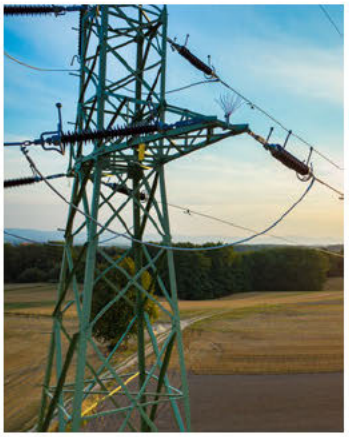
2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Appendix 7.02 – PUBLIC

GHD
Unit Rates for Repex Modelling Report

GHD Advisory



Unit Rates for Repex Modelling

Powerlink

November 2020

Executive summary

Powerlink has commenced preparations for its next regulatory determination process for the 2023-27 regulatory period. As part of this process, GHD was engaged by Powerlink to independently prepare comparative industry unit rates for the scope as outlined in Appendix A.

The scope covers the following asset groups:

- Substation switch bays
- Secondary systems
- Telecommunications assets
- Buildings and infrastructure
- Transmission lines.

The scope and approach are based on the scope statements provided by Powerlink, reference drawings and an appreciation of industry standards and practices to provide a generic specification.

To allow for a reasonable comparison between the unit rates generated by GHD and Powerlink's internally derived costs, GHD has generated concise building block definitions for each asset category to identify all direct and indirect costs that have been included, and any assumptions that have been applied.

Unit rates have been determined using market costs for the building blocks and assumptions as detailed in section 5. The quality of the data supports Class 4 estimates (±30 per cent) as defined by the Association for the Advancement of Cost Engineering (AACE) International Recommended Practice No. 17R-97 for the asset replacement activities and zone substation projects as a comparative benchmark for the Powerlink unit costs.

GHD's building block unit rates are based on greenfields construction environments. Hence, for some renewal projects, brownfield factors are applied to direct costs and to labour hours to account for productivity differences. In addition contingencies are added to arrive at an intended mid-point for a Class 4 estimate (see AACE standards for definition of estimate classes) for the unit of work. This also allows for removal and disposal of replaced plant and materials where the costs are not explicitly included.

GHD initially provided independent estimated unit rates for the nominated capital works based on assumed scopes of work for the draft report. Following the review with Powerlink, several scope items and understandings were clarified. These have now been addressed in this final report.

Comparative unit rates developed by GHD are contained in the attached spreadsheet 'GHD Advisory – for Powerlink – Comparative Unit Rates Rev 1 (24 September 2020)' along with the scope of works, assumptions and allowances in the spreadsheet and in Section 5.

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1. Introduction

1.1 Background

Powerlink has commenced preparations for its next regulatory determination process for the 2023-27 regulatory period. Powerlink has engaged GHD (us) to independently prepare comparative industry unit rates for the scope outlined in Appendix A and summarised in section 1.2.

1.2 Scope and Objectives

Comparative industry unit rates have been prepared for the scope listed in Appendix A. The scope covers the following asset groups:

- Substation switch bays
- Secondary systems
- Telecommunications assets
- Buildings and infrastructure
- Transmission lines.

The scope and approach are based on the scope statements provided by Powerlink, reference drawings and an appreciation of industry standards and practices to provide a generic specification. Powerlink provided single line diagrams for typical substation layouts as follows:

- 'Powerlink – Typical Substation Layout 110_132kV – H_137122_006_REV_H'
- 'Powerlink – Typical Substation Layout 275kV – H_137122_001_REV_G'
- 'Powerlink – Typical Substation Layout 330kV – H_137122_013_REV_B'.

1.3 Assumptions

GHD assumed the following regarding the development of comparative rates with specific assumptions related to each rate being included with the data within the spreadsheet 'GHD Advisory – for Powerlink – Comparative Unit Rates Rev 1 (17 September 2020)':

- The scope and approach are based on the scope statements provided by Powerlink, reference drawings and an appreciation of industry standards and practices to provide a generic specification. A review session was completed on 11 September 2020 to enable alignment of the scope.
- The estimate has been prepared using historical information from similar projects, adjusted to reflect the requirements of the proposed unit scope and market conditions in which Powerlink operates.
- The costs are based on current costs in 2020/21 dollars. No allowances for price escalations or potential exchange rate fluctuations have been included.
- We have included costs for design and project management where specified in our inclusions for the respective unit costs.
- Powerlink owner's costs[1] have not been included in the rates. Allowance for brownfield environments have been included. These are detailed in each unit cost list of assumptions.

[1] Corporate overheads

- Contractors' site project management and margins have been included. These margins were removed from Powerlink free-issue equipment in the final unit rates estimates.
- Unit rates developed in the draft for secondary systems, telecommunications and building infrastructure did not include project establishment and contractor margins which were added for the final estimates with the other scope clarification changes
- Transmission structure input data related to surface areas for painting and number of members have been adjusted to better represent 110/132 kilovolt (kV) historically older tower designs.

1.4 Acronyms

Table 1-1 List of Acronyms

Acronym	Definition
AACE	Association for the Advancement of Cost Engineering
AC	Alternating Current
ACSR	Aluminium Conductor Steel Reinforced
AER	Australian Energy Regulator
AIS	Air Insulated Switchgear
CB	Circuit Breaker
CT	Current Transformer
CVT	Capacitor Voltage Transformer
DC	Direct Current
DCT	Double Circuit
E/S	Earth Switch
GST	Goods and Services Tax
GZ	Galvanised Steel
HMI	Human Machine Interface
kV	Kilovolt
OHEW	Overhead Earth Wire
OPGW	Optical Ground Wire
OT	Operational Technology
MUX	Multiplexor
PDH	Plesiochronous Digital Hierarchy
PLC	Programmable Logic Controller
RIN	Regulatory Information Notice
S&I	Supply and Install
SCT	Single Circuit
SF6	Sulphur Hexafluoride
WAN	Wide Area Network

2. Review Methodology and Process

Powerlink has prepared a list of asset building blocks to be used in generating its repex forecast as part of the upcoming regulatory control period (2023-27):

- Substation switchbay assets of various voltages and ratings for replacement work
- Secondary system bays, secondary system non-bays and metering
- Communication network assets
- Replacement of substation buildings (excluding amenities), communication buildings, substation site infrastructure and communications site infrastructure
- Replacement of transmission line (approximately 10 km), including towers, conductors, insulators and hardware
- Refit of existing transmission lines (approximately 10 km) including combinations of tower painting, replacement of members and bolts, and replacement of insulators.

The scope, as defined by Powerlink is summarised in Appendix A. In developing the unit rates, Powerlink has required all direct and indirect costs to be identified that relate to the supply, install and commissioning of equipment, and to the removal and disposal of redundant equipment.

No locality factors or escalation should be included in the unit rates. In all cases, an allowance for site project facilities, mobilisation and de-mobilisation has been included. No allowance for living away, remote allowances or construction camps has been included.

To allow for a reasonable comparison between the unit rates generated by GHD and Powerlink's internally derived costs, GHD has generated building block definitions for each asset category (see section 5) to identify all direct and indirect costs that have been included, as well as any other assumptions.

Direct and indirect costs include items shown in Table 2-1. Direct costs are those related to the equipment procurement costs, field labour (trades) and plant directly involved at the project site. Indirect costs included the project management team allocated directly on the project. Contractor overheads and margin include profit, risk margin and allocated corporate overheads. The indirect costs shown in Table 2-1 are consistent with contractor costs for the provision of contruction works and not directly attributable to any individual direct unit cost. These costs are typically allocated to client cost schedules by the contractor in tender submissions.

Table 2-1 Direct and Indirect Costs

Direct Costs		Typical Indirect Costs
• Costs of assets/equipment • Bulk materials, including civil works • Structures and electrical installation • Field labour • Testing and commissioning • Removal and disposal of any redundant assets/equipment	• Construction plant and vehicles • Allowances where applicable • Temporary construction facilities/mobilisation • Allowances where applicable (small in total where a unit cost is not available)	• Contractor overheads and margin (12%) • Contractor Project Management and site management costs (5-10%)

A summary of typical exclusions that are generally not included in any costing exercise is listed below (the asset owner adding these cost items for specific projects under either other construction costs or risks) :

- Cost to client of any downtime
- Cost to client of any isolation and de-isolation of plant and equipment
- Costs due to any construction power / transport outages
- Environmental approvals.

We have developed estimates based on market cost data. The quality of the data supports Class 4 estimates (±30 per cent) for the asset replacement activities and zone substation projects as a comparative benchmark for the Powerlink unit costs.

GHD has been able to incorporate knowledge of market-tested comparable rates from its recent similar project engagements. GHD is aware of the potential cost impacts from proposed large transmission projects in Australia, particularly in New South Wales and Victoria. These are likely to have an impact on labour resources available for business as usual projects across Australia. We have considered this matter and have weighted our building block rates to more recent pricing being offered in the market.

Although we have independently estimated the unit rates for the nominated capital works from our own data sources, we appreciate that there may be differences in work scope and/or practices that Powerlink has adopted due to its network design, coverage and field work requirements.

3. Approach for GHD's derivation of comparative unit rates

3.1 Comparative Estimate Data Sources

The data sources used for the development of unit rates include:

- Market cost data available through recent operational and capital expenditure reviews for electricity transmission and distribution utilities – in Australia and New Zealand. (New Zealand costs are converted to Australian dollars considering labour content and comparison of the average hourly wage rates between Australia and New Zealand – costs reviewed against comparable Australian projects)
- Contract and procurement costs available for recent projects completed by electricity utilities
- Material cost data that may be obtained from suppliers
- Recent asset valuations by GHD
- Cost data available in the public domain, including standard labour costs
- Category Regulatory Information Notice (RIN) data submitted by Australian electricity transmission and distribution utilities.

These costs may not necessarily reflect the actual costs incurred by Powerlink.

3.2 Methods Used in Developing the Unit Rates

We have used generally the same approach and methods to develop rates relevant to all of the particular scopes of work, namely:

- Substation switch bays
- Secondary systems
- Telecommunications assets
- Buildings and infrastructure
- Transmission lines.

Substation and transmission lines unit rate costs have been developed using the following process:

- A data base of building block unit rates is used by GHD which contains costs for the supply of plant and typical subcontracted work (eg. buildings and civil works) and for labour hours to install, test and commission plant for voltages ranging from 33kV to 500kV
- The unit rates are selected and applied to a specified project (in this case 4 substation bays or 10km of transmission line). The project is assigned site establishment/mobilisation cost, running costs and the other indirect costs as applicable including design, project management and contractor overheads/margin (no contractor margin included for free issue equipment)
- The direct costs are then assigned to the breakdown of Powerlink's specified unit rates and all indirect costs are allocated according to the direct costs proportions. This may or may not be exactly reflective of the relative effort involved for unit of work but should be a reasonable approximation
- The number of Powerlink units built up into the project is then used to derive a comparative cost for the unit rate.

For secondary systems, telecommunication, buildings and infrastructure the Powerlink scope is closely aligned to individual unit rates that GHD applies to projects. In these cases the GHD unit rate and scope has been compared to the scope of work required by Powerlink and adjustments made if necessary. In each case we have provided information on the assumptions underpinning the revised unit costs.

In the case of transmission line refurbishment for painting and replacement of members and bolts, GHD's rates are based on direct costs for painting per square metre and for member and bolt replacements on the number of members (both primary and secondary members). Tower designs have changed over the years and, hence, assumptions of painting surface area and number of members will have a major impact on the unit price. We have provided our assumptions in this report.

3.3 Development of Hourly Rates for Queensland

The hourly labour rates used have been based on hourly rates and allowances typical within the electricity industry awards for an electrical worker

Market average values for on-costs considered include:

- Leave – annual, personal, long service, statutory holidays
- Workers Compensation
- Payroll tax

The labour rate adopted for our estimates was developed on the assumption that contractors will be using their own field personnel for network augmentation and asset replacement activities, including protection installation works. Commissioning work is provided by Powerlink. We understand that Powerlink directly provides all work involving insulator replacement. However, we have not separated out this component for the development of transmission line refurbishment work.

The standard direct cost hourly rates (in FY2021) that we used are:

- Electrical worker – $150 per hour
- Senior technician/engineer – $150 per hour
- Linesman – $106 per hour
- Plant operator – $86 per hour.

These labour rates exclude consideration of contractor margin (overheads and profit) or GST which are separately added in the build up for each unit rate. The hourly rates used in our comparative estimates are not intended to directly reflect the various skill levels and associated hourly rates used by Powerlink in generating its unit rates.

3.4 Market Tested Cost Data

The quality of the market data used by GHD supports class 4 type estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International Recommended Practice No. 17R-97 for electricity network assets. The market data is drawn from a range of sources including:

- Market cost data available through recent operational and capital expenditure reviews for electricity transmission and distribution utilities. This includes:
    - Australian Energy Regulator (AER) Contingent Project Applications for major interconnectors

    - Regulatory submissions for five-year capex and repex programs in Australia and New Zealand
- Contract and procurement costs available from other recent GHD projects completed for electricity utilities, government agencies and renewable energy projects
- Material cost data that may be obtained from suppliers
- Recent asset valuations of existing electricity assets by GHD
- Cost data available in the public domain, including standard labour costs.

3.5 Allowances, Risk and Contingencies

An allowance has been added into some rates where a specific building block unit cost such as the removal and disposal of replaced plant and materials is not available explicitly in GHD's set of building blocks. These are identified for each unit rate.

No risk allowance has been added to unit rates. Contingencies have been applied to some unit rates to arrive at an intended mid-point for a Class 4 estimate (see AACE standards for definition of estimate classes). Contingencies applied to individual unit rates are identified in section 5.

4. Alignment of Scope

GHD Advisory independently developed unit rates using market data to be utilised as a benchmark for Powerlink's unit rates and provided Powerlink with the building blocks and assumptions utilised.

The scope and approach are based on the scope statements provided by Powerlink, reference drawings and an appreciation of industry standards and practices to provide a generic specification. However, as GHD has independently estimated the unit rates for the nominated capital works from its own data sources, GHD acknowledges that there may be differences in work scope and/or practices that Powerlink has adopted due to its network design, coverage and field work requirements.

A review of the building blocks and assumptions utilised by GHD and Powerlink was completed on 11 September 2020. In order to align the building blocks and assumptions, GHD and Powerlink agreed on the following general inclusions/exclusions to be incorporated in the revised rates:

- Contractor margins not applied to free issue equipment
- Removal of site locality factors inadvertently included in some unit data items
- Inclusion of project overheads for secondary systems, telecommunications and other infrastructure
- Removal of bay protection and control costs from the substation switch bay unit costs (as these are included in the secondary system unit rates)
- Reduction of tower surface areas and number of members for 132kV double circuit (DCT) and single circuit (SCT) refurbishment
- Details on individual building blocks are provided in Section 5.

To allow for a reasonable comparison between the unit rates generated by GHD and Powerlink's internally derived costs, GHD has incorporated these assumptions in the building block definitions for each asset category (see section 5).

5. Details underpinning GHD's selection of unit rates

5.1 Substation Switch Bays

GHD has calculated substation switch bay unit cost rates based on an estimate for the scope to deliver four complete air insulated switchgear (AIS) bays:

- 33 kV, 66 kV and 132 kV in a single circuit breaker feeder bay configuration
- 275 kV and 330 kV bays in a 1.5 circuit breaker configuration.

The overall approach and assumptions are:

- Design and direct site project costs have been allocated to the unit items by the relative dollar value for the direct costs for material and labour for each asset unit rate.
- Contractor project management and margin has been included (ex GST). The margin has been applied to the total direct costs, excluding procurement of plant (free issue equipment).
- An allowance for brownfield works have been assumed together with an allowance for the removal and disposal of waste equipment and materials.
- No busbars replacement in the unit rates have been included. An allowance for busbars and overhead cables has been included in the unit item rates.
- No other switchyard components and civil costs have been included.
- Following review of the initial rates provided to Powerlink, adjustments were made as outlined in Section 4, such as:
  - No inclusion of protection or secondary systems bay costs
  - No contractor margin for free issue equipment
  - Removal of any remaining remote area locality factors

Table 5-1 Substation Switch Bay Unit Item Configurations

AIS Bay	330kV and 275kV AIS Bays	132kv, 66kV and 33kV AIS Bays
Configuration	1.5 circuit breaker	Single circuit breaker feeder bay
Circuit breakers	4 diameters x 3 = 12 of 330 kV circuit breakers including foundations (unit rate - divide by 12)	4 x 132 kV circuit breakers including foundations (unit rate - divide by 4)
Isolators	4 diameters x 8 (2 per circuit breaker and 1 per feeder) = 32 of 3 phase isolators and earth switches including foundations (unit rate - divide by 16)	8 x isolators with earth switches including foundations (unit rate - divide by 4)
Voltage transformers	3 x 1 phase capacitive voltage transformers sets including foundations for each of 8 feeder bays (unit rate - divide by 8)	4 x 1 phase voltage transformers sets including foundations (unit rate - divide by 4)
Current transformers	Current transformers within dead tank circuit breakers	Current transformers within dead tank circuit breakers
Station posts	One 3 phase set station posts per circuit breaker and feeder surge arrestors included and allocated to the unit items by $ value	One 3 phase set station posts and feeder surge arrestors included and allocated to the unit items by dollar value

5.2 Secondary Systems

GHD has calculated the supply and installation of secondary system unit cost rates based on an estimate for the scope to deliver four secondary system bays and associated non-bay works. The overall approach and assumptions are:

- GHD has used its unit rate items (material and labour) for the respective direct costs for each unit cost.
- Contractor design and direct site project costs have been allocated to the unit items
- Contractor margin has been included (ex GST). Margins not applied to free issue equipment.
- A brownfield works environment has been assumed, as the project relates to repex rather than augex
- Assumptions specific to each unit rate has been provided below in Table 5-2.
- The initial rates provided to Powerlink in the draft report were reviewed based on the alignment of scope to Powerlink's assumptions as outlined in Section 4, such as:
  - Inclusion of overheads, site establishment and an allowance for the removal of old equipment
  - Contractor margins not applied to free issue equipment

Table 5-2 Secondary Systems Assumptions

Unit Rate	Assumptions
Secondary systems bay	All protection and control including cabling directly associated with feeder/transformer/reactive plant bays Design, test and commissioning Direct site project costs Contractor project management and margin included - GST exclusive Margins not applied to design and free issue equipment Brownfield works assumed - uplift factors included Average costs of 330kV, 275kV and 132kV Switch Bay protection schemes
Metering	Duplicate Type 2 meters (Class 0.5) – (S&I) One new panel (S&I) Design, test and commissioning Direct site project costs Contractor project management and margin included - GST ex Margins not applied to design and free issue equipment Brownfield works assumed - uplift factors included Metering panel replaced with duplicate Class 0.5 meter. Additional $3,000 for Class 0.2 meters.

Unit Rate	Assumptions
Secondary systems non-bay	All non-bay secondary systems including AC and DC systems - average of 275kV and 132kV substations AC Distribution (500kVA Site) - boards, cables and outlets (S&I) Site secondary systems cabling - not bay related (S&I) x no. of Bays Control Cable (S&I) Control Cable Termination (S&I) DC Distribution System (outside building) - boards, cables and outlets (S&I) Substation Automation System (S&I) Building AC and DC Distribution System, fire protection, lighting Other site fire protection (including equipment) (S&I) Building and site security systems (S&I) Direct Costs before design, test, commission, PM and other overheads.

5.3 Telecommunication Assets

GHD has calculated the supply and installation of the telecommunication asset unit cost rate based on an estimate for the scope to deliver the work associated for a small substation site. The overall approach and assumptions are:

- GHD has used its unit rate items (material and labour) for the respective direct costs for the unit cost.
- Contractor design, test and commissioning, and direct site project costs have been included
- Contractor margin has been included (ex GST). Margins not applied to free-issue equipment.
- A brownfield works environment has been assumed, as the project relates to repex rather than augex.
- Assumptions specific to the unit rate has been provided below in Table 5-3.
- The initial rates provided to Powerlink in the draft report have been reviewed based on the alignment of scope to Powerlink's assumptions as outlined in Section 4, such as:
  - Inclusion of overheads, site establishment and an allowance for the removal of existing equipment
  - Contractor margins not applied to free issue equipment
  - Inclusion of project overheads.

Table 5-3 Telecommunication Assets Assumptions

Unit Rates	Assumptions
Communication network assets	Design Test and Commissioning 50V DC Rack Power Supply (S&I) Communications Equipment Cabinets (S&I) Optical Distribution Frame PDH System Mux System Fibre Cable (50 metres) Direct site project costs Contractor project management and margin included - GST ex

5.4 Buildings and Infrastructure

GHD has calculated the building and infrastructure unit cost rates based on an estimate for the scope to deliver the work along with the four complete secondary system bays and with respect to:

- Substation buildings (demountable)
- Communication building and communication site infrastructure (with associated telecommunication equipment for a small substation site)
- Substation site infrastructure associated with four complete 132kV AIS bays for a small substation site.

The overall approach and assumptions are:

- GHD has used its unit rate items (material and labour) for the respective direct costs for each unit cost.
- Contractor design and direct site project costs have been included .
- Contractor margin has been included (ex GST) Margins not applied to free-issue equipment.
- A brownfield works environment has been assumed, as the project relates to repex rather than augex
- Assumptions specific to the unit rate has been provided below in Table 5-4.
- The initial rates provided to Powerlink in the draft report have been reviewed based on the alignment of scope to Powerlink's assumptions as outlined in Section 4, such as:
  - Inclusion of project overheads, civil costs and installation
  - Contractor margins not applied to free issue equipment.

Table 5-4 Buildings and Infrastructure Assumptions

Unit Rates	Assumptions
Replacement of a demountable control room building	14m × 4m demountable control building without any secondary system fitted, on concrete pad. Suitable to house 4-6 diameters (i.e. 12-18 bays) secondary systems. No amenities. Delivered and installed on site.
Replacement of a demountable communications building	For communication use only with air conditioning, fire system without communication equipment and supply and construction on a concrete pad. No amenities. Delivered and installed on site. Suitable to house 4 diameters (i.e. 12 bays) and associated telecoms equipment.
Replacement of substation site infrastructure, not included within other unit rates, e.g. earthworks, earth grid, perimeter fences, etc.	Common site civil costs (switchyard road, earthwork, earth grid, fencing, drainage, and lighting) not included within individual primary system diameters. Excludes other common items such as buildings, station/auxiliary AC/DC supply system, battery and charger. This size/area of site should be able to house 4 diameters (i.e. 12 bays) of 132kV AIS, so approximate 12,000m^2 footprint. Excludes real estate, access land, oil containment system, transformer compound, landscaping.
Replacement of telecommunications site infrastructure, not included within other unit rates.	Site civil costs (fencing, drainage, lighting, plumbing, access track) not included within signal hut or communication building. Excludes diesel generator, AC/DC backup, inverter, real estate and access land cost. This size/area of site should be able to house a signalling or communication hut.

5.5 Transmission Lines

5.5.1 Replacement

GHD has calculated replacement unit cost rates per tower based on an estimate for the scope to deliver the replacement of 10 km of transmission line including decommissioning and disposal of old towers, and new tower costs and conductors. General assumptions include:

- 400-metre span length
- Allowance for 15 per cent of tension towers and 85 per cent of suspension towers
- Allowance for road and track upgrades (10 per cent of a new construction project)
- Complete replacement of foundations
- Steel Tower Twin Mango 7/3.75 optical ground wire (OPGW) for 330 kV and 275 kV Transmission Lines
- Steel tower – Lemon ACSR/GZ 30/7/3.00 3-core 262 mm2[2] for 132 kV Transmission Line.

The overall approach and assumptions are:

- Design and direct site project costs are allocated to each tower at the same ratio for the whole 10km project value applied to the direct costs for material and labour overall.
- Allowance for some detailed design by the contractor based on standard Powerlink designs has been included.
- Contractor project management and margin has been included (ex GST). The margin has been applied to the total direct costs including the procurement of steel, conductors, fittings and civil works.
- An allowance of 3 per cent has been included for difficult civil works geotechnical conditions. This a typical industry average included in the cost for large transmission line projects.
- Allowance for minor creek, road or electricity line crossings have been included.
- Additional costs to work near adjacent live transmission lines or for major transmission line crossings have not been included.
- Costs to decommission and dispose of old towers, conductors and fittings have been explicitly included.
- The respective cost build up for civil works, structural and electrical and project management/margin costs have been provided in Table 5-5 for the respective lowest and highest unit cost items.

[2] Square millimetres.

Table 5-5 Transmission Line Replacement Cost Build Up*

Unit Rates	Assumptions
132 kV Single Circuit Transmission	Civil cost 22% Electrical and Structural 37% Project management, contingencies and other 41%
330 kV Double Circuit Transmission Line	Civil costs 23% Electrical and Structural 35% Project management, contingencies and other 43%

**Percentages may not sum up to 100% because of rounding.*

5.5.2 Refit

GHD has calculated renewal unit cost rates per tower based on an estimate for the scope to deliver 10 km of transmission line renewal work. General assumptions include:

- 400-metre span length
- Allowance for 15 per cent of tension towers and 85 per cent of suspension towers
- Twin conductors per phase for 330 kV and 275 kV transmission lines
- Single conductor per phase for 132 kV transmission lines.

The overall approach and assumptions are:

- Design and direct site project costs are allocated to each tower at the same ratio for the whole 10km project value applied to the direct costs for material and labour overall.
- No allowance for design work by the contractor has been included.
- Contractor project management and margin has been included (ex GST). The margin has been applied to the total direct costs including the procurement of the required steel, bolts and insulators.
- Allowance for lead and asbestos removal has not been included
- Unit rate build up for painting has been based a per square metre rate and tower type (volume of square metres). The assumed areas per tower are provided in Table 5-7 below.
- Unit rates for bolts and replaced member have been based on the number of primary and secondary members per tower type. The assumed number of members and percentage of primary structural members are provided below in Table 5-7.
- The number of bolts has been calculated on the bases of an average of 4.5 bolts per member.
- Specific assumptions for each rate type have been provided below in Table 5-6.
- The initial rates provided to Powerlink in the draft report were reviewed based on the alignment of scope to Powerlink's assumptions as outlined in Section 4, such as reduction to the surface areas and the number of members, and percentage of primary and secondary members for 132 kV transmission towers.

Table 5-6 Refit Transmission Line Assumptions

Unit Rates	Assumptions
Refit members, bolts – repaint – insulators retained	1% of members with bolts and 5% of bolts replaced 330kV and 275kV - average of 4.5 bolts per member 132kV – average of 2 bolts per member Insulators retained Tower repainted
Refit members, bolts – repaint – insulators replaced	1% of members with bolts and 5% of bolts replaced 330kV and 275kV - average of 4.5 bolts per member 132kV – average of 2 bolts per member Insulators replaced Tower repainted
Refit members, bolts – no repainting – insulators replaced	5% of members with bolts and 20% of bolts replaced 330kV, 275kV - average of 4.5 bolts per member 132kV – average of 2 bolts per member Insulators replaced

Table 5-7 Tower Type Assumptions

Tower Type	Assumptions
330 kV Single Circuit	Total members: 480 Surface area (square meters): 350 75% secondary members; 25% primary
275 kV Single Circuit	Total members: 400 Surface area (square meters): 300 75% secondary members; 25% primary
132 kV Single Circuit	Total members: 300 Surface area (square meters): 200 75% secondary members; 15% primary
330 kV Double Circuit	Total members: 575 Surface area (square meters): 600 65% secondary members; 35% primary
275 kV Double Circuit	Total members: 550 Surface area (square meters): 550 65% secondary members; 35% primary
132 kV Double Circuit	Total members: 450 Surface area (square meters): 300 65% secondary members; 15% primary

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Appendices

Appendix A – Unit Costs Reviewed

Table 1 – Substation switch bays asset group unit rates

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure
< = 33kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 33kV air insulated switchgear bays.	ea
< = 33kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea
< = 33kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea
< = 33kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea
> 33kV & < = 66kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 66kV air insulated switchgear bays.	ea
> 33kV & < = 66kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea
> 33kV & < = 66kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea
> 33kV & < = 66kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea
> 66kV & < = 132kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 132kV air insulated switchgear bays.	ea
> 66kV & < = 132kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea
> 66kV & < = 132kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea
> 66kV & < = 132kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea
> 132kV & < = 275kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 275kV air insulated switchgear bays within 1.5 circuit breaker diameter configuration.	ea
> 132kV & < = 275kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea
> 132kV & < = 275kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea
> 132kV & < = 275kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea
> 275kV & < = 330kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 330kV air insulated switchgear bays within 1.5 circuit breaker diameter configuration.	ea
> 275kV & < = 330kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure
> 275kV & < = 330kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea
> 275kV & < = 330kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea

Table 2 – Secondary systems asset group unit rates

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure
Secondary systems bay	All protection relays, control system, panel and wiring associated with a primary plant switch bay	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea
Secondary systems non-bay	Control and monitoring assets not associated with a specific bay (e.g. substation HMI, remote monitoring equipment)	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea
Metering	Duplicate Type 2 metering	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea

Table 3 – Telecommunication assets group unit rates

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure
Communication network assets	Includes a single multiplexer, communications rack, fibre driver or digital microwave radio replacement	Installation as part of bundled scope to deliver four complete secondary systems bays and associated telecoms for small substation site.	ea

Table 4 – Buildings and infrastructure asset group unit rates

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure
Substation buildings, excluding amenities	Replacement of a demountable control room building	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea
Communication buildings	Replacement of a demountable communications building	Installation as part of bundled scope to deliver four complete secondary systems bays and associated telecoms for small substation site.	ea
Site infrastructure, substations	Replacement of substation site infrastructure, not included within other unit rates, e.g. earthworks, earth grid, perimeter fences, etc.	Installation as part of bundled scope to deliver four complete 132kV air insulated switchgear bays.	ea

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure
Site infrastructure, communications	Replacement of telecommunications site infrastructure, not included within other unit rates.	Installation as part of bundled scope to deliver four complete secondary systems bays and associated telecoms for small substation site.	ea

Table 4 – Transmission lines asset group unit rates

Asset category / Estimating building-block	Reference scope and basis of unit rate derivation	Unit of Measure
Replacement transmission line		
> 66kV & < = 132kV; Single Circuit	Assumes whole section of line to be replaced for approx. 10km, and includes: • decommissioning and disposal of old towers • new tower costs: materials, construction, etc. with a typical span length of approx. 400m • conductors, OPGW and overhead electrical wire (OHEW), insulators and hardware	Twr
> 132kV & < = 275kV; Single Circuit		Twr
> 275kV & < = 330kV; Single Circuit		Twr
> 66kV & < = 132kV; Multiple Circuit		Twr
> 132kV & < = 275kV; Multiple Circuit		Twr
> 275kV & < = 330kV; Multiple Circuit		Twr
Refit of existing transmission line		
> 66kV & < = 132kV; Single Circuit	For each structure on a contiguous section of approx. 10km includes: • 1% of members, 5% of bolts replaced • surface preparation and painting • insulators retained • OHEW & OPGW retained	Twr
> 132kV & < = 275kV; Single Circuit		Twr
> 275kV & < = 330kV; Single Circuit		Twr
> 66kV & < = 132kV; Multiple Circuit		Twr
> 132kV & < = 275kV; Multiple Circuit		Twr
> 275kV & < = 330kV; Multiple Circuit		Twr
> 66kV & < = 132kV; Single Circuit	For each structure on a contiguous section of approx. 10km includes: • 1% of members, 5% of bolts replaced • surface preparation and painting • insulators replaced • OHEW & OPGW retained	Twr
> 132kV & < = 275kV; Single Circuit		Twr
> 275kV & < = 330kV; Single Circuit		Twr
> 66kV & < = 132kV; Multiple Circuit		Twr
> 132kV & < = 275kV; Multiple Circuit		Twr
> 275kV & < = 330kV; Multiple Circuit		Twr
> 66kV & < = 132kV; Single Circuit	For each structure on a contiguous section of approx. 10km includes: • 5% of members, 20% of bolts replaced • insulators replaced • OHEW & OPGW retained	Twr
> 132kV & < = 275kV; Single Circuit		Twr
> 275kV & < = 330kV; Single Circuit		Twr
> 66kV & < = 132kV; Multiple Circuit		Twr
> 132kV & < = 275kV; Multiple Circuit		Twr
> 275kV & < = 330kV; Multiple Circuit		Twr

Appendix B – ‘GHD Advisory – for Powerlink – Comparative Unit Rates Rev 1 (24 September 2020)’

AIR INSULATED SWITHGEAR BAYS

General Comments and Assumptions	
330kV and 275kV AIS Bays	**132kV, 66kV and 33kV AIS Bays**
4 complete 330kV AIS diameters within a 1.5 CB configuration	4 complete single circuit breaker feeder bays
4 Diameters x 3 = 12 x 330 kV 3 Ph circuit breakers including foundations (unit rate - divide by 12)	4 x 132 kV circuit breakers including foundations (unit rate - divide by 4)
4 Diameters x 8 (2 per CB + 1 per feeder) = 32 3 Ph isolators/earth switches (unit rate - divide by 16)	8 x isolators with E/S including foundations (unit rate - divide by 4)
3 x 1 Ph CVTs sets including foundations for each of 8 feeder bays (unit rate - divide by 8)	4 x 1 Ph VTs sets including foundations (unit rate - divide by 4)
CTs within dead tank CBs	CTs within dead tank CBs
One 3 Ph set station posts per CB and feeder surge arrestors included and allocated to the unit items by $ value	One 3 Ph set station posts and feeder surge arrestors included and allocated to the unit items by $ value
Design and direct site project costs allocated to the unit items by $ value	Design and direct site project costs allocated to the unit items by $ value
Contractor project management and margin included - GST ex	Contractor project management and margin included - GST ex
Brownfield works assumed - uplift factors included	Brownfield works assumed - uplift factors included
No busbar sections	No busbar sections
Removal and disposal of replaced plant and material	Removal and disposal of replaced plant and material
No other switchyard components and civil costs included	No other switchyard components and civil works included

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure	GHD Rate	GHD rate additonal comments
< = 33kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 33kV air insulated switchgear bays.	ea	$ [redacted]	
< = 33kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea	$ [redacted]	
< = 33kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea	$ [redacted]	
< = 33kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea	$ [redacted]	
> 33kV & < = 66kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 66kV air insulated switchgear bays.	ea	$ [redacted]	
> 33kV & < = 66kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea	$ [redacted]	
> 33kV & < = 66kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea	$ [redacted]	
> 33kV & < = 66kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea	$ [redacted]	

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure	GHD Rate	GHD rate additonal comments
> 66kV & < = 132kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 132kV air insulated switchgear bays.	ea	$ [redacted]	
> 66kV & < = 132kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea	$ [redacted]	
> 66kV & < = 132kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea	$ [redacted]	
> 66kV & < = 132kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea	$ [redacted]	
> 132kV & < = 275kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 275kV air insulated switchgear bays within 1.5 circuit breaker diameter configuration.	ea	$ [redacted]	
> 132kV & < = 275kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea	$ [redacted]	
> 132kV & < = 275kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea	$ [redacted]	
> 132kV & < = 275kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea	$ [redacted]	
> 275kV & < = 330kV; air insulated circuit breaker	1 x 3 phase dead tank SF6 insulated circuit breaker, incl. foundations	Installation as part of bundled scope to deliver four complete 330kV air insulated switchgear bays within 1.5 circuit breaker diameter configuration.	ea	$ [redacted]	
> 275kV & < = 330kV; air insulated isolator/earth switch	2 x isolator / 1 x earth switch, incl. foundations		ea	$ [redacted]	
> 275kV & < = 330kV; voltage transformer	3 x 1 phase free standing capacitor voltage transformers (CVT), incl. foundations.		ea	$ [redacted]	
> 275kV & < = 330kV; current transformer	3 x 1 phase free standing CTs, incl. foundations.		ea	$ [redacted]	

SECONDARY SYSTEMS

General Comments and Assumptions		
Secondary Systems - Switchbays	**Duplicate Type 2 metering**	**Secondary Systems Non - Bay**
All protection and control inc cabling directly associated with feeder/transformer/reactive plant bays	Duplicate Type 2 meters (Class 0.5) - S&I	AC Distribution (500kVA Site) - boards, cables and outlets (S&I)
Design, test and commissioning	One new panel S&I	Site secondary systems cabling - not bay related (S&I) x no. of Bays
Direct site project costs	Design, test and commissioning	Control Cable (S&I)
Contractor project management and margin included - GST ex	Direct site project costs	Control Cable Termination (S&I)
Margins not applied to design and free issue equipment	Contractor project management and margin included - GST ex	DC Distribution System (outside building) - boards, cables and outlets (S&I)
Brownfield works assumed - uplift factors included	Margins not applied to design and free issue equipment	Substation Automation System (S&I)
Average costs of 330kV, 275kV and 132kV switchbay protection schemes	Brownfield works assumed - uplift factors included	Building AC and DC Distribution System, fire protection, lighting
		Other site fire protection (incl equipment) (S&I)
		Building and site security systems (S&I)
		Direct Costs before design, test, commission, PM and other overheads

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure	GHD Rate	GHD Comments
Secondary systems bay	All protection relays, control system, panel and wiring associated with a primary plant switch bay	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea	$ [redacted]	Average of 132kV, 275kV and 330kV
Secondary systems non-bay	Control and monitoring assets not associated with a specific bay (e.g. substation HMI, remote monitoring equipment)	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea	$ [redacted]	Inclusions above - all non-bay secondary systems including AC and DC systems - average of 275kV and 132kV substations
Metering	Duplicate Type 2 metering	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea	$ [redacted]	Metering panel replaced with duplicate Class 0.5 meter. Additional [redacted] for Class 0.2 meters.

TELECOM ASSETS

General Comments and Assumptions
Communication Network Assets
Design, Test and Commissioning
50V DC Rack Power Supply (S&I)
Communications Equipment Cabinets (S&I)
Optical Distribution Frame
PDH System
Mux System
Fibre Cable (50 metres)
Direct site project costs
Contractor project management and margin included - GST ex

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure	GHD Rate	GHD Comments
Communication network assets	Includes a single multiplexer, communications rack, fibre driver or digital microwave radio replacement	Installation as part of bundled scope to deliver four complete secondary systems bays and associated telecoms for small substation site.	ea	$ [redacted]	Includes DC power supply and 50 metres of fibre cable

BUILDINGS AND INFRASTRUCTURE

General Comments and Assumptions

Asset category / Estimating building-block	Basis of unit rate derivation	Reference scope	Unit of Measure	GHD Rate	GHD Comments
Substation buildings, excluding amenities	Replacement of a demountable control room building	Installation as part of bundled scope to deliver four complete secondary systems bays.	ea	$ [redacted]	14m × 4m demountable control building with air con, AC supply, fire system without any secondary system fitted, on concrete pad. Suitable to house 4-6 diameters (i.e. 12-18 bays) secondary systems. No amenities. Delivered and installed on site.
Communication buildings	Replacement of a demountable	Installation as part of bundled scope to deliver four complete secondary systems bays and associated telecoms for small substation site.	ea	$ [redacted]	For communication use only with air con, AC supply, fire system without any communication equipment and DC supply in it and on concrete pad. No amenities. Delivered and installed on site.
Site infrastructure, substations	Replacement of substation site infrastructure, not included within other unit rates, e.g. earthworks, earth grid, perimeter fences, etc.	Installation as part of bundled scope to deliver four complete 132kV air insulated switchgear bays.	ea	$ [redacted]	Common site civil costs (switchyard road, earthwork, earth grid, fencing, drainage, lighting) not included within individual primary system diameters. Excludes other common items such as buildings, station/aux AC/DC supply system, battery, charger. This size/area of site should be able to house 4-6 diameters (i.e. 12-18 bays) of 132kV AIS, 12,000m2 footprint. Excludes real estate, access land, oil containment system, Tx compound, landscaping.
Site infrastructure, communications	Replacement of telecommunications site infrastructure, not included within other unit rates.	Installation as part of bundled scope to deliver four complete secondary systems bays and associated telecoms for small substation site.	ea	$ [redacted]	Site civil costs (fencing, drainage, lighting, plumbing, repairs to access track) not included within signal hut or communication building. Excludes diesel generator, AC/DC backup, inverter, real estate and access land cost.

TRANSMISSION LINES

General Comments and Assumptions			
330kV and 275kV transmission line replacements	**132kV transmission line replacements**	**Refit members, bolts and repaint**	**Refit members, bolts and replace insulators**
Steel Tower Twin Mango 7/3.75 OPGW	Steel tower - Lemon ACSR/GZ 30/7/3.00 3-core 262 mm2	400 metre span length	400 metre span length
400 metre span length	400 metre span length	10 kilometre line section	10 kilometre line section
10 kilometre line section	10 kilometre line section	Allowance for 15% tension towers and 85% suspension towers	Allowance for 15% tension towers and 85% suspension towers
Allowance for 15% tension towers and 85% suspension towers	Allowance for 15% tension towers and 85% suspension towers	Allowance for lead and asbestos not included	OHEW & OPGW retained
Allowance for road and track upgrades (10%)	Allowance for road and track upgrades (10%)	OHEW & OPGW retained	Unit rates for bolts and replaced member based on number of primary and secondary members per tower type
Complete replacement of foundations	Complete replacement of foundations	Unit rates for painting per square metre and tower type	
		Unit rates for bolts and replaced member based on no. of primary and secondary members per tower type	
		330kV/275kV average 4.5 bolts per member; 132kV average 2 bolts per member	

Tower Assumptions:

Tower	Sq metres	No. of Members	% Primary Members
330kV DCT	575	600	35%
275kV DCT	550	550	35%
132kV DCT	300	450	15%
330kV SCT	480	350	25%
275kV SCT	400	300	25%
132kV SCT	200	300	15%

Asset category / Estimating building-block	Reference scope and basis of unit rate derivation	Unit of Measure	GHD Rate	GHD rate additonal comments
Replacement transmission line				
> 66kV & < = 132kV; Single Circuit	Assumes whole section of line to be replaced for approx. 10km, and includes: • decommissioning and disposal of old towers • new tower costs: materials, construction, etc. with a typical span length of approx. 400m • conductors, OPGW and OHEW, insulators and hardware	Twr	$ [redacted]	132kV SCT Civil cost 20%
> 132kV & < = 275kV; Single Circuit		Twr	$ [redacted]	Electrical and Structural 39%
> 275kV & < = 330kV; Single Circuit		Twr	$ [redacted]	Project management, contingencies and other 41%
> 66kV & < = 132kV; Multiple Circuit		Twr	$ [redacted]	330kV DCT Civil costs 24%
> 132kV & < = 275kV; Multiple Circuit		Twr	$ [redacted]	Electrical and Structural 36%
> 275kV & < = 330kV; Multiple Circuit		Twr	$ [redacted]	Project management, contingencies and other 40%

Asset category / Estimating building-block	Reference scope and basis of unit rate derivation	Unit of Measure	GHD Rate	GHD rate additonal comments
Refit of existing transmission line				
Refit members, bolts - repaint - insulators retained				
> 66kV & < = 132kV; Single Circuit	For each structure on a contiguous section of approx. 10km includes: • 1% of members, 5% of bolts replaced • surface preparation and painting • insulators retained • OHEW & OPGW retained	Twr	$ [redacted]	1% of members with bolts + 5% of bolts replaced
> 132kV & < = 275kV; Single Circuit		Twr	$ [redacted]	Insulators retained
> 275kV & < = 330kV; Single Circuit		Twr	$ [redacted]	Tower repainted
> 66kV & < = 132kV; Multiple Circuit		Twr	$ [redacted]	
> 132kV & < = 275kV; Multiple Circuit		Twr	$ [redacted]	
> 275kV & < = 330kV; Multiple Circuit		Twr	$ [redacted]	
Refit members, bolts - repaint - insulators replaced				
> 66kV & < = 132kV; Single Circuit	For each structure on a contiguous section of approx. 10km includes: • 1% of members, 5% of bolts replaced • surface preparation and painting • insulators replaced • OHEW & OPGW retained	Twr	$ [redacted]	1% of members with bolts + 5% of bolts replaced
> 132kV & < = 275kV; Single Circuit		Twr	$ [redacted]	Insulators replaced
> 275kV & < = 330kV; Single Circuit		Twr	$ [redacted]	Tower repainted
> 66kV & < = 132kV; Multiple Circuit		Twr	$ [redacted]	
> 132kV & < = 275kV; Multiple Circuit		Twr	$ [redacted]	
> 275kV & < = 330kV; Multiple Circuit		Twr	$ [redacted]	
Refit members, bolts - no repainting - insulators replaced				
> 66kV & < = 132kV; Single Circuit	For each structure on a contiguous section of approx. 10km includes: • 5% of members, 20% of bolts replaced • insulators replaced • OHEW & OPGW retained	Twr	$ [redacted]	5% of members with bolts and 20% of bolts replaced
> 132kV & < = 275kV; Single Circuit		Twr	$ [redacted]	Insulators replaced
> 275kV & < = 330kV; Single Circuit		Twr	$ [redacted]	
> 66kV & < = 132kV; Multiple Circuit		Twr	$ [redacted]	
> 132kV & < = 275kV; Multiple Circuit		Twr	$ [redacted]	
> 275kV & < = 330kV; Multiple Circuit		Twr	$ [redacted]	

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