energy market consulting associates

Endeavour Energy 2024 to 2029 Regulatory Proposal

REVIEW OF PROPOSED EXPENDITURE ON DER AND NON-RECURRENT ICT

Report prepared for:

AUSTRALIAN ENERGY REGULATOR

August 2023

Preface

This report has been prepared to assist the Australian Energy Regulator (AER) with its determination of the appropriate revenues to be allowed for the prescribed distribution services of Endeavour Energy from 1st July 2024 to 30th June 2029. The AER's determination is conducted in accordance with its responsibilities under the National Electricity Rules (NER).

This report covers a particular and limited scope as defined by the AER and should not be read as a comprehensive assessment of proposed expenditure that has been conducted making use of all available assessment methods nor all available inputs to the regulatory determination process. This report relies on information provided to EMCa by Endeavour Energy. EMCa disclaims liability for any errors or omissions, for the validity of information provided to EMCa by other parties, for the use of any information in this report by any party other than the AER and for the use of this report for any purpose other than the intended purpose. In particular, this report is not intended to be used to support business cases or business investment decisions nor is this report intended to be read as an interpretation of the application of the NER or other legal instruments.

EMCa's opinions in this report include considerations of materiality to the requirements of the AER and opinions stated or inferred in this report should be read in relation to this over-arching purpose.

Except where specifically noted, this report was prepared based on information provided by to us prior to 16th June 2023 and any information provided subsequent to this time may not have been taken into account. Some numbers in this report may differ from those shown in Endeavour Energy's regulatory submission or other documents due to rounding.

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ABBREVIATIONS

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ARENA	Australian Renewable Energy Agency
BAU	Business as Usual
CBA	Cost Benefit Analysis
CCP	Community Connection Point
CECV	Customer Export Curtailment Value
CER	Customer Energy Resources
DER	Distributed Energy Resources
DERM	Distributed Energy Resources Management
DNSP	Distribution Network Service Provider
DOE	Dynamic Operating Envelopes
DSUB	Distribution Substation
DVMS	Dynamic Voltage Management System
EG	Embedded Generation
EMS	Energy Management Systems
EV	Electric Vehicles
GHG	Greenhouse Gas
HCM	Hosting Capacity Model
ICT	Information and Communication Technology
IES	Inverter Energy System
IOT	Internet of Things
ISP	Integrated System Plan
kVA	Kilo volt amperes
kW	Kilowatt
LVVA	LV Visibility and Analytics
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
NSP	Network Service Provider's
PQ	Power Quality

Term	Definition
PV	Photovoltaic
RCP	Regulatory Control period
RIT-D	Regulatory Investment Test for Distribution
STATCOM	Static synchronous Compensator
WACC	Weighted Average Cost of Capital

1 INTRODUCTION

AER has asked us to review and provide advice on Endeavour Energy's proposed allowances over the next Regulatory Control Period for expenditure to facilitate increasing Distributed Energy Resources (DER) and for non-recurrent Information and Communication Technology (ICT). Our review is based on information that Endeavour Energy provided and on aspects of the National Electricity Rules relevant to assessment of expenditure allowances.

1.1 Objective of this report

1. The purpose of this report is to provide the AER with a technical review of aspects of the expenditure that Endeavour Energy has proposed to facilitate Distributed Energy Resources and aspects of its proposed Non-recurrent ICT expenditure. These items form part of its revenue proposal for the 2024-29 regulatory control period (next RCP).

2. The assessment contained in this report is intended to assist the AER in its own analysis of the proposed capex allowance as an input to its Draft Determination on Endeavour Energy's revenue requirements for the next RCP.

1.2 Scope of requested work

3. Our scope of work is as defined by AER. Relevant aspects of this are as summarised in Figure 1.1.

Figure 1.1: Scope of work

Requested scope for Endeavour Energy review covered in this report

The scope of this review covers components of the proposed ex-ante capex forecast and proposed opex step changes consistent with the AER's expenditure forecast assessment guideline. This comprises the review of expenditure relating to the following aspects:

- Endeavour Energy's capex and opex forecast for:
  - Distributed Energy Resources (DER)/CER; and
  - ICT non-recurrent programs

Further scope requirements for review of DER

The consultant is required to provide advice to the AER on whether the DNSP has sufficiently demonstrated the need for network investment to accommodate forecast levels of DER. The advice should consider the DNSP's approach to assessing network hosting capacity, including its level of network visibility and use of data (such as data provided by smart meters) to identify and forecast DER export constraints on its low voltage networks.

Scope - Non-recurrent ICT expenditure

The consultant is required to assess and advise on whether the NSW DNSP's forecast expenditure for non-recurrent ICT programs is prudent and efficient, consistent with clauses 6.5.6 and 6.5.7 of the NER. In particular, the consultant is required to provide an alternative forecast in the event that the findings are that the DNSP's forecast is not prudent and efficient.

1.3 Our review approach

1.3.1 Approach overview

4. In conducting this review, we first reviewed the regulatory proposal documents that Endeavour Energy had submitted to AER. This includes a range of appendices and attachments to Endeavour Energy's regulatory proposal and certain Excel models, and which are relevant to our scope.

5. We next collated some information requests. AER combined these with information request topics from its own review and sent these to Endeavour Energy.

6. In conjunction with AER staff, our review team met with Endeavour Energy at its offices on 18th April 2023. Endeavour Energy presented to our team on the scoped topics and we had the opportunity to engage with Endeavour Energy to consolidate our understanding of its proposal.

7. Endeavour Energy provided AER with responses to information requests and, where they added relevant information, these responses are referenced within this review.

8. We have subjected the findings presented in this report to our peer review and QA processes and we presented summaries of our findings to AER prior to finalising this report.

9. The limited nature of our review does not extend to advising on all options and alternatives that may be reasonably considered by Endeavour Energy, or on all parts of the proposed forecast. We have included additional observations in some areas that we trust may assist the AER with its own assessment.

1.3.2 Conformance with NER requirements

10. In undertaking our review, we have been cognisant of the relevant aspects of the NER under which the AER is required to make its determination.

Capex Objectives and Criteria

11. The most relevant aspects of the NER in this regard are the 'capital expenditure criteria' and the 'capital expenditure objectives.' Specifically, the AER must accept the Network Service Provider's (NSP's) capex proposal if it is satisfied that the capex proposal reasonably reflects the capital expenditure criteria, and these in turn reference the capital expenditure objectives.

12. The NER's capex criteria and capex objectives are reproduced below.

Figure 1.2: NER capital expenditure criteria

NER capital expenditure criteria

The AER must:

*(1) subject to subparagraph (c)(2), accept the forecast of required capital expenditure of a Distribution Network Service Provider that is included in a building block proposal if the AER is satisfied that the total of the forecast capital expenditure for the regulatory control period reasonably reflects each of the following (**the capital expenditure criteria**):*

(i) the efficient costs of achieving the capital expenditure objectives;

(ii) the costs that a prudent operator would require to achieve the capital expenditure objectives; and

(iii) a realistic expectation of the demand forecast and cost inputs required to achieve the capital expenditure objectives.

Source: NER 6.5.7(c) Forecast capital expenditure, v200

Figure 1.3: NER capital expenditure objectives

NER capital expenditure objectives

*A building block proposal must include the total forecast capital expenditure for the relevant regulatory control period which the Distribution Network Service Provider considers is required in order to achieve each of the following (**the capital expenditure objectives**):*

(1) meet or manage the expected demand for standard control services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;

(3) to the extent that there is no applicable regulatory obligation or requirement in relation to:

(i) the quality, reliability or security of supply of standard control services; or

(ii) the reliability or security of the distribution system through the supply of standard control services,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of standard control services; and

(iv) maintain the reliability and security of the distribution system through the supply of standard control services; and

(4) maintain the safety of the distribution system through the supply of standard control services.

Source: NER 6.5.7(a) Forecast capital expenditure, v200

Opex Objectives and Criteria

13. The most relevant aspects of the NER in this regard are the ‘operating expenditure criteria’ and the ‘operating expenditure objectives.’ The NER’s opex criteria and opex objectives are reproduced below.

Figure 1.4: NER operating expenditure criteria

NER operating expenditure criteria

*(c) The AER must accept the forecast of required operating expenditure of a Distribution Network Service Provider that is included in a building block proposal if the AER is satisfied that the total of the forecast operating expenditure for the regulatory control period reasonably reflects each of the following (**the operating expenditure criteria**):*

(1) the efficient costs of achieving the operating expenditure objectives;

(2) the costs that a prudent operator would require to achieve the operating expenditure objectives; and

(3) a realistic expectation of the demand forecast and cost inputs required to achieve the operating expenditure objectives.

Source: NER 6.5.6(c) Forecast operating expenditure, v200

Figure 1.5: NER operating expenditure objectives

NER operating expenditure objectives

*(a) A building block proposal must include the total forecast operating expenditure for the relevant regulatory control period which the Distribution Network Service Provider considers is required in order to achieve each of the following (**the operating expenditure objectives**):*

(1) meet or manage the expected demand for standard control services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;

(3) to the extent that there is no applicable regulatory obligation or requirement in relation to:

(i) the quality, reliability or security of supply of standard control services; or

(ii) the reliability or security of the distribution system through the supply of standard control services,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of standard control services; and

(iv) maintain the reliability and security of the distribution system through the supply of standard control services; and

(4) maintain the safety of the distribution system through the supply of standard control services.

Source: NER 6.5.6(a) Forecast operating expenditure, v200

How we have interpreted the capex and opex criteria and objectives in our assessment

14. We have taken particular note of the following aspects of the capex and opex criteria and objectives:

- Drawing on the wording of the first and second criteria, our findings refer to efficient and prudent expenditure. We interpret this as encompassing the extent to which the need for a project or program or opex item has been prudently established and the extent to which the proposed solution can be considered to be an appropriately justified and efficient means for meeting that need;

- The criteria require that the forecast '*reasonably reflects'* the expenditure criteria and in the third criterion, we note the wording of a '*realistic expectation'* (emphasis added). In our review we have sought to allow for a margin as to what is considered reasonable and realistic, and we have formulated negative findings where we consider that a particular aspect is outside of those bounds;
- We note the wording '*meet or manage'* in the first objective (emphasis added), encompassing the need for the NSP to show that it has properly considered demand management and non-network options;
- We tend towards a strict interpretation of compliance (under the second objective), with the onus on the NSP to evidence specific compliance requirements rather than to infer them; and
- We note the word '*maintain'* in objectives 3 and 4 and, accordingly, we have sought evidence that the NSP has demonstrated that it has properly assessed the proposed expenditure as being required to reasonably maintain, as opposed to enhancing or diminishing, the aspects referred to in those objectives.

15. The DNSPs subject to our review have applied a Base Step Trend approach in forecasting their aggregate opex requirements. Since our review scope encompasses only proposed expenditure for certain purposes, we have sought to identify where the DNSP has proposed an opex step change that is relevant to a component that we have been asked to review. Where the DNSP has not proposed a relevant opex step change, then we assume that any opex referred to in documentation that the DNSP has provided is effectively absorbed and need not be considered in our assessment.

1.3.3 Technical review

16. Our assessments comprise a technical review. While we are aware of stakeholder inputs on aspects of what Endeavour Energy has proposed, our technical assessment framework is based on engineering considerations and economics.

17. We have sought to assess Endeavour Energy's expenditure proposal based on Endeavour Energy's analysis and Endeavour Energy's own assessment of technical requirements and economics and the analysis that it has provided to support its proposal. Our findings are therefore based on this supporting information and, to the extent that Endeavour Energy may subsequently provide additional information or a varied proposal, our assessment may differ from the findings presented in the current report.

18. We have been provided with a range of reports, internal documents, responses to information requests and modelling in support of what Endeavour Energy has proposed and our assessment takes account of this range of information provided. To the extent that we found discrepancies in this information, our default position is to revert to Endeavour Energy's regulatory submission documents as provided on its submission date, as the 'source of record' in respect of what we have assessed.

1.4 This report

1.4.1 Report structure

19. The substance of our review is contained in the following sections, which cover respectively our review of Endeavour Energy's proposed DER and our review of its proposed non-recurrent ICT. In each section, we have presented:

- An overview of the proposed expenditure;
- An overview of the nature of the proposed works or projects and the justifications that Endeavour Energy has submitted; and

- Our assessment of each of the elements of what Endeavour Energy has proposed.

20. We have taken as read the considerable volume of material and analysis that Endeavour Energy provided, and we have not sought to replicate this in our report except where we consider it to be directly relevant to our findings.

1.4.2 Information sources

21. We have examined relevant documents that Endeavour Energy has published and/or provided to the AER in support of the areas of focus and projects that the AER has designated for review. This included further information at virtual meetings and further documents in response to our information requests. These documents are referenced directly where they are relevant to our findings.

22. Except where specifically noted, this report was prepared based on information provided by AER staff prior to 16th June 2023 and any information provided subsequent to this time may not have been taken into account.

23. Unless otherwise stated, documents that we reference in this report are Endeavour Energy documents comprising its regulatory proposal and including the various appendices and annexures to that proposal.

24. We also reference information responses, using the format IR#XX being the reference numbering applied by AER. Noting the wider scope of AER's determination, AER has provided us with IR documents that it considered to be relevant to our review.

1.4.3 Presentation of expenditure amounts

25. Expenditure is presented in this report in $2024 real terms, to be consistent with each NSW DNSP's RP unless stated otherwise. In some cases, we have converted to this basis from information provided by the business in other terms.

26. While we have endeavoured to reconcile expenditure amounts presented in this report to source information, in some cases there may be discrepancies in source information provided to us and minor differences due to rounding. Any such discrepancies do not affect our findings.

2 RELEVANT CONTEXT TO OUR DER ASSESSMENT

Our review of proposed DER expenditure, and which includes some items of ICT expenditure, is conducted in the context of an accelerating transition of the energy sector towards a lower carbon future. Aspects of this that are most relevant to DNSPs such as Endeavour Energy include further increases in DER, such as PV and increased electrification including for transport (such as EVs) and within homes (e.g. through the phase-out of gas).

This transition creates a prima facie potential case for increased network augmentation capex, where this satisfies the NER criteria. However, it also provides the opportunity for non-network 'DER' initiatives that can help to moderate the levels of network augmentation capex that might otherwise be required. For example, this can be through improving 'visibility' of the LV network and through dynamic services, including dynamic tariffs and dynamic controls that may combine to 'orchestrate' distributed electricity production, storage and demand, thereby minimising the net impact on the distribution network.

Changes in the regulatory landscape are taking place to accommodate the changed and changing roles of DNSPs such as Endeavour Energy. This includes changes to the NER and AER guidelines, which we have considered in our assessment.

An overarching consideration in assessing both network augex and non-network DER-related expenditure, is uncertainty on the specifics of the energy transition over investment assessment timeframes of the order of 15 to 20 years. The energy transition and its impact on electricity networks will be driven by and leverage off technologies that will evolve and likely assist both technically and economically. Consumer behaviours as they adopt DER will also evolve. In our assessments we are therefore particularly cognisant of future uncertainties, the consequent value of retaining options to adapt as uncertainties resolve, and the potential regret that could arise from over-investment if based on a false perspective of future certainty.

2.1 Energy transition

2.1.1 Network investments and the transition to renewables and storage

27. The NEM is experiencing a significant transition away from reliance on thermal generation towards renewable generation and storage. This is supported by the Powering Australia Plan including reducing emissions by boosting renewable energy.

28. As a result, the location of these larger renewable energy sources is also shifting to be more geographically distributed and diverse. This will require a substantial investment in transmission infrastructure to enable connection of these new technologies and to facilitate benefits for consumers by way of a lower cost of electricity.

29. At the same time, there has been significant growth in distributed energy resources led by roof-top solar. Customers are now more engaged with their energy system, which is demanding different services in terms of their ability to supply, consume and trade energy. This has implications for investments in energy infrastructure, and digital applications and infrastructure to support changes in how the energy system is used.

30. The transition is being driven by a number of forces, including decarbonisation and 'net zero' emissions policies. Not only will this result in investments in new technologies, but there is also likely to be significant changes in the costs of such technologies, consumers' interactions with these technologies and the services provided to consumers by DNSPs, by electricity retailers, and potentially by other parties (including 'aggregators').

31. We have necessarily undertaken our review in accordance with the current planning and regulatory framework. Nevertheless, to the extent that benefits are based on an assessment of future energy systems, or a projection of a future climate scenario, it is necessary to consider the likelihood of continuing changes to technologies and also changes to the regulatory and planning framework that may affect justification for projects of this type.

2.1.2 Definition of CER/DER

32. Distributed energy resources (DER) encompass a range of consumer level technologies used by households and businesses, such as inverter connected generation and storage systems (IES) which include solar photovoltaic (PV) and battery energy storage systems (BESS), energy management systems (EMS), controllable loads, and electric vehicles (EV) and their charging points.[1]

33. Consumer energy resources (CER) is often used interchangeably with DER, although we note that the Australian Energy Market Operator (AEMO) considers that DER encompasses both CER (behind the meter resources at a consumer's premise) and distribution connected energy resources, including for example, neighbourhood batteries.'[2] Although Endeavour Energy tends to use DER in its relevant documentation, we refer to CER and DER interchangeably in this document.

2.1.3 DER developments and the regulatory landscape

34. In its Post-2025 Market Design Review, the Energy Security Board (ESB) developed a DER Implementation Plan ('Plan') to support the effective integration of DER and flexible demand. Three horizons were included in the Plan, with phasing in of dynamic operating envelopes (DOE) over 2022-2025 included as a feature of the NEM DER 'ecosystem', among other things.[3] The figure below shows pertinent quotes from the ESB report regarding coordination of DER.

1 Based on AEMO 2019, *Technical Integration of Distributed Energy Resources*, page 10

2 AEMO, submission to AEMC regarding the draft report *Consumer Energy Resources Technical Standards Review (EMO0045),* 25 May 2023, page 2

3 ESB 2021, DER Implementation Plan – Three Year Horizon

Figure 2.1: Recognition of the need for transition to a 'two-sided market'

Energy Security Board, Clean and Smart Power in the New Energy System:

> *'Coordination or management of distributed energy resources is important to keep the system safe and stable so everyone can use energy as they wish to do so.'*
>
> *'Now more consumers are buying and producing their own power. They might choose to produce to use; they might want to sell back to the grid.*
>
> *All this is made possible by renewables technology – with people putting solar PV on their rooftops, and turning on smarter home devices like air conditioning, hot water systems and pool pumps.*
>
> *We are seeing the start of a two-way market. With all the right technical and security settings under the hood, advances in digital technology can enable appliances and systems to talk to each other securely.'*

Source: Energy Security Board, Clean and smart power in the new energy system, final report (July 2021), page 3

35. The Australian Energy Market Commission (AEMC) made a rule determination in 2021 to introduce technical standards that will enable distribution network service providers (DNSPs) and AEMO to better manage the growing number of micro-embedded generators connecting across the National Electricity Market (NEM).

36. In making this final rule determination, the AEMC stated that '*…[it] recognises the importance of promptly addressing the concerns of AEMO and the Energy Security Board (ESB) about the impact significant growth in distributed solar PV connections can have on networks and the electricity grid. In particular the final rule focuses on the ability and role DER in managing voltage disturbances.*'[4]

37. Throughout this report, the term 'compliance' is used to capture the technical settings requirements across the supply chain. This broad term is intended to encapsulate the requirements to manufacture to the standard, setting selection at installation, and ongoing behaviour after installation. Primarily, compliance is in respect of AS/NZS4777.2, which is a standard for the grid-connection of small-scale inverters. AEMO put forward a review to raise the performance requirements, with a major focus on improving the inverter's disturbance ride-through capabilities. The new Standard AS/NZS4777.2:2020 was published on 18 December 2020, and became mandatory for all new installations in Australia one year later.[5]

38. The key features of the final rule are:[6]

- *'The creation of DER Technical Standards which embedded generating units connecting to a distribution network by way of a micro EG connection service must comply with*
- *DER Technical Standards that include the requirements set out in AS 4777.2:2020 as updated from time to time*
- *A requirement that model standing offers for basic connection services for embedded generating units include that embedded generating units the subject of the basic micro EG connection service must be compliant with the DER Technical Standards*
- *An obligation on DNSPs that the information to be provided to connection applicants in order for them to negotiate a connection contract must include the requirement that if the connection applicant is proposing to connect a new or replacement embedded generating unit by way of a basic micro EG connection service, that the micro*

4 AEMC 2021, *Rule determination Technical Standards for DER*, page i

5 AEMO 2023, *Compliance of DER with technical settings,* page 3

6 AEMC 2021, Rule determination Technical Standards for DER, pages i, ii

embedded generating unit must be compliant with the requirements of the DER Technical Standards

- *A requirement that the minimum content requirements of connection offers under Schedule 5A.1 to the NER must include the requirement that if the connection applicant is proposing to connect a new or replacement embedded generating unit by way of a basic micro EG connection service, that the embedded generating unit the subject of the connection application is compliant with the DER Technical Standards.*
- *The DER Technical Standards will apply only to new connections and replacement inverters and connection alterations (including upgrade, extension, expansion or augmentation)*
- *The rule [commenced] on 18 December 2021, approximately 10 months after it [was] made, to allow for the implementation of the new requirements*
- *Transitional provisions have been included so that if before the commencement date of the rule:*
  - *a connection applicant in relation to a basic micro EG connection service has made a connection application but not received a connection offer, the new Chapter 5A will apply to that connection offer and connection contract*
  - *if a connection applicant in relation to a basic micro EG connection service has received a connection offer from the relevant DNSP but has not yet entered into a connection contract, the old Chapter 5A will apply to that connection offer and connection contract.'*

2.2 Our framework for assessing proposed DER-related expenditure

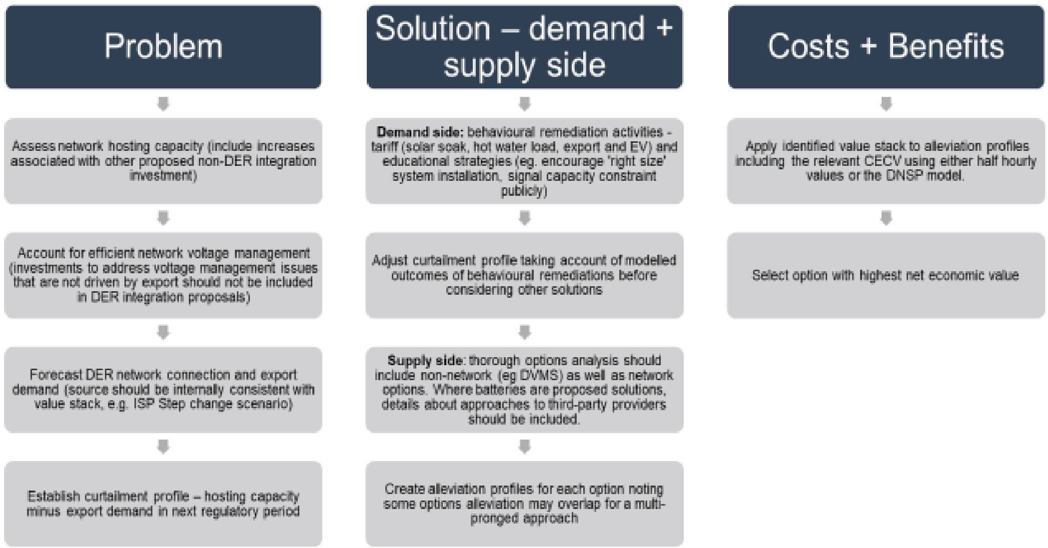
2.2.1 Relevant AER Guidelines

39. The AER published a 'DER integration expenditure guidance note' in mid-2022. It is designed to help DNSPs work through the process of developing DER integration plans and expenditure proposals. The figure below summarises the process.

40. The AER has noted that as '*DER penetration levels increase and customer expectations with respect to DER use evolve, [DNSPs] are responding by investing in projects aimed at increasing DER hosting capacity and supporting a broadening range of DER services.*'[7]

[7] AER, DER integration expenditure guidance note, page 4

Figure 2.2: AER's process for developing DER integration investment proposals



Source: AER 2022, DER Integration Guidance Note, Figure 1.1

41. Our assessment follows this sequence in that we have first assessed Endeavour Energy's problem definition, then its proposed solutions, and finally its cost benefit analysis.

42. The following AER and industry rules and guidelines are also particularly relevant to our assessment:

- CECV methodology, Oakley Greenwood, report to AER (June 2022) - this includes our consideration of matters raised by Houston Kemp in its submission on behalf of Energy Networks Australia, and Oakley Greenwood's response to that submission in its report; and
- Rule determination on National Electricity Amendment (Technical Standards for Distributed Energy Resources) Rule 2021, AEMC, (25 February 2021).

2.2.2 Taking account of uncertainty in considering network investments

43. Given the factors described above, and the reality that network investments tend to be both capital-intensive and attract long technical / economic lives, it is particularly necessary to consider option value in assessing deep investments into the electricity network.

44. Considerations of option value and the timeframe over which benefits are adequately able to be modelled, can help to ensure that any network investment is prudent and efficient in accordance with the regulatory objectives. This in turn helps in meeting the objective of ensuring that consumers do not end up paying the risk costs of projects that are developed earlier than required or which become stranded or 'regretted' due to changes in the electricity market, energy system, climate and the technologies deployed there.

2.2.3 Taking account of uncertainty in considering non-network DER-related investments

45. In considering economic business cases for DER-related expenditure, we are particularly cognisant of two factors:

- For the most part, the required investments are relatively short-lived, involving the development and integration of information systems and obtaining the information from those systems to enable the provision of new services to customers and the continuing prudent and efficient provision of existing services; and
- DER and the use of electricity in residential premises will both be strongly influenced by technological and consumer changes. While the pace and exact nature of such changes is a matter for conjecture, it is likely to involve reducing costs and increasing capacities

for local storage, increasing uptake of EVs, increased electrification within households, and increased capability to integrate between and to orchestrate DER with in-home usage.

46. These factors, and their uncertainties emphasise the value of agility and optionality in considering DER ‘solutions’ and the disadvantage of solutions that may result in material regret through over-investment based on an unrealistic view of future certainty. While it is important to undertake a degree of preparation for the future, the nature of non-network solutions to DER lends itself to taking a relatively agile approach that can leverage off technological and consumer behavioural changes as they become evident. An example of this is likely to be the way in which some combination of increasing EV uptake (with or without the addition of V2H and V2G capabilities), more cost-effective options for higher capacity home batteries and increased controlled electrification of storage hot water, may significantly reduce the incidence of PV exports and their impact on DNSPs’ LV systems.

47. In undertaking our assessments in this report, our consideration of these factors has led us to be wary of business cases that involve significant investments over the next regulatory period on the basis that they will solve supposed issues that will become evident or significant in 10 to 20 years’ time. There is a balance to be struck between prudent preparation and the potential for over-investment that may burden consumers with costs that turn out to be excessive or not to be needed for a cost-effective energy transition.

3 REVIEW OF PROPOSED DER EXPENDITURE

Endeavour Energy has proposed a program with total expenditure of $81.2m over the period. Of this, it proposes to invest $45.1m capex in strengthening its network and $5.0m on DER-related ICT capex to help provide flexible exports capability (Dynamic Operating Envelopes) within the next RCP. It forecasts spending $31m on DER-related opex, for which it seeks an opex step change allowance of $20m, primarily for acquisition of LV network visibility data and to assist with conversion of customers to 'solar soak' and off-peak regimes.

While we consider that Endeavour Energy has reasonably demonstrated that there is a need for it to undertake progressive interventions to assist in facilitating increasing DER, we consider that it has overstated its required expenditure in the next RCP. We consider that it has overstated its likely requirement for network capex and also the extent of LV data that it will need to acquire for the level of improved visibility that it needs and for its assumed commencement of dynamic service offerings within this period. Also, as presented, Endeavour Energy's proposed solar soak and off-peak conversion does not have a positive business case.

3.1 What Endeavour Energy has proposed

3.1.1 Overview and summary of proposed expenditure

48. Endeavour Energy has forecast DER capex of $50.1m, and two DER-related opex step changes totalling $31.0m, giving total forecast expenditure of $81.2m as shown in Table 3.1.

Table 3.1: Endeavour Energy proposed DER related expenditures - $million, real FY2024

Description	2025	2026	2027	2028	2029	Total
DER network capex	8.8	9.2	9.3	8.9	8.9	**45.1**
DER ICT capex	1.0	1.0	1.0	1.0	1.0	**5.0**
DER opex	6.9	7.3	5.1	5.6	6.1	**31.0**
TOTAL	**16.7**	**17.5**	**15.4**	**15.6**	**16.0**	**81.2**

Source: Endeavour Energy RP Attachment 10.40, DER integration Strategy, Table 25

49. Endeavour has proposed a capex allowance as per Table 3.1 above and we assess this combination of network and ICT capex in the current section of this report.

50. We sought to identify the projects within Endeavour Energy's proposed series of ICT Investment Briefs that make up the DER-related ICT capex of $5.0m, in order to avoid duplication within our assessment. In its DER strategy Endeavour Energy does not identify the specific ICT projects that it is referring to other than Flexible Exports (DOE) and neither does it clearly identify the DER-related projects comprising this amount in its ICT strategy. Further no relevant interdependency between the two reports is identified. We infer from project titles that this may comprise the projects in Investment Brief 2, and we assess these projects in section 4.6.2.

51. Of the total forecast opex of $31.0m referred to in Table 3.1, Endeavour Energy has sought an SCS opex step change of $20m as shown in Table 3.2.[8]

Table 3.2: Endeavour Energy proposed DER related opex step change - $million, real FY2024

Description	2025	2026	2027	2028	2029	Total
Opex step change - Solar Soak / Off-Peak Conversion	2.9	2.9	0.0	0.0	0.0	**5.8**
Opex step change - Network visibility	2.1	2.5	2.8	3.2	3.5	**14.2**
Total DER opex step change	**5.0**	**5.4**	**2.8**	**3.2**	**3.5**	**20.0**

Source: Endeavour Energy RP Attachment 11.0.1 opex model

3.1.2 Summary of the drivers for Endeavour Energy's proposed DER program

Endeavour Energy is experiencing increasing power quality issues from DER

52. Currently 23% of Endeavour Energy's residential customers have solar PV with an installed capacity of 1GW and with a further 200MW of commercial and industrial solar capacity. Based on trending the increase in the average size of residential PVs over the last 16 years, Endeavour Energy expects the average system size to increase to 9kW (from 7.2kW in 2022) by 2029.[9]

53. The rapid increase in solar PV and export-driven reverse power flows is leading to an increasing trend in power quality (PQ) complaints linked to issues with DER curtailment.[10]

Endeavour Energy has poor overall compliance to AS61000.3.100 and AS4777 response mode

54. From a small sample of PQ data, Endeavour Energy has concluded that the compliance trend to AS61000.3.100 ('AS61000') is worsening with overvoltage (v99, 253V) non-compliance sitting at 8.6% in late 2022, up from 5.6% in early 2022.

55. Separate analysis identified low volt-var setting compliance with AS4777- 2015 standards but a much higher, but still relatively low 47% volt-var setting compliance for systems installed since 2021 (i.e. under the AS4777-2020 requirements). Overvoltage disconnect compliance is lower than volt-watt compliance.[11]

Customer and stakeholder feedback supports investment in enabling solar panel technology

56. Endeavour Energy sought feedback from its Customer and Stakeholder Panel, and states that it strongly favoured 'modernisation' of the network to prepare for rapid energy transition:[12]

'Customers have told us that the top priority service that customers want us to invest in is the enablement of Solar panel technology. Specifically, customers are calling for the future grid to be one that is prepared to accommodate solar for anyone wanting to connect and export to the grid.'

57. Endeavour Energy advises that it has incorporated customer feedback in developing its DER integration plan.

8 We have extracted these numbers from AER's SCS opex model, as the source of reference to what it has proposed. We observe that Endeavour Energy lists opex step changes totalling $24.2m in Attachment 10.40, table 26, and which we assume is an aggregate amount before allocation to SCS.

9 Endeavour Energy, DER Integration Strategy and Business Case and Business Case, page 13

10 Endeavour Energy, DER Integration Strategy and Business Case and Business Case, page 16

11 Endeavour Energy 2022, 10.40 DER Integration Strategy and Business Case, pages 16,17

12 Endeavour Energy 2022, 10.40 DER Integration Strategy and Business Case, page 7

3.2 Assessment of Endeavour Energy's DER problem definition

58. The potential drivers for investments to accommodate increased DER relate to voltage management issues and the ability to host customer exports. These are functions of the network's inherent hosting capacity, assumptions regarding the future increases in DER and other factors that might mitigate the effects of such increases, and the way in which the network is managed to accommodate these. A key outcome from this aspect of the assessment is the extent to which exports may be curtailed as part of such voltage management.

59. In this section we consider the steps Endeavour Energy has taken to establish its future export curtailment profile, being the hosting capacity[13] less the export demand over time. Of particular focus is the next regulatory period, but as discussed in section 3.4, Endeavour Energy conducted a cost-benefit analysis over a 20-year period.

3.2.1 Endeavour Energy's DER-related issues

Endeavour Energy has demonstrated that it is experiencing DER-related issues

60. The information provided by Endeavour Energy in its DER Integration Strategy and Business Case echoes the issues that are recognised and increasingly manifesting throughout the NEM and NSW.

61. Endeavour Energy's rooftop solar penetration of 23% (in 2022) is likely to be the key factor in network over-voltage non-compliance and increasing customer power quality complaints. With the likely continued growth in rooftop solar penetration and inverter size in Endeavour Energy's service area, it is also reasonable to expect that, without intervention, constraints on PV hosting capacity will become more widespread and more frequent.

62. As discussed in section 3.1.2, Endeavour Energy has identified non-compliance with AS4777 inverter settings. It has an ongoing Power Quality Compliance program to reactively respond to customer complaints and address AS61000.3.100 breaches.

63. Similarly compliance with 5kW single phase and 30kW three-phase static export limits is poor at 22%[14] for single phase connections and 'not measured' for three-phase connections.

Endeavour Energy needs to continue to invest in interventions to integrate DER throughout the next RCP

64. In summary, we consider that Endeavour Energy has adequately demonstrated that it currently experiences sufficient DER-related issues to warrant an investigation into prudent and efficient means of integrating the forecast uplift in DER into its network, with the objective of enabling customers' future energy choices.

65. We have used the AER's process (per Figure 2.2) as the basis for our assessment of Endeavour Energy's proposed DER integration investment.

3.2.2 Overview of Endeavour Energy's hosting capacity model (HCM)

66. Figure 3.1 illustrates Endeavour Energy's hosting capacity simulation tool, referred to as the hosting capacity model (HCM). We assess Endeavour Energy's approach to building the four stages of the HCM below.

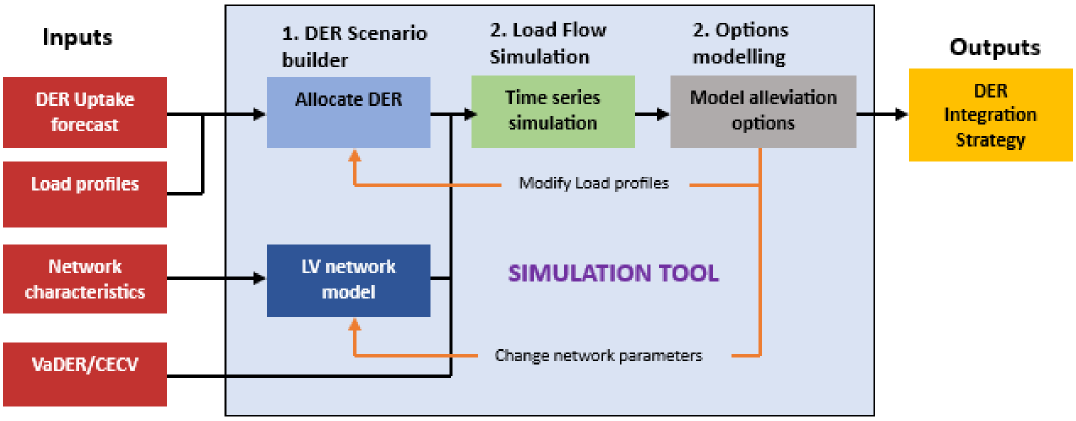
67. In this section we focus on assessment of the suitability of the model in determining the curtailment energy, focusing on the inputs and parts 1-3 of the Simulation Tool. In section

[13] Defined by the AER as *the ability of a power system to accept DER generation without adversely impacting power quality such that the network continues to operate within defined operational limits (without experiencing voltage or thermal violations)*

[14] Endeavour Energy 2022, 10.40 DER Integration Strategy and Business Case, Table 4

3.4 we consider the Options (solutions) modelling and in section 3.5 the proposed hierarchy of solutions derived from Endeavour Energy's cost-benefit analyses.

Figure 3.1: Endeavour Energy's hosting capacity model – inputs processing and outputs



Source: Based on DER integration hosting capacity model documentation, page 7

3.2.3 Derivation of hosting capacity

Endeavour Energy's Simulation Tool is fit for purpose

68. Endeavour Energy has developed the LV Simulation Tool with the University of Wollongong's Australian Power Quality and Reliability Centre. It uses the open-source electrical power flow engine (OpenDSS) to run time-series power flow simulations. Endeavour Energy has provided a document outlining its development and how it determines the impact of the forecast increases in residential PV, EVs, and batteries. The key modelled constraints to DER export are:[15]

- DER inverter curtailment – due to inverter trip settings and response modes;
- Distribution transformer capacity – due to overloading (kW) and maximum and minimum demand voltages; and
- High voltage feeder capacity – due to overloading (kVA).

69. Based on the information provided, we consider the simulation tool to be fit for purpose.

The network characteristics used in the HCM are fit for purpose

70. Endeavour Energy describes the zone substation, distribution substation, and LV feeder characteristics and sources. Endeavour Energy further advises that *'[e]ach NMI is mapped to the associated Customer Connection Point (CCP), then LV feeder, which is mapped to the DSUB and subsequently, Zone Sub.'*[16]

Endeavour Energy's LV network model is adequate and includes appropriate trip settings for inverters

71. Endeavour Energy has modelled the LV network (i.e. downstream from the distribution transformer) explicitly. The HV network is approximated in the model due to the size and complexity of modelling.[17] This is a reasonable approximation.

72. Endeavour Energy also models inverters as follows:

- Size: 4.9kW for systems installed prior to 2022 and 7kW installed after 2022; and

15 Endeavour Energy, DER integration hosting capacity model documentation

16 Endeavour Energy, DER integration hosting capacity model documentation, page 20

17 Endeavour Energy, DER integration hosting capacity model documentation, page 23

- Trip settings: existing inverters have only the volt-watt control function enabled per AS4777.2:2015; post 2022 inverters are set to trip if the average voltage exceeds 258V in a 30 minute period.

73. The assumption for new inverters is an approximation of the requirement of AS4777.2:2020 which requires the volt-var setting to trip the inverter with trip/disconnect if the average voltage exceeds 258V for 10 minutes.[18] The difference is due to the 'lack of high-resolution data'.[19] This is a reasonable approximation given the cost of acquiring 5 minute data from smart meters (as discussed in section 3.3.2.)

3.2.4 Other modelling assumptions

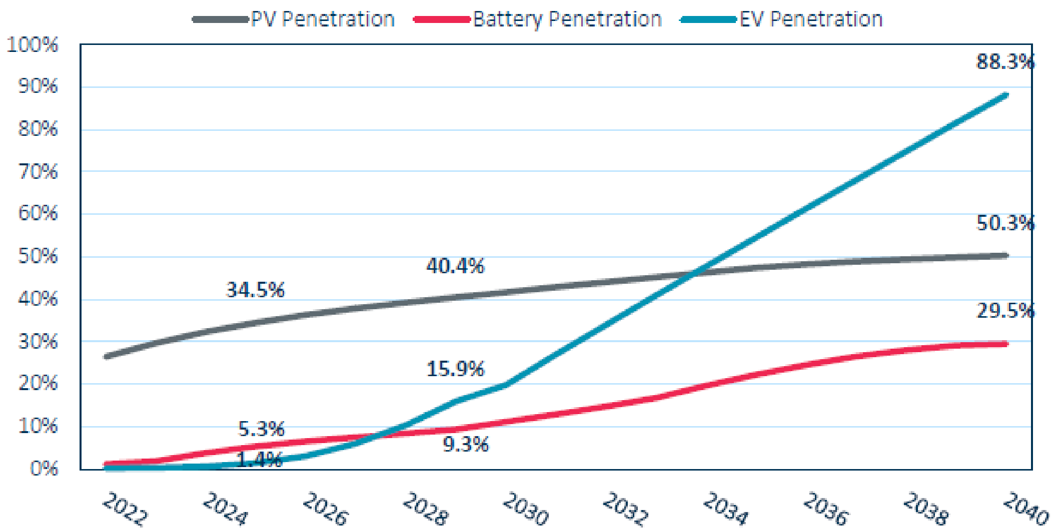
DER uptake and load profiles

The DER uptake forecast inputs are credible

74. Endeavour Energy has applied the ISP Step Change Scenario to forecast DER penetration for PV, EV, and Batteries through to 2040, as shown in the figure below. We consider that:

- Endeavour Energy has applied the AER-recommended AEMO ISP Step Change Scenario per its DER integration guidance note;[20]
- Other sources (referenced in Endeavour Energy's HCM description), are adequate for modelling purposes;
- It is reasonable to expect that with falling technology costs, national support for DER as a plank of energy sector transition to lower GHG emissions, and the increasing cost of grid-delivered electricity, that DER penetration will continue to grow; and
- Based on the information provided, it is reasonable for Endeavour Energy to assume that residential inverter sizes will continue to grow for at least the next few years towards the (current) 10kW installed capacity cap.

Figure 3.2: Step Change Scenario forecast DER penetration as % of customers on Endeavour Energy network



Source: Endeavour Energy 2022, 10.40 DER Integration Strategy and Business Case, figure 3

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18 Volt-var and volt-watt settings respond to voltage rise and have the effect of reducing export for the PV including by tripping the inverter – for example, 265V AS4777.2:2020 requires the inverter to trip if 265V (or more) is sustained for 1 second or more; if the inverter detects 275V, instantaneous tripping is required

19 Endeavour Energy, DER integration hosting capacity model documentation, page 27

20 Noting that it is beyond our scope to assess the derivation of the penetration as a percentage of customers on the Endeavour Energy network from the ISP Step Change Scenario

Endeavour Energy's DER and non-DER load profile inputs are reasonable

75. Endeavour Energy's model includes a base-case 'non-DER' or underlying residential consumption profile for each customer and profiles for PV, EV and batteries. Each of the profiles are 30-minute time series forecasts for 20 years and allocated to customers within each of the modelled substations:

- Within the model, variants of non-DER profiles are used to reflect tariff reforms and controlled-load tariff programs;[21]
- The PV profile was scaled to account for more typical solar irradiance; and
- The EV profiles were built up from six charging types,[22] with the convenience charging forecast to drop by 60% over the next 30 years.

76. We consider that the profile assumptions and approach to deploying them described by Endeavour Energy are both appropriate for modelling purposes.

Voltage management

Endeavour Energy has undertaken steps towards efficient voltage management in the current RCP

77. As discussed in more detail below, Endeavour Energy proposes implementing Dynamic Voltage Management Systems (DVMS) at its zone substations to dynamically adjust target voltage settings and has implemented '…*distribution transformer tap changing, commencing daytime voltage reduction schemes at two thirds of [its] zone substations…*'[23]

78. We also note that Endeavour Energy reports a 20% reduction in PV-driven customer complaints from 2021 to 2022 as a result of its voltage management initiatives. We consider the further application of such voltage management initiatives in section 3.4.

3.2.5 Derivation of curtailment profile

Endeavour Energy's approach to load flow simulation to determine the forecast BAU curtailment energy is reasonable

79. New PVs, EVs and batteries within each year of the HCM are allocated 'to customers according to the Endeavour Energy LV Network forecast scenarios.'[24] Based on its description, Endeavour Energy follows an acceptable allocation approach but we consider that it could be improved by allocating EV uptake in accordance with higher income areas, at least for the next decade, to give a more likely geographical concentration of EV penetration.

80. Endeavour Energy's Simulation Tool runs load flow simulations for each customer based on its LV network model and the DER scenario builder. Load and voltage profiles are analysed to measure constraints arising from either voltage excursion above or below prescribed limits or line or transformer capacity overloads.

Endeavour Energy's curtailment profile is based on the Base Case (BAU)

81. Endeavour Energy's Base Case (or BAU) scenario was developed with inputs as described above, with no intervention actions.

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21 Endeavour Energy, DER integration hosting capacity model documentation, page 15

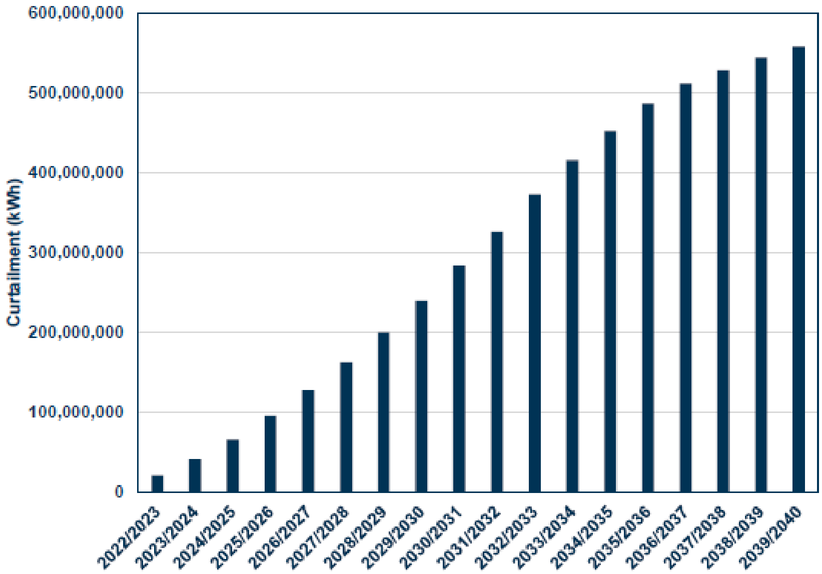
22 Convenience, night time, day time, coordinated charge, V2H and V2G; the AEMO/CSIRO EV charging curves have baked in tariff response, with charging transitioning away from peak demand periods over time (Endeavour Energy, DER integration hosting capacity model documentation, page 17)

23 Endeavour Energy 2022, 10.40 DER Integration Strategy and Business Case, page 16

24 Endeavour Energy, DER integration hosting capacity model documentation, page 22

82. Endeavour Energy's forecast modelled curtailment energy profile builds rapidly from a very low starting point, as to be expected and as shown in the figure below. By the end of the next RCP, the curtailment energy is expected to be 200,000MWhr.

Figure 3.3: Curtailment energy forecast for Step Change Scenario



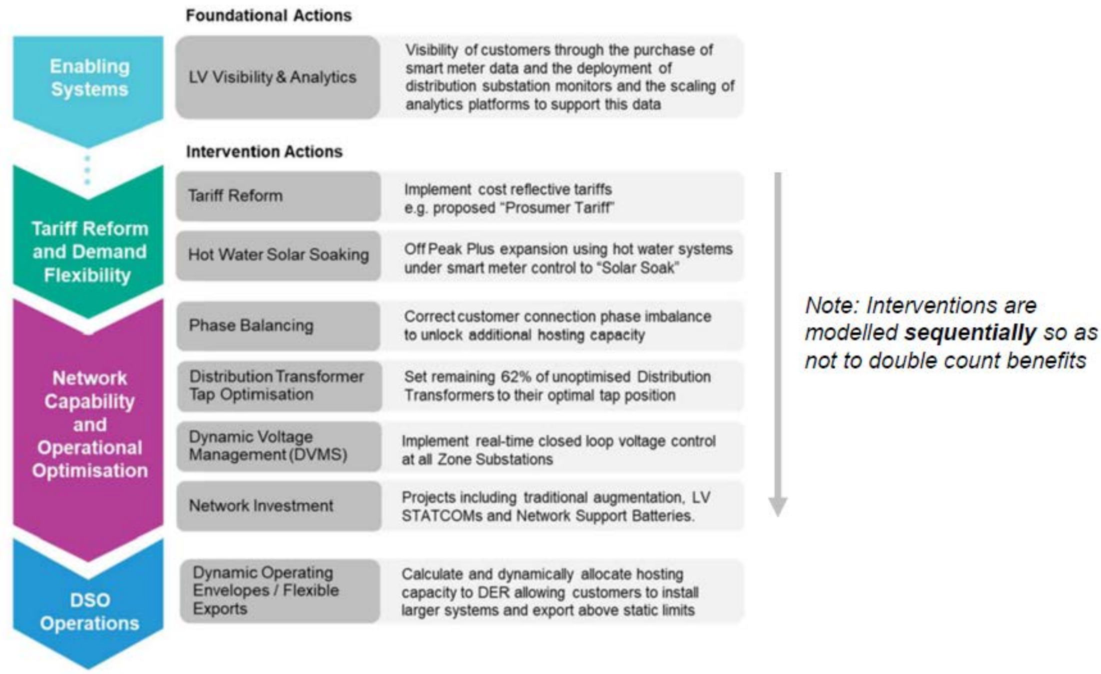
Source: Endeavour Energy 2022, 10.40 DER Integration Strategy and Business Case, page 53

3.3 Assessment of Endeavour Energy's proposed solutions

3.3.1 Overview of proposed solutions

83. Endeavour Energy has identified eight DER integration solutions, as shown in the figure below. We discuss the solutions and the costs and benefits attributed to them in this section after first considering the DER-related investments Endeavour Energy has made or is making in the current RCP.

Figure 3.4: Endeavour Energy DER Integration plan

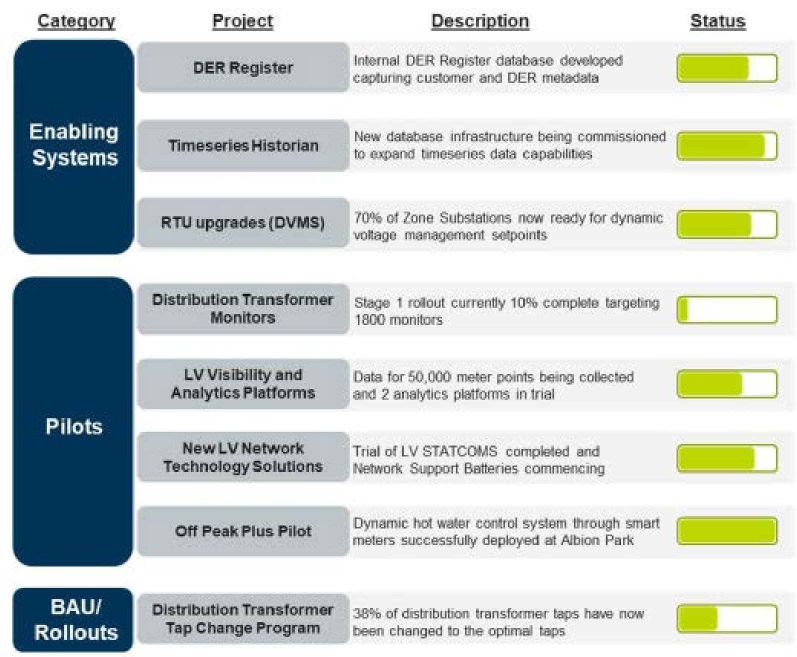


Source: on-site presentation slide 49

Several DER-related investment proposed for the next RCP build off pilot projects in the current RCP

84. As shown in Figure 3.5, Endeavour Energy's DER integration investment in the current period focusses on enabling systems and pilots. Together, Figure 3.4 and Figure 3.5 show that there are a number pilot and other projects which Endeavour Energy proposes continuing into the next RCP.

Figure 3.5: Status of DER integration initiatives in the current RCP



Source: Endeavour Energy 2022, DER Integration Strategy and Business Case, page 19

85. Although pilot programs can have limitations, they are generally a good first step to demonstrate the likely prudency of subsequent, expanded investments.

86. Endeavour Energy's program of works in the current RCP provides a measure of confidence in the bases for the costs, benefits and timing. Nonetheless, we have examined the merits of the proposed investments individually and as a package.

3.3.2 LV Visibility and Analytics (LVVA)

LVVA is reasonably positioned as an enabling capability for other DER projects

87. LV visibility refers to correcting the relative paucity of Endeavour Energy's knowledge (in its models) about the standing characteristics (such as phase connections), power flows (that is from customers premises and, in the case of DER, 'reverse' power flows), voltage, and current and, with the exception of standing data how they vary over time across the LV network.

88. The strategy is to collect 'sufficient' LV data to enable analysis in support of the proposed corrective actions or interventions proposed by Endeavour Energy.

89. We consider it reasonable that Endeavour Energy describes the LVVA project as a foundational investment, supporting the other intervention investments proposed for the next RCP. In the balance of this section and in sections 3.3.6 and 3.4.3, we assess the prudency of the proposed expenditure.

The Data access requirements may be overstated

90. Endeavour Energy proposes a smart meter data acquisition program at an estimated operating cost of $10.0m over the next RCP. It proposes to build up from access to data from 54,000 meters in FY24 to 165,000 in FY25 and linearly to access data from 300,000 meters (25% of available meters) by the end of FY29.[25]

91. Endeavour Energy also proposes spending a further $11.0m capex on 3,800 distribution transformer monitors in addition to the 1,800 monitors to be installed in the current RCP.

92. The data unit costs assumed by Endeavour Energy appear to be commensurate with market prices at the time for NSW and the unit costs for distribution transformer monitoring are reasonable.[26]

93. Endeavour Energy has presented its rationale for selecting a combination of smart meter-derived power quality data and distribution transformer monitor data, with the main advantages cited as:

- Both are mature, proven, and consistent sources of LV visibility; and
- The two sources provide complementary, not duplicate information useful for a range of analyses in support of intervention aspects.

94. Endeavour Energy has also presented three principles it claims to have adopted in determining its visibility/data requirements, including balancing cost and outcomes, growing visibility commensurate with its analytical capability, and establishing minimum viability to enable all the planned DER interventions.[27] We consider these principles to be reasonable.

95. Endeavour Energy references the experience of other DNSPs, and ARENA's 'Solar Enablement Initiative' and 'Project Shield'[28] to support its 20-25% coverage of available data points.

96. As discussed in section 3.4, Endeavour Energy has developed a cost-benefit model which indicates a positive NPV for its LVVA initiative. Nonetheless, we remain concerned about the cost of its data acquisition program because:

25 Endeavour Energy – IR005 – Att DER Model V13 – 20230321 - Public

26 Based on Endeavour Energy's information provided and from information available from confidential documents from other NSW DNSPs

27 Endeavour Energy 2022, DER Integration Strategy and Business Case, page 40

28 Endeavour Energy 2022, DER Integration Strategy and Business Case, pages 40-41

- Whilst we consider it reasonable to target 20-25% data coverage to design/set transformer tapping, phase balancing, and DVMS, this level of coverage is only required for the feeders at which there are over-voltage constraints and which a solution needs to be developed, not across the whole LV network. We consider that:
  - Endeavour Energy can leverage off its LV network modelling and any customer complaints to target the areas of the network with the highest levels of over-voltage and then secure the minimum LV visibility in those areas to identify the best solution(s)
  - A targeted approach is likely to maximise the cost-benefit of any intervention; and
- Similarly, targeted DOEs, which are to be introduced after the other interventions in its hierarchy of interventions, do not need to be accurate, at least initially, to enable less curtailment of solar export.

97. Therefore, at least for the duration of the next RCP, we do not consider that the ramp up to 25% coverage of all meters is required by the end of FY29.

3.3.3 Tariff Reform

Endeavour Energy has assumed a 'Solar Soaking' (prosumer) tariff combined with 'Off Peak Plus' hot water control to increase minimum loads at times of high solar export

98. The Step Change ISP forecast has EV and battery tariff reforms embedded within it, and are included implicitly in Endeavour Energy's BAU case, but these are weighted to the later years of the current RCP and then building strongly throughout the next decade.

99. Endeavour Energy's approach to non-DER tariff reform is to develop a 'Solar Soaking'[29] tariff combined with an Off Peak Plus[30] offering to shift demand to times of high solar output. The target for the Off-Peak Plus component is to accelerate take up of the hot water control to 100% by 2027 (i.e. advanced from 2036 in the BAU case).

100. Both of these initiatives are consistent with proactively reducing the over-voltage impact of solar export, however as discussed in section 3.4, we have concerns with the robustness of Endeavour Energy's cost-benefit analyses.

Endeavour Energy has assumed a trivial impact of non-DER tariff reform in the next RCP and beyond

101. Endeavour Energy's customer feedback '*demonstrates that tariff-based and cost reflective signals are valued by customers…*'[31] Despite this feedback, Endeavour Energy has assumed that electricity is strongly price inelastic, with its model predicting that a 10% price increase will result in only a 1% reduction in the baseline customer demand.[32] Endeavour Energy provides its analysis to support the assumed trivial impact of its Solar Soaking and Off Peak Plus initiatives.[33] The major factors accounting for the negligible impact are that Endeavour Energy assumes low retailer pass through, a very small assumed fraction of customer load able to be shifted, and a low price response.

102. We consider this to be a conservative perspective that is likely to undervalue the potential impact of cost reflective price signals, dynamic or otherwise and the potential for orchestrated responses to DER integration impacts.

29 Also referred to by Endeavour Energy as its 'Solar Soak' tariff

30 Off peak hot water control via smart meters to shift hot water heating loads into the peak solar export periods

31 Endeavour Energy 2022, DER Integration Strategy and Business Case, page 36

32 Endeavour Energy 2022, DER Integration Strategy and Business Case, page 42

33 Endeavour Energy 2022, DER Integration Strategy and Business Case, Table 8, page 46

Endeavour Energy does not countenance the development of dynamic pricing in the current RCP

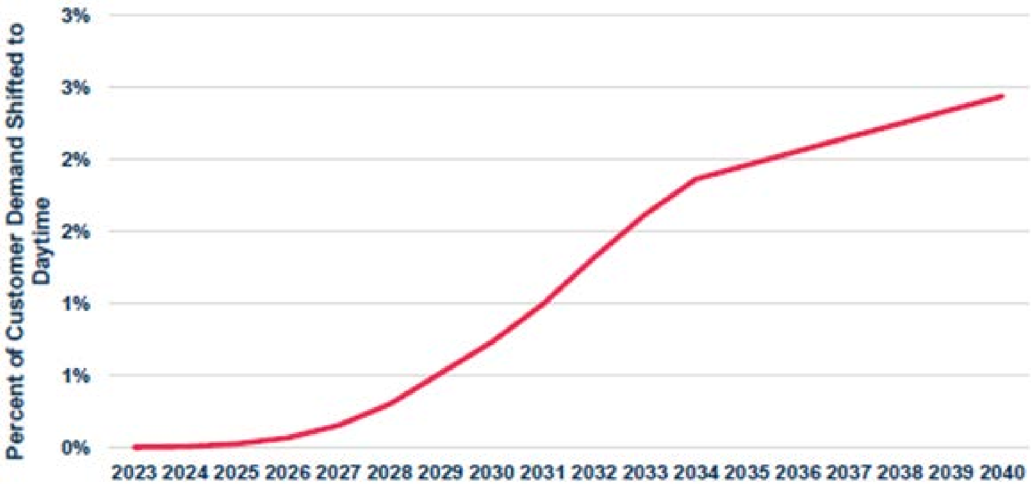
103. There is only one reference to dynamic pricing in Endeavour Energy's DER Integration Strategy, with the emphasis instead on introducing Solar Soaking and Off Peak Plus cost reflective. Endeavour Energy does not appear to have any plans to introduce dynamic pricing within the next RCP.

104. Dynamic pricing has the potential to improve hosting capacity by sending the appropriate pricing signals to reward customers (likely through agents and/or their own home energy management systems) to manage their DER and controllable loads to mitigate negative impacts on hosting capacity. Ausgrid's Project Edith is exploring the use of dynamic network prices (DNPs) for customers who already have a retailer or aggregator managing their battery in a VPP.

105. Endeavour Energy's assumed behavioural change in response to non-DER tariff reform is illustrated in the figure below where Endeavour Energy assumes that there will be essentially an insignificant contribution to managing solar impacts.

106. Whilst dynamic pricing would be unlikely to have a major impact within the next five years, it shows promise as a means of increasing hosting capacity and therefore reducing curtailment energy (all other things being equal) in the medium term and onwards.

Figure 3.6: Endeavour Energy's assumed impact of tariff reform on behavioural change



Source: Endeavour Energy on-site presentation

3.3.4 Phase balancing and tap changing

Phase balancing is a relatively low-cost initiative to increase overall hosting capacity

107. Phase balancing is a relatively low cost means of releasing hosting capacity by changing CCPs to balance the connections across phases to balance loading on the network.

108. Endeavour Energy has determined through its LV analytics platform trial that the average phase unbalance on its network is approximately 50/30/20 split.

Transformer tap changing is a relatively low-cost initiative to increase overall hosting capacity

109. Endeavour Energy has approximately 33,000 distribution transformers. The tap settings on most of the transformers can be characterised as being set for the following conditions and

are therefore not optimally tapped for improving solar hosting capacity and steady state voltage compliance:[34]

- Under-voltages due to peak demand impacts; and
- Superseded voltage standard of 240V with overvoltage limit of +8% (254V) and an undervoltage limit of -6% (225V) rather than the current standard of 230V with +10% (253V) and -6% (216V) limits.

110. Endeavour Energy has changed the tap settings on 38% of its distribution transformers and plans to continue the program in the current RCP and into the next RCP to increase hosting capacity.

Endeavour Energy has combined its phase balancing and tap changing programs

111. Endeavour Energy proposes undertaking tap change/phase balancing at 950 sites per year in the next RCP at $1,000 per site, which it has capped based on its resource limits. Modelling of targeted tap changes prioritises the worst/poorest voltage compliance sites each year and will address approximately 25% of the remaining suboptimal transformer tap settings (and contiguous phase unbalance).

3.3.5 Augmentation options and selection criteria

Endeavour Energy has shortlisted three augmentation (network investment) options for deployment in the HCM

112. As shown in the table, below, Endeavour Energy selects one of three augmentation options depending on the technical circumstances. With the exception of network LV batteries, the other options are now regarded as well proven and ‘traditional’ solutions. Endeavour Energy’s quoted costs used for modelling purposes are based on recent historical costs and/or quotes from suppliers with Endeavour Energy-added installation costs. In our view, the unit cost assumptions are reasonable.

Table 3.3: Augmentation options and selection criteria

Option	Technical selection criteria	Assumed costs	Benefits source
Distribution transformer tank replacement	If the transformer is a legacy type without buck taps (to reduce voltage)	$15k Based on historic replacement costs	CECV Avoided future replacement
LV STATCOM	Where the X/R ratio is sufficient	$30k average	CECV
Minor LV augmentation Major LV augmentation (LV mains + additional DTX) Network LV battery	Minor: moderate voltage and/or capacity constraint Major/battery: more severe voltage and/or capacity constraint	LV mains augmentation: $30k Major augmentation or network (pole top) battery: $90k	CECV VCR LRMC (for battery only 50%)

Source: EMCa modified version of On-site presentation, slide 57 plus and Tables 21 and 22 in DER Integration Strategy and Business Plan

[34] Endeavour Energy 2022, DER Integration Strategy and Business Case, page 24

We consider that Endeavour Energy has overstated the justified level of such augmentations

113. Endeavour Energy's modelling results lead to investment in 1,140 transformer tank replacements, 240 STACOMs, 50 LV batteries and 50 major augmentations at a total cost of $29.0m being justified in the next RCP. Appropriately, Endeavour Energy states that this amount should be regarded as an approximate allocation to network investments in the next RCP with the actual solutions depending on more detailed analysis closer to the time at which the solution is required.[35] However, as we describe in section 3.4.3, we consider that a flawed approach in Endeavour Energy's CBA has led it to overestimate the prudent and efficient level of augmentation.

3.3.6 Dynamic exports (DERMS and DOEs)

114. Dynamic operating limits (DOEs) are designed to allow customers to use more energy or export larger amounts of their rooftop solar at times when there is extra network hosting capacity. DOEs provide upper and lower bounds on the import or export of power in a given time interval for each of these distributed assets or CCPs. A DERM (distributed energy resources management system) is a software platform used to manage a group of DER assets to deliver network services within voltage and other limits.

115. The combination of DOE and DERMs (and DNP) may be used to support frequency or voltage on the grid, shift load, or provide emergency demand response.

DOEs are being trialled throughout the NEM and are likely to assist with making the most of hosting capacity.

116. Endeavour Energy is trialling DOEs at existing and new customer sites in the current RCP to '…*help develop [its] technical understanding and experience with DOEs as well as identify and test end processes and systems required to achieve DOEs…[and] engage with customers and stakeholders*…'[36] The Evolve Project, a $13 million ARENA funded research and demonstration project, centres around the use of DOEs and Ausgrid's 'Project Edith' is currently exploring the use of DOEs and DNP.

117. Based on the results to date and progress internationally, the risk that Endeavour Energy's implementation of DOE/DERMs will fail to deliver on its intended purpose is low.

Endeavour Energy plans to offer DOE from 2025

118. To be able to offer DOEs from 2025, Endeavour Energy advises that it needs a DERMS, customer connection portals, and associated processes that:

- *Enrols a new DER customer to a Dynamic Exports connections offer*
- *Uses LVVA to calculate DOEs informed by local distribution network level constraints…*
- *Communicates these constraints to applicable DER via standardised protocols such as IEEE2030.5 / CSIP AUS.'*

119. The DERMs cost estimate is based on quotes and for the customer connection portals and system integration, Endeavour Energy's own experience with similar projects. The costs appear to be reasonable.

Endeavour Energy has not yet finalised its approach to allocating the dynamic hosting capacity

120. Whilst Endeavour Energy plans to enlist DER customers on DOEs to enable export above the current 5kW static limit (to an upper limit of 10kW), it is yet to determine the mechanism

35 Endeavour Energy 2022, DER Integration Strategy and Business Case, Figure 50

36 Endeavour Energy 2022, DER Integration Strategy and Business Case, page 47

for allocation of DOEs to customers. Two possibilities (or a combination of both) are referred to in its DER Integration Strategy:[37]

- Equitable dispatch – same incremental kW export opportunity to all customers; and
- Maximum dispatch – allow maximum total kW export.

3.3.7 Non-compliance with AS4777 and AS61000.3.100

Endeavour Energy's strategy for improving compliance is the introduction of DOEs

121. As discussed in section 3.2.3, compliance with volt-var and overvoltage tripping settings under AS4777 is relatively poor (whilst volt-watt compliance is satisfactory).

122. Every non-compliant PV system fails to equitably contribute to solar hosting capacity and benefits from not being tripped in response to over-voltages at the expense of compliant neighbours.

123. With the planned increase in low voltage visibility and the concomitant analytical capability, Endeavour Energy will be able to progressively identify non-compliant inverter systems, with identification of non-compliance in hosting capacity constrained areas being more important than the rest.

124. However, governance of compliance with the technical standards for inverters is not Endeavour Energy's responsibility, nor does Endeavour Energy have the jurisdictional authority to enforce compliance.

125. Endeavour Energy's DER Integration Strategy does not explicitly contemplate an initiative to improve compliance with AS4777 directly, instead it plans to rely upon DOE implementation to progressively improve inverter compliance and equity of export access. Our understanding is that Endeavour Energy does not have the jurisdictional role or authority to undertake a program of retrospective compliance action, however we expect that a prudent operator would seek to improve compliance levels for new installations in order to minimise or defer the need for new investments to achieve the same result.

Endeavour Energy's strategy for improving compliance with AS61000.3.100:2022 is through a combination of initiatives

126. As discussed in section 3.1, Endeavour Energy does not fully comply with the steady state v99 limit. In addition to reactive responses to customer complaints, Endeavour Energy's proposed DVMS, tap changing, and network augmentation initiatives combined with DOE should help improve compliance.

3.4 Assessment of Endeavour Energy's cost benefit analysis

3.4.1 AER base case guidelines

127. Consistent with the RIT-D guidelines, the AER expects DNSPs to define a business as usual (BAU) base case against which to measure the net economic benefit of options. The guideline states that the BAU base case should have the following characteristics:

- DNSP continues its BAU activities which are 'ongoing, economically prudent activities that occur in the absence of a credible option being implemented';
- Comprises BAU operating expenditure associated with voltage management which are already in place;

[37] Endeavour Energy 2022, DER Integration Strategy and Business Case, page 48

- Allow for inverter systems to trip at times where DER exports exceed hosting capacity; and
- Incorporate export curtailment assumptions based on existing static export limits.

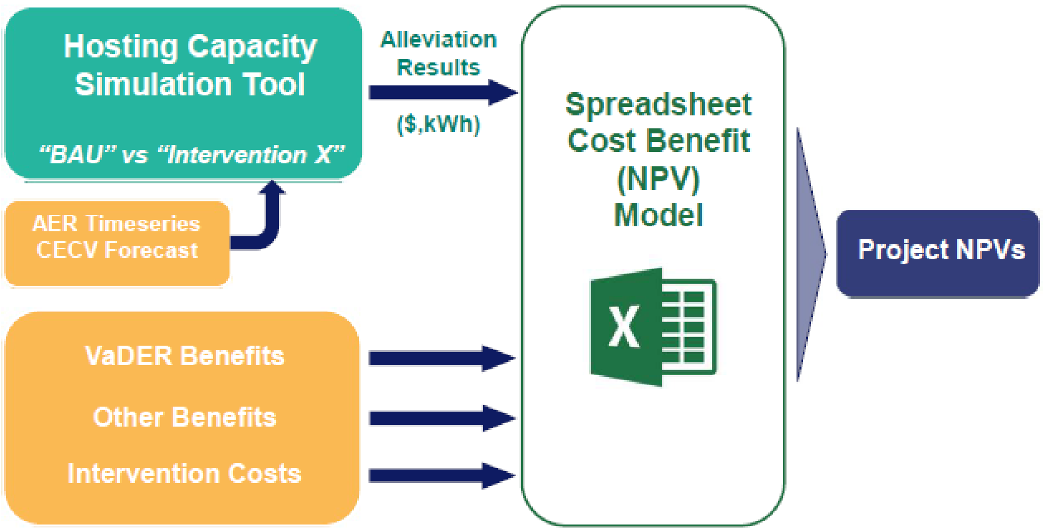
128. The guideline states that the preferred option should be that which maximises the net economic benefit across the NEM, with the base case representing the best option if there is no option that yields a net economic benefit.

3.4.2 Endeavour Energy's cost benefit analysis (CBA) modelling

Model overview

129. Endeavour Energy provided its CBA model in response to an information request (IR#05). In Figure 3.7 Endeavour shows the overall assessment framework and the model that it provided for review is the 'Spreadsheet Cost Benefit (NPV) Model referred to in this diagram.

Figure 3.7: Cost-benefit modelling



Source: Endeavour Energy, On-site presentation

130. The key elements of this model can be summarised as follows:

- The core output from the model is a sheet that presents 'DER expenditure and NPVs' This sheet presents investment costs and economic benefits in what it refers to as nominal and real terms, along with what it refers to as NPVs. Each of these (i.e. costs, economic benefits and net benefits) are presented for each of the five years of the next regulatory period, and in aggregate for this period;
- Costs and benefits are separately identified for:
  - DERMS and flexible exports
  - Off Peak Plus + (Solar Soaking)
  - LV visibility, analytics and DVMS
  - Transformer tapping and phase balancing
  - Customer call investigations
  - Network capex (LV augmentation), and
  - Transformer monitoring; and
- The LV augmentation forecast is calculated from what is in effect a sub model, which lists every distribution substation along with a potential 'technical solution', determines if

and when such technical solution first has a positive NPV and, if so, includes this solution as a proposed network project within the regulatory period. The aggregate cost and NPVs of benefits associated with those augmentations over the regulatory period, are divided by five and attributed equally to each year in the regulatory period.

Costs as presented in Endeavour Energy's CBA

131. Endeavour Energy presents the costs of its proposed DER program for the five years of the next regulatory period, as shown in Table 3.4.

132. There are some differences between the costs presented in its CBA model and the proposed DER expenditure allowance as shown in Table 3.1:

- The CBA model capex of $44.5m compares with Endeavour Energy's proposed capex of $45.0m. The CBA model shows that $4.5m of this is 'ICT' and $40m is 'system' capex;
- As shown in Table 3.1, Endeavour Energy has proposed an opex step change of $5.8m for 'Off peak Solar Soak', which compares with $5.7m in its CBA model; and
- As shown in Table 3.1, Endeavour Energy has proposed an opex step change of $14.2m for 'network visibility, which compares with $15.9m in its CBA model.

133. The year-by-year phasing of expenditure also differs between the CBA and Endeavour Energy's proposal.

134. Endeavour Energy has not proposed opex step change amounts for transformer tapping and phase balancing or for customer call investigations.

135. Whilst there are differences between the costs in its proposal and those in its CBA, we consider that the costs in the CBA are similar enough for the purpose of assessing the CBA.

Table 3.4: DER costs (as presented in Endeavour Energy's CBA)

	FY25	FY26	FY27	FY28	FY29	Total
ICT CAPEX (DERMS & Flexible Exports)	0.9	0.9	0.9	0.9	0.8	**4.5**
System capex (LV Augmentation)	6.1	5.9	5.8	5.7	5.5	**29.0**
System capex (TX Monitoring)	2.1	2.4	2.4	2.1	2.0	**11.0**
Sub-total capex	**9.1**	**9.2**	**9.1**	**8.6**	**8.4**	**44.5**
Opex (off peak Solar Soak)	2.7	2.6	0.2	0.2	0.1	**5.7**
Opex (LV visibility, Analytics & DVMS)	2.4	2.8	3.2	3.5	3.9	**15.9**
Opex (transformer tapping & phase balancing)	0.9	0.9	0.8	0.8	0.8	**4.3**
Opex (customer call investigations)	0.4	0.4	0.4	0.3	0.3	**1.8**
Sub-total opex	**6.4**	**6.6**	**4.5**	**4.9**	**5.2**	**27.6**
Total costs	**15.5**	**15.9**	**13.7**	**13.5**	**13.5**	**72.1**

Source: EMCa, from Endeavour Energy CBA, sheet 'DER Expenditure and NPV', costs (real)[38].

Curtailment value

136. A curtailment simulation summary is also included in the model. This shows the assessed amounts of curtailment in kWh, and in cost terms (based on the CECV), for the BAU 'no intervention' base case and then progressively for interventions in the following order:

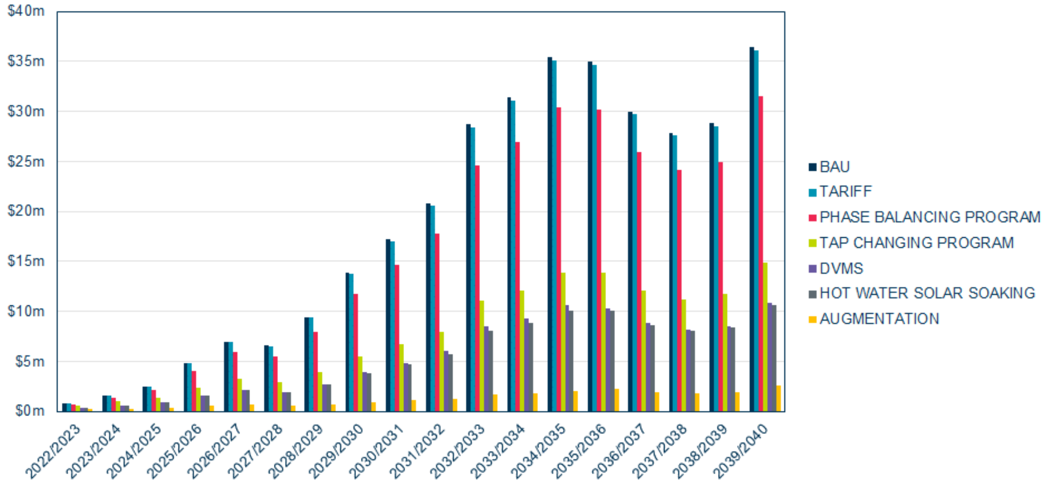
- Tariffs;
- Phase balancing program;
- Tap changing program;

38 The summation in Endeavour Energy's CBA model is $70.3m, because it does not include the cost of customer call investigations

- DVMS;
- Hot water solar soaking; and
- Augmentation.

137. In Figure 3.8 we have reproduced Endeavour Energy's presentation of the costs of customer curtailment with no intervention (BAU) and with the progressively introduced interventions listed above. Endeavour Energy's analysis is that tariffs would provide minimal reduction, while the largest reductions in curtailment tap changing, augmentation and phase balancing.

Figure 3.8: Endeavour Energy's assessment of forecast modelled curtailment value per annum post intervention



Source: Endeavour Energy graph from its business case analysis (Endeavour Energy CBA model)

138. Endeavour Energy's analysis shows curtailment costs increasing rapidly (in the absence of any interventions, but that the proposed interventions would reduce these by orders of magnitude and that they would effectively halt the increase in the cost of curtailment that would otherwise occur.

Endeavour Energy's assessment of NPV

139. In its CBA, Endeavour Energy shows an NPV of $55.9m for the DER program overall and positive NPVs for each element of the program.

3.4.3 Assessment of Endeavour Energy's CBA

Representation of NPVs is flawed

140. Endeavour Energy's model is flawed in its presentation of Net Present Values.

141. We observe firstly that the model uses what it designates as a 'real WACC' (of 2.42%) to convert what it describes as nominal costs and benefits into real costs and benefits using what it describes as a 'discount multiplier'. This appears to conflate the concept of discounting (to produce present values) with inflation-related adjustments that would be required to convert between nominal and real costs and benefits. While the model logic implies that costs and benefits are being calculated in nominal terms (because it then converts these into real terms), it is also unclear whether the costs and benefits that are being determined in the various calculation sheets are all in nominal terms in the first place.

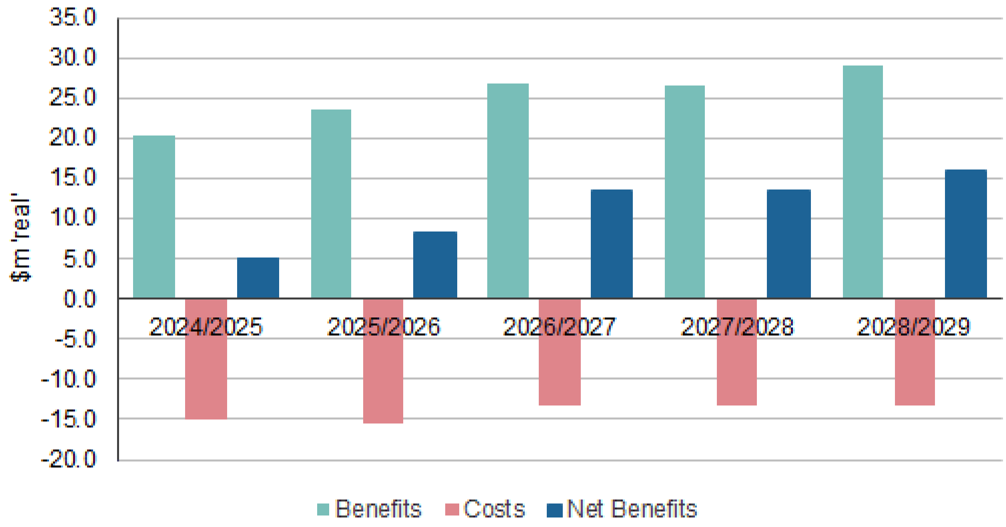
142. Secondly, we observe that what are described as NPVs are calculated simply by deducting the costs in each year of the regulatory period from the 'benefits' ascribed to that year. When we further examine the sources of the costs and benefits, we find that the costs in each year align with the expenditures (capex and opex) that Endeavour has proposed.

However, the benefits ascribed to each year in the regulatory period comprise a mixture of benefits assessed as being realised in those years and NPVs of future benefits.

143. Further, we observe that costs beyond the regulatory period are not considered in the 'NPV' analysis.

144. Endeavour's 'NPV' results are as shown in Figure 3.9. However, due to the modelling flaws referred to above we conclude that the CBA model does not contain any valid representation of the annual benefits or net benefits in the next regulatory period, nor of the NPV of the proposed DER program nor of any element of that proposed program.

Figure 3.9: Proposed DER benefits, costs and net benefits (as presented by Endeavour Energy)



Source: EMCa (from Endeavour Energy CBA model, sheet 'DER expenditure and NPV'

The method Endeavour has used to determine its proposed distribution substation augmentation expenditure is flawed and overstates its requirement

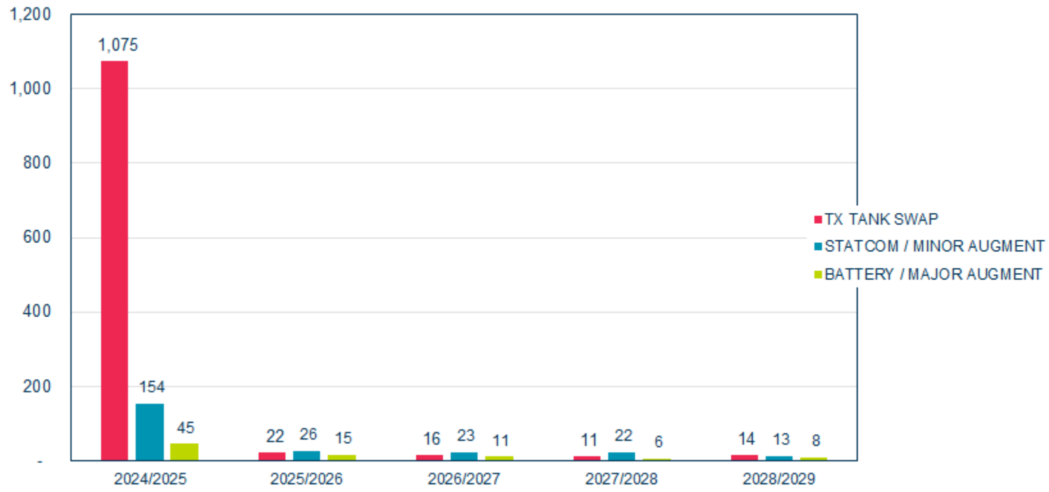
145. In the 'sub model' within Endeavour's CBA model, the proposed augmentation expenditure is determined for each distribution substation by identifying the first year in which the forward-looking NPV of the 'technical solution' is greater than zero. The benefits considered in this calculation are the CECV-based benefits of avoided curtailment. In the first year in which the forward-looking NPV is positive, the model then schedules the defined technical solution. The proposed augex is determined by summing the solution expenditure for each scheduled augmentation determined in the model for the regulatory period. This is then annualised by dividing the nominal cost result by five (and which then results in the cost in real terms decreasing over the regulatory period).

146. There are several issues with this modelling. Firstly, as noted above, this sub model incorporates the flawed logic regarding the difference between inflation adjustments and discounting, in that the 'PV' of the benefits is derived from the nominal benefits adjusted only by the 'discount multiplier'. As discussed above, this multiplier may be intended to adjust from nominal to real terms or it may be intended to determine present values, but it does not in itself do both.

147. Secondly, the model incorporates flawed logic on the optimum timing to undertake works that are determined on the basis of their economic value. Specifically, the first year in which a positive NPV is achieved is not necessarily the optimum (from an economic perspective) and it is typically the case that the NPV is higher if the investment is deferred. The optimum timing (as represented by the highest NPV) is defined by the year in which the annual benefits exceed the annuitised costs.

148. Unsurprisingly, the Endeavour model schedules the distribution substation augmentation almost entirely in the first year of the period, implying (incorrectly) that it should have already been undertaken. The 'raw' analysis from Endeavour's model is shown in Figure 3.10.[39]

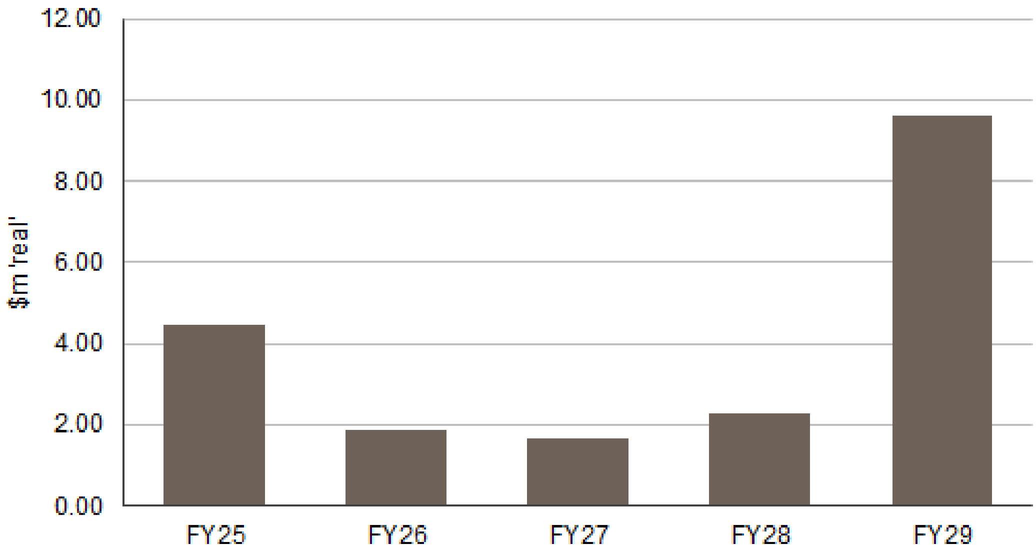
Figure 3.10: Justifiable capex project count per year forecast RCP 24-29



Source: Endeavour Energy CBA model, sheet 'Business case graphs'

149. We made some indicative modifications to test the extent to which Endeavour's method 'front loads' and overstates the economically justifiable expenditure. As shown below, a correct application of the economic test removes the front-loading of the 'justifiable' expenditure and even the raw results from modelling (which could be smoothed to provide for an operationally preferrable program of work) are more evenly spread. The resulting justifiable level of augmentation is also lower, at just under $20m, compared with $29m in Endeavour's model (and which is therefore included in its proposed $45m DER capex).

Figure 3.11: Indicative annual expenditure on distribution substation solutions if timing optimisation is correctly applied



Source: EMCa analysis from Endeavour Energy CBA, with modifications made to 'System CAPEX NPV' sheet

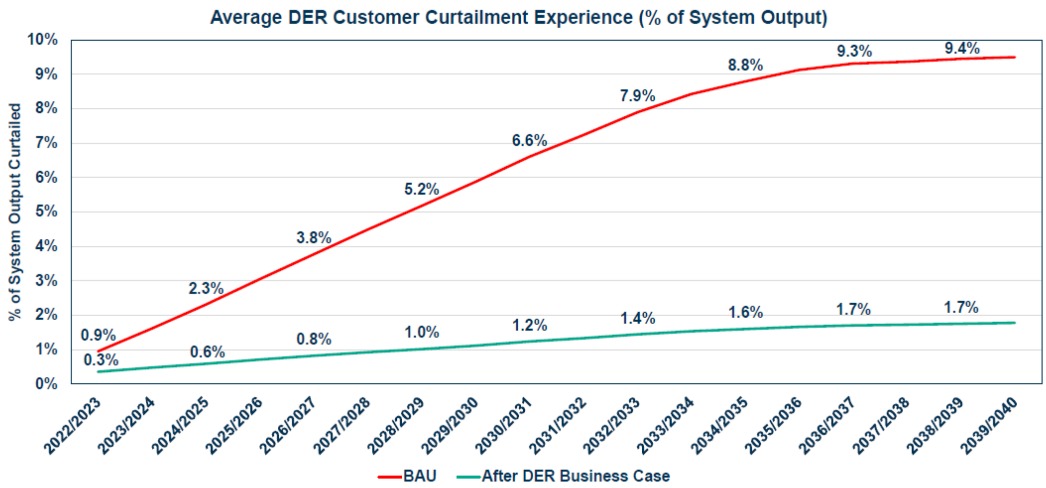
[39] This graph, which is taken directly from Endeavour Energy's model, is a 'count' of the numbers of such projects.

The basis for Endeavour Energy's assessment of some benefits is unclear or unsupported by evidence

150. There are numerous assumptions within Endeavour Energy's CBA that are hard coded and unsupported by evidence. The materiality of these assumptions varies, however at least some of them materially affect the claimed economic outcome. Examples of such assumptions are as follows:

- In its assessment of LVVA benefits, Endeavour Energy assumes that its proposed LVVA program can achieve average voltage reductions starting at 0.5% but increasing to 2.5% by 2029. Endeavour Energy counts a 'conservation benefit' from reduced energy use, based on an annual SRMC of generation, and which amounts to $15m over the regulatory period;
- Endeavour Energy attributes a benefit of $7.5m over the period to the contribution of LVVA to its tap change program. However, this would be overstated to the extent that its 'network capex' program is overstated (as above);
- Endeavour Energy's derivation of DERMS benefits, which it assesses at $16.5m over the period, is obscure. We would have expected this to be based on its detailed CECV simulation, however these are not linked within the model and the core CECV benefit driver in the DERMS sheet is a hard coded value for the '*incremental CECV per 1kW solar added per annum*'. The calculation is also driven by a static limit of 5.0kW and an assumption that customers' (un-curtailed) peak exports will rise to 9.0kW by 2029[40] and
- Endeavour's DERMS benefit calculation also assumes hard coded *'percentages of time curtailed by DoE*' of 1% in 2024/25 and rising annually to 5% by 2028/29. None of the calculations of avoided curtailment in the DERMS benefits calculations appear to be consistent with those shown in Endeavour Energy's business case, as shown in Figure 3.12.

Figure 3.12: Average DER customer curtailment experience (% of System Output)



Source: Endeavour Energy Attachment 10.40: DER Integration Strategy

- Endeavour Energy attributes four benefit streams to its proposed Hot Water Solar Soaking / Off Peak Plus initiative. The principal assumed benefit is referred to as a 'deferral benefit per meter'. This is calculated by reference to a derived per-meter replacement cost at zone substations, which in its modelling is divided by 20 with annotation that this is an '*Avoided RAB cost recovery per meter*', being a *'PV assuming 20-year life'*). From Endeavour Energy's descriptive material, the benefit arises from being able to bring forward the avoidance of the need to replace this equipment (by three years, from 2030 to 2027). However we consider it unlikely that AFIC would be replaced in 2027, that was otherwise not going to be required from 2030. Endeavour

40 Per figure 29 in Att 10.40 DER Integration Strategy – December 2022 - Public

Energy appears to have considered a RAB sunk cost, rather than a forward-looking economic cost in its calculations and, without this benefit, the NPV of Endeavour Energy's proposed acceleration of solar soak transfers is negative.

3.4.4 Conclusions on our assessment of Endeavour Energy's CBA

Endeavour Energy's CBA does not demonstrate a net economic benefit

151. As currently presented, Endeavour Energy's CBA does not demonstrate that its proposed DER would provide a net economic benefit.

152. From our inspection of the CBA model, we consider that there is a level of distribution substation augmentation expenditure that is likely to be viable, however we consider that the appropriate level of such expenditure is considerably less than Endeavour has proposed.

A rework of the CBA would be required in order to be able to draw useable conclusions on the economics of the proposed DER program

153. Demonstration of the economic justification for the remainder of Endeavour Energy's proposed DER program would require a rework of its CBA. In particular (and this is not an exhaustive list) this should involve:

- Developing a model that estimates and incorporates costs and benefits of the program over a period of (say) 20 years;
- Correcting for the misapplication of inflation indexing (to the extent that costs and/or benefits are estimated in nominal terms) and of the real WACC in present value calculations;
- Transparently linking key elements of the intervention benefit assessment, such as avoided curtailment, into the benefits incorporated into the NPVs over the analysis period; and
- Correcting the distribution substation sub-model (as represented in the 'system capex NPV' sheet) to determine a program that represents the best option based on economic criteria.

154. We consider that it will be useful to retain the disaggregated approach that is evident in the CBA, of seeking to align benefits of each element of the proposed program against its costs. This will help to confirm (to the extent that they are separable) the economics of each element of the proposed program and, in turn, this can assist in demonstrating that the proposed program represents the best combination of options considered. Importantly, a CBA that transparently sets out annual costs and annual benefits over the full analysis period will help to reveal the appropriate timeframe for DER investment relative to 'need' as evident from benefit assessment, and the most promising focus areas for deployment of DER-related technologies and service offerings to maximise the benefit of DER investment.

3.5 Our findings and implications

3.5.1 Summary of our findings

Endeavour Energy has established a case for action to address network constraints caused by DER

155. As with all DNSPs in the NEM, Endeavour Energy is experiencing increasing power quality issues from DER as a result of increasing DER penetration and solar export into its network.

156. Endeavour Energy has provided sufficient evidence that that over-voltage network constraints in particular will lead to increasing volume and frequency of export energy curtailment over the duration of the next RCP and beyond, exacerbating its existing poor overall compliance to AS61000.3.100.

157. Endeavour Energy's customer and stakeholder engagement has confirmed support for it to invest in 'modernising' its network, with a focus on enabling solar panel technology uptake.

158. We are also satisfied that through the current RCP, Endeavour Energy has undertaken a number of prudent steps to assist with efficient voltage management, including through LV data acquisition to support trial/pilot programs that have informed the

Endeavour Energy's DER hosting capacity model is fit for purpose

159. Endeavour Energy's derivation of the curtailment profile and modelling of the alleviation impacts of the various solutions it proposes are derived from its simulation tool (incorporating a network model, and load flow analysis capability, etc) which we consider to be fit for purpose.

160. Importantly, the DER (PV, EV, and batteries) uptake forecasts inputs to the model are credible, being based on AEMO's ISP Step Change Scenario. Similarly, we consider Endeavour's load profile, network characteristics, and approach to its load flow simulation to be fit-for-purpose.

161. We also consider that Endeavour Energy has set appropriate over-voltage limits as triggers for curtailment of solar inverter output.

Endeavour Energy has identified a reasonable range of solutions to integrate DER however it potentially under-rates the potential of tariff reform

162. Endeavour Energy's identified 'tool box' of solutions are common within the industry, comprising of a traditional 'supply side' solutions and tariff levers and DOEs, all enabled by low voltage visibility and the underpinning analytic capability.

163. Whilst Endeavour Energy has included a 'solar soaker' (prosumer) tariff combined with 'off peak plus' hot water control to increase minimum loads at times of high solar export in its forecast as a means of reducing DER impacts, it has assumed a trivial impact of non-DER tariff reform in the next RCP and beyond. This appears to be overly conservative given the expressed appetite for consumers to respond to appropriate price signals, the availability of home energy management systems, the likely rise of agents (such as VPPs), and the overall potential of 'orchestration' of DER, controllable loads, and controls such as BESS. To this end, Endeavour Energy does not countenance the development of dynamic pricing in the next RCP, which is being tested within the industry.

Endeavour Energy's data access requirements may be overstated

164. Whilst industry experience and trials support the need for 20-25% coverage of the connection points/LV feeders to enable adequate modelling accuracy, we understand that this coverage is only required to help select the appropriate solutions, solution timings, and, in the case of DOE/DERMs, thresholds.

165. Given the capacity of its hosting capacity model to identify areas of network constraints (including with inputs from its distribution transformer monitors and customer complaints), we consider Endeavour Energy may need less data than it has proposed, particularly in the early years of the next RCP

Endeavour Energy's Solar Soak / Off-Peak step change is not adequately justified

166. Whilst we consider that the Solar Soaking / Off Peak Plus initiative is likely to be help with avoiding a number of costs associated with the current infrastructure, the claimed benefits are not robust enough to lead us to conclude that there is likely to be a net benefit.

Representation of NPVs in Endeavour Energy's cost benefit model is flawed

167. Endeavour Energy's CBA model is flawed in its calculation of NPVs. It does not contain modelling of discounted cashflows that would be required to determine NPVs, nor are full 'analysis period' annual cost and benefit streams available in its model to allow a 'corrected' discounted cashflow-based NPV calculation. The CBA model provided therefore does not

provide usable economic analysis results for the proposed DER program wither in aggregate, or for any element of that proposed program.

The method Endeavour Energy has used to determine its proposed network augmentation expenditure is flawed leading to an overstatement of such augmentations

168. Endeavour Energy's modelling leads to a proposed $29.0m investment in network augmentations. However, we consider that a flawed approach in Endeavour Energy's CBA has led it to overestimate the prudent and efficient level of augmentation.

The basis for Endeavour Energy's assessment of some benefits is unclear or unsupported by evidence

169. There are numerous assumptions related to alleviation benefits within Endeavour Energy's CBA that are hard coded and unsupported by evidence. The materiality of these assumptions varies, however at least some of them materially affect the claimed economic outcome.

Endeavour Energy's CBA does not demonstrate a net economic benefit

170. Endeavour Energy's CBA does not demonstrate that its proposed DER would provide a net economic benefit. We consider that there is a level of distribution substation augmentation expenditure and investment in LVVA that is likely to be viable, however we consider that the appropriate level of such expenditure is considerably less than Endeavour has proposed.

171. A rework of the CBA would be required in order to be able to draw useable conclusions on the economics of the proposed DER program.

3.5.2 Implications of our findings for proposed expenditure

172. Given the flaws we have found in Endeavour's CBA model, it is not a reliable platform for Endeavour Energy's conclusions regarding the appropriate solutions, the timing, nor the scope and cost of them for DER integration in the next RCP.

173. Despite these limitations, we have been able to discern that it is likely that Endeavour's model, when corrected, will lead to the need for less capital investment in the next RCP.

174. We also consider that by focussing on progressively acquiring data targeted at zones of its network subject to constraints, the overall volume and cost of data acquisition may be less than Endeavour Energy has proposed. Within constrained zones, we consider that LV visibility from 20-25% of the connections is likely to be required to enable analysis with adequate accuracy, however acquiring such data across the whole network is not warranted.

175. Furthermore, we do not consider that the proposed Solar Soaking / Off Peak Plus 'acceleration' initiative and the proposed opex step change is likely to be prudent nor efficient.

4 REVIEW OF NON-RECURRENT ICT EXPENDITURE PROVIDING 'NEW CAPABILITY'

Endeavour Energy has proposed non-recurrent ICT capex of $70.3m, comprising 89 discrete projects which Endeavour Energy has combined into four 'Investment briefs.' We review $16.3m of this, being cyber security-related projects, in a separate report, leaving $54.0m of proposed project capex reviewed in the current report. The proposed expenditure is spread across a large number of projects each ranging from a few hundred thousand dollars up to several million dollars within the period, with no single large-scale project.

Associated with this project capex, our analysis suggests that Endeavour Energy forecasts $15.9m of project opex; however, it has not proposed any ICT-related opex step change.

The AER requires that non-recurrent ICT projects that provide capability growth are supported by analysis that demonstrates that they are economically beneficial. In Endeavour Energy's CBA, it has not demonstrated that this is the case, with systemic flaws including in its calculation of NPVs, benefits being 'allocated' to projects, a lack of justification for benefits, some projects with costs but no benefits and others with benefits but no costs. For some projects there was no discernible logic for some of the benefits being ascribed to them.

We have analysed such cost and benefit information as Endeavour Energy has provided and we consider that $12.7m of its proposed $54m of capex can be reasonably considered to provide an economic benefit.

4.1 What Endeavour Energy has proposed

4.1.1 Overview and summary of proposed expenditure

Non-recurrent ICT capex

176. Endeavour Energy has proposed ICT capex of $129m in the next regulatory period, comprising $58.7m recurrent and $70.3m non-recurrent capex. Endeavour Energy has proposed these under four 'Investment Briefs', as shown in Table 4.1.

177. Within Investment Brief 3, Endeavour Energy has proposed $16.3m for 'compliance' projects, which we have assessed in a separate report, leaving $54m in total (i.e. across the four Investment Briefs) which we assess in the current report and which Endeavour describes as non-recurrent projects which provide 'new capability' (also referred to by Endeavour Energy as 'capability growth').

Table 4.1: Endeavour Energy proposed non-recurrent ICT capex for 'new capability' - $million, real FY2024

Description	FY2025	FY2026	FY2027	FY2028	FY2029	Total
IB#1: Customer expectations	3.1	1.7	0.5	0.4	1.7	**7.4**
IB#2: Customer Future Choice	0.5	2.4	0.0	0.0	0.8	**3.6**
IB#3: Resilient Network	4.8	6.3	1.3	8.7	4.2	**25.3**
IB#4: Sustainable Growth	2.3	3.4	2.6	4.8	4.6	**17.7**
TOTAL	**10.7**	**13.7**	**4.4**	**13.9**	**11.4**	**54.0**

Source: EMCa table derived from Endeavour Investment Brief 1, 2, 3 and 4 workbooks. Excludes $16.3m of 'compliance' capex assessed in our cyber security assessment report.

Non-recurrent ICT opex

178. In workbooks that it provided for each Investment Brief, we created pivot tables to seek to identify the project opex associated with each of the 89 projects. In Table 4.2 we show the results of this analysis, noting that this excludes expenditure for the 'compliance' projects which we have assumed to be for cyber security and also (to the extent that it is listed in Endeavour Energy's workbooks) 'ongoing costs.' We infer therefore that the expenditure shown represents 'project' opex.

Table 4.2: Endeavour Energy proposed non-recurrent ICT Project opex for 'new capability' - $million, real FY2024

Description	FY2025	FY2026	FY2027	FY2028	FY2029	Total
IB#1: Customer expectations	1.0	1.2	0.0	0.2	1.6	**4.0**
IB#2: Customer Future Choice	0.4	0.8	0.0	0.0	0.2	**1.5**
IB#3: Resilient Network	0.4	0.6	0.3	5.3	0.5	**7.1**
IB#4: Sustainable Growth	0.4	0.6	0.2	1.3	0.8	**3.3**
TOTAL	**2.2**	**3.2**	**0.5**	**6.8**	**3.1**	**15.9**

Source: EMCa table derived from Endeavour Investment Brief 1, 2, 3 and 4 workbooks. Excludes $4.4m 'compliance' opex for cyber security. Also excludes 'ongoing opex'.

179. Endeavour Energy has not proposed any ICT-related opex step change.

4.1.2 Summary of the basis for Endeavour Energy's proposed expenditure

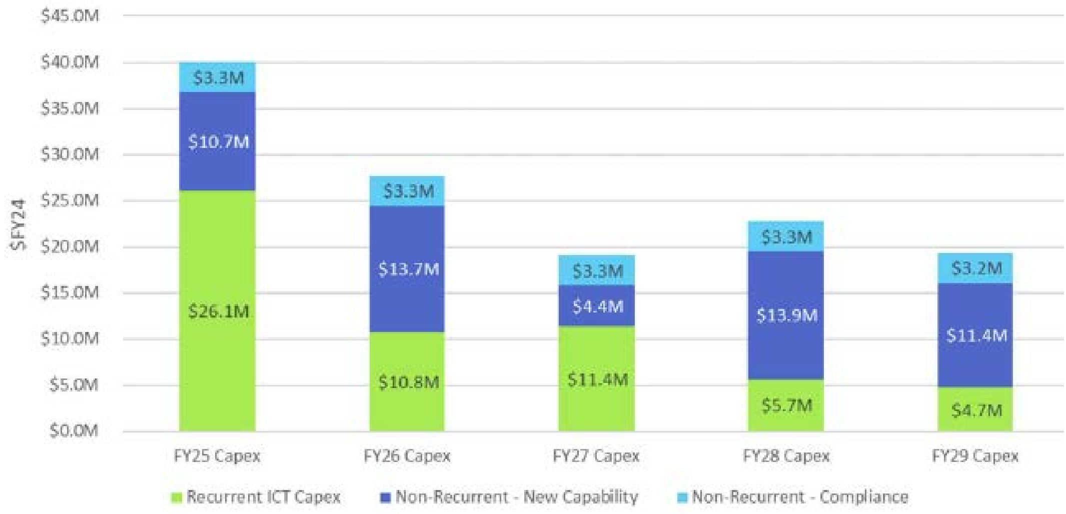
ICT strategy and Investment Briefs

180. Endeavour Energy's ICT Asset Strategy comprises a total of 89 discrete projects, grouped into 21 Strategic Responses across the four Investment Briefs. The Investment Briefs cover four 'priority themes' which are:

- #1 Meeting core customer expectation for a safe, affordable and reliable electricity supply;
- #2 Enabling customers' future energy choices for a sustainable future, moving us towards the future integrated and low carbon energy system;
- #3: Providing a resilient network for the community adapting to changing climate and external hazards; and
- #4 Supporting the sustainable growth of our communities.

181. The figure below shows the capex profile for the next RCP, with our focus on the non-recurrent (new capability) capex.

Figure 4.1: ICT Program capex by AER sub-category - $m, FY24



Source: Endeavour Energy Att 10.43 ICT Asset Strategy – November 2022- Public, Figure 10

Project-level information

182. When we sought further information on the make-up of the four Investment Briefs, Endeavour Energy provided us with a model containing a total of 89 projects, for each of which it had fields available to enter capex, opex and benefits over a 10-year period. The projects were categorised as shown in Figure 4.12, allowing us to filter and apply pivot tables to reveal the projects of relevance for our review. However, many of the fields were blank or contained zero values and therefore did not necessarily contain cost or benefit information for every project, or were incomplete meaning that for some projects, such information was provided only for part of the period.

4.2 Our assessment approach and context

4.2.1 Our assessment approach

183. Our assessment approach is based on assessing Endeavour Energy's proposed non-recurrent ICT capex against the following project dimensions:[41]

- Regulatory expectation – the business case (or equivalent, cognisant of the project development lifecycle) meets regulatory requirements set out in the NER and AER guidelines;
- Strategic alignment – the business case is aligned to the ICT strategy/strategic priorities;
- Cost estimation methodology – the derivation of the project cost estimates is based on a methodology that is likely to lead to a prudent and efficient delivered project cost, including a cross-check with dependent, inter-dependent or related projects to ensure there is no duplication of expenditure;
- Deliverability – the project and/or program of work is likely to be deliverable at an efficient cost, including understanding critical path inter-dependencies with other projects; and
- Customer engagement – the business case demonstrates how it aligns to customer expectations, with evidence of customer engagement.

[41] We would normally consider benchmarking in our reviews of ICT expenditure, however this is not helpful in assessing non-recurrent ICT project or even programs of work due to the diverse timelines on which non-recurrent ICT operate

184. All of the non-recurrent capex within the scope of this report is classified by Endeavour Energy as 'new capability' which equates to the category of 'new or expanded ICT capability, functions and services' in the AER's Non-network ICT expenditure assessment guidance note.

185. We have assessed the non-recurrent capex in each of the four Investment Briefs in sections 4.5 to 4.8.

4.2.2 Relevant context: AER Guidelines

186. The AER's Non-network ICT capex assessment approach[42] provides the following guidance on its approach to assessing non-recurrent ICT projects as part of its reviews of NSPs five-year revenue forecasts. We provide excerpts from this guideline in Figure 4.2.

Figure 4.2: Excerpts from AER guideline on assessment of non-network ICT

Maintaining existing services, functionalities, capability and/or market benefits

'Given that these expenditures are related to maintaining existing service, we note that it will not always be the case that the investment will have a positive NPV. As such, it is reasonable to choose the least negative NPV option from a range of feasible options including the counterfactual. For such investments, we consider that they should be justified on the basis of the business case, where the business case considers possible multiple timing and scope options of the investments (to demonstrate prudency) and options for alternative systems and service providers (to demonstrate efficiency). The assessment methodology would also give regard to the past expenditure in this subcategory.'

Complying with new / altered regulatory obligations / requirements

'It is likely that for such investments, the costs will exceed the measurable benefits and as such, the least cost option will likely be reasonably acceptable in regard to the NER expenditure criteria. Therefore the assessment of these expenditures is similar to subcategory one. Should there be options to achieve compliance through the use of external service providers, the costs and merits of these should be compared.'

New or expanded ICT capability, functions and services

'We consider that these expenditures require justification through demonstrating benefits exceed costs (positive NPV). We will make our assessment therefore through assessing the cost-benefit analysis. Where benefits exceed costs consideration should also be given to self-funding of the investment.

For each subcategory of non-recurrent expenditure, we note that there may be cases where the highest NPV option is not chosen. In these cases, where either the chosen option achieves benefits that are qualitative or intangible, we would expect evidence to support the qualitative assumptions. We consider the evidence provided must be commensurate with the cost difference between the chosen and highest NPV option.

We also note that where non-recurrent projects either lead to or become recurrent expenditures in the future, this needs to be identified in the supporting business case and accounted for in any financial analysis undertaken to support the investment.'

42 AER, Non-network ICT capex assessment approach, Nov 2019, pp11-12

187. Our assessment is based on these guidelines, in particular, the need to identify where, and the extent to which, proposed expenditure is to provide new or expanded capability and the need for economic justification of such expenditure.

4.3 Assessment of Endeavour Energy's investment framework

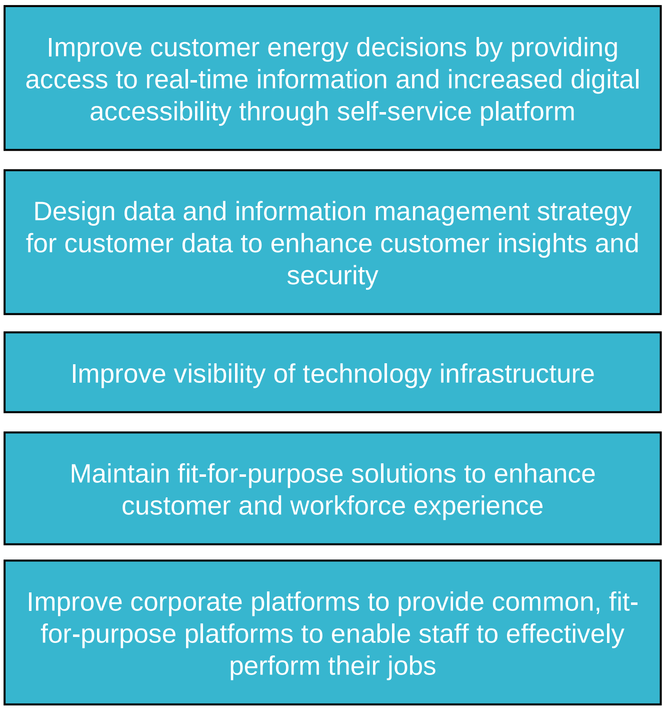
4.3.1 Endeavour Energy's ICT Strategy

188. Endeavour Energy advises that it has four priority themes which underpin its Purpose, Vision and Strategic Goals, and which in turn inform its ICT expenditure plans and forecasts for the 2024 - 2029 regulatory period. The priority themes are:

- Safe, affordable and reliable;
- Resilience;
- Sustainable growth; and
- Future energy choice.

189. Endeavour Energy's five strategic responses to these are shown in the figure below.

Figure 4.3: Endeavour Energy's strategic responses to its strategic drivers



Source: Extracted from Endeavour Energy ICT Asset Strategy 2024 – 2029, Figure 2

Links between the strategic priorities, the strategic responses and the Investment Briefs are explicit

190. In the four Investment Briefs, Endeavour Energy shows how the initiatives and outcomes link to one or more of the strategic responses. For example, for the first Investment Brief the links to the uppermost strategic responses is via initiatives to:

- Improve customer experience through real-time data access; and
- Enable customer self-service and chat services.

191. Based on our experience and the information provided, the planned initiatives are aligned to the strategic priorities.

4.3.2 Cost estimation methodology

Endeavour Energy's cost components are calculated in a manner largely consistent with industry norms

192. The costs for ICT investments have been estimated based on the following definitions and assumptions:[43]

- Program costs – for the resources to manage the Program including the running of the program; calculated using a time and material allocation to individual program delivery schedules
- Other Program costs – for travel and hotel accommodation, technology resources, and the office accommodation; calculated as a percentage of overall program costs;
- Develop and deploy – for the resources to support the planning, design, build, test and deployment of the solution; were calculated using a time and material allocation to individual project resource requirements and project delivery schedules;
- Infrastructure acquisition - for the provision of solution components; calculated using a standard price per size of project;
- Infrastructure upgrade - for maintaining existing ICT services, functionalities, capability and/or market benefits, and occurs at least once every five years;
- Contingency - related to the increases due to risks that are known, as well as unknown; calculated as 19% of overall non-recurrent – new capability total expenditure costs – refer to our comment below;
- Infrastructure maintenance - where applicable, a recurrent 5.78% of project costs has been applied to cover licence, break fix, and support calls for technology devices, digital storage, network devices, bandwidth equipment and rental, software licences and security equipment; and
- Service management - costs related to an uplift in costs required to cover additional operational support, likely from additional capacity from ICT service providers.

Inclusion of a 19% contingency in the proposed regulatory allowance would lead to an overestimate of the aggregate capex requirement

193. While it is standard practice to allow for contingencies in project-level budgeting, this leads to an overestimation of the aggregate capex allowance to the extent that Endeavour Energy has based its cost estimates on its actual costs (where applicable) for similar projects and estimates provided by vendors and these would already include contingent amounts. Inclusion of project-level contingency allowances in the overall regulatory capex allowance is not required in a 'portfolio' forecast.

4.4 Assessment of Endeavour Energy's cost-benefit analysis modelling and claimed results

4.4.1 Information that Endeavour Energy provided

194. Following an information request and subsequent to our onsite meeting, Endeavour Energy provided four cost-benefit analysis models (CBA models), one for each of the four

43 Endeavour Energy, Att 10.43 ICT Asset Strategy – November 2022 – Public, p42

Investment Briefs.[44] The CBA models provide a significant amount of detail regarding the multiple projects underpinning each Investment Brief in worksheets, including:

- The specific projects included in each Investment Brief
- The derivation of costs at the project level and which can be aggregated at the Program level
- A benefit-cost worksheet, which (i) allows the links between programs, projects, project costs (recurrent, non-recurrent, and ongoing) and project benefits to be identified, and (ii) the derived costs and benefits for each project
- Benefits calculation which, for the most part, shows the sources of benefits and the derivation of the total benefit from each source
- Other worksheets with input information, such as resource costs and project timing.

4.4.2 Our assessment

Scope of review of the CBA models

Our assessment is of non-recurrent projects providing new capability, and is relevant to Endeavour Energy's proposed allowance for ICT capex

195. The Investment Brief CBAs include recurrent projects, non-recurrent projects (new capability and compliance), non-recurrent costs and ongoing costs, capex and opex. Our assessment scope in this report covers only 'non-recurrent – new capability' projects. Acceptance of these projects in the regulatory allowance requires demonstration that they would provide a net economic benefit. Our reference to projects and project economics in the following sections of this report therefore relate solely to these projects within our scope. Our consideration of the economics of these projects necessarily includes consideration of forecast capex and opex, however for its regulatory allowances Endeavour Energy has not sought opex 'step changes' for these projects but has sought to include the proposed capex. Therefore, the implications of our assessment are for capex only.

Endeavour Energy's representation of the economics of the proposed projects

The CBA analyses do not provide a usable assessment of the economics of the proposed projects

196. We find that there are common issues with Endeavour Energy's cost-benefit analyses which we discuss below, and which individually and collectively result in what we consider to be unreliable outputs and inadequate justification of the non-recurrent new-capability capex sought by Endeavour Energy.

197. For each of the issues we identify, we provide examples in our discussion of each Investment Brief in sections 4.5 to 4.8.

Endeavour Energy's representation of NPVs and Benefit Cost Ratios is flawed

198. Endeavour Energy's CBA models include what are described as Net Present Values (NPVs) and Benefit Cost ratios (BCRs). These would normally provide measures of the economic net benefit of a project, based on some form of discounted cashflow analysis, taking account of the time value of money through application of a Weighted Average Cost of Capital (WACC).

199. We find that neither NPVs nor BCRs in the Endeavour Energy's economic models incorporate any concept of discounted cashflow analysis or application of the WACC.

44 Endeavour Energy response to IR#013

- What is described as an NPV in the model is derived in aggregate for the non-recurrent new capability expenditure by subtracting the (undiscounted) sum of 10 years of forecast capex from the sum of 10 years of assumed capex-related benefits.
- What are described as a BCR is the ratio of 10 years of total benefits (being for recurrent and non-recurrent projects) divided by the sum of 10 years of forecast costs (being capex plus opex).
- While a WACC is shown in the model assumptions, it appears not to be used in deriving discounted cashflows but the square of it is used (for reasons that are unclear) in reducing the 'NPV'.
- The model purports to show sensitivity analysis, however this is simply the 'NPVs' that have been multiplied by 1.2 and 0.8.

200. In short, there are no usable metrics in Endeavour Energy's CBA models that would demonstrate the economic value of the projects that it has proposed.

Our approach to considering the economics of the proposed projects

We sought to undertake an indicative 'proxy' analysis of the economics of each proposed project

201. Due to the unreliability of the economic result metrics presented in Endeavour Energy's CBA, and because such results as are presented are only for the bundled set of projects in each of the four Investment Briefs, we sought to unpack the information at a project level in order to be able to gauge some indication as to whether any of the individual projects might provide a positive economic value. We have undertaken this analysis also in order to be able to provide an alternative forecast, and which we present in section 4.10.2.

202. By applying pivot tables to the data that Endeavour Energy presents in its CBA, we were able to extract ten-year cost and benefit streams for each of the non-recurrent – new capability projects. As mentioned above, benefits are not present in the model for all projects, but for projects for which Endeavour Energy had calculated benefits, we were able to create a 'discounted cashflow', and therefore a project-level NPV.

203. For proxy economic assessment purposes, we utilised the (capex and opex) costs in Endeavour Energy's model 'as given', together with Endeavour Energy's assessment of benefits for each project. In our assessment of specific projects, under the headings of each Investment Brief in sections 4.5 to 4.8, we discuss some issues that we find with some such costs and benefits, and within the current section we refer to some common issues that we find with Endeavour Energy's assessment of costs and benefits.

Representation of project costs and benefits in the CBA

Some projects incur cost but are not credited with generating any benefit

204. In the Project Listing worksheet it is possible to identify the non-recurrent - new capability projects within each Investment Brief incurring capex and those that generate quantified benefits. Our expectation is that each non-recurrent-new-capability project should be proposed on the basis that it generates quantified benefits in excess of the proposed expenditure to demonstrate that the project satisfies the AER's guidelines for 'new or expanded ICT capability, functions and services.'

205. However, there are some proposed capex projects which do not generate any benefits and therefore clearly do not satisfy the AER guidelines for such projects.

Some projects incur cost but generate insufficient benefits to cover the costs

206. This is an extension of the previous issue but in this case, there are some projects which are credited with benefits, but (in PV terms) they are not higher than the cost. Again, these projects do not appear to satisfy the AER's guidelines for such projects.

For most projects, no ongoing cost is assumed

207. For most projects, Endeavour Energy has not included ongoing costs over the analysis period beyond the initial (typically one-year) capital cost. This is despite typically assuming benefits over the whole 10-year period.

Attributing benefits at a project level

Simplifying assumption apportioning benefits masks 'true' benefits of each proposed project

208. Endeavour Energy advises that its methodology for calculating and validating the quantitative benefits involved thorough internal consultation and '*extensive research and communication with external stakeholders*'.

209. In the CBA model we find that Endeavour Energy has typically calculated a particular benefit for a cluster of projects as an aggregate amount. It has then apportioned this aggregate amount between the projects in the cluster for which it considers the 'type' of benefit to be relevant. Endeavour Energy describes how it has done this as follows:

> *[*Endeavour Energy has*] 'apportioned the quantitative benefits according to the nature of investment and the proportion of cost of the underlying initiatives between recurrent and non-recurrent benefits. Further sub-categorisation of non-recurrent benefits is distributed between:*
>
> - *Complying with new/altered regulatory obligations/requirements*
> - *New or expanded ICT capability, functions and services.'*[45]

210. Where such projects are interdependent, then this could be a valid approach. However, Endeavour provides no indication of the dependencies between the 'clustered' projects and for the most part it appears that the projects are independent and therefore each would warrant separate assessment of its benefits. There is nothing in Endeavour Energy's calculation to suggest that the aggregate benefit would only occur if it was to undertake all of the projects to which that benefit has been apportioned. And we find that in practice, in almost every case the aggregate benefits are apportioned between projects based on their cost. This masks any valid assessment of benefits for a particular project and therefore undermines the ability to assess the economics of any specific project.

211. This issue makes it challenging for the reviewer and, we suspect, Endeavour Energy itself, to understand which of the multiple projects are likely to add true value if pursued by Endeavour Energy.

The logic for allocations of certain benefits to some projects is not discernible

212. For most projects the reason a particular benefit is included is discernible through a combination of Endeavour Energy's project descriptions, benefits calculation, and our experience.

213. However, in some cases this link is not readily discernible as a logical proposition. We identify examples of this in our assessment of the individual Investment Briefs.

Major sources of benefits are inadequately justified

214. In some of the Investment Briefs there are benefits that are not allocated via the 'proportion of cost' approach. Instead, they are quantified in some other way, but the basis for the quantum of the benefit is not discernible (either in the CBA model nor from the relevant Investment Brief document). Again, we identify these projects in our assessment of relevant Investment Briefs.

[45] Endeavour Energy, ICT Asset Strategy 2024-2029 - Investment Brief 1, p29

Other input assumptions are not adequately justified

215. The Investment Briefs each list cost, benefit and other assumptions (and in most cases the sources of underpinning information). This helps understand the CBA model, but the explanations are not always adequate to justify the assumption.

216. For example, it is not clear why the number of impacted customers from planned and unplanned outages is based on the average of the total of customers impacted by unplanned outages in FY16-FY21 and multiplied by two to estimate unplanned and planned outages.[46] This may be a reasonable assumption, but it is not possible to discern this from the information provided, noting that the benefits accruing across the four Investment Briefs to avoided system failure costs is significant.

Cost assumptions

Costs typically do not extend beyond the next RCP

217. Whilst benefits extend through to the end of the 10-year study period, Endeavour Energy has not allocated any ongoing costs beyond the next RCP. We consider it likely that in reality there will be some ongoing costs, albeit they are likely to be relatively small within the study period.

Counterfactual

Endeavour Energy does not identify a Base Case/Do nothing option

218. Endeavour Energy has not identified the pros and cons of a Base Case, which is typically to ‘do nothing’ or to undertake the minimum incremental expenditure throughout the next RCP. It may be that the costs and benefits presented in the CBA model are all relative to a ‘do nothing’ implicit base case, however if this is the case then it should be stated explicitly. Also, if there are other (perhaps unquantified) implications of not proceeding with a particular project, then this too would be relevant to assessment.

4.5 Assessment of Investment Brief 1

4.5.1 What Endeavour Energy has proposed

Overview of Investment Brief 1: Meeting core customer expectations for a safe, affordable and reliable electricity supply

219. Endeavour Energy proposes to spend $7.4m capex and $4.0m opex over the next RCP on non-recurrent ICT initiatives to improve customer service. The initiatives are designed to respond to four customer-driven priorities established through customer and stakeholder engagement.

220. Endeavour Energy has identified 18 projects (not all of them non-recurrent-new capability) to deliver on the objectives of Investment Brief 1, and which are grouped under five Programs:

- Program 1: Improve customer energy decisions by providing access to real-time information and increased digital accessibility through self-service platform – 8 projects;
- Program 2: Enhance data platform and tools to support customer data and information model and strategy – 4 projects;
- Program 3: Improve corporate platforms to provide common, fit-for-purpose platforms to enable staff to effectively perform their jobs – 2 projects;

[46] Endeavour Energy, ICT Asset Strategy 2024-2029 - Investment Brief 1, p48

- Program 4: Maintain fit-for-purpose solutions to enhance customer and workforce experience – 1 project; and
- Program 6: Improve visibility of technology infrastructure – 3 projects.

221. In Table 4.3 we list the descriptions of the non-recurrent-capability-growth projects attributed to Investment Brief 1.

Table 4.3: Descriptions of projects requiring non-recurrent 'capability growing' capex – Investment Brief 1

Projects	Description
2 Augmented/Virtual Reality Interface	Design and implementation of AR and VR interfaces to customer omnichannel portal
8 End to end cross-platform self-service automation	Development of enterprise workload automation platform to interface to business and IT systems to provide self-service automation capability
9 Customer Experience Platform Enhancements (ongoing)	Enhancement of omnichannel customer portal, including retailer self-service and enhancements to integrations and interfaces
12 Real-time data access for customer portals	Transformation of data to enable real-time integration with customer omnichannel portals for customers to access real-time data (e.g. crisis information, sustainability initiatives, safety issues)
58 Enterprise payment gateway	Development of enterprise payment gateway microservice for consumption by any platform required to process payments using the enterprise integration platform (predominantly for customers and training services with partners)
60 Cash and liquidity risk management	Implementing Visual Risk platform to centrally manage cash and liquidity risk
137 DR, failover, backup and recovery solutions (ongoing)	Enhancement and management of systems and processes to ensure recovery from disruptions and enable resumption of normal business operation
159 Customer Connection Speed & Self Service	Build interactive customer portal to automate/digitise workflows and increase connection speed
161 Cust Fault Response ETA & Insights Unplanned	Enhance fault response through storm impact prediction, fault response prioritisation, AI-based resource modelling and ETA assessments, and outage cause feedback to customers

Source: Endeavour Energy – ICT Investment Brief 1

Endeavour Energy's case for change

222. As the priority theme suggests, the drivers for this Investment Brief all concern feedback from customers and stakeholders gathered from its Customer Panel and other engagements and are summarised in Figure 4.4.

Figure 4.4: Drivers of priority themes for Investment Brief 1

Core customer expectations	Customer expectations for differentiated personalised and timely services, seamless transactions, and accurate information are increasing
Safe and private customer data	Management and security of customer and shared data continues to grow in importance.
Reliable electricity supply	Customers want to be confident they can turn on their lights, use their heating & cooling, stay connected with family & friends, and have the choice to work and learn from home
Affordable electricity supply	Customers expect Endeavour Energy to recognise and respond to the pricing and affordability impacts of its investment plans and service delivery

Source: Extract from Endeavour Energy Investment Brief 1, Figure 2 and pages 8-10

Endeavour Energy's options analysis

Endeavour Energy considered three options

223. Endeavour Energy has considered three options with each option building on the other:

- Option 1: Maintain regulatory requirements for customer data privacy – which addresses two of the four drivers in Figure 4.4: Safe and private customer data; Reliable supply of electricity (vulnerable customers only)
- Option 2: maintaining compliance and providing safe, affordable and reliable supply of electricity – which builds on Option 1 and addresses an additional driver: Affordable electricity supply
- Option 3: Maintaining compliance, providing a safe, affordable and reliable supply and meeting core customer expectations – which builds on Options 1 and 2 by addressing the remaining driver: Core customer expectations.

Measurable benefits are defined for each benefit stream

224. Endeavour Energy provides a qualitative description of the benefits, the means of deriving the benefits and the mapping of the benefits to each option considered. The measures of benefit are shown in the figure below.

Figure 4.5: Endeavour Energy's identified sources of benefits for Investment Brief #1

Source: Extracts from Endeavour Energy Investment Brief 1, Figure 2 and pp12-13

Costs and benefits

225. The tables below show the non-recurrent – new capability projects that Endeavour Energy identifies as contributing to the costs and benefits for Investment Brief 1. Costs are shown in Table 4.4.

Table 4.4: Investment Brief 1, Option 3 - Non-recurrent – capability growth projects – costs ($m, FY24)

Meeting core customer expectation	Total Capex	Total Opex	Total
2 Augmented/Virtual Reality Interface	0.31	0.08	0.38
8 End to end cross-platform self-service automation	0.26	0.38	0.64
9 Customer Experience Platform Enhancements (ongoing)	0.77	0.19	0.97
12 Real-time data access for customer portals	0.88	1.17	2.05
58 Enterprise payment gateway	0	0.94	0.94
60 Cash and liquidity risk management	0	0.96	0.96
137 DR, failover, backup and recovery solutions (ongoing)	0.29	0.03	0.32
159 Customer Connection Speed & Self Service	1.68	0	1.68
161 Cust Fault Response ETA & Insights Unplanned	1.11	0	1.11
Program Overheads and Contingency	2.08	0.24	2.32
Total	**7.37**	**3.98**	**11.36**

Source: Endeavour Energy 01. Investment Brief 1 v1.2 CBA

226. Table 4.5 shows the 10-year sum of benefits that Endeavour Energy has attributed to each non-recurrent new capability project.

Table 4.5: Investment Brief 1, Option 3 - Non-recurrent – capability growth projects - benefits ($m, FY24)

Meeting core customer expectation	Total 10y benefits
2 Augmented/Virtual Reality Interface	0.84
9 Customer Experience Platform Enhancements (ongoing)	2.52
58 Enterprise payment gateway	0.18
60 Cash and liquidity risk management	0.15
137 DR, failover, backup and recovery solutions (ongoing)	0.73
159 Customer Connection Speed & Self Service	5.19
161 Cust Fault Response ETA & Insights Unplanned	2.93
Total Non-Recurrent - New Capability	**12.54**

Source: Endeavour Energy 01. Investment Brief 1 v1.2 CBA

4.5.2 Our assessment of Investment Brief 1 projects

227. From the tables above and drawing on information in the CBA model and the Investment Brief 1 document, we have identified projects which exhibit one of more of the issues we identify in section 4.4.2.

Some projects incur non-recurrent-capability growth-related capex but are not credited with generating any benefit

228. Projects 8 and 12 do not receive a benefit in Endeavour Energy's CBA model.

Some projects incur cost but generate insufficient benefits to cover the costs

229. From our NPV analysis, we conclude that only four of the nine projects identified in Table 4.4 result in a positive NPV.

Simplifying assumption for apportioning benefits masks 'true' benefits

230. By way of example, Project 2 within this Investment Brief is *Augmented/Virtual Reality Interface* which involves the 'design and implementation of AR and VR interfaces to its customer omnichannel portal.' Qualitatively, Endeavour Energy claims that Project 2 will make a contribution to risk mitigation[47] and quantitatively the benefits derive from saving time for (i) 'Agents'[48] and (ii) Customers. The estimated cost of Project 2 is 5% of the total cost of the nine projects that combine to generate the two benefit sources. Endeavour Energy allocates 5% of the total benefit for Agent time saving and for Customer time saving to Project 2. It is not clear to us how the benefits will be derived in practice and it seems to be a speculative investment from the information provided.

The logic for allocation of benefits to some projects is not discernible

231. Most of the benefits from non-recurrent expenditure allocated to projects in this Investment Brief from the sources listed in Figure 4.5 can reasonably be expected to be generated from the projects. For example, it seems reasonable to assume that Project 9 (Customer experience platform enhancements) will contribute to a customer time-savings benefit.

232. However, Project 58 (Enterprise payment gateway[49]) and Project 60 (Cash and liquidity risk management[50]) are each credited with contributing benefits from avoided system (network)

47 Endeavour Energy Investment Brief 1, Table 14

48 Who are not defined

49 Which involves 'development of enterprise payment gateway microservice for consumption by any platform required to process payments using the enterprise integration platform (predominantly for customers and training services with partners)'

50 Which involves 'implementing Visual Risk platform to centrally manage cash and liquidity risk'

failure. The link between these projects and the benefit is not obvious from the information provided.

4.5.3 Findings from our assessment of Investment brief 1 projects

Selection of Option 3 by Endeavour is based on flawed NPV analysis and questionable benefit allocations

233. Endeavour Energy has selected Option 3 as its preferred option because its CBA leads it to conclude that it has the highest NPV of the three options.

234. The flaws we have identified with its CBA lead us to conclude that Endeavour Energy's NPV and BCR are unreliable.

We consider only four of the nine projects can reasonably be assumed to be economically justified

235. Projects 2, 9, 137, 159 and 161 have a positive NPV using Endeavour's derived benefits. For four of these projects, we consider that the project is appropriately linked to the designated benefit source(s) and that there is likely to be a quantifiable benefit. However, for Project 2 there is insufficient information[51] for us to conclude that the project is likely to produce a net benefit.

236. The combined NPV for the projects we assess as likely to generate a positive NPV is $4.97m with a BCR of 2.20. This is a relatively high BCR and provides a measure of confidence that even if costs are somewhat higher or benefits somewhat lower than estimated, a positive NPV is reasonably likely.

4.6 Assessment of Investment Brief 2

4.6.1 What Endeavour Energy has proposed

Overview pf Investment Brief 2: Enabling customers' future energy choices for a sustainable future

237. Endeavour Energy proposes to spend $3.6m capex and $1.5m opex over the next RCP on non-recurrent ICT initiatives to improve customers' energy choices. The initiatives are designed to respond to four customer-driven priorities established through customer and stakeholder engagement.

238. In Table 4.6 we describe each of the relevant non-recurrent projects.

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51 For example there is no scope for the project, no information about whether it is a trial or based on trials/implementation by others – in the absence of supporting information we consider it to be speculative

Table 4.6: Descriptions of projects requiring non-recurrent 'capability growing' capex – Investment Brief #2

Projects	Description
43 IOT data management (behind the meter/customer)	Enhancement of Industrial Internet of Things (IIOT) customer data management to adopt modern predictive and prescriptive asset management capabilities
90 Customer connections transformation (ongoing)	Transformation of customer connections systems to enable smart infrastructure and customer trading platform
148 Operations orchestration, automation and workflows (ongoing)	Streamline execution of routine technology operational tasks through the use of orchestration, automation and workflow tools
150 Application performance testing and testing automation tools	Enhancement of ability to anticipate the impact of new products or services on the data network through performance testing and test automation tools
154 DER customer portal	Development of a customer portal for DER
155 DERMS register	Productionising of a DERMS register linked to the customer portal for Endeavour Energy and customers to view DER

Source: Endeavour Energy – ICT Investment Brief 2

Endeavour Energy's case for change

239. As the priority theme suggests, the drivers for this Investment brief all concern feedback from customers and stakeholders gathered from its Customer Panel and other engagements and are summarised in the figure below.

Figure 4.6: Drivers of priority themes for Investment Brief 2

Customers' future energy choices	Ensure customers, in choosing to access new technologies and services related to their energy usage, are able to maximise the derived value
Future integrated energy system	Endeavour Energy needs to find better ways of delivering and installing new technologies
Sustainable future	Technology capabilities and automation drive innovation to deliver sustainable solutions aligning with expanding customer choices in a renewable energy future
Low carbon energy system	Support customers in achieving sustainability targets by making sure the network can cater for the increasing demand of renewables and DER

Source: Endeavour Energy Investment Brief 2, Figure 2 and pp8-9

Endeavour Energy's options analysis

Endeavour Energy considered three options

240. Endeavour Energy has considered three options with each option building on the other:

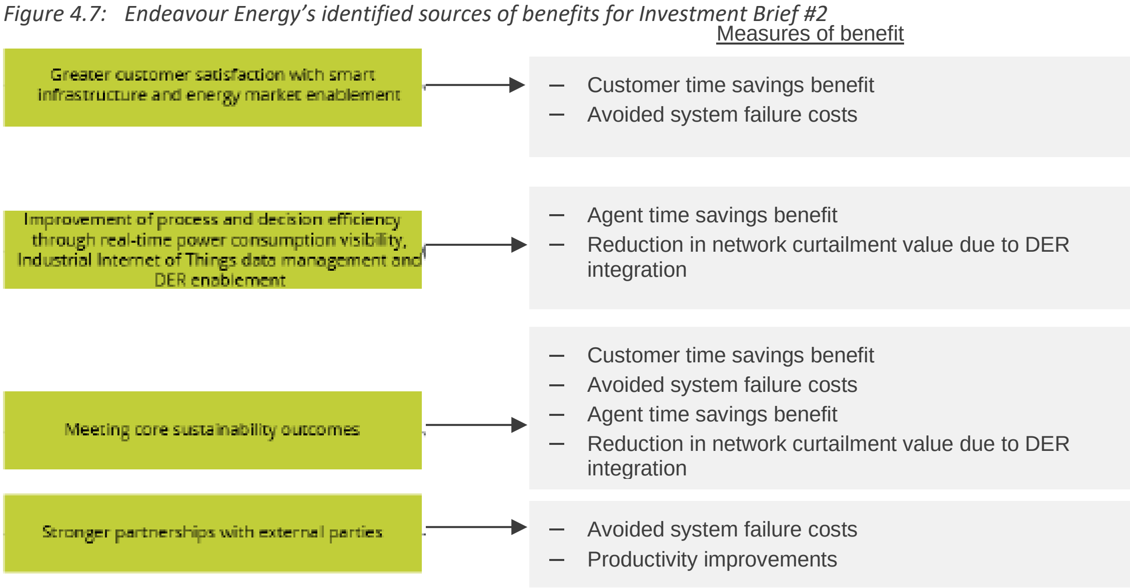
- Option 1: Meeting core sustainable outcomes – focus is to help decision making related to environmental and social outcomes, thereby improving reputation for customers and workplace culture – this option addresses one of the four drivers in Figure 4.6: Sustainable future;

- Option 2: Meeting core sustainable outcomes and customer expectations – it builds on Option 1 by addressing the evolving nature of the network towards low energy carbon options and addresses two additional drivers: Customers' future energy choices and Future integrated energy system; and
- Option 3: Meeting core sustainable outcomes and customer expectations and building capabilities and stronger partnerships – which builds on Options 1 and 2 by addressing the remaining driver: Low carbon energy system.

Measurable benefits are defined for each benefit stream

241. Endeavour Energy provides a qualitative description of the benefits, the means of deriving the benefits and the mapping of the benefits to each option considered. The measures of benefit are shown in Figure 4.7. These drivers are common throughout the industry (to a greater or lesser extent) and it is reasonable for Endeavour Energy to consider cost-effective responses to them.

Figure 4.7: Endeavour Energy's identified sources of benefits for Investment Brief #2



Source: Endeavour Energy Investment Brief 2, Figure 2 and pp10-12

Costs and benefits

242. The tables below show the non-recurrent – new capability projects that Endeavour identifies as contributing to the costs and benefits for Investment Brief 2. Costs are shown in Table 4.7.

Table 4.7: Investment brief 2, Option 3 - Non-recurrent – capability growth projects – capex and opex ($m, FY24)

Enabling customer energy choices	Total Capex	Total Opex	Total
43 IOT data management (behind the meter/customer)	1.00	0.22	1.23
90 Customer connections transformation (ongoing)	0.00	0.33	0.33
148 Operations orchestration, automation and workflows (ongoing)	0.30	0.07	0.37
150 Application performance testing and testing automation tools	0.77	0.51	1.27
154 DER customer portal	0.30	0.07	0.37
155 DER register	0.29	0.07	0.36
Program Overheads and Contingency	0.96	0.17	1.13
Total	**3.61**	**1.46**	**5.06**

Source: Endeavour Energy 01. Investment Brief 2 v1.2 CBA

243. Table 4.8 shows the 10-year sum of benefits that Endeavour Energy has attributed to each non-recurrent new capability project.

Table 4.8: Investment Brief 2, Option 3 - Non-recurrent – capability growth projects - Benefits ($m, FY24)

Enabling customer energy choices	Total 10y benefits
43 IOT data management (behind the meter/customer)	**2.39**
90 Customer connections transformation (ongoing)	**0.52**
148 Operations orchestration, automation and workflows (ongoing)	**0.08**
150 Application performance testing and testing automation tools	**0.24**
154 DER customer portal	**0.98**
155 DER register	**0.97**
Total	**5.19**

Source: Source: Endeavour Energy 01. Investment Brief 2 v1.2 CBA

4.6.2 Our assessment of Investment Brief 2 projects

244. From the tables above and drawing on information in the CBA model and the Investment Brief 2 document, we have identified projects which exhibit one of more of the issues we identify in section 4.4.2.

245. As we refer to in section 3.1.1, some ICT projects are part of Endeavour Energy's proposed DER expenditure. From their titles, projects 154 and 154 are clearly part of the DER-related ICT expenditure and from our review of Endeavour Energy's ICT-related documents, including for Investment Brief 2, it appears that projects 90 is also.[52]

Some projects incur cost but generate insufficient benefits to cover the costs

246. The benefits for Projects 148 and 150 do not generate a positive NPV based on EMCa's analysis.

[52] The capex for these projects does not sum to the $5.0m referred to in Table 3.1 and which comes from Endeavour Energy's DER integration strategy document. However no other non-recurrent capability growth projects that are within the scope of our ICT assessment in this section appear to be DER-related, and therefore that these are the only project expenditure amounts that overlap.

Simplifying assumption apportioning benefits masks 'true' benefits

Project 150 (Application performance testing and testing automation tools) involves '*enhancement of ability to anticipate the impact of new products or services on the data network through performance testing and test automation tools*.' The estimated cost of the option is $1.4m, which is 19% of the total cost of the Investment Brief and therefore it is allocated 19% of each of the benefit streams to which it linked, which over the ten-year study period is, in aggregate, $0.24m. On this basis it does not contribute a net benefit, however the means of benefit apportionment masks the 'true' value, which could be higher or lower.

The logic for allocation of benefits to some projects is not discernible

247. Whilst most of the benefits from non-recurrent expenditure allocated to projects in this Investment Brief from the sources listed in Figure 4.7 can reasonably be expected to be generated from these projects. For example, Project 148 – Operations orchestration, automation and workflows - is likely to contribute to productivity improvement.

248. However, Project 150 (Application performance testing and testing automation tools) is linked to benefits from avoided system (network) failure costs. The link is not obvious from the information provided.

Major sources of benefits are inadequately justified

249. Projects 154 (DER customer portal) and 155 (DER Register) are credited with generating multiple sources of benefits. However, in both cases the benefits start accruing from the first year of the next RCP when the investment is not scheduled to occur until 2029. This is not credible and we therefore consider the NPV to be invalid.

4.6.3 Findings from our assessment of Investment Brief 2 projects

Selection of Option 3 by Endeavour is based on flawed NPV analysis and questionable benefit allocations

250. Endeavour Energy has selected Option 3 as its preferred option because its CBA leads it to conclude that it has the highest NPV of the three options.

251. The flaws we have identified with its CBA lead us to conclude that Endeavour Energy's NPV and BCR are unreliable.

We consider only two of the six projects can reasonably be assumed to be economically justified

252. Projects 43, 90, 154, and 155 have a positive NPV using Endeavour Energy's derived benefits. For two of these projects, we consider that the project is appropriately linked to the designated benefit source(s) and that there is likely to be a quantifiable benefit. However, for Projects 154 and 155 we conclude that they are unlikely to produce a net benefit.

253. The combined NPV for Projects 43 and 90, which we assess as likely to generate a positive NPV is $0.83m with a BCR of 1.53, with the latter providing some margin for unfavourable variances.

4.7 Assessment of Investment Brief 3

4.7.1 What Endeavour Energy has proposed

Overview of Investment Brief 3: Provide a resilient network for the community adapting to changing climate and external hazards

254. Endeavour Energy proposes to spend $25.3m capex and $7.1m opex over the next RCP on non-recurrent ICT initiatives for 'new capability'[53] to develop insights and understanding to improve processes through greater information sharing from implementation of new innovations and data sources.

255. In Table 4.9 we describe each of the relevant non-recurrent projects.

Table 4.9: Descriptions of projects requiring non-recurrent 'capability growing' capex – Investment Brief #3

Projects	Description
15 Enterprise Social Networking tool	Enabling staff to informally connect to their peers through a common Unified Comms platform
22 Connected Vehicles & AI implementation	Implementation of smart cars and trucks to be used for business operations with satellite connectivity and wireless service
31Enhance workforce apps & app modernisation (ongoing)	Enhancement of workforce applications to provide a modern digital experience
44 IOT data management (operational)	Enhancement of Industrial Internet of Things (IIOT) operational data management to adopt modern predictive and prescriptive asset management capabilities
48 Federated records management, enterprise search and secure sharing (ongoing)	Design and governance of practices for integrated and easy to use federated records management systems, enterprise searchable records (current and historical) and secure sharing of documents with internal and external stakeholders to comply with regulations
51 Fleet management system	Uplift of fleet management system to provide automation and support data-driven insights and decision making
56 Migrate to SAP SaaS	Migrating human resource, enterprise resource planning and employee expense management data to SAP SaaS
59 Enterprise GRC (Investment) (ongoing)	Implementing an enterprise GRC solution for risk and compliance across Endeavour Energy
61 Predictive maintenance	Enhancement of asset management system and data platforms to enable predictive maintenance capability
96 Advanced operational efficiency	Maintenance and enhancements to OT systems to improve operational efficiency, including implementation of AI and ML capabilities
158 Data platforms and pipelines to facilitate Asset management analysis at an Asset Level	Asset management of poles & wires, switchgear and underground cables, with asset-specific modelling, risk management and analytics
163 Data platforms and pipelines to facilitate Asset management analysis at an Asset Level	Visualisation and understanding of current state network, simulation of future states and ability to introduce interventions into simulations

Source: Endeavour Energy – ICT Investment Brief 3

Endeavour Energy's case for change

256. The drivers for this Investment brief are summarised in the figure below:

53 The capex figure excludes $16.3m which Endeavour Energy describes as being for 'compliance'

Figure 4.8: Drivers of priority themes for Investment Brief #3

Anticipate	High DER penetration will lead to high network variability with the potential for large peaks and troughs in net demand. This can lead to increased network stress which Endeavour Energy must anticipate and plan for and nudge customer
Withstand	As electricity networks are critical assets, it is important they are secure and resilient against a wide range of threats including cyber security and physical
Respond & Recover	Customers expect a consistent level of service in terms of reliable electricity supply during periods of any disruptions in the face of external threats. The role of renewable electricity in the energy sector is expanding as the costs of delivering new renewable technologies continue to decrease in the long term. This means management of unplanned outages, incident responses and business continuity related to disruptive events will require a dynamic solution
Learn & Adapt	New ways of working can be developed based on insights from previous security threats and disruptive events. To ensure we can successfully capture and properly incorporate these insights into future decisions and planning process, information systems from across the business need to work together seamlessly.

Source: Endeavour Energy Investment Brief 4, Figure 2 and pp9-11

257. These drivers are common throughout the industry (to a greater or lesser extent) and it is reasonable for Endeavour Energy to develop cost-effective responses to them.

Endeavour Energy's options analysis

Endeavour Energy considered three options

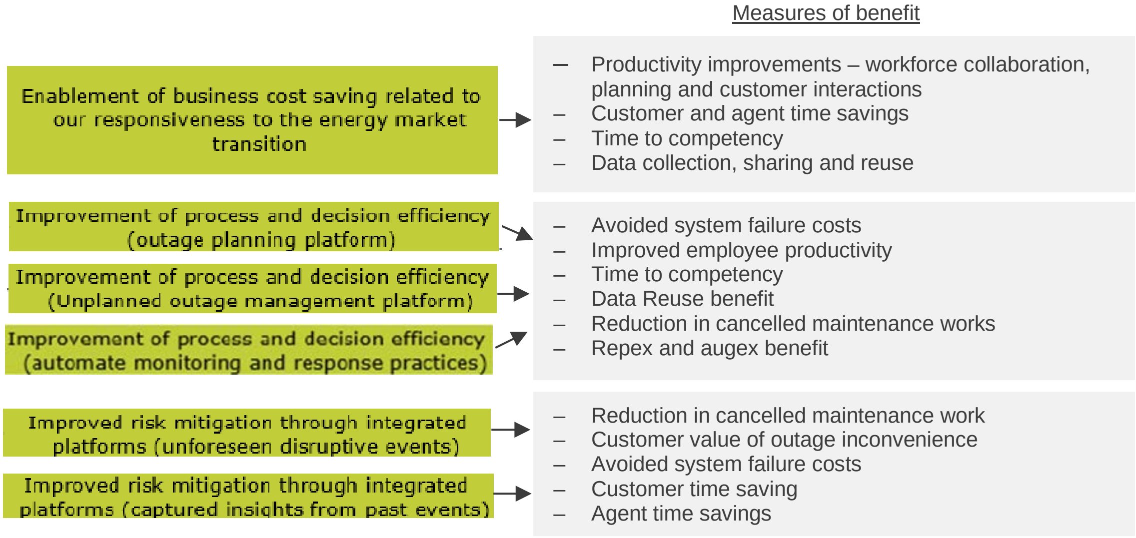
258. Endeavour Energy has considered three options with each option building on the other:

- Option 1: Ensure regulatory changes and improved response to vulnerable customers– this option addresses two of the four drivers in Figure 4.8: Withstand and Response and recover (for vulnerable customers);
- Option 2: Ensure regulatory changes, improved response and recovery to all customers, and improved anticipation of weather events and energy market transition– Option 2 builds upon the drivers that are the focus of Option 1 by addressing the evolving nature of the network in response to changing climate and external hazards. It addresses two additional drivers: Anticipate (real/short term) and Respond and recover (for all customers); and
- Option 3: Ensure regulatory changes, improved anticipation, response and recovery, and improved learning and adaptation capabilities – which builds on Options 1 and 2 by addressing drivers: Learn & adapt and Anticipate (long term).

Measurable benefits are defined for each benefit stream

259. Endeavour Energy provides a qualitative description of the benefits, the means of deriving the benefits and the mapping of the benefits to each option considered. The measures of benefit are shown in the figure below.

Figure 4.9: Endeavour's identified sources of benefits for Investment Brief #3 (non-cyber-security related)



Source: Endeavour Energy Investment Brief 3, Figure 2 and pp12-15

260. The tables below show the costs and benefits for Investment Brief 3 and the major drivers of each. Endeavour Energy has identified 10 non-recurrent-capability-growth capex projects and 10 projects that generate non-recurrent-capability-growth related benefits, noting that Projects 15 and 56 incur zero capex, but are credited by Endeavour with capex benefits.

261. Costs are shown in Table 4.10.

Table 4.10: Investment brief 3, Option 3 - Non-recurrent capex – capability growth projects ($m, FY24)

Providing a resilient network	Total capex	Total opex	Total
15 Enterprise Social Networking tool	0.00	0.43	**0.43**
22 Connected Vehicles & AI implementations	3.35	0.34	**3.69**
31 Enhance workforce apps & app modernisation (ongoing)	0.77	0.19	**0.97**
44 IOT data management (operational)	2.57	0.62	**3.19**
48 Federated records management, enterprise search and secure sharing (ongoing)	0.77	0.19	**0.96**
51 Fleet management system	1.72	0.19	**1.91**
56 Migrate to SAP SaaS	0.00	3.41	**3.41**
59 Enterprise GRC (Investment) (ongoing)	0.25	0.06	**0.31**
61 Predictive maintenances	1.86	0.23	**2.09**
96 Advanced operational efficiency	2.74	0.61	**3.35**
158 Data platforms and pipelines to facilitate Asset management analysis at an Asset Level	0.40	0.00	**0.40**
163 Next Gen Planning System	4.79	0.00	**4.79**
Program Overheads and Contingency	6.09	0.77	**6.87**
Total	**25.32**	**7.05**	**32.37**

Source: Endeavour Energy 01. Investment Brief 3 v1.2 CBA

262. Table 4.11 shows the 10-year sum of benefits that Endeavour Energy has attributed to each non-recurrent new capability project.

Table 4.11: Investment brief 3, Option 3 - Non-recurrent – capability growth project benefits ($m, FY24)

Providing a resilient network	10 years benefits
15 Enterprise Social Networking tool	0.33
31 Enhance workforce apps & app modernisation (ongoing)	1.43
44 IOT data management (operational)	2.73
48 Federated records management, enterprise search and secure sharing (ongoing)	2.95
51 Fleet management system	3.68
56 Migrate to SAP SaaS	4.27
59 Enterprise GRC (Investment) (ongoing)	0.68
96 Advanced operational efficiency	2.87
158 Data platforms and pipelines to facilitate Asset management analysis at an Asset Level	8.25
163 Next Gen Planning System	25.00
Total	**52.21**

Source: Endeavour Energy 01. Investment Brief 3 v1.2 CBA note: Project 15 generates capex benefits but incurs only opex

4.7.2 Our assessment of Investment Brief 3 projects

Some projects incur non-recurrent-capability growth-related capex but are not credited with generating any benefit

263. Projects 22 and 61 are not attributed benefits in Endeavour Energy's CBA model.

264. Also we note that Projects 15 and 56 generate benefits but do not incur non-recurrent capex (they do incur opex).

Some projects incur cost but generate insufficient benefits to cover the costs

265. The benefits for Projects 44 and 96 do not cover the costs, resulting in a negative NPV for each according to our analysis.

Simplifying assumption apportioning benefits masks 'true' benefits

Project 44 (IOT data management (operational)) involves '*enhancement of Industrial Internet of Things (IIOT) operational data management to adopt modern predictive and prescriptive asset management capabilities*.' The estimated non-recurrent cost of the option is $3.48m, which is typically 19% of the total cost of the set of projects generating a particular benefit and therefore it is allocated 19% of each of the benefit streams to which it linked.[54] Over the ten-year study period the aggregate benefit is $2.73m. On this basis Project 44 does not contribute a net benefit, however the means of benefit apportionment masks the 'true' value, which could be higher or lower.

The logic for allocation of benefits to some projects is not discernible

266. Most of the benefits from non-recurrent expenditure allocated to projects in this Investment Brief from the sources listed in Figure 4.9 can reasonably be expected to be generated from these projects.

267. However, Project 48 (Federated records management, enterprise search and secure sharing (ongoing)) which involves '*design and governance of practices for integrated and easy to use federated records management systems, enterprise searchable records (current*

[54] The exception is for Data collection, sharing and reuse for which the cost share is 24%; Project 44 is linked to eight quantified benefit sources

and historical) and secure sharing of documents with internal and external stakeholders to comply with regulations' is linked to benefits from avoided system (network) failure costs. The basis for this is not discernible to us. Nonetheless, there are four other benefits linked to Project 48 which appear to us to be logical.

268. Seven other projects in this Investment Brief are linked to benefits from 'Avoided system failure costs.' As with Project 48, the link for some of these is somewhat tenuous in our view, however, overall this source of benefit is relatively small in this Investment Brief.

Major sources of benefits are inadequately justified

269. Project 163 (Next gen planning) and Project 158 (Data platforms and pipelines to facilitate Asset management analysis at an Asset Level) are allocated hard-coded benefits rather than being allocated benefits based on the typical 'proportion of cost' methodology.

270. Project 163 is assigned an annual benefit of $5.0m (for 5 years) due to a 'repex and augex benefit' but we cannot see adequate justification of this assumption in either the CBA model or in the Investment Brief document.

271. Project 158 is assigned an annual benefit of $1.65m for 5 years due to an 'opex reduction and STIPIS benefit' but we cannot see adequate justification of this assumption in either the CBA model or in the Investment Brief document.

272. Furthermore, (i) Endeavour Energy's modelled benefits for Project 158 are huge compared to the cost, and (ii) the benefit is credited in FY25 which is the same year as the project investment occurs. This is not credible unless perhaps the project was commenced in the current RCP - but there is no information that we can discern to confirm this.

273. Similarly, the benefit for Project 163 is credited in FY25 and FY26 which is when the investment occurs – this is not credible.

274. The benefits from these two sources contribute 64% of the claimed $52.19m total benefit from non-recurrent-capability growth projects comprising this Investment Brief.

4.7.3 Findings from our assessment of Investment Brief 3 projects

Selection of Option 3 by Endeavour is based on flawed NPV analysis and questionable benefit allocations

275. The flaws we have identified with its CBA lead us to conclude that Endeavour Energy's NPV and BCR are unreliable. Furthermore, the other issues we have identified combine to cause significant doubt about the extent to which the benefits can be relied upon in assessing at the project level, whether the proposed capex is likely to be a prudent investment.

We consider that only five of the twelve proposed projects can reasonably be considered to be economically justified

276. We consider only Projects 31, 48, 51, 56, and 59 have both positive NPVs and are without obvious and/or significant flaws in the benefits assigned.

277. The combined NPV for these projects is $3.58m with a BCR of 1.50, with the latter providing some margin for unfavourable variances.

4.8 Assessment of Investment Brief 4

4.8.1 What Endeavour Energy has proposed

Overview of Investment Brief 4: Supporting the sustainable growth of our communities

278. Endeavour Energy proposes to spend $17.7m capex and $3.3m opex over the next RCP on non-recurrent ICT initiatives to (i) promote the safety and wellbeing of workers due to unprecedented growth in population and energy choices in Western Sydney, (ii) promote the

safety and wellbeing of customers and identify and build on current business capabilities, and (iii) deliver a more efficient back-office operation through the use of new ICT technologies.[55]

279. In Table 4.12 we describe the projects from Investment Brief 4 that are relevant to our assessment.

Table 4.12: Descriptions of projects requiring non-recurrent 'capability growing' capex – Investment Brief 4

Projects	Description
14 AR/VR Communication	Development of AR/VR communication capabilities for remote job locations
17 AI-Driven Contact Centre	Enabling AI capabilities for contact centres
28 AI/Robotic response for emergency (e.g. Drones, Automated Vehicles)	Enhancement of workforce mobility platforms to automation and robots in the field (including smart cars, trucks, drones) as part of emergency response capability
40 Smart plant asset management integration	Develop and configure data platforms, integration systems and smart plant asset management systems to support predictive and prescriptive asset management models
62 Contractor lifecycle management (ongoing)	Enhancement of contract lifecycle management platform to enable management of Endeavour Energy contractors
141 Self-service deployment portal	Uplift in infrastructure to support the implementation of technology self-service deployment portal for application delivery and security
156 Physical Network Data Capture	Physical data capture (Lidar and imagery feeds) for digital twin simulations, design and GIS information capture
157 End to End Work Delivery	Planning/scenario model to draft plans, analytics/optimisation for scheduling, link mobile apps to logistics & maintenance forms & data, and performance dashboards

Source: Endeavour Energy – ICT Investment Brief 4

Endeavour Energy's case for change

280. The drivers for this Investment Brief are summarised in the figure below and are linked closely to the expected future growth and change across Greater Sydney (per the Greater Sydney Region Plan, March 2018):

55 Endeavour Energy Investment Brief 4, pages 15-16

Figure 4.10: Drivers of priority themes for Investment Brief #4

Source: Endeavour Energy Investment Brief 4, Figure 2 and page 9

281. These drivers are common throughout the industry (to a greater or lesser extent) and it is reasonable for Endeavour Energy to develop cost-effective responses to them.

Endeavour Energy's options analysis

Endeavour Energy considered three options but does not define a Base Case/Do nothing option

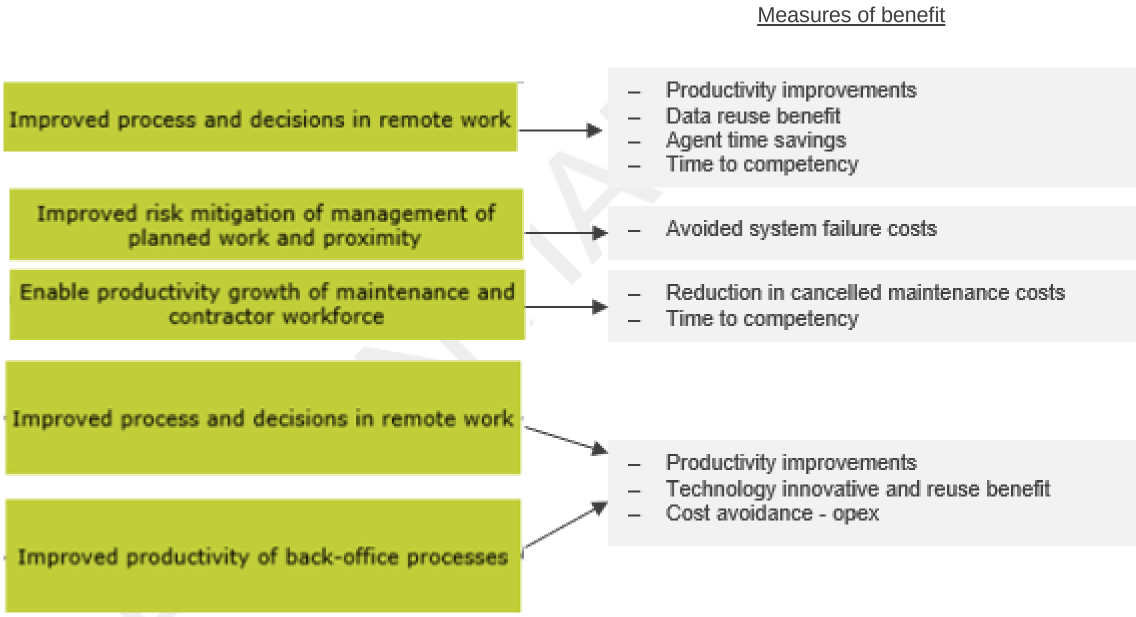
282. Endeavour Energy has considered three options with each option building on the other:

- Option 1: Ensure regulatory changes and improved response to vulnerable customers– this option addresses two of the four drivers in Figure 4.8: Withstand and Response and recover (for vulnerable customers);
- Option 2: Ensure regulatory changes, improved response and recovery to all customers, and improved anticipation of weather events and energy market transition– Option 2 builds upon the drivers that are the focus of Option 1 by addressing the evolving nature of the network in response to changing climate and external hazards. It addresses two additional drivers: Anticipate (real/short term) and Respond and recover (for all customers); and
- Option 3: Ensure regulatory changes, improved anticipation, response and recovery, and improved learning and adaptation capabilities – which builds on Options 1 and 2 by addressing drivers: Learn & adapt and Anticipate (long term).

Measurable benefits are defined for each benefit stream

283. Endeavour Energy provides a qualitative description of the benefits, the means of deriving the benefits and the mapping of the benefits to each option considered. The measures of benefit are shown in the figure below.

Figure 4.11: Endeavour Energy's identified sources of benefits for Investment Brief #4



Source: Endeavour Energy Investment Brief 4, Figure 2 and pages 10-12

284. The tables below show the costs and benefits for Investment Brief 4 and the major drivers of each. Endeavour Energy has identified 8 projects that contribute non-recurrent capex to the Investment Brief and 6 projects that contribute benefits.

285. Costs are shown in Table 4.13.

Table 4.13: Investment Brief 4, Option 3 - Non-recurrent – new capability capex projects – capex ($m, FY24)

Supporting sustaining growth	Capex	Opex	Total
14 AR/VR Communication	2.43	0.92	**3.35**
17 AI-Driven Contact Centre	0.77	0.51	**1.28**
28 AI/Robotic response for emergency (e.g. Drones, Automated Vehicles)	3.64	0.67	**4.32**
40 Smart plant asset management integration	1.23	0.23	**1.46**
62 Contractor management (ongoing)	0.00	0.33	**0.33**
141 Self-service deployment portal	0.42	0.03	**0.45**
156 Physical Network Data Capture	5.04	0.00	**5.04**
157 End to End Work Delivery	0.21	0.00	**0.21**
Program Overheads and Contingency	3.94	0.60	**4.54**
Total	**17.67**	**3.30**	**20.98**

Source: Endeavour Energy 01. Investment Brief 4 v1.2 CBA

286. Table 4.14 shows the 10-year sum of benefits that Endeavour Energy has attributed to each non-recurrent new capability project.

Table 4.14: Investment Brief 4, Option 3 - Non-recurrent – new capability benefits by project ($m, FY24)

Supporting sustaining growth	10 years benefits
14 AR/VR Communication	5.79
17 AI-Driven Contact Centre	1.68
40 Smart plant asset management integration	3.74
62 Contractor management (ongoing)	1.32
141 Self-service deployment portal	0.37
157 End to End Work Delivery	40.00
Total	**52.89**

Source: Endeavour Energy 01. Investment Brief 4 v1.2 CBA

4.8.2 Our assessment of Investment Brief 4 projects

Some projects incur non-recurrent-capability growth-related capex but are not credited with generating any benefit

287. Projects 28 and 156 are not attributed benefits in Endeavour Energy's CBA model.

Some projects incur cost but generate insufficient benefits to cover the costs

288. The benefit for Projects 141 falls well short of matching the cost and Project 17 essentially breaks-even according to our NPV analysis.

Simplifying assumption apportioning benefits masks 'true' benefits

289. Project 17 is linked to an annual savings of $0.21m which is from 'technology innovation and reuse benefit' and 'productivity improvements.' Only $21k-24k p.a. is ascribed to the latter benefit source from Project 17, which is a relatively small amount and which we assume is based on reducing the number of staff in Endeavour Energy's call centre. However, the link to the former benefit stream is not at all clear and at approximately $175k p.a. is the substantive benefit.

Major sources of benefits are inadequately justified

290. The major source of benefit within the 'improvement of process and efficiency' benefit stream is project 157 (End to End Work Delivery) which is attributed $8m p.a. capex benefits. The means of deriving this benefit is not readily apparent from either the Investment Brief or from the CBA model:

- The benefit is hard coded in the CBA model; and
- The Investment Brief states that Project 157 relates to Program 19, which involves *'implementation of data platforms and capabilities to enable predictive and prescriptive modelling and data-driven decision-making.'*[56]

291. Given this comprises the majority of the benefits for the Investment Brief, more explanation for the basis of the assumed benefit is warranted.

4.8.3 Findings from our assessment of Investment Brief 4 projects

Selection of Option 3 by Endeavour is based on flawed NPV analysis and questionable benefit allocations

292. The flaws we have identified with its CBA lead us to conclude that Endeavour Energy's NPV and BCR are unreliable. Furthermore, the other issues we have identified combine to cause

56 Endeavour Energy Investment Brief 4, Appendix 7

significant doubt about the extent to which the benefits can be relied upon in assessing at the project level, whether the proposed capex is likely to be a prudent investment.

We consider that only three of the eight projects that Endeavour Energy has proposed, can reasonably be assumed to be economically justified

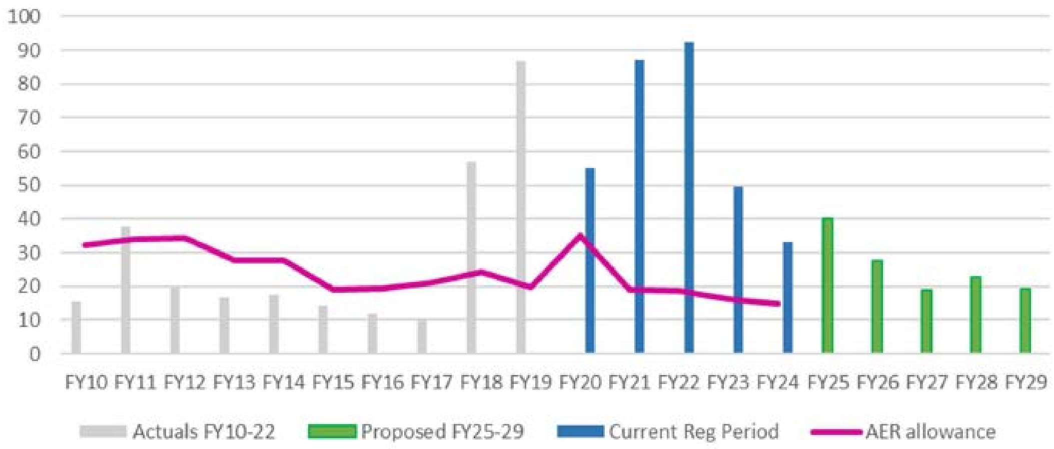
293. We consider only Projects 14, 40, 62 have both positive NPVs and are without obvious and/or significant flaws in the benefits assigned.

294. The combined NPV for these projects is $3.68m with a BCR of 1.74, with the latter providing some margin for unfavourable variances.

4.9 Deliverability risk

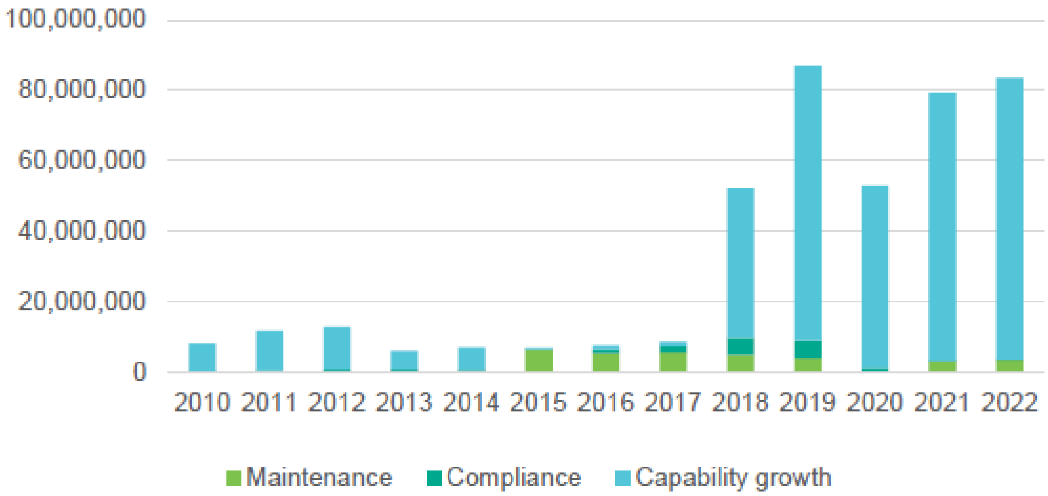
295. For context, Figure 4.12 illustrates the declining trend in total ICT spend over the seven years from FY23. Figure 4.13 shows that the majority of the spend in the period FY18-Fy22 was on non-recurrent capex to provide capability growth.

Figure 4.12: ICT spend FY10-FY29 - $m FY24



Source: Endeavour Energy Att 10.43 ICT Asset Strategy – November 2022- Public, Figure 3

Figure 4.13: Non-recurrent ICT capex- $m FY24



Source: Endeavour Energy on-site presentation, slide 14

Portfolio-level delivery risk is moderate-low

296. Given that Endeavour Energy is on track to deliver non-recurrent projects with a combined value well in excess of its program for the next RCP, we do not have any material concerns about its capacity to deliver the planned 2024-29 non-recurrent (and recurrent) capex.

Initiative-level delivery risk is likely to be moderate-low

297. The four Investment Briefs for the initiatives in the next RCP each include a:

- A delivery roadmap;
- Program governance arrangements; and
- Program resource sourcing strategy.

298. An explicit delivery risk analysis is not provided in the Investment Briefs. Nonetheless, with the information provided we consider that delivery risks at an Investment Brief level are likely to be moderate to low with the controls that are evident.

4.10 Our findings and implications

4.10.1 Summary of our findings

Endeavour Energy has identified a case for action in the next RCP to address a range of drivers

299. Endeavour Energy has identified drivers for its four Investment Briefs which respond to customer and stakeholder expectations regarding quality of service, flexibility and choice, integration of DER, and improving operational efficiency.

300. The drivers are common throughout the industry (to a greater or lesser extent) and it is reasonable for Endeavour Energy to develop cost-effective responses to them.

Endeavour Energy's cost estimation methodology incorporates common industry practices but includes contingency at a Program level

301. For the most part, Endeavour Energy has deployed common industry cost estimation practices to establish forecast expenditure over the next RCP, including applying historical costs, vendor quotes, and 'rules of thumb' (typically for loadings). However, its proposed capex includes a contingency which is shown to be 19%.

Endeavour Energy has identified three options for each of its Investment Briefs but no BAU (Base) cases

302. The ICT Asset Strategy comprises a total of 89 discrete projects, grouped into 21 Strategic Responses across four Investment Briefs. In each Investment Brief, Endeavour Energy defines three options with Options 2 and 3 building on Option 1's scope and intent, however no 'business as usual' case is defined to serve as a counterfactual.

Significant economic analysis flaws combine to undermine the credibility of the NPV results in the four CBA models

303. As the non-recurrent projects within scope are to build capability, a cost benefit analysis is required and Endeavour Energy needs to demonstrate that the proposed projects and the selected options are each economically justified. However, we find that Endeavour Energy's CBA model presents no usable metrics that demonstrate that its proposed projects provide a net economic benefit. Issues include:

- The claimed NPVs and BCRs are not calculated correctly, and in any case are calculated only in aggregate for each Investment Brief and not for each project within an Investment Brief;

- There is inadequate justification of key benefits
  - Three of the largest sources of benefits are hard coded in the CBA model and we cannot discern compelling justification for the quantum;
- The simplifying assumption for apportioning benefits masks 'true' benefits
  - With some exceptions, quantitative benefits are apportioned from aggregate benefit estimates for a cluster of projects, according to their proportion of cost. This distorts the 'true' or expected value of each project, making it challenging for the reviewer and, we suspect, Endeavour Energy itself, to understand which of the multiple projects are likely to add value; and
- The logic for the allocation of certain benefits to some projects is not discernible and neither is it explained.

4.10.2 Implications of our findings for proposed expenditure allowance

Endeavour Energy has not proposed an opex step change

304. Our consideration of the economics of these projects necessarily includes consideration of forecast capex and opex, however for its regulatory allowances Endeavour Energy has not sought opex 'step changes' for these projects but has sought an allowance for the proposed capex. Therefore, the implications of our assessment are for capex only.

We have assessed an alternative ICT non-recurrent capex forecast

305. Our concerns with the justification of benefits and the approach to modelling lead us to conclude that the proposed level of expenditure for the next RCP on ICT non-recurrent capex is not adequately justified and does not meet the requirements of the NER.

306. We have assessed an alternative forecast, which is based on economic analysis and assessment of the information in Endeavour Energy's CBA model and associated descriptive material that Endeavour Energy provided on the projects within the Investment Briefs. In the absence of any usable economic justification from Endeavour Energy, we consider that the alternative capex forecasts in Table 4.15 to Table 4.18 provide a reasonable estimation of an aggregate capex amount that would be able to be justified.

Table 4.15: EMCa Adjustment table for Investment Brief 1 - $m, real 2024

	FY25	FY26	FY27	FY28	FY29	RCP Total
Proposed capex	3.10	1.66	0.46	0.42	1.73	**7.37**
less adjustments	(0.77)	(0.52)	(0.09)	(0.42)	(1.73)	**(3.53)**
Plus allowance for program costs	0.14	0.07	0.02	-	-	**0.22**
Adjusted capex	**2.47**	**1.21**	**0.39**	**-**	**-**	**4.07**

Source: EMCa table derived from Endeavour Investment 1 spreadsheet.

Table 4.16: EMCa Adjustment table for Investment Brief 2 - $m, real 2024

	FY25	FY26	FY27	FY28	FY29	RCP Total
Proposed capex	0.46	2.39	-	-	0.77	**3.61**
less adjustments	(0.46)	(1.38)	-	-	(0.77)	**(2.61)**
Plus allowance for program costs	-	0.06	-	-	-	**0.06**
Adjusted capex	**-**	**1.06**	**-**	**-**	**-**	**1.06**

Source: EMCa table derived from Endeavour Investment 2 spreadsheet.

Table 4.17: EMCa Adjustment table for Investment Brief 3 - $m, real 2024

	FY25	FY26	FY27	FY28	FY29	RCP Total
Proposed capex	4.84	6.25	1.32	8.66	4.25	**25.32**
less adjustments	(3.82)	(3.76)	(1.32)	(8.66)	(4.25)	**(21.81)**
Plus allowance for program costs	0.06	0.14	-	-	-	**0.20**
Adjusted capex	**1.08**	**2.64**	**-**	**-**	**-**	**3.72**

Source: EMCa table derived from Endeavour Investment 3 spreadsheet

Table 4.18: EMCa Adjustment table for Investment Brief 4 - $m, real 2024

	FY25	FY26	FY27	FY28	FY29	RCP Total
Proposed capex	2.31	3.35	2.61	4.77	4.63	**17.67**
less adjustments	(2.31)	(3.35)	(2.61)	(1.11)	(4.63)	**(14.01)**
Plus allowance for program costs	-	-	-	0.21	-	**0.21**
Adjusted capex	**-**	**-**	**-**	**3.87**	**-**	**3.87**

Source: EMCa table derived from Endeavour Investment 4 spreadsheet

307. In aggregate, the alternative capex forecast would provide for an allowance of $12.7m, which is 76% less than Endeavour Energy's proposed amount of $54m (which was shown in Table 4.1).