, poultry spot load and general background growth, the load forecast on the 79W feeder is forecast to increase as follows.

Table 20 Griffin West Area Load Forecast[97]

Load	17/18	18/19	19/20	20/21	21/22
Feeder 79W	9.8	12.2	19.1	19.4	19.7

Essential Energy is expecting this investment will address all the immediate voltage and thermal constraints caused by the increased demand by supporting an additional 19.1MVA load.

5.1.2 Options analysis

Essential Energy has proposed three options to address capacity issues within the Tabbita/Goolgowi area.

Table 21 Proposed options – Tharbogang to Tabbita Lane 33kV feeder (preferred option bolded)[98]

Option	Description	Initial capital cost ($FY19)	NPV ($FY19)
Option 1 – Do nothing	This option will result in future load level beyond the thermal and voltage regulation capacity of the feeder.	$ 0	$0
Option 2 – Construct a second 33kV feeder	Establishment of a second 33kV feeder from Tharbogang to Tabbita Lane. This option will require the acquisition of an easement, which has been priced into the option. The	$ 7m	$20.24

[97] Essential Energy 2018, *Major Project Options Report – ESS_4021 Tharbogang to Tabbita Lane 33kV Feeder*, pg 6
[98] Essential Energy 2018, *Major Project Options Report – ESS_4021 Tharbogang to Tabbita Lane 33kV Feeder*, pg 7

Option	Description	Initial capital cost ($FY19)	NPV ($FY19)
	overhead construction is expected to be a single circuit, timber, rural construction.		
Option 3 – Non-network option	This option involves Essential Energy incentivising the poultry farms to install solar panels on the sheds. Essential Energy would provide batteries to match the shed's demand to the output provided by the solar panels. This would ensure that peak demand is reduced.	$ 0.3m ($11.7m over 40 years)	$11.36

Essential Energy has used the following six parameters to measure the risk associated with the project:

- safety
- value of unserved energy
- environmental
- financial
- compliance
- reputation.

It appears that all the risk parameters have been qualitatively measured except the value of reliability which compares the value of unserved energy between each option. Essential Energy has used the following assumptions related specifically to this project to calculate the value of unserved energy.

Table 22 Assumptions used for calculation of VCR[99]

Parameter	Estimated value
Number of outages	2 outages / 100km / year
Time to find and repair	4 hours
Capacity factor	0.3
Feeder length	30 km

[99] Essential Energy 2018, *Major Project Options Report – ESS_4021 Tharbogang to Tabbita Lane 33kV Feeder*, pg 7

Based on the options provided and the risk parameters, Option 2 provides the greatest unserved energy savings. Although non-network solutions are feasible, Option 2 has been selected as the preferred option due to the NPV benefit.

Arup observation

This project appears to be a reasonable response to forecast increases in demand. The poultry load applications are from more than one party, and therefore the new feeder would be considered a shared network asset. As the connection policy states, Essential Energy funds the augmentation if it is used on the shared network.[100]

Essential Energy also seems to have followed a reasonable methodology in its options development. As the network's ability to measure, extract and synthesise data improves, we would expect to see an increase in the level of quantification of the six parameters used to measure project risk.

5.2 Cobaki Lakes Development

The Cobaki Lakes Development involves the establishment of a 66/11kV zone substation. Essential Energy has proposed a $5.71m spend on the project over the upcoming regulatory control period. This project is anticipated to undergo a Regulatory Investment Test for new distribution assets (RIT-D) under Clause 5.17.3 of the NER.[101]

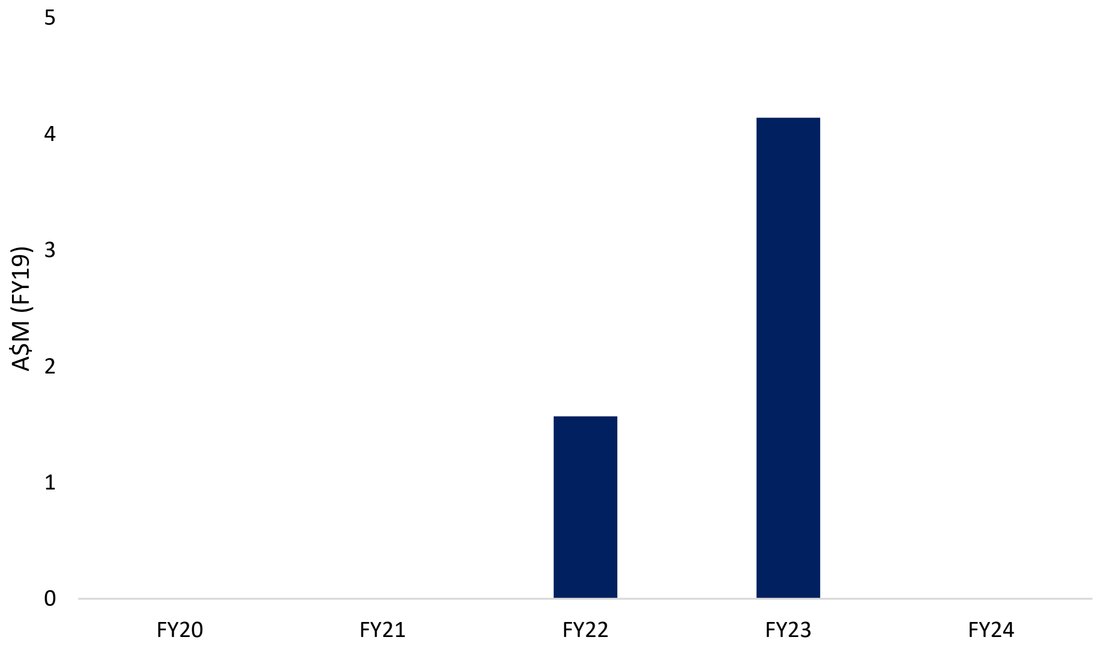

Figure 43 Proposed expenditure – Cobaki Lakes Development[102]

5.2.1 Drivers for investment

The main driver for this investment is the approval of a large residential development in Cobaki Lakes west of Tweed Heads. The development by [redacted] is

[100] Essential Energy 2015, *Connection Policy – Connection charges*, pg 4
[101] Essential Energy 2018, *Major Project Options Report – ESS_1005 Cobaki Lakes Development*, pg 4
[102] Essential Energy 2018, *Major Project Options Report – ESS_1005 Cobaki Lakes Development*, pg 3

anticipated to consist of 4,800 residential lots in addition to a range of commercial and educational lots. Based on the master plan load report completed for the development, the estimated undiversified increase in peak demand will be 30MVA, and the diversified load in excess of 20MVA.[103]

The area is currently limited by the existing 11kV distribution capacity that has spare capacity of 2MVA. This project would alleviate the anticipated issues of limited capacity available, so that Essential Energy can provide reliable supply in the future to customers.

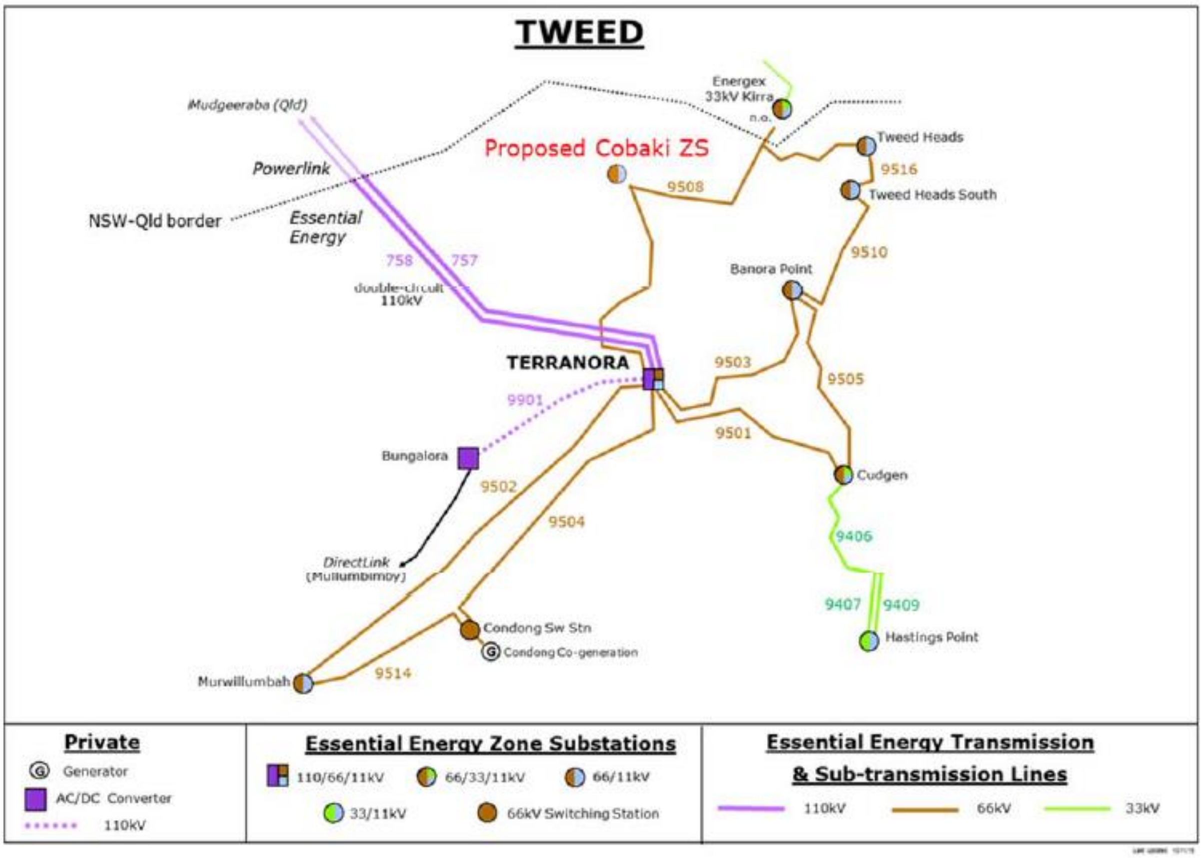

Figure 44 Tweed Area sub-transmission network (includes the proposed new substation and 66kV lines)[104]

5.2.2 Options analysis

Essential Energy has proposed two options to address the anticipated capacity issues associated with the Cobaki development.

[103] Essential Energy 2018, *Major Project Options Report – ESS_1005 Cobaki Lakes Development*, pg 6
[104] Essential Energy 2018, *Major Project Options Report – ESS_1005 Cobaki Lakes Development*, pg 5

Table 23 Proposed options – Cobaki Lakes Development (preferred option bolded)[105]

Option	Description	Initial Capital cost ($FY19)	NPV ($FY19)
Option 1 – Establish 66/11kV Zone Substation	This is the staged establishment of a new 66/11kV zone substation. The initial stage includes the installation of a single 66/11kV transformer, 11kV switchboard and 66kV feeder tee connection. An additional transformer will be added as part of the second stage of the installation. This option will ensure that there is sufficient supply during peak demand or unplanned outages.	$ 8.68m (over more than one period)	$ 45.05m
Option 2 – Augment 11kV Distribution Network	Augmentation of the 11kV network will require the installation of four new distribution feeders. Two would be from the Tweeds Head South zone substation and the other two from the Terranora zone substation. This is anticipated to add more than 5MVA of capacity per feeder. As peak demand cannot be supplied from the one source, distribution load is expected to shift between the Tweed Heads area zone substations. This installation will also be staged; once demand exceeds 10MVA, the additional two defers will be installed from the Terranora zone substation. In the longer term it is expected that sections of the feeders will need upgrading.	$ 10.83m	$ 43.77m

Essential Energy has explored potential non-network options in the form of either demand management or embedded generation. However, neither of the non-network options are expected to provide a cost-effective solution as they will not significantly defer a network solution.

Based on the NPV analysis completed, Option 1 is the preferable option as would provide a long-term and reliable solution. The installation of two 66kV feeders from the new substation will ensure that there is sufficient supply for peak demand event in the case of unplanned outages. The installation is expected to support peak demand increases in the future in Cobaki Lakes as well as the Tweed Heads and Tweed Heads south zone substations. Therefore, this option has a greater NPV benefit from unserved energy losses.[106]

Arup observation

This project is driven by the need for augmentation due to the planned real estate development at Cobaki Lakes. Essential Energy's connections policy states that this should

[105] Essential Energy 2018, *Major Project Options Report – ESS_1005 Cobaki Lakes Development,* pg 5

[106] Essential Energy 2018, *Major Project Options Report – ESS_1005 Cobaki Lakes Development,* pg 8

be generally funded by the developer, however in this case it is expected that the planned substation will be used by the shared network.[107] As such, electricity users in the wider Cobaki region will benefit from the installation of the substation as peak demand increases.

There is a case for the developer to pay for augmentation of the network. However, in this case it is not the most cost effective or reliable option, and would have the potential to result in greater unserved energy losses.

[107] Essential Energy 2015, *Connection Policy – Connection charges*, pg 4

6 Non-network capex observations

6.1 ICT

Essential Energy's current focus is modernising its Enterprise Resource Planning (ERP) and Enterprise Asset Management (EAM) systems. Proposed renewals and new IT systems include:

- Market System and Meter Data Management; renewal and upgrade (PEACE and EDDIS)
- Geographic Information System; upgrade (General Electric Smallworld)
- Asset Inspection System; renewal and upgrade (DAIS)
- Distribution Management System; renewal and upgrade (General Electric PowerOn)
- Customer Engagement and Interaction Systems; renewal.

Figure 45 summarises the ICT transformation program.

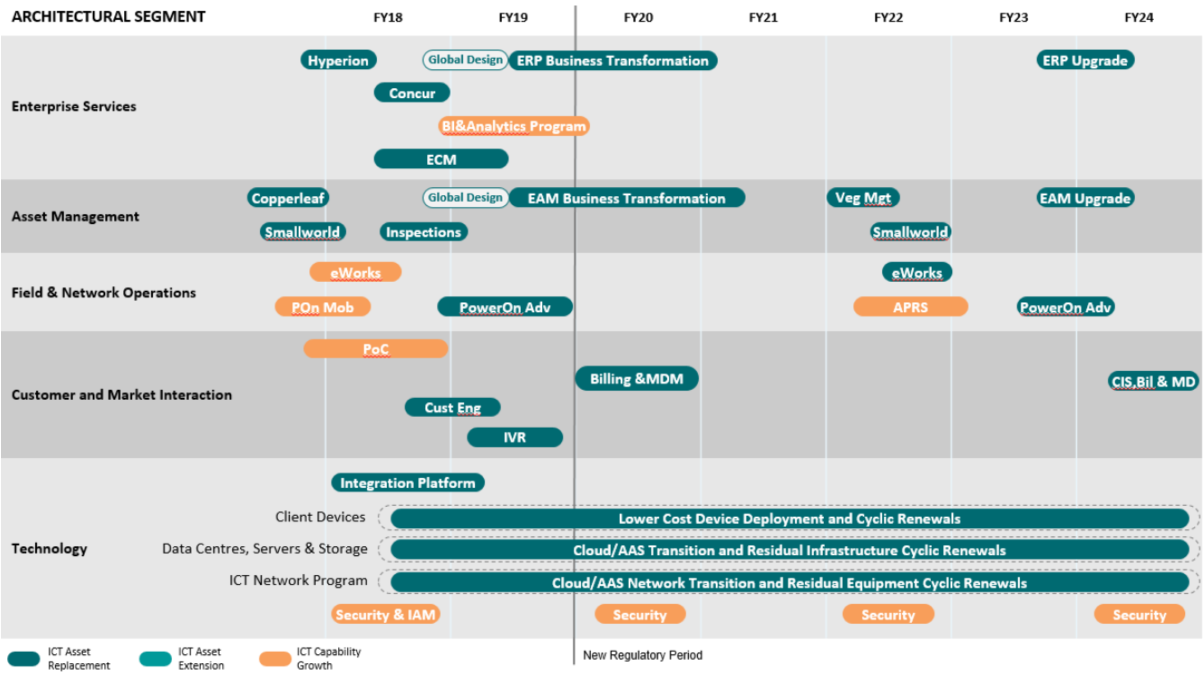

Figure 45 ICT program roadmap[108]

This transformation plan requires significant investment. In line with Figure 46 Essential Energy states that:

> *in the first years of the current regulatory control period, Essential Energy under-invested in ICT due to cost containment, focussing primarily on critical system upgrades and remediation. Since early 2017, the ICT strategy has been revised with a*

[108] Essential Energy, 2018, *12.1.6a ICT Plan*, p. 22

renewed focus on leveraging ICT as a key enabler of business transformation and efficiency. [109]

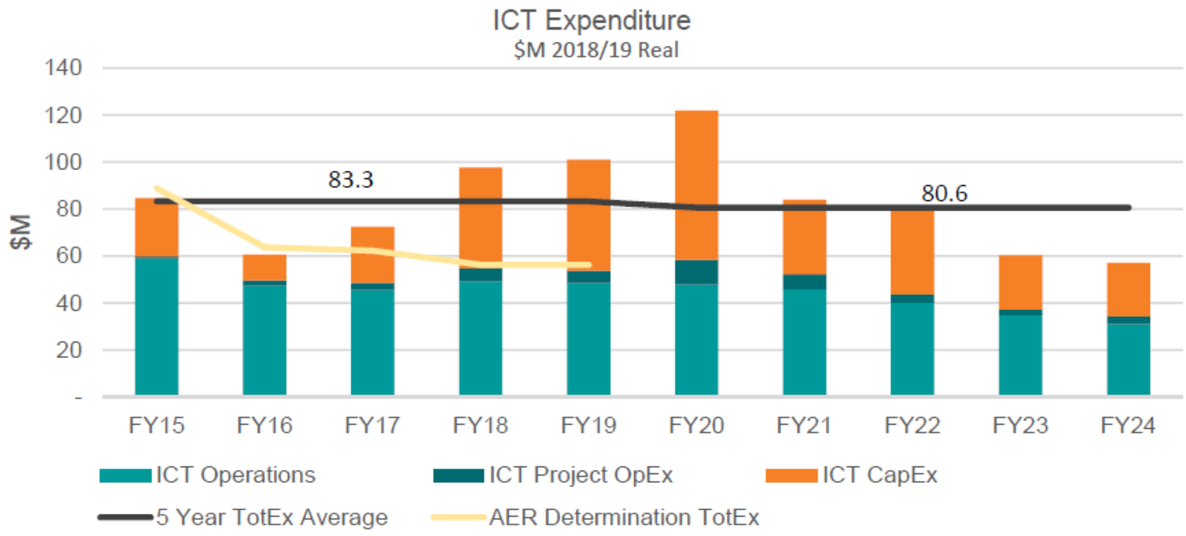

Figure 46 ICT expenditure summary - current and proposed period[110]

Table 24 details expenditure for the current and proposed periods. ICT Capex is expected to increase by 22% over the next period, to account for the above changes. ICT totex is forecast to decrease from $416.3m to $403.2m between RCPs, with opex savings largely by upfront capex investments.

Table 24 ICT expenditure[111]

$M 2018/19 Real	Cash Flow During 2015-20 Reg Period ($M)						Cash Flow During 2020-24 Reg Period ($M)					
	FY15	FY16	FY17	FY18	FY19	5yr Total	FY20	FY21	FY22	FY23	FY24	5yr Total
ICT OpEx	**59.9**	**49.7**	**48.6**	**54.7**	**53.7**	**266.7**	**58.4**	**52.3**	**43.6**	**37.2**	**34.3**	**225.8**
ICT Operations	**58.9**	**47.3**	**45.5**	**49.2**	**48.5**	**249.6**	**48.0**	**45.8**	**40.2**	**34.8**	**31.2**	**200.0**
eTech Support	**29.8**	**20.0**	**20.3**	**19.0**	**18.1**	**107.1**	**15.1**	**13.7**	**13.7**	**13.9**	**13.7**	**70.0**
Baseline for current services	29.8	20.0	20.3	20.3	19.9	110.3	19.8	19.5	19.5	19.8	19.5	98.0
Step change from forward program	-	-	-	-1.3	-1.8	-3.2	-4.7	-5.8	-5.8	-5.9	-5.8	-28.0
Third Party Costs	**20.9**	**19.3**	**17.5**	**23.2**	**23.6**	**104.4**	**26.2**	**25.5**	**19.6**	**13.8**	**10.4**	**95.3**
Baseline for current services	20.9	19.3	17.5	17.5	17.1	92.3	17.0	16.8	16.8	17.0	16.8	84.5
Step change from forward program	-	-	-	5.7	6.4	12.1	9.1	8.7	2.7	-3.3	-6.5	10.8
Telecommunications	**8.3**	**8.0**	**7.7**	**7.1**	**6.9**	**38.0**	**6.7**	**6.7**	**6.9**	**7.2**	**7.1**	**34.6**
ICT Project OpEx	**0.9**	**2.3**	**3.1**	**5.5**	**5.2**	**17.1**	**10.4**	**6.4**	**3.4**	**2.4**	**3.1**	**25.8**
ICT CapEx	**24.8**	**10.9**	**23.8**	**42.9**	**47.4**	**149.7**	**63.5**	**31.7**	**36.4**	**23.0**	**22.8**	**177.4**
ICT Asset Extension	0.2	0.5	2.7	1.5	2.5	7.3	1.4	1.1	1.0	0.9	0.9	5.4
ICT Asset Remediation	0.1	0.2	0.1	0.6	1.1	2.0	0.6	0.4	0.4	0.4	0.4	2.4
ICT Asset Replacement	21.8	9.1	12.5	19.3	34.0	96.6	50.5	25.0	24.7	18.8	16.9	135.8
ICT Capability Growth	2.8	1.1	8.6	21.6	9.8	43.8	11.0	5.1	10.3	2.9	4.5	33.8
ICT TotEx	**84.7**	**60.5**	**72.4**	**97.6**	**101.1**	**416.3**	**121.9**	**83.9**	**80.0**	**60.3**	**57.1**	**403.2**

As the Table 24 above shows, most of the proposed capex investment covers ICT asset replacement. The remainder of proposed ICT capex is primarily accounted for by capability growth. Table 25 details the investment categorisation of the core system upgrades.

[109] Essential Energy, 2018, *ICT Plan - Financial Years 2020-2024*, p. 16
[110] Essential Energy, 2018, *ICT Plan - Financial Years 2020-2024*, p. 13
[111] Essential Energy, 2018, *ICT Plan - Financial Years 2020-2024*, P. 14

Table 25 IT Investment categorisation[112]

INITIATIVE	Profile ICT Asset Extension	ICT Asset Remediation	ICT Asset Replacement	ICT Capability Growth
ERP - Procurement	0%	0%	80%	20%
ERP - HR and Payroll	0%	0%	80%	20%
ERP - Finance	0%	0%	80%	20%
Analytics	0%	0%	0%	100%
Enterprise Content Management Phs 1 & 2	0%	0%	100%	0%
EAM - Asset Management / Maintenance	0%	0%	80%	20%
EAM - Supply Chain Planning & Execution	0%	0%	80%	20%
Vegetation Management (VIMS Replacement)	0%	0%	100%	0%
SmallWorld Upgrade	0%	0%	100%	0%
Asset Inspections (DAIS replacement)	0%	0%	100%	0%
Mobile Work Force Management (eWorks)	0%	0%	0%	100%
Power on Advantage	0%	0%	100%	0%
Automated Power Restoration Scheme (APRS)	0%	0%	0%	100%
Market Systems, Network Billing and Meter Data (PEACE and Eddis Replacement)	0%	0%	100%	0%
IVR	0%	0%	100%	0%
Mulesoft Implementation (completion)	0%	0%	100%	0%
Client Devices	0%	0%	100%	0%
Data Centres, Servers and Storage	36%	19%	45%	0%
ICT Network Services Program	10%	0%	90%	0%
Cyber Security	0%	0%	0%	100%

6.1.1 Core systems

Essential Energy manages over 1,600 ICT applications. This degree of architectural fragmentation can create inefficiencies and result in legacy data issues that can constrain business transformation.

Core systems are summarised below:

Table 26 ICT Core Systems

Function	Platform	Arup note
Enterprise Asset Management System (EAMS)	WASP	WASP doesn't have all the functionality of a modern EAMS The proposed new AMS will integrate with People Soft
Enterprise Resource Planning	People Soft – Finance Procurement – manual systems and Lotus notes Timesheets – run through spreadsheets	Essential Energy does not run a 'vanilla' implementation of People Soft, which inhibits integration There are gaps in data flow
Field Force Automation	E-Works	Essential Energy is in the pilot stage of rolling out a new system (next 6 months before new period)

[112] Essential Energy, 2018, *IR008*, p. 5

Function	Platform	Arup note
		It is the last DNSP to do this
GIS	Small World	This package is relatively up to date with a 2022 renew date Essential Energy is deciding if this comes together with a new AMS
Distribution Management System	Poweron Fusion v8.1	The software platform is fit for purpose but this version is out of date There is an Investment Case up for upgrading
Billing and Meter Data	Peace	This includes some bespoke platforms for meter and data management
Project management	Project Online; Primavera; Access databases	This function will become part of the AMS

6.1.2 ICT strategy

A 2016 Utilities ICT Benchmarking analysis by KPMG compared Essential Energy's ICT operations against seven peer businesses. Figure 47 illustrates that Essential Energy's ICT expenditure was lower than average in most measures. Essential Energy stated:

> *total ICT expenditure tracked materially below the AER determination in the first two years of the current period (FY15 and FY16). This lower-than-planned expenditure resulted primarily from under-investment in ICT capital. In those years, capital investment largely focussed on upgrades of critical business systems for basic supportability until their planned renewal in the coming period (e.g. PEACE and Peoplesoft) as well as other smaller upgrades, extensions and remediation.*[113]

[113] Essential Energy, 2018, *12.1.6a ICT Plan*, p. 15

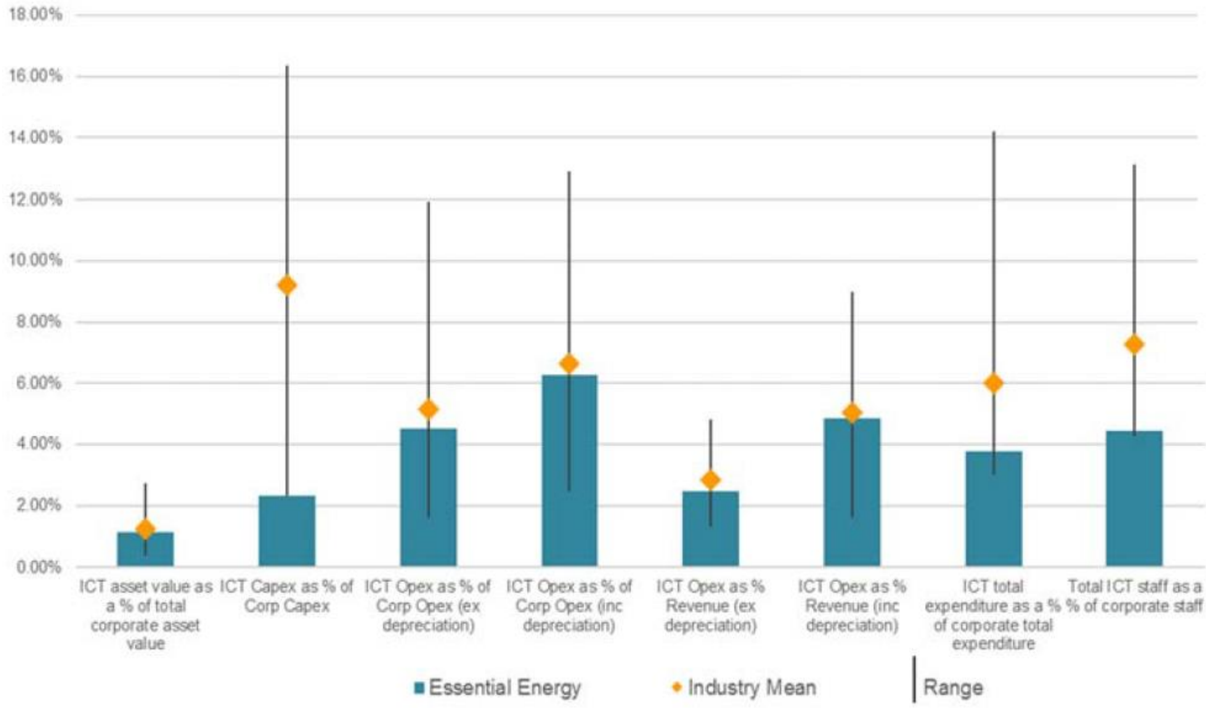

Figure 47 Essential Energy KPMG benchmarking results[114]

Given the systemic legacy issues with data and asset management systems and outdated core systems, this benchmarking result appears to be more symptomatic of under-investment than overall peer-leading business efficiency – particularly in capex. Essential Energy may be operating the systems it has efficiently, but issues with fragmented systems and legacy data issues are constraining the efficiency of its core asset management and planning functions.

Essential Energy has identified that deferring renewal and upgrade of systems has maintained legacy issues. Moreover: [115]

- *In 2017, Essential Energy implemented a contemporary integration platform, MuleSoft, to provide more agile integration capabilities. Since this time there has been an ongoing program to establish re-usable APIs across the application landscape, including across both the EAM and ERP footprint and soon for both the DMS and Market Systems footprints. This will assist in reducing the integration effort and costs for the above four IT programs.*
- *KPMG has been engaged to assist with the market preparation and detailed business case activities for both the EAM and ERP Programs.*
- *Once the market exercises are complete, a specialised System Integrator (SI) will be engaged for the implementation of the EAM and ERP programs. This will be complemented by the engagement of an external Business Implementation Partner/s to ensure that an appropriate transition plan for the people, process and information changes is executed.*

Essential Energy's Asset Management System (AMS) has become unsupported by the vendor and hasn't been significantly invested in since 2000. This creates a corporate risk for the

[114] Essential Energy, 208, *ICT Plan*, p. 16
[115] Essential Energy, 208, *ICT Plan*, p. 18

business. Although core systems are due for replacement or upgrade, ICT capex was reduced in the previous regulatory period in line with business-wide cost reductions.

Issues with asset data and process integration can constrain the business's ability to collect detailed asset information, make well-informed risk-optimised investment decisions, and plan and track works efficiently.

There is therefore an underlying need to replace these systems, but also a need to upgrade Essential Energy's capability to enable transformation across the business. However, IT architecture capability was dissolved in 2014 as part of organisation wide cost containment. This constrained the business's ability to transform.

6.1.2.1 Transformation

An IT Strategy and Planning team has thus been re-established. The new team includes IT architecture resources and Essential Energy has also appointed an IT transformation manager.

The principal drivers for ICT transformation include:

1. Legacy system issues
    a. Legacy applications don't support the business's end to end processes
    b. Essential Energy is lagging other businesses significantly
2. There is a need for updated ICT functionality to enhance core business processes and decision-making
3. There is a future expectation of additional functional capability - e.g. facilitating distributed generation.

Essential Energy has also implemented an EDO (Enterprise Delivery Office) and an enterprise change project management office (PMO) established in the last 12 months. The PMO can implement certain sized projects but beyond that will need to engage System Integrators and partners to deliver transformations. The EDO also utilises Post Implementation Review (PIR) to ensure benefits are realised. The EDO framework has a PIR framework / benefits realisation framework and is responsible for cultural change.

Arup observation

Core ICT systems such as AMS have not been renewed in at least two regulatory periods and may be constraining Essential Energy's transformation towards modern asset management and planning processes. Transforming these core systems is required to underpin risk-based investment optimisation that drives value for customers. Essential Energy states that "these expenditures results have a positive net benefit to customers"[116], and has implemented an EDO with benefits realisation monitoring. However, it's not yet clear whether the approving the proposed capital investment will maximise this value to customers, or whether the expenditure can be funded by Essential Energy's own operational efficiency returns.

Legacy issues and outmoded ICT systems create significant corporate risks. In particular, cybersecurity risks may cause noncompliance with the NER.

[116] Essential Energy, 2018, *IR008*, p. 3

Cultural change will be key to realising the benefits of the ICT transformation program. The business has thus far implemented an effective governance and project management process through the EDO and on-boarded an experienced ICT transformation resource to drive this capability. Successful adoption of cultural change and the increased usage and improved transparency, coverage and accuracy of the asset data should provide significant upside for efficiency improvements going forward. Essential Energy should be encouraged to monitor such improvement to satisfy stakeholders that this expenditure provides benefits to its customers.

6.2 Other non-network

Essential Energy's other non-network capex is comprised of fleet and property investments. Management has developed a business plan for each outlining the proposed capex for the upcoming RCP.

6.2.1 Fleet business plan

Essential Energy has proposed $182.8m for the 2019/24 regulatory period in fleet capex, representing an overall decrease of 3% in capex from the current RCP[117]. The investment is designed to meet and remediate the challenges posed by the current state of the fleet, being:

- an aged and deteriorated fleet
- increasing risk profile and exposure
- poor fleet reliability and high total cost of ownership
- absent asset management practices.

The key initiatives being employed by management are:

- application of asset management principles and processes to fleet
- introduction of lifecycle performance (utilisation and efficiency) monitoring and management
- light and heavy fleet replacement strategy[118].

Essential Energy's fleet business plan continues an optimisation process undertaken by the three NSW DNSP's whereby Essential Energy reduced the number of vehicles in their flight by 28% between FY13 and FY18.

Arup observation

Generally, Essential Energy's fleet capex forecast appears reasonable in light of the fleet optimisation undertaken between FY13 and FY18, however one could question why at the completion of the five-year optimisation process there remains "absent asset management

[117] Essential Energy, 2018, *Business Plan: Fleet 2019-24 Standard and Alternate Control Supporting Document 12.1.7*, page 11
[118] Essential Energy, 2018, *Business Plan: Fleet 2019-24 Standard and Alternate Control Supporting Document 12.1.7*, page 8

practices"[119] among other challenges to address. Essential Energy is encouraged to focus further on optimisation of fleet management, works scheduling and length of truck rolls.

6.2.2 Property business plan

Essential Energy are proposed $102m in property capex for the upcoming RCP, representing a $48.3m, or 91%, increase over property capex in the current regulatory period.[120]

The majority of the difference in capex, being $34.5m, can be attributed to a change in accounting standards relating to leases AASB 117 being replaced by AASB 16. Essential Energy sate:

> *Under the current lease accounting standard rental payments are recognised in operating expenditure over the lease period, with no recognition of a leased asset or a liability for future contracted payments. Under the new standard a lease liability and a corresponding 'right of use' asset are recognised in the balance sheet. In the Income Statement lease payments are replaced by a depreciation expense on the asset, and an interest expense (using our borrowing rate) on the lease liability.*[121]

Other key drivers of property capex are:[122]

- previous years of cost containment has led to latency issues resulting in increased capital
- deterioration of aging infrastructure has resulted in WHS risk issues requiring end-of life refurbishment and replacement programs
- standard life-cycle replacement of assets
- capital program 'back-end loaded' due to previous years of cost containment.

Arup observation

Essential Energy's property capex is forecast to increase in the upcoming RCP. Much of that increase is due to a change in accounting practices, however there remains a material increase of $13.8m, or ~25%, outside of this driver.

This increase comes despite six cost reduction initiatives outlined by Essential Energy, and appears to be driven in part by latency or back-end loaded issues from the current RCP, represented in two of the five Key Drivers of Capex outlined by Essential Energy.

We would therefore expect this increase to represent a one-off adjustment to correct for these carry over issues, and for Essential Energy to be forecasting a reduction in property capex, all else equal, for the RCP following 2024.

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[119] Essential Energy, 2018, *Business Plan: Fleet 2019-24 Standard and Alternate Control Supporting Document 12.1.7*, page 8

[120] Essential Energy, 2018, *Business Plan: Property 2019-24 Standard and Alternate Control Supporting Document 12.1.18*, pg 16

[121] Essential Energy, 2018, *Business Plan: Property 2019-24 Standard and Alternate Control Supporting Document 12.1.18*, pg 15

[122] Essential Energy, 2018, *Business Plan: Property 2019-24 Standard and Alternate Control Supporting Document 12.1.18*, pg 16

7 Next steps for Essential Energy

Overall, Essential Energy's approach to capex appears to be generally robust, with proposed expenditure approximately in line with historical levels. Essential Energy has a well-structured approach to identifying key project drivers, and the development and prioritisation of options which allows a consideration of lowest cost delivery of outcomes.

However, the process by which Essential Energy prioritises areas of investment through an optimisation program known as C55, results in an unclear picture of overall network risk. This is reflected in the selection of some projects that appear to exhibit diminishing marginal rates of return when compared to other options considered. Arup understands integration of risk considerations into C55 could be achieved for the following RCP, and would encourage Essential Energy to explore this further development of its analytical processes.

Network risk, particularly when measured by unserved energy, should be considered in the context of Essential Energy's customers who were generally "satisfied with the current reliability of the network" [123]. This indicates that Essential Energy should generally be able to maintain its current overall reliability profile, and should not need to invest (except in isolated pockets) to improve performance over the coming regulatory period.

We would expect Essential Energy to continue its focus its efforts on improving expenditure and delivery optimisation processes, along with updating legacy ICT systems and exploring opportunities that reflect its uniquely large grid with coverage of remote areas. Such steps will be key in Essential Energy maintaining a reliable and affordable network for its customers.

[123] Essential Energy, 2018, *Empower communities: 2019-24 Regulatory Proposal*, pg 67

8 Glossary

AEMC: Australian Energy Market Commission

AEMO: Australian Energy Market Operator

AER: Australian Energy Regulator

Augex: Augmentation expenditure

Capex: Capital expenditure

DNSP: Distribution Network Service Provider

FY: Financial Year

HV: High Voltage

LV: Low Voltage

NEL: National Electricity Law

NEM: National Electricity Market

NEO: National Electricity Objectives

NER: National Electricity Rules

NSP: Network Service Provider

PEC crossarms: pigment emulsified creosote crossarms

RCP: Regulatory Control Period

Repex: Replacement expenditure

SAIDI: System Average Interruption Duration Index

SAIFI: System Average Interruption Frequency Index

VCR: Value of Customer Reliability