Transmission Cost Database Update

25 November 2022

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We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

We pay respect to their Elders past, present and emerging.

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Please note that this forum will be recorded and published online.

Welcome

Eli Pack

Agenda

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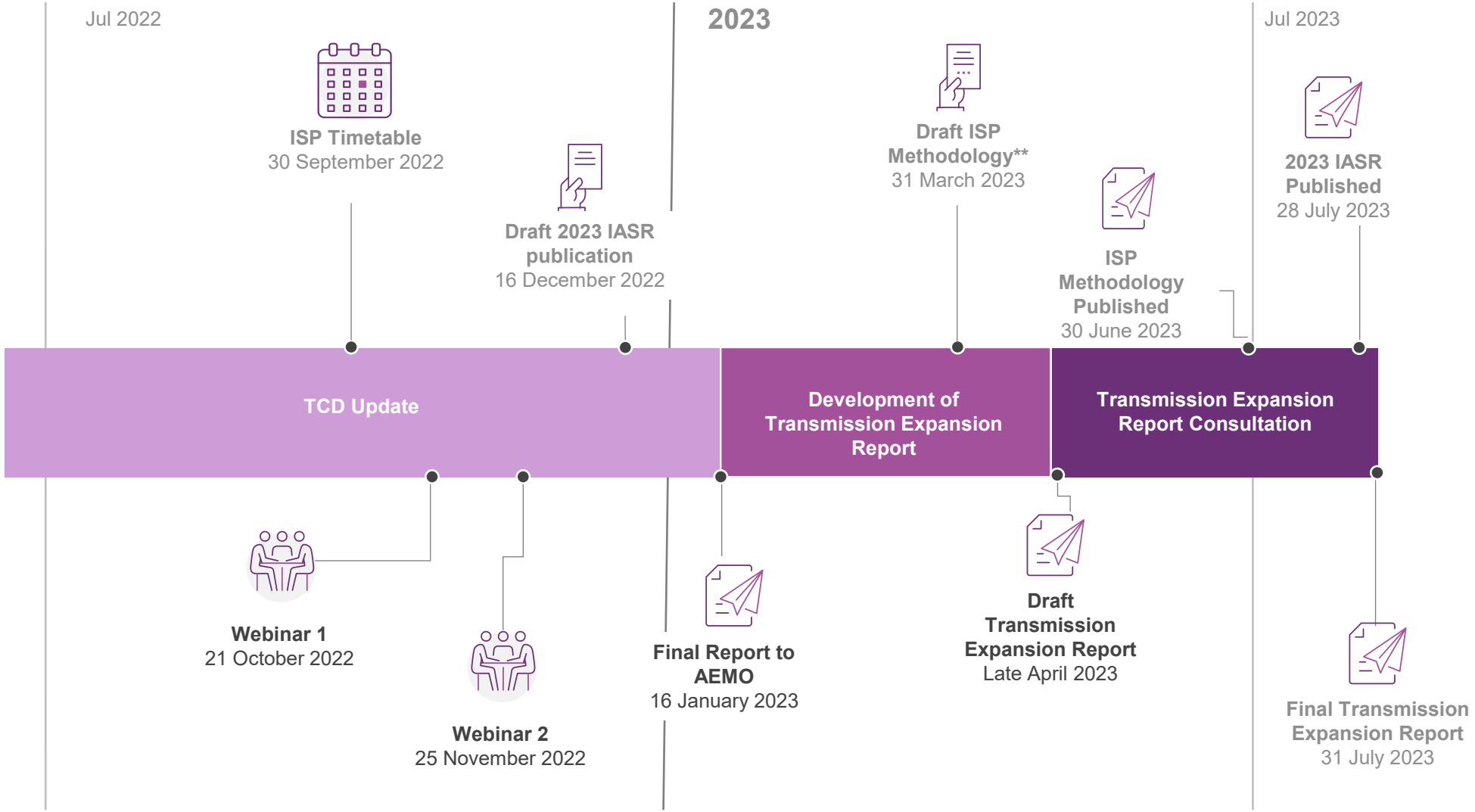
- Update insights
  - Building block updates
  - Adjustment factors, risks and indirect cost updates
  - Escalation factors
  - International Benchmark
  - Economic indexes
  - Basket of indexes
  - Parametric formulas
- Discussion
  - Questions taken on notice

Background

Christopher du Plessis

Timeline


Jul 2022
2023
Jul 2023
ISP Timetable
30 September 2022
Draft 2023 IASR publication
16 December 2022
Draft ISP Methodology**
31 March 2023
ISP Methodology Published
30 June 2023
2023 IASR Published
28 July 2023
TCD Update
Development of Transmission Expansion Report
Transmission Expansion Report Consultation
Webinar 1
21 October 2022
Webinar 2
25 November 2022
Final Report to AEMO
16 January 2023
Draft Transmission Expansion Report
Late April 2023
Final Transmission Expansion Report
31 July 2023

Update focus

Transmission Cost Database

Macro tool

- Published on the AEMO website and used to develop cost estimates
- Produces excel workbook cost estimate files

Cost & Risk Data

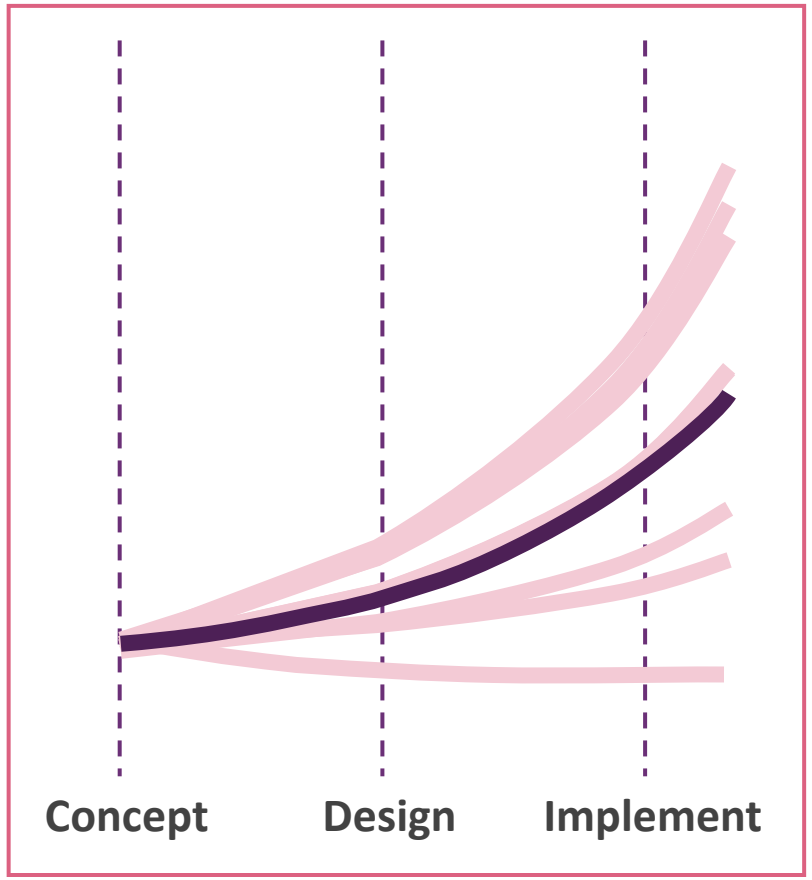
- Access within the macro tool and comprised of unit costs, escalation factors and risk allowances
- Unit costs, factors and allowances are calibrated with the latest project data

Master File

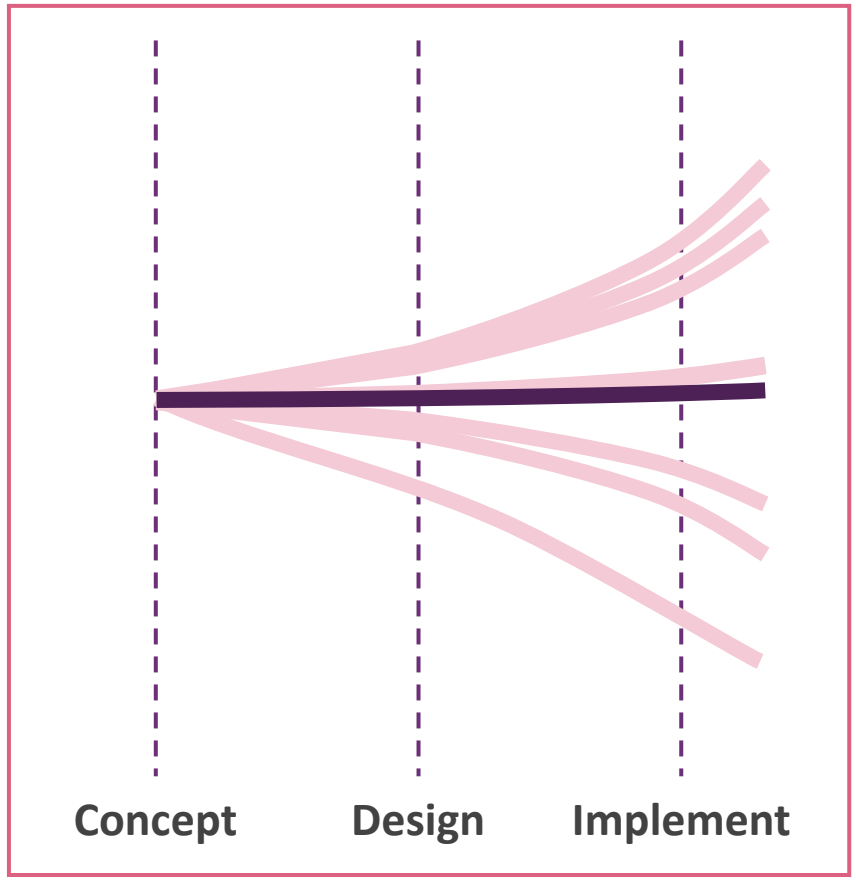
- Internal tool used to batch process cost estimates from previous macro tool files

Objective

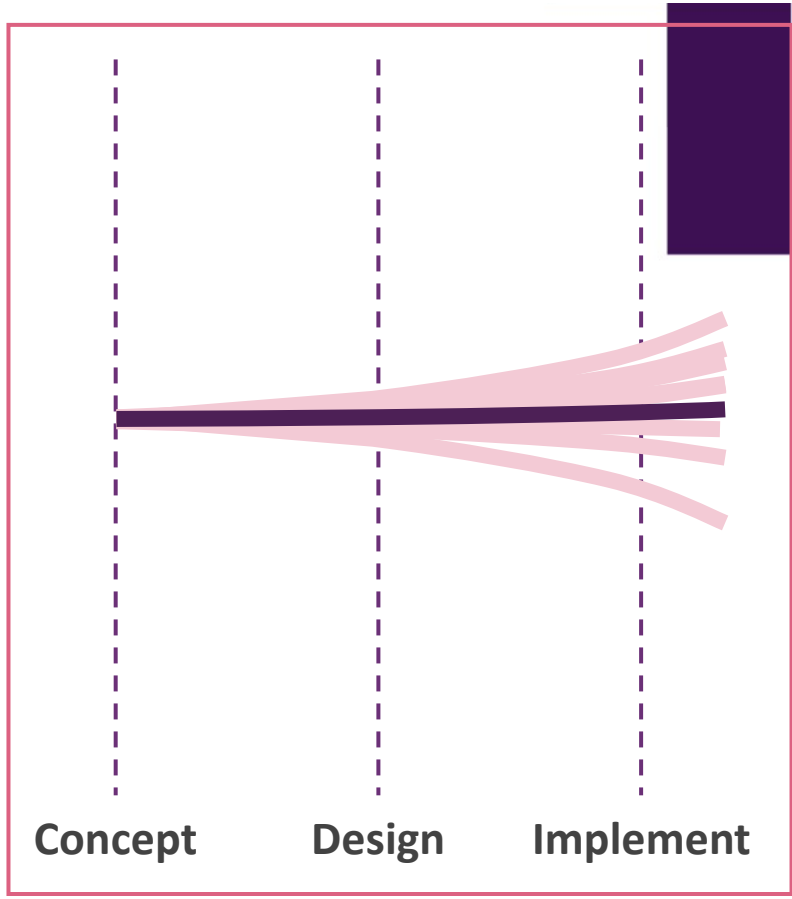
We had low estimates



We want them to stabilise



…and be more accurate



Add risk offsets

Add rigour

Update insights

Patrick Ross-Taylor

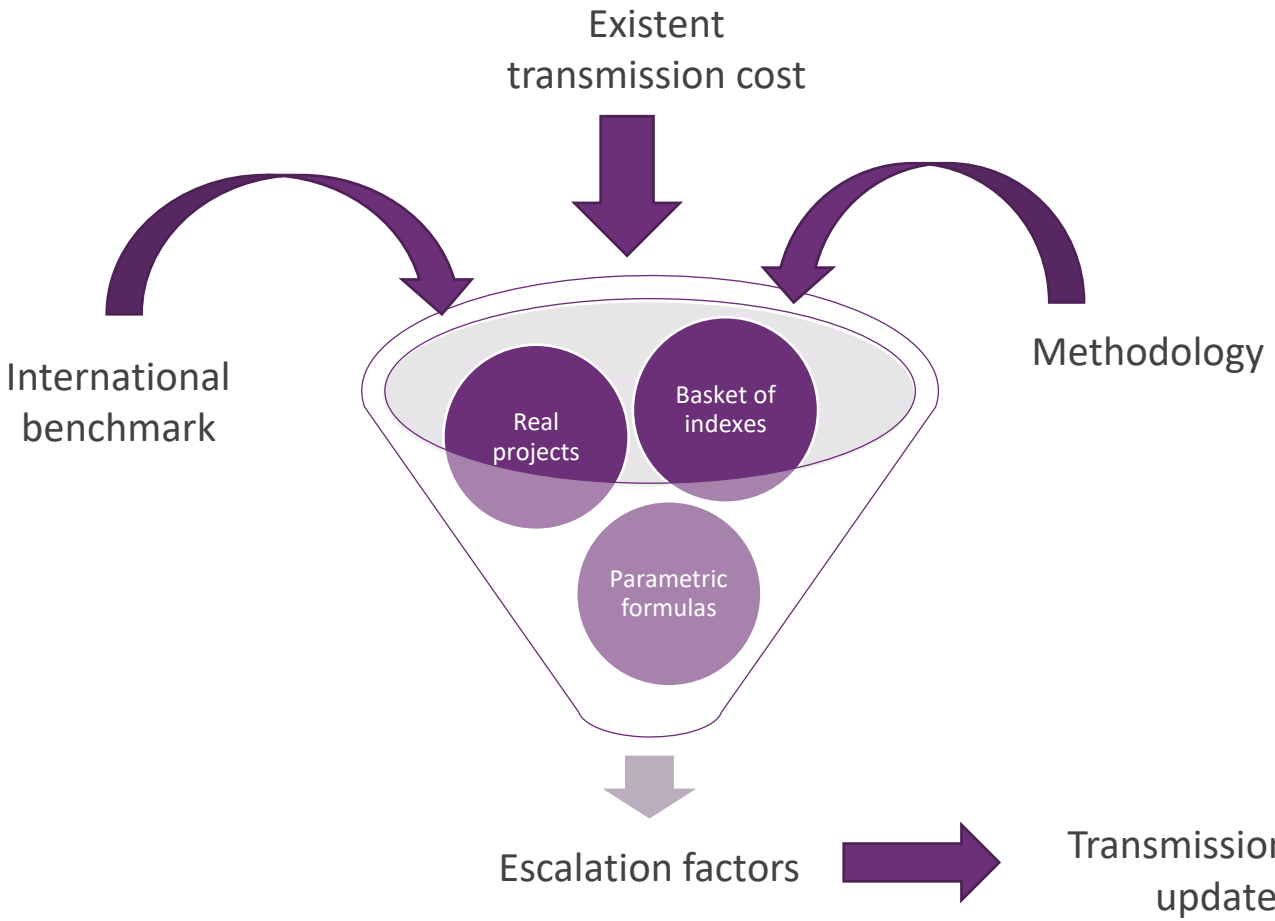
Building block updates

- Project costs trending upwards
- Significant increases in property/easement costs
  - Impacted by landholder sentiment, more generous government projects, increases in agricultural land prices
- Significant increases in Environmental costs
  - New biodiversity schemes

Adjustment factor, risk, and indirect costs updates

- Adjustment factors for project conditions, location jurisdiction
- Known and Unknown risk factors
- Developing new “Expectations of Producer Price Index” adjustment factor
- Original Transmission Cost Database had limited project data from periods of high economic uncertainty and significant supply constraints, a greater upper range on macroeconomic risk factor
- Stakeholder engagement costs are increasing with increased expectations for stakeholder and community engagement
- Risks around Cultural Heritage and Social License are frequently underestimated

Escalation factors



Advantages

- Take into account factors that most influence the formation of the costs of equipment, materials and services.
- Ability to update the costs at any time, ensuring a good approximation of the values practiced in the market.
- Balances the weights of different indexes inside each basket.
- Use of public economic data.

International Benchmark

- The proposed methodology uses relevant and public available Australian economic indexes that impact directly each existent and new building blocks, by applying suitable weights to build customised basked of indexes in order to update the transmission database.

- The international experience of our consultants and our database were used to adjust the weights of each economic index for each building block.

Economic indexes

CPI	Iron smelting and steel manufacturing	Basic non-ferrous metal manufacturing	Other electrical equipment manufacturing
• Measures household inflation and includes statistics about price change for categories of household expenditure.	• Bar, iron or steel, manufacturing. • Steel alloy manufacturing. • Structural steel shape manufacturing.	• aluminium, copper, silver, lead, zinc.	• batteries, electric motors, generators, electricity transmission or distribution equipment, switchgear, switchboards, transformers, other electrical machinery

Sources: Australian Bureau of Statistics and Reserve Bank of Australia

Economic indexes

Electric cable and wire manufacturing	Petroleum refining and petroleum fuel manufacturing	Other heavy and civil engineering construction Australia	Engineering design and engineering consulting services	The Australian dollar trade-weighted index (TWI)
• Optical fibre cable, insulated • Telecommunications cable • Wire or cable, electric. • Co-axial cable	• Oil or grease base stock • Fuel oil	• Distribution line, electricity or communication, construction. • Electrical machinery, heavy, installation (on-site assembly). • Electricity power plant construction (except buildings).	• Electrical engineering consulting service. • Mechanical engineering consulting service. • Civil engineering consulting service. • Construction consulting service. • Geotechnical engineering consulting service	• The price of the Australian dollar in terms of a group (or 'basket') of foreign currencies based on their share of trade with Australia. • TWI provides a broader measure of whether the Australian dollar is appreciating or depreciating against the currencies of its trading partners (17).

Sources: Australian Bureau of Statistics and Reserve Bank of Australia

Baskets of indexes

Indexes	Basket 1	Basket 2	Basket 3	Basket 4	Basket 5	Basket 6	Basket 7	Basket 8	Basket 9
CPI	X		X		X	X		X	X
Iron smelting and steel manufacturing	X	X			X	X		X	
Basic non-ferrous metal manufacturing					X	X			
Other electrical equipment manufacturing			X		X	X			
Electric cable and wire manufacturing		X						X	
Petroleum refining and petroleum fuel manufacturing						X			
Other heavy and civil engineering construction				X					
Engineering design and engineering consulting services							X		
The Australian dollar trade-weighted index (TWI)		X	X		X	X		X	

Baskets of indexes x building blocks

Basket 1	Basket 2	Basket 3	Basket 4	Basket 5
▪ Switchbay ▪ Construction of bays of GIS switchgear with circuit breakers and secondary system ▪ AIS site infrastructure ▪ Pre-fabricated demountable building to house substation secondary system	▪ HVAC tunnel installed cable ▪ HVAC underground direct buried cable ▪ HVDC subsea cable ▪ HVDC underground direct buried cable	▪ Secondary system	▪ Civil and structural Works ▪ Electrical Works ▪ Testing & Commissioning	▪ CB (circuit breaker) ▪ CVT (current-voltage transformer) ▪ SA (surge arrestor) ▪ CT (current transformer) ▪ HVDC converters ▪ Modular Power flow controller

Basket 6	Basket 7	Basket 8	Basket 9
▪Phase shifting transformer ▪SVC ▪Reactor ▪Capacitor ▪Statcom ▪Synchronous Condenser ▪Transformer	▪ Design & Survey ▪ Contractor Project Management & Overheads	▪ HVAC: second circuit strung on the vacant side of the double circuit tower ▪ HVAC line diversion ▪ HVAC with HTLS conductor ▪ HVDC – LCC ▪ HVDC - VSC	▪ Easement/ Property Costs ▪ Environmental Offset Costs

Parametric formulas

- Each building block has been assigned the most suitable basked of indexes with different weights applied for each economic index appropriate to that building block. The aim is to capture the main materials, labour and services that impact the cost of each equipment installed.

- The selection of the Australian economic indexes and their weights for each equipment and building blocks took into account internationally established and proven methods for updating the transmission costs. However, these weightings were adjusted to consider the differences between those countries, their energy markets and the National Electricity Market.

- The escalation factors are calculated by the following parametric formula that applies for each basked of index :

$$Escalation\ factor = \sum index\ variation\ x\ weight$$

Basket of indexes for transformers and infrastructure works

Plant	Civil and structural Works	Electrical Works	Secondary Systems	Design & Survey	Testing & Commissioning
CPI	Other heavy and civil engineering construction Australia	Other heavy and civil engineering construction Australia	CPI	Engineering design and engineering consulting services	Other heavy and civil engineering construction Australia
Other electrical equipment manufacturing			Other electrical equipment manufacturing		
Iron smelting and steel manufacturing			The Australian dollar trade-weighted index (TWI)		
Basic non-ferrous metal manufacturing					
Petroleum refining and petroleum fuel manufacturing					
The Australian dollar trade-weighted index (TWI)					

Sources: Australian Bureau of Statistics and Reserve Bank of Australia

Parametric formulas for transformers and related infrastructure works

Index	Plant	Civil and structural Works	Electrical Works	Secondary Systems	Design & Survey	Testing & Commissioning	Index variation
	Weight	Weight	Weight	Weight	Weight	Weight	**Set/21 - Jun/22**
CPI	10%			20%			1.0535
Iron smelting and steel manufacturing	20%						1.1323
Basic non-ferrous metal manufacturing	20%						1.1662
Other electrical equipment manufacturin	40%			50%			1.0763
Petroleum refining and petroleum fuel manufacturing	5%						1.7843
Other heavy and civil engineering construction Australia		100%	100%			100%	1.0658
Engineering design and engineering consulting services					100%		1.0460
The Australian dollar trade-weighted index (TWI)	5%			30%			1.0131
Escalation factors	**1.1354**	**1.0658**	**1.0658**	**1.0528**	**1.0460**	**1.0658**	

$$Escalation\ factor = \sum index\ variation\ x\ weight$$

Example 1

Transformer and associated civil, structural, electrical and secondary system
Nominal voltage: 500/330 kV
Details: 2 winding Tx (3ph) 1,000 MVA

Building blocks		Sep-21	Jun-22	
	Unit	Estimated value	Escalation factors	Estimated value
Plant	$	10,239,000	1.1354	11,625,733
Civil and structural Works	$	2,000,000	1.0658	2,131,600
Electrical Works	$	942,000	1.0658	1,003,984
Secondary Systems	$	100,000	1.0528	105,278
Design & Survey	$	471,000	1.0460	492,673
Testing & Commissioning	$	118,000	1.0658	125,764
Total estimate of building blocks (direct costs)	**$**	**13,870,000**		**15,485,033**
Difference (%)				**11.64%**

Basket of indexes for overhead lines

Plant	Civil and structural Works	Electrical Works	Contractor Project Management	Design & Survey	Easement/ Property Costs	Environmental Offset Costs
CPI	Other heavy and civil engineering construction Australia	Other heavy and civil engineering construction Australia	CPI	Engineering design and engineering consulting services	CPI	CPI
Electric cable and wire manufacturing						
Iron smelting and steel manufacturing						
The Australian dollar trade-weighted index (TWI)						

Sources: Australian Bureau of Statistics and Reserve Bank of Australia

Parametric formulas for overhead lines

Index	Plant	Civil and structural Works	Electrical Works	Design & Survey	Contractor Project Management & Overheads	Easement/ Property Costs	Environmental Offset Costs	Index variation
	Weight	Weight	Weight	Weight	Weight	Weight	Weight	**Set/21 - Jun/22**
CPI	10%					100%	100%	1.0535
Iron smelting and steel manufacturing	50%							1.1323
Electric cable and wire manufacturing	35%							1.1917
Other heavy and civil engineering construction Australia		100%	100%					1.0658
Engineering design and engineering consulting services				100%	100%			1.0460
The Australian dollar trade-weighted index (TWI)	5%							1.0131
Escalation factors	**1.1392**	**1.0658**	**1.0658**	**1.0460**	**1.0460**	**1.0535**	**1.0535**	

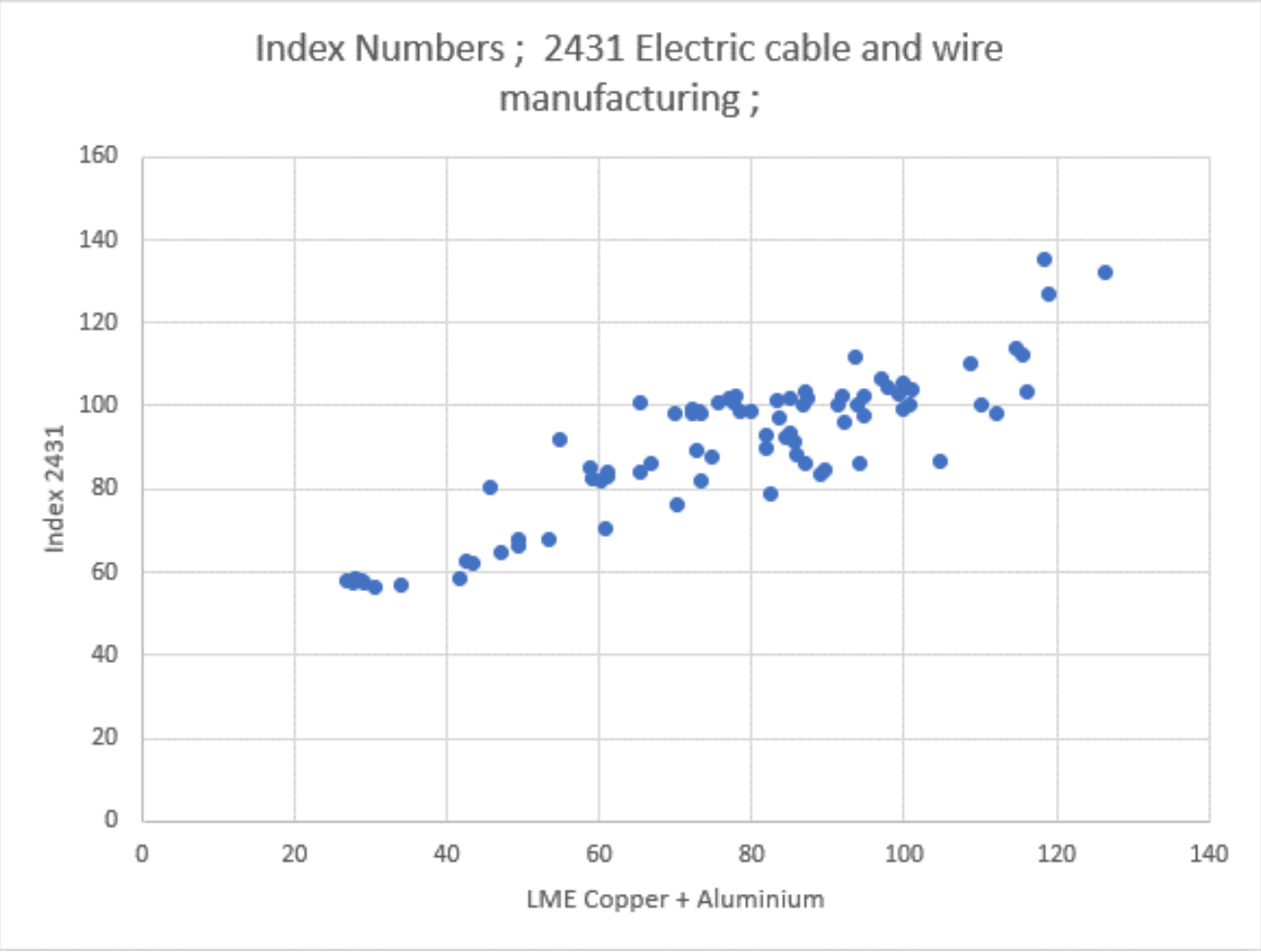
$$Escalation\ factor = \sum index\ variation\ x\ weight$$

Example 2

Overhead lines double circuit single tower, twin conductor per phase, 1886 MVA
Nominal voltage: 330 kV

Building blocks	Unit	Sep-21	Jun-22	
		Estimated value	Escalation factors	Estimated value
Plant	$/km	489,306	1.1392	557,437
Civil and structural Works	$/km	388,758	1.0658	414,338
Electrical Works	$/km	277,863	1.0658	296,146
Design & Survey	$/km	65,417	1.0460	68,427
Contractor Project Management & Overheads	$/km	108,887	1.0460	113,898
Easement/ Property Costs	$/km	225,000	1.0535	237,030
Environmental Offset Costs	$/km	150,000	1.0535	158,020
Total estimate of building blocks (direct costs)	**$/km**	**1,705,231**		**1,845,297**
Difference (%)				**8.21%**

Forecasting costs



We draw on publicly available forecasts/indicators and check that the indices track commodity price movements.

For example: This scatter plot demonstrates that our input index “Electric cable and wire” tracks with LME Copper and Aluminium prices (scatter plot quarterly numbers). This gives us confidence that we can draw upon the LME futures market for these commodities to give us an expectation of what that index would be in the future.

Next steps

- Benchmarking the escalation factors against anonymised data from projects provided by AEMO.
- Use of appropriate futures market commodities prices as a proxy for long term prices forecasts.
- Draft Transmission Expansion Report late April 2023
  - Transmission Cost Database published
- Consultation on Draft Transmission Expansion Report
- Final Transmission Expansion Report 31 July 2023

Discussion

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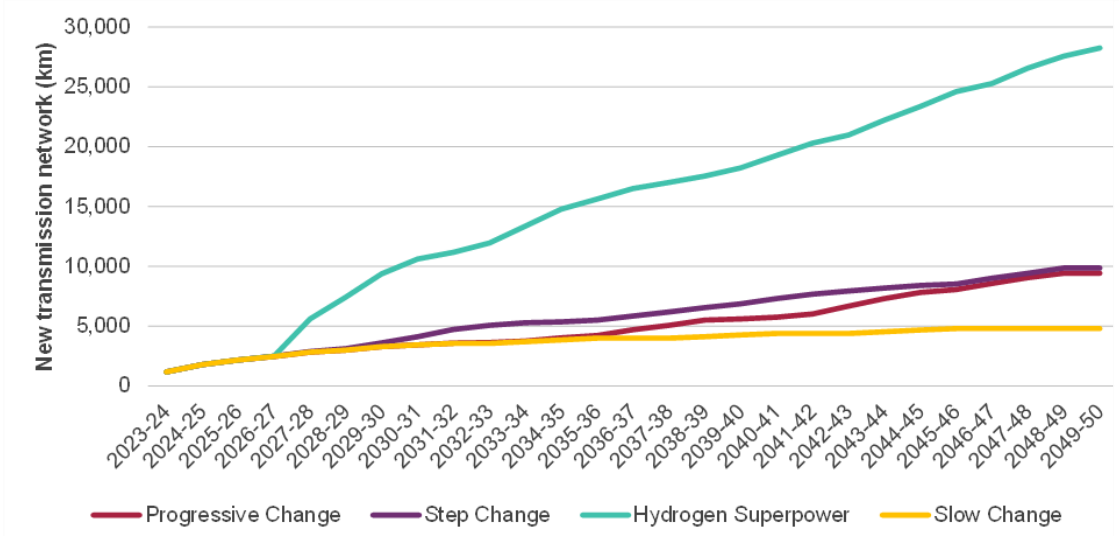
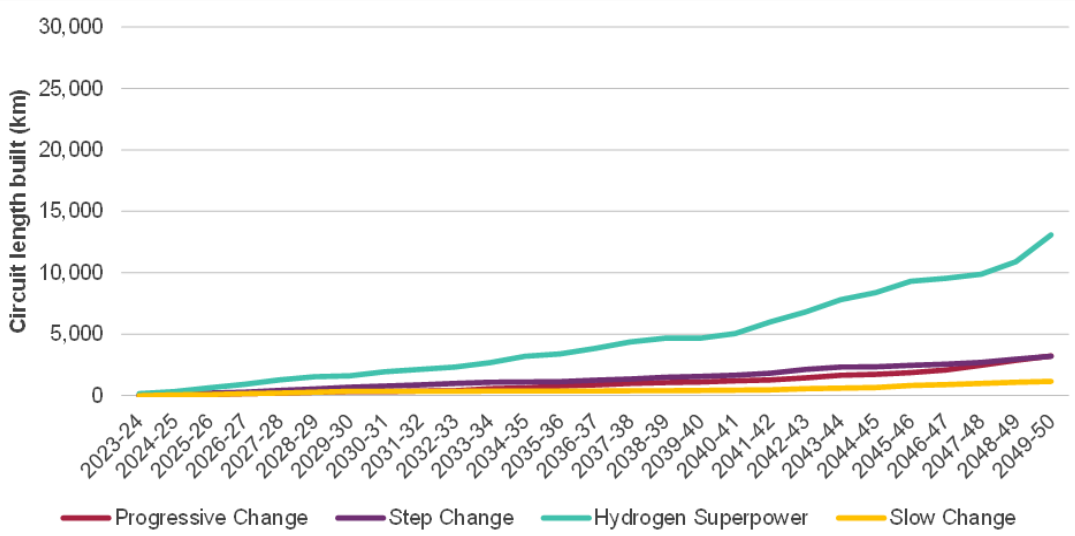
Questions taken on notice

- *How much of total project activity is connection transmission versus new and upgraded national transmission?*

Questions taken on notice





Questions taken on notice

- *Is it possible to have the list of projects currently in total project activity?*

AEMO
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MOTT MACDONALD

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