2024 ISP Consumer Panel

To: AEMO

Attention: ISP@aemo.com.au

Submission:

DRAFT 2023 Inputs, Assumptions and Scenarios Report

- Transmission Expansion Options Report (TEOR).

14 June 2023

Contents

1. Introduction and Summary

A key input to consumer confidence in the ISP is confidence that the capex and opex cost estimates used to assess the Optimal Development Path are robust. This is driven by recent experience of significant cost blowouts over the development cycle of ISP projects.

For example, had the $2.3b capex approved by the AER for Project Energy Connect[1] been used in the RiT-T process instead of the then capex estimate of $1.5, the project would not have passed the RIT-T[2]. All other ISP projects have seen significant increases in estimated capex over their development cycle. Now we are seeing similar outcomes with State based projects. The estimated Class 5b (± 50%) capex of the Central West Oriana REZ has increased significantly from earlier estimates to $3.2b in the just released NSW Network Infrastructure Strategy[3]. Copperstring in Queensland has gone from $2.5b in December 2021[4] to $5b in March 2023[5].

The development of the Transmission Cost Database (TCD) has been a major achievement by AEMO. The basis for ISP network capital costs has progressed from a simple excel spreadsheet with no explanation of how the estimates were derived in the 2020 ISP, to the first iteration of the TCD in the 2022 ISP and the significant further developments presented in this Transmission Expansion Options Report (TEOR).

The task to develop the database is very complex. Major new high voltage network has not been built since QNI was built over 20 years ago. Planning is advanced on building multiple QNIs in a very hot construction market with the added complexity of social licence and biodiversity that were relatively minor matters in 2000. Any wonder there is difficulty in estimating costs. There is the old Q&A – How much does [fill in the project name] cost to build? Answer – "I will tell you when it is finished and up and running".

This submission focusses on Section 3 in the Draft TEOR that presents the TCD Methodology. Our approach is to focus on examining the robustness of the evidence provided by AEMO to support its proposed methodology. Inevitably forecasting is a combination of data and judgement. The significant uncertainties around capex estimation over the next 5-15 years means there is a lot of judgement involved. We test the data and the arguments used to reach these judgements.

We begin by setting out our understanding of how the TCD is used in the ISP – where changes in capex costs are incorporated in the modelling and where changes are irrelevant. We then discuss the major cost pressures we see driving capex over the next decade – supply chain for labour and materials to complete multiple concurrent projects, local content requirements, availability of project management resources, contracting strategies and social licence.

[1] https://www.aer.gov.au/news-release/aer-approves-costs-for-project-energyconnect
[2] https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/contingent-projects/electranet-sa-energy-transformation-regulatory-investment-test-for-transmission-rit-t
[3] See p. 31 https://www.energyco.nsw.gov.au/sites/default/files/2023-05/network-infrastructure-strategy.pdf
[4] See p. 15 https://www.epw.qld.gov.au/__data/assets/pdf_file/0023/19715/north-west-electricity-province-cris.pdf
[5] https://statements.qld.gov.au/statements/97314

We use this discussion to assess Mott MacDonald's (MM) proposed updated TCD and AEMO's application of the results to obtain the capex estimates.

Our conclusion is that while the 2023 version of the TCD is a significant improvement on the version used in the 2022 ISP, the MM forecasting approach and the way AEMO has adopted the MM report may lead to potentially considerable underestimates of forecast network capex. This submission argues that:

- MM have underestimated supply chain impacts by their use of historical data as a basis for forecasts and no obvious consideration of the impact of the US Inflation Reduction Act
- AEMO's application of the AACE framework to determine the level of cost accuracy in Class 5a/5b estimates is flawed with no empirical basis to the conclusions made especially around modelling of unknown risks and the conclusion of symmetrical cost accuracy
- AEMO's justification is weak for its assumed 'return to normal' date of 2027 ie the date after which the real level of costs stay constant
- The final version of the TOER should provide greater transparency around how AEMO will 'cross check' capex estimates provided by TNSPs to ensure there is consistency across projects in different jurisdictions; at this stage the 'cross check' seems more like an 'empty box' than anything substantive.

All the recent evidence suggests that, especially for early stage (Class 5 and 4) projects costs always go up, not down. The Panel does not believe the methodology proposed fully reflects that experience. So to argue for symmetrical cost bands requires a much greater 'unknown risk' allowance than the 30% proposed. We conclude that there need to be much greater level of justification and transparency around the proposed capex forecasting approach.

Finally, this submission argues that there is no detailed justification provided for the assumption that opex is 1% of capex.

We appreciate the engagement we have had with AEMO as this submission has developed. There are many issues that will involve further discussion and we look forward to working with AEMO on these matters.

2. The role of the Transmission Cost Database in ISP modelling should be made clearer

Consumers have long expressed concern about the lack of accuracy in the capex cost estimates used in the ISP. The development of the TCD for the 2022 ISP was a welcome development as are the significant improvements that are proposed in the 2024 ISP. It is important for the TEOR to be clear about how the TCD is (or is not) applied in the ISP. The TEOR does not provide much clarity on this issue.

2.1 It is not relevant to 'committed and anticipated' ISP projects

The model assumes their project capacity is available but costs are not revisited through the ISP process. So, for Northern REZ Stage 2, Central West Orana and Western Renewables Link, costs are irrelevant even if the latest cost estimate would have meant the projects would not have passed the RIT-T. This approach is based on AEMO's interpretation of the AER Cost Benefit Analysis Guideline.

Committed and anticipated ISP Projects	Delivery date advised by project proponent†
VNI Minor: Victoria – New South Wales Interconnector Minor upgrade	November 2022
Eyre Peninsula Link	Early-2023
QNI Minor: Queensland – New South Wales Interconnector Minor upgrade	Mid-2023
Northern QREZ Stage 1	September 2023
Central West Orana REZ Transmission Link	July 2025
Project EnergyConnect	July 2026
Western Renewables Link *(formerly Western Victoria Transmission Network Project)*	July 2026

We recommend that in the final TEOR, AEMO provide a fuller explanation of their approach that seems to be saying that the ISP net benefits calculation is the same no matter the capital cost of these projects. If that is the case then we find that difficult to understand.

2.2 It is used to 'cross check' cost estimates provided by TNSPs to ensure they are comparable AACE class estimates for actionable projects[6]

AEMO receives cost estimates from TNSPs where (p.27):

> "…each have a unique project cost estimation process that has evolved through the development of their respective transmission project portfolios."

Which means AEMO:

> "…engage(s) with each TNSP to establish a process to ensure cost estimates are aligned across all projects in AEMO's ISP modelling."

Actionable Projects	To be progressed urgently – latest delivery date	Actionable Framework
HumeLink	July 2026	ISP
Sydney Ring (Reinforcing Sydney, Newcastle and Wollongong Supply) ¥	July 2027	NSW ‡
New England REZ Transmission Link	July 2027	NSW ‡
Marinus Link	Cable 1: July 2029 Cable 2: July 2031	ISP
VNI West (via Kerang)	July 2031, or earlier with additional support	ISP

We recommend that in the final TEOR, AEMO provide a fuller explanation of which projects this 'cross check' applies to and what changes were made in project capex as a result of this cross check. We discuss this 'cross check' in more detail below.

2.3 It is used to estimate the costs of Future ISP projects

There are two categories of Future ISP projects:

- Where a project does not have a TNSP estimate – AEMO applies the TCD to develop estimate accuracy of 5b (±50%) and 5a (± 30%)
- Where a project does have a TNSP estimate (we understand that will be the case for QNI Connect when the final TEOR is published in July) AEMO does a 'cross check'

[6] For an explanation of the AACE class cost classification see https://web.aacei.org/docs/default-source/toc/toc_96r-18.pdf

Future ISP Projects
Interconnector projects: QNI Connect
New South Wales Projects: New England REZ Extension
Queensland Projects: Central to Southern Queensland, Darling Downs REZ Expansion, Gladstone Grid Reinforcement, Far North Queensland REZ Expansion and Facilitating Power to Central Queensland
South Australia Projects: South East South Australia REZ Expansion, Mid North SA REZ Expansion
Victoria Projects: South West Victoria REZ Expansion
Additional projects to expand REZs and upgrade flow paths beyond 2040, which are highly uncertain and vary between scenarios

We recommend that in the final TEOR, AEMO provide a fuller explanation of which projects are in which category.

3. Cost pressures are enormous, still increasing and are likely to persist for many years to come

These cost pressures range across supply chain, local content requirements, availability of project management resources, contracting strategies and social licence.

3.1 Domestic constraints on skilled labour and materials

There are a range of recent reports highlighting significant supply chain pressures across the whole construction market – whether transport or electricity or housing. The most recent was the December 2022 report by Infrastructure Australia[7]. Electricity supply chain demand is emerging to provide resource challenges to the 'traditional' project market in transport infrastructure[8]. Where is the labour, materials and project management skills for the huge pipeline of infrastructure investment coming from?

The last two Federal Budgets have maintained strong commitments on infrastructure spending[9], but there is growing concern about the impact of supply chain pressures on costs and deliverability[10]. The Federal Government recently announced a major review of their $120b pipeline of infrastructure projects to assess the impact of supply chain constraints and ensure they can be fully funded and completed[11]. This may result in a 'slowing down' of the project pipeline but that will probably mean, given the political nature of infrastructure expenditure, that supply chain pressures will last longer as the pipeline is extended, not reduced. Governments have made all sorts of commitments to projects and they generally are reluctant to drop a project, preferring to delay. Just last week the Federal

[7] https://www.infrastructureaustralia.gov.au/listing/media-release/Infrastructure-market-capacity-2022-risks-to-project-delivery-increase-as-5-year-investment-climbs-by-%2415b

[8] https://www.theaustralian.com.au/business/companies/transurban-ceo-scott-charlton-to-exit-by-end2023-record-firsthalf/news-story/ff749f8a1d7d51b512d3671d1ad38b67?utm_source=TheAustralian&utm_medium=Email&utm_campaign=Editorial&utm_content=TA_BUSINESS_AM_04&net_sub_id=286354456&type=free_text_block&position=2&overallPos=2

[9] https://www.afr.com/politics/federal/infrastructure-spending-tops-55b-20221024-p5bsbv

[10] https://www.afr.com/companies/infrastructure/albanese-s-government-wary-of-overheating-infrastructure-20221118-p5bzd9

[11] https://minister.infrastructure.gov.au/c-king/media-release/securing-australias-120-billion-nation-building-infrastructure-pipeline

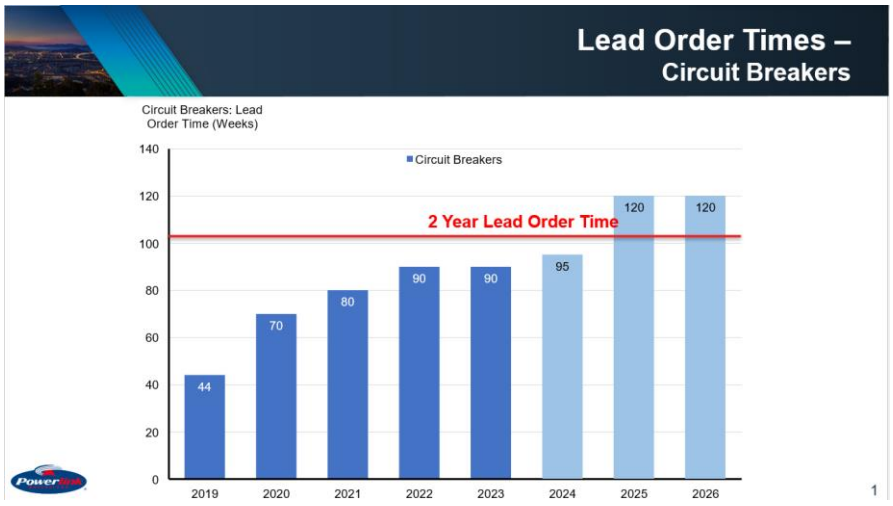
Parliament rejected a call for greater transparency around project costs for the projects under scrutiny in that review[12].

The pressures along the electricity supply chain have been highlighted by many over the last 12 months. A KPMG report prepared for the ENA and CEC and published in August 2022[13] reported stakeholder concerns about supply chain price shocks. Stakeholders interviewed for the report were seeing increases of up to 40% in capex and 5% in opex for major projects. These increases were occurring across labour, fuel, logistics, steel, cement, copper aluminium and other key commodities. This increase in project costs was seen as a contributor to "damaging delays and in some cases indefinite postponement of transmission corridors…".

At the AFR Infrastructure Conference last November the Transgrid speaker talked about the fierce competition for equipment for renewable projects around the world. The Project Marinus speaker said[14]:

> "One of our suppliers did tell us that their assessment is that by 2030, there will be twice as much demand for HVDC (high voltage direct current) cable and equipment as supply in the world…And that's with significant increase in supply capacity being invested in right now."

Panel members hear similar stories of rapidly rising labour costs and delays in material availability from the transmission and distribution networks we regular engage with. The following two slides provide a simple illustration of the issue. There were presented by Paul Simshauser, the Powerlink CEO in a recent CEDA presentation[15]. The first slide shows the order time for circuit breakers has nearly trebled from 2019 to 2025.



[12] https://www.smh.com.au/politics/federal/dutton-and-albanese-unite-to-block-teal-transparency-demands-on-120b-of-projects-20230524-p5daw6.html

[13] https://www.energynetworks.com.au/resources/reports/2022-reports-and-publications/market-sounding-report-on-transmission/

[14] https://www.afr.com/companies/infrastructure/the-global-scramble-for-electricity-cables-to-unlock-clean-energy-20221121-p5c03r

[15] Paul Simshauser 'Queensland Energy Market Outlook' presented to CEDA lunch Brisbane 7th June 2023; slides provided by the author

The second slide shows the order time for phase shifting transformers has almost doubled over the same period.

Infrastructure Australia, in partnership with AEMO, has prepared two reports in recent years - 2021 (focus on the 2020 ISP projects) and 2022 (includes 2022 ISP projects) and are referred to in the TEOR (see p.31)[16]. The 2022 Report, published in December 2022 concluded:

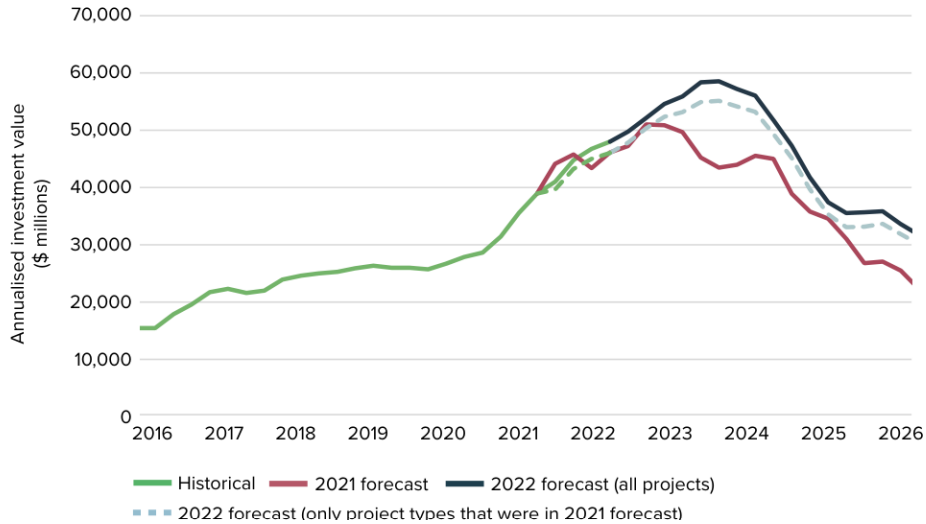
> "The report finds that Australia's public infrastructure pipeline has increased by $15 billion in value over the last 12 months. During this time, labour shortages and the cost of construction materials have risen significantly, 30-year productivity remains low, unfair risk allocation pervades working practices, and the industry has struggled to grow female participation beyond 12% of women working in construction.
>
> The effects of this overheated construction market are evident in rising construction insolvencies, plus likely project delays and cost increases throughout current and upcoming major public infrastructure projects."

Economy wide productivity continues to fall[17]. This figure shows the revision in project value from the 2021 to 2022 in the 2022 report. The forecast 2026 level is still considerably above the pre COVID level. We argue that it is reasonable to expect that continual announcements of project delays along with increased budgets mean the strong demand will continue well beyond 2026.

[16] The 2021 report - https://www.infrastructureaustralia.gov.au/market-capacity-electricity-infrastructure; the 2022 report - https://www.infrastructureaustralia.gov.au/publications/2022-market-capacity-report#:~:text=Infrastructure%20Australia%20is%20pleased%20to,over%20the%20last%2012%20months

[17] The March 2023 National accounts show the fall over the last 12 months has been 4.5%, the largest annual fall since measurement began in 1979. https://www.afr.com/policy/economy/gdp-growth-slows-to-0-2pc-as-productivity-slumps-20230607-p5deo8

Figure 7: Total demand for major public infrastructure has increased since the 2021 *Infrastructure Market Capacity* report



Supply chain issues can take years to resolve. Building manufacturing capacity to produce towers and electrical equipment, training the skilled labour and then providing the years of experience they need, all take time. Enhancing productivity performance is much harder in a tight labour market with shortages of the specific skills required. The ability to develop domestic supply chains is limited given the material requirements for network build are substantially imported from countries that are able to exploit scale economies not available in Australia. The electricity sector is competing with other infrastructure sectors like road and rail. We have claims from the road sector that network investment requirements are 'stealing money from roads'[18].

A January 2023 report by UTS for AEMO highlighted the great challenges facing the labour market to supply the required skilled construction and maintenance labour for the energy transition[19]:

> "A rapid scale up of the energy workforce is needed to implement the optimal development path in the Integrated System Plan (ISP) for all scenarios except the Slow Change…"[20]
>
> "The rapid increase in requirements for in-demand occupations brings a high risk of skill shortages which could impact on the achievement of the ISP's optimal development path. Skill shortages create the risks of delays, increased project costs (wage inflation, recruitment costs and liquidated damages), and increased cost of capital to reflect increased risk."

Governments are recognising the skill shortages and seeking to address it but it takes time. A Queensland Government report prepared as part of the QEJP which concludes that the[21]:

> "Energy transition in the next 10 years faces blockers for key skills"

[18] https://www.afr.com/companies/infrastructure/renewable-energy-boom-stealing-money-from-roads-says-transurban-ceo-20230501-p5d4hc

[19] See p.4 https://aemo.com.au/-/media/files/major-publications/isp/2022/supporting-materials/the-australian-electricity-workforce-for-the-2022-isp.pdf?la=en

[20] In its Draft 2023 IASR, AEMO has proposed to remove the Slow Change scenario from the collection.

[21] See p. 4 https://www.epw.qld.gov.au/__data/assets/pdf_file/0019/34057/queensland-energy-plan-future-skills-gap.pdf

and identifies skill shortages in five areas that will not be quickly addressed – electrical commissioning and installation of REZs, pumped hydro storages, grid scale battery storage systems and operating and planning power networks. There are particular challenges in regional and rural areas where much of the energy transition capital works will be undertaken. A strategy for the short and medium term is to attract skilled workers from interstate which only exacerbates the problems in those States.

3.2 Australia is hostage to the world demand for electricity supply chain capex

Given the substantial reliance the Australian electricity supply chain has on imported materials (and now labour) the capex forecasts need to consider the impact of international developments.

The slides above by the Powerlink CEO show the 'coalface' impact of the world wanting to decarbonise all at the same time and the impact that is having on the demand for the resources to do so. Countries are increasing their subsidies to speed up that process with the biggest example being the US Inflation Reduction Act passed in August 2022 that provides for nearly $US400b in subsidies for clean energy, with the goal of substantially lowering US carbon emissions by 2030. The funds will be delivered through a mix of tax incentives, grants and loan guarantees. Clean electricity and transmission will receive the biggest share - $US250b[22].

The EU has responded with its Green Deal Industrial Plan[23] to support EU's climate targets[24]. The result is a 'subsidy war' which will suck in electricity supply chain resources from around the world to the US and the EU. Those countries without the ability to match those subsidies will either wait in line longer or pay the higher prices to get their preferred slot in the manufacturing line.

Both policies are expected to have an enormous impact on the availability of capital and materials for ISP projects. Other countries are developing their own versions. Australia is caught in the middle of a subsidy war that some are saying we should join[25] but it is difficult to see how we can win. We have limited ability to respond given our relatively small industrial and labour force base.

The Australian Government is providing a relatively very limited range of subsidies eg Rewiring the Nation[26] and the recent $2b budget funding for hydrogen[27], but these cannot compete with what the US and the EU are offering. The Rewiring the Nation fund is expected to have only a small impact on transmission tariffs given it is structure as a low interest loan rather than a grant[28]. The $2b hydrogen

[22] https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-inflation-reduction-act-heres-whats-in-it

[23] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510 and https://www.afr.com/companies/energy/green-subsidy-war-looms-as-eu-moves-to-match-us-20230310-p5cqzx

[24] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan_en; for an Australian perspective see https://www.afr.com/companies/energy/green-subsidy-war-looms-as-eu-moves-to-match-us-20230310-p5cqzx

[25] https://www.afr.com/politics/federal/australia-falling-off-the-pace-in-global-hydrogen-race-20230223-p5cn0f

[26] https://www.energy.gov.au/news-media/news/rewiring-nation-supports-its-first-two-transmission-projects

[27] https://arena.gov.au/blog/budget-2023-arena-to-shape-green-hydrogen-future/

[28] See the analysis in the EUAA/ECA submission to the AEMC - https://www.aemc.gov.au/sites/default/files/2022-11/eca_euaa.pdf and https://www.aemc.gov.au/sites/default/files/2022-11/eca_euaa_attachement_-_concessional_finance_report.pdf

fund, structured as a $2-4/t production credit similar to the US IRA would back only a small fraction[29] of the 5 m tonne/yr project pipeline in the recently published State of Hydrogen 2022[30].

Some stakeholders are claiming that the recent Australian Government signing of Australia-United States Climate, Critical Minerals, and Clean Energy Transformation Compact will mitigate the impact of the US IRA on Australian ISP supply chains. We see no evidence of this claim.

The US President's press release[31] simply refers to as a 'statement of intent to advance climate co-operation'. It is not obvious that the Australia-U.S. Forum on Clean Energy Industrial Transformation and Taskforce on Critical Minerals will lead to Australia getting any preferential or lower cost access to international capital and materials required to complete ISP transmission and generation investment. We look forward to seeing the concrete evidence that signing the agreement will result in lower cost materials for ISP projects.

The Prime Minister's press release[32] referred to commitment to develop supply chains:

> "Both countries intend to use domestic financial instruments and incentives to foster greater integration of responsible clean energy supply chains and encourage investors to regard our two countries as leading destinations in which to build the future global clean energy industrial base."

This suggests Australia will use its budget to create incentives to develop domestic supply chains, but if there is a choice for a company supplying inputs for transmission build to locate in the US or Australia our point is that the IRA subsidies are much more attractive in the US that Australia. We have already seen this with discussion on hydrogen developments with Woodside saying that the US is the more attractive development option[33]. As noted above the Australian Government's support is a small fraction of the incentives offered in the US.

In US political terms the main aim of the US Administration's agreements – there are currently 13 with Pacific nations including Australia – is to improve supply chains into the US by reducing reliance on China for critical minerals and increasing the opportunities for US companies to do business in the region[34]. Australia will get 'domestic supplier' status under the Inflation Reduction Act.

3.3 State Governments are looking to their State based renewable energy and emissions targets as a mechanism for the development of State base supply chains

[29] https://www.theaustralian.com.au/business/mining-energy/production-subsidies-the-focus-of-2bn-hydrogen-headstart-funding/news-story/2e605d7855c5cd74467a80faba5672d3
[30] https://www.dcceew.gov.au/about/news/state-of-hydrogen-2022
[31] https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/australia-united-states-joint-leaders-statement-an-alliance-for-our-times/
[32] https://www.pm.gov.au/media/australia-united-states-climate-critical-minerals-and-clean-energy-transformation-compact
[33] https://www.afr.com/companies/energy/green-law-swells-woodside-s-us-hydrogen-ambitions-20230313-p5crpv
[34] https://www.nytimes.com/2023/05/27/business/economy/biden-indo-pacific-trade-deal.html?campaign_id=2&emc=edit_th_20230529&instance_id=93715&nl=todaysheadlines&regi_id=50462365&segment_id=134172&user_id=cb77c7237607df5b49e6a097837ed9ba

NSW Roadmap

There are extensive local content requirements under the legislation with minimum requirements (as well as stretch goals) set out in the NSW Renewable Energy Sector Plan[35]:

Table 2. Minimum requirements and stretch goals in merit assessment

Theme: Supply chain inputs	**Criteria**	**Minimum requirements**				
		Wind	**Solar**	**Pumped hydro**	**Battery storage**	**Network projects**
	Development phase	40%	49%	66%	23%	68%
	Operation and maintenance phase	51%	71%	61%	35%	78%
	Steel products and components using locally milled steel	10%	95%	30%	95%	Maximise to the extent possible
	Criteria	**Stretch goals**				
		Wind	**Solar**	**Pumped hydro**	**Battery storage**	**Network projects**
	Development phase	72%	81%	86%	78%	93%
	Operation and maintenance phase	76%	81%	82%	79%	89%
	Steel products and components using locally milled steel	95%				
Theme: Employment, skills and knowledge transfer	**Criteria**	**Minimum requirement**			**Stretch goal**	
	Learning workers (% of total project workforce)	20%			40%	
	Apprentices (% of all trades positions on a project)	20%			30%	
Theme: First Nations participation	**Criterion**	**Minimum requirement**			**Stretch goal**	
	First Nations participation	1.5%			10%, or the goal in the region-specific protocol under the First Nations Guidelines, where stated	
Theme: Fair and ethical practice	**Criterion**	**Minimum requirement**			**Stretch goal**	
	Employment of underrepresented groups	15%			25%	
Theme: Environmentally sustainable procurement	Numerical minimum requirements do not apply. Proponents are required to respond to evidence requirements to demonstrate environmentally sustainable procurement.					

Queensland

A key focus of the Queensland Energy and Jobs Plan is 'Secure jobs and communities' with actions to 'grow the renewable energy supply chain in Queensland' and 'partner with industries and communities to maximise benefits from the energy transformation and drive regional economic opportunities'[36]:

> "The clean energy infrastructure outlined in this Plan to build the SuperGrid will create a pipeline of investment to help expand Queensland's share of the renewable energy supply chain and increase the use of local content on projects…
>
> To maximise opportunities for more local manufacturing and jobs from renewable investment, the Queensland Government is committed to 'Buy Local' to provide local businesses with access to the government market and stimulate regional economies."

With a range of funding commitments to support these initiatives. The Queensland Government recently strengthened its Buy Queensland[37] policy. All major Government contracts – including Government owned generators and networks – are required to follow a range of Government policies around preferred contractors, union membership, pay and conditions and local procurement. In particular, the Best Practice Industrial Conditions[38] (BPICs) that mandate pay and

[35] See p.11 https://www.energy.nsw.gov.au/sites/default/files/2022-09/nsw-renewable-energy-sector-board-plan.pdf

[36] See p. 48 https://www.epw.qld.gov.au/__data/assets/pdf_file/0029/32987/queensland-energy-and-jobs-plan.pdf

[37] https://www.epw.qld.gov.au/news-publications/news/strengthening-buy-queensland

[38] https://www.epw.qld.gov.au/__data/assets/pdf_file/0014/20435/best-practice-industry-conditions.pdf

conditions for workers employed on Government projects will apply to all contractors wishing to bid for these projects.

The impact of BPIC requirements on labour costs is illustrated by the recent advice from Queensland Heath to bidders for $10b of projects that their bids need to assume an annual 6% labour cost increase for the next 5 years in their responses[39]. This will set the benchmark for labour costs rises across all major civil construction projects in Queensland.

3.4 Constraints on project management resources are increasing

In the last six months we have had the exit of Clough from being a major EPC contractor following cost overruns on Snowy 2.0[40]. Its JV partner, Webuild, is now the sole EPC contractor. Earlier this year Downer announcing that it is withdrawing from building transmission. In its investor webcast in February, the new CEO said[41]:

> "While there are significant opportunities in areas such as energy transition, we are not rushing into them. For example, the construction of high voltage transmission lines to the renewable energy zones, an area where we have significant expertise, but at the moment, the risk allocation in these very large projects does not fit our risk appetite and we are waiting for this to improve."

Last October, Downer was one of three parties shortlisted by Transgrid for Humelink construction as a[42]:

> "…reputable Tier 1 Delivery Partner(s) with strong experience in delivering infrastructure projects in Regional NSW to bid for the project's delivery contracts."

There are regular reports in the press of smaller and medium sized building contractors going into liquidation[43].

The scale of investment required, not just in the electricity sector but also in the wider economy, means that there will be significant constraints on the availability of EPC resources. Those that are remaining are making fundamental changes to their contracting strategy to push considerable risk back on to the TNSP and hence to consumers.

3.5 This is leading to a fundamental change in infrastructure contracting strategies

The recent significant increase in number of construction companies going into liquidation or withdrawing from areas of business has been driven by the fallout from fixed price contracts signed pre- and early COVID. There is so much uncertainty on actual costs, even EPC contracts that included what was regarded as an acceptable level of contingency when signed, are failing. Insurers are

[39] https://www.afr.com/work-and-careers/workplace/queensland-government-budgets-6pc-pay-rises-for-cfmeu-20230314-p5crvy
[40] https://www.afr.com/chanticleer/clough-collapse-comes-as-cracks-spread-beyond-construction-20221206-p5c40g
[41] Downer Half Year Results 2023 webcast 27 February 2023 https://publish.viostream.com/app/s-daeppbn See at around the 23 minute mark
[42] https://www.transgrid.com.au/media-publications/news-articles/transgrid-shortlists-proponents-for-critical-humelink-transmission
[43] https://www.afr.com/property/commercial/building-failures-to-overtake-last-year-s-total-with-4-months-to-go-20230228-p5co4h

withdrawing from the construction sector forcing a fundamental re-examination of where capex risk lies. As Cough's receiver noted – it is the end of lump sum contracts[44].

On 5th May 2023 Snowy Hydro announced that[45]:

> "Snowy Hydro's management team is working towards resetting the delivery timeline and budget for the Snowy 2.0 project with its principal contractor, Future Generation Joint Venture (FGJV), as part of an ongoing project review.
>
> The reset will ensure this critically important clean energy infrastructure project is placed on a robust and sustainable footing for FGJV to progress the schedule in a realistic and productive manner.
>
> While significant progress has been achieved by FGJV on Snowy 2.0, there are delays to Snowy 2.0's contracted schedule and likely cost impacts beyond the contingency allowed, which remain under review by Snowy Hydro."

There were four broad categories contributing to schedule delays and likely cost increases – COVID related delays in mobilisation, global supply chain issues, changing design elements and unexpected geological conditions. Then in evidence to the Senate Estimates Committee on 22nd May 2023, the Snowy Hydro CEO discussed current negotiations with the EPC contractor to move to a cost plus or 'incentivised target cost' contract in the next 2-3 months[46] to limit cost increases. But recent experience suggests that there are even problems with cost plus contracts from supply chain constraints[47].

One prominent commentator notes[48]:

> "Remarkably, there's near universal agreement on the solutions: vastly improving scoping of projects, so risks can be properly assessed and priced; a recognition that project owners must share some risks; and a more collaborative approach from all parties."

With regulated electricity networks pushing risk on to owners through cost plus contracts means that there is about to be a significant risk shifting to consumers compared to the pre COVID fixed price contract world. That is why consumers need much more confidence on the capex estimates used in the ISP.

(i) Social licence is bringing uncertain costs and uncertain project timelines

---

[44] https://www.theaustralian.com.au/business/mining-energy/clough-is-mostly-saved-with-webuild-deal-but-administrators-say-contracting-model-must-change/news-story/f24b1457d013cab19f06e7ddc380fd61?utm_source=TheAustralian&utm_medium=Email&utm_campaign=Editorial&utm_content=TA_BUSINESS_AM_04&net_sub_id=286354456&type=free_text_block&position=2&overallPos=4

[45] https://www.snowyhydro.com.au/news/snowy-2-0-project-update/

[46] See p. 115 of the transcript 22nd May 2023 of the Environment and Communications Estimates Committee https://www.aph.gov.au/Parliamentary_Business/Senate_estimates/ec/2023-24_budget_estimates

[47] https://www.theaustralian.com.au/business/mining-energy/second-major-webuild-project-flags-delays-blowouts-after-clough-takeover/news-story/1c6d6ca78c17025af9fe1b358625aa0d

[48] https://www.afr.com/chanticleer/probuild-collapse-could-be-just-the-start-in-a-broken-system-20220224-p59zh0

The impact of social licence on project costs and timeline has been well documented so no need to repeat here. The Western Renewables Link was the prime example with VNI West now providing strong support for the proposition.

(ii) Which all contribute to longer potential project delays

We think it is reasonable to assume that the whole range of supply chain issues – labour, materials and reduction in the number of large project EPC contractors will inevitably delay ISP project build. We should know the latest Snowy 2.0 timetable in a few months. At the time of the Cough receivership last December Transgrid said that the remaining EPC contractor Elecnor will be able to complete construction by the previously announced deadline of 'late 2024'[49]. There has been no update since. The just published NSW Roadmap Network Infrastructure Strategy[50] has the full commissioning of Central West Orana in 2027-2028, 2-3 years later than the July 2025 date advised to AEMO as part of the 2022 ISP published only 10 months ago[51].

4. We do not consider that the TEOR has adequately considered these cost pressures

While the TEOR provides a significant improvement on the 2022 TCD, our overall conclusion is that neither the Mott MacDonald nor the TOER fully take the factors discussed in the previous section. Neither the MM report nor the TEOR refer to the US IRA or EU Plan nor the UTS study[52] that was developed in conjunction with AEMO. Our submission on the Draft IASR[53] argued that we believe supply chain pressures have been underestimated, that there was insufficient justification for the 'return to normal' date in the CSIRO GenCost study and employment factors. We take up these issues again here.

We discuss our concerns in two parts:

(i) Mott MacDonald (MM) transmission cost database report, and
(ii) How the TOER incorporates the MM results into the TCD

4.1 Mott MacDonald Report

The MM report extends and improves the 2022 ISP TCD methodology in many important ways. The Panel has appreciated the opportunities AEMO has provided to engage with MM as their report was developed. MM developed a building block approach with a basket of indices with different indices applying to different capex components. They undertook a statistical analysis to understand what

[49] https://www.afr.com/companies/energy/clough-collapse-threatens-10b-of-energy-transition-projects-20221206-p5c41s
[50] See p. 31 https://www.energyco.nsw.gov.au/sites/default/files/2023-05/network-infrastructure-strategy.pdf
[51] See Table 1 p.13 https://aemo.com.au/-/media/files/major-publications/isp/2022/2022-documents/2022-integrated-system-plan-isp.pdf?la=en
[52] Though it is referred to in the Draft IASR as the source of data on employment factors. See Section 3.13 pp 152-3 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/2023-inputs-assumptions-and-scenarios-consultation/draft-2023-inputs-assumptions-and-scenarios-report.pdf?la=en
[53] https://aemo.com.au/-/media/files/major-publications/isp/2023/58-2024-isp-consumer-panel-draft-2023-iasr-submission.pdf?la=en

drives the cost of each index within each basket of items. For example, the cost indices relevant to Basket 2 – Underground cables – are the following.

Basket 2	• Underground cables (HVAC[4]/HVDC[5])	• Consumer Price Index • Iron smelting and steel manufacturing • Electric cable and wire manufacturing • The Australian dollar trade-weighted index

They did a statistical analysis to establish linear relationships between each price index (transformed to real terms by deflating by CPI) and a combination of significant drivers such as commodity prices, labour costs and supply constraints represented by the volume of construction activity (as a proxy for demand pressure during cyclic construction activity). The estimated relationships are based on quarterly observations since 2010. The estimated relationships were used to produce forecasts of the price indices based on assumptions about the input variables.

Cost estimates were based in $June 2022 with indices to enable forecasts out to 2040. These indices have varying rates of price growth over that period. For example, the table shows the real cost index for a range of 'baskets' ie group of cost components[54]:

	Basket 1 (switch bay and buildings)	Basket 2 (underground cables)	Basket 5 (circuit breakers etc)	Basket 9 (Easement and property)
June 2022	1	1	1	1
June 2023	0.9654	0.9741	0.9949	1.0222
June 2030	1.1229	0.8863	1.0301	1.2514
June 2035	1.1260	0.8618	1.0378	1.3624
June 2040	1.1260	0.8358	1.0456	1.4833

The methodology to incorporate future supply chain pressures underestimates these pressures

MM list a number of key assumptions that may, at first glance, seem to be contradictory. Consider the following two[55]:

> "To develop our forecasting basket of weighted indices, we have made informed assumptions as to the impact of supply chain challenges, global economic trends and forecasts, Australia's economic activity and projected transmission project build-out."
>
> and:
>
> "Use of historic price trends for transmission infrastructure, say over the last two decades is not appropriate to transmission infrastructure cost increases out to 2040 given that the

[54] See Table 3.3 pp 52-3 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en
[55] See p. 12 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en

> projected scale of projected transmission infrastructure build has not been observed since the 1980s"

The first is more a statement of approach than an assumption ie supply chain challenges were considered. The second seems to say that available historical data is a poor guide to understand the supply chain issues.

Yet the MM methodology was based on an analysis of the historical data of the total (private and public sectors) $ value of engineering construction activity (ABS 8762.0 Table 1) as the proxy for supply chain/resource demand pressures. This covers both public and private sector projects in all categories – not just the category 'Electricity generation, transmission and distribution'. MM conclude (p.47):

> "We also assumed that future construction activity (measured in real dollar values) will continue to increase at current levels of around 20 per cent per annum until 2024, and thereafter remain at the same constant high level, reflecting a high level of construction activity until at least 2030."

While MM have a reasonable starting point that increased construction activity is empirically correlated to higher labour costs, their forecast for the next 10-15 years seems to assume that the ramp-up in the supply of resources to the energy sector will mean supply matches demand from 2025. We would suggest that this assumption is difficult to accept given the large pipeline of projects outside of the energy sector that is competing for resources with the energy sector. Our concerns with the MM model are that it:

- relies on historical data that does not include any major network build because PEC is the first major network project built in over 20 years the historical data
- does not provide any guidance on the impact of building multiple concurrent network projects as will be the case over the next 10-15 years eg the report makes no mention of the impact of the Queensland Government's decision in March 2023 to bring forward the construction of the 1,100km Copperstring project to full completion by 2029 at a cost of $5b[56]; this compares to the timetable in the September 2022 QEJP of completion of the Townsville – Hughenden section (~4-500kms) by 2035 and the Hughenden to Mt Isa section (~5-600kms)at some later unspecified date; the cost was estimated at $2.5b[57] in December 2021
- does not provide much analysis to give confidence that the mix of skills required historically to deliver projects in the ABS database are representative of the skills required in the next 10-15 years; various reports have highlighted the skills shortage discussed above
- makes no direct reference to the US Inflation Reduction Act or EU policy and the impact on supply chains to Australia of the global race to meet net zero targets underpinned by massive Government subsidies
- does not include the impact of State local content policies

all of which contribute to our view that there should be more justification that the historic multiplier is appropriate as a forecasting tool

[56] https://statements.qld.gov.au/statements/97314

[57] See p. 15 https://www.epw.qld.gov.au/__data/assets/pdf_file/0023/19715/north-west-electricity-province-cris.pdf

Estimates of environmental/biodiversity offset costs

Biodiversity costs can be a significant component of total capex. In Transgrid's application to the AER for Humelink early works costs, Transgrid estimated they were 28% of total capex and expected that they would achieve an AACE Class 2 estimate of those costs at the end of early works.

Category capex	Description	Expected Class estimate for Stage 2 CPA	Comments	Expected Class estimate for PACR	PACR Cost		
					Real$2020 *(as per the PACR)*	Real$2018 *(as per the Humelink CPA)*	Share
Direct capex							
Procurement	Substations and transmission lines	Class 3/2	Striving for Class 2 but will be dependent on level of accuracy possible for high risk scope items which are part of the ECI procurement.	Class 4	1754	1732	54%
	Long-lead time equipment – Substation transformers and reactors	Class 2	Options to be exercised to secure slots to maintain program. Further design work to be completed to achieve class 2 accuracy	Class 4	121	119	4%
Land acquisitions	Acquisition costs	Class 3	Class 3 due to he an icipated number of compulsory acquisitions and variability in these numbers.	Class 4	207	205	6%
	Environmental 'offset' costs	Class 2	Class 2 due to iming of and inherent forecasting uncertainties related to how biodiversity offsets will be finalized and implemented.	Class 4	922	911	28%

MM conclude there is still such 'a high level of uncertainty in forecasting environmental offsets costs…' and TNSP data was not sufficient to build a model[58]. While provision of anonymised TNSP data by AEMO helped, they considered there was still too much uncertainty around how these costs might escalate in environmentally or agriculturally sensitive regions in the future and so did not provide a biodiversity cost forecast.

Updating adjustment factors etc (Section 2.5 p. 25-8)

The Panel found a response from MM to a Panel question on cost updating cost adjustment factors, confusing:

> "The 2020 TCD was originally designed to produce early stage (class 5) project cost estimates, accuracy range of ± 30%. With the TCD unknown risk factors, which are intended to be used by AEMO to review advanced stage cost estimates provided by the project proponents, the accuracy of the estimates may be assumed to be Class 3 (± 15%).
>
> The escalation factor method used for this 2022 TCD maintains the same class 5 accuracy level of the original 2020 TCD and moves to class 3 when adding the unknown risk factors."

There has been an increase in the use of cost 'classes' in the last couple of years but there is no consistency. The EUAA (and others) material costs rule change in January 2021 explicitly referred to the AACE classification. The 2022 ISP Transmission Cost Report said[59]:

> "While AEMO has adopted the AACE standard for the ISP, this standard is not currently a requirement for TNSPs. TNSPs each have a unique project cost estimation process that has evolved through the development of their respective transmission project portfolios."

[58] See p. 24 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en

[59] See p.16 https://aemo.com.au/-/media/files/major-publications/isp/2021/transmission-cost-report.pdf?la=en

The problem is that when you get into the detail it is not obvious that this is the case for AEMO and it seems that TNSPs (or at least Transgrid) seem to deliberately confuse the reader about what they really want to convey. For example, in their Humelink PACR, Transgrid say[60]:

> "We consider our cost estimates to be 'class 4' estimates, which is in-line with the level of accuracy expected at this stage of the investment process. For example, AEMO commented during the consultation process on its transmission cost database that the cost certainty at the PACR stage is typically between -30 per cent and +50 per cent ('class 4' estimates) or -20 per cent and +30 per cent ('class 3' estimates). …
>
> We consider that the capital costs used in the PACR analysis are 'P50' estimates, i.e., they have a 50 per cent expected probability of cost underrun."

So what is the estimate accuracy? There is no reference to the AACE standards and the level of cost accuracy is self-assessed. Is the Transgrid Class 4 self-assessment meant to be the same as the AEMO Class 4 accuracy band, which is different from the 'official' AACE accuracy band[61]. Does Transgrid self-assess that Class 4 accuracy band as P50? If so, how?

But in any case, AEMO does not use the AACE Class 4 or 5 accuracy bands. In the 2022 ISP TCD, AEMO uses the concept of 'unknown risks' to develop a Class 5 that is ±30% accuracy.

> "The AACE International methodology typically contains accuracy bands which are skewed to the positive side, reflecting higher likelihood of cost increases than decreases as the estimate progresses. The Transmission Cost Database has been designed to include an average allowance for unknown risks which offsets the adjusted building block estimate, such that the 'total expected cost' resulting from the Transmission Cost Database can be used as the mid-point of a symmetrical accuracy band for ISP modelling purposes.
>
> The Transmission Cost Database is currently designed to produced Class 5a estimates. The accuracy of the Class 5a estimates produced by the Transmission Cost Database is ±30%, with an average unknown risk allowance of 15%. This was determined by GHD using statistical analysis of current major projects as they progressed from screening stage scope definition to CPA – further detail on this analysis is provided in the GHD report15. Accuracy bands have been derived statistically, such that 80% of project estimates should fall within these limits. It is therefore expected that, across a large sample of projects, approximately 20% of them will fall outside of these bands."

Which seems a bit odd that it is still called Class 5. But the more significant issue is the methodology used by GHD to get to the ±30% accuracy. The 2022 Panel were not convinced[62] and neither were GHD which commented in their May 2021 report to AEMO that[63]:

> "… the improving accuracy range as the cost estimate matures have been formed based on linear extrapolation of recent NEM projects early stage cost estimate accuracy range and the AACE RP 96R-18 optimistic accuracy range for more advanced stage cost estimate (as shown in Figure 9). We note that this representation of improving accuracy range is mostly

[60] See p.24 https://www.transgrid.com.au/media/rxancvmx/transgrid-humelink-pacr.pdf
[61] See p. 7 https://web.aacei.org/docs/default-source/toc/toc_96r-18.pdf
[62] See pp 68-90 https://aemo.com.au/-/media/files/major-publications/isp/2021/isp-consumer-panel-report-on-2021-iasr.pdf?la=en
[63] See p. 30 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/transmission-costs-for-2022-isp/transmission-cost-database-ghd-report.pdf?la=en

> academic and based on observation of recent NEM projects as their cost estimates matured. Given the lack of major transmission augmentation project works in the NEM in recent history and thus the absence of empirical actual cost information allowing the estimate vs actual cost analysis (with benefit of hindsight), further conclusive insight into the improving accuracy range is unavailable. As such the data in the following table should be viewed in this context."

MM make a passing reference to the AACE standard in their discussion of contingency to address unknown risks[64]:

> "The 2020 Transmission Cost Database was originally designed to produce early stage (Class 5) project cost estimates, accuracy range of ± 30%. With the Transmission Cost Database unknown risk factors, which are intended to be used by AEMO to review advanced stage cost estimates provided by the project proponents, the accuracy of the estimates may be assumed to be Class 3 (± 15%) given that they have been benchmarked against actual and recent transmission infrstructure (sic) build out cost data."

and simply accepting the AEMO 2022 ISP analysis on symmetrical accuracy bands based on the 2021 GHD report[65]. They provide no evidence that they sought to use more recent empirical data to test the 2022 ISP assumptions on implied contingency. We would have expected that the data since 2020 eg the size and uncertainty of biodiversity costs, that has highlighted the large cost inaccuracy of Class 5 and 4 estimates, would have provided the opportunity to review the contingency assumptions for unknown risks.

In summary, the two paras at the start of Section 2.5 seem to be just statements without foundation.

Consideration of State based local content policies

In our discussions with MM as they were preparing their report we recommended that they consider the impact of jurisdictional local content policies. MM decided not to include these impacts.

Forecasting future prices

Our comments are around the methodology to forecast the components and then how the escalation factors are applied. High R^2 are a necessary but not sufficient condition to justify the forecasting methodology. The relationships described at the top of p. 46 are either hardly revelatory or do not provide a convincing story that history is a guide to the future.

The fact that non-ferrous metals are strongly correlated with aluminium and copper resource prices is a bit like saying David Warner's test batting average is strongly correlated with the number of test runs he has scored and the number of times he has been dismissed in test matches.

While the historical data from 2010 might show "engineering design and engineering consulting services is related to the cost of labour for these kinds of services, but not significantly with the level of construction activity" there is no evidence that this is a robust forecast of the future (multiple concurrent ISP projects) that is quite different from the last 13 years. Further that is not the experience the Panel is hearing from the networks we regularly engagement with. The cost of

[64] See p. 26 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en

[65] https://aemo.com.au/-/media/files/major-publications/isp/2021/transmission-cost-database---ghd-report.pdf?la=en

engineering services is increasing because of the demand for these services from the large level of contracting activity – both in network build and more generally across all categories of infrastructure projects. Is MM really proposing that the concurrent development of many major network projects (including the bringing forward of Copperstring by 6-10 years) is going to have no impact on the cost of engineering services?

A key assumption in the analysis (p. 12) is:

> "Futures market commodity prices and projections of future labour costs are considered by us as suitable proxies for long term price forecasts"

which seems circular 'forecasts are a suitable proxy for forecasts'.

The influence of the availability of appropriately qualified EPC contractors

MM did not consider individual events like the insolvency of Clough or the withdrawal of Downer. There was just the general allowance for a high demand for engineering services. So at what stage of EPC contractors leaving the sector would MM consider it might have an additional impact on the cost of these services?

The influence of the change in contracting strategy

MM make no comment on the potential impact of a change in EPC contracting strategy to cost plus.

The influence of social licence delaying project timing on project cost

The MM report provides a summary (pp 58-9) of the issues raised in the two webinars held on their study. Both show participants raised the issue of social licence on capex. Yet the report has no explicit consideration of social licence impacting on capex.

4.2 How the TOER incorporates the MM results.

The 'return to normal' date

The TCD provides cost estimates in $June 2022 with indices to enable forecasts out to 2040. These indices have varying rates of price growth over that period. For example, the table shows the real cost index for a range of 'baskets' ie group of cost components[66]:

	Basket 1 (switch bay and buildings)	Basket 2 (underground cables)	Basket 5 (circuit breakers etc)	Basket 9 (Easement and property)
June 2022	1	1	1	1
June 2023	0.9654	0.9741	0.9949	1.0222
June 2030	1.1229	0.8863	1.0301	1.2514
June 2035	1.1260	0.8618	1.0378	1.3624
June 2040	1.1260	0.8358	1.0456	1.4833

AEMO has taken the MM report and then overlaid an overall assumption that (p.32):

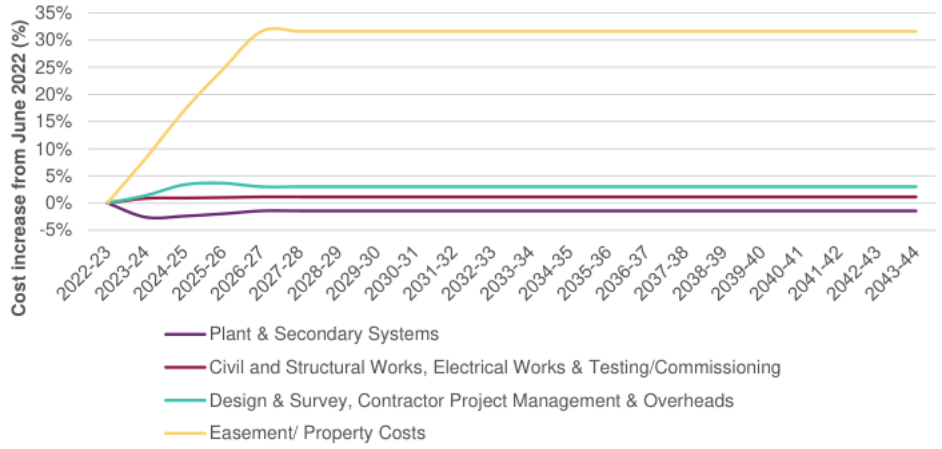
[66] See Table 3.3 pp 52-3 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en

> "AEMO proposes to assume that projected cost increases for transmission infrastructure also settle beyond 2027…"

And apply this to all cost categories including property and easement costs, but not to biodiversity costs given MM did not provide a forecast of that category. MM did not propose a 'return to normal date'.

This given the following forecast trends in real costs for various cost components.

Figure 8 Projected cost increases for transmission infrastructure



The only justification provided by AEMO for this 'return to normal' date is a desire to be aligned to the CSIRO Gen Cost assumption. The logic of that argument seems to be something like 'having a different date would bias towards either non-network alternatives (forecasts costs in the Gen Cost report) or network alternatives (forecast costs in the TCD)'.

We commented on the 'return to normal' date concept in the Gen Cost study in our Draft IASR submission[67]. We understand the conventional and generally accepted technique in long term modelling, that at some stage in the future, 'things are assumed to return to normal' ie costs remain constant in real terms. CSIRO justified its 2027 date as follows[68]:

> "The inflationary cycle is assumed to be at its peak in 2022 and 2023 and to take until 2027 to return to normal costs. Forecasts of the input price indices are used to shape the profile of cost reductions to 2027 as global inflationary pressures unwind. After 2027, our standard projection methodologies are resumed."

The justification for selecting 2027 is based on RBA inflation forecasts presented to the October 2022 FRG – inflation is expected to return to the RBA target range of 2-3% by then. The Panel's response was that even if the economy wide inflation level returns to the RBA target range, this is no guarantee that supply chain pressures will still not apply for generation and storage investment. As we argued above, we expect these pressures to be maintained for many years based on a combination:

- continuation of the current project delays from supply chain pressures mean projects are completed much later than originally planned (which is why the Panel proposed a modelling sensitivity on project timeline and capex), and

[67] See p 59 https://www.transgrid.com.au/media/rxancvmx/transgrid-humelink-pacr.pdf
[68] See p. ix https://publications.csiro.au/publications/publication/PIcsiro:EP2022-5511

- the political imperative of Governments around the world to achieve their interim 2030 emission targets will drive large subsidies which drives supply chain pressures.

Irrespective of what is the right 'return to normal' date for Gen Cost estimates, the return to normal date for the TCD has to be viewed separately based on cost influences for networks. Consistency between the two 'return to normal' dates does not guarantee an unbiased choice between network and non-network investment. It may lead to a bias in favour of one or the other if the rate of change in costs is different between the two options.

We would recommend that the final TOER provide more analysis to justify:

- the choice of the 2027 date – it is much more complicated that a simple judgement on when the RBA will achieve their inflation target,
- why the same 'return to normal' date should apply to all cost components, and
- why it is seen as an appropriate to align the Gen Cost and TCD dates.

The treatment of biodiversity costs is confusing

There are two aspects here – how the forecast is done and whether the forecast is capex or opex.

In the absence of a forecast from MM, biodiversity costs are forecast on a project by project basis using the same ratio (environmental offset costs/total direct costs) from original values developed in 2020. The proposed methodology to address this uncertainty is[69]:

> "To capture the known risks that might impact projects with different levels of complexity, the Excel workbook tab "dataRisk" contains five classifications available for Environmental offset costs: low (+20%), BAU (+ 50%), high (+ 100%), very high (+ 400%), and observed maximum (+2000%). These changes were proposed by AEMO to reflect hypothetical projects with extremely high environmental risks."

There needs to be much more transparency around how this process is done for projects, especially at a Class 5 or 4 estimate when there is no specific route and only very general understanding of the biodiversity conditions that the project cost estimator is seeking to cost. What criteria are to be used to select a classification and how is that going to be consistent among projects?

On the second, there is the statement in the TEOR (p.32):

> "AEMO proposes to assume that projected cost increases for transmission infrastructure also settle beyond 2027, to ensure a consistent approach for like parameters in the ISP. This cost forecast does not address the future cost of biodiversity offsets, as AEMO's position is to address this through operational expenditure given the nature of jurisdictional schemes."

Yet Table 5 (pp 21-22) shows biodiversity costs being part of the TCD with different levels of accuracy at different stages of the RIT-T.

We recommend that the final TOER provide clarity around:

- Whether biodiversity offset costs are treated as capex or opex or both, and

[69] See p. 24 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en

- If it is treated as capex, provide more transparency around how the AEMO five classifications of costs will work in practice
- If it is treated as opex, more transparency around how those costs will be estimated.

Market impacts on transmission costs

Section 3.6 of the TEOR discusses the Infrastructure Australia reports mentioned above but strangely does not refer to the UTS report. It says (p.31):

> "The Transmission Cost Database allows the selection of a known risk to reflect the impact on transmission costs of the concurrent delivery of large transmission projects that is attributable to competition for labour and materials."

It is not clear what this means. Is it optional and, if so, who decides whether it is selected and the size of the risk? The TEOR goes on to say:

> "It is expected that the projects estimated by the TNSPs will have allowances included for market pressure, since these are to be constructed in a shorter time horizon."

What evidence have the TNSPs provided to give AEMO that confidence? How will AEMO ensure that there has been a consistent approach across TNSPs and AEMO in Victoria? We presume this will be through the 'cross check' process.

AEMO's 'cross check' role for TNSP provided cost data is opaque

The capex estimates for actionable ISP projects are provided by the TNSP through the RiT-T (VNI West, Marinus, Humelink) or jurisdictional schemes (Sydney Ring and New England Ring). The costs listed in the TOER are:

VNI West	$3,282m from the February 2023 Consultation Report
Marinus	$3,782m (June 2021) based on the Jacobs estimate in H1 2021 used in the PACR
Humelink	$3,317m ($June 2020)
Sydney Ring	Actionable project
New England Ring	Actionable project

Once AEMO receives the estimates from the TNSP, AEMO (p.15):

> "To ensure consistency across regions, AEMO reserves the right to add offsets to prices advised by TNSPs to ensure uncertainty and risks are applied consistently across investment options."

And on p.13:

> "Where updated cost estimate information is provided to AEMO by TNSPs for future ISP projects with preparatory activities, and for projects undergoing the Regulatory Investment Test for Transmission (RIT-T) process, AEMO will cross-check this information[9] using the latest Transmission Cost Database before it is included in the final 2023 Transmission Expansion Options Report and final 2023 IASR."

While the TEOR provides a good qualitative explanation of the 'cross check' process in Section 3.3, the Panel would recommend greater quantitative information in the final TEOR on how this process worked in practice. This would include information on the following:

- How have the different accuracy bands been converted to the AEMO accuracy band for each AACE cost class discussed in the next section given it seems each jurisdiction has its own interpretation of the AACE classification? For example:

    - Trangrid's description of the cost accuracy in the Humelink PACR in 2021 was[70]:

        "We consider our cost estimates to be 'class 4' estimates, which is in-line with the level of accuracy expected at this stage of the investment process. For example, AEMO commented during the consultation process on its transmission cost database that the cost certainty at the PACR stage is typically between -30 per cent and +50 per cent ('class 4' estimates)…"

        We consider that the capital costs used in the PACR analysis are 'P50' estimates i.e. they have a 50 per cent expected probability of cost underrun."

        The AEMO accuracy band for a Class 4 estimate is ± 20%

    - Marinus PACR capex in 2021 range from $3.1 (P10) -3.8b (P90); while reference was made to the AACE methodology the costs estimates were not assigned a 'class'[71] ; the cost quoted above from the TOER is the P90 cost
    - NSW Roadmap costs in 2023 are at Class 5b ie ±50%[72] so given AEMO Services prepared the forecasts can we assume that Roadmap capex estimates require no cross check?

- In the preparation of the 2022 ISP, TransGrid, alone among TNSPs, chose to only provide confidential capex estimates to AEMO. This meant AEMO was unable to apply the 'cross check' process to the majority of ISP projects[73]. We understand this data on preparatory activities is due by 30th June so hopefully AEMO will not have the same problem in the 2024 TEOR.
- How have the costs have accounted for supply chain pressures and jurisdictional local content requirements?
    - While we understand (but do not accept) the TOER argument to ignore concurrent project risk for Class 5a/b projects, how has AEMO evaluated the TNSP data on earlier projects, especially those in the 2022 ISP ODP?
- Does the cross check cover land acquisition/access/biodiversity costs?
- What specific $ capex adjustments have been made to each project?

So far we are yet to be convinced that the 'cross check' is much more than an 'empty box'. TNSPs have the most data on individual project costs. Perhaps the benefit of the 'cross check' is getting alignment on cost categories given the tendency of TNSPs to 'self-assess' their estimate category.

---

[70] Transgrid "Reinforcing the Southern Shared Network to increase transfer capacity to demand centres" (Humelink) PACR 29 July 2021 p 24 https://www.transgrid.com.au/media/rxancvmx/transgrid-humelink-pacr.pdf

[71] See p. 14 https://www.marinuslink.com.au/wp-content/uploads/2021/06/Project-Marinus-PACR-summary-document.pdf

[72] See p.25 https://www.energyco.nsw.gov.au/sites/default/files/2023-05/network-infrastructure-strategy.pdf

[73] See the discussion on pp88-9 of the 2022 Consumer Panel's submission on the 2021 IASR https://aemo.com.au/-/media/files/major-publications/isp/2021/isp-consumer-panel-report-on-2021-iasr.pdf?la=en

Impact of social licence on project capex

There is a general discussion on pp 34-5 in the TOER on social licence be it does not provide any specific information on how it is going to ensure consistency in TNSP inclusion of social licence costs apart from legislated jurisdictional compensation arrangements. Given the absence of discussion of the issue in the MM report, AEMO should provide more detail on how it proposes to develop the capex costs to be used in the model sensitivities on social licence and project delay. We raised this issue in our submission on the ISP Methodology[74].

5. We consider that AEMO's analysis of the cost accuracy estimate progression is flawed

We support AEMO's use of the ACCE cost framework (p.19):

> "AEMO has adopted the AACE International framework for its cost estimate methodology to classify cost estimates, and defined sub-categories to reflect the range of estimates and accuracies that are available within the Australian regulated electricity sector."

However, we are not convinced that the application is robust. The table shows the AACE expected accuracy band[75] for transmission projects has a decreasing accuracy range as the cost class moves from 5 to 1 that is explicitly non-symmetrical simply because history suggests there is a greater risk of a cost increase than a cost decrease.

Estimate Class	Expected Accuracy Range (Typical variation in low and high ranges at an 80% confidence interval)
Class 5	-50% to +100%
Class 4	-30% to +50%
Class 3	-20% to +30%
Class 2	-15% to + 20%
Class 1	-10% to + 15%

The ACCE guidance note says this (p.7):

> "Depending on the technical complexity of the project, the availability of appropriate reference information, the degree of project definition and the inclusion of appropriate contingency determination, a typical Class 5 estimate for an electrical transmission substation facilities project may have an accuracy range as broad as -50% to +100% or as narrow as -20% to +30%. However, note that this is dependent upon the contingency included in the estimate appropriately quantifying the uncertainty and risks associated with the costs estimate. Research for power transmission projects has shown that industry has greatly underestimated risks and contingency for Class 5 and 4 estimates. Environmental and

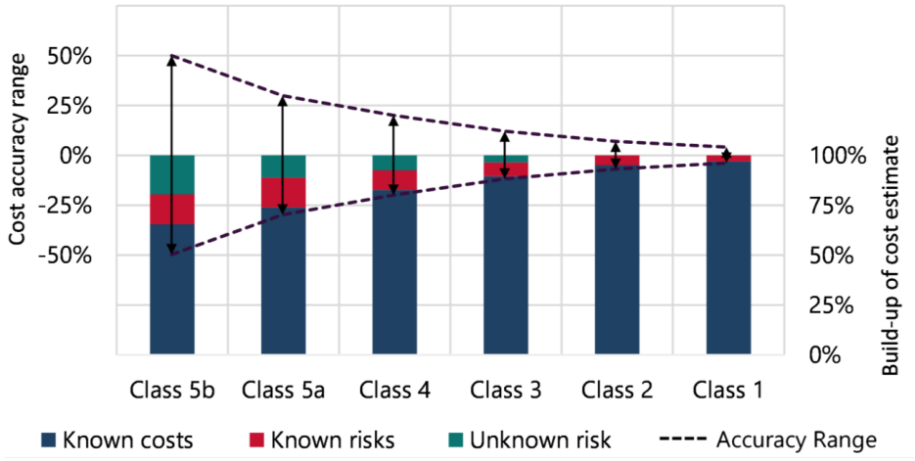
[74] See the discussion on pp 5-7 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/isp-methodology-2023/submissions/17-isp-consumer-panel-isp-methodology-submission.pdf?la=en

[75] See p. 7 https://web.aacei.org/docs/default-source/toc/toc_96r-18.pdf

political risk are increasing and that becomes a particular concern when regulators require reporting of maximum costs or similar dictates to accuracy."

AEMO's approach in Figure 6 shows cost accuracy bands that differ from the AACE approach in two ways – the accuracy band is narrower and it is symmetrical.

Figure 6 Cost estimate summary breakdown from Class 5b to Class 1



The TEOR provides this justification for the different approach (p.25):

> "The AACE International methodology typically contains accuracy bands which are skewed to the positive side, reflecting higher likelihood of cost increases than decreases as the estimate progresses. The Transmission Cost Database has been designed to include an average allowance for unknown risks which offsets the adjusted building block estimate, such that the 'total expected cost' resulting from the Transmission Cost Database can be used as the mid-point of a symmetrical accuracy band for ISP modelling purposes."

This is confusing given any estimate of the 'total expected cost' of unknown risks is pure guess work. Why is a 30% risk factor for 'unknown risks' any more accurate than any other %? There is reference back to the GHG report in 2021 for the 2022 ISP where this figure first appeared and are used to justify the following accuracy bands:

Table 6 Class 5 estimate sub-categories

Class	Definition	Unknown risk allowance[A]	Accuracy[B]
Class 5b	Concept level scoping with no site-specific review or TNSP input	30%	±50%
Class 5a	Screening level scoping including high level site-specific review and TNSP input	15%	±30%

A. Unknown risk allowance defined as a percentage of the known cost (adjusted baseline cost).
B. Accuracy bands have been derived statistically, such that 80% of project estimates should fall within these limits. It is therefore expected that, across a large sample of projects, approximately 20% of them will fall outside of these bands.

The TEOR goes on to say (p.25):

> "The Transmission Cost Database is currently designed to produce Class 5a and Class 5b estimates. The accuracy of the Class 5a estimates produced by the Transmission Cost Database is approximately ±30%, with an average unknown risk allowance of 15%. This was determined by GHD using statistical analysis of current major projects as they progressed from screening stage scope definition to CPA – further detail on this analysis is provided in the GHD report. Accuracy bands have been derived statistically, such that 80% of project estimates should fall within these limits. It is therefore expected that, across a large sample of projects, approximately 20% of them will fall outside of these bands."

The 2022 ISP Consumer Panel commented on the GHD report and its 5a/5b accuracy ranges in its submission on the 2021 IASR – see Appendix B pp 68ff. It is worth quoting at length GHD's discussion of 'unknown' risk factors[76].

> "A set of 4 unknown risk factors for each of the 3 categories (station, overhead lines and underground cables) and their respective selection choices (proxy for probabilities) has been adopted for the TCD. This results in unknown risks being estimated using a 'top-down' percentage of network element costs.
>
> Developing an approach to derive an estimate for unknown risk factors (or also referred to as 'contingency') is more problematic by definition – we do not know what the risks are, and we may only know either the cost impact and not the probability or vice versa. At worse we will not know either.
>
> However, we know the probability distribution of the variation of costs that occurs in infrastructure projects, including past distribution augmentation projects and recent transmission augmentation estimates, from early to final/advanced estimated costs. Most cost predictions or estimates for infrastructure projects demonstrate some measure of asymmetrical distribution or skewness, usually to the high side where the probability of overrun is higher than the probability of underrun.
>
> Unknown risk factor or contingency is thus usually a positive allowance added to cover the variability surrounding the base estimate in quantity and cost base Class 5 estimates, and to equalise the chance of project overrunning and underrunning from the best estimate of project costs."

GHD then go on to describe their methodology to get to symmetrical cost accuracy estimates:

> "The reasons and magnitude of changes from the Project Assessment Draft Report (PADR) to the CPA stage for these projects has been drawn upon to inform the determination of the unknown risk factors in the TCD. We note that this is mostly based on progressive updates to these recent project cost estimates, rather than actual or incurred cost records. In few instances some elements of these project estimates were based on newly executed contracts or competitive market bids. In the remainder of cases these project cost estimates were based on increasingly detailed or updated information."

They discuss how they examined 22 recent major project network elements to measure the level of adjustment required to enable early estimates to be more accurate. However, all this has a fundamental problem. Footnote B in Table 6 above says the accuracy bands were derived statistically, yet the available data to do the statistical analysis on is almost non-existent. And that that did exist at the time of GHD's analysis (Q1, 2021) was early stage ISP projects. Even if GHD has access to the detailed cost estimates provided by Transgrid and Electranet for PEC (provided to the AER in September 2020[77]), those estimates were prepared before the surge in supply chain and other

[76] See p. 26 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/transmission-costs-for-2022-isp/transmission-cost-database-ghd-report.pdf?la=en

[77] https://www.aer.gov.au/system/files/TransGrid%20-%20Letter%20to%20AER%20-%20Project%20%20EnergyConnect%20-%2030%20September%202020.pdf; MM do say in their report (p. 24) that they had access to '…anonymous data from TNSPs on environmental offset costs'

pressures discussed above became fully evident. GHD acknowledges the problems with their database[78]:

> "It is noted that the improving accuracy range as the cost estimate matures have been formed based on linear extrapolation of recent NEM projects early stage cost estimate accuracy range and the AACE RP 96R-18 optimistic accuracy range for more advanced stage cost estimate (as shown in Figure 9). We note that this representation of improving accuracy range is mostly academic and based on observation of recent NEM projects as their cost estimates matured. Given the lack of major transmission augmentation project works in the NEM in recent history and thus the absence of empirical actual cost information allowing the estimate vs actual cost analysis (with benefit of hindsight), further conclusive insight into the improving accuracy range is unavailable. As such the data in the following table should be viewed in this context. "

What we have seen in the last year or so is considerable change in the actual route over the course of the course of the RIT-T and then early works as more work is done on social licence and biodiversity issues. Look at the number of routes that have been considered in VNI West and AEMO has some work to do before being able to define the actual route. Class 5 estimates necessarily have a high level approach to the route which suggests, given the additional data since the GHD study, that unknown risk contingency is very likely to be much greater than 30% and that cost accuracy cannot symmetrical.

Finally, we would argue that contracting strategy can have a significant impact on the level of unknown risk. Does AEMO think that a 30% or 15% 'unknown risk' is consistent with a cost plus EPC contracting strategy?

In summary, the TEOR provides no data to justify its conclusion that a 30% and 15% 'unknown risk' allowances for Class 5b/5a cost estimates and hence the ± 50%/30% cost estimates are valid. It seems that AEMO has simply followed the 2021 GHD report that has no empirical basis. There is certainly no empirical data for the accuracy bands for Class 3, 2 and 1 cost estimates because no ISP project has reached that level of accuracy.

6. Section 3.4 Estimating operational expenditure

The TEOR says that (p.28):

> "To estimate the operational expenditure for transmission projects, 1% of the total capital cost per annum is typically assumed as operation and maintenance cost for each transmission project, as this has historically been an appropriate figure for new build projects dominated by line works rather than substation works, and at present this value appears to be appropriate for future project estimates."

In the recently released VNI West PACA, AEMO commented:

> "In response to a query raised during the March 2023 deep dive sessions, AVP and Transgrid note that the 1% of capital cost value is consistent with that used in the 2021 Inputs, Assumptions and Scenarios Report (IASR) (this is the latest final IASR released by AEMO). During consultation on the 2021 IASR, stakeholders questioned the appropriateness of this

[78] See p. 30 https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/transmission-costs-for-2022-isp/transmission-cost-database-ghd-report.pdf?la=en

> value and, in response, AEMO reviewed recent revenue determinations, contingent project applications and RIT-Ts, and concluded that 1% was reasonable for ISP purposes, because the cost of major projects in the ISP are dominated by transmission lines rather than substations."

The Project Energy Connect PACR[79] does not discuss operating costs. Neither does the Marinus PACR[80]. The Western Renewables Link has opex at 3.5-3.8% of total capital costs depending on option[81]. Transgrid's estimate of Humelink opex:

> "In addition, we have refined the assumption regarding annual operating costs based on more detailed cost assessment. We now assume this to be 0.5 per cent of each option's capital costs each year (excluding capital costs relating to biodiversity costs, since these are one-off and do not require ongoing operating costs)."

But provide no more detail.

Given AEMO's reference to the research it has undertaken, we recommend that this research be published to ensure full transparency. In particular:

- We are unaware of how 5 yearly revenue resets could provide data to support AEMO's view; opex data is not broken down into specific projects and relates to a mix of past and proposed capex projects
- Our review of RiT-T does not provide much support for the 1% assumption

Given the TOER treatment of biodiversity costs as opex given jurisdictional schemes (p.32) the opex section should have more discussion on how AEMO proposes to calculate those costs. There is no guidance on how AEMO will choose a particular risk classification discussed above in the MM report.

[79] https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nsp_consultations/2019/sa-energy-transformation-pacr.pdf?la=en&hash=195A2D36ED4B3D32D94811BB277B3F59
[80] https://www.marinuslink.com.au/wp-content/uploads/2021/06/Project-Marinus-RIT-T-PACR.pdf
[81] See Table 14 p.40 https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/2019/pacr/western-victoria-rit-t-pacr.pdf?la=en&hash=D49070EAF9E12EF7C043F6984BB91B2F