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

Issues raised in TransGrid's Submission[1] and First Hearing[2]

Ted Woodley - 23 July 2023

Issues/claims raised in TransGrid's submission and at the first Hearing of the Inquiry are extracted, followed by questions on those issues and a comment in some cases.

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[1] TransGrid submission to Inquiry
https://www.parliament.nsw.gov.au/lcdocs/submissions/80108/0102%20Transgrid.pdf

[2] Proceedings of Standing Committee on 18 July 2023
https://www.parliament.nsw.gov.au/lcdocs/transcripts/3105/Transcript%20-%2018%20July%202023%20-%20UNCORRECTED.pdf

1 New generators should pay their fair share of new transmission infrastructure

TransGrid Submission page 5
Transgrid is investing $16.5 billion in transmission infrastructure in NSW over the next decade. Our major projects will create an energy superhighway, connecting new renewable generation to a strong and flexible network

As well as TransGrid's projects there is an additional $5 billion or more for transmission to the Renewable Energy Zones (REZs) under the responsibility of EnergyCo, bringing the total proposed expenditure to around $25 billion over the next ten years.

TransGrid, EnergyCo, the AER and AEIC are assuming that the cost of this new transmission will be paid for entirely by electricity consumers, by adding the whole amount to the Regulatory Asset Base (RAB) of TransGrid or other operators – on which a regulated return is ultimately applied.

TransGrid's current RAB is approximately $7 billion, so the additional investments will approximately triple current transmission tariffs for electricity consumers.

The inequity of the current payment approach is epitomised by HumeLink, which is being built primarily to connect Snowy 2.0 to the grid, from a new substation at Maragle (near Talbingo Reservoir) to Bannaby (near Goulburn) and Wagga Wagga. Were it not for Snowy 2.0 it is arguable whether HumeLink is needed, but certainly its route (involving a 100 kilometre dog-leg deviation to Maragle), size and timing would be very different, and much cheaper.

HumeLink's capacity of 2,570 MW will be almost completely taken up when Snowy 2.0 is pumping or generating at its full load of 2,040 MW. Snowy 2.0 is stranded without HumeLink.

So, in this example, as Snowy 2.0 is the major reason for and beneficiary of HumeLink, Snowy Hydro should be paying its fair share rather than leaving it to electricity consumers to bear the cost. Snowy Hydro is paying for the 9 kilometre connection of Snowy 2.0 to Maragle. But Snowy Hydro should also be paying for the new Maragle substation, contributing to the 360 kilometres of 500kV double-circuit lines to Bannaby and Wagga Wagga and their substation augmentations, and contributing to Sydney Ring South and VNI West to enable its output to reach Sydney and Melbourne.

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Ms CATE FAEHRMANN: So the owner, the developer, Snowy 2.0—they don't pay for the connection [HumeLink] because of the regulatory environment, correct?
JIM COX: The regulatory environment doesn't require them to pay, no.
Ms CATE FAEHRMANN: It doesn't require them to pay; it requires consumers to pay, and only consumers?
JIM COX: Only consumers, yes, is the way that things are at the moment. I suppose the other thing that's around and important is the Government has got ideas about concessional financing of these transmission links. Were that to go ahead, that would reduce the amount that consumers have to pay. So that's another possibility that's being considered at the moment.
Ms CATE FAEHRMANN: I suppose it's a result of history that we have this regulatory environment that dictates that the consumer, and only the consumer, pays for this transmission infrastructure. Shouldn't we consider regulatory change to potentially split that between, say, the proponent, the developer, the Government and, yes, potentially the consumer?
JIM COX: Let's see. The idea that generators should contribute is one that's around, and I think there are respectable arguments in that direction. I certainly wouldn't want to rule that out.
It might be reasonable for such costs to be borne by all electricity consumers when it is not possible to distinguish any individual generator or load that is causing the need for additional transmission

capacity. However, in many cases the need for the additional transmission can be directly linked to specific new generators or new loads.

The only reason that 'this is the way things are at the moment' is because governments and energy industry regulators have taken the path of least resistance and allowed it to be so – there are no specific rules requiring consumers to pay for additional transmission. However, as Mr Cox indicates, there are sound reasons to require contributions from new generators and new loads.

To put it simply, if Snowy Hydro decides to build a big battery in the middle of Kosciuszko National Park, it should pay for the transmission augmentations required to enable it to receive its pumping power and deliver its generation to the major load centres. Snowy Hydro should not expect someone else (consumers via TransGrid) to provide that infrastructure for free[3].

More generally, no developer should be allowed to build a new generator (or load) and then expect someone else to design and build the transmission connection and someone else (consumers) to pick up the tab. The new generators should be paying their fair share of the cost of connection.

Not only would this be the just outcome, but it would also send an important pricing signal to developers to optimise the location of their plant (generators, batteries, pumped hydro, loads etc) by taking into consideration the cost of transmission.

This is a fundamental issue for consideration by the Inquiry and the NSW Government.

The oft-quoted response that electricity consumers pay in the end anyway so why worry, is incorrect. Any extra costs to developers of new generation for the associated transmission infrastructure cannot be recovered by charging higher prices in a competitive National Electricity Market. Also, there is inherent value in attributing all related costs to individual projects to ensure the most efficient outcome.

Questions:

1. Where new generators or loads require additional transmission, shouldn't they be required to contribute their fair share of the costs rather than leave it to electricity consumers to bear the full amount?
2. Doesn't the current pooling of transmission costs diminish cost-reflectivity and shield developers from the relative costs associated with the locational choice for their projects?
3. Should Snowy 2.0 contribute its fair share of the cost of HumeLink and other transmission augmentations required to enable its output to reach Sydney and Melbourne?

2 HumeLink cost increase to $5 billion results in negative net benefit

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The Hon. WES FANG Are we still expecting around $3.3 billion [for HumeLink] or are we expecting somewhere closer to five or six?
BRETT REDMAN: So that number is now a bit out of date … It's about three or four years old … I expect broadly the cost of infrastructure and transmission has gone up about 30 per cent.
The Hon. WES FANG: So $3.3 billion, 30 per cent, about $5 billion …?

[3] And at least the section of line through the Park should be underground, as was mandated in the Park's statutory Plan of Management until the government approved an amendment to exempt Snowy 2.0. If undergrounding cannot be justified in Kosciuszko National Park, then it is hard to see undergrounding being justifiable anywhere.

BRETT REDMAN: Yes

Note that a cost of about $5 billion represents an almost five-fold increase on the 2018 estimate of $1.1 billion.

The HumeLink Project Assessment Conclusions Report (PACR), dated 29 July 2021, was prepared on the basis of a $3.3 billion cost, and concluded that HumeLink would result in a net benefit of $39 million:

> *"On a weighted-basis, Option 3C is the top-ranked option and is expected to deliver approximately $39 million in net benefits (excluding competition benefits)"*

A net benefit of $39 million is miniscule, just 1% of the cost. (It is noted that AEMO's 2022 ISP estimated a net benefit of $1.3 billion, under different assumptions.)

The PACR also included a sensitivity analysis that decreased the net benefit by $180 million if Kurri Kurri and Tallawarra gas power stations were built - both stations are under construction. Also, at the time independent experts criticised many questionable assumptions in the PACR (e.g. opex of only 0.5%, Snowy 2.0 operational from July 2025) and optimistic estimates (e.g. 'A review of the HumeLink PACR', Victoria Energy Policy Centre, Sep 2021').

It would now seem that the benefits of HumeLink, which have already declined due to substantial delays in Snowy 2.0, could be considerably less than its increased cost. Either way, such a significant increase in the estimated cost should surely constitute a 'material change in circumstance' in the Regulatory Investment Test (RIT-T) process, requiring a review of the merits of the project.

4. What is the latest estimate for HumeLink's cost, benefit, and net benefit?
5. Does the latest cost increase constitute a 'material change in circumstance' and hence require the RIT-T to be reviewed?
6. If the net benefit of HumeLink is now negative, should it be built?
    - also, this is another reason to review the viability of proceeding with Snowy 2.0
7. If HumeLink is still built at a net cost, is it reasonable for electricity consumers to pay – shouldn't the new generators, mainly Snowy 2.0, pick up the deficit as well as their fair share?

3 $633 million of overhead line equipment committed for HumeLink

In August 2022 the AER approved expenditure of $383 million for HumeLink Stage 1 (early works). Subsequently in May 2023 TransGrid sought a further $250 million, which if approved would increase the total for early works to $633 million[4].

This expenditure is largely to place orders for long lead time equipment to meet a completion target date of July 2026. Such expenditure is well ahead of the exhibition of the Environmental Impact Statement and formal project approval.

Clearly, continuing to commit substantial expenditure on overhead line equipment may unduly influence the deliberations of the Inquiry and prejudice the merits of undergrounding HumeLink.

As noted below, with the delay of Snowy 2.0 to 2029 (and counting), there is no urgency in building HumeLink, certainly not by 2026.

[4] https://www.aer.gov.au/system/files/A.1%20-%20Transgrid-HumeLink%20Stage%201%20Part%202_Principal%20Application-23052023-Public.pdf

8. Should all expenditure on HumeLink be paused till the Inquiry has concluded and the government made a decision on future undergrounding of transmission?
9. Has TransGrid already signed up a contractor to build HumeLink, as is rumoured to be the case?
10. What commitments beyond the $633 million for early works have been made?

4 Claim that it is uneconomic to tie into HumeLink if it is a DC circuit

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HVDC lines do have limitations. Transmission projects, including HumeLink, which form part of the National Electricity Market's energy 'superhighway' require, High Voltage Alternating Current (HVAC) transmission lines that will act as collector lines. These lines are designed to collect large volumes of renewable energy across their routes rather than a point-to-point delivery.

This implies that it would be inappropriate for HumeLink to be HVDC because it would be uneconomic to connect renewable energy sources along the route. This claim was repeated at the Hearing on 18 July by TransGrid executives and the AEIC. TransGrid stated that a 500kV AC substation costs about $100 - $150 million, compared to some $400 - $500 million for a DC converter station, and hence AC is much more suitable for adding connection points.

But TransGrid hasn't proposed any tie-in connections of renewable sources along the route of HumeLink – i.e. from Maragle to Wagga Wagga or from Maragle to Bannaby. It is expected that renewable energy sources along the route will connect to the existing 132kV and 330 kV networks, which will link with HumeLink at Wagga Wagga and Bannaby.

As noted earlier, HumeLink will be almost maxed out when Snowy 2.0 is pumping or generating at full input/output, so it has minimal capacity of around 500 MW for tying-in additional generators anyway.

When incorporating HVDC transmission into an existing AC network the HVDC system may be better conceived and designed as a bypass of the existing network for shunting or transfer of bulk power more directly from generation source to the main load centres (aka superhighway) thereby alleviating constraints on the existing network that can then be better utilised for connection of localised generation, thereby making more efficient use of the existing AC network.

11. Are there any proposals for additional connections along the route of HumeLink?
12. If so:
    - why weren't they included in the PACR, and its benefit-cost analysis?
    - how much spare capacity does HumeLink have when Snowy 2.0 is operating?

5 No evidence of consideration of upgrading existing lines or conversion to DC

Before proposing to build new lines, the first thing to consider is what further can be done with the existing network, such as:

- restringing existing circuits to increase capacity
- replacing existing single-circuit lines with double-circuits (will involve new, taller towers, but on the same or adjacent easement)
- replacing existing 330kV AC lines with DC
- 'adding' a DC circuit to an existing AC line (possibly involving new towers)

The recent German Ultranet Project is an example, replacing one of two circuits of an existing 380kV double-circuit AC line with a 2,000 MW DC circuit over 340 kilometres.

Such an arrangement could be possible for a Sydney to Melbourne DC connection, 'replacing' Sydney Ring South, HumeLink and VNI West.

13. What consideration was given to upgrading existing AC lines or replacing with/adding DC circuits for proposed new transmission in NSW?

6 Potential use of existing overhead line easements for underground cables

One obvious opportunity for routing underground cables is to locate them within or near existing overhead line easements, providing numerous significant benefits:

- far less need for additional underground cable easement
- far less objections from landowners, no objections from neighbours or local communities
- minimal additional environmental impact after construction
- minimal if any biodiversity offset and easement purchase costs. For HumeLink such costs are estimated to be well over $1 billion:
  - $930 million for biodiversity offsets
  - $90 million for easement purchase (likely to be understated)
  - $180 million for the additional payment of $200,000 per kilometre (though this payment may still be appropriate compensation for landowners)
- 'combined' maintenance savings, few additional access tracks

Of course, it would not be practical to install underground cables along some sections of line, but it would be for significant distances.

14. What consideration has been given to locating underground cables within, or near, existing overhead line easements?

7 Claim that HumeLink will be delayed beyond 2026 if undergrounded

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Notwithstanding the technical requirements of HumeLink as a collector line and the limitations of undergrounding for this purpose, as outlined above, the findings of the Study also found that undergrounding increased the cost and significantly delayed completion, up to five years.
This delay would threaten the timely connection of the new renewable energy and the related essential new interstate connections to the grid. It is essential that the infrastructure is completed by 2026 to secure the network before the ageing power stations are decommissioned.

15. As per Q1, what are the requirements for HumeLink to be 'a collector line'?
16. What is the basis for claiming that HumeLink would be delayed up to five years if undergrounded?
17. What delays are expected for HumeLink due to public opposition against overhead lines?
18. What renewable energy will not be able to be connected if HumeLink is not completed by 2026?
19. What new interstate connections will not be able to be connected if HumeLink is not completed by 2026, noting that VNI West will not be completed till well after that date?
20. Is it realistic to expect that HumeLink could be built by 2026 anyway?
21. Could an underground HumeLink be completed by the time Snowy 2.0 is completed (2029+)?

8 Claim that Snowy 2.0 delay increases importance of HumeLink completion by 2026

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The potential delay of Snowy 2.0 places even more importance on the timely completion of HumeLink. HumeLink will reduce the risk of supply scarcity for NSW consumers by reinforcing the southern network. The project will improve access to stored energy from across the entire Snowy scheme, renewable energy from southern NSW and energy from South Australia (via EnergyConnect) and Victoria (via VNI and VNI West), even in the absence of Snowy 2.0. It will also provide greater network resilience if other generation, storage and transmission projects are delayed.

A fundamental routing flaw of HumeLink is that it does not connect into the existing 330kV network of the Snowy Scheme (except a minor tie-in to the Upper Tumut to Lower Tumut transmission line at Maragle). As HumeLink will not connect to any of Snowy's three existing switching stations it will not 'improve access to stored energy from across the entire Snowy scheme'.

Independent experts have been suggesting for years that Snowy 2.0 and HumeLink should have been connected at the existing Lower Tumut Switching Station, rather than at the proposed Maragle Substation. As Maragle is largely isolated from the rest of the Snowy network, HumeLink will not improve the transmission capacity to/from the Snowy Scheme. All HumeLink will do is connect Snowy 2.0 to Bannaby and Wagga Wagga – it will provide no benefit for the existing 4,000 MW of Snowy generators.

Surely, as HumeLink is being built primarily to connect Snowy 2.0, the delays in Snowy 2.0 will decrease rather than increase the importance of HumeLink's timely completion (by 2026).

22. Why is the delay in Snowy 2.0 considered to be 'potential'? Snowy Hydro's latest update is 2029 (initially 2021), noting that this may be extended further.
23. How does HumeLink improve 'access to stored energy from across the entire Snowy scheme' as HumeLink does not connect into the existing Snowy Scheme 330kV network (except the UTSS to LTSS line)?
24. What new interstate connections will not be able to be connected if HumeLink is not completed by 2026, noting that VNI-West will not be completed till well after that date and Project EnergyConnect will be connected to the existing 330kV network at multiple locations?
25. Is it realistic to expect that HumeLink could be built by 2026 anyway?

9 Claim of delays for South West REZ if HumeLink is undergrounded

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The timely delivery of HumeLink is also linked to the success of the NSW Government's South West REZ as it increases transfer capacity between Southern NSW and Sydney. The South West REZ is indicatively planned to enable up to an additional 3200MW of renewable generation to connect in the south west of NSW. These renewable projects curtailment risks between Wagga Wagga and Sydney, and thus revenue risks, are reduced with the delivery of HumeLink unlocking network capacity towards Sydney. If HumeLink is delayed, this would likely delay many of the new renewable projects expected to connect in the South West REZ, increasing costs and reliability risks for NSW consumers. It should be noted HumeLink is the only actionable ISP project that could be delivered in the critical period that directly addresses the risk of limited dispatchable capacity – if it is not delivered on time in 2026, it will jeopardise network reliability.

26. How is HumeLink expected to transmit 3,200 MW of South West REZ generation when its

capacity is almost fully taken up when Snowy 2.0 is operating?

27. What is the amount of renewable generation planned to be added in the South West REZ prior to 2030?
28. What additional power is estimated to be transmitted to Sydney by HumeLink over the next decade, in addition to Snowy 2.0?

10 German example of priority for underground cables

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The SuedLink and SuedOstLink projects were ultimately determined to be undergrounded due to public opposition to overhead lines. The opposition to the projects culminated in a law being adopted in 2015 that required all DC transmission lines to be planned and delivered as underground cables.

Public opposition to overhead lines was but one consideration, as explained in the German Ministry explanation for the Act giving priority to underground cables as a principle in federal planning:

> *"Where major electricity highways are concerned (= new ultra-high voltage direct current transmission lines), the Act will give priority to underground cables as a principle in federal planning. Overhead cables will only be used exceptionally in certain cases, e.g. in order to protect the natural environment. To put it simply, this means that there will be an absolute ban [on] overheard cables being used wherever people live. So overhead cables can only be used in very strict exceptions."*

29. Is there any reason why priority should not be given for undergrounding transmission lines in NSW, as is the case in many overseas countries?

11 Claimed technical problems for underground cables

Multiple problems/disadvantages have been claimed in the TransGrid submission for underground cables, including:

- heat problems
- more challenging maintenance
- moisture seepage
- ground sterilisation
- more access roads
- impacts on cultural heritage

11.1 Heat problems

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Other technical limitations of underground transmission lines are the heat generated. Specialised materials are required to ensure the insulation can withstand the very high voltages. If heat is not effectively removed from the cables, the insulating materials can suffer from accelerated degradation leading to cable failures or a shortening of the cable operational life.
This intense heat generated by underground lines also means they do not have the same capacity as overhead lines therefore will limit the ability to transport renewable generation sources along the route.

30. Are not underground cables designed to cope with the heat generated?
31. Are not fibre optic monitoring cables installed to prevent overheating?
32. Can examples be provided where this has not been the case and hence why it has been highlighted in the submission?

33. Can't underground cables be designed to equal the capacity of overhead lines?

11.2 More challenging maintenance

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Another technical consideration is monitoring and maintenance of the line. Maintenance of the condition of underground transmission lines can be more challenging than with overhead lines. Regular inspection and maintenance require specialised equipment and techniques. Detecting and locating faults in buried cables can be time-consuming, increasing the time required to restore the power supply.

34. In what ways is maintaining underground lines more challenging than overhead lines?
35. What 'regular inspection and maintenance' is required for underground cables other than occasional 'driving or droning of the route' to ensure no building activities?
36. Aren't monitoring systems installed with underground cables, providing real-time information on cable conditions and warnings of potential problems?
37. Doesn't modern fault detection technology usually locate underground faults within hours?
38. What is the typical fault history of underground cables – it is understood to be far superior to overhead lines?

11.3 Moisture seepage

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Underground cables are more susceptible to deterioration over time, primarily due to moisture seepage. This deterioration poses a significant risk to the reliability of the network and leads to increased ongoing maintenance expenses. In contrast, overhead lines are more exposed to weather and external events, but these events are typically temporary and transient in nature.

39. Aren't underground cables designed to withstand moisture seepage (e.g. subsea cables)?
40. What is the prevalence of this 'moisture seepage problem'? Can examples be provided where this has not been the case and hence why it has been highlighted in the submission?
41. How is it that underground cables require 'increased ongoing maintenance expenses' when they are not subject to weather impacts (lightning, wind, ice, heat etc) and are considerably more reliable than overhead lines?

11.4 Ground sterilisation

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Additionally, because heat from the underground cables is dissipated through the soil), as well as the ongoing requirement to provide access for excavation in the event of a fault, the land above underground lines must be kept clear of certain types of vegetation, for example, taller shrubs and trees with deep root systems. As such, easements above underground cables may be sterilised for other productive purposes. Also, due to the much larger quantities of soil disturbance and vehicle movement with underground cables there are also greater biosecurity risks.
Farming activities can also be impacted as undergrounding is more invasive during construction. Also, some ongoing operational limitations will be placed on land use, which can include restrictions on farming activities and types of crops planted over the cables.

Hearing page 34

BRETT REDMAN: The impact of that is you can put a light dusting of soil on the top, but you can't really grow most things on the top of it. Some specialised grasses will grow. From a farming point of view, you can't crop it, both because things won't grow as well but also because you can't keep driving heavy machinery like ploughs over it.

Hearing page 35

MARIE JORDAN: When you think about a trench for undergrounding cable, we'd have to be, for

this distance, doing an HVDC, which would be at least 50 metres wide … minimum two metres deep, typically more.

42. What is the difference between overhead and underground easements with respect to being ‘kept clear of certain types of vegetation’ and sterilisation for other productive purposes?
43. Aren’t there substantial restrictions on farming activities for overhead lines (tall machinery, cropping planes, drones, interference of GPS machinery etc)?
44. Don’t the much wider easements for overhead lines result in greater biosecurity risks?
45. Where are there examples of a 50 metre wide trench being required?
    - what is the width of trenches for underground cables in Australia and overseas?
    - the GHD report, commissioned by TransGrid, shows trenches 2.1 metres wide, spaced 3 metres apart (7.2 metres combined width) for the largest HVDC option.
46. Where are there examples of trenches a ‘minimum two metres deep, typically more’?
47. Can’t underground cables be routed to avoid land that is unsuitable or of particular construction difficulty or having high economic/environmental value?
48. Can’t underground cables be routed to be beside existing roads, tracks, fences, fire breaks etc to minimise the impact and the need for additional access tracks or ‘sterilisation’?
49. In some circumstances can’t farmers reorient paddocks to ‘fit’ with the underground trench location (e.g. beside new fence lines and under new fire breaks)?
50. Can’t most forms of farming be continued on an underground easement (cropping, pastures etc)?

11.5 More access roads

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An additional environmental impact related to the trenching of the easement is that an access road for the entire route is required, whereas with overhead transmission access roads are only required for individual tower locations.

51. Don’t access roads (tracks) for overhead lines usually extend along the entire line?
52. Is an access track always required along underground cables? As noted above, with collaborative routing there may be no need for additional access tracks.

11.6 Impacts on cultural heritage

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Australia’s cultural heritage also needs to be considered when considering route and construction methodology. There is a higher potential for disturbance of aboriginal heritage with underground cables as the whole route is required to be excavated. Discovering heritage items during construction would have a greater impact than during the earlier detailed design phases where alignment changes can be captured.
With overhead lines the proposed tower locations themselves can be surveyed, with the option of moving locations along the alignment for the final design should heritage items be discovered.

53. Isn’t the identification of aboriginal heritage essential for both overhead lines and underground cables?
54. Can’t underground cables be routed to avoid such sites, even when discovered during construction?