AEMO SERVICES

Draft 2023 Infrastructure Investment Objectives Report

May 2023

Important notice

PURPOSE

AEMO Services Limited (AEMO Services) publishes this Draft 2023 Infrastructure Investment Objectives Report for the purpose of consulting with market, consumer and other stakeholders. AEMO Services Limited (AEMO Services) publishes the 2023 Infrastructure Investment Objectives Report (IIO Report) pursuant to its functions as Consumer Trustee under section 45(1)(2) of the Electricity Infrastructure Investment Act 2020 (NSW).

DISCLAIMER

The contents of this document are for information purposes only. This document is not intended to provide any advice or imply any recommendation or opinion constituting advice. This document may include inputs and assumptions that are not necessarily current as at the date of publication.

The Draft 2023 Infrastructure Investment Objectives Report reflects a draft for the purposes of consultation. Until such time as it is published in final, the 2022 Infrastructure Investment Objectives Report remains the most recent Infrastructure Investment Objectives Report. In preparing the Final Report, AEMO Services will consider submissions and any further relevant information it is required to consider.

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VERSION CONTROL

Version	Release date	Changes
1.0	16 May 2023	

ACKNOWLEDGMENT OF COUNTRY

AEMO Services acknowledges the Traditional Owners of Country throughout Australia and recognises their continuing connection to land, waters and culture.

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Abbreviations

Term	Meaning
AEMO	Australian Energy Market Operator
CO2-e	Carbon dioxide equivalent
CWO	Central-West Orana
Draft Development Pathway	Updated Development Pathway
Draft 10-Year Plan	Updated 10-Year Plan
EII Regulations	Electricity Infrastructure Investment Regulation 2021 (NSW)
EII Act	Electricity Infrastructure Investment Act 2020 (NSW)
EnergyCo	Energy Corporation of NSW
ESOO	AEMO's Electricity Statement of Opportunities
2022 ESOO	AEMO's 2022 Electricity Statement of Opportunities dated 31 August 2022
EST	Energy Security Target
EST Monitor	Energy Security Target Monitor
2022 ESTM Report	2022 Energy Security Target Monitor Report dated 28 October 2022
Firming Direction	Direction by the Minister under section 47(2) of the EII Act to conduct a competitive tender for LTESAs for firming infrastructure
HCC	Hunter-Central Coast
IASR	Inputs, Assumptions and Scenarios Report
2021 IASR	AEMO's 2021 Inputs, Assumptions and Scenarios Report dated 30 July 2021
IIO Report(s)	Infrastructure Investment Objective Report(s)
2021 IIO Report	2021 Infrastructure Investment Objective Report dated 7 December 2021
2022 IIO Report	2022 Infrastructure Investment Objective Report dated 2 December 2022
2023 IIO Report	2023 Infrastructure Investment Objective Report
ISP	AEMO's Integrated System Plan
2020 ISP	AEMO's 2020 Integrated System Plan dated 30 July 2020
2022 ISP	AEMO's 2022 Integrated System Plan dated 30 June 2022
LDS	Long-duration storage
LTESA(s)	Long-term energy services agreement(s)
Minimum objectives	The minimum infrastructure investment objectives established by section 44(3) of the EII Act
Minister	NSW Minister for Energy

Term	Meaning
NEM	National Electricity Market
NER	National Electricity Rules
NIS	Network Infrastructure Strategy
OECC	NSW Office of Energy and Climate Change
Overall objectives	The overall infrastructure investment objectives established by section 44(2) of the EII Act
QED Q3 2022	AEMO's Quarterly Energy Dynamics Q3 2022
QNI	Queensland to NSW Interconnector
RES Board Plan	Renewable Energy Sector Board Plan
REZ(s)	Renewable Energy Zone(s)
Roadmap	NSW Electricity Infrastructure Roadmap
USE	Unserved energy
VNI	Victoria to NSW interconnector
VRE	Variable renewable energy

Invitation to engage

The Infrastructure Investment Objectives Report (IIO Report) serves dual purposes.

It sets out a least-cost pathway for developing new electricity infrastructure in NSW that meets legislative objectives, so that consumers, communities, and industry can understand and plan for the energy transformation with confidence.

Critically, it also seeks to operationalise this pathway by providing developers and investors with a forward view of opportunities to secure financial support through regular tenders over the next 10 years. It demonstrates that AEMO Services, with our NSW Government partners, is committed to delivering built energy.

This draft report builds on our two previous IIO Reports, calling for consistent investment over the 2020s to meet NSW's minimum targets as quickly as possible. Beyond 2030, it calls for significantly greater investment in new renewable generation infrastructure than previously forecast, in order to minimise costs for NSW electricity customers.

Due to the rapid pace of the energy transition in NSW, the assumptions underpinning the modelling contained within this report are fast becoming outdated. The modelling, for example, does not include the recent announcements of delays in committed projects such as Snowy 2.0, and project developments, such as the first stage of a large-scale battery at the Eraring Power Station. Notwithstanding, we are seeking to engage on the pathway but more importantly our underpinning methodology so that feedback can be incorporated in the final version of this 2023 IIO Report published in December.

As we prepare to update our modelling and publish the final version, we welcome constructive and critical input from our stakeholders. We are hosting public forums during May 2023 and intend to run deep dive sessions in June 2023 based on your feedback regarding topics of interest. I also encourage you to make a written submission.

Details of the consultation process are set out in section 6 of this draft report.

We look forward to your feedback.

Paul Verschuer

Executive General Manager

At a glance

Supporting consistent, strong investment in electricity infrastructure

The IIO Report is issued every two years to set out NSW's 20-year pathway for investment in new electricity infrastructure, alongside a 10-year plan for conducting tenders for long-term energy service agreements (LTESAs) to support that infrastructure.

While the 2022 IIO Report focussed on near-term reliability needs, the Draft 2023 IIO Report leverages updated forecasting assumptions and methodologies to provide a clearer indication of NSW's long-term electricity infrastructure needs.[1]

The draft development pathway in this report seeks to deliver affordable, reliable, secure and sustainable electricity to NSW customers, assuming a scenario that is broadly consistent with AEMO's ISP Step Change scenario.

The draft tender plan provides the market with regular opportunities to secure financial support over the next 10 years. **The tenders are anticipated to support 3,000 GWh of annual generation every six months and up to 1 GW of long-duration storage capacity every year until we hit our 2030 targets.**

- **Generation: The equivalent of 3,000 GWh of annual generation every six months**

  NSW has a legislated minimum target for the construction of renewable generation capable of producing 33,600 GWh of electricity every year by 2030. To achieve this, AEMO Services will conduct biannual tenders with the aim of supporting 3,000 GWh of annual generation each tender, and is agnostic as to the location and mix of that generation. AEMO Services' view is that this scale of investment is needed across all reasonable assumptions for future demand, coal plant retirements and network infrastructure delays.

  From 2030 through to 2043, significantly more renewable generation than forecast in the 2021 and 2022 IIO Reports will be needed to maintain downward pressure on prices for NSW electricity customers. The increased amount of generation infrastructure in the second decade is the result of several factors, including increased electricity demand and earlier NSW coal generator retirements.

- **Long-duration storage: Technology readiness to be tested through annual tenders**

  NSW has a legislated minimum target for the construction of 2 GW of long-duration storage by 2030. This is not likely to be delivered until the late 2020s, later than forecast in the 2022 IIO Report (due to updated assumptions regarding pumped hydro lead times and battery costs).

  However, these assumptions are highly uncertain and AEMO Services will continue to test them through annual tenders from 2023 to 2028. This may reveal that pumped hydro projects will be ready earlier and/or that other technologies are cost competitive.

- **Firming: Only one tender planned at this stage**

  AEMO Services has launched a tender for an indicative minimum of 380 MW of firming infrastructure in Q2 2023.[2] AEMO Services considers that at least this much firming infrastructure capacity along with 2 GW of long-duration storage delivered by 2030, is needed to meet NSW's reliability needs through to 2040. This view is consistent with the 2022 IIO Report and no other tenders are currently expected unless there are major market events, (e.g. delays in critical transmission infrastructure projects or announcements of early coal-fired power station closures).

The proposed tenders for generation and long-duration storage are more regular than planned in the 2022 IIO Report, to provide greater consistency and certainty for the market. However, AEMO Services may recommend more or less LTESAs than the target volumes in response to market developments and/or depending upon information received during tenders about the quality, financial value and lead times of individual projects.

Stakeholders are encouraged to provide feedback on the content of this draft report, to inform the final 2023 IIO Report.

1 The draft 2023 IIO Report is informed by modelling leveraging key inputs and assumptions reflecting information known at a certain point in time. Information from events or publications after the modelling was conducted such as timing updates for Snowy 2.0 and a final investment decision on the first stage of a large-scale battery at the Eraring Power Station have not been directly incorporated. See section 1.2.4 for further detail on modelling limitations.

2 In the long-term financial interest of NSW electricity customers, the Consumer Trustee may expand the indicative tender size for this Tender Round to meet the overall objective under the EII Act if, for example, market or regulatory changes occur. Proponents who are successfully registered will be notified via AEMO Services online platform, should this occur.

Executive Summary

What's changed since the previous IIO Reports?

- **Generation infrastructure:** Until 2030, the Draft Development Pathway for generation infrastructure is largely consistent with the Development Pathway set out in the 2022 IIO Report. After 2030, the updated pathway includes significantly more generation to 2043. This increase is largely driven by updated demand forecasts, generator retirement announcements and later REZ delivery dates, as well as the use of a new market model that optimises differently for capacity expansions and retirement decisions.
- **Long-duration storage infrastructure:** The Draft Development Pathway involves long-duration storage being delivered later in the 2020s than under the Development Pathway in the 2022 IIO Report. This is driven by updated assumptions regarding lead times for pumped hydro projects and the cost of long-duration battery storage.
- **Firming infrastructure:** The Draft Development Pathway for firming infrastructure is consistent with the Development Pathway in the 2022 IIO Report until 2040, when additional firming is forecast to be required to meet reliability needs.
- **Updated 10-Year Plan:** The Draft 10-Year Plan in respect of generation and long-duration storage infrastructure has been updated to set out more regular-sized tenders. The report also provides guidance on when indicative tender sizes may be revised. This is intended to provide greater simplicity and certainty to the market, while better reflecting the indicative nature of the tender sizes.

In recent months, there have been significant developments in the NSW energy market, driven by broader changes in the Australian and global economy. The vulnerability of NSW customers to global commodity prices has been heightened due to a tightening supply-demand balance, with the National Electricity Market (NEM) experiencing high levels of planned and unplanned outages during some periods of 2022.[3] Average wholesale electricity spot prices across the NEM and average east coast gas prices reached their highest recorded levels in Q2 2022.[4] The result is a period of increased electricity prices for NSW electricity customers.

The NSW Electricity Infrastructure Roadmap and the underpinning *Electricity Infrastructure Investment Act 2020* (EII Act) provide a mechanism to deliver new infrastructure by incentivising private investment in a new wave of assets at unprecedented scale to improve reliability and affordability, and to meet our future electricity needs.

As the Consumer Trustee appointed under the EII Act, AEMO Services is required to prepare an Infrastructure Investment Objectives Report (IIO Report) every two years.[5] The IIO Report sets out a plan for investment in energy infrastructure to mitigate the impact of these and future developments in the electricity market.

Each IIO Report must contain:

- A **Development Pathway** for the construction of infrastructure necessary to meet the infrastructure investment objectives over the following 20 years, and
- A **10-Year Plan** for competitive tenders that AEMO Services will conduct to give effect to the development pathway.

The 2023 IIO Report is due in December 2023. This document is a draft report produced for the purpose of consulting with market, consumer and other stakeholders, as discussed in section 6. It contains draft versions of an updated Development Pathway (Draft Development Pathway) and 10-Year Plan (Draft 10-Year Plan).

3 See AEMO (July 2022), Quarterly Energy Dynamics Q2 2022, page 13. Available at:https://aemo.com.au/energy-systems/major-publications/quarterly-energy-dynamics-qed.

4 See QED Q3 2022, page 3.

5 AEMO Services must also prepare an IIO Report as soon as practicable after being directed by the NSW Minister for Energy (Minister) under section 47(2) of the EII Act to conduct a tender for LTESAs in respect of firming infrastructure. The 2022 IIO Report was prepared and published in response to such a direction.

This Draft 2023 IIO Report has been developed having regard to modelling completed by AEMO, with inputs from the Energy Corporation of NSW (EnergyCo), to co-optimise investment in generation, long-duration storage, firming and network infrastructure. It contributes to the final Network Infrastructure Strategy (NIS) to be published by EnergyCo.

The modelling undertaken for this draft report leverages updated demand assumptions and enhanced optimisation functionality to provide a clearer indication as to the likely infrastructure requirements required beyond 2030 to minimise costs for NSW electricity customers. The Development Pathway in the 2021 and 2022 IIO Reports was focused on ensuring sufficient electricity supply is available in the short- to medium-term ahead of coal withdrawal, with a particular focus on achieving the minimum infrastructure investment objectives by 2030. In those reports, the second decade of the Development Pathway was subject to greater uncertainty, with electrification and hydrogen development trends still taking shape.

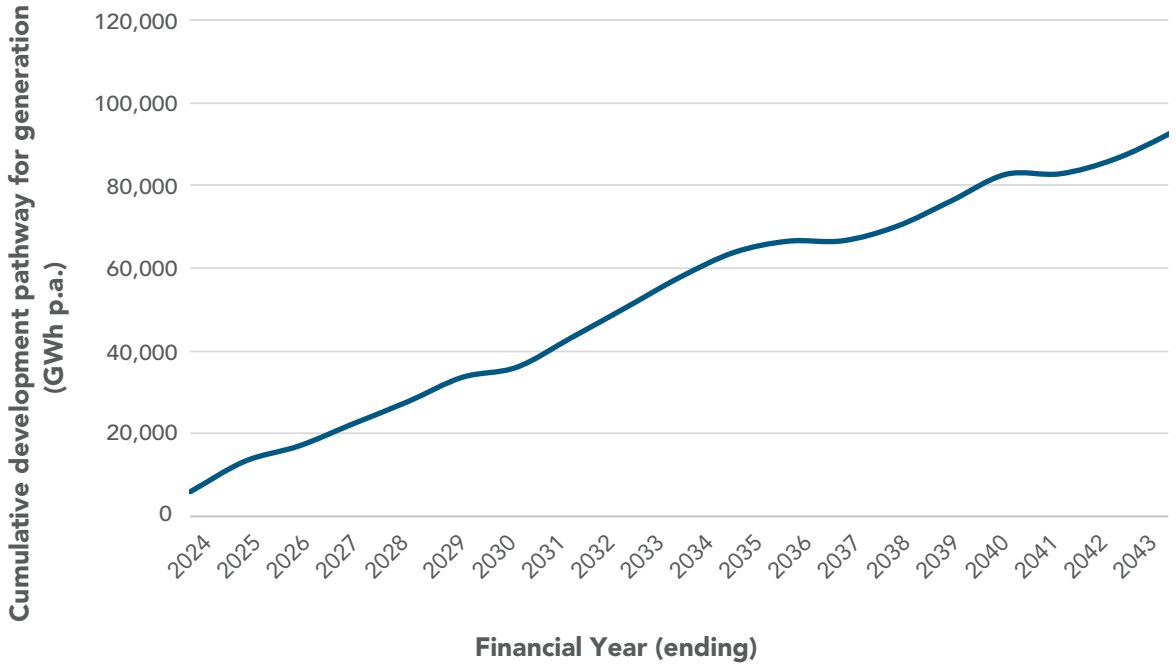
Draft Development Pathway and 10 Year Plans

Generation

The generation element of the Draft Development Pathway is set out in Figure 1, which shows the cumulative annual output of generation infrastructure over the period 2024 to 2043.[6]

The Draft Development Pathway is technology and location neutral.

Figure 1: Draft Development Pathway (Generation)



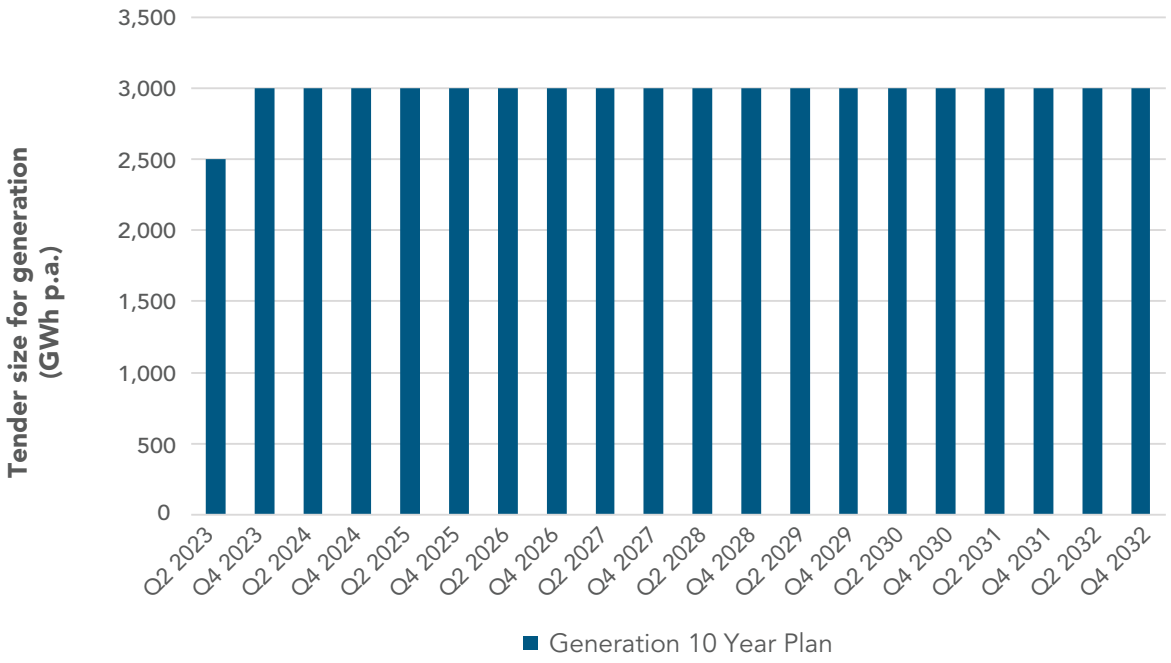
The Draft Development Pathway seeks to provide for a managed build of electricity infrastructure to mitigate uneven investment and high-priced periods that can be expected to characterise normal market operation under current regulatory settings.

Under the Draft Development Pathway, the minimum objective for the construction of generation infrastructure capable of producing 33,600 GWh of electricity per year is achieved by 2030. The Draft Development Pathway then shows a steady build of generation infrastructure continuing beyond 2030 for the purpose of minimising electricity costs to NSW customers. It avoids periods without any investment, which is intended to support the sustainable development of relevant supply chains.

AEMO Services intends to conduct six monthly tenders over the next ten years in accordance with the generation element of the Draft 10-Year Plan set out in Figure 2.

6 In this report, references to years in relation to the Draft Development Pathway, network infrastructure timing or other modelling results are to financial years (ending) – for example, 2024 under the Draft Development Pathway means the year starting July 2023 and ending June 2024.

Figure 2: Draft 10-Year Plan (Generation)

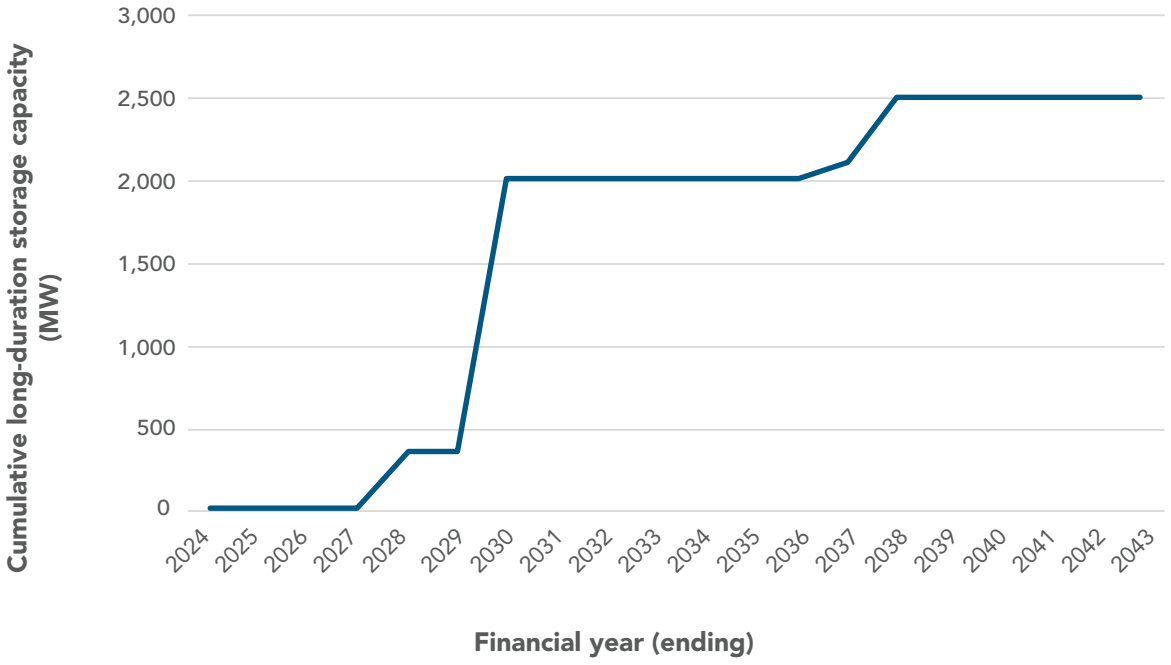


As with all Consumer Trustee tenders, the target volumes should be interpreted as indicative only. AEMO Services may recommend more or less than the indicative size depending on its assessment of projects during tenders. AEMO Services may also adjust the tender sizes to respond to changes that occur prior to the publication of the next IIO Report where an alternative development pathway and corresponding tender plan is considered more in the long-term financial interests of NSW electricity customers.

Long-duration storage

The long-duration storage element of the Draft Development Pathway is set out in Figure 3, which shows the cumulative capacity installed over the period 2024 to 2043.

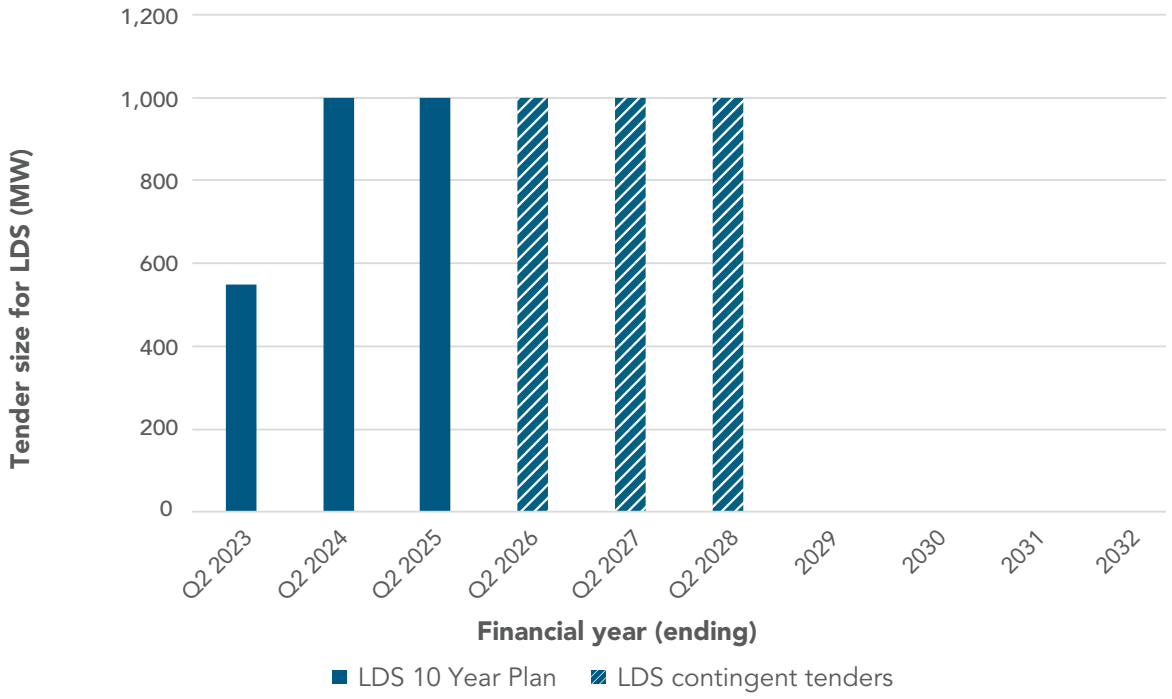
Figure 3: Draft Development Pathway (Long-duration storage)



The Draft Development Pathway suggests it is in the interest of NSW consumers to target construction of the minimum objective of 2 GW of long-duration storage in the late 2020s. Due to the estimated lead times for pumped hydro projects in NSW, the Draft Development Pathway does not see long-duration storage commissioned until mid-2027. Other long-duration storage technologies are likely to be deliverable before this time, but are unlikely to be cost competitive under current (highly uncertain) modelling assumptions. AEMO Services intends to test these modelling outcomes via its competitive tender process, which may reveal that pumped hydro can be delivered earlier and/or that other technologies are cost-competitive.

AEMO Services intends to conduct annual tenders for long-duration storage from Q2 2023 as set out in the Draft 10-Year Plan for LDS in Figure 4.

Figure 4: Draft 10-Year Plan (Long-duration storage)

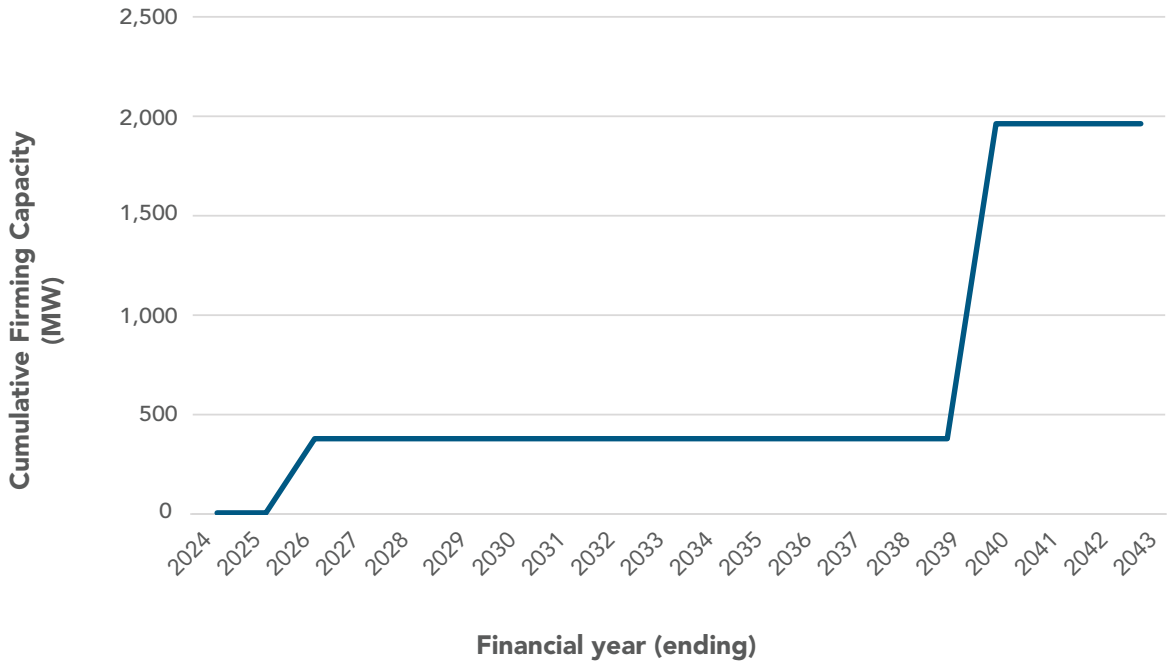


In the Q2 2023, 2024 and 2025 tenders of the plan (shown in solid blue in Figure 4) AEMO Services will seek to recommend projects up to the 2 GW target. However, should projects not be of sufficient quality and/or financial value in these tenders, then AEMO Services will proceed to the contingent tenders set out in Figure 4 until such time as the 2 GW target is met.

Firming

The firming element of the Draft Development Pathway is set out in Figure 5, which shows the cumulative annual capacity installed over the period 2024 to 2043.

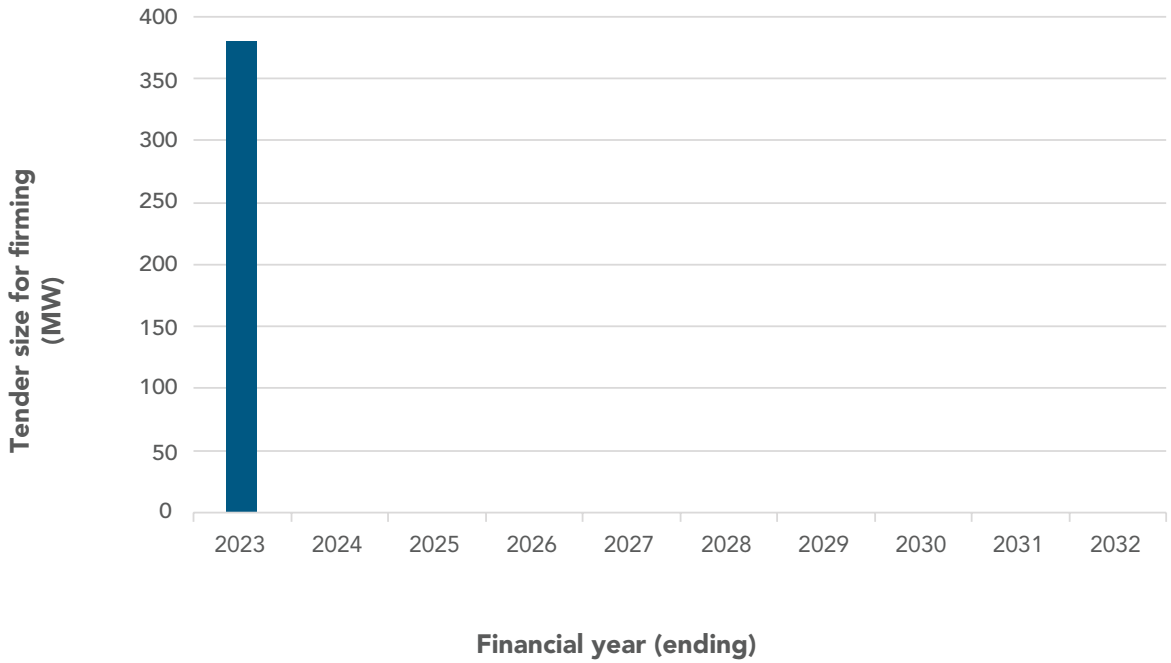
Figure 5: Draft Development Pathway (Firming)



The Draft Development Pathway includes 380 MW of firming infrastructure in the Sydney-Newcastle-Wollongong sub-region (or in close proximity to this sub-region, provided it can demonstrate its contribution to meeting the energy security target), commissioned prior to December 2025. AEMO Services expects that at least this amount of firming infrastructure will be required to meet reliability needs in the summer after the planned retirement of the coal-fired Eraring Power Station. This has not changed since AEMO Services' 2022 IIO Report. Beyond this, further firming infrastructure is forecast to be required to meet reliability needs in 2040.

The Draft 10-Year Plan for firming includes only the currently announced tender for Q2 2023 per Figure 6.

Figure 6: Draft 10-Year Plan (Firming)



Costs for the supply of wholesale electricity services

The modelling undertaken for this IIO Report has identified that the implementation of the Draft Development Pathway and underpinning network projects will result in a total cost for the supply of wholesale energy services to NSW electricity customers of $78.0 billion over 20 years, including $1.8 billion in costs for LTESA liabilities, $3.6 billion in transmission infrastructure (representing annualised capital costs, only reported for a 20 year period) [7,8] and $72.6 billion in wholesale electricity costs.

These costs need to be compared to the costs that would have otherwise been borne by customers in the absence of the NSW Electricity Infrastructure Roadmap (also referred to as the "no roadmap modelling"). The NSW Office of Energy and Climate Change (OECC) is currently in the process of updating the modelling of these costs. Draft results of this modelling indicate that the delivery of the Draft Development Pathway and underpinning network infrastructure is forecast to save NSW consumers approximately $10.6 billion (net present value) over 20 years. The OECC's modelling is intended to be finalised with the final 2023 IIO Report (due in December 2023).

Next steps

AEMO Services welcomes and encourages written submissions from all stakeholders on the Draft 2023 IIO Report, as well as participation in our public forums and deep dive sessions.

AEMO Services has planned a consultation process to ensure stakeholders understand and have the opportunity to provide feedback on the content of, and process for preparing, the 2023 IIO Report.

Public and targeted stakeholder engagements are planned for the consultation process, to ensure all stakeholders are presented an opportunity to participate in the consultation process. Table 1 below details public consultation events. If you are interested in attending, please register for events through the AEMO Services website.

Written submissions should be sent to iioreport@aemoservices.com.au, by 30 June 2023. Guidance on the content of those submissions is given in section 6.2.

Table 1: Public consultation events

Date	Event	Purpose
18 May 2023	Public webinar 1 – Draft IIO Report overview	Discuss and highlight key points in Draft 2023 IIO Report. Introduce key topics for feedback and consideration.
29 May 2023	Public Webinar 2 – Draft IIO Report overview (repeated)	Second briefing for those unavailable to attend the first.
w/c 5 June 2023	Deep dive sessions	Consultation around feedback topics for stakeholders to share views and opinions.

7 The estimated total capital costs for REZ network infrastructure projects and priority transmission infrastructure projects that were used to calculate this figure is set out in section 3.6. This is based on estimates provided by EnergyCo in July/August 2022.

8 The full costs associated with these projects will be recovered over their economic lifetimes (generally 50 years).

1. Introduction

1.1 Background

The Infrastructure Investment Objectives Report (IIO Report) is a foundational document for energy system planning in NSW. This section sets out how the IIO Report fits within the NSW Government's Electricity Infrastructure Roadmap (Roadmap) and the broader energy market context.

1.1.1 Roadmap and Consumer Trustee

The legislation enabling the delivery of the Roadmap was passed by the NSW Parliament in November 2020 through the Electricity Infrastructure Investment Act 2020 (EII Act). The Roadmap is the NSW Government's plan to support investment in the new generation, storage and network infrastructure required to ensure affordable, reliable, and sustainable electricity supply as coal-fired power stations retire.

The EII Act establishes the role of the Consumer Trustee. This is an independent statutory role with various planning, advisory and procurement functions to enable the delivery of energy investment in the long-term financial interests of NSW electricity customers.

The Consumer Trustee's key functions are set out in the EII Act and include:

- Planning for the construction of electricity infrastructure through the production of infrastructure investment objectives reports (IIO Reports),
- Conducting competitive tenders for built energy, including long-term energy services agreements (LTESAs) and access rights, and
- Authorising the carrying out of network infrastructure in NSW Renewable Energy Zones (REZs).

As the Consumer Trustee, AEMO Services plays a key role in the broader Roadmap, working closely with other entities, including the Energy Corporation of NSW (EnergyCo), to support firmed renewables and network infrastructure to deliver energy in a socially responsible way as early as possible.

1.1.2 Infrastructure Investment Objective Reports

As the Consumer Trustee, AEMO Services prepares an Infrastructure Investment Objective Report (IIO Report) every two years.[9]

These reports must contain:

- A **Development Pathway** for the construction of infrastructure necessary to meet the infrastructure investment objectives over the following 20 years, and
- A **10-Year Plan** for competitive tenders that AEMO Services will conduct to give effect to the development pathway.

Regulations made under the EII Act set out additional items that the report must contain or matters that AEMO Services must have regard to in preparing the report.[10]

The IIO Reports provide the basis for AEMO Services to conduct competitive tenders. The Consumer Trustee will take into account any new information of which it becomes aware after publication of the most recent IIO Report in conducting competitive tenders. When this occurs, AEMO Services will make its best endeavours to communicate publicly and transparently with all stakeholders.

The final 2023 IIO Report is due in December 2023. This report is a draft report produced for the purpose of consulting with market, consumer and other stakeholders, as discussed in section 6. It contains draft versions of an updated Development Pathway (Draft Development Pathway) and 10-Year Plan (Draft 10-Year Plan).

9 AEMO Services must also prepare an IIO Report as soon as practicable after being directed by the NSW Minister for Energy (Minister) under section 47(2) of the EII Act to conduct a tender for LTESAs in respect of firming infrastructure. The 2022 IIO Report was prepared and published in response to such a direction.

10 *Electricity Infrastructure Investment Regulation 2021* (EII Regulation), clauses 24 and 25.

1.1.3 Previous IIO Reports

In December 2021, AEMO Services (acting as the Consumer Trustee) published its inaugural IIO Report (2021 IIO Report).

The 2021 IIO Report set out a 20-year Development Pathway for renewable generation and long-duration storage infrastructure that sought to minimise costs for NSW electricity customers and maintain reliable supply by meeting the energy security target and reliability standard.[11] That pathway focused on ensuring sufficient electricity supply is available ahead of coal withdrawal, with a particular focus on achieving the minimum infrastructure investment objectives by 2030. The second decade was subject to a greater degree of uncertainty, particularly as electrification and hydrogen development trends take shape.

In December 2022, AEMO Services published its second IIO Report (2022 IIO Report) following a firming direction from the NSW Minister for Energy to conduct a competitive tender for LTESAs to support firming infrastructure. That direction arose from the announcement of the Eraring Power Station's expected retirement earlier than previously scheduled. The 2022 IIO Report added firming infrastructure to the Development Pathway in the 2021 IIO Report to address a forecast breach of the energy security target due to this closure. It otherwise largely maintained the Development Pathway and 10-Year Plan for generation and long-duration storage from the 2021 IIO Report.

Previous IIO Reports are available on AEMO Services' website.

1.2 Context for 2023 Infrastructure Investment Objective Report

1.2.1 Market developments

There have been significant developments in the NSW energy market since the 2021 IIO Report, these have been driven by broader changes in the Australian and global economy.

As noted in AEMO's Quarterly Energy Dynamics Q3 2022 (QED Q3 2022):[12]

> International energy commodity prices remain at record high levels, influenced by the ongoing war in Ukraine and associated falls in energy exports (coal, gas and oil) from Russia due to imposed sanctions and gas pipeline supply issues. As Northern Hemisphere countries look to build energy stockpiles before winter, they have been forced to seek energy security elsewhere, pushing up prices for liquefied natural gas (LNG) and thermal coal. Adding to this, historically wet weather across eastern Australia has also caused flooding and impacted the rail-bound supply of export-grade black coal.

The vulnerability of NSW customers to commodity prices is heightened due to a tightening supply-demand balance, with the National Electricity Market (NEM) experiencing high levels of planned and unplanned outages during some periods of 2022.[13]

Average wholesale electricity spot prices across the NEM and average east coast gas prices reached their highest recorded levels in Q2 2022.[14]

The result of these developments is a period of increased electricity prices for NSW electricity customers.

The Roadmap provides a mechanism to deliver new infrastructure to mitigate the impact of these developments.

11 See EII Act, section 44(2).

12 AEMO (October 2022), Quarterly Energy Dynamics Q3 2022, page 3. Available at: https://aemo.com.au/energy-systems/major-publications/quarterly-energy-dynamics-qed.

13 See AEMO (July 2022), Quarterly Energy Dynamics Q2 2022, page 13. Available at: https://aemo.com.au/energy-systems/major-publications/quarterly-energy-dynamics-qed.

14 See QED Q3 2022, page 3.

1.2.2 Relationship to Integrated System Plan

This report has been informed by AEMO's 2021 Inputs, Assumptions and Scenarios Report (IASR),[15] with it being the most recent information available from AEMO at the time modelling was commenced.

Information in relation to various matters, including capital costs, fossil fuel costs and network infrastructure, was also updated for this report.[16] The modelling methodology and input assumptions underpinning this report are detailed in section 5.

Similarly, the IIO Report is an input into AEMO's ISP process, in the same way any state or territory policy that meets certain National Electricity Rules (NER) criteria is an input to the ISP.

Both reports serve critical, and distinct, purposes. The purpose of the IIO Report is to set out a plan for the development of generation, long-duration storage and firming infrastructure in NSW that meets the EII Act objectives, with a focus on maximising value to NSW electricity customers. The IIO Report also seeks to operationalise this plan by setting a schedule of tenders for LTESAs to support these projects. In contrast, AEMO's ISP is a NEM-wide plan that is produced under the NER. The ISP finds alignment between jurisdictional plans and seeks to minimise costs across the energy system as a whole.

1.2.3 Relationship to Network Infrastructure Strategy

IIO Reports include a Development Pathway and 10-Year Plan for the delivery of generation, long-duration storage and, if directed by the NSW Energy Minister, firming infrastructure. The IIO Report is also required to contain:

- information about REZ network infrastructure projects that may be required, and
- details of current, planned and expected infrastructure for the supply of electricity in NSW and the NEM.

In its 2022 ISP, AEMO identified that investment in essential transmission infrastructure (in addition to renewable energy generation and storage) remains the best strategy to deliver affordable and reliable energy.[17]

Consistent with this approach, this report considers the optimal size and timing of network infrastructure that may be required to facilitate or otherwise affects the Draft Development Pathway. This has involved optimising the build of NSW REZ network infrastructure with generation, long-duration storage and firming infrastructure. This approach differs from the 2021 IIO Report, which relied on static input assumptions regarding network infrastructure. The co-optimisation of the delivery of NSW REZ network infrastructure with the build of generation, storage and firming infrastructure enables AEMO Services to determine a Development Pathway that improves cost outcomes for NSW customers. This co-optimisation exercise has been enabled by new information from EnergyCo regarding options for NSW REZ network infrastructure and downstream augmentations, provided in July / August 2023.[18]

In addition to using this co-optimisation to inform the preparation of the Draft Development Pathway, AEMO Services provided advice to EnergyCo on the modelled optimal combination and sequence of network infrastructure projects under different conditions for EnergyCo's consideration in developing the NIS.[19]

The NIS is intended to be a 20-year strategy for the coordinated development of network infrastructure to deliver at least five Renewable Energy Zones and other critical energy infrastructure needed to meet the Development Pathway in the IIO Report and broader objectives of the EII Act. It sets out a proposed sequence of REZ network and priority transmission infrastructure projects, having regard to the co-optimised modelling undertaken by AEMO Services as well as other factors such as providing flexibility and minimising host community impacts.

15 AEMO (July 2021), *2021 Inputs, Assumptions and Scenarios Report*. Available at https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios.

16 Key diversions from the 2021 IASR assumptions are summarised in Table 7.

17 AEMO (June 2022), 2022 Integrated System Plan, page 17. Available at https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp

18 These inputs were not available to inform the modelling for the 2021 and 2022 IIO Reports.

19 This advice was requested and provided under clause 18(1) of the EII Regulations.

The NIS is expected to serve as a consideration for EnergyCo (in its capacity as Infrastructure Planner under the EII Act) when assessing and making recommendations to AEMO Services about REZ network infrastructure projects [20] (and to the NSW Energy Minister about priority transmission infrastructure projects[21]). In addition, AEMO Services intends to consider the NIS as a key input to its IIO Reports moving forward to continue to co-optimise generation, storage, and network infrastructure. This includes where the NIS investigates opportunities and trends in the NSW energy system such as offshore wind and green hydrogen, that may inform AEMO Services' planning in the IIO Report.

Together, the IIO Report and the NIS are intended to provide guidance, increase confidence and provide a level of certainty for investors, broader industry, consumers and communities about the coordinated development and delivery pathway for generation, storage and network infrastructure in NSW under the Roadmap.

The NIS will be available at the EnergyCo website.

Together, the IIO Report and NIS enable the coordinated development of network, generation, and storage in the long-term interests of NSW consumers and communities.

IIO Report

Provides a 20-year Development Pathway for generation, long-duration storage and firming in NSW, including to meet the minimum infrastructure investment objectives as legislated in the EII Act.

Provides a 10-year tender plan for generation, long duration storage and firming to give effect to the Development Pathway.

Considers the NIS as a key input to help co-optimise the development of generation, storage, and network infrastructure.

Provides a forecast of wholesale electricity costs and costs for NSW electricity customers that are due to contributions required to be paid by distribution network service providers under the EII Act.

Network Infrastructure Strategy

Provides a 20-year strategy for the coordinated development of network infrastructure to deliver at least five REZs and other critical energy infrastructure needed to meet the Development Pathway and broader objectives of the EII Act. The strategy consists of a proposed development sequence of REZ and Priority Transmission Infrastructure Projects (PTIP) proiects embedded in the broader context of ISP proiects.

Provides network development options for consideration in the IIO Report to help co-optimise the development of generation, storage and network infrastructure.

Identifies potential network infrastructure options for recommendation to the Consumer Trustee and/or Minister.

Investigates the extent of NSW's energy resources and opportunities to inform the IIO Report, joint network planning, industry, communities, and potential government policies.

Both documents:

- provide guidance, increase confidence and provide for a level of certainty for investors, broader industry, consumers and communities about the coordinated development and delivery pathway for generation. storage and network infrastructure in NSW under the Roadmap.
- facilitate meaningful engagement with all key stakeholders (industry, consumers and communities) on all elements of the pathway.

20 EII Act, sections 30 and 31.

21 EII Regulation, clause 43(1)(b).

1.2.4 Limitations

The draft 2023 IIO Report is informed by modelling leveraging key inputs and assumptions from AEMO's 2021 IASR and key assumptions for NSW REZ network infrastructure options from EnergyCo. These inputs reflect information known at a certain point in time.

Information from events or publications after the modelling was conducted has not been directly incorporated. This includes information from or regarding:

- AEMO's Draft 2023 IASR, published in December 2022;
- consideration of government announcements of coal and gas price caps;
- announcements of early generator closure dates after October 2022;
- announcements on delayed project timings and additional investment commitments from August 2022;
- ongoing EnergyCo tender process for the CWO REZ network infrastructure;
- the AEMO Services tender process for generation and long-duration storage LTESAs; and
- declaration of the Illawarra REZ by the NSW Minister for Energy on 27 February 2023.

These matters will be considered in the final 2023 IIO Report.

As with any modelling exercise, the modelling undertaken for this report has a range of inherent uncertainties. It is used as a tool to identify a development pathway which is considered most likely to minimise costs to NSW electricity customers, based on a simplified view of the commercial and technical factors that drive investment decision-making. AEMO Services recognises that market actors may make different decisions or have access to more accurate and specific information. Accordingly, AEMO Services intends to consider information received from the market via LTESA tenders, when updating future development pathways and 10-year tender plans.

2. Infrastructure Investment Objectives

2.1 Overview

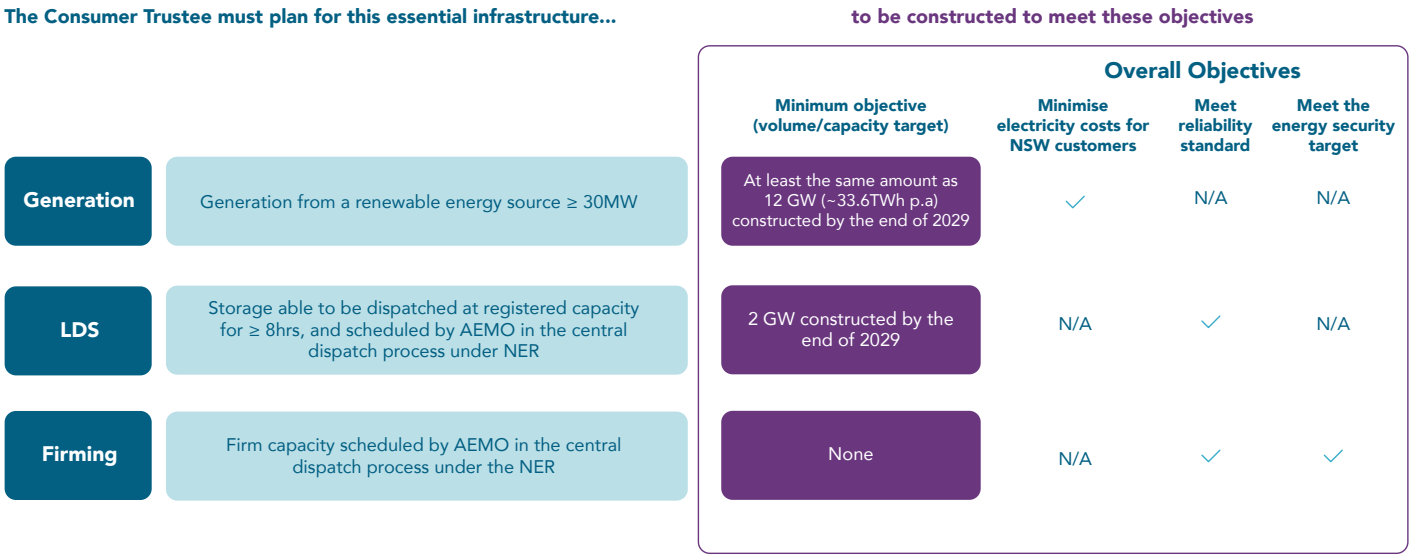
This section explains the infrastructure investment objectives, which the Development Pathway in the IIO Report must plan to meet.

The EII Act establishes the infrastructure investment objectives to be considered by this report.[22] The objectives are set out in Figure 7 and include both:

- minimum objectives for the construction of specified amounts of generation and long-duration storage infrastructure by the end of 2029, and
- overall objectives to construct additional generation, long-duration storage, and firming infrastructure to minimise costs to NSW electricity customers and meet the NSW energy security target and reliability standard. These apply across the full 20-year period of the IIO Report, beyond 31 December 2029.[23]

The Draft Development Pathway sets out how infrastructure could be constructed over 20 years to achieve both the minimum and overall objectives.

Figure 7: Infrastructure investment objectives and eligible infrastructure



Projects only count towards the achievement of the objectives if they were identified as committed or existing in a generation information page published by AEMO after 14 November 2019.[24]

22 EII Act, section 44.
23 EII Act, section 44(2).
24 EII Act, section 43(2).

2.2 Minimum objectives

This section explains the minimum objectives that apply for each type of eligible electricity infrastructure under the EII Act.

2.2.1 Generation infrastructure

The EII Act requires that the generation infrastructure is comprised of renewable energy generators in NSW, each with generation capacity of at least 30 MW.[25]

The EII Act establishes a minimum objective for the construction of new generation infrastructure by 31 December 2029 that generates at least the *same amount of electricity* in a year as:

- 8 GW of generation capacity from the New England REZ,
- 3 GW of generation capacity from the Central-West Orana REZ, and
- 1 additional GW of generation capacity from elsewhere.[26]

This objective is an annual generation volume (GWh per year) target rather than a target for capacity at a point in time. Further, the EII Regulations require that IIO Reports include an estimate of this amount of electricity using information in the 2020 ISP.

AEMO Services estimates that this volumetric target equates to 33,600 GWh of annual generation. As explained in the 2021 IIO Report,[27] this is based on assumptions of technology capacity mix and capacity factor estimates from AEMO's 2020 ISP.

2.2.2 Long-duration storage infrastructure

The EII Act also establishes a minimum objective for the construction of a total of 2 GW of long-duration storage infrastructure by 31 December 2029.[28]

This infrastructure must:

- provide for the storage of electricity,
- consist of storage units with a registered capacity that can be dispatched for at least 8 hours, and
- be scheduled by AEMO in the central dispatch process under the NER.[29]

Unlike generation infrastructure, the EII Act sets an objective for long-duration storage capacity (GW), rather than a volumetric objective of available energy (GWh).

2.2.3 Firming infrastructure

Generally, firming infrastructure refers to flexible capacity that can be dispatched when there is a sudden increase in demand. Firming can be provided by a range of technologies, including both short- and long-duration storage such as pumped hydro and batteries, as well as gas generators. For the purposes of the infrastructure investment objectives, firming infrastructure must be scheduled by AEMO in the central dispatch process under the NER.

The EII Act does not establish a minimum objective for the construction of firming infrastructure. Rather, the Minister may direct AEMO Services to conduct a competitive tender for LTESAs to support firming infrastructure as necessary.

25 EII Act, section 43(1)(a).
26 EII Act, section 44(3)(a).
27 AEMO Services (December 2021), 2021 Infrastructure Investment Objectives Report, box 3.
28 EII Act, section 44(3)(b).
29 EII Act, section 43(1)(b).

2.3 Overall objectives

In addition to the minimum objectives, AEMO Services' Development Pathway must also plan to meet the overall objectives.

2.3.1 Minimising costs to NSW customers

The EII Act establishes an objective to construct generation infrastructure that is necessary to minimise electricity costs for NSW electricity customers.[30] This means AEMO Services must consider whether additional generation infrastructure to the minimum infrastructure investment objective is required to minimise electricity costs (both before and after 2029).

Section 3.7 provides a forecast of costs for the provision of wholesale energy services to NSW electricity customers under the Draft Development Pathway.

2.3.2 Meeting the reliability standard

The EII Act establishes an overall objective for the construction of long-duration storage and firming infrastructure that is necessary to meet the reliability standard.[31]

The reliability standard is:

- until 30 June 2025, the NEM interim reliability measure of expected unserved energy (USE) in a region not exceeding 0.0006% of the total energy demanded in that region for a given financial year, and
- from 1 July 2025, the NEM reliability standard of expected unserved energy in a region not exceeding 0.002% of the total energy demanded in that region for a given financial year.[32]

The minimum objective for the construction of 2 GW of long-duration storage by the end of 2029 is expected to make a significant contribution to meeting the reliability standard over time. AEMO Services may also plan for additional long-duration storage if required.

The reliability standard may also be met through the construction of firming infrastructure (if the Minister directs AEMO Services to conduct a tender for firming infrastructure). The use of shorter duration firming may be preferable to long-duration storage where, for example, the shorter-duration firming presents a lower-cost option to address a near-term reliability gap.

AEMO's 2022 Electricity Statement of Opportunities (ESOO), forecast gaps in meeting the reliability standard in NSW in 2025-26 and 2026-27. The modelling undertaken by AEMO for its Central scenario in the ESOO only incorporates existing and committed generation projects and does not take account of the additional generation and long-duration storage included in the Development Pathway under the IIO Reports (or the additional network infrastructure that is expected to be constructed in NSW under the Roadmap). The 2022 ESOO did note that the reliability forecast in NSW would be improved by the achievement of the Development Pathway in the 2021 IIO Report, the HumeLink augmentation and the Hunter Transmission Project (which, in AEMO's modelling, includes the Waratah Super Battery).[33]

30 EII Act, section 44(2)(a).

31 EII Act, section 44(2)(b) and (c).

32 See EII Regulation 2021, clause 23. Under EII Act section 43(3), the reliability standard is the standard implemented by AEMO under the National Electricity Rules that has been prescribed by the regulations.

33 2022 ESOO, page 57.

2.3.3 Meeting the energy security target

The EII Act establishes an overall objective for the construction of firming infrastructure that is necessary to meet the energy security target.[34] The energy security target sets the target firm capacity required to meet NSW's maximum consumer demand, with a reserve margin to account for the unexpected loss of the two largest generating units in the state.[35]

The EII Act and associated regulations require the Energy Security Target Monitor (EST Monitor) to calculate the energy security target for each of the next 10 years, and monitor and report on whether there is sufficient firm capacity to meet the target.[36] The various matters that the EST Monitor must take into account when calculating the energy security target and preparing its reports,[37] including inter-regional network constraints are also regulated.

The Minister has appointed AEMO as the EST Monitor and may decide what action to take in response to a report received from the EST Monitor.[38] For example, such a response could include Minister directing AEMO Services to conduct a competitive tender for LTESAs in respect of firming infrastructure.

The latest EST Monitor report was prepared in October 2022 (2022 ESTM Report).[39] The 2022 ESTM Report forecast a breach of the energy security target under its Central scenario in 2025-26 and 2026-27 (following the expected closure of the Eraring Power Station) and again from 2029-30 (following the expected closure of the Vales Point Power Station).[40] AEMO's modelling of its Central scenario for the 2022 ESTM Report only included existing projects and committed projects. Further analysis included in the 2022 ESTM Report confirms that, with certain transmission projects and the firming infrastructure element of AEMO Services' Development Pathway from the 2022 IIO Report, there are no forecast breaches over the 10-year horizon.[41]

2.3.4 Network infrastructure

There are no infrastructure investment objectives under the EII Act for network infrastructure. However, as noted above, the IIO Report must contain details regarding the REZ network infrastructure projects that may be required and details of current, planned and expected infrastructure for the supply of electricity in NSW and the NEM.

34 EII Act, section 4(2)(c).

35 EII Act, section 12.

36 EII Act, sections 12-14.

37 *EII Infrastructure Investment Regulation 2021 (EII Regulation)*, Part 3.

38 EII Act, section 15.

39 AEMO (October 2022), *Energy Security Target Monitor Report*. Available at https://www.energy.nsw.gov.au/sites/default/files/2022-12/28October2022-Energy-Security-Target-Monitor-Report.pdf

40 2022 ESTM Report, page 3.

41 2022 ESTM Report, page 4.

2.4 Progress in achieving the minimum objectives

Each IIO Report after the first report must contain an assessment of the progress in achieving the minimum objectives specified in the EII Act.[42]

Generation and long-duration storage infrastructure constructed since 14 November 2019 may contribute to the achievement of the minimum objectives regardless of whether they are awarded an LTESA. AEMO's existing and committed status can be interpreted as 'constructed' and 'to be constructed' infrastructure, respectively. Since 14 November 2019, as per AEMO's generation information page, in NSW:

- 2,110 MW (~5,400 GWh per annum) of generation infrastructure has been classified as existing, and
- 1,380 MW (~3,600 GWh per annum) of generation has been classified as committed and is expected to reach commercial operation by June 2024[43], and
- No long-duration storage infrastructure has been classified as existing or committed.

This sums to a total of 3,490 MW of existing and committed generation in NSW as of May 2023, or approximately 9,000 GWh of available energy per year.

On 1 May 2023, the successful projects from AEMO Services' first competitive tender were announced. These are three renewable generation projects with a capacity of 1,395 MW (~4,000 GWh per year), alongside a 50 MW / 400 MWh long-duration storage lithium-ion battery project. Of the renewable generation projects, 995 MW (~3,000 GWh per year) are additional to the committed capacity listed above, bringing the total amount of generation capacity that can contribute to the minimum objectives to 4,480 MW (~11,900 GWh per year).

As noted above, the minimum objective for construction of generation infrastructure by 2030 is 33,600 GWh of available energy per year.

2.5 Outcome of tenders since previous report

Each IIO Report after the first report must contain the outcomes of tenders carried out since the previous report.[44] Since the 2022 IIO Report, the first tender for generation and long-duration storage infrastructure has been completed with successful projects being announced on 1 May 2023. Outcomes of the Tender are captured in Table 2.

Table 2: Tender one projects

Project name	Company	Capacity MW	Available GWh p.a.	REZ	Type
Stubbo Solar Farm	ACEN Australia	400 MW	1,135	Central West Orana	Generation
Coppabella Wind Farm	Goldwind Australia Pty Ltd	275 MW	870	Non REZ	Generation
New England Solar Farm	ACEN Australia	720 MW	2,004	New England	Generation
Limondale BESS	RWE Renewables Australia	50 MW/ 400 MWh+		South West REZ	Long Duration Storage

42 EII Regulation, clause 24(2)(d).

43 As per AEMO's Generation Information page May 2023.

44 EII Regulation, clause 24(2)(b).

3. Draft Development Pathway

3.1 Overview and considerations

IIO Reports must include a Development Pathway for generation, long-duration storage and firming infrastructure that is required to be constructed over the following 20 years to achieve the minimum and overall infrastructure investment objectives.

This section sets out the Draft Development Pathway for each of these three infrastructure types over the 20-year period from 2023-24 to 2042-43.

The Draft Development Pathway is the outcome of an electricity market modelling exercise and represents AEMO Services' view of the pathway for achieving the infrastructure investment objectives that is in the long-term financial interests of consumers. The modelling methodology is explained in section 5.

In conducting competitive tenders, AEMO Services will be guided by the Development Pathway in the final 2023 IIO Report. AEMO Services may recommend LTESAs to support the construction of infrastructure in excess of or less than the amounts indicated if, for example, price information received during tender processes revealed that an alternative pathway would result in better long-term financial outcomes for NSW electricity customers.

The Draft Development Pathway is primarily intended to meet the infrastructure investment objectives in a cost-minimised way. AEMO Services has also considered how the design of the Draft Development Pathway might mitigate against a range of future risks, ranging from supply chain constraints to lulls in wind and solar resources.

In considering such risks, AEMO Services has had regard to the plan prepared by the NSW Renewable Energy Sector Board (RES Board Plan), which was published in September 2022.[45] The RES Board Plan sets out how local workers, communities and industries can benefit from the economic opportunities presented by the Roadmap. The RES Board Plan identifies major opportunities and barriers faced by the renewable energy sector in NSW. In particular, AEMO Services notes that the plan identifies:

- the need to build capacity and capability in the NSW renewable energy sector, including through long-term planning and supply chain development[46] and
- barriers including skill and labour shortages, including as a result of competition from a large general infrastructure pipeline, low levels of unemployment in renewable energy zones and shortages in key occupations (e.g., electricians).[47]

The implications of this are discussed further in section 3.3.

AEMO Services also considers risks associated with climate change and the transition to an energy system based on variable renewable energy. A methodology has been developed for assessing the resilience of the Draft Development Pathway to lulls in wind and solar resources, as discussed further in section 5.6.

45 Available at https://www.energy.nsw.gov.au/nsw-plans-and-progress/major-state-projects/electricity-infrastructure-roadmap/entities-delivering#renewable-energy-sector-board.

46 See RES Board Plan, page 13-14.

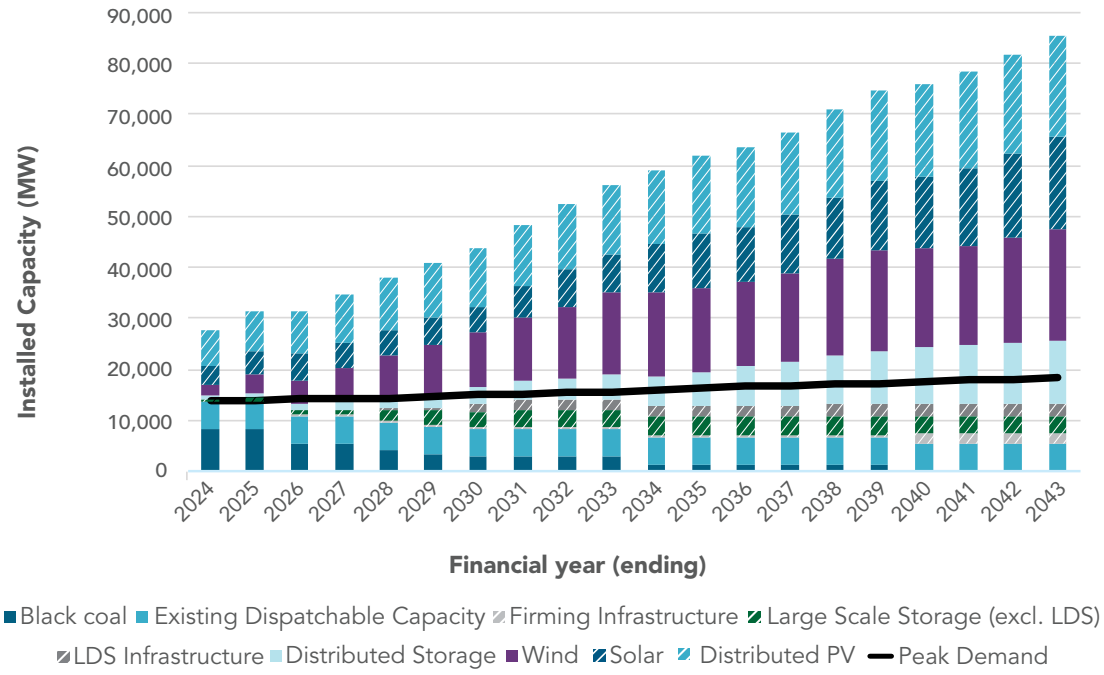
47 RES Board Plan, page 25.

3.2 Part of a broader energy system

The Draft Development Pathway sets out an optimal build trajectory for NSW electricity customers regarding new renewable generation, long-duration storage and firming infrastructure. The infrastructure forecast under the Draft Development Pathway complements the broader NSW energy system, which incorporates a broader technology mix.

An indicative forecast of the different types of infrastructure (by technology type) for the supply of electricity in NSW over the next 20 years is set out in Figure 8. This forecast is indicative only. AEMO Services will recommend LTESAs for eligible infrastructure types based on its assessment of the value of projects that participate in its competitive tenders, irrespective of technology type.

Figure 8: Forecast installed capacity in NSW over time



3.3 Generation infrastructure

The generation element of the Draft Development Pathway is set out in Figure 9 and Figure 10, which show the annual and cumulative annual output of the infrastructure over the period 2024 to 2043, respectively.

The generation element of the Draft Development Pathway is technology- and location-neutral.

Figure 9: Draft Development Pathway - Annual (Generation)

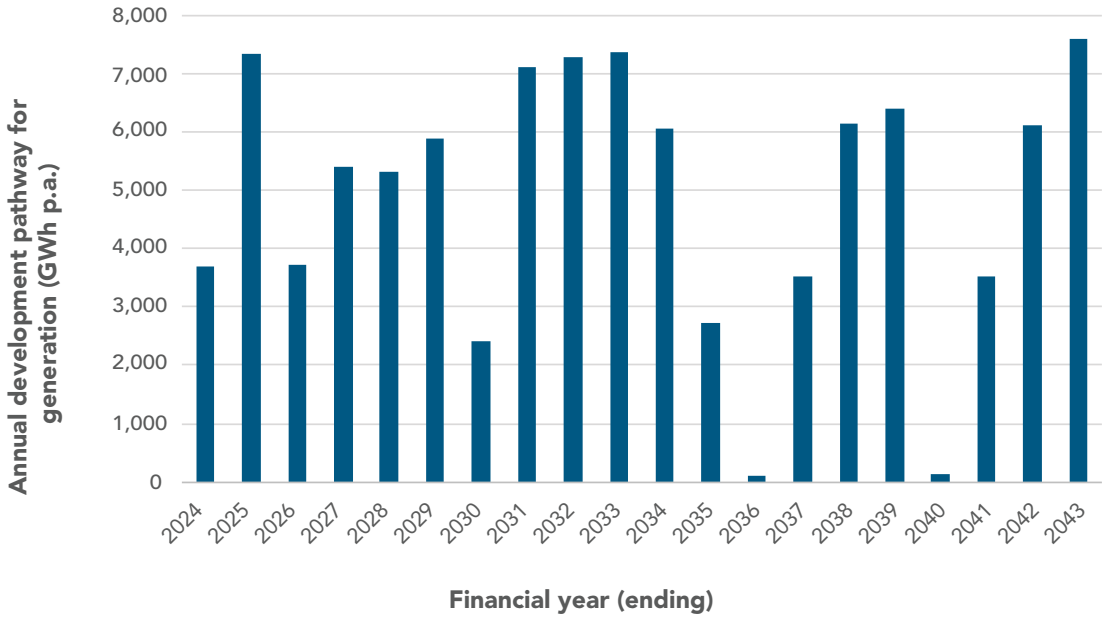
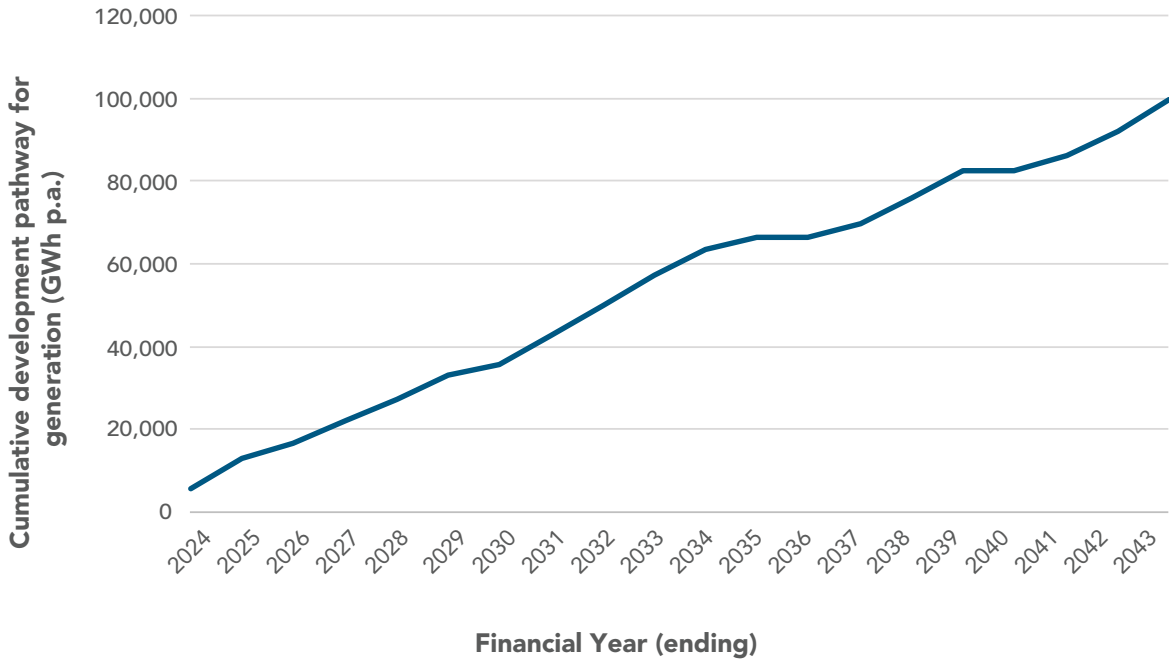


Figure 10: Draft Development Pathway - Cumulative (Generation)



The Draft Development Pathway seeks to provide for a managed buildout of electricity infrastructure to mitigate uneven investment and high-priced periods that can be expected to characterise normal market operation under current regulatory settings.

Under the Draft Development Pathway, the minimum objective for the construction of generation infrastructure capable of producing 33,600 GWh of electricity per year is achieved by 2029-2030. The Draft Development Pathway then shows a steady build of generation infrastructure continuing beyond 2030 for the purpose of minimising electricity costs to NSW customers.

Reflecting the issues identified in the RES Board Plan, the Draft Development Pathway was modelled with limits on the amount of generation that is assumed to be able of being constructed in any given year. These limits are set at:

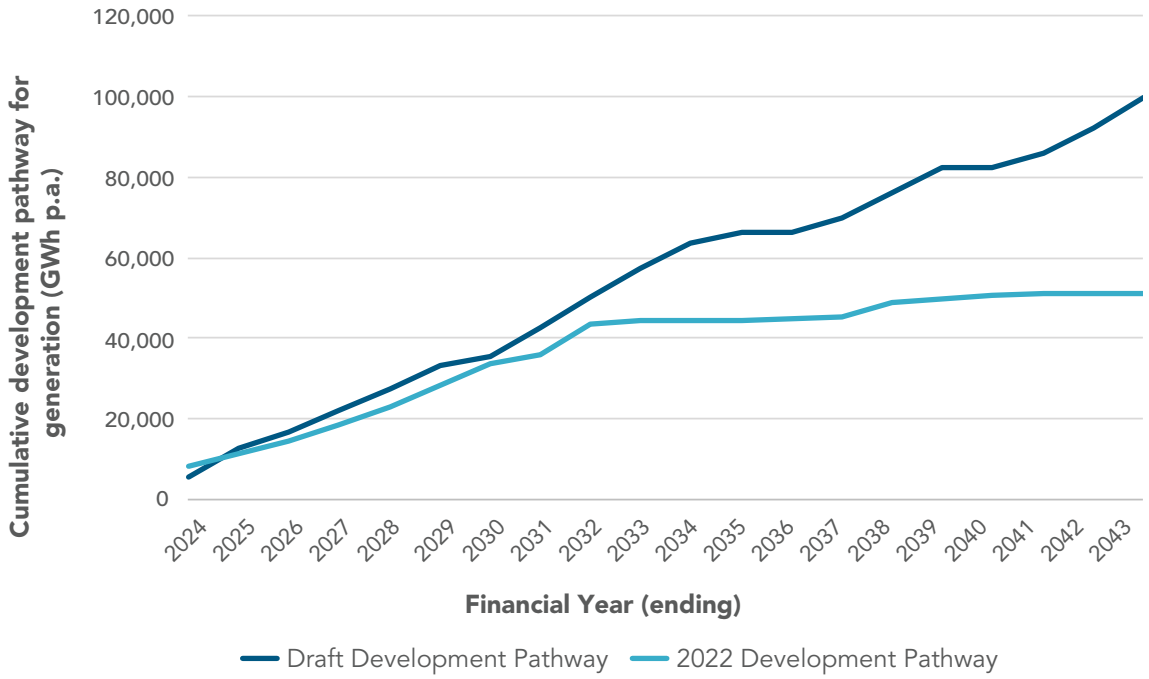
- to 2030, generation infrastructure capable of producing a maximum of 6,000 GWh of electricity per year, and
- from 2030, generation infrastructure capable of producing a maximum of 7,600 GWh of electricity per year.

This approach was retained from the 2021 IIO Report and 2022 IIO Report. The detailed considerations underpinning these annual limits are discussed in the 2021 IIO Report.[48]

48 See 2021 IIO Report, Appendix D.

Figure 11 compares the generation element of the Draft Development Pathway to the current Development Pathway in the 2022 IIO Report.

Figure 11: Comparison of Draft Development Pathway to 2022 Development Pathway (Generation)



The Draft Development Pathway is largely consistent with the Development Pathway in the 2022 IIO Report to 2030, although the projected build runs slightly ahead. From 2030, the Draft Development Pathway involves a significantly greater projected build of generation infrastructure for the remainder of the modelled period to 2043. The increased amount of generation infrastructure in the second decade is the result of several factors, including increased electricity demand and earlier NSW coal generator retirements.

3.4 Long-duration storage infrastructure

The long-duration storage element of the Draft Development Pathway is set out in Figure 12 and Figure 13, which show the annual and cumulative capacity installed over the period 2024 to 2043, respectively.

The long-duration storage element of the Draft Development Pathway is technology and location-neutral.

Figure 12: Draft Development Pathway - Annual (Long-duration storage)

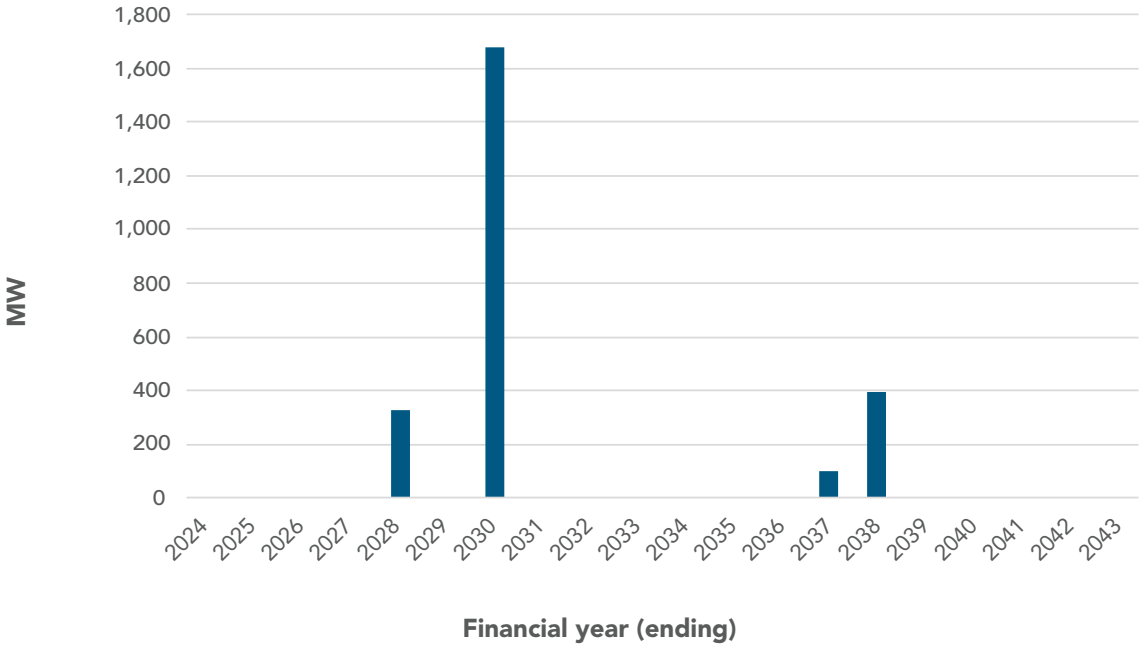
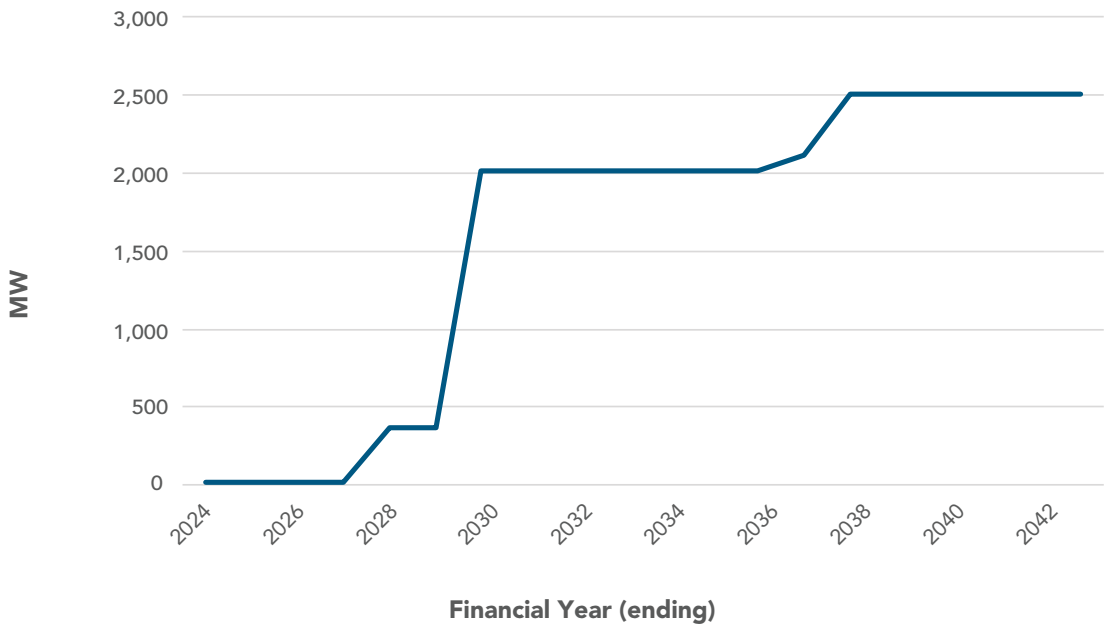


Figure 13: Draft Development Pathway - Cumulative (Long-duration storage)



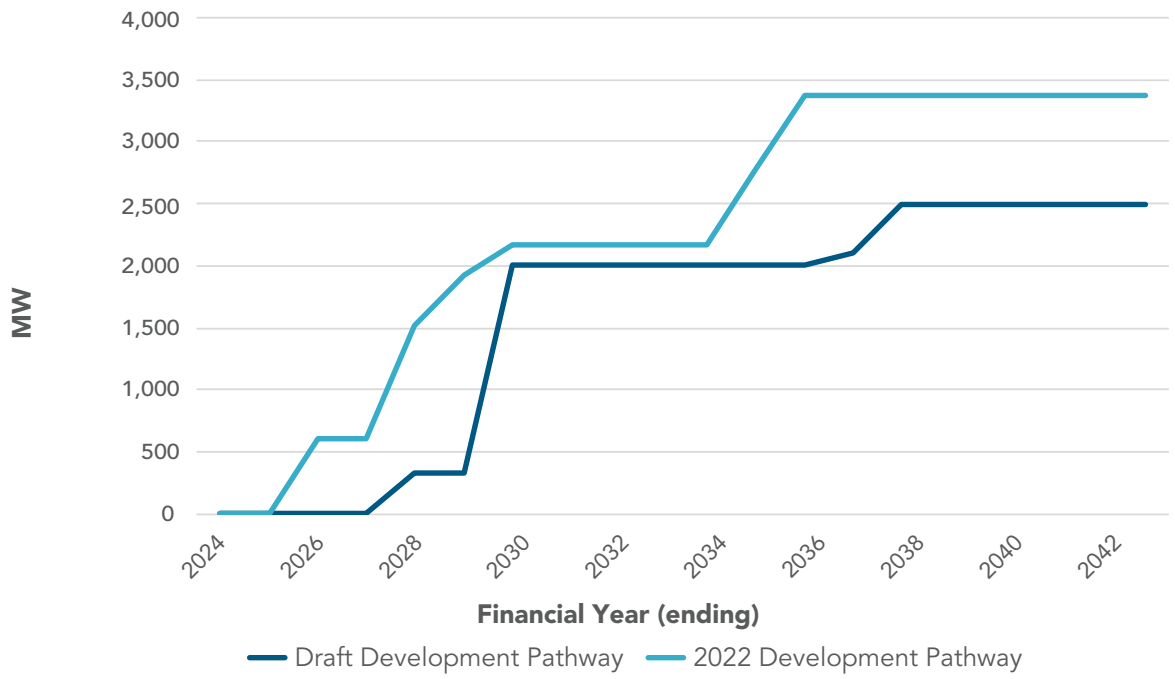
The Draft Development Pathway does not see long-duration storage projects commissioned until mid-2027, reflecting current estimates of lead times for pumped hydro projects in NSW. Other long-duration storage technologies may be viable before this time, but under current assumptions are unlikely to be cost competitive. The Draft Development Pathway therefore suggests it is in the interest of NSW consumers to delay construction of the 2 GW long-duration storage minimum objective to the latter part of the decade.

Although the least-cost approach, AEMO Services considers planning for the construction of 2 GW of long-duration storage infrastructure in the final years of the 2020s to carry some deliverability risk. Accordingly, AEMO Services considers there may be some benefit in seeking to support earlier investment in long-duration storage. There may also be benefits in bringing forward the build if other long-duration storage technologies prove to be lower cost than currently assumed.

AEMO Services intends to test the assumptions underpinning the later build via its competitive tender process, which may give rise to earlier construction dates either where other technologies prove cost competitive or where pumped hydro can be delivered earlier. This issue is considered further in the design of the 10-Year Plan in section 4.3.

The Draft Development Pathway also forecasts less long-duration storage capacity than the 2022 Development Pathway from the mid-2030s, as shown in Figure 14. The lower amount of long-duration storage in the Draft Development Pathway from the mid-2030s is reflective of updated assumptions regarding higher rooftop PV and distributed storage uptake, and increased amounts of generation infrastructure and firming infrastructure (driven by updated assumptions regarding technology costs and demand-side factors).

Figure 14: Comparison of Draft Development Pathway to 2022 Development Pathway (Long-duration storage)



3.5 Firming infrastructure

The firming element of the Draft Development Pathway is set out in Figure 15 and Figure 16, which show the annual and cumulative capacity installed over the period 2024 to 2043, respectively.

The firming element of the Draft Development Pathway is technology-neutral, so long as it is can be scheduled by AEMO in its central dispatch process.

Figure 15: Draft Development Pathway - Annual (Firming)

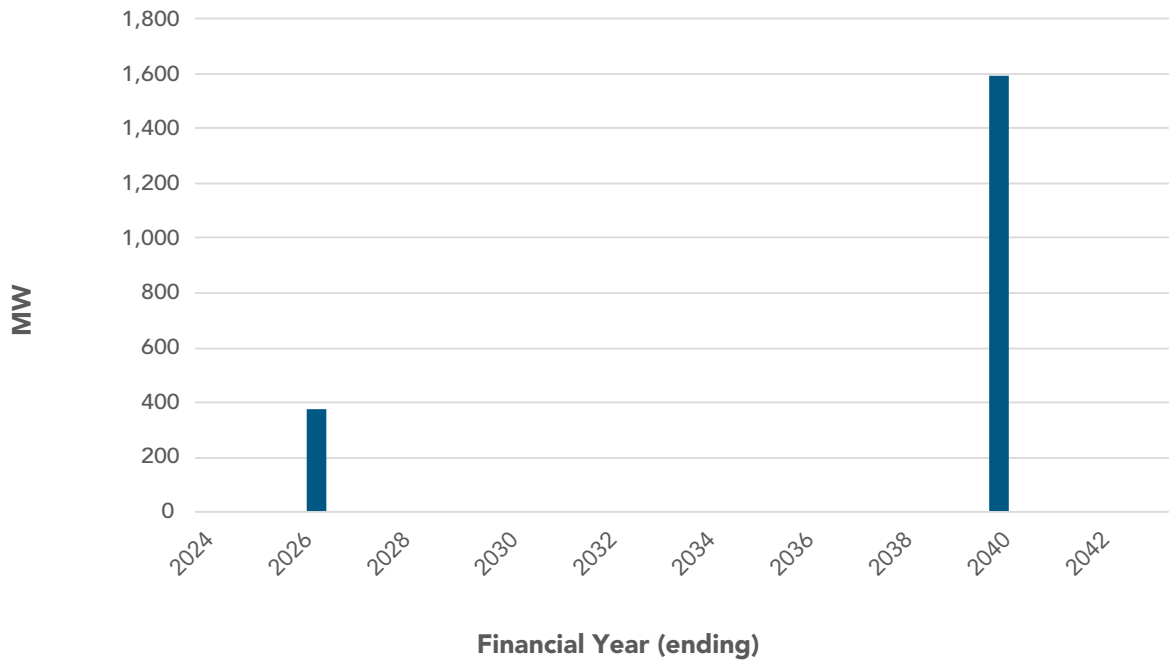
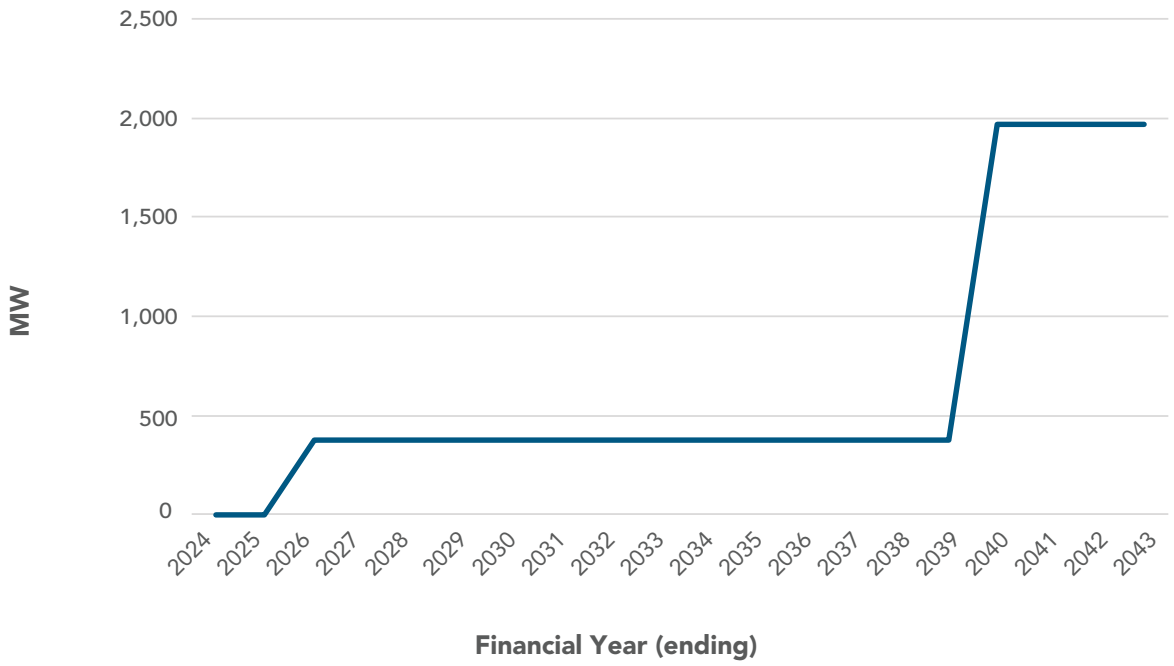


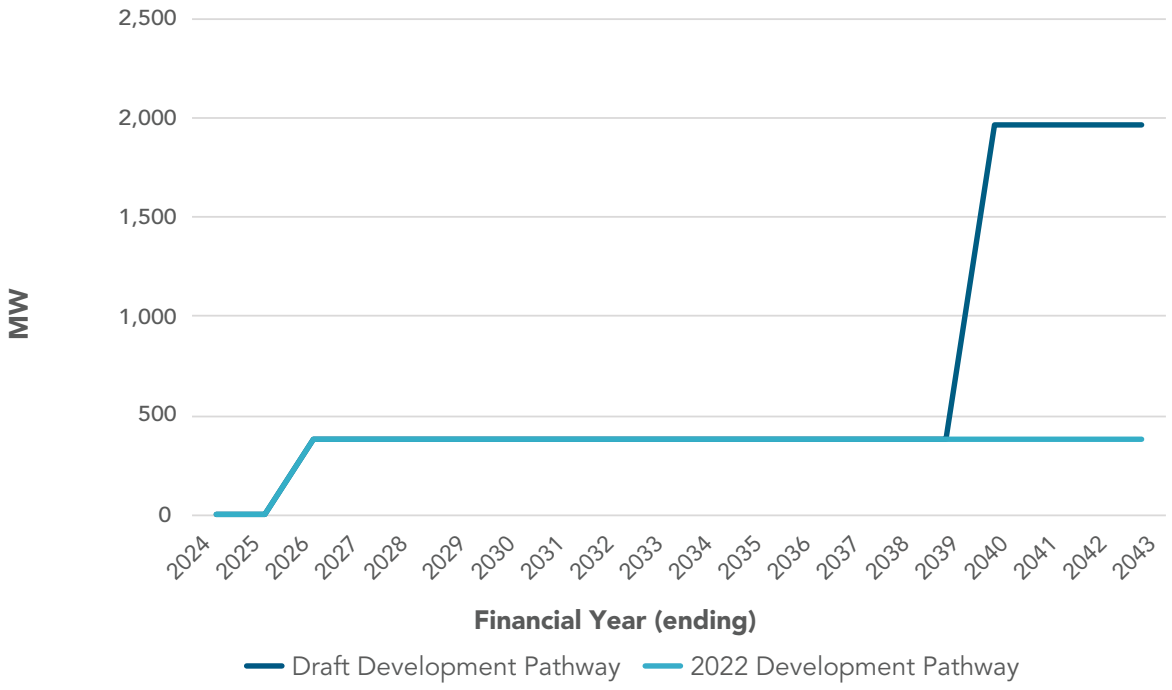
Figure 16: Draft Development Pathway - Cumulative (Firming)



The firming element of the Draft Development Pathway consists of 380 MW of firming infrastructure located within the Sydney-Newcastle-Wollongong sub-region (or in close proximity to this sub-region, provided it can demonstrate its contribution to meeting the energy security target), commissioned in 2025-26.[49]

From 2040, modelling undertaken for this report indicates that an additional 1,600 MW of firming infrastructure is required to meet the reliability standard. This differs from the current Development Pathway in the 2022 IIO Report, as shown in Figure 17.

Figure 17: Comparison of Draft Development Pathway to 2022 Development Pathway (Firming)



49 The calculations undertaken for the 2022 IIO Report indicated a breach of the energy security target would take place over summer 2025-26 without the firming element of the Development Pathway. Accordingly, AEMO Services intends to tender for projects that will be commissioned by December 2025.

Explainer: ISP sub-regions

As part of its modelling of the NEM, AEMO divides the NEM in regions and subregions.[50] The NSW NEM region is made up of the Sydney-Newcastle-Wollongong sub-region, the Northern NSW sub-region, the Central NSW sub-region and the Southern NSW sub-region.

The EII Regulations prescribe that the Energy Security Target Monitor is to take into account major constraints on transmission infrastructure across different sub-regions of NSW.[51] Consistent with the 2022 ESTM Report, the 2022 IIO Report identified a shortfall of capacity in the Sydney-Newcastle-Wollongong sub-region because there is insufficient capacity on the lines into that sub-region to import sufficient electricity from other sub-regions. This means that to meet demand within the Sydney-Newcastle-Wollongong sub-region in 2025-26, additional capacity is required within that sub-region (or in close proximity to the sub-region, depending on the ability of the project's output to reach peak demand in the Sydney-Newcastle-Wollongong sub-region with the two largest generating units out, subject to network constraints).

The design of the firming element of the Draft Development Pathway is explained in section 3.3.2 of the 2022 IIO Report.

AEMO Services is not able to conduct competitive tenders for LTESAs to support firming infrastructure in the absence of a direction from the Minister.[52] As at the date of this report, no such direction has been given (other than the August 2022 direction to conduct the Q2 2023 tender scheduled via the 2022 IIO Report).

3.6 Network infrastructure

The Draft Development Pathway is a plan for the construction of generation, long-duration storage and firming infrastructure. The EII Act does not establish infrastructure investment objectives for the construction of network infrastructure. Notwithstanding, network infrastructure will be critical to facilitating the development of new renewable generation and long-duration storage infrastructure. Accordingly, as part of the modelling for this report, AEMO Services has considered how network augmentations might best support the delivery of the Draft Development Pathway.

AEMO Services has provided this modelling as advice to EnergyCo to inform its NIS (as noted in section 1.2.3).

Network infrastructure under the EII Act

The EII Act provides a framework for the development, construction, operation and cost recovery of new network infrastructure projects,[53] outside of the usual NER process. EnergyCo – in its capacity as the Infrastructure Planner for the five REZs specified in the EII Act – is responsible for assessing and making recommendations to AEMO Services about REZ network infrastructure projects.[54] AEMO Services must consider EnergyCo's recommendations and decide whether to authorise a network operator to carry out such a project.[55] A similar regime exists in respect of priority transmission infrastructure projects, where EnergyCo makes recommendations to the Minister and the Minister may decide to authorise or direct a network operator.[56]

50 See 2021 IASR, page 120.
51 EII Regulation, clause 15(4).
52 EII Act, section 47(2).
53 See EII Act, Part 5.
54 EII Act, section 30(1).
55 EII Act, section 31(1).
56 EII Act, sections 32(1) and 36(2).

The network projects that have been co-optimised with generation and storage infrastructure as part of the modelling that underpins the Draft Development Pathway are set out in Table 3.[57] [58]

These options (i.e. their technical configurations and the network capacity they enable) and their estimated capital costs[59] were provided by EnergyCo in July/August 2022, along with other projects for consideration. The modelling for this report involved producing an optimal combination and set of timings for network infrastructure. Based on EnergyCo's inputs from July/August 2022, the estimated total capital costs of the network projects in Table 3 amount to $9.5 billion (in real 2021 dollars), which equates to $7.0 billion in present value terms.[60] Importantly, these projects do not form part of the Draft Development Pathway (which only covers generation, long-duration storage and firming infrastructure). Rather, network infrastructure projects will support the delivery of the Draft Development Pathway.

EnergyCo designs the NIS. In doing so, EnergyCo has had regard to the optimal combination and timing of network projects from AEMO Services' modelling results. In addition, the NIS considers other factors in setting out a strategy for the development and delivery of network projects. EnergyCo's NIS also reflects refinements and updates to the potential network projects in NSW since July/August 2022. The preparation of the final 2023 IIO Report, which will involve a re-optimisation of forecast generation, storage, firming and network builds based on latest information, will consider the updated network options in the NIS.

Table 3: REZ network and priority transmission infrastructure projects underpinning the Draft Development Pathway

Project	Description	Optimal timing under Draft Development Pathway
Waratah Super Battery	New battery with system integrity protection scheme and associated minor network augmentation, to improve transfer limit between Central NSW and Sydney-Newcastle-Wollongong.	2025-26*
Hunter Transmission Project	A 500 kV transmission upgrade to reinforce supply to Sydney, Newcastle and Wollongong load centres.	2027-28*
New England Option 1	Upgrades to the existing transmission lines between Tamworth and Armidale, as well as upgrades and construction of new 500 kV lines between Armidale and Bayswater to allow an additional network capacity of 3,000 MW.	2028-29
New England Option 2B	Building on New England Option 1, enables an additional 3,000 MW of network capacity through operating a line at higher voltage, installing a new high-voltage line, and installing or expanding associated infrastructure.	2032-33
CWO Option 1	New 500 kV and 330 kV transmission lines from the existing network at Wollar to Merotherrie, with extensions to Elong Elong and Uarbry to enable the delivery of 3,000 MW of additional network capacity.	2027-28
CWO Option 2A	An additional 330 kV line from Merotherie to Uarbry, as well augmentations to associated infrastructure. This will support at additional 1,000 MW of additional network capacity.	2031-32
CWO Option 2B	An increase to the operating voltage from 330 kV to 500 kV between Merotherie and Elong Elong. This will support at additional 1,500 MW of additional network capacity.	2037-38
HCC Option 3[61]	New 330 kV switching station at Singleton that cuts into the existing Line 82 between Liddell to Tomago to enable 500 MW of additional capacity.	2026-27

*The timing of Waratah Super Battery and Hunter Transmission Project were input assumptions aligned with the 2021 IASR.

57 Table 3 sets out the optimal options and timings under the Central scenario. See section 5 for further discussion regarding the scenarios modelled for this report.

58 Additional network projects may be required to facilitate the connection of certain pumped hydro projects if they are developed. These are set out in EnergyCo's NIS. The modelling for this draft report included simplified representations of the costs associated with such network projects as an uplift to the connection costs of candidate pumped hydro projects.

59 The capital costs of the network projects are based on standard.

60 This figure is derived by discounting estimated costs from the modelled delivery date to 2023-24 using a 5.5% discount rate.

61 As noted above, the NIS is informed by, but does not necessarily directly adopt, the modelling outcomes regarding network infrastructure. EnergyCo has had regard to a range of factors in developing its plan for network infrastructure. This means that the NIS may set out alternative approaches to the development of some REZs. For example, EnergyCo's plan in the NIS includes a different network option for the HCC REZ.

In addition to network projects that are expected to be delivered under the EII Act framework, the Draft Development Pathway also requires the completion of the network projects set out in Table 4. These projects are either currently under construction or listed as Actionable or Future projects in AEMO's 2022 ISP. As above, these projects do not form part of the Draft Development Pathway.

Table 4: Current or actionable ISP projects underpinning the Draft Development Pathway

Project	Description	Assumed timing under Draft Development Pathway
Project EnergyConnect	A new 330 kilovolt (kV) double-circuit interconnector between South Australia and New South Wales.	2026-27
HumeLink	A 500 kV transmission upgrade to connect the Greater Sydney load centres to Project EnergyConnect and the Snowy Mountains Hydroelectric Scheme.	2028-29
VNI West	A new 500 kV double-circuit transmission line to connect Western Renewables Link (north of Ballarat) with Project EnergyConnect, which will increase network capacity between NSW and Victoria, provide greater access to Snowy 2.0's deep storage and support new VRE in Victorian REZs.	2031-32
QNI Connect	A new 330 kV double-circuit line (one circuit strung) from locality of Armidale South to Dumaresq to Bulli Creek to Braemar, which will enable ~1GW of transfer capacity between southern Queensland and the New England REZ.	2030-31

3.7 Costs for the supply of wholesale energy services to NSW electricity customers

In preparing the Draft Development Pathway, AEMO Services has considered a forecast of its impact on the costs of providing wholesale energy services to NSW customers. This involves considering:

- wholesale electricity costs, and
- 'scheme costs', being the following costs associated with the scheme established by the EII Act:
  - costs associated with payments made under LTESAs to generation, long-duration storage and firming infrastructure projects, and
  - costs of network infrastructure that is delivered under the EII Act.

These different cost components, which are included in AEMO Services' forecast, are defined in Table 5.[62]

The forecast costs set out in this section are calculated using the results of the market modelling detailed in section 5.

Given the multitude of variables inherent in the modelling, it is impossible to accurately forecast precise market conditions and resulting wholesale electricity costs or scheme costs over a 20-year period. Rather, cost forecasts are prepared and compared across multiple scenarios so that decision-making can be informed by an understanding of the relative cost impacts of different development trajectories under different future scenarios.

The results of the modelling for this report indicate that the present value[63] of total costs for the supply of wholesale energy services to NSW electricity customers is $78.0 billion over the full 20-year horizon of the Draft Development Pathway. This excludes other cost components that may appear on or affect retail electricity bills such as charges for investment in and operation of NSW's distribution networks and Transgrid's transmission network (both regulated under the National Electricity Rules), retail charges, or other environmental charges. This is because the analysis and modelling that underpins this report does not quantify the impact of different future scenarios on these cost components.

62 In addition to these cost categories, contributions under section 58 of the EII Act may also cover costs of the entities appointed under the EII Act to exercise functions related to the Roadmap. The Australian Energy Regulator published its first contribution determination in February 2023 (after the modelling for this draft report), which includes amounts for administrative costs from 2022-23 to 2025-26. https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/cost-pass-throughs/nsw-electricity-infrastructure-fund-2023%E2%88%9224-contribution-determination/decision

63 The present value of the cost forecast is in real 2021 dollars, calculated by discounting costs to the first modelling year (2023-24) at a real discount rate of 5.5% (consistent with the discount rate in AEMO's 2021 IASR).

To illustrate the definition of Scheme (LTESA) costs, Figure 18 provides an example of the annual revenues and costs assumed for a single 100 MW LDS project. Scheme revenues represent a proxy for the LTESA costs required to be recovered from NSW customers and are the difference between the project's annual costs and the sum of its wholesale and additional market revenues. This definition is an intentional simplification of the LTESA contract design.

Table 5: Cost components included in forecast of costs for provision of wholesale energy services to NSW customers

Cost type	Definition	Cost recovery mechanism
Wholesale electricity costs	The wholesale electricity purchase costs to NSW customers (assuming that spot prices reflect contract prices). This is calculated by multiplying the load-weighted average of NSW spot prices by NSW region operational demand.	Via retailers
Scheme (LTESA) costs	**Generation LTESA liabilities** – A proxy for the total net cost paid by the Scheme Financial Vehicle[64] under LTESAs for generation projects. For the purposes of this report,[65] this has been calculated as the difference between total levelised cost of energy (LCOE) and revenue for each unit. This is effectively a representation the 'missing money' required by each unit to breakeven on its costs. This is only considered for projects with greater costs than revenues across their economic life. For Generation units, revenue includes the wholesale electricity market revenue and the Large-Scale Generation Certificate[66] (LGC) revenue.	Via distribution network service providers under the EII Act contribution determination process[67]
	Long-duration storage LTESA liabilities – A proxy for the total net cost paid by the Scheme Financial Vehicle under LTESAs for long-duration storage projects. For the purposes of this report, this has been calculated using the same method as outlined above for generation LTESAs. For Long-duration storage units, revenue includes the wholesale electricity market revenue with a 15% revenue uplift to reflect other revenue streams.[68]	
	Firming LTESA liabilities – A proxy for the total net cost paid by the Scheme Financial Vehicle under LTESAs for firming projects. For the purposes of this report, this has been calculated using the same method as outlined above for generation LTESAs. For Firming units, revenue includes the wholesale electricity market revenue with a 30% revenue uplift to reflect other revenue streams.[69]	
Scheme (Transmission) costs	**EII Act network infrastructure** – The annualised capital costs (reported for 20 years only) of new 'REZ network infrastructure projects' or 'priority transmission infrastructure projects' (as defined under the EII Act) that are funded by the Scheme Financial Vehicle. The capital costs are annualised over their economic lifetime[70] using a 3.83%[71] rate of return, noting that the Draft Development Pathway only reports on 20-year period.	Via distribution network service providers under the EII Act contribution determination process[72]

64 The Scheme Financial Vehicle is established under the EII Act to fund key activities of the Roadmap and collects contributions from NSW distribution network service providers.

65 This approach is different to previous IIO Reports.

66 For Generation-eligible LTESA projects, revenue earnt from LGCs was considered. The LGC assumptions were derived from the Mercari LGC forecast to 2026, followed by a linear decrease to $15 in 2030, followed by $0 from 2031 onwards. The $15 LGC value in 2030 reflects the continuation of high demand currently observed in the market caused by voluntary surrendering. The $0 value from 2031 onwards reflects the conclusion of the Large-scale Renewable Energy Target (LRET) scheme.

67 See EII Act, Part 7.

68 For LDS and Firming LTESA-eligible projects, multiple additional revenue streams were considered. The FCAS markets and cap contract markets are two primary revenue streams analysed in the development of this assumption. Other existing, future and potential markets were also considered, such as capacity credits, portfolio optimisation, Fast Frequency Response (FFR) markets and inertia markets. Given the inherent uncertainty surrounding these markets, a simplified and bundled assumption was made, noting that each revenue stream is highly dependent on project qualities such as size, location and technical characteristics. A revenue uplift of 15% and 30% on wholesale revenues has been assumed for all LDS and Firming-eligible projects respectively in the calculation of Scheme (LTESA) costs. These assumptions are believed to be conservative in nature and aims to increase the accuracy of Scheme (LTESA) costs. They were derived from analysis provided through Aurora Energy Research Q4 2022 Flexible and Storage Market report.

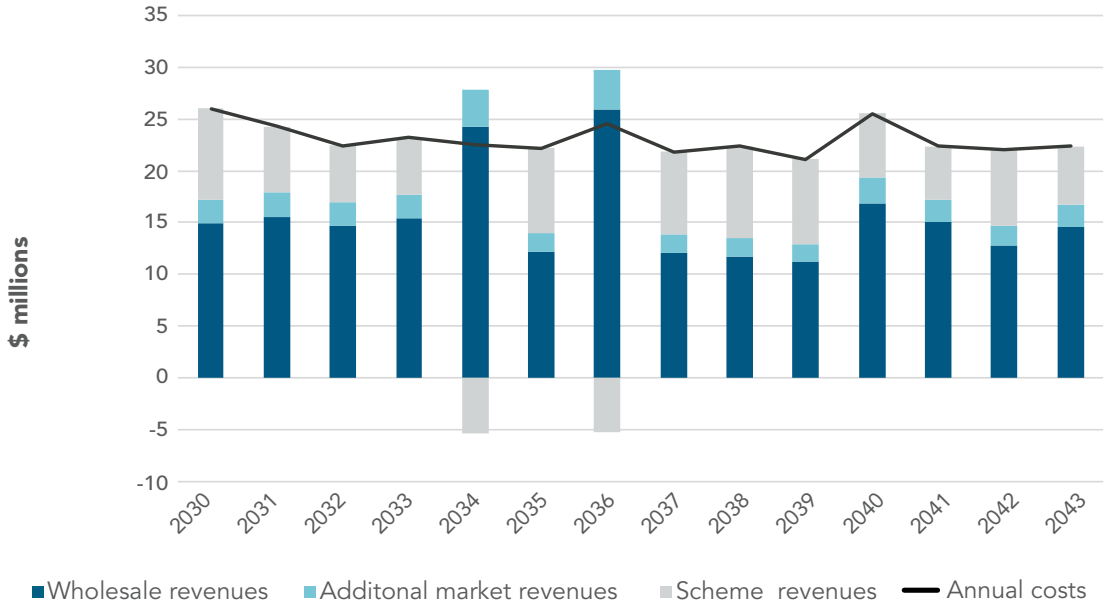
69 See footnote 66.

70 Assumed to be 50 years in line with AEMO's assumptions in the ISP.

71 Aligned with the 2022-23 update of AER's transmission determination for TransGrid. See Table 7 for all WACC assumptions and rationale.

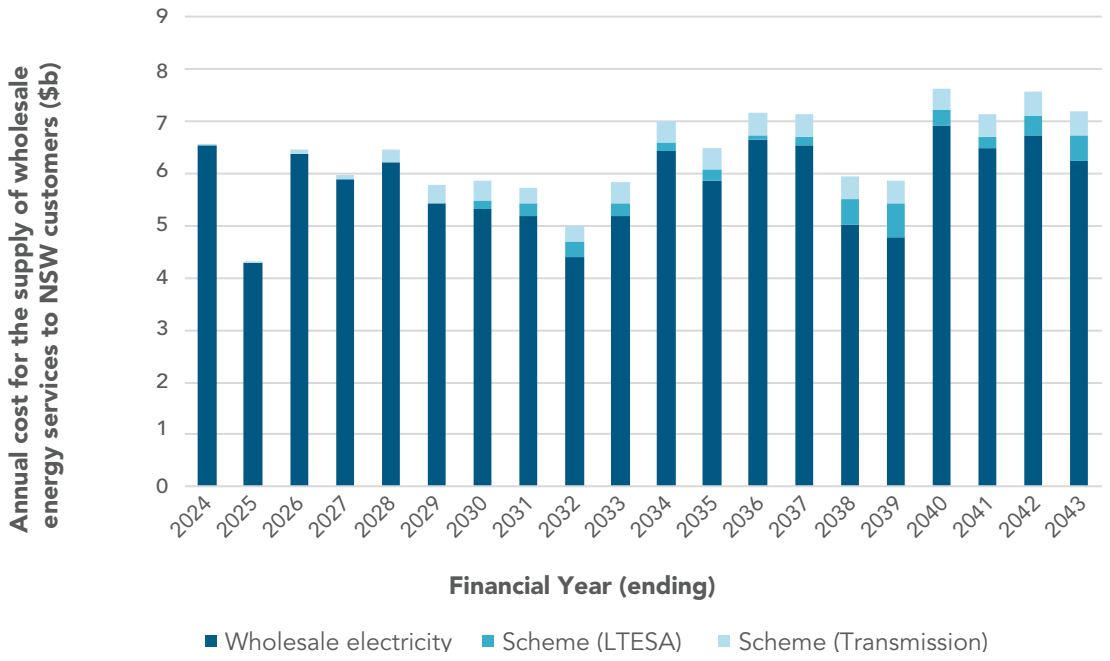
72 See EII Act, Part 7.

Figure 18: Scheme (LTESA) cost illustration via an example of revenues and costs for single 100 MW pumped hydro project



An annual breakdown of forecast wholesale and scheme costs, in real terms, is set out in Figure 19.

Figure 19: Forecast of annual costs for the supply of wholesale energy services to NSW electricity customers (2024-2043)



Higher wholesale costs are generally associated with generator retirements and/or higher demand. Lower wholesale costs are generally associated with new investment in generation and/or transmission capacity. In the near-term, the wholesale electricity costs are forecast to drop in 2025 due to increased levels of distributed and utility-scale renewable generation and storage. In 2026, there is upwards pressure on wholesale electricity costs associated with the withdrawal of the Eraring power station.

The forecast costs set out in Figure 19 need to be compared to the costs that would have otherwise been borne by customers in the absence of the NSW Electricity Infrastructure Roadmap.

The OECC is currently undertaking modelling to provide an update on the customer benefits of the infrastructure that is planned to be enabled by the Roadmap. This modelling was undertaken as a separate exercise to the modelling for this report, but used a comparable set of input assumptions. OECC's draft results indicate that the total costs for providing wholesale energy services to NSW electricity customers in a "no roadmap modelling" scenario (i.e. with a different development pathway for generation and network infrastructure) over the same 20-year horizon to be $88.6 billion. Comparing the forecast prepared for this report with the OECC's draft results indicates a net benefit of $10.6 billion to NSW electricity customers over the same 20-year period. The OECC's modelling is intended to be finalised with the final 2023 IIO Report (due in December 2023).

4. Draft 10-Year Plan

4.1 Overview

The purpose of the 10-Year Plan is to set out the schedule for competitive tenders for built energy to give effect to the Development Pathway in respect of generation, long-duration storage and firming infrastructure. AEMO Services intends for the 10-Year Plan to provide a level of certainty to investors, allowing them to plan for participation in tenders, improving the likelihood of receiving high-value submissions.

As with all Consumer Trustee tenders, the target volumes should be interpreted as indicative only.

AEMO Services may recommend more or less LTESAs depending on its assessment of matters including the quality of projects, size of projects, lead times and financial value of individual projects bidding in any one tender. These decisions will be based on the evaluation of submissions received in each competitive tender process against a set of merit criteria, which will include the extent to which a project offers financial value to NSW customers and has a pathway to commercial operation.[73]

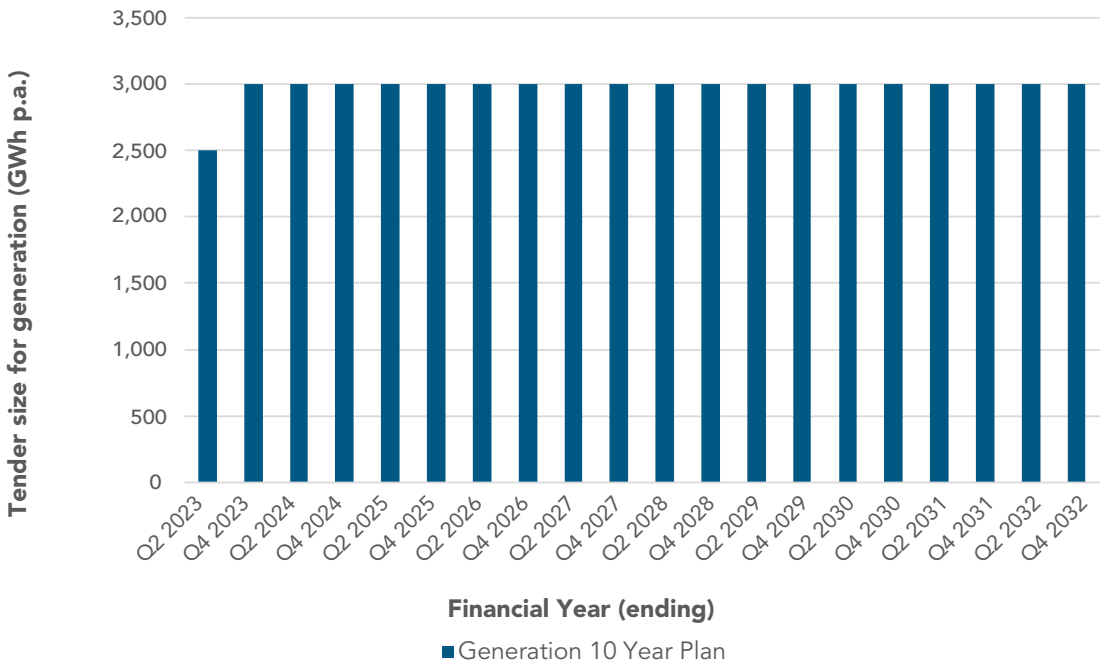
While the 10-Year Plan primarily schedules competitive tenders for LTESAs, AEMO Services has also been requested by EnergyCo to conduct tenders for REZ access rights. Tender participants will be able to bid for both products in a tender. Where a tender participant is seeking an access right only,[74] AEMO Services may recommend the award of access rights above the indicative tender size (up to the maximum aggregate capacity for any given REZ).

AEMO Services may also adjust the tender sizes prior to the next publication of an IIO Report if it considers this to be in the long-term financial interests of NSW electricity customers.

4.2 Generation infrastructure

The draft timing and indicative sizing for competitive tenders for generation infrastructure over the next 10-year period is shown in Figure 20.

Figure 20: Draft 10-Year Plan (Generation)



73 The current Tender Rules and Tender Guidelines, which set out the eligibility and merit criteria for competitive tenders, are available on AEMO Services' website at https://aemoservices.com.au/tenders/tender-pack.

74 Projects that have received an access right may only seek an LTESA in a later tender in exceptional circumstances.

The design of the Draft 10-Year Plan differs from that in the 2021 and 2022 IIO Reports. The plan in this report sets out consistently-sized tenders over the next 10 years for generation infrastructure capable of producing 3,000 GWh of electricity per year. The indicative size of the tenders has been set by:

- Considering the total amount of generation infrastructure to be constructed under the Draft Development Pathway by 2035-36 to reflect the next 10 years as well as an additional two-year lead time. This captures the additional time anticipated to be required between tendering for LTESAs and the construction of infrastructure.[75]
- Considering the amount of existing and committed projects eligible for generation LTESAs (as at January 2023), and what portion of these may require an LTESA.
- Apportioning this volume equally over biannual tenders from Q2 2023.

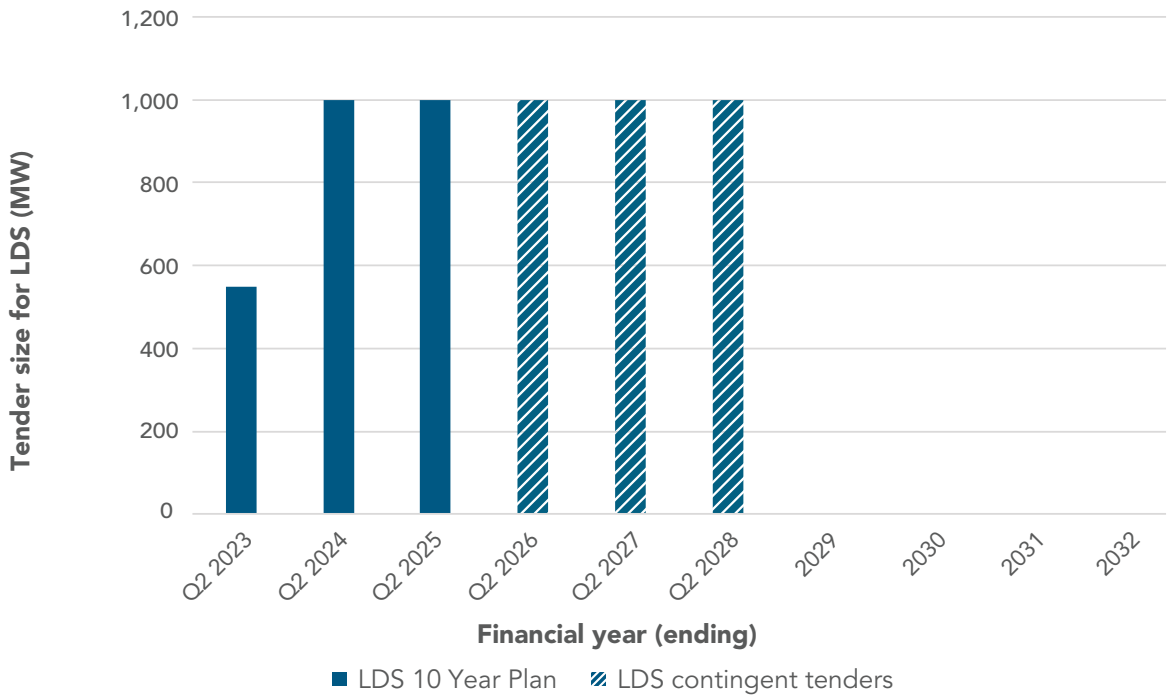
This approach is intended to be simpler and provide greater certainty for participants in AEMO Services' competitive tenders, rather than having indicative tender sizes that vary over the 10-Year Plan. It also reflects the reality that not all projects will have the same lead time between receiving an LTESA and commissioning.

How AEMO Services might adjust the indicative tender sizes over time in response to various events is discussed in section 4.5.

4.3 Long-duration storage infrastructure

The timing and indicative sizing for competitive tenders for long-duration storage infrastructure over the next 10-year period is shown in Figure 21.

Figure 21: Draft 10-Year Plan (LDS)



75 Lead time assumptions are average estimates to reflect the requirement to tender for LTESAs in advance of infrastructure being constructed. These will vary greatly by project. AEMO Services expects that future sizes of LTESA tenders will be informed by the outcomes of previous tenders.

As discussed in section 3.4, the Draft Development Pathway does not include long-duration storage projects until mid-2027. This occurs as a result of lead times for pumped hydro projects in NSW and the costs of other technologies. Having regard to risks associated with a late build in meeting the minimum objective of 2 GW by the end of 2029, AEMO Services intends to test these assumptions via its competitive tender process. From 2023, AEMO Services intends to conduct consistently-sized tenders in respect of long-duration storage infrastructure. This departs from the 2021 and 2022 IIO Reports, where the tender plan sought to give effect to the Development Pathway by assuming a four-year lead time between receiving an LTESA and commissioning.

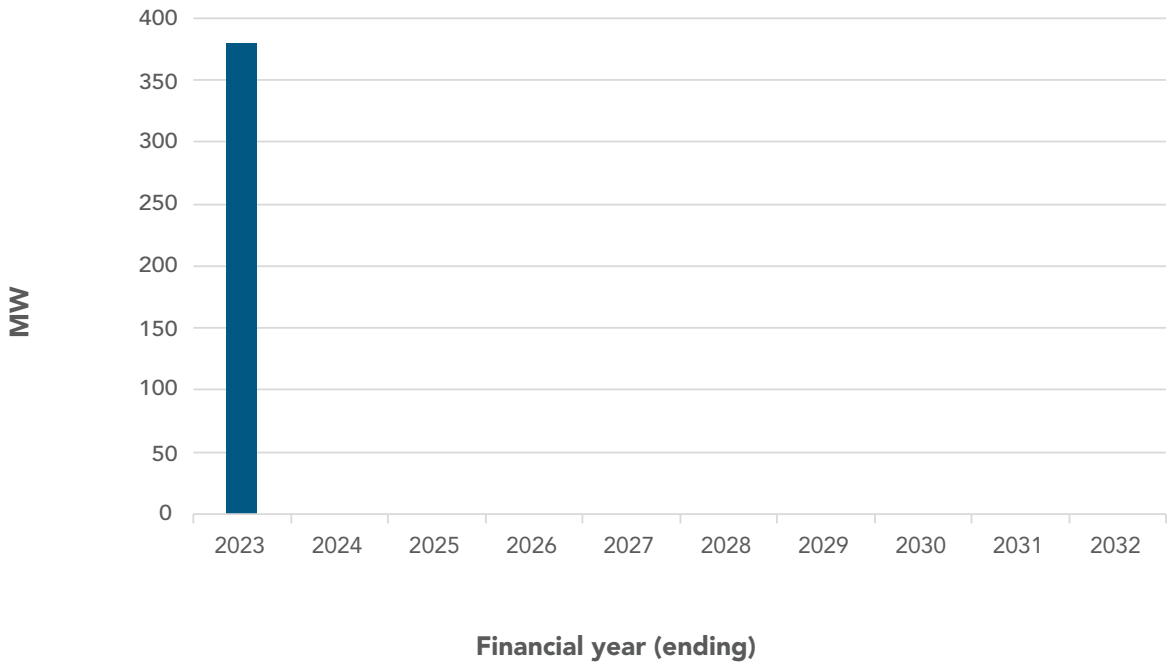
In the Q2 2023, 2024 and 2025 tenders under the plan, AEMO Services will consider recommending projects up to the 2 GW target, if it is in the long-term financial interests of NSW customers. However, this will depend on the market out-performing the assumptions used in preparing the Draft Development Pathway. Should projects not be of sufficient quality and/or financial value in these tenders, then AEMO Services will proceed to conduct the contingent tenders set out in Figure 21 until the 2 GW target is met.

How AEMO Services might adjust the indicative tender sizes over time in response to various events is discussed in section 4.5.

4.4 Firming infrastructure

The timing and indicative sizing for competitive tenders for firming infrastructure over the next 10-year period is shown in Figure 22.

Figure 22: Draft 10-Year Plan (Firming)



Consistent with the 2022 IIO Report, the 10-Year Plan for firming consists of a single tender, which AEMO Services has determined should commence in Q2 2023. The minimum indicative size of the tender is 380 MW and the firming infrastructure must be located within the Sydney-Newcastle-Wollongong sub-region (or in close proximity to this sub-region, provided it can demonstrate its contribution to meeting the energy security target). To meet the Development Pathway, the recommended projects are required to be commissioned by December 2025.

This is the only firming tender expected to be conducted at this stage. Should circumstances change, the NSW Energy Minister may direct AEMO Services to conduct an additional firming infrastructure tender.

4.5 Adjusting the 10-Year Plan over time

There are various circumstances in which AEMO Services may adjust the indicative tender sizes in the 10-Year Plan.

For example, and without limitation, AEMO Services may determine to vary the indicative tender sizes in the following circumstances:

- If a material event has or is anticipated to occur in the energy market, with the alternative scenarios modelled for this report providing an indication of how AEMO Services may seek to vary the Draft Development Pathway (and corresponding tenders).
- If AEMO Services decides to recommend more LTESAs than the indicative size as part of a tender, because:
  - tender submissions demonstrate more competitive prices or earlier project lead times than assumed by AEMO Services in setting the Development Pathway and 10-Year Plan, or
  - individual projects of high merit are of a large size and exceed the indicative tender size.
- If AEMO Services decides to recommend fewer LTESAs than the indicative size as part of a tender, because tender submissions demonstrate less competitive prices or later project lead times than assumed by AEMO Services in setting the Development Pathway and 10-Year Plan.

In such circumstances, AEMO Services expects to adjust the indicative size of the subsequent tenders for the remainder of the 10-Year Plan.

In addition to simplifying the 10-Year Plan for the market, this approach is intended to enhance competition. It provides an incentive for projects to participate early (given the possibility of AEMO Services recommending LTESAs above the indicative size if high-quality bids are received), while also ensuring that the subsequent tenders remain of a size that allows large projects to participate.

As noted above, where a tender participant is seeking an access right only, AEMO Services may recommend the award of access rights above the indicative tender size (up to the maximum aggregate capacity for any given REZ).

5. Determining the Draft Development Pathway

Key updates to methodology

- **Scenarios of different futures:** For this report, AEMO Services has considered four scenarios representing different futures. These scenarios consist of different assumptions, including in relation to demand for electricity and technology costs. This differs to the modelling that informed the 2021 and 2022 IIO Reports, where AEMO Services modelled the consumer impact of different build trajectories for generation infrastructure under a consistent set of assumptions. For this draft report, AEMO Services has selected the build trajectory under the scenario it considers most likely, while the other scenarios provide useful insights into the resilience of this build and how it may need to be updated if different circumstances eventuate.
- **Co-optimisation of generation, storage and network builds:** As well as considering generation and long-duration storage needs, the model was able to select from inputs provided by EnergyCo regarding network infrastructure options for NSW REZs and downstream capacity. This enabled the co-optimisation of investment in generation, long-duration storage, firming and network infrastructure across the four scenarios. These detailed network inputs were not available for the modelling that informed the 2021 and 2022 IIO Reports, and so those reports relied on static input assumptions regarding the scope and delivery timing of NSW network infrastructure.
- **Consideration of additional revenue streams:** In addition to considering wholesale electricity revenues for LTESA-eligible projects, modelling to inform this report also considered additional revenues associated with markets outside of the wholesale market, such as LGCs, FCAS markets and cap contract markets (as they differ between the four modelled scenarios). These additional revenue streams act to reduce scheme costs associated with LTESAs, as they are considered a reduction to the 'missing money' required for each project to breakeven.

5.1 Overview of market modelling

AEMO Services uses electricity market modelling, undertaken by AEMO, to inform the Development Pathway. Key characteristics of this modelling are explored in this section of the report.

The market modelling involves considering a range of forecast inputs and assumptions over a 20-year period – including existing and planned supply, forecast demand, fuel costs, the transmission network configuration and the expected costs and attributes of new candidate infrastructure – to produce an optimal (consumer least-cost) trajectory for the development of new infrastructure (including generation, storage, firming and network infrastructure).

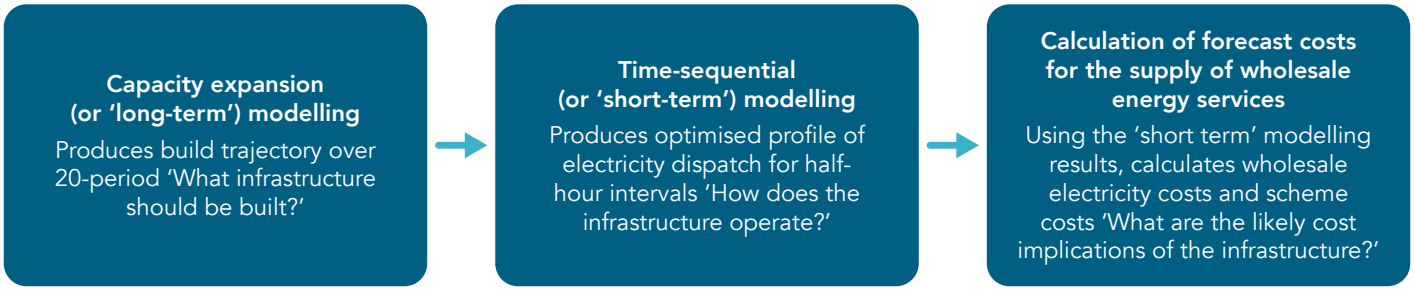
Given the multitude of variables, it is impossible to accurately forecast precise market conditions over a 20-year period. Rather, the purpose of the market modelling is to inform AEMO Services' decisions and ultimately inform investment decisions about timing and need for new infrastructure to best achieve outcomes for NSW electricity customers.

The preparation of this report relies on use of AEMO's in-house models and, except where otherwise noted in this report, use of inputs and assumptions consistent with AEMO's 2021 IASR.

AEMO perform two broad modelling steps to conduct the market modelling activities required for this report:

- Capacity outlook modelling, which produces a long-term capacity expansion plan (for generation, storage and transmission infrastructure) across various scenarios. This is sometimes referred to as the 'long term model'.
- Time-sequential modelling, which produces wholesale price forecasts for calculating wholesale electricity costs and subsequently LTESA scheme costs to NSW electricity customers. This is sometimes referred to as the 'short term model'. This step validates the long-term capacity expansion plan by optimising electricity dispatch for every half-hourly interval (with the intention of reflecting participant behaviour and network constraint limitations in a more granular manner than the capacity outlook model). The steps in the modelling process for this report are summarised in Figure 23.

Figure 23: Overview of IIO Report modelling steps



5.2 Minimising consumer costs

The objective functions of the model are to:

- minimise costs for NSW electricity customers across the 20-year horizon, and
- achieve the minimum infrastructure investment objectives of approximately 33,600 GWh per year of available generation volume and 2 GW of long-duration storage by the end of 2029.

The model also includes proxies for the reliability standard and energy security target.

The model allows for the entry of generation or long-duration storage infrastructure that is additional to the minimum requirements, both before and after the end of 2029 if it is calculated to minimise costs for NSW electricity customers or is required to maintain reliability.

The objective functions of the model differ slightly from that of AEMO's standard modelling approach for the ISP. AEMO's ISP modelling optimises to produce least-cost outcomes across the energy system, with a particular focus on the capital costs of new infrastructure in the capacity expansion modelling stage. The modelling for the IIO Reports involves a level of iteration between the capacity expansion model and the time-sequential model. The purpose of this iteration is to validate the expansion plan produced in the capacity expansion step by assessing how the planned infrastructure is likely to operate and bid into the electricity market. In doing so, the modelling exercise is able to forecast the likely impacts of the new infrastructure on wholesale electricity costs, as well as the costs likely to be paid out under LTESAs. The costs of EII Act network infrastructure are also added at the third stage where the cost forecast is calculated.

As outlined in section 3.7, the model seeks to minimise wholesale electricity costs and scheme costs associated with LTESAs and certain network infrastructure projects. The calculation methodologies for each cost component are described in Table 5 in that section.

5.3 Scenarios

In preparing the Draft Development Pathway, AEMO Services has considered four scenarios representing different futures.

5.3.1 Four scenarios

The four scenarios were modelled to produce four alternative development pathways for each of generation, long-duration storage and firming infrastructure.[76] The build trajectories under each of the four scenarios are driven by a range of assumptions. Those assumptions are primarily drawn from AEMO's 2021 IASR, except where otherwise noted in this report. The input assumptions for each of the four scenarios are discussed in further detail in section 5.3.2.

The scenarios can be broadly described as follows:

- **Central:** This scenario largely aligns with the 'Step Change' scenario in AEMO's 2022 ISP.[77] It involves rapid consumer-led transformation of the energy sector and coordinated, economy-wide action to transition from fossil fuels to renewable energy in the NEM. Of the scenarios considered in the 2022 ISP, energy industry stakeholders considered this scenario to be the most likely to eventuate.[78]
- **No Coal by 2030 with Strong Electrification:** This scenario largely aligns with the Hydrogen Superpower in AEMO 2022 ISP.[79] It involves a rapid transition away from fossil fuels and a significant increase in electricity demand to support decarbonisation of the transport and manufacturing sectors, and the establishment of a hydrogen export industry in Australia.
- **Transmission Delay:** This scenario uses the same assumptions as the Central scenario described above, except that key actionable ISP network projects are assumed to be delivered later and the model limits the ability of new REZ network infrastructure to enter before certain dates.
- **Early Coal Exit:** This scenario uses the same assumptions as the Central scenario described above, except that it assumes that all units comprising the Bayswater Power Station retire by June 2030 and the accelerated delivery of some transmission augmentations.

76 For its NIS, EnergyCo has focussed on the results of three of these modelled scenarios.

77 See 2022 ISP, page 27.

78 2022 ISP, section 2.3.

79 See 2022 ISP, page 27.

5.3.2 Scenario input assumptions

A summary of key assumptions across the four scenarios modelled for this report (focussing on where they differ between scenarios) is included in Table 6, along with the source of the assumption. Most assumptions align with AEMO's 2021 IASR or off-cycle updates to these assumptions by AEMO.

Table 6: Key modelling assumptions

Assumption	Source	Central, Transmission Delay and Early Coal Exit scenarios			No Coal by 2030 with Strong Electrification scenario		
FYE		**2025**	**2030**	**2035**	**2025**	**2030**	**2035**
Demand – side							
NSW total operational consumption (GWh)	2022 ESOO	64,042	65,665	69,476	65,887	70,966	83,155
NSW distributed PV generation (GWh)	2022 ISP	8,401	11,970	15,380	8,828	13,168	17,017
NSW embedded energy storages (MW)	2022 ISP	998	2,949	6,673	1,122	3,404	7,466
Supply – side							
Assumed capacity	AEMO Generation Information (July 2022)	Existing, committed and anticipated projects are assumed as per AEMO Generation Information. Additional assumed capacity includes a 376 MW firming infrastructure in 2025-26 and the 850 MW Waratah Super Battery in 2025-26 (only part of which participates in the wholesale market).					
Coal retirement timing	2022 ISP	Aligned with 2022 ISP Step Change outcomes (except in Early Coal Exit, where all Bayswater units are retired by 2030)			Aligned with the 2022 ISP Hydrogen Superpower outcomes		
Capital cost of 2-hour battery* ($/kW)	CSIRO GenCost 2022	976	810	706	906	722	606
Capital cost of 8-hour battery* ($/kW)	CSIRO GenCost 2022	2,600	2,048	1,752	2,320	1,712	1,384
Capital cost of wind (onshore)* ($/kW)	CSIRO GenCost 2022	1,907	1,740	1,619	1,779	1,591	1,504
Capital cost of solar PV* ($/kW)	CSIRO GenCost 2022	1,305	1,080	885	913	578	529
Capital cost of pumped hydro 8 hours* ($/kW)	CSIRO GenCost 2022	2,508	2,487	2,465	2,508	2,487	2,465
Other jurisdictional policies							
QRET	2021 IASR	50% of Queensland electricity consumption to be provided by renewable generation by 2030					
TRET	2021 IASR	15,750 GWh of renewable generation by 2030 and 21,000 GWh of renewable generation by 2040					
VRET	2021 IASR	New entry renewable capacity required to meet a target of 40% of total Victorian generation by 2025 and 50% of total Victorian generation by 2030					

*Build costs in the model are applied on a technology-specific regional basis and should be considered alongside AEMO's Regional Cost Factors presented in the 2021 IASR.

The modelling for this report did include some key diversions from the 2022 ISP in terms of assumptions. In particular, modelling to inform the Draft Development Pathway is designed to identify development pathways in respect of generation and long-duration storage infrastructure that meet the minimum objectives specified in the EII Act (see section 2).[80] AEMO Services also imposes annual build limits for new (i.e. non-existing or committed) renewable energy projects in NSW to reflect supply chain constraints, as well as locational build limits in the first few years of the modelling horizon to reflect the existing pipeline of projects. The intention of these build limits is to produce development pathways that are achievable having regard to economic and logistical circumstances. The modelling also includes updated assumptions regarding costs of coal and gas fuel, renewable generation, transmission infrastructure, and other assumptions regarding NSW REZs. The key diversions in input assumptions from the 2022 ISP are summarised in Table 7.

Table 7: Key modelling assumption diversions from the 2022 ISP

Assumption	2022 ISP assumption	Draft 2023 IIO Report assumption	Rationale for diversion
Annual build limit to reflect a supply chain constraint	N/A	A limit of new generation infrastructure in NSW capable of producing approximately 6,000 GWh per year was assumed until 2030. Post-2030, a build constraint of generation infrastructure in NSW capable of producing approximately 7,600 GWh per year is applied.	Explicit consideration of supply chain constraints[81]
Technology-specific and locational build limits	N/A	Technology-specific build limits for each NSW subregion informed by EnergyCo analysis of project pipeline data. This equates to ~3 GW total new VRE limit by 2024-25 and ~7 GW total new VRE limit by 2025-26, as well as 2.5 GW pumped hydro limit by 2030-31.	Updated view on near-term ability for new project development using real world data
Build costs	CSIRO GenCost 2020-21: Final Report	CSIRO GenCost 2021-22: Final Report	Latest information at time of modelling
Coal and gas fuel cost assumptions[82]	2021 IASR	Off-the-shelf CORE Energy & Resources coal and gas forecast	Market conditions had changed since development of 2021 IASR assumptions at time of modelling
Generation, storage and transmission WACCs (real, pre-tax)	5.5% consistently for all technologies[83]	WACC assumptions for generation and storage projects are based on their technology, whether they have an LTESA and whether they are connecting to a NSW REZ. These assumptions are in line with the 2020 NAB report[84, 85] and will be updated for the Final 2023 IIO Report. WACC assumptions for transmission projects differ by region. The regulated WACC from the corresponding TNSP's 2022 AER determination is assumed. AEMO Services is intending to update these assumptions for the Final 2023 IIO Report.	Variations in cost of capital are important to reflect for the accuracy of consumer costs
Target transmission curtailment level	N/A	A constraint is applied to limit the amount of generation overbuild in the NSW REZs to reflect access scheme declaration settings such as the CWO REZ Target Transmission Curtailment Level.	Reflective of REZ Access Rights

80 The ISP considers AEMO Services' development pathway as an input to its modelling and does not identify a least-consumer cost path independently.

81 Appendix B of the 2021 IIO Report outlines the rationale on the Supply Chain Adjusted development pathway and how it considers a minimum and maximum amount of generation entry in NSW per year to reflect supply chain constraints.

82 AEMO has updated its coal and gas price forecasts for the Draft 2023 IASR, which are generally higher than what was assumed in the 2021 IASR and in Draft 2023 IIO Report modelling.

83 AEMO has since updated its WACC and discount rate assumption for the Central scenario for the Draft 2023 IASR, to 7%.

84 https://www.energy.nsw.gov.au/sites/default/files/2022-08/NSW%20Electricity%20Infrastructure%20Roadmap%20-%20WACC%20Report.pdf

85 The WACC value assigned to long-duration storage was aligned with the AEMO 2021 IASR (5.5%) given the valued produced in the 2020 NAB report was deemed unreasonably low.

Hunter Central Coast REZ	Does not exist in the 2022 ISP.	Exists as the HCC REZ which replaces the 2022 ISP NSW Shadow REZ.	New REZ as per legislation
REZ network augmentations	Options as per 2021 IASR	Optimise for timing of all NEM REZ network augmentations. Options, timings and costs for NSW REZs provided by EnergyCo	Updated information from EnergyCo

The modelling for this report also takes inputs provided by EnergyCo regarding network projects, which were independently reviewed for credibility by AEMO. These inputs enabled the co-optimisation of investment in generation, long-duration storage, firming and network infrastructure across the four scenarios. The model is able to select from network infrastructure options for NSW REZs and downstream capacity, which includes the additional network capacity delivered by the option, its earliest delivery date and its cost. The outcomes of this modelling are discussed in section 5.4. This work complements the final NIS, which will be on EnergyCo's website.

Updated assumptions around the delivery timing of some non-REZ transmission augmentations, including Project EnergyConnect, HumeLink and Hunter Transmission Project, were also provided by EnergyCo and incorporated into the modelling. These updated assumptions for each of the four scenarios (as they compare to the 2022 ISP Step Change scenario) are summarised in Table 8.[86]

Table 8: Assumed timing of network augmentations (financial year ending)

Augmentation	Central	No Coal by 2030 with Strong Electrification	Transmission Delay	Early Coal Exit	2022 ISP Step Change
QNI Connect	2031	2028	2031	2029	2033
Northern Sydney Ring (Hunter Transmission Project)	2028	2028	2029	2028	2028
HumeLink	2029	2027	2030	2027	2027
VNI West	2032	2031	2033	2032	2032
Project EnergyConnect	2027	2027	2027	2027	2027

5.4 Comparing the scenarios

Modelling the four scenarios has produced four alternative development pathways for generation, long-duration storage and firming infrastructure, each representing a least-consumer cost build trajectory having regard to the different input assumptions. Their differences are explored below.

The least-consumer cost build trajectory under a Central scenario is considered to be most likely. The other three scenarios – two based on the Central scenario with key discrete variations, and one considering a significantly different future – were modelled to provide insights as to the resilience of the build trajectory under the Central scenario to change. This approach differs to that taken for the modelling which informed the 2021 and 2022 IIO Reports, where AEMO Services considered the cost, reliability, emissions and resilience outcomes of different build trajectories under a consistent set of core assumptions.

The different build trajectories for each infrastructure type across the four scenarios are discussed in section 5.4.1. Each of these trajectories meets the minimum infrastructure investment objectives established by the EII Act. In addition to representing least-cost pathways for NSW electricity customers, the pathways are expected to satisfy the overall objectives of meeting the reliability standard and the energy security target.[87]

For completeness, the differences between the modelled outcomes in terms of costs, carbon emission profiles and network infrastructure build are also discussed in the following sections.

86 Table 8 sets out assumptions for network infrastructure projects that were provided by EnergyCo, except in respect of QNI Connection. The timing of QNI Connect under each scenario was an outcome of the modelling undertaken for this report.

87 AEMO Services has not undertaken an energy security target calculation or detailed reliability assessment for the purposes of this draft report. However, the model does require 'minimum reserve levels' to be met as a proxy for these measures. More detail calculations and assessments will be undertaken as part of an updated modelling exercise for the final report to confirm both the energy security target and reliability standard are met under the updated Development Pathway.

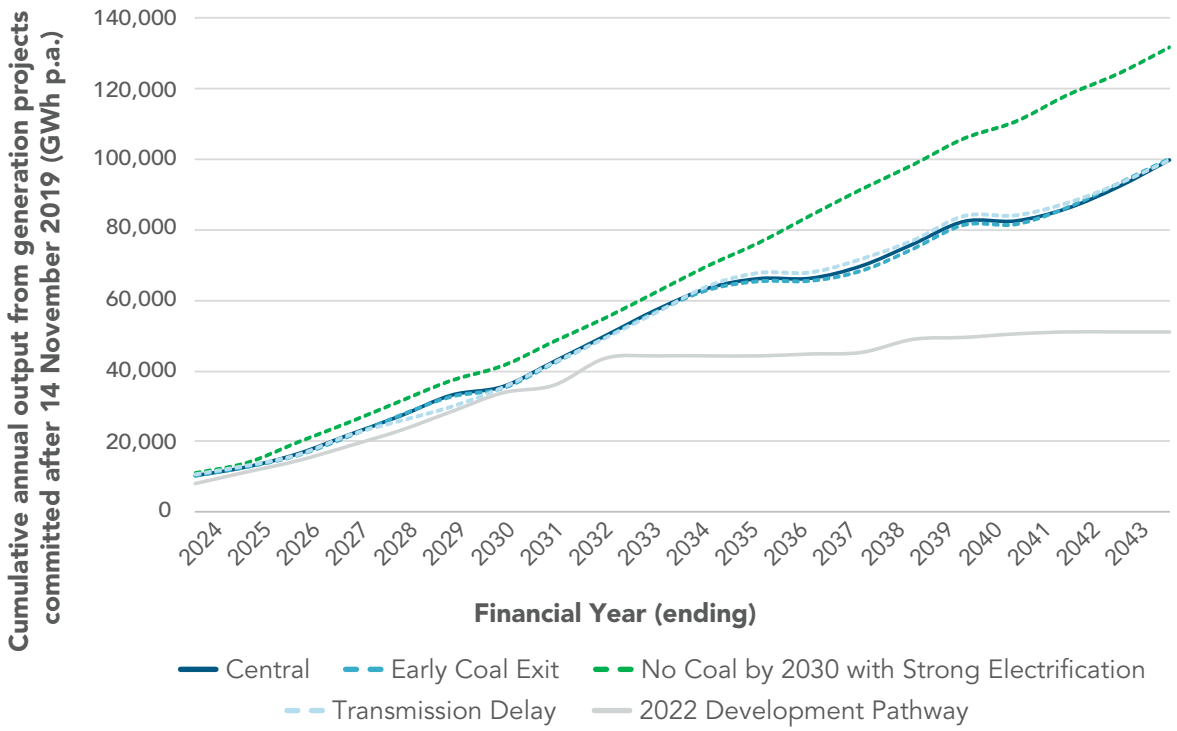
5.4.1 Build trajectories

This section compares the build trajectories for generation, long-duration storage and firming infrastructure under each of the four modelled scenarios.

Generation infrastructure

The build trajectories for generation infrastructure under the four scenarios are set out in Figure 24.

Figure 24: Comparison of alternative development pathways (generation)



To achieve the legislated minimum construction objectives of 33,600 GWh of annual generation from renewables by 2030, there is very little choice in the development pathway prior to this. This means the trajectories to 2030 under each of the scenarios is largely aligned with the 2022 Development Pathway. Analysis indicates that the least-cost trajectory, having regard to supply chain constraints, is largely unaffected by changes in demand, coal plant retirements or network infrastructure delays in the period before 2030.

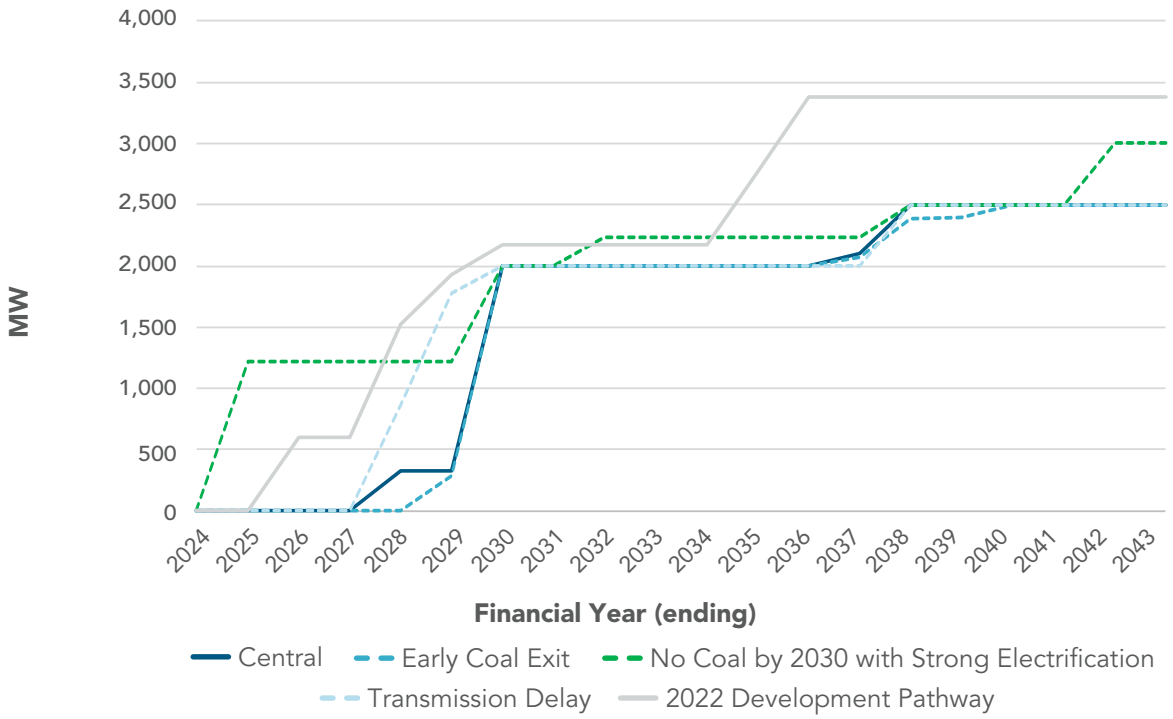
In the early years of the Development Pathway to 2030, the risks of overbuilding generation infrastructure are much lower than those associated with building less than what is modelled to be required under the Central scenario.

The generation builds under the Central, Transmission Delay and Early Coal Exit scenarios are largely aligned beyond 2030, while the No Coal by 2030 with Strong Electrification scenario involves a significantly greater amount of generation in order to align with the increase in energy demand.

Long-duration storage infrastructure

The build trajectories for long-duration storage infrastructure under the four scenarios are set out in Figure 25.

Figure 25: Comparison of alternative development pathways (long-duration storage)



The build trajectories for long-duration storage infrastructure vary significantly from each other and from the 2022 Development Pathway. As noted in section 4.3, the assumptions regarding pumped hydro lead times and the costs of long-duration batteries are uncertain. AEMO Services will continue to test these assumptions via our long-duration storage LTESA tenders.

Under the Central and Early Coal Exit scenarios, the delivery of long-duration storage infrastructure only begins from mid-2027. This is based on AEMO Services' current understanding of the lead times for pumped hydro projects in NSW and the assumption that long-duration batteries will not be cost competitive until after this time.

Under the Transmission Delay scenario, the need for long-duration storage capacity is brought forward. This is driven by a reliability need resulting from the one-year delay of the Hunter Transmission Project (which is delivered in 2027-28 in the Central scenario). While this is not featured in the Draft Development Pathway (given it is based on the Central scenario), AEMO Services is mindful of the implications of delayed transmission delivery and the potential need for earlier delivery of long-duration storage infrastructure. After 2030, the Transmission Delay and Central scenarios are aligned.

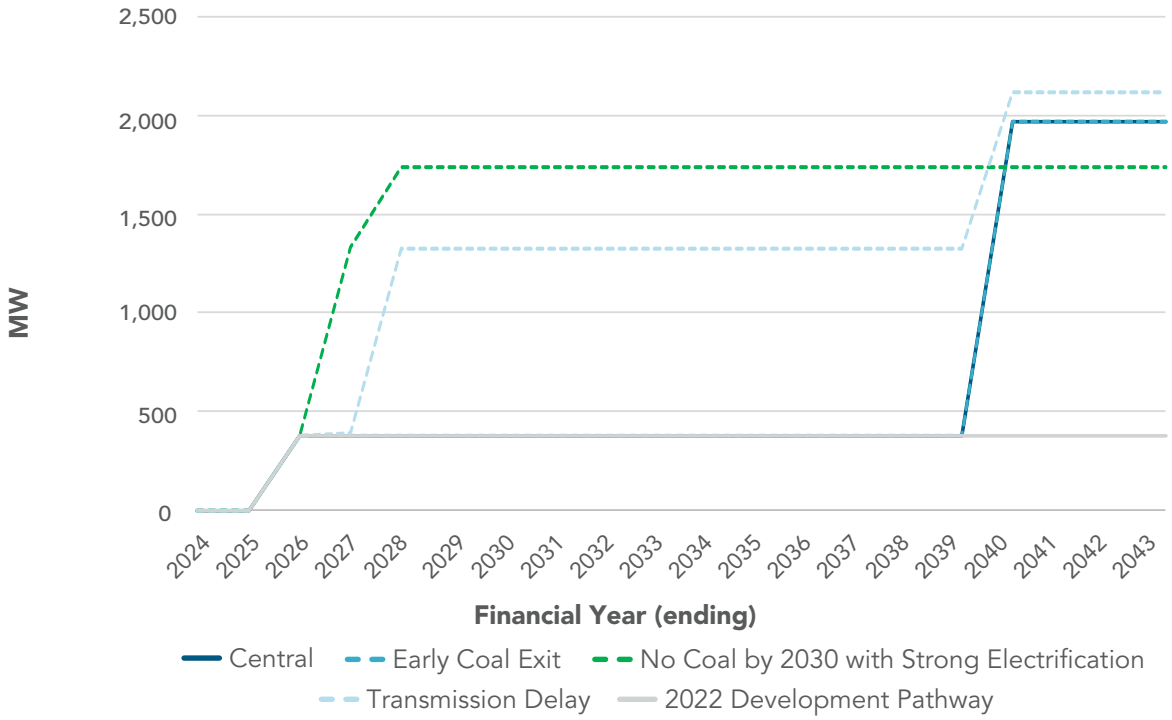
Under the No Coal by 2030 with Strong Electrification scenario, the build trajectory is further brought forward, with higher-cost long-duration batteries entering earlier (rather than the model indicating that investments should wait for pumped hydro projects). This suggests that if it is possible there could be value in delivering long-duration storage earlier in the 2020s. This supports AEMO Services' approach to tendering for long-duration storage infrastructure discussed in section 4.3.

Firming infrastructure

The modelling for this report enabled additional short-duration storage and gas generation to enter in order to meet the reliability standard.[88] These technologies would generally fall within the definition of firming infrastructure under the EII Act.

The build trajectories for firming infrastructure under the four scenarios are set out in Figure 26.

Figure 26: Comparison of alternative development pathways (firming)



Under the Central scenario, no additional firming infrastructure beyond the 380 MW identified in the 2022 IIO Report is required until 2040. This is the same for the Early Coal Exit scenario.

In contrast, under both the No Coal by 2030 with Strong Electrification and Transmission Delay scenarios, additional short-duration firming would be required in the 2020s in the Sydney-Newcastle-Wollongong sub-region to meet the reliability standard. In the No Coal by 2030 with Strong Electrification scenario, the need for this firming is driven by a significant increase in demand for electricity, while in the Transmission Delay scenario a smaller amount is required because delayed network augmentations limit the supply of electricity to relevant load centres.

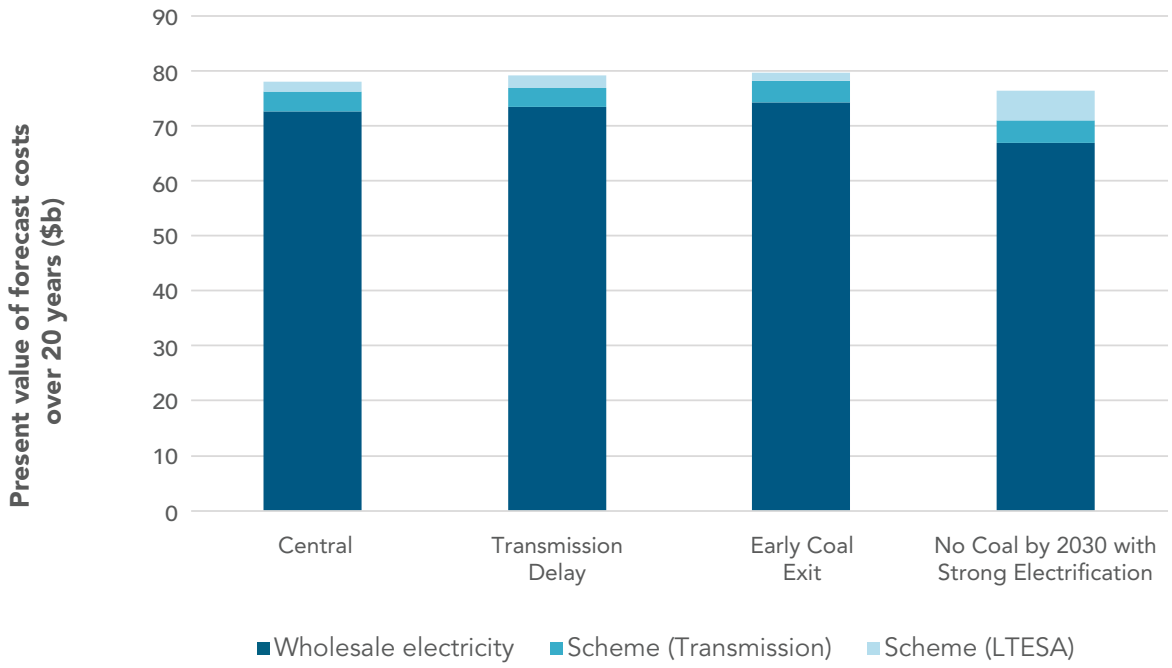
The modelling shows that this additional firming infrastructure is not entirely economic, rather it is required to meet the reliability standard. Accordingly, in the cost calculations detailed in section 5.4.1, tthis additional firming infrastructure increases the LTESA scheme costs under these scenarios.

88 As noted above, AEMO Services did not undertake a detailed reliability assessment for this draft report but rather, as is typical for the ISP modelling, relied on the incorporation of minimum reserve levels in the model as a proxy for meeting the reliability standard. A detailed reliability assessment will be undertaken for the final 2023 IIO Report to confirm that the ultimate development pathway meets the reliability standard.

5.4.2 Comparison of cost outcomes

Figure 27 outlines the forecast costs[89] for the supply of wholesale energy services to NSW electricity customers over a 20-year period under each of the modelled scenarios. Importantly, the build trajectory under each scenario is forecast to be the least-cost trajectory under the different input assumptions for that scenario. As discussed in section 5.5, AEMO Services' role is not to select the scenario under which forecast costs are expected to be lowest. Rather, AEMO Services has considered which scenario is most likely based on current information.

Figure 27: Present value of forecast costs by scenario



Wholesale electricity costs are the greatest driver of lower forecast costs under the No Coal by 2030 with Strong Electrification scenario, compared to the Central scenario. From the mid 2030s, wholesale electricity costs under the No Coal by 2030 with Strong Electrification scenario are materially lower than under the Central scenario due to higher levels of renewable generation coupled with high levels of 'flexible' demand (particularly in the form of hydrogen electrolysers).

The cost forecasts under the No Coal by 2030 with Strong Electrification scenario are dependent on a number of factors outside of AEMO Services' control, which are highly unlikely to eventuate (at least in the short term). In particular:

- Operational demand in NSW is 10% higher by 2030 under the No Coal by 2030 with Strong Electrification scenario than the Central scenario.
- There are high levels of flexible demand and approximately 900 MW additional embedded and aggregated storage.
- The cost of utility-scale solar PV is almost 50% lower by 2030 under the No Coal by 2030 with Strong Electrification scenario than in the Central scenario.

AEMO's latest 2023 Draft IASR does not include the Hydrogen Superpower scenario (the basis of the No Coal by 2030 with Strong Electrification scenario) and instead describes a Green Energy Exports scenario. Some assumptions under this new draft scenario more closely resemble the Central scenario, for example the cost of utility-scale solar PV is only 8% lower by 2030 compared to AEMO's new Diverse Step Change scenario.

There are significant deliverability risks in seeking to deliver the capacity outlook of the No Coal by 2030 with Strong Electrification scenario due to supply chain constraints, especially in the short-term. These risks may increase the cost of solar PV, which is not contemplated in the input assumptions. The forecast costs for the No Coal by 2030 with Strong Electrification scenario also do not account for additional costs associated with the development of a hydrogen industry or behind-the-metre distributed resources, which further support wholesale price suppression.

89 The present value of the cost forecast is in real 2021 dollars, calculated by discounting costs to the first modelling year (2023-24) at a real discount rate of 5.5% (consistent with the discount rate in AEMO's 2021 IASR).

Under the Early Coal Exit scenario, wholesale electricity costs are higher than under the Central scenario due to the relatively lower supply of generation (given the earlier retirement of coal-fired generation[90]). The earlier exit of coal generator units increases the amount of generation required by existing gas units in order to meet demand, as well as greater reliance on electricity import from other regions, which in turn increases NSW wholesale prices.

Under the Transmission Delay scenario, both wholesale electricity costs and scheme costs are higher than under the Central scenario. Wholesale electricity costs are projected to be higher because the model builds new generation infrastructure less efficiently to meet the minimum objectives, with higher curtailment of renewable generation and utilisation of resources with lower potential (given the need to locate projects in areas with more existing network availability). This also assumes that the market has perfect foresight enabling it to respond to a major transmission project delay. If there is not sufficient time to respond, then costs under this scenario can be expected to be even higher. Increased firming in the form of gas also contributes to higher wholesale electricity costs under this scenario. The higher levels of curtailment also mean that LTESA scheme costs are higher than under the Central scenario, as projects require more financial support via LTESAs.

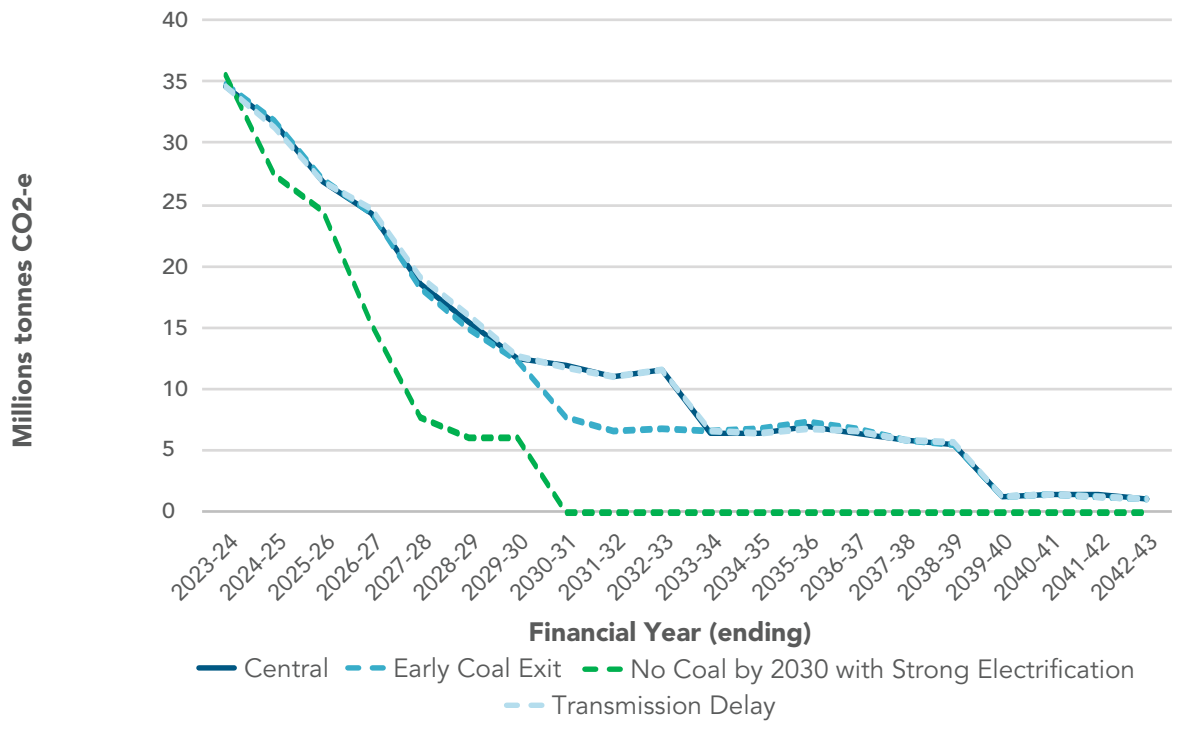
5.4.3 Comparison of emissions profiles

Figure 28 sets out the trajectories of carbon dioxide equivalent (CO2-e) emissions in the NEM under each of the modelled scenarios.

Under each of the scenarios, CO2-e emissions reduce significantly, reaching largely the same end-point by the end of the Draft Development Pathway. Decarbonisation occurs much more rapidly under the No Coal by 2030 with Strong Electrification scenario, due to the earlier phase out of existing coal-fired generation and the use of short-duration battery storage rather than gas-based firming). The reduction in CO2-e emissions is very similar across the Central, Transmission Delay and Early Coal Exit scenarios.

The rate of emissions reduction is driven by coal-fired generator retirement, uptake of rooftop solar and the build rate of new utility-scale renewable generation infrastructure.

Figure 28: Comparison of modelled NSW emissions profiles



90 While this scenario assumes the earlier retirement of two Bayswater units relative to the Central scenario, the modelling assumes perfect foresight for investment across the NEM in response.

5.4.4 Co-optimised network augmentation scheme

Each alternative development pathway also includes a different schedule of optimal timings for major REZ network augmentations, as set out in Table 9. This is in addition to the non-REZ network augmentation input assumptions outlined in Table 8.

Table 9: Modelled optimal timing of REZ network infrastructure projects (financial year ending)

REZ option	Additional REZ network capacity (MW)	Scenario			
		Central	No Coal by 2030 with Strong Electrification	Transmission Delay	Early Coal Exit
New England Option 1	3,000	2029	2029	2030	2029
New England Option 2B	3,000	2033	2033	2034	2033
New England Option 3C	1,500	Not built	2037	Not built	Not built
CWO Option 1	3,000	2028	2028	2029	2028
CWO Option 2A	1,000	2032	2031	2033	2032
CWO Option 2B	1,500	2038	2035	2038	2038
CWO Option 3A	3,000	Not built	2035	Not built	Not built
CWO Option 4	500	Not built	2042	Not built	Not built
HCC Option 1	950	Not built	2037	2028	2027
HCC Option 2	700	Not built	2040	2031	2033
HCC Option 3	500	2027	2027	Not built	Not built
HCC Option 4	800	Not built	2042	Not built	Not built

Under the No Coal by 2030 with Strong Electrification scenario, additional REZ network capacity is required overall and earlier than under the Central scenario. This affects the overall size of the REZs planned for NSW. For example, the Hunter-Central Coast REZ is forecast to have a network capacity of approximately 3 GW by 2042 under the No Coal by 2030 with Strong Electrification scenario, which is four times the size forecast to be required under the Central scenario by the same year.

In contrast, the Transmission Delay scenario included assumptions that some REZ projects could not be delivered prior to certain dates. This results in REZ network capacity being delivered later than under the Central scenario.

The trajectory for REZ network infrastructure affects the rate and quality of renewable generation constructed in NSW, as well as the transmission costs under the EII Act contribution determination process.

5.5 Selecting a Draft Development Pathway

AEMO Services has assessed the four alternative development pathways and selected the build trajectory under the Central scenario as the Draft Development Pathway. The modelled scenarios represent future scenarios of external factors, such as demand for electricity, capital costs for different technologies, and lead times for network infrastructure. In determining the Draft Development Pathway, AEMO Services has selected the build trajectory under the scenario it considers most likely to eventuate based on current information.

The other scenarios modelled for this report – comprising assumptions considered less likely to eventuate – provide useful insights into how the Draft Development Pathway may need to change (and how quickly this may be required) if future circumstances depart from the most likely scenario.

AEMO Services has selected the build trajectory under the Central scenario as the Draft Development Pathway for the reasons outlined in this section. In particular:

- based on current information, AEMO Services considers that the assumptions forming the Central scenario are more likely to eventuate than those under the No Coal by 2030 with Strong Electrification scenario,[91] and
- the build trajectory under the Central scenario:
  - represents the least-cost build under the Central scenario assumptions,
  - enables a level of resilience, with the ability to respond if risks such as an early coal withdrawal or a delay to a major transmission augmentation were to eventuate, and
  - enables AEMO Services to implement a 10-Year Plan that promotes competition via regular-sized tenders for LTESAs in respect of both generation and long-duration storage infrastructure.

AEMO Services' view regarding the likelihood of the Central scenario is consistent with AEMO's panel of experts that were used in considering which of the 2022 ISP scenarios was most likely to eventuate.[92]

AEMO Services and EnergyCo also consulted with a reference group representing consumers in designing the scenarios modelled for this draft report and the NIS. As outlined in section 6, we welcome feedback from other stakeholders on the appropriateness of these scenarios.

The other scenarios modelled for this report provide useful insights as to how the Draft Development Pathway may need to change if different circumstances were to eventuate. For example, the Transmission Delay and No Coal by 2030 with Strong Electrification scenarios indicate that if supply is lower or demand is greater than forecast under the Central scenario, this will likely result in the need for more long-duration and short-duration storage within the Sydney-Newcastle-Wollongong sub-region.

Based on current information, AEMO Services does not consider that it is appropriate to plan investment in new generation, long-duration storage or firming infrastructure based on the Transmission Delay or Early Coal Exit scenarios. While there is a material risk that assumptions forming part these scenarios may eventuate, modelling suggests that to plan the Development Pathway based on these scenarios now (for example, through accelerating the roll-out of firming infrastructure) could increase costs for the supply of wholesale energy services to NSW electricity customers.

There is scope to modify the Draft Development Pathway in coming years if the likelihood of these risks were to increase. The modelled build trajectories under the Transmission Delay and Early Coal Exit scenarios provide an indication as to what would be required in such cases, for example, through the construction of additional firming infrastructure. Such infrastructure can generally be deployed relatively quickly in response to market changes (compared to, for example, transmission or long-duration storage infrastructure, which generally have longer lead times). The modelling indicates that, under the Transmission Delay scenario, firming infrastructure may be required in 2027-28. Conducting a tender to support such infrastructure would require a direction from the Minister, with that tender needing to be held in 2025 at the latest (assuming a two-year lead time). AEMO Services will continue to closely monitor market events and the progress of new infrastructure as it undertakes its planning and procurement functions.

In contrast, AEMO Services notes that a more risk-based approach to planning for network infrastructure may be justified, given the longer lead times for network infrastructure compared to firming infrastructure, and EnergyCo has considered these matters in setting out a sequence of network infrastructure development in the NIS.

The legislated two-year cycle for IIO Reports will enable AEMO Services to re-assess future conditions as part of the 2025 IIO Report. By this time, it is expected we will have greater certainty in respect of a range of matters, particularly around the timing for the delivery of critical network infrastructure upgrades.

91 2022 ISP, page 33.

92 2022 ISP, section 2.3.

5.6 Resilience to lulls in variable renewable energy sources

The IIO Report must contain an assessment of the resilience of the NSW electricity system in relation to lulls in variable renewable energy (VRE) sources, as it relates to the Development Pathway.[93] The detailed assessment applied in the 2022 Firming IIO report indicated that the 2022 Development Pathway was resilient to VRE lulls.

This section provides an indicative assessment of the Draft Development Pathway via a comparison to the 2022 Development Pathway. This section also outlines the proposed methodology for the detailed assessment to be completed for the Final 2023 IIO Report. AEMO Services is seeking feedback on this proposed methodology.

5.6.1 Indicative resilience assessment

The 2022 IIO Report contained the inaugural assessment of resilience to VRE lulls. The assessment compared the level of generation, storage and interconnector headroom to the level of energy that would be needed if particular VRE lulls were to be extended to longer durations which were historically observed. The analysis indicated that the 2022 Development Pathway was resilient to VRE lulls but also indicated that the level of resilience generally decreases over time.

Figure 11, Figure 14 and Figure 17 in section 3 compare the Draft Development Pathway with the 2022 Development Pathway for Generation, Long-duration storage and Firming infrastructure. The following differences are observed:

- The Draft Development Pathway (Generation) is largely consistent out until 2030, after which it has a materially higher uptake of generation for the remainder of the modelling horizon.
- The Draft Development Pathway (Long-duration storage) is developed later in the 2020s before meeting the 2 GW minimum objectives in 2030. It also develops 875 MW less by the end of the modelling horizon.
- The Draft Development Pathway (Firming) is consistent until it develops an additional 1,590 MW in 2040.

Other notable modelling assumptions and outputs between the 2022 IIO Report and 2023 IIO Report and their differences are listed below:

- Some transmission timings have shifted (see Table 8).
- Coal generator closure dates have remained consistent with the 2022 ISP Step Scenario.
- Demand has been updated from the 2022 ISP Step Change Scenario to the 2022 ESOO Central scenario.

The most material difference between the Draft Development Pathway and the 2022 Development Pathway is the higher uptake of Generation from 2030 to 2043 and this would likely serve to increase resilience to VRE lulls.[94] The Draft Development Pathway has less long-duration storage capacity and more firming infrastructure capacity, and the net impact of this on resilience to VRE Lulls is likely to be limited. With other modelling assumptions and outputs remaining relatively similar, it is likely that the Draft Development Pathway is resilient to VRE lulls under the same methodology applied in the 2022 Firming IIO Report.

5.6.2 Proposed 2023 resilience to VRE lulls methodology

AEMO Services is already considering improvements to the 2022 IIO Report lull analysis method and invites feedback on these proposed improvements.

Refine the definition of a lull: In the 2022 IIO Report lull analysis method, VRE lulls were defined to occur when the 24-hour rolling average wind speed or solar irradiance within a REZ fell below the 5th percentile of the long-term average. This definition may be too geographically narrow, and neglects aggregated lull events across NSW. It is proposed that the new method define VRE lulls using aggregated NSW VRE generation availability.

Assess resilience using time-sequential modelling: In the 2022 IIO Report lull analysis method, the resilience assessment involved post-processing analysis of market modelling outcomes, whereby generation, storage and interconnection headroom was summed over the lull extension period. This meant that half-hourly dispatch dynamics were not captured. It is proposed that the new method endogenise the VRE lull extension into the input VRE traces and perform the resilience assessment through time-sequential modelling.

93 EII Regulation, clause 24(2)(e).

94 A diversity of VRE across technologies (wind and solar) and geographics (REZs) is what allows additional VRE to provide resilience to VRE lulls.

6. Consultation and next steps

6.1 Consultation overview

Consultation with our stakeholders is central to AEMO Services' role as the Consumer Trustee. AEMO Services welcomes and encourages written submissions from all stakeholders on the Draft 2023 IIO Report, as well as participation in our public forums and deep dive sessions.

AEMO Services has planned a consultation process to ensure stakeholders understand and have the opportunity to provide feedback on the content of, and process for preparing, the Draft 2023 IIO Report.

Several events are planned for the consultation process, as listed in Table 10 below. Please register for events through the AEMO Services website.

Written submissions should be sent to iioreport@aemoservices.com.au by 30 June 2023. Guidance on the content of those submissions is given below.

Table 10: Publication consultation events

Date	Event	Purpose
18 May 2023	Public webinar 1 – Draft IIO Report overview	Discuss and highlight key points in Draft 2023 IIO Report. Introduce key topics for feedback and consideration.
29 May 2023	Public Webinar 2 – Draft IIO Report overview (repeated)	Second briefing for those unavailable to attend the first.
w/c 5 June 2023	Deep dive sessions	Consultation around feedback topics for stakeholders to share views and opinions.

6.2 Guidance on written submissions

AEMO Services welcomes and encourages written submissions from all stakeholders on the Draft 2023 IIO Report.

To help guide the preparation of a submission, AEMO Services has compiled the following questions for your consideration:

- Do you consider the four scenarios (see section 5.3) are appropriate for the purposes of this report and provide sufficient insight to AEMO Services in preparing the Draft Development Pathway?
- To what extent do you think the Draft Development Pathway is likely to deliver value for NSW electricity customers, based on the information provided in this report?
- Do the annual build limits discussed in section 3.3 appropriately reflect supply chain constraints? Are there additional factors or approaches that AEMO Services could consider in seeking to reflect supply chain challenges?
- Beyond the build limits, how should AEMO Services account for risks to the timely delivery of generation, long-duration storage and firming infrastructure?
- Should AEMO Services be considering other factors in determining a Development Pathway?
- In designing the 10-Year Plan, are there other factors that should be considered to ensure AEMO Services can achieve the Development Pathway, and provide certainty to prospective bidders and promote competition?
- Are there improvements that could be made to the VRE lulls resilience assessment method in the 2022 IIO Report, noting the already proposed improvements for the 2023 method section 5.6.2? In particular, does this assessment method:
  - appropriately define VRE lulls?
  - appropriately utilise climate modelling?
  - appropriately assess the resilience of the NSW electricity system?

Submissions need not address every question posed and are not limited to them. Views related to inputs and assumptions or methodology which have been consulted on by AEMO separately as part of its ISP processes need not be reprosecuted here. AEMO Services as per section 1.2.4 of this report acknowledges that there are limitations to the modelling completed (this includes incorporating recent market developments such as timing for the delivery of Snowy 2.0 and a final investment decision being made on the first stage of a large-scale battery at the Eraring Power Station) and intends to capture these in the final 2023 IIO Report.

Submissions may be made public or shared with other stakeholders. If you wish for any elements of your submission to remain confidential, please identify them and explain why.