Submission on AEMO's Draft Transmission Options Reports from Simon Bartlett – 30th May 2023

Thank you for the opportunity to provide some observations and comments on the AEMO Draft Transmission Options Report (*Report)*

As there are so many projects with many subcomponents, it is not practicable to go through every cost estimate item by item. Instead, my submission takes the following approach

1. Reviewing the 11 questions that I submitted in writing to the webinar, stating AEMO response to each question verbatim, analysing that response from a technical/economic perspective, and suggesting matters for AEMO's consideration.

2. Examining a few cost estimates in detail, highlighting opportunities to improve the accuracy of the scope and cost estimation, eliminate inconsistencies between the options presented in the *Report* and to be compared and used in the 2024 ISP.

3. Comparing some of the estimates on a per unit cost basis (e.g., average $m/km) to ascertain whether their relative costs are plausible considering the scope differences between the projects

1. Review of the 11 questions and answers provided

The first question was about why there is a cost difference between the overall average cost per kilometre of similar 500 kV projects as the scope differences do not appear to justify such large differences. Examples were provided such as $m4.6/km for 500kV projects in Queensland and to establish an OSW terminal station in South Australian supplied from Heyward, $m6.6/km for the new 500kV extension of VNI West from New Kerang to Shepparton, $m13.1/km for the 500kV extension of the Latrobe Valley network to near the Basslink transition station in Gippsland. These cost estimates are at 2022 price levels which the *Report* concludes are approx. 20% higher than the 2022 ISP cost estimates (i.e., 2020/21 prices), yet nearly all of the 500kV cost estimates in the *Report* are significantly lower than the average cost of Humelink ($m9.4/km in 20/21 prices) and VNI West option 5A ($m8.5/km in 2020/21 prices).

Answer from AEMO: So the question refers to differences between one of the renewable energy zones in Victoria and one of the flow path options between central and northern Queensland as well as Humelink which is in New South Wales. The answer is that these projects all have their own differences. For Humelink, we have referred to the latest cost estimate from TransGrid, who is the major project proponent for that project. So, the cost estimates that we've been applying will be consistent with Transgrid's public regulatory and investment tests for transmission cost estimates. The difference between the rates that you're seeing in there for the Victorian renewable energy zone and for the Central Queensland to Northern Queensland flow path option is to do with the fact that it's a very long line in central Queensland to Northern Queensland. And we have assumed in our transmission cost database that there is an efficiency, there is an economy of scale there. So, with such a long line, we do assume that there are some cost reductions available for the dollar per kilometre rate.

In addition, the transmission cost database allows selection of different sort of land, traversing difficulties for different projects, and depending on the local land use arrangements for different areas. And we assumed more complexity for the renewable energy zone in Victoria than for that particular option that's being referred to there for between central and Queensland and Northern Queensland, just based on the characteristics of the land. Of course, these are high level estimates, and they will really need to be refined over time. So, we're talking about rough estimates here.

Observation on answer provided: There is only a 5% unit cost reduction for lines over 200km long in the *Report.* Usually, these economies of scale are modelled by estimating establishment costs which are then effectively spread over the entire project, however that cost component has not been modelled in the *Report*. The CQ-NQ project assumes an 80% reduction in easement costs by classifying the regions grazing and partly cultivated land as scrub, but even then, there would be only an 8% reduction in the overall line cost bringing the total difference to only 13% of just the line component, whereas the $m4.6/km is 43% lower than VNI West's $m8.5/km. Part of the difference may be from the *Report* assuming no intermediate 500kV substations along the 750km long line, which cannot work from a technical standpoint. There are numerous other scope omissions in the Report for the CQ-NQ project that I would be happy to provide details if required before finalising the *Report*. Foer example, on what basis has the *Report* assumed that the entire 750km of line would be cyclone rated?

2. **Only 2 conductors per bundle on a 500kV line**.

The next point is asking about why we have proposed to use twin conductors for 500 kV lines in Queensland and in South Australia cost estimates.

This is a good and interesting question.

Because quad conductors are understood to create less noise that is widely understood. This one is something that we're currently working through in joint planning processes with the local transmission networks and something that is still being considered as part of the high-level design process. And it really depends whether or not we think that the trade-offs between cost and design and noise outcomes where that line should be struck, and it often will depend on the land that it's traversing and the impact that it will have this isn't open questions still on the design. And so, I'd say this one still has more work to be done on the joint planning consideration in order to talk about how and why we've selected different things or if that may change over time.

Observation on answer provided: Powerlink has advised that they would not consider twin conductors on a 500 kV transmission line and that has never been done in Australia for obvious audible noise, interference and corona losses reasons. As the Report states, the line rating would be only 1,675MVA (or 1,500MW) per circuit due to what may be a poor choice lighter Olive conductor. It may be better to use Powerlink's standard 275kV line design with twin Sulphur conductors however neither would meet the requirements of the Queensland Energy Plan.

3. This next question is a good one. It's asking why we've got a line voltage of 320 kV I think and converters in the system and converters at 500 kV.

This one is a useful pickup in the questions. So, there will be some cases because of the manual selection process for using the transmission cost database. Sometimes there are some

mismatches in voltage, but obviously those will need to be corrected moving from the draft to the final. So, if that's what's happened here, we'll just correct that one.

Observation on answer provided: The Report has also rated the converters at one end of the line at 1,000MW whereas the each bi-pole of the line and the converters at the other end is rated at 750MW. There may be benefits in requesting the consultant to properly check their scope definition being used to estimate the costs, as well as the overall project costs in the *Report* for consistency and accuracy.

4. I think that the next question is a similar answer. This is what happens when you have almost more than 150 options coming through.

So, we're still going through our final checking process as we move from draft to final.

Observation on answer provided: It is essential that key data that will determine the scope and selection of actionable projects in the 2024 ISP be fastidiously checked and corrected where necessary. There have been other examples of incorrect data and spreadsheets that have resulted in the wrong project being selected and built. Stakeholders reviewing the *Report* may assume that the consultant and AEMO to have checked and validated the inputs and outputs of the *Report*.

5. The next question is asking about the types and size of line conductors that have been costed, and about the different tower structures and designs.

This one, there's a lot of detail to go into there. So, I'd suggest that the questioner should submit a request through the online to receive a copy of the AEMO transmission cost database. It's true that these kinds of design details are not mentioned in the spreadsheets, which are summarizing the options that have come through in the report. However, if you were to request a copy of the transmission cost database, and then have a look, I'm just having a look at the name so that we can point you to the correct area. Have a look at the cost and risk data part of the workbook. And that should have the details that you're asking about. If not just feel free to put a question in the submission on the 31st. And then we can we can put a response in. So, I'm just having a look to see.

Observation on answer provided: Considering that AEMO received my 11 questions three days before the webinar, there should have been enough time to provide the answers to this question and check the few vital parameters that determine the estimated cost of this HVDC project. The equivalent information is contained in the *Report* for all HVAC projects, however the even the few details provided for all HVDC project contain errors and inconsistencies that significantly affect their estimated costs and performance. It is more important than ever that HVDC VSC alternatives to traditional HVAC projects be correctly scoped and costed, now that this technology is being widely used to integrate large amounts of renewables into the power systems in Europe, China, India, Canada and now USA.

6. Just looking at a separate document for the answers that we're looking at is so we're up to the next question, which is about discussion of why we have selected the HVDC circuits.

In some cases, we will have a rating selected for 750 megawatts, and then there might be a similar or adjacent option for that flow path or rez where we're looking at a higher capacity HV AC option.

I agree that in general, you'd be wanting to compare like with like, however, in this case, where we're looking at a bag of options, what we have done is we've chosen a spread of options to cover a broad dollar cost estimate for different capacity uplifts. Because we want to feed a range of options from a cost perspective through to the ISP model. And then the question of whether or not ultimately an option would be HVDC or HVAC really comes down to the detailed assessment that would be done by the project proponent through the regulatory process. So here we have not necessarily gone through and fit every single AC option selected an exactly equivalent HVDC option. And that's really a product of resourcing and time available.

Instead, we've tried to focus on having a range of options that the ISP model can pick up as part of the CO optimization. And then ultimately, the technology selection will need to be refined as the project consideration develops. If there are particular cases where people think that there's a real need for a particular type of option, we really welcome that through the submissions process. But we've generally tried to get a good broad range, if there's an area where we need a bit more of a range, we're open to that we're trying though not to have 1000 options. So, we need to pick and choose where it makes sense to make sure we've got that broad range.

Observation on answer provided: The 2024 ISP will compare these options with a rating of only 1,500MW with an HVAC option with a rating of ~ 6,000MW. This will lead to an incorrect comparison as both should be rated to match the needs of the power system in that location, as forecast by the ISP. Of greater concern is that the ISP only compares HVDC options on the basis of power transmission capability, with no allowance for security of supply or recognition of the many socio-environmental-technical-economic benefits of HVDC VSC MMC technology, now being exploited globally to solve the very grid issues already challenging AEMO.

7. Looking at the next question here about why we've applied certain adjustments and risk allowances for one of the renewable energy zones in Queensland.

Where the stakeholder has noticed that we have chosen a 22% cost increase, an option which is about 22% of the total cost and then for other projects which are of equivalent voltage in other regions almost 50%. This one the answer lies in having a look at the detailed update report from Mott McDonald which has been published as an appendix to this report. So, in that detailed cost estimation update, you will see that we have updated our easement and property cost assumptions for individual states across the NEM, the national electricity market. And we've also done updates for the biodiversity offsets. So, if you have a look in there, you will see the values for Queensland are different to other regions, and you'll see the data sources for where those tables were derived from.

So, any specific feedback on Queensland we welcome if there is particular feedback back that needs to be brought in. But we do request that it'd be with reference to evidence or data. Because we're trying to make sure that when we prepare these estimates, we've got a particular data source that we can point to and that can be referenced to make the case for any changes.

Observation on answer provided: The same issue occurs when comparing projects in the same locality in Victoria or NSW. The adjustments, risk allowances and assumptions that determine the scope and cost of the project appear inconsistent. Examples include Greenfields projects having zero risk allowance compared with Brownfields projects having significant increased cost adjustment. Lines being built on existing spare easements having the same easement and biodiversity offset costs as a Greenfields line. Projects with short transmission lines needing line reactors while others with much longer lines do not. Some Projects in a strong part of the network having to fund $m200 synchronous condenser at a distant major load centre but others in much weaker locations having no allowance for strengthening even the local network. Allowances included for cultural and heritage monitors for electrical works being undertaken above ground.

8. I see that the next question is again talking about the quad conductive versus twin conductor. And so, I'll just refer back to my previous answer for that one.

Observation on answer provided: The *Report* only uses quad or twin conductors for 500 kV lines and has not evaluated the option of using higher rated conductors in a triple conductors bundle as commonly used overseas.

9. And for the option question about the southern Queensland option three which is asking about the $60 million cost estimate for a greenfield project at Borumba.

I think with this question, we're a little bit confused about where the 60 million is from because I think we've got a bit of a higher value in the transmission expansion options report around about 83 million.

It may be that there's a difference between which part of the spreadsheet the stakeholder is having a look at but regardless 60 or 80 million. If it were for a substation, I would agree that might be a relatively low-cost estimate but this is actually not a substation it's more of a switching station with line works and cut ins. So, I think that would explain why it's got that lower value. This is only a 500kV switching station without transformers and a lower voltage substation

Observation on answer provided: Borumba substation must connect the new 500kV transmission network to the lower voltage cables that run down the cable tunnel to the underground power station (most likely at 275kV or 330kV). Those cables and the generator transformer underground cannot possibly be 500kV. This means that the Borumba substation will be even bigger than the Maragle substation for Snowy 2.0. Its scope must include at least 2,250MVA of 500kV/275kV transformers plus a redundant transformer, a breaker and a half 275kV bus with at least 6 diameters, suitable for connecting the 6 outgoing cables to each of the Borumba units. It is not just a switchyard but a full high-reliability substation and $m80 appears understated compared with the cost of equivalent substations in the NEM.

10. And then if we have a look at the second to last question in southern Queensland option two, this question is asking why we would assume new easements be included in the cost estimate and the scope for a line going from Woolooga to South Pine when there already are spare easements in that area. And

that's definitely been a detailed point of discussion between AEMO and Powerlink.

Our cost estimate at the moment includes a little bit of easement along that line, but not the full length of the line because there are as Powerlink already is aware some spare easements available should that option be taken up. So, the estimate includes some but not all of that line. So, if further detail is required on that maybe a submission asking a question about exact details about that further information would be welcome. But we've definitely been speaking with Powerlink and that available spare easement is well understood.

Observation on answer provided: The easement and biodiversity costs in the Report for that line appear to assume that a new easement is required all the way to South-Pine, not just for a small part of the way. In the 1970's two easements were acquired, one being a dual width easement, but only one 275 kV line has been constructed on the dual width easement. It is possible there has been some encroachment on the vacant easement at its bottom end near Brisbane, however that would make the acquisition of a new easement even more difficult. There are other solutions that would not require the acquisition of a new easement in that section that I would be pleased to suggest, however Powerlink would be well across this issue.

10. And then finally we are not hiding a cost estimate for a 500 kV line from Halys to Calvale. However, I think maybe we, through the written submission process would be useful to get on the same page about which line is under discussion here. So, I'll just have a look at my notes separately. Because I think the misunderstanding maybe to do with the voltage there, we have included an option which has a 275 kV line between Calvale and Wandoan South. And this is a project where there's a hyperlink in the report which links to the Powerlink preparatory activities report which was received for one of the previous ISPs. And so that would be where the details are for that one. If that's not the answer or is missing a bit of detail and very happy to clarify that through the written submission process.

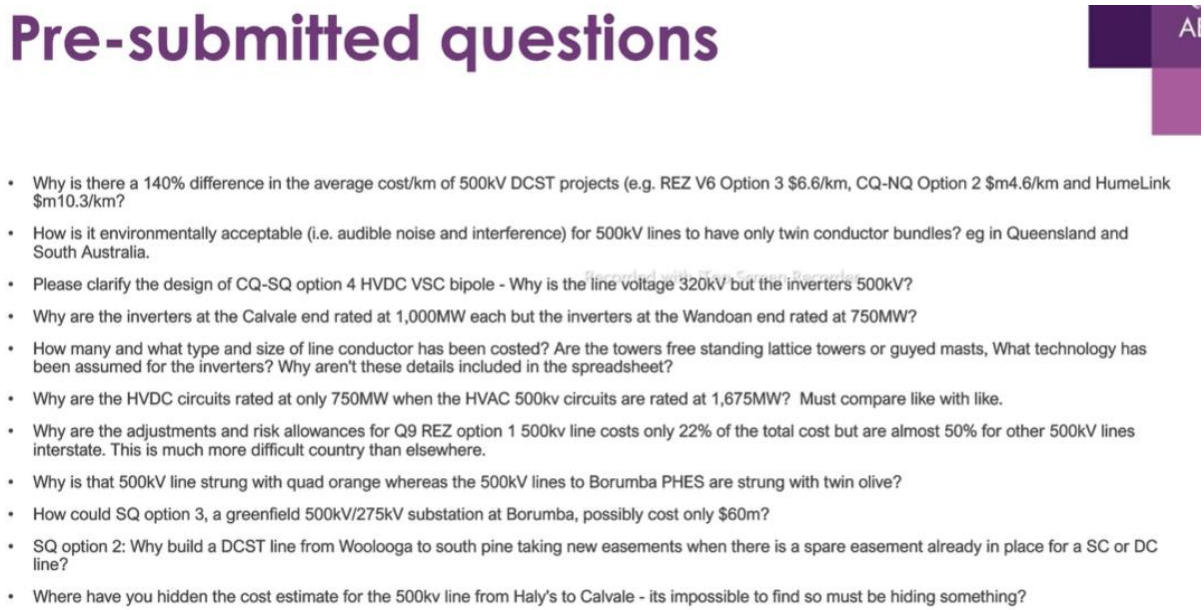
Observation on answer provided: The Queensland Energy Plan requires a 500kV line(s) to be constructed from Haly's substation to a new 500kv substation in Central Queensland**,** along a route to be determined by Powerlink including the need for a mid-way switchyard. The proposed 275kV Calvale to Wandoan South line and the Auburn River switchyard identified in the 2022 ISP as a Future project, preceded the

Queensland Energy Plan. Both of these future projects may not be require depending on the scope of the 500kV project that cannot be located in the *Report*.

Elwood to a new substation located near the a

2 Examining a project cost estimate in detail, highlighting opportunities to improve the accuracy of the scope and cost of the project

As an example of a more efficient scope than assumed in the R*eport* for many projects, the project to extend the existing Latrobe Valley 500kV network from Hazelwood to a new substation located near the Basslink transition structure in Gippsland has been critiqued and brief comments are set out below. Implementing most of these suggestions should reduce the estimated cost of this project by around 50% which is essential for this project to be recommended as an actionable project by the 2024 ISP. Otherwise, VicGrid will be disappointed as they are expecting AEMO to call tenders for this very project noting it was already being progressed by AusNet Services as an unregulated project. That would have guaranteed that no Victorian customer would ever have to contribute to its cost though-out its full life-cycle, despite



$m4.6/km to $m13.1/km and that recently approved 500kV projects were $m8.5/km to $m9.4/km, although costs have apparently since increased by 20%, taking them to $10.2/km and $m11.3/km. It is surprising that VNI West cost is lower than the Humelink cost as it is definitely a more complex project and its cost estimate includes $m315 for the incremental cost of upgrading both WRL and PEC at over $500m but its length does not include the 270km length of these upgrades. Adjusting the $m102/km for these factors would reduce VNI West's comparative cost to $m8.6/km which is clearly inconsistent with Humelink's $m11.2/km.

Simon Bartlett

31st May 2023