GHD Advisory

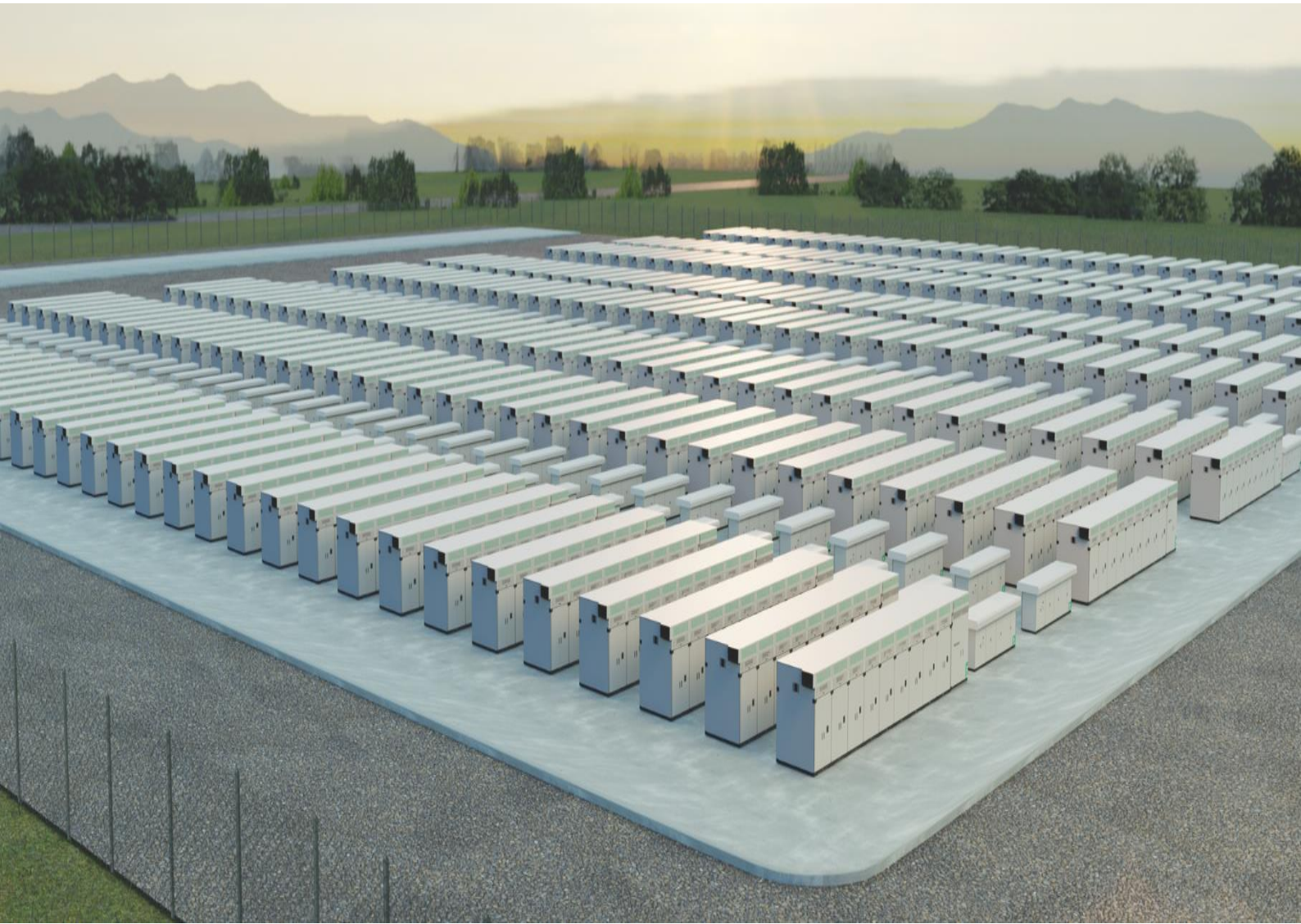
Waratah Super Battery

Non-contestable Independent Verification and Assessment

Transgrid

7 June 2023

→ The Power of Commitment



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Final	1	Bruce Clarke Raphael Ozsvath Mark Doherty	Guy Debney	[redacted]	Bruce Clarke	[redacted]	07/06/23

GHD Pty Ltd 39 008 488 373

180 Lonsdale Street

Melbourne, Vic 3000, Australia

T +61 3 8687 8000 | **F** +61 3 8687 6522 | **E** advisory@ghd.com | **ghd.com**

Executive Summary

In November 2020, the NSW Government released the NSW Electricity Infrastructure Roadmap (Roadmap). The Roadmap sets out a 20 year plan to transform the State's electricity system and is enabled by the Electricity Infrastructure Investment Act 2020 (EII Act). The EII Act is designed to support the delivery of the Roadmap which includes the delivery of the Waratah Super Battery (WSB).

Transgrid has been selected as the Network Operator for both the non-contestable and the contestable components of the WSB.

Non-contestable projects fall under the Transmission Efficiency Test and Revenue Determination Guidelines (TET) issued by the Australian Energy Regulator (AER) in April 2023. Based upon our understanding, the WSB project comprises the following non-contestable components related to Transgrid:

- A program of augmentations to existing transmission network lines and substation equipment
- System Integrity Protection Scheme (SIPS) control and communications systems (to be developed and operated by Transgrid).

GHD has been engaged to undertake independent verification and assessment of the non-contestable components of the WSB based on the requirements of the TET. GHD's scope of works, detailed in Section 1.2, is limited to independent verification and assessment of whether the:

- Scope of the project is appropriate to meet the requirements in the Ministerial Order
- Basis of Preparation (BOP) detailed in the capital forecasting methodology is reasonable
- Capital forecast is within ± 20 per cent the level of accuracy expected at this project stage considering the BOP and the level of support held / developed for each capital forecast component. With the accuracy and supportability of the resulting capital forecast assessed using a range of assurance techniques. These included validation against tender results, benchmarking against comparative projects, selection testing, recalculation and alignment with industry practice further detailed in Section 2.

For the purposes of this report, WSB refers only to the non-contestable components of the project.

The WSB project aims to address an expected breach of the NSW Energy Security Target in 2025–26 by increasing power transfer capacity on transmission lines that connect generation in the northern and southern regions of NSW to Sydney.

The forecasted costs (excl. equity raising costs) of the non-contestable is $254.8M detailed in the table below.

Table 1 Summary of Transgrid's WBS non-contestable capital forecast ($M, Real 2023-24)

Capital element	Total $M
Augmentation- Transmission lines	69.8
Augmentation- Substations	108.4
SIPS control	19.3
Labour and indirect costs	57.0
Real input costs	0.3
Total capex (excl. equity raising costs)	**254.8**

GHD has assessed the non-contestable capital forecast using the methodology set out in Section 2. The following table summarises GHD's conclusions on each of the capital components.

Table 2 GHD summary conclusion

Forecast component	GHD assessment
Transmission line augmentation forecast $69.8M (Real 2023-24)	98% of transmission lines costs are supported by the tender results. Given the high proportion of the forecast supported by the tender and the structure of the contract the transmission line capital forecast is likely to be within +/- 20%.
Substation augmentation forecast $108.4M (Real 2023-24)	90% of the substation forecast are supported by the tender results. Provisions for potential construction nominated events of [redacted]ave been included in the tender process as part of the negotiation process prior to award which is considered prudent. Given the high proportion of the forecast supported by the tender and the structure of the contract the substation capital forecast is likely to be within +/- 20%.
SIPS control forecast $19.3M (Real 2023-24)	The forecast has been based upon a bottom-up build based upon Transgrid's experience with smaller Special Protection Schemes (SPSs), with allowances for the complexity of this SIPS with similar projects. The forecast includes a small provision for other construction costs, such as additional design changes representing 2.1% of the SIPS forecast. The forecasted labour component is based upon a detailed bottom-up build of team resources phased according to the projects schedule. 75% of communication short life costs is supported by an external quote and a selection of 24% of equipment's costs have been verified to quotes. The total forecast at $19.3M (Real 2023-24) is 7.6% of the total non-contestable forecast and is not considered material with respect to the overall forecast accuracy expected of +/- 20%.
Labour and indirect costs $57.0M (Real 2023-24)	The resource types and costs provided appear to be in line with what is regarded as normal business practice and accepted within Australia's electricity industry. Overall, the labour and indirect costs accuracy is seen as within +/- 20% accuracy and considered appropriate at this stage of the project. Project management labour and labour related costs $28.8M (Real 2022-23) are supported by a detailed bottom-up build methodology and benchmarks align with comparative projects such as the Queensland NSW Interconnect (QNI). Other support and corporate labour and labour-related costs $10.8M (Real 2022-23) are supported by a robust bottom-up build methodology. These costs benchmark higher than comparative projects such as QNI but include higher development costs given the number of substations involved in the augmentation works. Indirect costs $6.9M (Real 2022-23) represent the costs to support regulatory approvals, procurement, and legal support, independent technical reviews, and the cost of mandatory PAI insurance. As these costs are / will be necessarily incurred in progressing the project their inclusion in the forecast is considered reasonable.
Overall conclusion	– The capital costs for development and construction for the network infrastructure project are prudent, efficient and reasonable – The accuracy of the capital forecast is likely to sit within +/- 20% which is considered to be reasonable at this stage of the project development – Total development and construction capex are necessary to carry out the network infrastructure project according to the Consumer Trustee's or Minister's direction or authorisation – Proposed staging of development and construction capex complies with the terms of the Consumer Trustee's or Minister's authorisation or direction.

Glossary

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BESS	Battery Energy Storage System
ECI	Early Contractor Involvement
BoP	Basis of Preparation
EII Act	Electricity Infrastructure Investment Act 2020
EnergyCo	Energy Corporation of NSW
FTE	Full Time Equivalent
ISP	Integrated System Plan
HV	High Voltage
PAI	Principal Arranged Insurance
PG	Paired Generator
PTIP	Priority Transmission Infrastructure Project
QNI	Queensland NSW Interconnect
RIN	Regulatory Information Notice
Roadmap	NSW Electricity Infrastructure Roadmap
SIPS	System Integrity Protection Scheme
SPS	Special Protection Schemes
TET	Transmission Efficiency Test
WSB	Waratah Super Battery
VNI	Victoria NSW Interconnect

Contents

Table index

Figure index

1. Introduction

In November 2020, the NSW Government released the NSW Electricity Infrastructure Roadmap. The Roadmap sets out a 20-year plan to transform the State's electricity system and is enabled by the EII Act.

The EII Act is designed to support the delivery of the Roadmap which includes the WSB. Under the EII the AER is the regulator responsible for determining the amount payable to the Network Operator for carrying out the network infrastructure project.

Energy Corporation of NSW (EnergyCo) has been appointed the Infrastructure Planner responsible for selecting the Network Operator to carry out a specific network infrastructure project.

Network Operators may be selected in one of two ways:

- Under a contestable process, a Network Operator is selected through a competitive assessment process conducted by the Infrastructure Planner
- Under a non-contestable process, a Network Operator is selected directly by the Infrastructure Planner.

Non-contestable projects fall under the TET. Based upon our understanding, the WSB project comprises the following non-contestable components related to Transgrid:

- A program of augmentations to existing transmission network lines and substation equipment
- SIPS control and communications systems (to be developed and operated by Transgrid).

In August 2022, NSW Minister for Energy (Minister) identified the WSB project as a Priority Transmission Infrastructure Project (PTIP).[1] A PTIP is defined as a transmission infrastructure project that is in NSW and is identified, or forms part of an infrastructure project identified in, the latest Integrated System Plan (ISP) published by Australian Energy Market Operator (AEMO).

Further, we understand that on the 14th of October 2022, the Minister published an Order directing Transgrid to carry out the WSB project. The WSB project aims to address an expected breach of the NSW Energy Security Target in 2025–26 by increasing power transfer capacity on transmission lines that connect generation in the northern and southern regions of NSW to Sydney.

For the purposes of this report WSB refers only to the non-contestable components of the project.

1.1 Purpose of this report

This report details GHD's independent verification and assessment of the capital forecast for the WSB subject to the scope and limitations set out in section 1.2 of this report.

1.2 Scope and limitations

Under the TET the AER will consider all information and matters set out in EII Chapter 6A, Schedule 6A.1. GHD's scope of works is limited to independent verification and assessment of whether the:

- Scope of the project is appropriate to meet the requirements in the Ministerial Order
- BOP detailed in the capital forecasting methodology is reasonable
- Capital forecast is within ± 20 per cent the level of accuracy expected at this project stage considering the BOP and the level of support held / developed for each capital forecast component. With the accuracy and supportability of the resulting capital forecast assessed using a range of assurance techniques. These included validation against tender results, benchmarking against comparative projects, selection testing, recalculation and alignment with industry practice.
- Capital costs for development and construction for the network infrastructure project are prudent, efficient and reasonable

[1] The Order is published in the Gazette on 14 October 2022

- Proposed staging of development and construction capex complies with the terms of the Consumer Trustee's or Minister's authorisation or direction

The following is considered out of scope:

- As detailed by the TET, revenue determinations made under the EII Act will not consider the prudency of the authorised network option against other potential network options.

This report has been prepared by GHD for Transgrid and may only be used and relied on by Transgrid for the purpose agreed between GHD and Transgrid as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Transgrid arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Verification process

GHD has used several verification approaches to assess the reasonableness / efficiency of costs included in the WSB forecast and supported by Transgrid's WSB Revenue Proposal. The approach applied depends on the nature of the cost element and included a combination of:

- Benchmarking: insights in terms of benchmarking covering brownfield projects such as WSB are limited as this information is not publicly available. However, GHD has access to other ISP projects and has access to other Transgrid cost elements such as QNI minor upgrade which contain brownfield elements. Where appropriate we have used benchmarking as a top-down assessment of reasonableness
- Reliance on the results of Transgrid's competitive tendering processes supported by appropriate documentary evidence
- Review against supporting evidence supplied by third parties. Including:
    - Verification of actual costs incurred and forecasted costs by reviewing supporting documentation on a selection basis to confirm the amount, period / scope covered and that the costs only relate to WSB
    - Verification of estimates based upon recalculation and verification of underlying assumptions to:
        - Regulatory charges where relevant
        - Cost estimates provided by third parties
        - Cost estimates which can be verified through benchmarking.
- Labour costs have been assessed on a bottom-up basis considering the reasonableness of the team structure, scheduled hours and position rates applied. Where possible we have also performed a top-down assessment using data from comparative projects
- Comparison between the capex forecast methodology, scope definition and cost forecasts supplied by Transgrid to ensure that cost forecasts accurately reflect the scope and the assumptions outlined in the WBS Revenue Proposal
- Consideration of whether costs are prudent and would be incurred by other TNSPs
- Consideration of whether costs relate to activities required to achieve project timeframes.

3. Waratah Super Battery non-contestable scope

3.1 Non-contestable scope

The October 2022 Order directed Transgrid as the Network Operator to carry out the WSB project which comprises:[2]

- Two contestable components being the SIPS and paired generation services
- A non-contestable component, which involve augmentation of Transgrid's existing transmission network and the installation of a control and communications system (SIPS control).

Under the Order Transgrid must comply with the WSB Delivery Plan detailed in the Order in carrying out the WSB project.

The non-contestable component covered in the order and set out in Schedule 2 and Schedule 3 of the Network Operator's Deed[3] involves:

1. Planning and design of the network augmentation works, being the feasibility assessment, augmentation and delivery of the Northern Works and Southern Works
2. Planning, design, coding, installation, delivery, commissioning and operation of the SIPS control and communications systems and interface.

The table below sets out a high-level definition of the scope of works. A more detailed description of the scope of works for each capital component is set out in Appendix A-1.

Table 3 Definition of non-contestable scope

Work element	Definition of the works	Milestone date
Network Augmentations – Northern Works	Feasibility assessment, augmentation and delivery of substation works associated with: – Line 81 Liddell to Newcastle – Line 82 Liddell to Tomago – Line 83 Liddell to Muswellbrook – Line 84 Liddell to Tamworth – Line 85 Armidale to Tamworth – Line 86 Armidale to Tamworth – Line 88 Tamworth to Muswellbrook – Line 8C Dumaresq to Armidale – Line 8E Sapphire to Armidale – Line 8J Dumaresq to Sapphire	1 November 2024
Network Augmentations – Southern Works	Feasibility assessment, augmentation and delivery of transmission lines works associated with: – Line 39 Bannaby to Sydney West – Line 3L/4 Yass to Marulan – Line 5 Yass to Marulan	Line 39 – 1 November 2024 Lines 3L/4 and 5 – 1 August 2025
	Feasibility assessment, augmentation and delivery of substation works associated with other southern transmission lines detailed in Appendix A-1, Table 34	1 August 2025

[2] The Minister directs Transgrid to carry out the WSB project in accordance with section 32 of the EII Act

[3] Network Operator Deed – Waratah Super Battery Project, 17 October 2022

Work element	Definition of the works	Milestone date
SIPS Control	Planning, design, coding, installation, delivery, commissioning and operation of the SIPS control and communications systems and interfaces.	1 November 2024

Source: WBS Revenue Proposal

3.2 Scope alignment with ministerial order

The New South Wales Ministerial Order number 473 - Electricity and Water, issued on Friday, 14th October 2022 (The Order), requires Transgrid to take all reasonable steps to complete the planning, design, and construction stages of the WSB project by the relevant dates specified in the Transgrid WSB Delivery Plan. Schedule 2 of The Order provides the following detailed actions.

Table 4 Extract from Schedule 2 of the Ministerial Order

Work element	Definition of the works	Milestone date
3. Transgrid to deliver SIPS Control	Includes delivery, testing and full implementation of the SIPS Control.	Later of 1 November 2024 and the date on which the SIPS Service Provider must commence providing the interim SIPS Service pursuant to the SIPS Service Agreement referred to in paragraph 3(c) of Schedule 1 to this Order
4A. Transgrid to complete first portion of Network Augmentation	Includes design and delivery of the below Network Augmentation works being: Transmission line works associated with: – Line 39 Bannaby to Sydney West Substation works associated with: – Line 81 Liddell to Newcastle – Line 82 Liddell to Tomago – Line 83 Liddell to Muswellbrook – Line 84 Liddell to Tamworth – Line 85 Armidale to Tamworth – Line 86 Armidale to Tamworth – Line 88 Tamworth to Muswellbrook – Line 8C Dumaresq to Armidale – Line 8E Sapphire to Armidale – Line 8J Dumaresq to Sapphire Confirmation that all other Network Augmentation works are proceeding in accordance with committed timeframe / plans.	Later of 1 November 2024 and the date on which the SIPS Service Provider must commence providing the interim SIPS Service pursuant to the SIPS Service Agreement referred to in paragraph 3(c) of Schedule 1 to this Order
4B. Transgrid to complete all Network Augmentation	Includes design and delivery of all Network Augmentation works.	1 August 2025

Source: Ministerial Order number 473 - Electricity and Water and Network Operator Deed

In assessing the scope listed in The Order against Transgrid's scope listed in Transgrid's Revenue Proposal the following differences are evident.

Transgrid have included additional remediation, not listed in 4A of the Network Operator Deed, on the following two transmission lines, which require remediation under item 4B:

– Line 3L/4 Yass to Marulan

- Line 5 Yass to Marulan

The southern NSW substation works, listed by Transgrid that require remediation under item 4B, are:

- Yass
- Canberra
- Stockdill
- Collector
- Marulan
- Bannaby
- Sydney West
- Macarthur
- Avon
- Sydney South
- Dapto
- Upper Tumut
- Lower Tumut

GHD understands that the WSB Delivery Plan which is Schedule 2 of the Ministerial Direction lists “equipment” only to identify what must be completed by the 1 November 2024 milestone. The remainder of the scope is not specifically defined in Schedule 2 as evidenced by Milestones 3 and 4B which ask, in general terms, for everything else required to be complete. The additional scope items are based on the results of network modelling by Transgrid to achieve the agreed outcomes - implementation of the complete SIPS further detailed in Appendix A-1.

4. Non-contestable capital forecast

The table below sets out a high-level summary of costs incurred to 31 March 2023 and the forecast with Table 6 setting out the same information illustrating project phasing.

Table 5 Total non-contestable forecast capex for WSB ($M, Real 2023-24)

Capital element	Report reference	Total $M
Augmentation- Transmission lines	Section 5	69.8
Augmentation- Substations	Section 6	108.4
SIPS control	Section 7	19.3
Labour and indirect costs	Section 8	57.0
Real input costs	-	0.3
Total capex (excl. equity raising costs)		**254.8**

Table 6 Phased total non-contestable forecast capex for WSB ($M, Real 2023-24)

Capital element	Actuals 2022-23 $M	2022-23 $M	2023-24 $M	2024-25 $M	2025-26 $M	Total $M
Augmentation- Transmission lines			21.7	48.1		69.8
Augmentation- Substations			34.4	62.5	11.5	108.4

Capital element	Actuals 2022-23 $M	2022-23 $M	2023-24 $M	2024-25 $M	2025-26 $M	Total $M
SIPS control	0.8	1.1	11.2	6.2		19.3
Labour and indirect costs	3.5	6.0	27.7	18.0	1.7	57.0
Real input costs			0.1	0.2	0.0	0.3
Total capex (excl. equity raising costs)	**4.3**	**7.1**	**95.2**	**134.9**	**13.3**	**254.8**

Source: WBS Revenue Proposal

4.1 Capital forecasting methodology basis of preparation

As detailed in Transgrid's Revenue Proposal, activities to deliver the non-contestable components of WSB comprise both direct capex and indirect and labour capex. Capital costs include:

- Actual costs to assess the feasibility of the augmentation works, define the scope of works, and develop the project to meet the requirements set out in the Minister's direction and Network Operators Deed
- Actual and forecast costs to competitively procure the efficient design and delivery of the works
- Actual and forecast costs for project management, procurement, community and stakeholder engagement, environmental approvals and other support and corporate roles.

As detailed in Transgrid's WBS Revenue Proposal, the Basis of Preparation BoP differs in each capital category outlined in the table below. The following sections consider:

- The reasonableness of the BoP
- Whether the costs incurred or forecasted are required to meet the requirements set out in the Minister's direction and Network Operators Deed
- Whether the costs incurred or forecasted are consistent with what would be incurred by a prudent and efficient business
- Whether costs to date have been necessarily incurred to satisfy the above
- Whether the capital forecasts are supported by sufficient evidence to provide a reasonable assurance for the level of accuracy expected at this stage of the project's development.

The following table summarises the BoP for each capital element and the section reference where the costs to date and the forecast has been reviewed.

Table 7 Total non-contestable forecast capex for WSB by category ($M, Real 2023-24)

Category of WSB capex	Basis of capex	Capex $M	Section reference
Augmentation- Transmission lines	– Design & Construct contract – Rates from our procurement panels for key equipment – Other construction costs	69.8	5
Augmentation- Substations	– Design & Construct contract – Rates from our procurement panels for key equipment – Other construction costs	108.4	6
SIPS control	– Forecast capex internal bottom-up build – Quotation from our communications service provider for new fibre optic link – Rates from our procurement panels for key equipment	19.3	7

Category of WSB capex	Basis of capex	Capex $M	Section reference
	– Other construction costs		
Labour and indirect costs	– Actual capex reflects records in Ellipse. – Forecast capex internal bottom-up build.	57.0	8
Real input costs	– Internal bottom-up build using AER's forecast real labour cost escalators	0.3	-

5. Augmentation- transmission lines

5.1 Nature of the works

The transmission lines augmentation non-contestable works as set out in the Network Operator deed requires uprating of the following three transmission lines:

- Line 39 Bannaby to Sydney West from 85C to 120C
- Line 3L/4 Yass to Marulan from 68C to 85C
- Line 5 Yass to Marulan from 68C to 85C

These uprating requirements were part of the technical specification which were used to determine the extent of uprating works. The uprating works primarily consist of installation of new tower structures, D string and V strings and tower strengthening.

The works for uprating these lines involve:

- Contracted design and construction works, including:
  - The design works comprising detailed electrical, civil and structural engineering
  - Procurement of transmission line structures and steelwork
  - Erecting, installing, and pre-commissioning the structures and insulator arrangements
  - Civils works including access tracks, tower foundation works and landscaping.
- HV equipment procurement:
  - Procurement of transmission line insulators by Transgrid from panel agreements and free issued to the contractor.

5.2 Transmission lines forecast basis of preparation

As detailed in Transgrid's Revenue Proposal the forecasts BoP is based upon the results of a tender for the design and construction elements with Transgrid sourcing insulators through their existing panel agreements.

5.3 Transmission line procurement process

The procurement process incorporated early expressions of interest, conducted in November 2022. Early Contractor Involvement (ECI) in December 2022 was untaken to allow bidders to develop their own concept designs to achieve technical compliance and to specify how they would most efficiently deliver the works.

An outline of the process is shown in Figure 1 below.

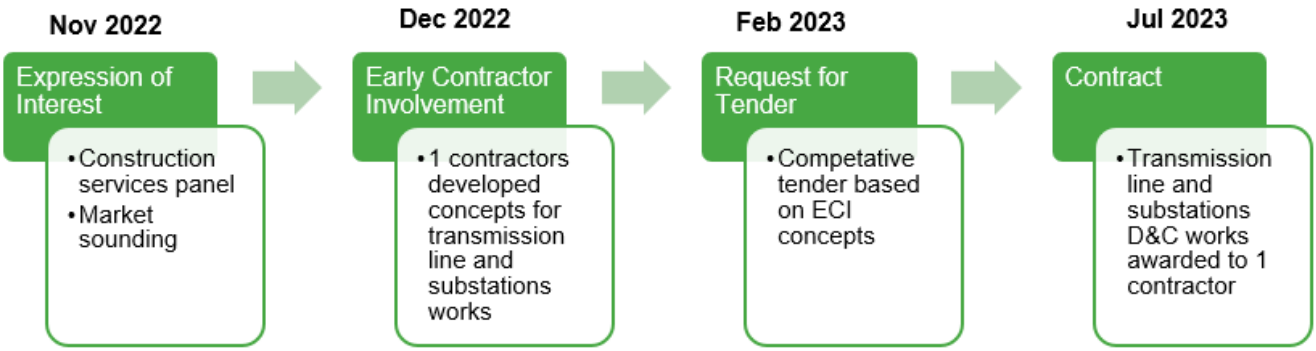


Figure 1 Transmission Lines Procurement Process

The tender was issued to two parties in February 2023 with an Early Works Agreement to be issued in June 2023 and the Design and Construct Contract to be executed in July 2023.

The tender was conducted over a relatively short time frame but given the standard nature of the scope of works the time frame is considered adequate.

GHD has not reviewed the selection process to determine the successful tenderer. However, GHD has sighted documentation that confirms that Transgrid undertook a tender process with appropriately experienced contractors.

5.4 Transmission line capital forecast

The following table represents a breakdown of the actual and forecasted capital costs with sufficient detail to identify tendered cost components and free issue insulators equipment.

Note: These costs do not include project management and other labour related costs incurred or forecasted and these have been included in Section 8.

Table 8 Transmission forecast capex breakdown ($M, Real 2023-24)

Transmission cost breakdown	GHD assessment	Section reference	Forecast $M
Tender response	Agreed to tender response schedules from winning responder	5.5	68.3
Transgrid free issued equipment	Selection verification	5.6	1.4
Other construction costs	-	-	0.1
Total			**69.8**

5.5 Transmission line tender response

The following table represents a breakdown of the tendered price based upon the tender schedules.

Table 9 Breakdown of transmission line tender response ($M, Nominal)

Capital component	Tender response $M
General and ancillary services	[redacted]
Design and procurement	[redacted]
TL39 works	[redacted]

Capital component	Tender response $M
TL3L,4,5	[redacted]
Nominated events agreed to tender schedules	[redacted]
Total	**68.5**

5.6 Transgrid free issued transmission line insulators and HV equipment

Under the transmission line contract Transgrid will deliver the following equipment as free issue.

Table 10 Transmission line free issue equipment (Real 2023-24)

Free issue equipment	Units	$	Forecast $M
170mm - Coupling Discs	[redacted]	[redacted]	0.1
146mm - Coupling Discs	[redacted]	[redacted]	0.0
Composite Insulator	[redacted]	[redacted]	0.0
170mm - Coupling Discs	[redacted]	[redacted]	0.8
146mm - Coupling Discs	[redacted]	[redacted]	0.4
Composite Insulator	[redacted]	[redacted]	0.0
Rounding	[redacted]		0.2
Total			**1.4**

A selection of the 170mm - Coupling Discs was made totaling $0.8M 57% of substation free equipment. These were verified against price quotes provided by the supplier with only immaterial differences noted.

5.7 Transmission line support and verification

In assessing transmission line forecast several attributes have been considered detailed in the following table.

Table 11 Transmission line forecast support and verification

Forecast element	Details and conclusion
Tender scope aligns with Ministerial Order	Our assessment indicates that tender scope aligns with The Order.
Tender scope aligns with scope underpinning the capital forecast	Our assessment indicates that tender scope aligns with the forecast definition.
Design and construction elements of the forecast are supported by the results of the tender	98% of transmission lines costs are supported by the tender results.
The terms and conditions of the agreement effectively transfer risks that could impact upon the accuracy of design and construction elements.	The general conditions of contract transfer design, construction, safety, and environmental risk to the contractor.
Free issue materials are based upon appropriate estimates.	A selection $0.8M 57% of transmission line free equipment. These were verified against a quote from the supplier.
Conclusion	98% of transmission lines costs are supported by the tender results. Given the high proportion of the forecast supported by the tender and the structure of the contract the transmission line capital forecast is likely to be within +/- 20%.

6. Augmentation- substations

6.1 Nature of the works

The non-contestable substation augmentation scope of works set out in the Network Operator Deed require the uprating (i.e. capacity increase) of substation equipment which is currently constraining the rating of the associated transmission lines to facilitate the SIPS.

The rating of the transmission lines is currently constrained by the thermal rating and control/protection system settings of associated substation equipment. The scope of works required to achieve the uprating involves replacing substation equipment with equipment that has a higher thermal rating of 3,150 A or 4,000 A and amending the control and protection system settings to facilitate the higher rating.

The substations works involve:

- Contracted design and construction works:
  - The design works comprising detailed high voltage electrical, secondary systems, civil and structural engineering and design
  - Installing and pre-commissioning the new substation equipment, including civil foundation works
  - Modification of the secondary systems at the substations.
- HV equipment and secondary systems procured by Transgrid and free issued to the contractor.

6.2 Substation forecast basis of preparation

As detailed in Transgrid's Revenue Proposal the forecast BoP is based upon the results of a tender for the design and construction elements with Transgrid sourcing some HV equipment through their existing panel agreements.

The major HV plant being supplied are:

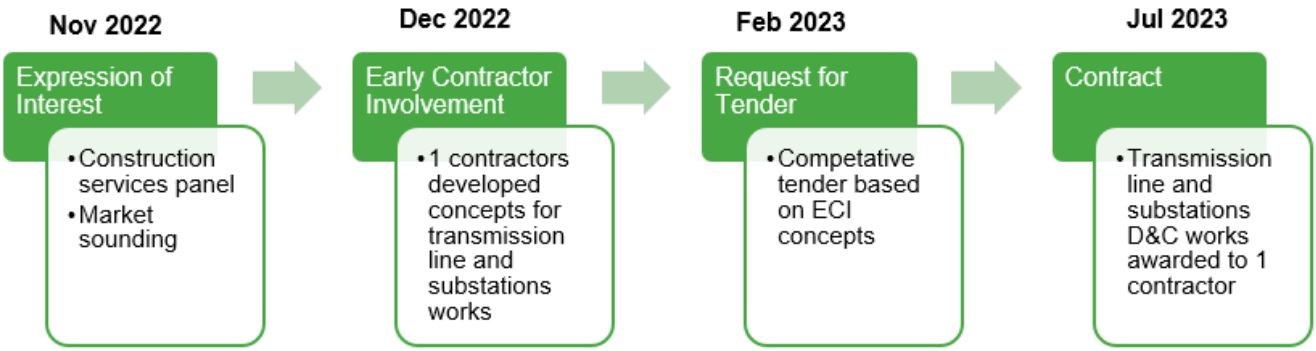
- 330 kV circuit breakers
- 330 kV current transformers
- 330 kV voltage transformers
- 330 kV disconnectors and associated earth switches
- 330 kV line traps
- Conductor for busbars, droppers and switchbay connections
- Insulators for installation of the equipment listed above.

6.3 Substation procurement process

The procurement process incorporated early expressions of interest, conducted in November 2022. ECI in December 2022 to allow bidders to develop their own concept designs to achieve technical compliance and to specify how they would most efficiently deliver the works.

An outline of the process is shown in Figure 2 below.

Figure 2 Substation Procurement Process



Two contractors were engaged in the early contractor engagement phase and issued with the RFT with only one contractor, [redacted] submitting a response to the RFT. The other contractor withdrew from the RFT. An Early Works Agreement was entered into with [redacted] in June 2023. The contract will be awarded to [redacted] July 2023.

The tender was conducted over a relatively short time frame but given the standard nature of works the time frame is considered adequate. GHD has not reviewed the tender selection process to award the substation tender.

6.4 Substation capital forecast

The following table represents a breakdown of the forecasted capital costs with sufficient detail to identify tendered cost components and free issue HV equipment.

Note: These costs do not include project management and other labour related costs incurred or forecasted and these have been included in Section 8.

Table 12 Substation forecast capex breakdown ($M, Real 2023-24)

Substation cost breakdown	GHD assessment	Section reference	Forecast $M
Tender response	Agreed to tender response schedules form winning responder	6.5	97.7
Tender "nominated events"			
Transgrid free issued equipment	Selection verification	6.6	9.6
Other construction costs	-	-	1.1
Total			**108.4**

6.5 Substation tender response

The following table represents a breakdown of the tendered price based upon the tender schedules.

Table 13 Breakdown of substation tender response ($M, Nominal)

Capital component	Tender response $M
General and ancillary services	[redacted]
Design, procurement, manuals, and management	[redacted]
Civil, fencing & site improvement works	[redacted]
Steel structures	[redacted]
Electrical works	[redacted]

Capital component	Tender response $M
Testing and commissioning	[redacted]
Tender nominated events	[redacted]
Total	**98.3** ($M Nominal) **97.7** (Real $M 2023-24)

As indicated above, the forecast includes tender adjustments and contingency allowance now included in the tender response for known and potential risks that were negotiated post tender submission and transferred to the contractor detailed in the table below.

Table 14 Substation tender adjustments and contingency ($M, Nominal)

Tender adjustment and contingency components – post tender submission	Tender response $M
[redacted]	[redacted]
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	

6.6 Transgrid free issued HV equipment

Under the substation contract Transgrid will procure the following equipment as free issue.

Table 15 Free issue substation HV equipment (Real 2023-24)

Free issue HV equipment	Units	Cost $/Unit	Forecast $M
Circuit Breaker (4000A)	[redacted]	[redacted]	[redacted]
Current Transformer (3150A) incl. delivery			0.9
Current Transformer (4000A) incl. delivery			1.0
Line Trap (3150A)			1.1
Line Trap (4000A)			1.3
Disconnector w. Assc E/S (3150A)			1.4
Disconnector w. Assc E/S (4000A)			1.3
Voltage Transformer (4000A) incl. delivery			[redacted]
Rounding			(0.2)
Total			**9.6**

A selection of these were made including, Circuit Breaker (4000A), Line Trap (3150A), Line Trap (4000A), Disconnector w. Assc E/S (3150A) and Disconnector w. Assc E/S (4000A) totaling $7.8M or 80% of substation free equipment. These were verified against supplier quotes or recent orders.

6.7 Substation support and verification

The following table outlines our assessment of the substation forecast..

Table 16 Substation forecast support and verification

Forecast element	Details and conclusion
Tender scope aligns with Ministerial Order	Our assessment determines that tender scope aligns with The Order. Note: None of the southern substations are specifically listed in The Order, as they are for northern substations. But under 4B of The Order, a requirement is included for all necessary work.
Tender scope aligns with forecast definition	The northern substations are itemised, making it practical to correlate alignment of tender scope. Though southern substations were itemised beforehand. Substations identified by Transgrid's internal technical assessment correlates to the definition forecast for this project.
Design and construction elements of the forecast are supported by the results of the tender	91% of substations capital costs are supported by the substations tender. Nominated events transferred to the contractor include[redacted]
The terms and conditions of the agreement effectively transfer risks that could impact upon the accuracy of design and construction elements.	The general conditions of contract transfer design, construction, safety and environmental risk to the contractor.
Free issue materials are based upon appropriate estimates.	80% of substation HV free issue equipment was verified based on a selection by GHD to supplier quotes or recent orders
Conclusion	90% of the substation forecast are supported by the tender results. [redacted] Given the high proportion of the forecast supported by the tender and the structure of the contract the substation capital forecast is likely to be within +/- 20%.

7. SIPS control

7.1 Nature of the works

Transgrid's Revenue Proposal details that the Network Operator Deed requires that Transgrid deliver a SIPS control scheme, including delivery, testing and implementation of the scheme by 1 November 2024.

The SIPS scheme will be implemented to:

- Increase power transfer capability from regional NSW to the Sydney / Newcastle / Wollongong region under system normal conditions by relaxing dispatch constraints, allowing existing transmission lines to be more highly utilised
- Monitor existing transmission lines and substations for overloads
- Manage any overloads by controlled dispatch of the Waratah Super Battery and runback of Paired Generators.

The SIPS scheme will interface with Transgrid's system via their SCADA system and interface with AEMO's dispatch engine.

The SIPS comprises of the following main elements:

- 1 core logic unit which will control the scheme
- 1 terminal site at the WSB Battery Energy Storage System (BESS) to monitor and control the BESS
- 3 terminal sites, one at each of the paired generators to monitor and control the paired generators
- 14 network monitoring sites at existing substations in northern and southern NSW, which will monitor 37 transmission lines for overload.

A detailed scope is outlined in Appendix A-1 SIPS basis of forecast.

7.2 SIPS forecast basis of preparation

As detailed in Transgrid's Revenue Proposal the forecast BoP is based upon internal labour cost estimate for undertaking the works, equipment costs from Transgrid's existing suppliers and a quotation for the communications fiber installation.

7.3 SIPS procurement process

The complex and specialised nature of the SIPS control means that internal delivery of the design and implementation by Transgrid is considered the most efficient and practical approach. Because:

- Designing and coding the SIPS control requires highly specialised skills and testing to ensure the integration and operation of the scheme works as intended.
- Transgrid has internal expertise developing Remedial Action Schemes using a proven standard design philosophy, which will be leveraged to achieve efficiency and reduce risks in SIPS development.
- Design by an external provider would require a high level of Transgrid oversight and review, leading to an overlap in resourcing.
- The implementation across 19 sites requires testing and commissioning with Transgrid's SCADA system where the use of an external provider would still require a high level of Transgrid personnel involvement to ensure the scheme is implemented safely and without impacting on the reliability of the network, making the use of an external provider less efficient.
- This delivery strategy has proven to be the most efficient based on multiple SPSs implemented across Transgrid's network.
- This highly specialised skillset required for the implementation, testing and commissioning of this complex scheme is not readily available in the market.

Transgrid are also best placed to consult with AEMO on the design development, testing and commissioning of the SIPS control scheme, including interfacing of the BESS and Paired Generator (PG).

Therefore, the SIPS scope of works will be delivered by Transgrid's internal labour force. The SIPS equipment is to be procured directly by Transgrid. The only component of the SIPS scope which is contracted is the installation of a communication fibre cable which is required between the Armidale Substation and a PG.

7.4 SIPS capital forecast

According to Transgrid's Revenue Proposal the capital forecast for SIPS includes:

- Establishing a new underground fiber optic cable link between the Armidale substation and a paired generator site
- Procurement of SIPS control panels and equipment
- Delivery of SIPS control design, installation, testing and commissions works.

The forecast has been based upon:

- Quotation from the communications service provider for new fiber optic link
- Rates from Transgrid's procurement panels for key equipment.

The following table represents a breakdown of the actual and forecasted capital costs for the SIPS equipment and external tendered services.

Note – To align with Regulatory Information Notice (RIN) reporting, Transgrid has split direct labour and labour-related costs and indirect labour and labour-related costs on a 70% and 30% basis. Additional information on this split is detailed in Section 8.

Table 17 SIPS forecast capex breakdown ($M, Real 2023-24)

SIPS cost breakdown (equipment and tendered services)	Section reference	Forecast $M
Historical and labour and indirect costs (design, installation and commissioning) (70%)	8.5	8.0
Equipment	7.5	2.5
Communications link	7.6	1.3
Future paired generation	7.7	6.2
Other construction costs	-	1.3
Total		**19.3**

7.5 SIPS control equipment

The following table provides a breakdown of SIPS control equipment included in the forecast.

Table 18 Control equipment breakdown (Real 2023-24)

Components	Units	Price $	Forecast $M
[redacted]	[redacted]	[redacted]	0.5
[redacted]			0.1
[redacted]			0.4
[redacted]			0.0
[redacted]			0.0
[redacted]			0.0
[redacted]			0.0
[redacted]			0.2
[redacted]			0.0
[redacted]			0.0
[redacted]			0.0
[redacted]			0.1
[redacted]			0.2
[redacted]			0.0

Components	Units	Price $	Forecast $M
[redacted]	[redacted]	[redacted]	0.0
[redacted]			0.0
[redacted]			0.2
[redacted]			0.0
[redacted]			0.0
[redacted]			0.0
[redacted]			0.0
[redacted]			0.1
Provision for additional design equipment changes			0.4
Rounding			0.3
Total			**2.5**

GHD has selected Standard SPS panels and [redacted] representing $0.9M or 24% of equipment costs in this category to be acceptable and estimated costs appear to be in line with accepted electricity industry practice.

Based on the information provided, GHD believes that the equipment and costs that have been supplied are reasonable as an initial provision.

7.6 Communications link

Underground fibre cable from Armidale 330kV Substation to Paired Generator Substation set out in a quote from the contractor $1.3M (Real 2023-24).

7.7 Future paired generation

The Transgrid Revenue Proposal details that EnergyCo has undertaken one tender round of paired generation for WSB. [redacted]

[redacted]

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

Task	Frequency	Qty	Unit rate	Total
[redacted]				
Total				**6.2**

The costs per round included in the above table are supported by a build-up of resources, hours and rates representing a detailed bottom up build of the forecast. The bottom-up build is robust, and rates and hours appear reasonable. From a materiality perspective, this forecast element only represents 2.2% of total WBS non-contestable costs and is unlikely to impact overall accuracy in a significant way.

7.8 SIPS control support and verification

In considering SIPS control costs to date and forecasted, several attributes have been considered and detailed in the following table.

Table 20 SIPS control line forecast support and verification

Forecast element	Details and conclusion
Forecast	The forecast has been based upon a bottom-up build based upon Transgrid's experience with smaller SPSs, with allowances for the complexity of this SIPS. The forecast includes a small provision for other construction costs, such as additional design changes representing 2.1% of the SIPS forecast. The forecasted labour component is based upon a robust bottom-up build of team resources phased according to the projects schedule, detailed in Section 8.5 75% of communication short life costs is supported by an external quote and a selection of 24% of equipment's costs have been verified to quotes. The total forecast at 7.8% of the total non-contestable forecast is not considered material with respect to the overall forecast accuracy expected of +/- 20%.

8. Labour and indirect costs

As detailed in Transgrid's Revenue Proposal some labour and labour-related costs are reported as direct costs for regulatory purposes. For these reasons the forecast labour and labour-related costs for WSB have been split between direct and indirect costs.

Additionally, for the 2021-22 financial year, 74% of Transgrid's capitalised labour and labour related costs were reported as direct costs within the category analysis Regulatory Information Notice (RIN) response.

For RIN consistency Transgrid has assumed that 70% of forecast Transgrid labour and labour-related costs for WSB are direct in nature with 30% of labour and labour-related costs are assumed to be indirect.

GHD confirms that these assumptions are embedded in their labour forecasting process.

The following table details labour and indirect costs included in the WSB capex forecast. Those costs considered material have been outlined in the following sections. There are seven categories of indirect capex:

- Historical indirect capex – this is capex that we incurred on the Project from 27 October 2022 to 31 March 2023. This represents the actual costs incurred on WSB to 31 March 2023 less the $3M provided by EnergyCo to develop the project
- Forecast indirect capex – we have grouped this capex into seven sub-categories:
  - Project Management - to directly manage the project, including various Deeds and Agreements
  - SIPS control implementation – to manage, design, construct, test and commission the SIPS control

- Other support and corporate roles - to provide support for the project including engineering and design, health and safety, legal, risk & audit and network operations
- Transaction procurement support - to support the tender process and ongoing support of contract administrative management
- Regulatory approvals - to provide support in preparing the revenue proposal
- Community and stakeholder engagement – for activities associated with engaging with the community and stakeholders affected by the project
- Environment – to undertake assessments, prepare and submit environmental approvals, including stakeholder consultation

The following table provides a breakdown of labour and indirect costs included in the forecast.

Table 21 Labour and indirect costs summary ($M, Real 2022-23)

Category	Section reference	Total $M
Labour and labour related costs		
Historical costs from 27 October 2022 to 31 March 2023 (70%)	8.3	[redacted]
Project management (70%)	8.4	
SIPS control implmentation (70%)	8.5	
Other support and corporate roles (70%)	8.6	
Regulatory approvals (70%)	Not material	
Community and stakeholder engagement (70%)	Not material	
Environment (70%)	Not material	
Indirect costs		
Historical costs from 27 October 2022 to 31 March 2023 (30%)	8.3	
Proportion of labour and labour related capex (30%)	8.7	
Project Management	8.8	
SIPS control implmentation		
Other support and corporate roles	8.8	
Regulatory approvals	8.8	
Environment	8.8	
Transaction procurement	8.8	
Total		**62.8**
Less SIPS control implementation		**(7.7)**
Total excl SIPS control implementation		**55.1**
Total excl SIPS control implementation (Real 2023-24)		***57.0***

8.1 Labour and indirect cost forecasting methodology

The forecasts considered in Sections 8.4 to 8.6 covering project management SIPS control implementation and other corporate and support roles has been estimated based upon:

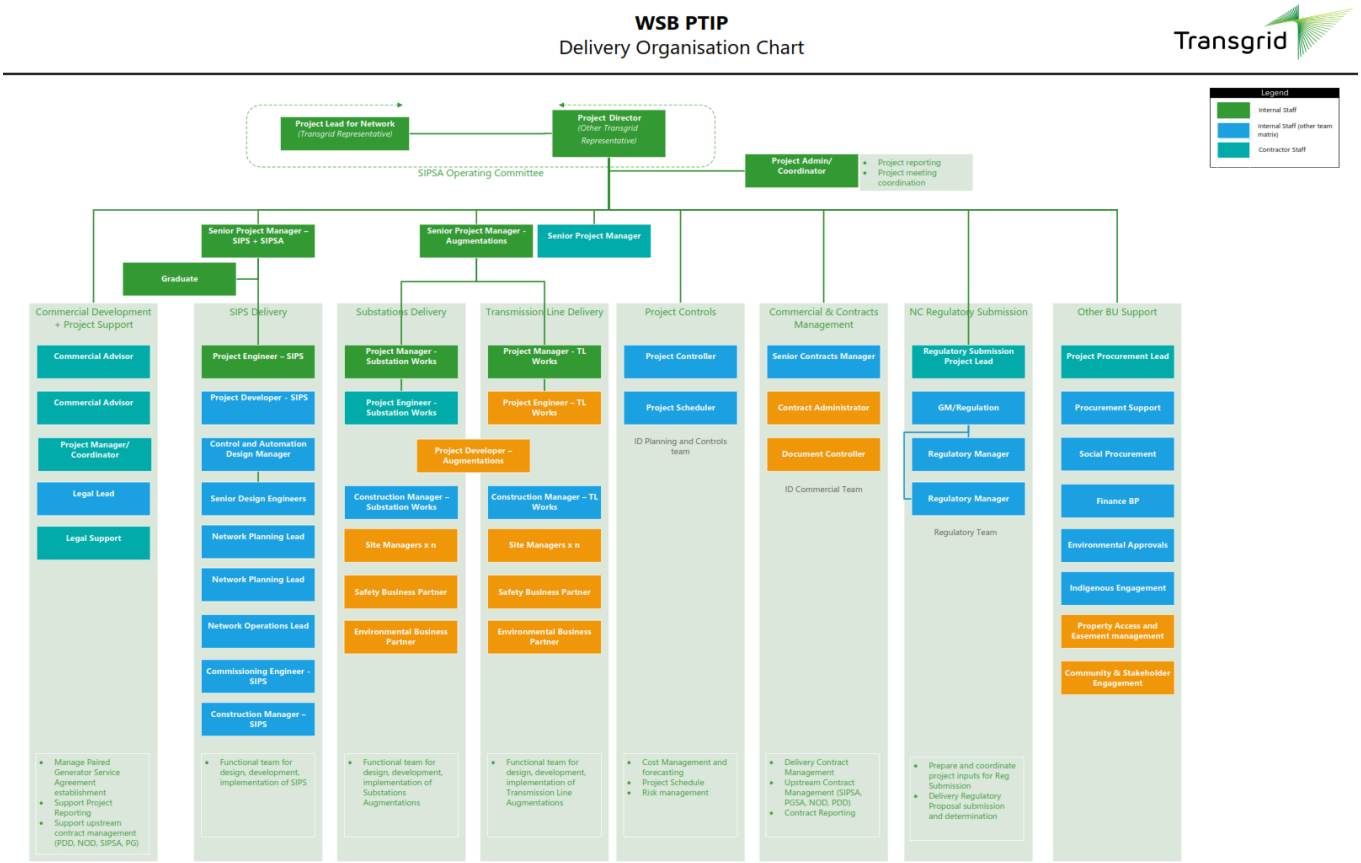
- The FTE profile and numbers required to deliver each of the project streams objectives to support delivery with the resources included in the forecast incremental to Transgrid's business as usual activities.
- The month-by-month FTE requirements for each role type phased to meet the project schedule drawn from Transgrid's project management tools

- Standard labour and overtime rates with hourly labour rates for FY2022-23 for each role type including on-costs and support costs. In relation to on-costs Transgrid has a standing overhead methodology that they have consistently applied across ISP projects. This includes loadings for annual leave, long service leave, payroll tax, superannuation, and workers compensation.

  The loading for internal FTEs is 35.8% and contractors 30.8% and this has been applied in determining hourly labour rates.

The following figure sets out the WSB team structure.

Figure 3 WBS team structure



8.2 Labour and indirect cost forecasting verification

Across the following sub-sections related to project management, SIPS delivery and other corporate and support roles, GHD has:

Bottom-up assessment

- Agreed the forecast to the underlying spreadsheet that has been used to generate labour cost forecasts
- Extracted and analyses the phased FTE profile to consider the appropriateness of roles and numbers required to deliver project streams objectives
- Considered the reasonableness of hourly rates applied by role in the forecast
- Performed a simple extension of the phased FTE profile by the hourly rates to confirm the material correctness of the forecast generated from Transgrid's project management tools.

Top-down assessment

- Where possible performed a benchmarking assessment to similar projects to further assess reasonableness.

8.3 Historical labour and indirect capex

Based upon the Transgrid Labour and Indirect Cost Report supporting the WSB Non-contestable Revenue Proposal and supported by the underlying spreadsheets supporting the labour and indirect cost forecast $4.2M was incurred from 27 October 2022 to 31 March 2023.

Table 22 Historical costs from 27 October 2022 to 31 March 2023 ($M Real 2022-23)

Category	$M to 31 March 2023
Labour (internal and outsourced, direct)	
Project Management	[redacted]
SIPS Control Implementation	
Other Support & Corporate Roles	
Regulatory Approvals	
Indirect	
Proportion of labour and labour-related costs	[redacted]
Project Management	
SIPS Control Implementation	
Other Support & Corporate Roles	
Procurement	
Transaction Procurement Support	
Total	**4.2**

8.4 Project management

Project management costs represent the internal and contracted services required to govern the project, provide project controls, and site supervision and support necessary to deliver the project.

8.4.1 Internal project management labour

The following table summarises 70% of the labour forecast to project completion.

Table 23 Breakdown of project management related costs (70% forecast only) (Real 2022-23)

Category	Total capex ($M)	GHD assessment
Labour forecast	[redacted]	Section 8.4.3
Labour related	[redacted]	
Travel	[redacted]	
Training	[redacted]	
Recruitment and other	[redacted]	
Total	**19.7**	

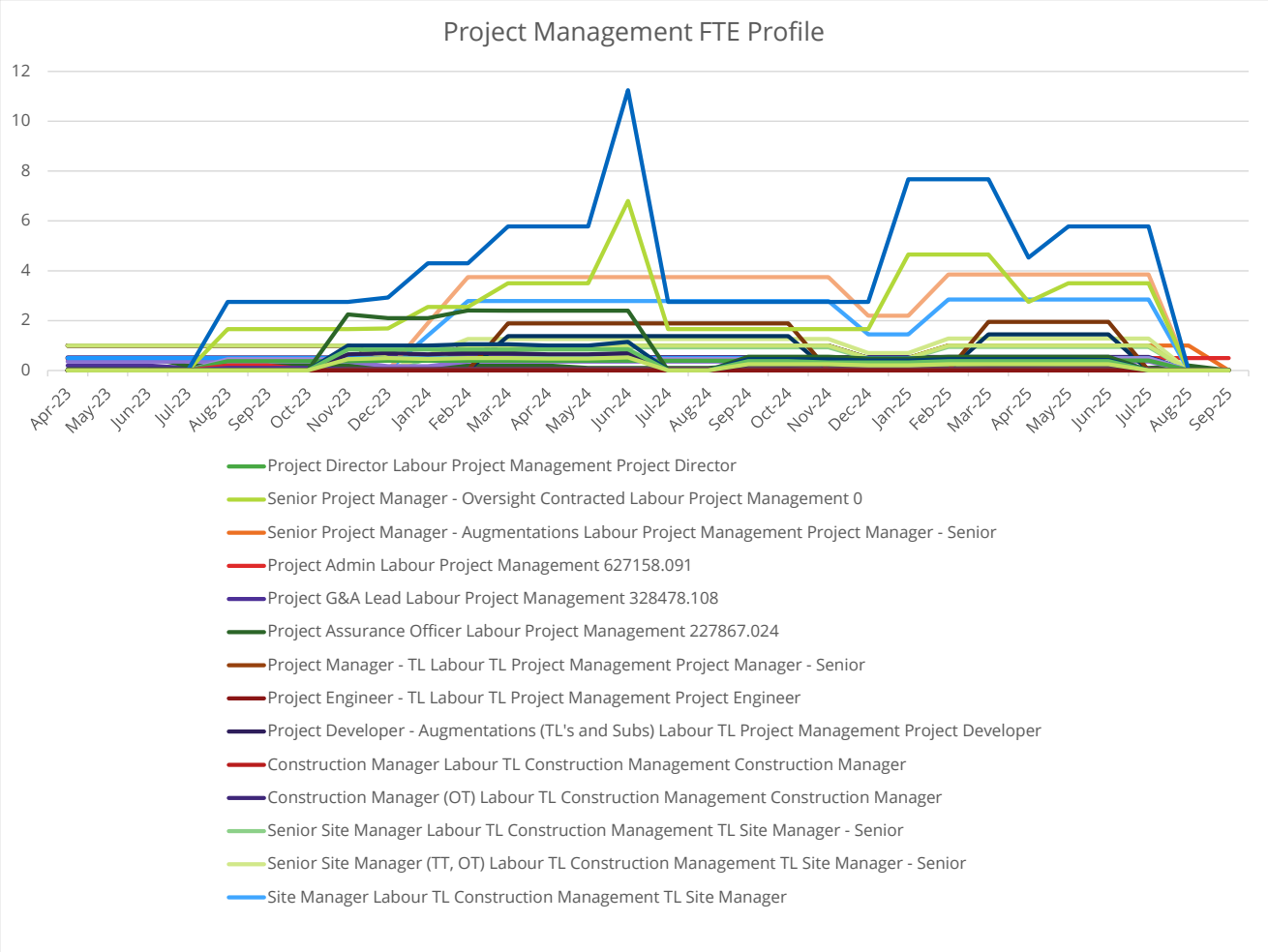
The internal project management costs have been based upon costs incurred to 31 March 2023 and a forecast to completion.

8.4.2 Project management structure

The figure below presents the internal and contracted project management FTE profile based off the same spreadsheet that has been used to generate labour cost forecasts. The analysis indicates a small core of project governance roles with larger resources allocated to substations and transmission line construction management. Substation construction management FTE profiles are driven by the number of substations, site management, construction, HSE and technical support profiles.

Transmission line construction management FTE profiles are driven by the number of towers, site management, construction, HSE and technical support profiles.

Figure 4 Project management FTE profile



Analysis of rates included overhead allowance indicates the following:

- Average rate per hour $182
- Minimum rate per hour $131
- Maximum rate per hour $251 (Senior Project Manager)

These hourly rates in the current market appear reasonable.

A sample extension of hourly rates by hours and FTE numbers indicate that they are close to the amounts calculated by Transgrid. Extending this calculation across the entire population indicates that Transgrid's calculation produces a forecast that is $0.5M lower than a manual calculation, or 2.7% of the total supporting that the calculation is materially correct.

8.4.3 Project management forecast conclusion

From a bottom-up build perspective, sufficient rigor has been applied to the forecast preparation.

From a top-down perspective, project management costs are $28.8M (100% of project management labour and labour related costs) compared to the total capex forecast of $254.8M (Real 2023-24). Benchmarking of WSB project management costs to comparatively sized projects indicate the following.

Table 24 WSB project management cost benchmarking

Project	Project total costs	Project management labour costs	Project management labour costs as a % of relevant project costs
WSB	$254.8M	$28.8M at 100%	11.3%
QNI	$222.8M	$25.4M	11.4%
Victoria NSW Interconnect (VNI)	$45.0M	$3.4M	7.5% 15% (Adjusted for Smart Wires Modular Power Flow Controllers cost)

QNI is of similar augmentation scope including transmission line uprating, substation works at 5 sites. The WSB project scope includes 22 substations with design costs included in other and corporate support labour costs detailed in Section 8.6.1 below.

The VNI project includes Smart Wires Modular Power Flow Controllers representing around 50% of the total project costs. Once this is adjusted this raises the proportion of project management to total costs to 15% which is what would be expected from a small project.

Generally various reports on infrastructure projects, including transmission projects indicate project management costs in total for all phases of a project with project controls managed by the owner are in the range of 9-15% of total project costs.

Ernst & Young Transport in 2011 prepared a report for the NSW Department of Transport titled “Infrastructure – Project Cost Benchmarking Study”. The study collected data from eight road and rail authorities across Australia for projects above $0.50 Billion in total cost – ranging up to $1 Billion.

Overall, this report found the average owner costs (excluding design costs) for road projects as a percentage of total construction costs was 11%. Including detailed design work the average percentage increased to 14%.

There were 14 road projects selected for analysis with owner costs (without design) varying from 7% to 16%. Removing the two outliers the range was from 8% to 14%. The average owner costs (excluding design costs) for rail projects were 16%. Including detailed design, the average percentage increased to 21%. There were 14 rail projects selected for analysis with owner costs (without design) varying from 8% to 30%. Removing the two outliers the range was from 9% to 20%. This illustrates a relatively flat distribution between these ranges for both road and rail projects.

The effect of scale of these projects is significant affecting the above average costs as shown below in Table 25[4].

Table 25 Owner costs as percentage of total construction cost[5]

Total construction costs	Rail owner costs (%)	Road owner costs (%)
(<$100M)	26.4	19.4
($100M-$1000M)	15.0	11.3
(>$1000M)	11.5	-

[4] Including design costs
[5] Infrastructure – Project Cost Benchmarking Study - Ernst & Young, fig 52 page 83

A guideline of direct relevance to transmission projects is the MISO[6] published "MTEP19 Transmission Cost Estimation Guide", which was last updated in December 2019. The MISO transmission planning process and role is similar to AEMO in Australia.

This guide is prepared to support MISO planning staff in developing cost estimates and deriving benefit-to-cost ratios for solutions proposed for the expansion of the MISO transmission network. In this respect this process is similar to the RIT-T process under the Australian NER.

MISO's transmission cost estimation guide describes the approach and cost data that MISO uses in developing its cost estimates. This document assumptions and cost data are reviewed annually with stakeholders.

In section 3.4 of this guide, project overheads applied to cover costs for developing and delivering a potential project are aggregated into three categories with the percentage of total project costs applied:

- Project management (including mobilisation and demobilisation) - 5.5%
- Engineering, environmental studies, testing and commissioning – 3.0%
- Administrative and general overhead – 1.5%

The costs for the transmission and substations projects therefore include a total margin of 10% for overheads. This is a margin on the total project estimate rather than a cost mark-up of the individual transmission and substation costs.

Given the rigour applied in the bottom-up build and these top-down comparatives the proportion of project management costs to the total capital forecast of the project is considered reasonable and within +/-20% given the accuracy expected at this stage of the project's development.

8.5 SIPS labour and indirect costs

The following table details a breakdown of 70% of the SIPS labour and indirect forecasts to completion.

Table 26 Breakdown of SIPS control implementation related costs (70% forecast only) (Real 2022-23)

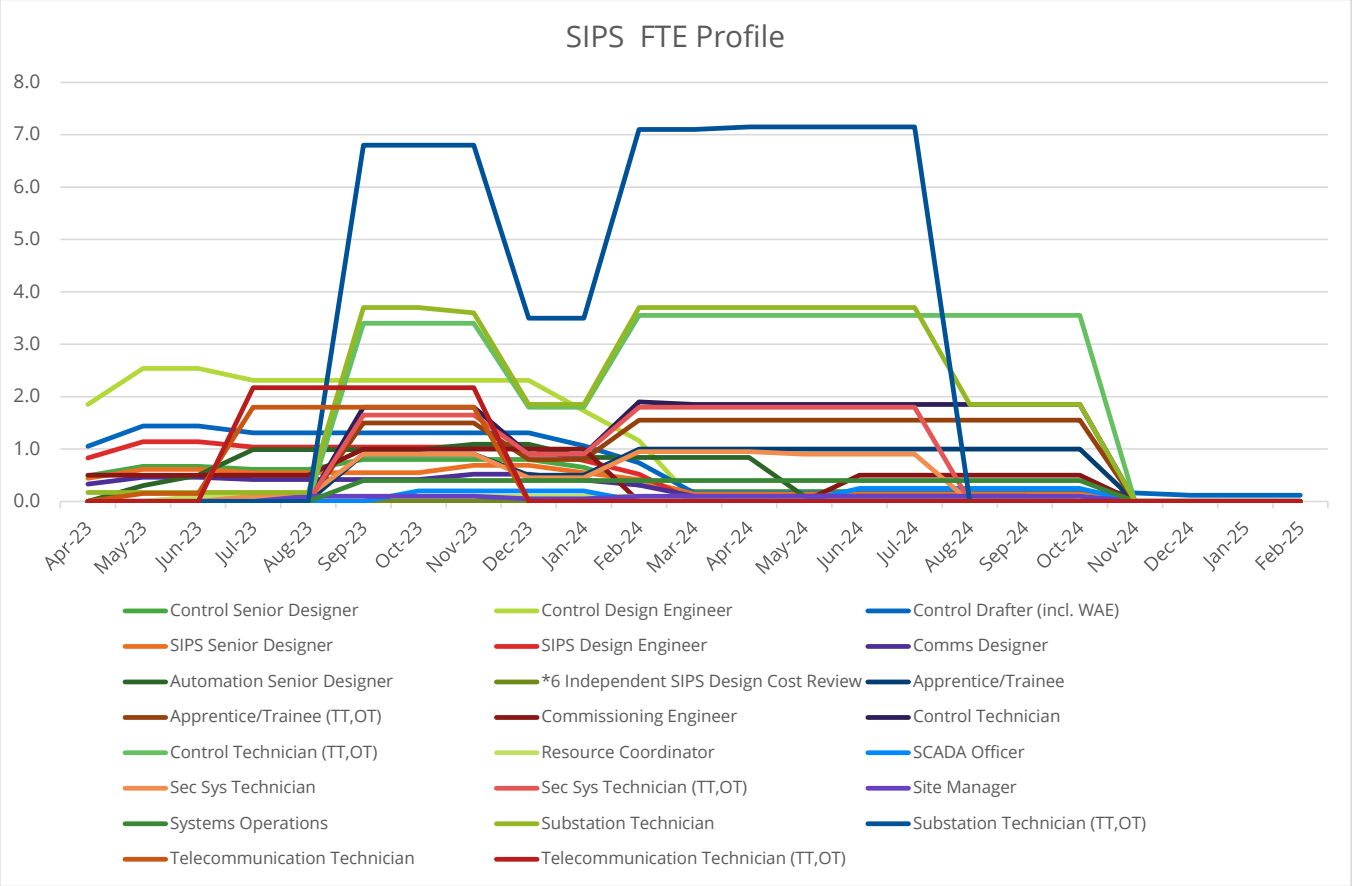
Category	Total capex ($M)	GHD assessment
Labour forecast	[redacted]	Section 8.5.3
Labour related direct		-
Indirect		-
Total	**6.9**	

8.5.1 SIPS internal labour cost forecast

The figure below presents the internal and contracted project management Full Time Equivalent (FTE) profile based off the same spreadsheet that has been used to generate labour cost forecasts. The analysis indicates a small core of project governance roles with larger resources allocated to the specialised design work for secondary systems.

[6] The Midcontinent Independent System Operator (MISO) is an Independent System Operator providing open-access transmission service and monitoring the high-voltage transmission system in the Midwest United States and Manitoba, Canada and southern United States which includes much of Arkansas, Mississippi, and Louisiana.

Figure 5 SIPS internal and contract FTE profile



Analysis of rates indicates the following:

- Average rate per hour $165
- Minimum rate per hour $84
- Maximum rate per hour $202 (Senior Project Manager)

These hourly rates in the current market appear reasonable.

Extension of hourly rates by hours and FTE numbers across the entire population indicates that Transgrid's calculation is $0.1M lower than our manual calculation, or 1.6% of the total supporting that the calculation is material correct.

The SIPS total internal labour costs (capex) estimated by Transgrid is $8.0M. The supporting information has been provided and appears to be reasonable for a project of this size and unique complexity.

8.5.2 SIPS external labour cost forecast

The external labour cost forecasted is relatively low and is justified considering that the short time frame of the project does not favor the ability to bring in a larger external workforce that is specialised in secondary systems. It can be expected that external labour specialised in communications would be more plentiful compared to secondary systems.

8.5.3 SIPS internal and external labour cost forecast conclusion

GHD has attempted a review of other projects however there appears to be no similar project that has a detailed cost breakdown available for comparison. The WSB SIPS project requires an intense allocation of specialised internal and external resources to meet the tight timeframe for implementation of the SIPS.

The resource types and costs provided appear to be in line with what is regarded as normal business practice and accepted within Australia's electricity industry.

8.6 Other support and corporate roles

The following table details a breakdown of 70% forecasts to completion.

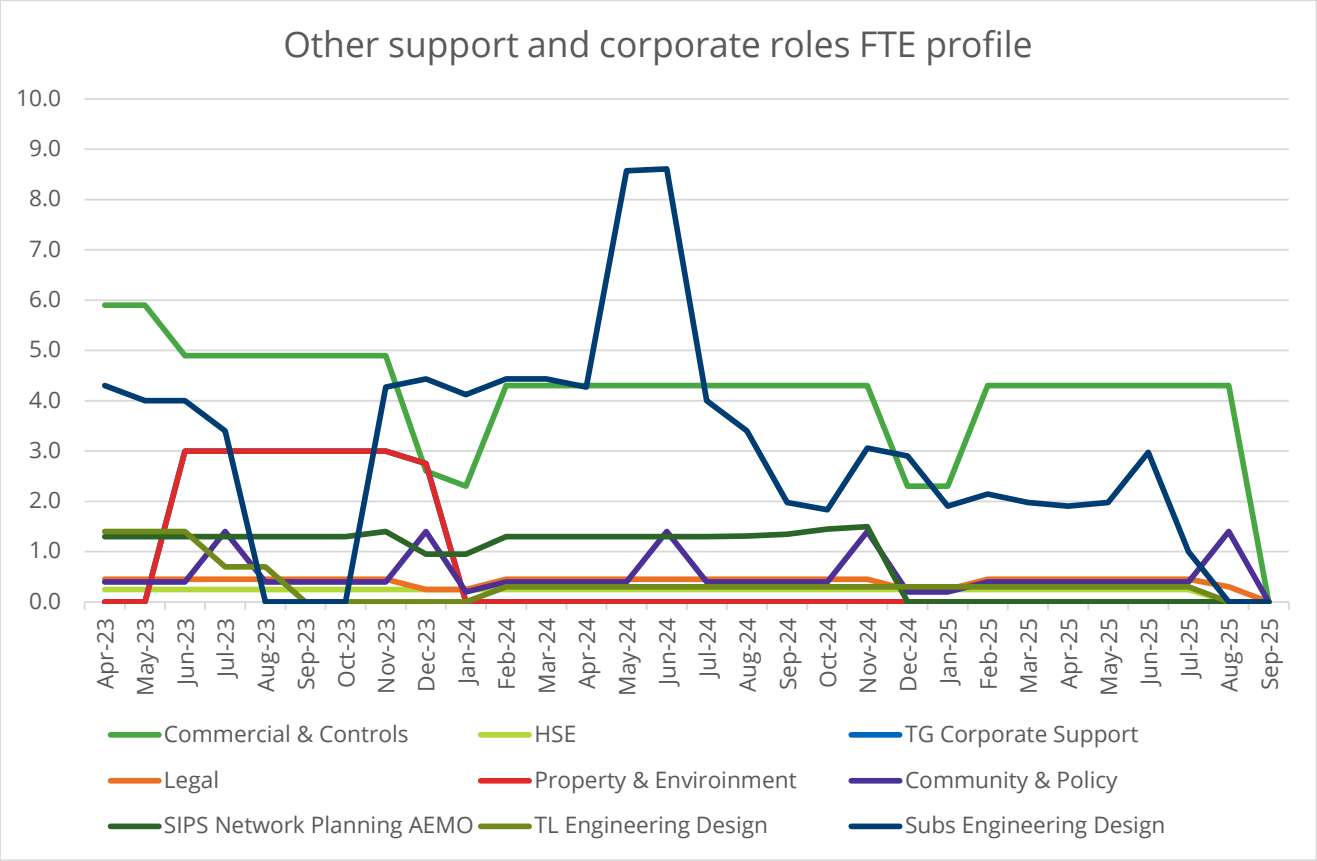
Table 27 Breakdown of other support and corporate roles related costs 70% (Real 2022-23)

Category	Total capex ($M)	GHD assessment
Labour forecast	[redacted]	Section 8.6.2
Indirect costs Travel		
Total	**6.9**	

8.6.1 Internal labour support costs

The figure below presents the internal and contracted corporate and FTE profile based off the same spreadsheet that has been used to generate labour cost forecasts. The analysis indicates the typical corporate and support roles to deliver the project.

Figure 6 Other support and corporate role FTE profile



Analysis of rates indicates the following:

- Average rate per hour $216
- Minimum rate per hour $165
- Maximum rate per hour $257 (Senior Project Manager)

These rates, reflecting corporate and specialist roles are higher than the previous areas, but not unreasonable in the current market.

Extension of hourly rates by hours and FTE numbers across the entire population indicates that Transgrid's calculation is $0.1M lower than our calculation, or 1.5% of the total supporting that the calculation is material correct.

8.6.2 Other support and corporate roles internal labour support costs conclusion

From a bottom-up build perspective, sufficient rigor has been applied to the forecast preparation.

From a top-down perspective, other support and corporate roles labour costs are $10.8M (100%) compared to the total capex forecast of $254.8M (Real 2023-24). Benchmarking of WSB project management costs to comparatively sized projects indicate the following.

Table 28 WSB other support and corporate roles cost benchmarking

Project	Project total costs	Other support and corporate role labour costs	Other support and corporate role labour costs as a % of relevant project costs
WSB	$254.8M	$10.8M at 100%	4.3%
QNI	$222.8M	$3.3M	1.5%
VNI	$45M	$3.6M	8%

WBS corporate costs includes approximately $3.4M in transmission and substations design costs reflecting the higher number of substations compared to QNI after adjustment the other support and corporate costs fall to 2.9% as a percentage of the total projects cost.

8.7 Proportion of labour and labour-related costs

As indicated in Section 8 Transgrid has assumed a 70% / 30% labour split with 30% of labour and labour-related costs are assumed to be indirect.

Across Sections 8.6 to 8.6 the total number and phasing of FTE's involved in project management, SIPS delivery and other corporate and support roles have been considered for reasonableness. These sections also consider the reasonableness of FTE role hourly rates and the extension of these factors to calculate the forecast.

Given these assessments, in this Section GHD only needs to confirm that the 30% split applies.

Table 29 Breakdown of the proportion of labour and labour related costs (Real 2022-23)

Category	Total capex ($M)	GHD assessment
Proportion on labour forecast	**15.5**	
Internal	[redacted]	Confirmed 30%
Outsourced	[redacted]	Confirmed 30%

8.8 Indirect costs

The following table details actual indirect costs to 31 Match 2023 and the forecast to project completion. In total these represent the costs to support regulatory approvals, procurement, and legal support, independent technical reviews and the cost of mandatory PAI insurance.

Table 30 Indirect cost forecast ($M Real 2022-23)

Capital category	Details	Total $M
Project management		
Project Management	*1 Assurance Gate Reviews	[redacted]
TL Project Management	Management of Distribution TL Undercrossings	[redacted]
SIPSA Technical Reviews	*8 Independent Engineer (NOD, SIPSA, PGSA)	[redacted]
Sub-total		[redacted]
Corporate and support roles		
	*3 Schedule Support / Review	[redacted]
	Document Controller	[redacted]
	*4 Contract Independent Adjudicator	[redacted]
HSE	*5 Independent Audit (HSE)	[redacted]
TG Corporate Support	Legal Consultant - Property & Easements	[redacted]
	Landowner Compensation Payments	[redacted]
	Principal Arranged Insurance (PAI) Insurance	[redacted]
Sub-total		[redacted]
Regulatory approvals		
Regulatory approvals	Independent Verification	[redacted]
	Regulatory Modelling	[redacted]
Sub-total		[redacted]
Environment		
TL Environmental Approvals	SER external costs	[redacted]
Sub-total		[redacted]
Transaction procurement support		
TL ECI Agreement Zinfra	ECI Line Works Supplier 1	[redacted]
TL ECI Agreement Genus	ECI Line Works Supplier 2	[redacted]
Subs ECI Agreement Zinfra	ECI Subs Works Supplier 1	[redacted]
Sub total		[redacted]
Total		**6.9**

8.9 Labour and indirect costs conclusion

Table 31 Labour and indirect cost support and verification

Forecast element	Details and conclusion
Project management labour and labour-related costs	Project management labour and labour-related costs are supported by a robust bottom-up build methodology and benchmarks align with comparative projects such as QNI.
Other support and corporate labour and labour-related costs	Other support and corporate labour and labour-related costs are supported by a robust bottom-up build methodology. These costs benchmark higher than comparative projects such as QNI, but include higher design development costs given the number of substations involved in the augmentation works.
Indirect costs	Indirect costs represent the costs to support regulatory approvals, procurement and legal support, independent technical reviews and the cost of mandatory PAI insurance. As these

Forecast element	Details and conclusion
	costs are / will be necessarily incurred in progressing the project their inclusion in the forecast is considered reasonable.
Conclusion	Actual and forecasted labour, labour-related and indirect costs are likely to be within +/-20% which is considered appropriate for the stage of the project's development.

A-1 Waratah Super Battery scope

The following provides a more detailed description of the WSB scope.

Transmission lines

The non-contestable transmission lines scope of works set out in the Network Operator Deed require the uprating (i.e. capacity increase) on three existing transmission lines to facilitate the SIPS planning works, as required have determined the uprating requirement set out in the table below.

Table 32 Transmission line augmentation work requirements

Transmission line	Uprating requirement	Delivery date
Line 39 Bannaby to Sydney West	Increasing capacity from 85°C to 120°C	1 November 2024
Line 3L/4 Yass to Marulan	Increase capacity from 68°C to 85°C	1 August 2025
Line 5 Yass to Marulan	Increase capacity from 68°C to 85°C	1 August 2025

Increasing the operating temperature of these transmission lines means that the conductor will sag more at these higher operating temperatures, reducing conductor clearances in some sections of the transmission lines below the safe clearances set out in AS/NZS 7000.

These uprating requirements were provided to the early contractor involvement participants, to develop a concept design and scope of works.

The early contractor involvement developed concept design is summarised below.

Table 33 Scope of transmission line capex works

Transmission line	Scope quantity			
	New structure install	D string and V string install	Tower strengthening	New footings
Line 39 Bannaby to Sydney West	2 suspension	64	16	4
Line 3L/4 Yass to Marulan	8 suspension and 2 tension	199	84	20
Line 5 Yass to Marulan	2 suspension and 3 tension	182	79	13

Substations

The non-contestable substation scope of works set out in the Network Operator Deed require the uprating (i.e. capacity increase) of substation equipment which is currently constraining the rating of the associated transmission lines to facilitate the SIPS. Planning works have determined the uprating requirement set out in the table below.

Table 34 Nature of substation capex works

Substation	Transmission line terminal equipment for uprating at each substation	Delivery date
Northern substations and line 39 substations		
Liddell	81, 82, 84, 84	1 November 2024
Newcastle	81	
Tomago	82	
Muswellbrook	83, 88	
Tamworth	84, 85, 86, 88	
Armidale	8U, 86, 8C, 8E	

Substation	Transmission line terminal equipment for uprating at each substation	Delivery date
Uralla	85, 8U	
Dumaresq	8C, 8J	
Sapphire	8E, 8J	
Bannaby	39	
Sydney West	39	
Southern substations		
Yass	3, 3L, 5	1 August 2025
Canberra	7	
Stockdill	1 (pending detailed design)	
Collector	3L, 4	
Marulan	4, 5	
Macarthur	17	
Avon	17	
Sydney South	11	
Dapto	11	
Upper Tumut	1	
Lower Tumut	3, 7	

The table above sets out the rating of the transmission lines which are currently constrained by the thermal rating and control/protection system settings of associated substation equipment. The scope of works required to achieve the uprating involves replacing existing substation equipment with:

- Equipment that has a higher thermal rating of 3,150 A or 4,000 A, and
- Amending the control and protection system settings to facilitate the higher rating.

The table below sets out the scope of works required at each substation.

Table 35 Scope of substation capex works

Substation	Scope of HV equipment replacement works	Scope of secondary systems modifications works
Northern substations and line 39 substations		
Liddell	6 Circuit Breakers, 6 Current Transformers, 2 Line Traps, 13 Disconnectors, 14 Earth Switches, Droppers and bay conductors replacement on 3 line bays	Control, automation and protection system updates Increase current transformer ratio
Newcastle	2 Circuit Breakers, 2 Current Transformers, 1 Line Trap, 1 Disconnector, 1 Earth Switch, Droppers and bay conductors replacement on 2 line bays,	
Tomago	1 Line Trap, 5 Disconnectors , 6 Earth Switches, Droppers and bay conductors replacement on 1 line bay	
Muswellbrook	Nil	
Tamworth	2 Line Traps, 3 Disconnectors, 2 Earth Switches, Overhead bus, droppers and bay conductors on 2 bays	
Sapphire	Nil	
Armidale	1 Line Trap, 1 Earth Switch, Overhead bus and bay conductors on 1 bay and droppers on 4 bays	

Substation	Scope of HV equipment replacement works	Scope of secondary systems modifications works
Dumaresq	Droppers on 2 bays	
Uralla	Droppers on 2 bays	
Bannaby	Droppers and bay conductor replacements on 1 bay	
Sydney West	2 Disconnectors, droppers, bay conductors on 1 bay	
Southern substations		
Yass	Overhead bus, dropper and 2 bay conductor replacements	Control, automation and protection system updates
Canberra	2 Circuit Breakers, 2 Current Transformers and 1 bay conductor	
Collector	Droppers replacement on 2 bays	
Macarthur	2 Current Transformers, 1 Line Trap, 4 Disconnectors, 5 Earth Switches, Overhead bus, droppers and bay conductors	
Sydney South	1 Line Trap, droppers and bay conductors on 1 bay	
Dapto	1 Circuit Breaker, 2 Disconnectors, 1 Earth Switch, Overhead bus, droppers and bay conductors on 1 bay	
Marulan	6 Current Transformers, 2 Line Traps, 12 Disconnectors , 14 Earth Switches, Overhead bus, droppers and bay conductors on 2 bays	
Upper Tumut	Overhead bus, droppers and bay conductors on 1 bay	Control, automation and protection system updates Increase current transformer ratio
Lower Tumut	Overhead bus, droppers and bay conductors on 2 bays	
Avon	1 Current Transformer, 1 Voltage Transformer, 1 Line Trap, 2 Disconnectors, 1 Earth Switch, Overhead bus, droppers and bay conductors on 2 bays	

The works will require various substation equipment and transmissions lines to be taken out of service to allow for safe access by construction crews. The works are scheduled for:

- Northern substations: October 2023 to August 2024
- Southern substations: February 2024 to March 2025

The substations works involve:

- contracted design and construction works:
  - The design works comprising detailed high voltage electrical, secondary systems, civil and structural engineering and design
  - Installing and pre-commissioning the new substation equipment, including civil foundation works
  - Modification of the secondary systems at the substations
- HV equipment procurement:

- Procurement of high voltage equipment and secondary systems equipment by Transgrid and free issued to the contractor

SIPS control

The SIPS will comprise of:

- 1 core logic unit which will control the scheme
- 1 terminal site at the WSB BESS to monitor and control the BESS
- 3 terminal sites, one at each of the paired generators to monitor and control the paired generators
- 14 network monitoring sites at existing substations in northern and southern NSW, which will monitor 37 transmission lines for overload.

The scope of works to implement the SIPS will involve:

- Installing the central data concentrator for the core logic unit
- Installing a logical controller and panel in a modular building at the WSB BESS site
- Installing a logical controller and panel in a modular building at the three current negotiated paired generation sites and establishing a communications link to each site
- Installing a logical controller and panel at each of the 18 network monitoring sites within existing substation buildings
- construction a new underground fibre optic communications link from one of the paired generator sites to our existing network
- Designing the logic for the scheme
- Testing and commissioning the scheme.

All components of the SIPS will be duplicated across independent No.1 and No.2 systems for redundancy.

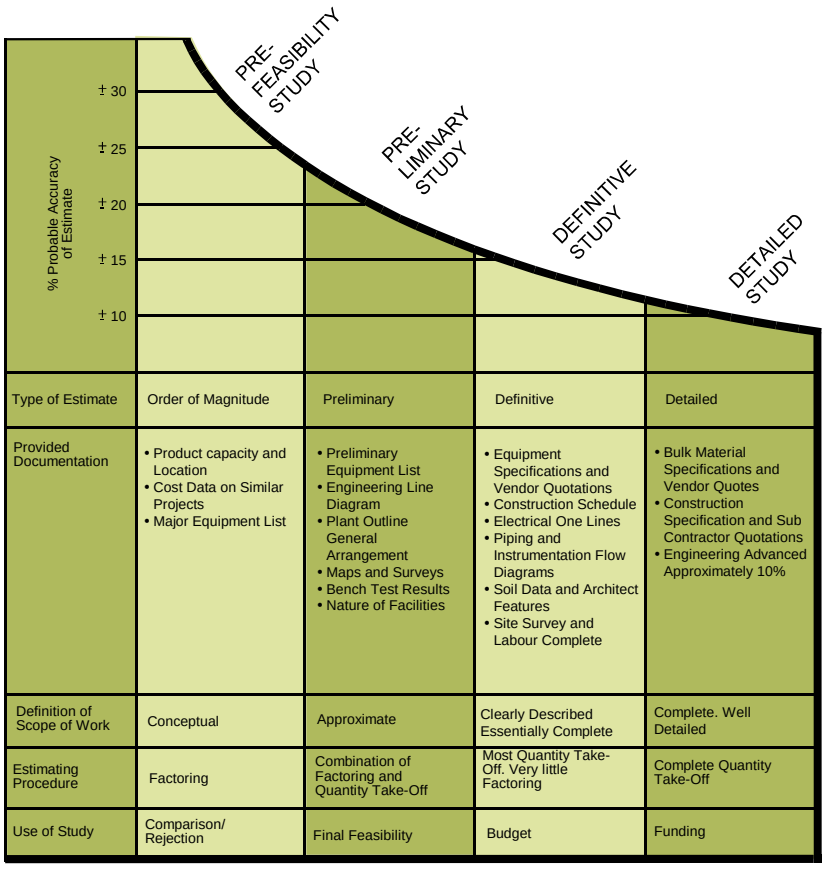
A-2 Unit cost benchmarking methodology and assumptions

Estimate accuracy for assessment

In assessing forecasts included in the Revenue Proposal that are based upon capital network components, consideration must be given to the level of accuracy that can be achieved in generating indicative cost estimates for the network augmentation work packages identified.

The graph shown in Figure 7 indicates the levels of accuracy that can be expected for estimates prepared for capital works at various stages of a project development. Due to the different levels of engineering input, and completeness in the design, there are various levels of accuracy that can be reasonably expected.

Figure 7 ***Standard estimate accuracy levels***



Type of Estimate	Order of Magnitude	Preliminary	Definitive	Detailed
Provided Documentation	• Product capacity and Location • Cost Data on Similar Projects • Major Equipment List	• Preliminary Equipment List • Engineering Line Diagram • Plant Outline General Arrangement • Maps and Surveys • Bench Test Results • Nature of Facilities	• Equipment Specifications and Vendor Quotations • Construction Schedule • Electrical One Lines • Piping and Instrumentation Flow Diagrams • Soil Data and Architect Features • Site Survey and Labour Complete	• Bulk Material Specifications and Vendor Quotes • Construction Specification and Sub Contractor Quotations • Engineering Advanced Approximately 10%
Definition of Scope of Work	Conceptual	Approximate	Clearly Described Essentially Complete	Complete. Well Detailed
Estimating Procedure	Factoring	Combination of Factoring and Quantity Take-Off	Most Quantity Take-Off. Very little Factoring	Complete Quantity Take-Off
Use of Study	Comparison/ Rejection	Final Feasibility	Budget	Funding

Table 36 shows the classification of estimates as defined in the AACE International *Recommended Practice No. 17R-97 Cost Estimating Classification System*.

Table 36 AACE IRP No. 17R-97 generic cost estimate classification matrix[7]

Estimate class	Primary characteristic	Secondary characteristic			
	Level of project definition Expressed as % of complete definition	**End usage** Typical purpose of estimate	**Methodology** Typical estimating method	**Expected accuracy range** Typical +/- range relative to best index of 1 (a)	**Preparation effort** Typical degree of effort relative to least cost index of 1 (b)
Class 5	0% to 2%	Screening or Feasibility	Stochastic or judgement	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorisation or Control	Mixed, but primarily stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 o 100

a. If the range index value of 1 represents +10/-5%, then an index value of 10 represents +100/-50%

b. If the cost index of 1 represents 0.005% of project costs, then an index value of 100 represents 0.5%

The level of information available to us for assessing the augmentation work packages was typical of concept study level. Therefore, we consider our comparative estimates are based on 1% to 15% project definition and should be classified as Class 4 estimates with an accuracy of ±30%.

[7] AACE International, *Recommended Practice No. 17R-97: Cost Estimating Classification System (TCM Framework: 7.3 – Cost Estimating and Budgeting)*, 12 August 1997, p. 2

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