NSW Legislative Council Inquiry
Feasibility of undergrounding transmission for renewable energy projects

Further Issues

Ted Woodley – 4 August 2023

This Paper follows my previous document 'Issues raised in TransGrid's Submission and First Hearing, 23 July 2023'.

Its purpose is to alert the Inquiry to AEMO's 2023 Transmission Expansion Options Report, 28 July 2023 (Report) and implications for the Committee's considerations, particularly with respect to HumeLink. The Report outlines *"transmission expansion options to be evaluated in the 2024 ISP, including conceptual design, lead time, location and cost estimate*".

The main message from this Report is that the transmission expansion across NSW (and the rest of Australia) will be considerably more extensive than currently revealed.

The other message concerns the questionable viability of HumeLink, and the need for a duplicate HumeLink.

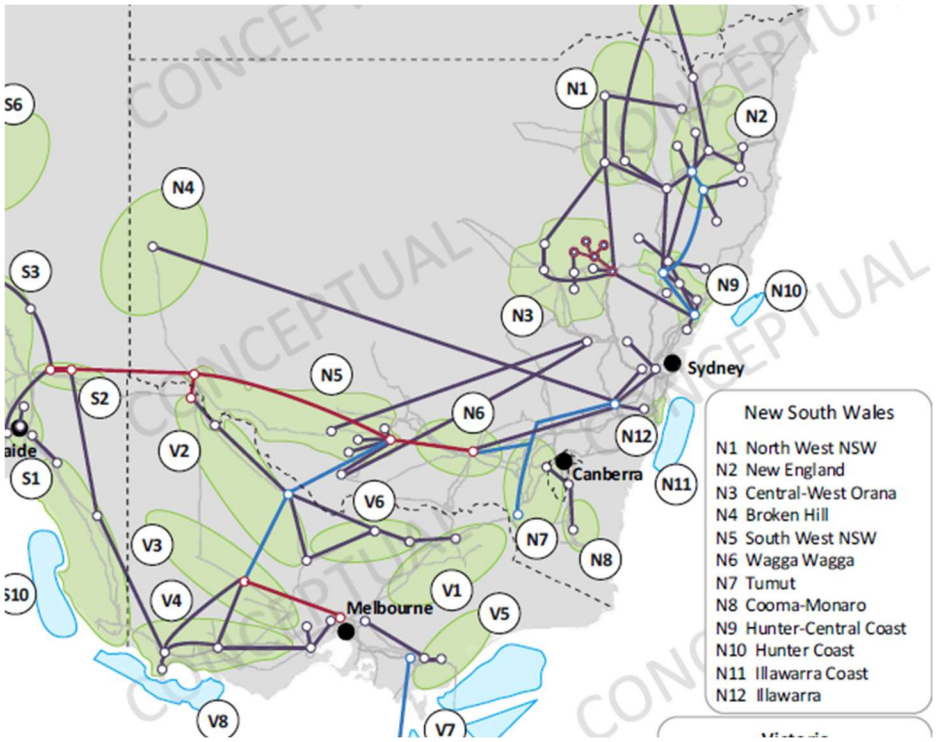


Figure 1 - Conceptual REZ expansion options and flow path augmentation options (AEMO Report Fig 3 extract)

1 Further transmission expansions

As shown in Figure 1 there are a number of potential additional REZs and a significant number of additional transmission expansions across NSW (purple lines).

It is appreciated that these additional projects are conceptual, but they provide AEMO's view of what is needed to continue the energy transition through to 2050.

Some of these additional lines are in areas where new transmission lines are already being progressed (e.g. HumeLink, Central-West REZ, New England REZ), some are in adjacent areas and some span new territory. Also, many of the additional lines would be terminated at existing substations, some of which are already being augmented, and will need to be further expanded to accommodate additional lines.

No doubt, the prospect of further transmission and substation expansions in those communities where augmentations are already underway will be a challenge. It would be a daunting task to return to communities with an additional transmission proposal just a couple of years after being through the process and possibly even before the first line was completed.

One obvious planning issue is the consideration of a DC backbone network across NSW. The best time to plan such a backbone is now, rather than in another decade or so when some of the benefits will have been forgone due to new AC lines being constructed in the meantime. A prime benefit of DC lines is that they are less obtrusive than overhead AC lines and can be undergrounded for longer distances.

Questions:

1. To what extent will the potential additional transmission (and REZ) expansions be conveyed to the wider public, especially to those communities that would be impacted?
2. Should not the planning and routing of transmission extensions currently underway take account of possible additional adjacent extensions, for example in gaining social licence and obtaining easements once rather than twice?
3. Should not the opportunity be taken now to more seriously consider a DC backbone network?

2 HumeLink cost blowout and capacity decrease

Figure 2 (at the end of the Paper) provides the latest specifications for HumeLink (termed Option 1) - relevant observations are:

- HumeLink's cost has increased to $4,892m, 48% higher than the $3,317m estimate in the PACR (note the 2018 ISP estimate was $1.1bn)
- its capacity has decreased to 2,200 MW, 14% less than the 2,570 MW capacity in TransGrid's Project Assessment Conclusions Report (PACR), dated 29 July 2021
- the new easement length of 630km seems to be erroneous as the length of HumeLink is 360km

The estimated cost of HumeLink was discussed during the Sydney Hearing. Mr Redman stated that the 'official number' and the estimate 'loaded up with the market operator [AEMO]' is $3.3bn. But he conceded that costs have since gone up by about 30% and he 'expects to see that when we finish the [updated] costing in the next few months':

> *BRETT REDMAN: The current official number is about $3.3 billion to build HumeLink.*
> *The Hon. WES FANG: We know from the Commonwealth Games that probably there's a figure and then there is an actual figure. Are we still expecting around $3.3 billion or are we expecting somewhere closer to five or six?*
> *BRETT REDMAN: So that number is now a bit out of date. That was the last time it was loaded up with the market operator. It's about three or four years old. Since then inflation and cost of construction have gone up. I would use it as a marker. I expect broadly the cost of infrastructure and transmission has gone up about 30 per cent. We're going to see that when we finish the costing in the next few months.*

The Hon. WES FANG: So $3.3 billion, 30 per cent, about $5 billion—and you say that $11½ billion was generated last year by the thing?
BRETT REDMAN: Yes. Mr Redman stated "I expect broadly the cost of infrastructure and transmission has gone up about 30 per cent. We're going to see that when we finish the costing in the next few months.
The Hon. WES FANG: So $3.3 billion, 30 per cent, about $5 billion—and you say that $11½ billion was generated last year by the thing?
BRETT REDMAN: Yes.

However, contrary to Mr Redman's comments:

- the 'official number' and the 'number loaded up with AEMO' is $4.892bn, not $3.3bn
- the previous estimate of $3.3bn (PACR) is only two years old, not 'three or four'
- the increase in HumeLink's cost is 50% (rounded), not 30%
- the increase in equipment and construction costs must be considerably more than 50%, assuming the cost of offsets has remained about the same at $935m

The PACR estimate of $3.3bn came with a Class 4 classification of an accuracy range of -30% to +50%. That is, the cost was estimated to be somewhere between $2.3bn and $5bn. We now find that just two years later the cost has soared to the upper limit.

The latest estimate of $4.892bn has a Class 5 classification with an accuracy range of -50% to +50%. That is, the cost lies somewhere between $2.5bn and $7.5bn, a range of $5bn! Given the five-fold increase in the estimated cost since 2018, it would seem to be highly optimistic to not expect further increases beyond $5bn.

The AEMO 2022 ISP indicated that the then estimated cost for HumeLink of $3.3bn was at the maximum level and the project could not be justified if there is a further increase:

> *"Nonetheless, protection is needed against rising project costs. To ensure the benefits are robust, the project costs cannot materially increase from the current estimate of $3.3 billion. Further work to drive down costs should be undertaken urgently"* (page 65)

Surely the latest estimate of $5bn (or higher) must well exceed the threshold cost that AEMO determined for HumeLink's viability in 2022. It must also be more than sufficient to constitute a 'material change in circumstance' and require the RIT-T to be reviewed.

4. When did TransGrid advise AEMO of the $4,892m updated cost estimate?
5. What is the likelihood for this estimate to increase further?
6. Why is the cost increase of 50% considerably higher than the general industry increases of 30% indicated by Mr Redman?
7. What are the elements of such a substantial increase and why was the estimate of just two years ago so inaccurate?
8. Why has the cost of HumeLink increased almost five-fold since 2018?
9. Does the capacity decrease and cost increase constitute a 'material change in circumstance' and hence require the RIT-T to be reviewed?
10. Does the latest cost estimate for HumeLink, and lower capacity, result in a substantial negative net benefit?
11. Why has the capacity of HumeLink decreased to 2,200MW?
12. Does this mean that HumeLink has virtually no spare capacity when Snowy 2.0 is pumping or generating at its full load of 2,040 MW?
13. What capacity is left for transmission of new REZ generation?

3 HumeLink 2

The AEMO Report includes three augmentation options additional to HumeLink (Fig 2):

- Option 2: a 2000 MW overhead DC line from Bannaby to Wagga, 260 km, costing $2,450m
- Option 3: a 6,000 MW 500kV double-circuit line from Bannaby to Wagga to Dinawan, 481 km, costing $3,014m
- Option 4: a 3,000 MW 500kV single-circuit line from Bannaby to Wagga to Dinawan, 481 km, costing $2,370m

It would seem that, as HumeLink will have no spare capacity when Snowy 2.0 is operating at or near its full load, one of these augmentation options will be needed in the intermediate future to transmit from the REZ's in the South West and Wagga to Bannaby. For ease of reference I have termed the augmentation as HumeLink 2.

It would also seem that the necessary timing for HumeLink and HumeLink 2 will be similar as the latest commissioning date for Snowy 2.0 of 2029 is likely to be delayed further and this will coincide with, if not be later than, the development of the REZ's in southwest NSW.

If so, shouldn't HumeLink 2 be considered at the same time as HumeLink.

For example the routing is likely to be similar for much of the distance from Bannaby to Wagga and an additional easement will be necessary. It would be most inappropriate if the HumeLink route was determined and then almost immediately afterwards the route for HumeLink 2 was then sought.

It is also noted that the route from Dinawan to Wagga parallels Project EnergyConnect. Even though the easement for EnergyConnect has been obtained and work is about to start, there may be some adjustments that are appropriate if a parallel line is to be required in the future. One obvious choke point will be accessing Wagga Wagga and (the new) Gugaa substations.

14. When will HumeLink 2 be required to meet the expected construction of renewable generation in the REZs?
15. Shouldn't HumeLink 2 be developed at the same time as HumeLink, as the timeframes for Snowy 2.0 and the REZ developments are now similar?
16. With the potential for double the transmission capacity of HumeLink being required doesn't that improve the case for a DC 'superhighway' from Bannaby to Wagga and beyond, preferably underground for most if not all the distance?
17. If HumeLink has a negative net benefit, won't that also be the case for HumeLink 2?

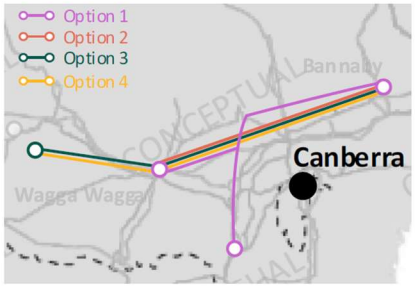
3.8 Southern New South Wales to Central New South Wales

Summary

The transmission network between Southern New South Wales (SNSW) and Central New South Wales (CNSW) provides access for the hydroelectric generation in the Snowy mountains, renewable generation in SNSW, and import from Victoria and South Australia to New South Wales major load centres.

HumeLink is a proposed transmission network augmentation that reinforces the New South Wales southern shared network to increase transfer capacity to New South Wales load centres. This was identified as an actionable ISP project in the 2022 ISP. Transgrid has completed the RIT-T process for this project and early works funding has been approved by the AER.

Subsequent to HumeLink, three options are proposed to increase the maximum network transfer capability between SNSW and CNSW to access increased import from Victoria and South Australia with increased generation in SNSW to NSW major load centres.



Existing network capability

The maximum transfer capability from SNSW to CNSW is 2,700 MW at peak demand and summer typical and 2,950 winter reference periods. The maximum transfer capability is limited by thermal capacity of Yass– Marulan or Crookwell-Bannaby 330 kV lines following a credible contingency.

The maximum transfer capability from CNSW to SNSW is 2,320 MW at peak demand and summer typical and, 2,590 MW at winter reference periods. The maximum transfer capability is limited by thermal capacity of Yass–Canberra or Marulan–Yass[62] or Gullen Range–Bannaby 330 kV lines following a credible contingency

Augmentation options

Description	Additional network capacity (MW)	Expected cost ($ million)	New easement length (km)	Lead time
Option 1 (HumeLink): • New Wagga Wagga 500/330 kV substation and 330 kV double-circuit connection to the existing Wagga Wagga 330 kV substation. • Three new 500 kV transmission lines: - Between Maragle and Bannaby 500 kV substations. - Between Maragle and new Wagga Wagga 500 kV substations. - Between new Wagga Wagga and Bannaby 500 kV substations. • Three 500/330 kV 1,500 MVA transformers at Maragle. • Two 500/330 kV 1,500 MVA transformers at new Wagga Wagga. • 500 kV Line shunt reactors at the ends of Maragle – Bannaby, Maragle – new Wagga Wagga and new Wagga Wagga – Bannaby 500 kV lines. *Provided by Transgrid – see Section 1.2.*	2,200[63] N6+N7: 2,200 (N6: 1,500), N5: 800	4,892[64] (June 2023 dollars) Class 5 (± 50%)	630	Short
Option 2: • A 2,000 MW bi-pole overhead transmission line from locality of Bannaby to locality of Wagga Wagga. • A new 2,000 MW bipole converter station in locality of Bannaby.	2,000 (both directions SNSW to CNSW) N6: 2,000	2,450 Class 5b (± 50%)	260	Long
• A new 2,000 MW bipole converter station in locality of Wagga Wagga. • AC network connection between new HVDC converter station in the locality of Bannaby and the existing Bannaby 500 kV substation. • AC network connection between HVDC converter station in the locality of Wagga Wagga and a future Wagga Wagga 500 kV substation. *Pre-requisite: HumeLink*				
Option 3: • An additional new 500 kV double-circuit line from Dinawan to Near Wagga Wagga. • An additional new 500 kV double-circuit line from Near Wagga Wagga to Bannaby. • 4 additional new 500/330/33 kV 1,500 MVA transformers at Dinawan. *Pre-requisite: HumeLink, VNI West, SNW Southern 500 kV loop.*	6,000 (both directions SNSW to CNSW) REZ N5+N6: 6,000	3,014 Class 5b (± 50%)	481	Long
Option 4: • An additional new 500 kV single-circuit line from Dinawan to Near Wagga Wagga. • An additional new 500 kV single-circuit line from Near Wagga Wagga to Bannaby. • 2 additional new 500/330/33 kV 1,500 MVA transformers at Dinawan. *Pre-requisite: HumeLink, VNI West, SNW Southern 500 kV loop.*	3,000 (both directions SNSW to CNSW) REZ N5+N6: 3,000	2,370 Class 5b (± 50%)	481	Long

Adjustment factors and risk

Option	Adjustment factors applied	Known and unknown risks applied
Option 1	• Cost estimate provided by Transgrid.	• Cost estimate provided by Transgrid.
Option 2	• Land Use: Developed area/Grazing • Jurisdiction: NSW – Southern • Project network element size: # of total Bays above 31/applicable for HVDC converter station project/Above 200 km • Location (regional/distance factors): Regional/Urban • Delivery timetable: Long	Known Risks: • Compulsory acquisition: High/BAU • Cultural heritage: High/BAU • Outage restrictions: High/BAU • Project complexity: Highly complex • Environmental offset risks: High • Others: BAU Unknown risks: class 5b
Option 3	As per Option 2 except: • Project network element size: # of total Bays 6 – 10/Above 200 km	As per Option 2 except: • Project complexity: BAU
Option 4	As per Option 2 except: • Project network element size: # of total Bays 1 – 5/Above 200 km	• As per Option 2 except: • Project complexity: BAU

[62] Uprating of Marulan – Yass and Marulan – Collector – Yass 330 kV transmission lines were included in limit assessment.

[63] Limit from Transgrid's Project Assessment Conclusions Report is 2,570 MW based on a lower Victoria to New South Wales transfer than that used in the ISP.

[64] Transgrid. At https://www.transgrid.com.au/media/rxancvmx/transgrid-humelink-pacr.pdf.

Figure 2 – Options for additional transmission between southern and central NSW (AEMO Report 3.8)