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Appendix 4c: Project EnergyConnect Benchmark Report - KPMG

KPMG

Transgrid

Project EnergyConnect Benchmark Report

FINAL

REDACTED VERSION (PUBLIC)

June 2025

KPMG.com.au

[redacted]

Document review and approval

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Contents

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Inherent Limitations

This report has been prepared as outlined with Transgrid in the Scope Section of the Engagement Letter [redacted]

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by the Transgrid management and personnel consulted as part of the process.

KPMG have indicated within this report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

KPMG is under no obligation in any circumstance to update this report, in either oral or written form, for events occurring after the report has been issued in final form.

The findings in this report have been formed on the above basis.

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[redacted]

1. Executive Summary

1.1. Scope of Services

KPMG has been engaged by Transgrid to obtain benchmark data for transmission lines and substations and undertake a comparative analysis with the new contract price of [redacted] for the Project EnergyConnect (PEC) project. The benchmark data has been provided by Transgrid, and, sourced from publicly available information and in-house data was also provided by KPMG's international partners, where available.

The content of this report represents the key findings from this analysis as of 10 March 2025.

1.2. Limitations

This benchmarking report was prepared throughout January and February 2025 by KPMG Australia for Transgrid as part of our engagement to review major components of the PEC Contract Price. This report was developed for the sole use of Transgrid.

In the process of obtaining and retrieving benchmarking data, either in Australia or overseas, it became extremely difficult to obtain approvals from the various sources to incorporate into this report. We have reached out to [redacted] for actual data but clients are hesitant to share detailed information due to sensitivities. [redacted]

The benchmarks in this report are a reflection only of the projects of a similar nature included in the sample and should not be extrapolated to suggest these results are indicative of broader infrastructure project delivery outcomes achieved by a particular country, or industry sub-sector.

Detailed limitations of this benchmarking analysis are contained in Section 3.3.

1.3. Key Findings

There is limited data available on capital costs for Australian projects for both transmission lines and substations for 500kV and 330kV, additionally PEC uses guyed transmission towers which have not been in used in Australia. The last project of this scale was the Heywood Interconnector, a 275kV transmission line connecting Victoria to South Australia and was commissioned in 1988. There are more recent from a global perspective, however, when contacted by us, the various organisations were reluctant to release the data and detailed information around the success or otherwise of the project. Notwithstanding, the information that could be sourced has been aggregated and analysed against PEC for both transmission lines and substations.

The following are key findings of the transmission line and substation costs for the PEC project compared with the reference projects selected for the benchmark analysis. Section 3.2 details the project selected and reasons for nomination. All the cost data from different regions have been converted to a common base year of 2024 (to align with the PEC costings) to account for price changes over time.

Transmission Lines

Figure 1 below represents the project data that has been normalised on a cost per kilometre (km) for transmission lines and includes contractors directs, indirects, and contingency. Normalising transmission costs using cost per kilometre is effective as it provides a consistent and simple measure for direct comparisons, simplifies complex cost structures, and aids in industry benchmarking and informed decision-making.

[redacted]

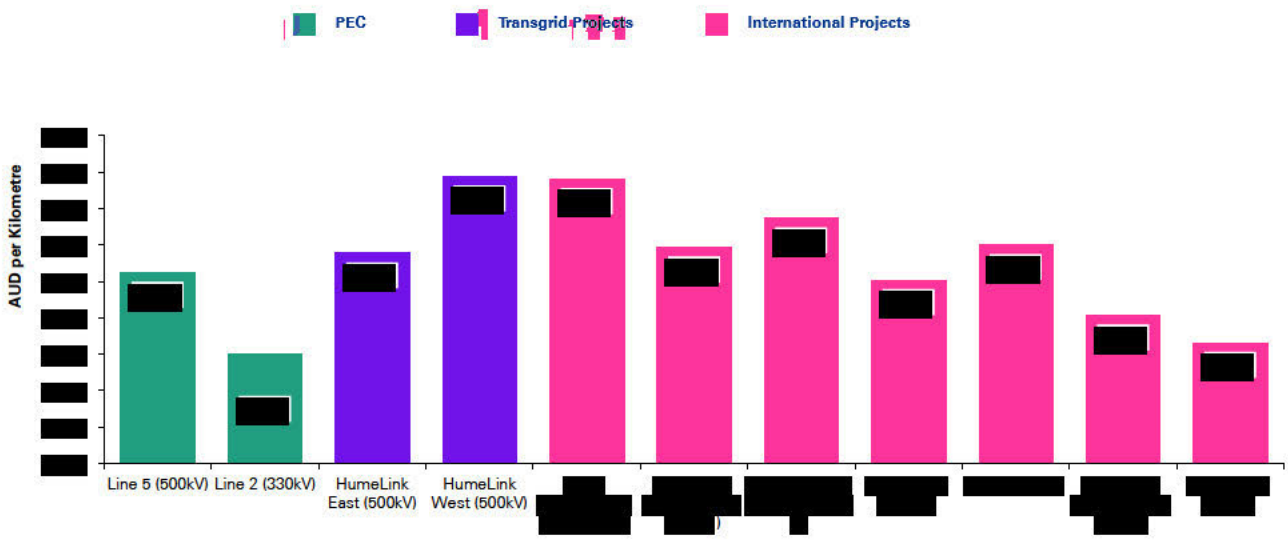

Figure 1. Transmission lines cost per km

The key findings on transmission line benchmarking are outlined below:

- From a Transgrid perspective, Line 5 of PEC (500kV) cost per km benchmarks at [redacted]. PEC is fully designed, with almost all landowner matters resolved and high certainty around materials costs and productivity rates. This compares to HumeLink East (500kV) benchmarked at [redacted] and HumeLink West (500kV) at [redacted], which are tendered rates. However, both Humelink projects are still in design and construction has not commenced. HumeLink West cost per km is higher than the other Transgrid projects as it is being delivered in an alpine terrain. Both HumeLink projects have unresolved landowner issues, incomplete design, untested tower design and unproven production rates, which may generate future cost overruns and program delays.
- The average cost per km of the Transgrid projects is [redacted]. The average cost per km of all 500kV reference projects (excluding PEC) is [redacted].
- Line 2 of PEC (330kV) cost per km benchmarks at [redacted], compared to the average cost per km of [redacted] for 330kV.

The key considerations to the above findings are:

- The contracting strategies for PEC and HumeLink differ primarily due to different approaches to cost estimation and risk allocation. PEC adopts a fixed-cost price in the new contract price, transferring greater cost certainty to Transgrid but limits its contractual flexibility with the contractor. In contrast, HumeLink follows an Incentivised Target Cost model for transmission lines, incentivising cost efficiency while sharing risk between the client and contractors and could arguably come in at a lower target cost, with potential gain or painshare if the actual cost is lower or higher than the target cost.

Substations

Substations are designed and constructed under different configurations depending on the system requirements of the network. Therefore, the costs of substations widely vary due to these differing factors, including supply of phase-shift transformers (in some cases, this equipment is supplied by the Owner, common with Transgrid procured projects), supply of line shunt reactors, synchronous condensers, size and location of switchyards, switching stations, number of bays and site configurations.

By way of example for the differing factors just described, Figure 2 below presents the 330kV and 500kV substations [redacted] selected for comparison and then Figure 3 presents a normalised view where many of the differing factors are removed or amended to make the scope as consistent as possible for the purposes of benchmarking.

[redacted]

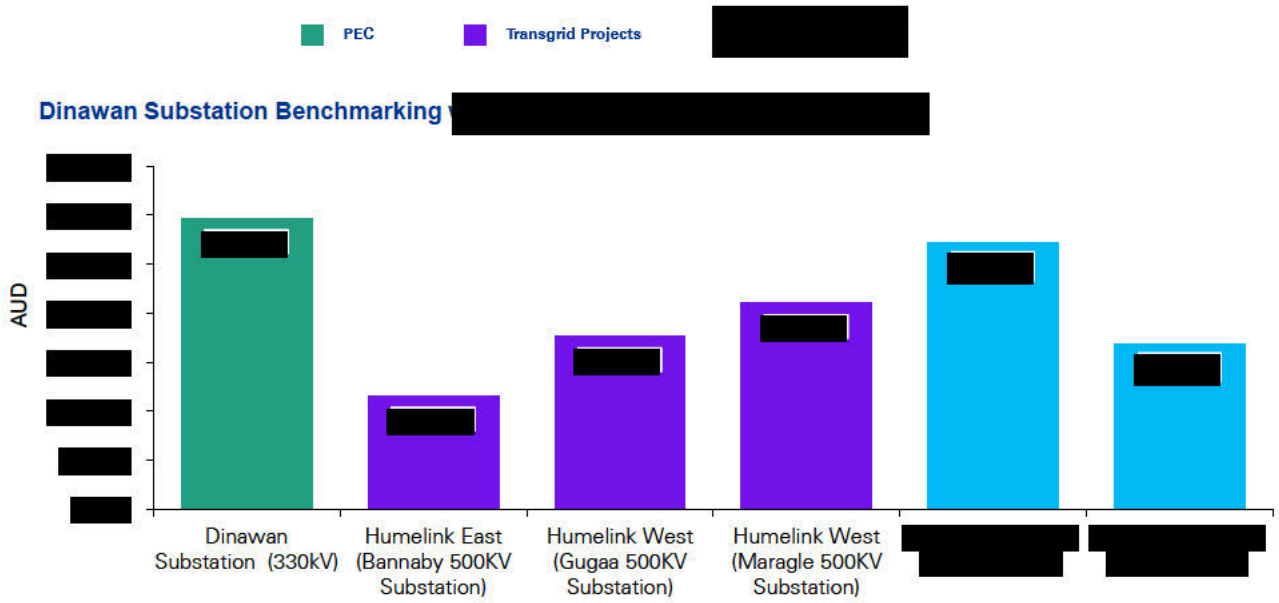

Figure 2. Dinawan substation total costs benchmarking

The scope and configuration of each substation are uniquely different and normalising this dataset to ensure a like-for-like comparison is contained in Figure 3.

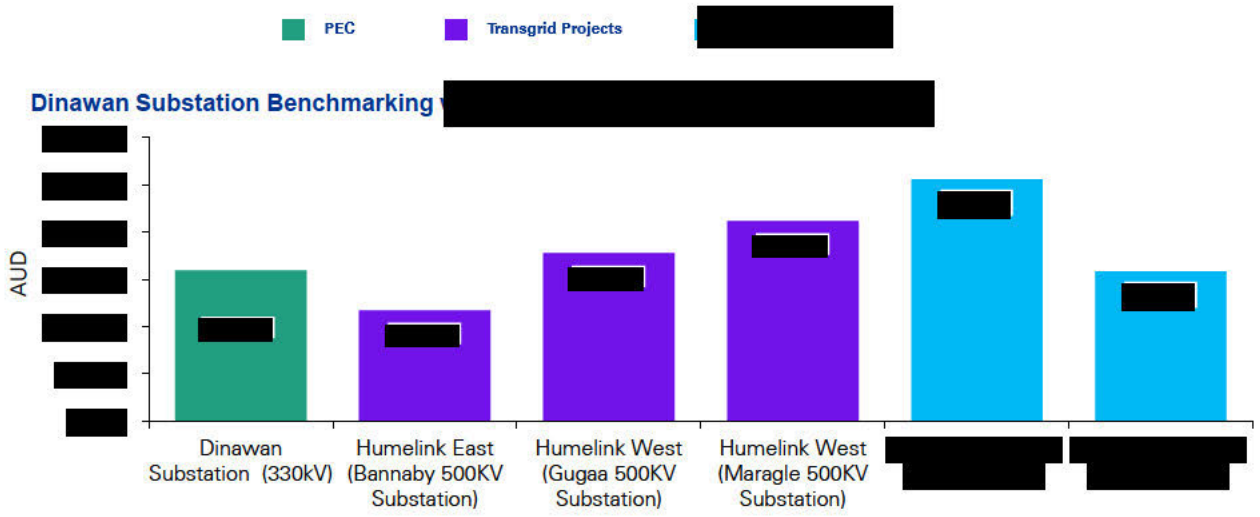

Figure 3. Dinawan substation benchmarking [redacted] (excl. synchronous condensers and switching station)

The key findings on substation benchmarking are outlined below:

- The construction costs of the Dinawan and [redacted] projects are generally comparable when excluding the costs of transformers, synchronous condensers, and switching stations.
- The cost for Dinawan substation is comparable with similar 330kV substations and is less expensive than the average cost of the 500kV substations in the benchmark pool. However, the international data sets have limited information pertaining to the inclusions and assumptions section of what the costs represent, making it difficult to compare them with Dinawan on a like-for-like basis.

The key considerations to the above findings are:

- The higher total (un-normalised) cost of Dinawan substation compared to other Transgrid substations and the [redacted] substation is primarily driven by its unique infrastructure requirements. Specifically, the inclusion of two synchronous condensers and a switching station, which are not present in the other benchmark substations, significantly increases its overall cost, as shown in Figure 2.

[redacted]

- HumeLink substations have a higher voltage level compared to Dinawan, hence resulting in higher costs for civil and structural works, steel structures, equipment supply and install and secondary systems. Bannaby substation, is a substation upgrade project, hence resulting in a lower total cost than Dinawan, Gugaa and Maragle.
- After normalising the dataset to ensure a like-for-like comparison, Dinawan's costs fall within the benchmark range of peer substation projects. As shown in Figure 3, excluding the costs of synchronous condensers and the switching station from Dinawan's total construction cost lowers its overall cost, making it more comparable to similar projects, though differences in bay numbers and key components limit direct comparison.

Detailed analysis and findings of L2, L5, and Dinawan substation benchmarking with other Transgrid, Australian and international projects are discussed in section 4 and 5.

2. Purpose of this Report

KPMG has been engaged by Transgrid to undertake a comparative analysis of the Contract Price for Project EnergyConnect (PEC) (the project) with the following data categories and sources:

- **Category 1 – Transgrid Projects:** Project costs for PEC[1], HumeLink East[2] and West[3].
- **Category 2 - Publicly available sources:** publicly accessible datasets based on the AER, AEMO, Australian university research papers, international regulatory bodies such as [redacted], and international research papers from established institutions.
- **Category 3 -** [redacted]: [redacted]

All data sources used in this benchmarking analysis are contained in section 3.2 of this report.

This benchmarking analysis included reviewing two specific components *'transmission lines'* and *'substations'* of the contract price for PEC.

The content of this report represents the key findings from this analysis as of 6 March 2025. The scope of this report excludes independently developing detailed estimates for these scope items, nor engaging with [redacted], the entity delivering the project for Transgrid. This report represents our Initial Benchmarking Report (or this **report**) in accordance with the requirements of our Engagement Letter [redacted]. This report includes our findings and is issued to **Transgrid** for publication and sharing with Transgrid executives.

1 [redacted]
2 [redacted]
3 [redacted]

[redacted]

3. Benchmarking Methodology

This section of the report outlines the methodology undertaken by KPMG to benchmark the costs for PEC against several Australian and international projects.

Our benchmarking review has been conducted in four (4) discrete phases:

- *Phase 1 – Data collection*
- *Phase 2 – Data Sanitisation*
- *Phase 3 – Normalisation and Detailed Analysis; and*
- *Phase 4 – Reporting and Key findings*

A significant portion of the benchmarking review has been dedicated to Phase 3, 'normalisation and detailed analysis' and our findings from this process are contained in sections 4 and 5.

3.1. Overview of Methodology

The process map below illustrates the approach adopted for this benchmark exercise:

3.2. Data sources

Transmission Lines

The data collected during phase 1 of this engagement is contained in the following table. The samples selected includes previous 330kV and 500kV transmission line projects.

Data Sources	Key Attributes	Description of Project	Rationale for Selection	Category
HumeLink East and HumeLink West	**Location**: Australia **Year:** 2023 **Voltage Level**: 330kV and 500kV **Project status**: In Delivery **Total Cost**: [redacted]	The Transgrid projects used for comparison of L2 and L5 is the HumeLink project. This includes both HumeLink East and West. HumeLink is Transgrid's 500kV transmission line project, extending approximately 365km and connecting Wagga Wagga, Bannaby and Maragle. HumeLink East includes about 237km of transmission line from Bannaby to Wodalga and the upgrade of the existing 500/330kV Bannaby substation. HumeLink West includes 148km of transmission line from Maragle to Wagga Wagga, construction of two new 500/330kV substations at Gugaa and Maragle and the upgrade of the existing 330kV Wagga Wagga substation.	The HumeLink data is the most relevant and accurate data to compare with PEC L2 and L5, this is because: • The costs are tendered rates (uplifted to $2024 dollars) • Like PEC (except for the PEC scope based in SA and VIC), the project is largely based in NSW, and, • Like PEC, HumeLink is delivered by Transgrid under similar regulatory requirements and market conditions.	Category 1 (Transgrid Projects)
[redacted]	**Location**: [redacted] **Year**: 2024 **Voltage Level**: 345kV and 500kV **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)

Data Sources	Key Attributes	Description of Project	Rationale for Selection	Category
		[redacted]		
[redacted]	**Location**: [redacted] **Year**: 2012 **Voltage Level**: 330kV **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)
[redacted]	**Location**: [redacted] **Year**: 2019 **Voltage Level**: 500kV [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)

Data Sources	Key Attributes	Description of Project	Rationale for Selection	Category
	[redacted]		[redacted]	
[redacted]	**Location**: [redacted] **Year**: 2025 **Voltage Level**: 220kV **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)
Additional projects referenced but not used for benchmarking analysis				
[redacted]	**Location**: [redacted] **Year**: 2014 **Voltage Level**: 500kV **Project status**: Completed **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)

Substations Data Sources

Data from previous 330kV and 500kV substation projects, industry reports, and relevant guidelines were gathered to establish baseline standards. Data sets include past Transgrid projects (HumeLink East and HumeLink West) and publicly available transmission line cost data.

Data Sources	Key Attributes	Description	Rationale for Selection	Category
HumeLink East and HumeLink West	**Location**: Australia **Year:** 2023 **Voltage Level**: 500kV **Project status**: In Progress **Total Cost**: $ [redacted]	HumeLink East includes an upgrade of the existing 500kV/330kV Bannaby substation, and HumeLink West includes the construction of two new 500/330kV substations at Gregadoo (Gugaa substation) and Maragle, along with an upgrade of the existing 330kV Wagga Wagga substation. The cost data from HumeLink's initial cost plans were analysed and compared with Dinawan substation costs.	Similar to reasons provided for selecting the HumeLink project for the transmission line component, HumeLink is the most relevant and accurate data to compare with Dinawan substation.	Category 1 (Transgrid Projects)
[redacted]	**Location**: [redacted] **Year:** 2021 **Voltage Level**: 330 kV and 500kV **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 3 [redacted]
[redacted]	**Location**: [redacted] **Year**: 2024 **Voltage Level**: 345kV and 500kV **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)

Data Sources	Key Attributes	Description	Rationale for Selection	Category
[redacted]	**Location**: [redacted] **Year**: 2023 **Voltage Level**: Not Applicable **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)
[redacted]	**Location**: [redacted] **Year**: 2023 **Voltage Level**: 330kV and 500kV **Project status**: Not Applicable **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)
[redacted]	**Location**: [redacted] **Year**: 2018 **Voltage Level**: 240kV **Project status**: Completed **Total Cost**: [redacted]	[redacted]	[redacted]	Category 2 (Publicly available resources)

The normalised costs of benchmark projects were compared with the PEC costs, specifically the Dinawan substation. However, no two substations are identical due to variations in size, capacity, and the types of equipment used. To ensure that the benchmark pool is relevant to Dinawan, the costs were adjusted (refer to Sections 5.2, 5.3 and 5.4 for further detail) based on key factors like voltage level, number of bays and equipment specifications. It must be noted that this normalisation impacts the accuracy of the benchmark, however, for the purposes of this analysis, the results are sufficient to illustrate the likely cost differential between Dinawan and other completed projects both in Australia and around the world.

3.3. Limitations on Data

The following limitations are to be considered when reviewing this report:

- There is limited data available on capital costs for Australian projects for both transmission lines and substations for 500kV and 330kV, including guyed towers. The last project of this scale was the Heywood Interconnector, a 275kV transmission line connecting Victoria to South Australia and was commissioned in 1988.
- Due to the unique nature of commercial arrangement of PEC being based on the contract failure and its rectification through direct negotiations for the contract and new contract price has likely added costs to the project. The additional costs associated with this are not identifiable in the benchmarking as it is a top down approach.
- **Substations** by nature are designed and constructed under different configurations depending on the system requirements of the network. Therefore, the costs of substations vary widely due to these differing factors, including but not limited to:
    - Supply of phase-shift transformers (in some cases, this equipment is supplied by the Owner, common with Transgrid procured projects)
    - Supply of line shunt reactors (in some cases, this equipment is supplied by the Owner, common with Transgrid procured projects)
    - The synchronous condensers are a first in Australia, especially considering the spatial and procurements requirements that impact the overall cost of Dinawan substation
    - The size of switchyard and location of switchyards, the latter influencing the cost of site establishment, remote allowances and civil works
    - The inclusion of switching stations
    - Number of line bays specified, and,
    - Whether the substation is new or modified.
- **Transmission lines** are more readily comparable on a 'like-for-like' capacities. The differences in characteristics may be attributed to the following:
    - Varying terrain for transmission line construction, including whether in bush, scrub or forest, impacts to flora and fauna due to clearing which also adds biodiversity offsets
    - Locality of the transmission line that may require remote work
    - Supply of material, such as the cables and steel (in some cases, this material is supplied by the Owners, common with some Transgrid procured projects)
    - Foundation designs.
- **Comparative analysis of Australian projects with international projects** must also consider differences in procurement, market factors, regulatory requirements for:
    - Large geographical distances, impacting the cost and time to supply and deliver of materials to site
    - Different Legislative requirements
    - The substantial increase in major energy projects in Australia, where market capacity has declined over time, whereas many global markets have continued to deliver major energy projects which supports contractors in maintain a large workforce.
    - Planning and environmental regulations
    - Labour costs

    - Commercial contracts
    - Availability of contractors with the capability to deliver the project (for example, in Australia, there are limited contractors that have the resources and expertise to deliver 500kV transmission lines and guyed towers. Specifically for PEC, the contractor is an international organisation providing experience from abroad).
- We have not considered how productivities are impacted by the Australian geography.
- Due to the limited information available projects in the benchmark pool we are not able to assess the level of contingency allowed for in each project.
- In most cases, a top-down approach, where the analysis is largely derived from historical data, was adopted for both transmission lines and substation components. Whereas a bottom-up approach would depend on estimating detailed scope elements that make up the project. The top-down approach was largely used because of the limited information available that provides detail on the scope of each project from the benchmark pool. For transmission lines, using a top-down approach is reasonable considering that the scope of works will include:
    - Access and clearing
    - Foundations
    - Pads
    - Tower assembly and erection
    - Stringing and clipping-in.

The strategy behind the procurement of material could not be extracted from the data, i.e., supply of cables and steel structure. It is assumed that the benchmark data are all-inclusive costs and include material, based on the way the information has been presented. Whilst, clients regularly procure certain long items due to time constraints, in major projects as demonstrated by PEC, the contractor procures most materials and equipment.

4. Transmission Line

4.1. PEC Transmission Line Summary as per Schedule 10

The following table summarises the Contract Price of transmission lines for PEC, specifically the construction of lines L2 – Buronga to Dinawan transmission line and L5- Dinawan to Wagga Wagga. Note, as advised by Transgrid, this is a commercially negotiated price as of September 2024.

Table 1. L2- Buronga to Dinawan Cost Summary as per Schedule 10

Description	L2– Buronga to Dinawan		L5– Dinawan to Wagga Wagga	
	Amount	% of Direct Cost	Amount	% of Direct Cost
Direct Costs	[redacted]			
Access and Clearing				
Foundations				
Supply and erection of Structure Steelwork				
Stringing				
Clipping - in				
Crossings				
Testing and Commissioning				
Bonds, insurance, contingency, overhead and profit				
Rearrangement Costs				
Claim settlement and works to date variations[1]				
Design				
Line only design				
Site investigations and survey + Transmission Line Design + SPC[2]*+ project documentation, pre-mobilisation, planning and training*[3]				
Preliminaries and Project Management				
Site Establishment and Mobilisation				
Site Management Costs				
Site Running Costs				
Demobilisation Costs				
Risk and Contingency[4]				
[redacted]*Risk*				
Total Cost[5]				
Total Cost per km				

[1]The estimated cost included in '*claim settlement and variations*' have not been validated for this benchmarking analysis.

[2]Site investigations and survey, transmission line design, special protection and communication (SPC), preliminaries and project management are all-inclusive amounts for the PEC project. To enable a thorough assessment of the appropriate amount for L2 and L5, KPMG have apportioned these elements to determine an appropriate amount for the benchmarking analysis of L2 and L5.

[3]Project documentation, premobilisation, planning and training costs were included under Design and Development costs in [redacted]

[4]Risk and Contingency is an all-inclusive amount of [redacted] for the PEC transmission project. In Table 1, and to enable a thorough assessment of the appropriate amount of contingency for L2 and L5,

[redacted]

KPMG have apportioned these elements to determine an appropriate amount for benchmarking analysis of L2 and L5.

[5]The OHP of [redacted] built into the direct cost and preliminaries components.

4.2. Comparable Transgrid Contractor Projects

4.2.1. Summary of Transgrid Project Data

Transgrid's HumeLink East and HumeLink West projects have been selected as benchmark comparisons for Project Energy Connect (PEC). These are major high-voltage transmission projects in New South Wales that have recently undergone procurement and construction, providing a high level of comparability with PEC.

Table 2 PEC Cost Summary Benchmark against HumeLink East and West Transgrid projects

Attribute	L2 (330kV)	L5 (500kV)	HumeLink East (500kV)	HumeLink West (500kV)
Length of Line		[redacted]		
Number of Towers				
Direct Costs				
Design				
Preliminaries				
Risk and Contingency				
Other				
Provisional Sum				
Margin				
Total Line Cost				
Total Line Cost per km				

- Design costs shared amongst HumeLink East (HLE) and HumeLink West (HLW) transmission lines were split based on the portion of the direct costs for both projects.
- Similarly, the preliminaries and margin for HumeLink East and HumeLink West were apportioned using a similar pro-rata approach, based on their share of direct costs, as line-specific estimates were unavailable.
- An inflation multiplier factor of [redacted] based on [redacted] has been applied to adjust 2023 HumeLink data to current values.

Table 3 provides a comparative analysis of projects L2, L5, HumeLink East and HumeLink West, detailing their location, voltage level, line length, configuration, and high-level cost per kilometre. Additionally, the table breaks down the cost per kilometre of key project components, offering a more detailed view of project expenditures.

[redacted]

[redacted]

Table 3. Comparison with Transgrid Projects

Attribute	L2	L5	HumeLink East	HumeLink West
Location	Australia	Australia	Australia	Australia
Voltage Level (kV)	330kV	500kV	500kV	500kV
Length of line (km)	376	157	229	140
Number of Towers	**800**	**336**	**467**	**366**
Type	Double Circuit	Double Circuit	Double Circuit	Double Circuit
Total Line Cost	[redacted]			
Total Line Cost/km				
Access and Clearing (cost/km)				
Foundations (cost/km)				
Supply and erection of Structure Steelwork (cost/km)				
Stringing (cost/km)				
Clipping – in (cost/km)				
Crossings (cost/km)				
Testing and Commissioning (cost/km)				
Spare Equipment				
Others including QA testing, earthing, FAT witness, tower sign plates, bird guard, surge arrestor, AWM and AMB				
Temporary Works for Transmission Line				
Bonds, insurance, contingency, overhead and profit (cost/km)				
Rearrangement Costs (cost/km)				
Claim settlement and works to date variations (cost/km)				
Direct Cost				
Direct Cost/Km				

4.2.2. Comparative Assessment

The following are key considerations comparing PEC and HumeLink:

1) **Procurement Strategy:** PEC is based on a fixed-cost price in the new contract price, meaning all risks, contingencies and overhead and profits (OHP) are built into the total cost. On the other hand, HumeLink follows an incentivised target cost model for transmission lines. As a result, the allocation of risk and OHP differs between the two projects. While the OHP costs are separately accounted for in HumeLink, they are embedded within the direct and indirect costs in PEC. Furthermore, HumeLink was competitively procured compared to PEC being a negotiated price.

2) **Direct costs**: The direct costs are higher for L5, HumeLink East and HumeLink West. KPMG attributes this to mainly the following:

   a. **Access and Clearing Costs:** HumeLink West has significantly higher access and clearing costs compared to L5. This is due to its construction in hilly terrain, requiring extensive earthworks, specialised equipment, and additional labour for site preparation. L5 and HumeLink East, in contrast, are located on relatively flat or accessible areas, leading to lower access-related expenses.

   b. **Structural Steel and Stringing:** The higher voltage level of L5, HumeLink East and HumeLink West compared to L2 significantly impact the costs for structural steel and stringing. Specifically, 500kV transmission lines require significantly larger structures than

[redacted]

330kV due to increased electrical and mechanical demands, resulting in the need for larger and stronger towers. Additionally, the stringing process for higher voltage lines is more complex and labour-intensive, further driving up costs. The increased weight and size of the conductors and insulators for 500kV lines also contribute to higher material and installation expenses.

When access and clearing costs are excluded, and L2 cost is normalised to reflect the cost for a 500kV transmission line, the direct costs per km for L2, L5, HumeLink East and HumeLink West are [redacted] respectively, indicating overall cost comparability.

4.3. Comparison with Global Benchmarks

4.3.1. Global Benchmark Data

The cost/km for 330kV transmission line has been compared with global benchmarks and is represented in Table 4 below.

The cost/km are within reasonable ranges when compared with global unit rate benchmarks.

Table 4 330kV (L2) Cost Comparison with Global Benchmarks (Multiple Sources)

Attribute	L2 (330kV)	[redacted]
Location	Australia	
Voltage Level (kV)	330kV	
Year	2024	
Type	Double Circuit	
Length of line (km)	376	
Total Line Cost (AUD)	[redacted]	
Cost/km (AUD in 2024)		

- [redacted]
- [redacted]

[redacted]

- [redacted]

- Please note that the above information is only correct at this point of time and the information may change in future based on data availability and the fluctuation in conversion rate.

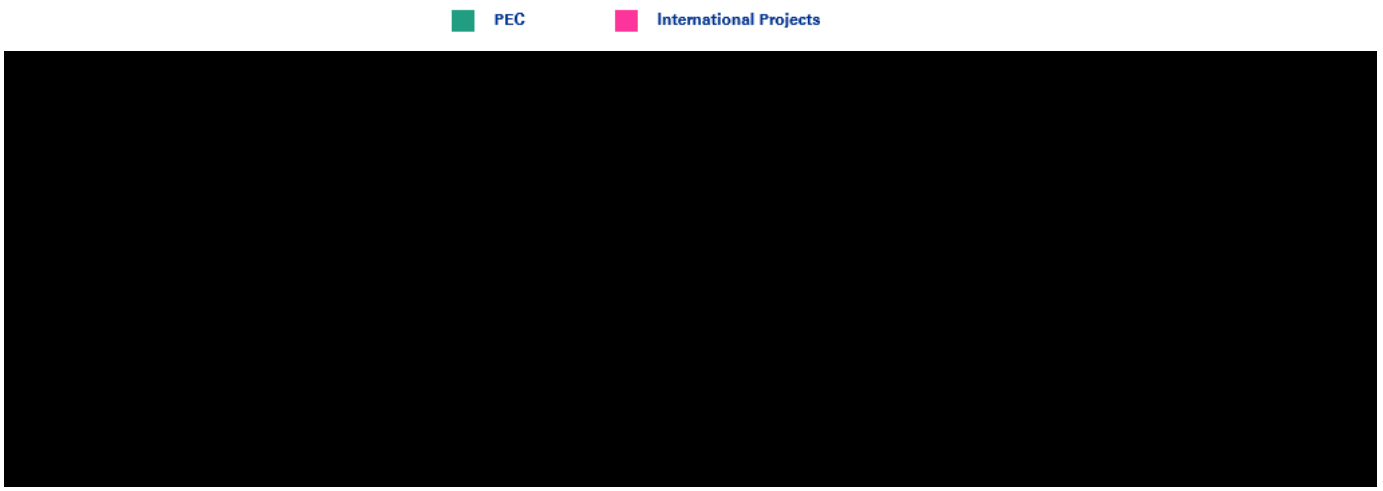

Figure 4 Cost/Km Global Benchmarks for 330kV Transmission Line Projects

The cost/km for 500kV transmission line has been compared with global benchmarks and is represented in Table 5.

[redacted]

Table 5 500kV (L5) Cost Comparison with Global Benchmarks (Multiple Sources)

Attribute	L5 (500kV)	HumeLink East (500kV)	HumeLink West (500kV)	[redacted]
Location	Australia	Australia	Australia	
Year	2024	2023	2023	
Voltage Level (kV)	500kV	500kV	500kV	
Length of line (km)	157	237	148	
Type	Double Circuit	Double Circuit	Double Circuit	
Total Line Cost (Native currency in original year)	[redacted]			
Total Line Cost (AUD in 2024)				
Cost/km ($AUD)				

[redacted]

- [redacted]

- Please note that the exchange rate and escalation used to convert the costs above for comparative purposes may change for future comparison.

PEC Transgrid Projects International Projects

[redacted]

Figure 5 Cost/Km Global Benchmarks for 500kV Transmission Line Projects

[redacted]

[redacted]

4.3.2. Comparative Assessment

- Both L2 and L5 cost per km are below the Nominal 2024 transmission line projects in the 330kV and 500kV benchmark data pool.
- [redacted]

[redacted]

5. Substation

5.1. PEC Dinawan Substation Summary as per [redacted]

Table 6 represents a summary of the total cost associated with construction of Dinawan Substation.

Table 6. L2- Buronga to Dinawan Cost Summary as per [redacted]

Description	Amount	% of Direct Cost
Direct Costs	[redacted]	
Civil, Fencing and Site improvement		
Steel Structures		
Electrical Equipment Supply and Install		
Secondary Systems		
Buildings and Site Services		
Testing and Commissioning		
Bonds, Insurance, Contingency and OH&P		
Bonds, Insurance Fees, LSL		
Contingency		
Overhead and Profit		
Other Payments		
Claim Settlement[1]		
Works to Date Variations		
Design		
Line only design		
Site investigations and survey +Transmission Line Common Design + SPC[2]*+ project documentation, pre-mobilisation, planning and training*[3]		
Preliminaries and Project Management		
Site Establishment and Mobilisation		
Site Management Costs		
Site Running Costs		
Demobilisation Costs		
Risk and Contingency[4]		
[redacted]*Risk*		
Total Cost[5]		

[1]The estimated cost included in '*claim settlement and variations*' have not been validated for this benchmarking analysis.

[2] Site investigations and survey, transmission line design, special protection and communication (SPC), preliminaries and project management are all-inclusive amounts for the PEC project. To enable a thorough assessment of the appropriate amount for Dinawan substation, KPMG have apportioned these elements to determine an appropriate amount for benchmarking analysis of Dinawan substation.

[3]Project documentation, pre-mobilisation, costs are included under Design and Development costs in [redacted].

[4]The 'Risk and Contingency is an all-inclusive rate of all the PEC transmission and substation scope. Therefore, this cost item is a portion of Dinawan substation derived from the direct cost of Dinawan over the total direct costs. For this exercise, only [redacted]s risk and contingency costs of [redacted]has been considered.

[5]The OHP of [redacted]built into the direct cost and preliminaries components.

[redacted]

5.2. Cost Comparison with Transgrid Contractor Projects

5.2.1. Summary of Transgrid Project Data

Transgrid's HumeLink East and HumeLink West projects have been selected as benchmark comparisons for Project Energy Connect (PEC). These are major high-voltage transmission projects in New South Wales that have recently undergone procurement and construction, providing a high level of comparability with PEC.

Table 7 compares PEC's cost summary for Dinawan substation (S2) against those for HumeLink East and HumeLink West.

Table 7 PEC Cost Summary Benchmark against HumeLink East and West Transgrid projects

Attribute	Dinawan (S2) 330kV	HumeLink East (Bannaby Substation)	HumeLink West (Gugaa 500kV Substation)	HumeLink West (Maragle 500kV Substation)
Direct Costs	[redacted]			
Design				
Preliminaries				
Risk and Contingency				
Margin				
Total Construction Cost				
Extra for Synchronous Condensers				
Extra for Switching Station				
Total Substation Cost ($AUD)				

1) Design costs shared amongst HumeLink East (HLE) and HumeLink West (HLW) substations were split based on the portion of the direct costs for Bannaby, Gugaa and Maragle.
2) Similarly, the preliminaries and margin for HumeLink East and HumeLink West were apportioned using a similar pro-rata approach, based on their share of direct costs of each substation above, as line-specific estimates were unavailable.
3) An inflation multiplier factor of [redacted] based on [redacted] has been applied to adjust 2023 HumeLink data to current values.

Table 8 provides a comparative analysis of Dinawan, Bannaby, Gugaa and Maragle substations, detailing their location, voltage level, area and components of the total construction cost.

[redacted]

[redacted]

Table 8. Comparison of Dinawan cost with HumeLink Costs

Attribute	Dinawan	HumeLink East (Bannaby 500kV Substation)	HumeLink West (Gugaa 500kV Substation)	HumeLink West (Maragle 500kV Substation)
Location	Australia	Australia	Australia	Australia
Data Year	2024	2023	2023	2023
Voltage Level (kV)	330kV	500kV	500kV	500kV
Area (m2)	45,807	36,000		
No. of bays	4		4	
Project costs				
Civil and Structural Works	[redacted]			
Steel Structures				
Equipment Supply & Install				
Secondary Systems				
Building and Site Services				
Testing and Commissioning				
Other costs including bonds, insurance, contingency, OHP, claim settlement and works to date variations.				
Total Direct Cost				
Design Cost				
Preliminaries Cost				
Risk and contingency				
Margin				
Total Construction costs (excluding synchronous condensers and switching station)				
Extra for Synchronous Condensers				
Extra for Switching Station				
Total Substation Cost ($AUD)				

- Direct costs for synchronous condensers have been extracted from [redacted] The synchronous condensers costs for testing and commissioning, bonds, contingency, OHP and other payments have not been specified in [redacted] and have hence been excluded from the analysis.
- In the absence of the cost breakdown of the switching station costs, the associated costs for the switching station have been treated as an additional bay to the existing 4 bays. The total costs have been pro-rated, assuming they represent 5 bays in total, with one bay (switching station) separated out accordingly.

[redacted]

5.2.2. Comparative Assessment

The following are key considerations comparing Dinawan substation and HumeLink substations:

- **Voltage level**: The key difference between Dinawan substation and HumeLink substations is in their voltage level. Dinawan is a 330kV substation, whereas HumeLink's Bannaby, Gugaa and Maragle substations are all 500kV.
- **Direct Costs:** The direct costs are higher for substations in comparison with Dinawan substation. KPMG attributes this to the following:
    - **Civil and structural costs:** HumeLink West substations are being built across a more complex geographical region, hence requiring extensive infrastructure like access roads and utility connections, more demanding technical specifications and advanced engineering solutions. All three HumeLink substations, are of higher capacity than Dinawan substation, leading to increased costs for high civil and structural costs.
    - **Steel structures:** The cost of steel structures is higher for HumeLink substations due to their higher capacity and requirement for larger towers. The increased capacity necessitates more substantial infrastructure, which includes larger and more robust towers to support the higher electrical loads and ensure stability and reliability in the transmission network.
    - **Equipment supply and secondary systems:** The higher capacity of HumeLink substations impacts the costs associated with equipment supply and secondary systems due to the need for more substantial and advanced equipment to handle increased electrical loads. This requires higher-quality materials and advanced engineering solutions, which are typically more expensive.
    - Building and site services for Bannaby, and testing and commissioning, bonds, insurance, contingency and OHP for Bannaby, Gugaa and Maragle are not split out in the initial cost plans. KPMG have assumed these to have been embedded within other direct cost elements.
- **Transformers:** The cost of supply and installation of transformers are excluded in construction cost of all 4 projects, primarily because these costs are covered by Transgrid.
- **Synchronous Condensers and Switching Station:** Dinawan costs include [redacted] for 2 synchronous condensers and [redacted] for a switching station (approximated from the direct cost schedule). These components are unique to Dinawan and are not included in HumeLink projects. The total construction cost for Dinawan, excluding the two synchronous condensers and one switching station, seems comparable to HumeLink substation costs. However, the lack of information on the total number of bays and key component characteristics for HumeLink substations significantly impacts the ability to make a direct comparison with Dinawan substation.
- **Design Costs:** The design costs for the Dinawan substation, which include project documentation, pre-mobilisation, planning, and training costs as outlined in [redacted], have contributed an additional [redacted] to its overall design cost. When these additional expenses are excluded, the design costs for Dinawan substation are comparable to those of the HumeLink substations.

[redacted]

5.3. Cost Comparison with a National Project

5.3.1. Summary of [redacted] Project Data

A [redacted] substation cost data was used for comparison with Dinawan substation costs. Table 9 below compares the cost summary between the two projects.

Table 9. PEC Cost Summary Benchmark against similar [redacted] project

Attribute	Dinawan (S2) 330kV	[redacted]
Direct Costs	[redacted]	[redacted]
Design		
Preliminaries		
Risk and Contingency		
Margin		
Total Construction Cost		
Extra for Transformers		
Extra for Synchronous Condensers		
Extra for Switching Station		
Total Substation Cost ($AUD)		

[redacted] has been applied to adjust 2021 project data to current values.

Table 10 provides a comparative analysis of Dinawan, detailing its location, voltage level, area and components of the total construction cost.

Table 10. Detailed Comparison with [redacted] project

Attribute	Dinawan	[redacted] project
Location	Australia	[redacted]
Data Year	2024	
Voltage Level (kV)	330kV	
Area (m2)	45,807	
No. of bays	4	
Components	2 transformers 4 shunt reactors 2 synchronous condensers 1 switching station	
Project costs		
Site establishment	[redacted]	
Steel Structures		
Equipment Supply & Install		
Secondary Systems		
Building and Site Services		
Testing and Commissioning		
Miscellaneous		
Total Direct Cost		
Design Cost		
Preliminaries Cost		
Risk and contingency		
Margin		
Total Construction costs (excluding synchronous condensers and switching station)		
Extra for Transformers		
Extra for Synchronous Condensers		
Extra for switching station		
Total Substation Cost ($AUD)		

[redacted]

5.3.2. Comparative Assessment

The benchmarking analysis indicates that the construction costs of the two projects are generally comparable when excluding the costs of transformers, synchronous condensers, and switching stations.

5.4. Cost Comparison with International Projects

5.4.1. Summary of Global Project Data

The cost for 330kV Dinawan substation has been compared with Australian and global benchmarks and is represented in Table 11 below. Given the inherent variability in project characteristics and underlying assumptions, direct comparisons can be challenging. Considering there are major variabilities in the makeup of substations and how they are configured, it was challenging to collect comparable data to benchmark against. However, we have identified the following sources that have some level of relevancy to Dinawan substation.

Table 11 Dinawan Substation Benchmark Summary

Attribute	Transgrid Data			
	Dinawan Substation (S2)	HumeLink East (Bannaby 500kV Substation)	HumeLink West (Gugaa 500kV Substation)	HumeLink West (Maragle 500kV Substation)
Location	Australia	Australia	Australia	Australia
Data Year	2024	2023	2023	2023
Voltage Level (kV)	330kV	500kV	500kV	500kV
Area (m2)	~46,000	~36,000	~170,000	
No. of bays	4		4	
Total Direct Costs				
Site establishment				
Steel Structures				
Equipment Supply & Install				
Secondary Systems				
Building and Site Services				
Testing and Commissioning				
Other costs including bonds, insurance, contingency, OHP, claim settlement and works to date variations.				
Design Cost				
Preliminaries Cost				
Risk and contingency				
Margin				
Total Construction costs (excluding synchronous condensers & switching station)				
Extra for transformers				
Extra for Synchronous Condensers				
Extra for switching station				
Total Substation Cost ($AUD in 2024)				

[redacted]

- [redacted]

- Please note that the above information is only correct at this point of time and the information may change in future based on data availability and the fluctuation in conversion rate.

5.4.2. Comparative Assessment

Benchmarking substations is more complex than benchmarking transmission lines due to the numerous variables and unique characteristics of each substation, especially in comparison with Dinawan substation which includes two synchronous condensers and a switching station.

The cost for Dinawan substation is comparable with similar 330kV substations in the benchmark pool and is less expensive than the average cost of the 500kV substations in the benchmark pool. However, the international data sets have limited information on the inclusions and assumptions section of what the costs represent, making it difficult to compare them with Dinawan on a like-for-like basis.

[redacted]

6. References

Transgrid Projects

PEC

- [redacted]

HumeLink

- [redacted]

[redacted]

[redacted]

International Projects

Transmission lines

- [redacted]

Substations

- [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]