EnergyCo

NSW GOVERNMENT

The Hon Cate Faehrmann MLC
Committee Chair
Select Committee on State Development
Legislative Council
NSW Parliament House,
Macquarie Street
SYDNEY NSW 2000

9 January 2024

Dear Ms Faehrmann

Thank you for the opportunity to respond to questions on notice from the hearing on Feasibility of Undergrounding the Transmission Infrastructure for Renewable Energy Projects on 27 November 2023 and provide further information.

Interruptions to major transmission lines during the 2019/20 bushfire season
EnergyCo offered to provide further details of interruptions to major transmission lines during the 2019/20 bushfire season, and implications for the construction of renewable energy zone (REZ) network infrastructure.

EnergyCo has reviewed Transgrid's *Overview of 2019-20 Bushfire Damage to TransGrid's Network* and obtained further information from Transgrid, as follows.

<u>Impacts on main transmission lines vs sub-transmission</u>
EnergyCo has clarified the impacts on main transmission lines (500 kV and 330 kV) vs impacts on sub-transmission lines (132 kV) in the 2019/20 bushfires.

The most significant damage referred to in Transgrid's report is to wood pole structures, which are used on 132 kV sub-transmission lines but not typically on 500 kV or 330 kV main transmission lines. Naturally, wood pole structures are more at risk of bushfire damage due to their construction. Figure 41 of the report indicates the extent of wood pole structure throughout the state, with 12 structures destroyed and a further 44 damaged. EnergyCo is not considering the installation of wood pole structures as a part of REZ infrastructure, thereby eliminating the risk of this damage.

Some other components of transmission lines such as insulators, vibration dampers and conductors, were damaged in the 2019/20 bushfires on both main transmission lines and sub-transmission lines. With the exception of one 330 kV transmission line (Line 2), all 500 kV and 330 kV main transmission lines remained serviceable and these components could be replaced at a later date.

The total cost to repair the damage to the Transgrid network from the 2019-20 bushfires was estimated at $49.8 million. While significant, this is small compared to the projected cost of undergrounding all new transmission infrastructure.

We note that the only interruption to electricity supply resulting from unavailability of a 330 kV main transmission line in the 2019/20 bushfires was an interruption in the Lismore area for 22 minutes. There was no interruption to electricity supply resulting from unavailability of a 500 kV main transmission line.

500 kV transmission lines
At the hearing, you referred to 12 trips of 500 kV transmission lines during 2019/20 fires and raised the question whether this is a positive for underground transmission.

EnergyCo obtained further information from Transgrid on the 12 trips of 500 kV transmission lines. Of the 12 trips:

- On 9 occasions, the lines were returned to service by the transmission lines ‘self-healing’, that is, being automatically switched back on within approximately 20 seconds
- On 3 occasions, the lines were returned to service manually in 1 minute, 13 minutes and 24 minutes respectively

These events had negligible impact on the power system. During all 12 trips, there was no interruption to electricity supply as electricity flowed through other available transmission lines. There was no material damage to 500 kV transmission lines, all of which remained serviceable, or interruption to electricity supply resulting from the trips of 500 kV transmission lines.

On balance, we do not consider the impact of bushfires on overhead 500 kV or 330 kV transmission lines to be sufficiently material to underground REZ transmission lines. We consider the measures EnergyCo takes to manage bushfire impacts when designing overhead transmission lines, outlined at the hearing, to be sufficient.

Impact on consumer bills of undergrounding transmission infrastructure
EnergyCo estimates the additional cost to typical household electricity bills from undergrounding its projects at between $131 and $588 per year. This estimate is based on undergrounding all transmission line projects identified to ‘Deliver Now’ in the 2023 Network Infrastructure Strategy. The range reflects cost estimates for underground transmission cable costs of between 3 times and 10 times the cost of overhead transmission lines.

These estimates do not include the likely impact of higher wholesale electricity market prices for longer periods due to the additional construction time of underground transmission cables compared with overhead transmission lines, which would delay the integration of low cost renewable electricity generation and potentially require life extension of coal-fired power stations to maintain sufficient electricity supply.

Use of HVAC and HVDC
High voltage electricity can be transmitted using either alternating current (AC) or direct current (DC). Historically, almost all transmission infrastructure in NSW has been constructed as high voltage alternating current (HVAC) overhead lines, typically at voltages of 500 kV, 330 kV, 220 kV or 132 kV, depending on capacity requirements and distance.

AC technology has been used historically because it allows for voltages to be changed using transformers at reasonably low cost. This allows for high voltages to be used, where electricity can be transmitted over long distances with relatively little energy loss. AC power is naturally generated by rotating generators, and is used by traditional large motors. Until the last few decades, it was not practicable to transform the voltage of DC, as this requires the use of large semiconductor switching devices which are a more recent and higher cost technology.

For these reasons, the vast majority of existing transmission in Australia is HVAC, which means that new HVAC lines can be easily integrated into the existing network at lower cost, time and complexity. HVAC technology also allows for ‘meshing’ of a network, where multiple lines are connected or ‘meshed’ together to robustly connect generation and demand. This ‘meshing’ is key to the reliability and resilience of the power system. HVDC does not readily allow significant meshing.

With respect to underground cables, HVAC cables face challenges which are less prevalent in overhead lines, principally due to their higher capacitance. This capacitance necessitates reactive power compensation at regular intervals along underground HVAC cables. The exact interval varies with factors such as fault level and cable capacity, but is typically around 40-50 km for 500 kV lines and 80-100 km for 330 kV lines. This reactive power compensation is provided via above-ground equipment. In this regard, HVDC has advantages in that it does not require reactive power compensation and has slightly lower losses.

HVDC technology requires complex power electronics at both ends of every line to convert the power between AC and DC. In addition to being complex and expensive, these converter stations do not readily allow 'cut-ins' to connect future generators, do not allow practicably for meshed network configurations such as in Renewable Energy Zones (REZs) and are uneconomic in networks with large numbers of short connections. This is due to the large number of DC/AC converter stations which would be required, the insufficiency of existing DC circuit breaker technology to support high levels of meshing, and cost. HVDC is also limited in its ability to share ancillary services that are required for the stable operation of the power system, such as system strength and inertia, likely leading to a requirement for additional dedicated assets to provide these services.

Further information on vegetation and underground cables
Underground transmission cables are typically installed in trenches. The exact trench cross-section, and the volume of thermal backfill required, will depend on a range of factors including the number of cables installed, depth of burial, power rating of the circuit, operating temperature of the circuit, proximity of other circuits, and the thermal resistivity of the fill material or natural soil.

While design varies due to the above factors, agricultural activities such as ploughing and growth of deep-rooted plants are generally not permitted within easements.[1,2] This avoids damage to cables and the thermal fill. It is possible that some grasses may grow above the cables, depending on the trench cross-section and backfill.

Further information on EnergyCo's sources
At the hearing, panel members noted similar information between EnergyCo's submission and other submissions. While EnergyCo prepared its own submission, we note that common source documents were used in both EnergyCo's and other submissions:

- GHD, *Concept Design and Cost Estimate: HumeLink Project – Underground*, August 2022
- Moorabool Shire Council, *Comparison of 500 kV Overhead Lines with 500 kV Underground Cables*, September 2020
- NSW Parliamentary Inquiry, *Feasibility of undergrounding the transmission infrastructure for renewable energy projects*, 2023 (submissions, transcripts & summary report)
- AEMO *Integrated System Plan* and *Transmission Expansion Options Report*

Please feel free to contact me if the committee would like to discuss any of these matters further, at

Yours faithfully

Andrew Kingsmill
Executive Director, Technical Advisory Services

[1] Aurecon White Paper, "High Voltage Overhead vs Underground Transmission Infrastructure (330kV and 500kV)", 2023, p5.
[2] UK National Grid, "Undergrounding high voltage electricity transmission lines: The technical issues", 2015, p9.