Submission No 33

INQUIRY INTO FEASIBILITY OF UNDERGROUNDING THE TRANSMISSION INFRASTRUCTURE FOR RENEWABLE ENERGY PROJECTS

Organisation: Clean Energy Investor Group (CEIG)

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50 Camberwell Road Hawthorn East VIC 3123

10 November 2023

Select Committee on the Feasibility of Undergrounding the Transmission Infrastructure for Renewable Energy Projects
NSW Legislative Council
Lodged on the Parliament of NSW website

Dear Committee Members,

Response to Parliament Inquiry into the Feasibility of Undergrounding the Transmission Infrastructure for Renewable Energy Projects

The Clean Energy Investor Group (CEIG) welcomes the opportunity to provide feedback on the *Feasibility of Undergrounding the Transmission Infrastructure for Renewable Energy Projects* (the Inquiry) established on 13 September 2023.

CEIG represents domestic and global renewable energy developers and investors, with more than 16GW of installed renewable energy capacity across more than 76 power stations and a combined portfolio value of around $38 billion. CEIG members' project pipeline is estimated to be more than 46GW across Australia. CEIG strongly advocates for an efficient transition to clean energy with a focus on the stakeholders who can provide the cost-effective capital required for this transition.

Key Points

- Undergrounding transmission lines has a greater impact on hosts' land and landowners than overhead transmission lines.
- The limited global adoption of undergrounding high-capacity transmission lines can be attributed to cost, construction, and operational challenges.
- There is a need for regulatory reform that splits costs and benefits equally amongst users.
- To enhance the process of gaining social licence and delivering essential transmission infrastructure, there should be a prioritisation of climate, environmental, and societal policies.
- Future consideration should be given to undergrounding transmission lines, but it is not currently a feasible option.

GENERAL COMMENTS

CEIG notes that the potential benefits of undergrounding transmission lines might be applicable in certain cases, particularly for short distances within visually sensitive areas, however, it is typically more expensive to build and maintain than overhead transmission lines, slow to construct, and very dependent on suitable geology, topography and soil moisture.

Meeting the requests of some landholders to underground transmission lines is expected to triple the cost and introduce considerable delays to the government's efforts aimed at addressing the impending gap in the State's power supply brought about by the retirement of end of life coal-fired power stations[1].

CEIG does not endorse the view that underground transmission lines are a universally effective solution, and the continued pursuit of this option carries the risk of consuming valuable time and resources that we cannot afford to waste.

You can find more information in our previous submission with Nexa Advisory[2] on the *Parliamentary Inquiry into the feasibility of undergrounding transmission infrastructure.*

Undergrounding transmission lines has a greater impact on hosts' land and landowners than overhead transmission lines

While undergrounding transmission lines can reduce their visual impact, it introduces the potential for increased environmental impacts due to the larger construction footprint required[3]. This expansion in footprint can lead to various consequences.

Landowner impacts differ significantly between overhead and underground lines. Overhead lines primarily affect visual aesthetics, aerial activities, and noise, while allowing low vegetation to remain between the towers[4]. In contrast, underground lines come with significant land disturbance issues during initial trenching works, and maintenance access is more invasive, often requiring digging up soil and crops to address faults[5].

Opting for underground transmission adds further excavation and land disruption during construction, along with the need for additional converter stations along the route[6]. These elements contribute to increased land requirements, easements, and costs in addition to those associated with the cables and converter stations.

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[1] Standing Committee on State Development (Aug-23) Feasibility of undergrounding the transmission infrastructure for renewable energy projects
[2] CEIG & Nexa Advisory (July-23) Inquiry into feasibility of undergrounding transmission infrastructure
[3] Squadron Energy (July-23) Inquiry into feasibility of undergrounding transmission infrastructure
[4] Standing Committee on State Development (Aug-23) Feasibility of undergrounding the transmission infrastructure for renewable energy projects
[5] Transgrid (Sept-22) Undergrounding Humelink would triple the cost, Transgrid report finds
[6] RE-Alliance (July-23) NSW Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects

Many farming and other activities can be safely undertaken under overhead lines, with some restrictions to maintain a safe height distance from electrical conductors[7]. Underground lines must have the entire corridor kept clear of vegetation other than grass, and farming activities are not permitted in the corridor. For instance, extensive research was undertaken for the Western Victoria Transmission Project (now named Victoria Renewables Link) to address uncertainty around the issue of farming under transmission lines, which found that farming would be able to continue under the transmission line should an overhead option be chosen, including irrigated horticulture[8]. In addition, AEMO found that having extra high voltage transmission lines is often less disruptive for farmers compared to lower voltage towers, as they are generally taller and allow for the operation of larger machinery and irrigation systems[9].

Moreover, underground transmission lines have limited capacity compared to overhead transmission lines[10]. This necessitates the construction of multiple underground lines to match the capacity of a single overhead line. The disturbance to the host land is typically far greater for underground lines, involving excavations for each conductor along the entire transmission line[11]. The continuous trench required for underground line construction results in greater soil disturbance compared to overhead lines, limiting the ability to avoid direct impacts on environmentally and culturally sensitive areas. In contrast, ground disturbance for overhead lines primarily involves the excavation of footings at the tower sites which can be strategically located to avoid sensitive areas.

The limited global adoption of undergrounding high-capacity transmission lines can be attributed to cost, construction delay, and operational challenges.

Undergrounding transmission lines is typically used in unique situations where securing a corridor for overhead lines is not feasible, such as in densely developed urban areas or underwater environments. The installation of 500kV cables over a 75 km distance underground has yet to be done[12]. As of 2020, there were a limited number of 500 kV underground cables installations globally and none in Australia. The primary deterrents to wider adoption of this approach are the associated cost, construction complexities and delays, and operational challenges.

[7] Legislative Council Hansard (Sept-23) Standing Commitee of State Development Reports
[8] AusNet (Jun-21) Farming certainty under proposed Western Transmission Line
[9] AEMO, Faming and electricity transmission
[10] Transgrid (July-23) Inquiry into the feasibility of undergrounding transmission for renewable energy projects
[11] Australian Energy Infrastructure Commissioner (July-23) Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects
[12] Moorabool Shire Council (Sept-2020) Comparison of 500 kV Overhead Lines with 500 kV Underground Cables

Table 1: *Examples of underground lines around the world*[13].

Location	Voltage	Length	Year Complete
Japan, Tokyo (Shinkeiyo to Toyosu)	500 kV	40 km	2000
China, Shanghai City (Shibo to Sanlin)	500 kV	17 km	2010
USA, Southern California Tehachapi Renewable Transmission Project	500 kV	6 km	2016
Denmark, Copenhagen Metropolitan Power Project	400 kV	36 km	1998/1999
United Kingdom (Elstree to St. Johns Wood)	400 kV	20 km	2004
Australia, New South Wales (Sydney South to Haymarket)	330 kV	28 km	2003
Australia, Victoria (Cranbourne to Victorian Desalination Plant)	220 kV	88 km	2012

In Australia, there are currently no existing 500 kV underground cable installations, which limits local technical expertise at this voltage level[14]. As a result, expertise in 500 kV underground line systems is currently non-existent, with most specialists tied to cable suppliers, further constraining availability. This is a crucial consideration as major expansions in Australia's Renewable Energy Zone (REZ) transmission links are proposed to operate at mostly 500 kV or 330 kV, with some at 275 kV[15].
When it comes to electricity transmission, particularly over long distances and at high capacity, overhead transmission lines prove to be a more significantly more cost-effective, faster to install, easier to maintain, and a longer-lasting option compared to underground lines. A summary of life expectancy, cost, repair time, and construction timeline between underground and overhead transmission lines is presented in Table 1 (overleaf).

Installing underground transmission lines over extensive distances is considerably more challenging and time-consuming, often taking years longer to complete[16]. Additionally, underground lines incur significantly higher costs, which is a major deterrent to their widespread use in Australia and globally. Various assessments have estimated that underground lines can cost between three to ten times more than overhead lines, depending on the project.

Maintenance and repair of overhead lines are comparatively straightforward. They are susceptible to weather-related outages, such as those caused by lightning strikes, but faults are usually quickly located and repaired within hours or a day or two[17]. Even in the

[13] Moorabool Shire Council (Sept-2020) Comparison of 500 kV Overhead Lines with 500 kV Underground Cables
[14] RE-Alliance (July-23) NSW Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects
[15] AEMO (Sept-23) 2023 Transmission Expansion Options Report
[16] Standing Committee on State Development (Aug-23) Feasibility of undergrounding the transmission infrastructure for renewable energy projects
[17] RE-Alliance (July-23) NSW Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects

worst-case scenario where a tower fails, a substantial portion of supply can be restored, within 3-5 days.

In contrast, underground cables require a larger number of cable joints, increasing the risk of failure. Locating and repairing a cable fault requiring underground lines repairs can be challenging and time-consuming, often taking several weeks or even months to repair[18]. The duration of outages varies widely depending on various factors, including operating voltage, the fault's nature, parts availability, and the repair personnel's expertise. Typical repair time ranges from five to nine days[19].

Table 2: *Summary of considerations between overhead and underground transmission lines.*

	Overhead Transmission	**Underground Transmission**
Life Expectancy[20]	80-100 years	~40 years
Cost (based on HumeLink, 360 km)[21]	$4.89 billion	$11.5 billion HVDC line $17.1 billion HVAC line
Repair Time[22]	1-2 days	3-6 months
Estimated Completion Date (based on Humelink)[23,24]	2026	2031

There is a need for regulatory reform that splits costs and benefits equally amongst users

CEIG contends that the current regulatory framework is inadequate for its intended purpose.

The existing regulatory landscape is causing delays in transmission infrastructure investments. If not urgently addressed, these delays will not only hinder investments in Variable Renewable Energy (VRE) generation, affecting Australia's ability to achieve net zero emissions, but they will also likely result in higher electricity prices for consumers and

[18] RE-Alliance (July-23) NSW Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects
[19] T&D World (Feb-2022) Overhead or Underground Transmission? That is (Still) the Question
[20] RE-Alliance (July-23) NSW Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects
[21] Standing Committee on State Development (Aug-23) Feasibility of undergrounding the transmission infrastructure for renewable energy projects
[22] RE-Alliance (July-23) NSW Inquiry into the feasibility of undergrounding the transmission infrastructure for renewable energy projects
[23] GHD (Aug-22) Concept Design and Cost Estimate: HumeLink Project – Underground
[24] Standing Committee on State Development (Sept-23) Feasibility of undergrounding the transmission infrastructure for renewable energy projects

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less reliable supply outcomes. These issues can be alleviated through a more robust regulatory assessment and approval framework.

To enhance the process of gaining social licence and delivering essential transmission infrastructure, there should be a prioritisation of climate, environmental, and societal policies

The necessity for new transmission infrastructure is clear as renewable energy resources are often situated in new areas distant from existing transmission lines. CEIG supports the work done by various jurisdictions in creating REZs. Nonetheless, it is crucial that the development of new REZ transmission infrastructure minimises its impact on, and maximises its benefits for, the local communities and landowners who will host it.

Social licence is completely undermined when doubts arise about the legitimacy and credibility of the regulatory process, leading to a loss of trust in the laws, rules, and objectives governing it[25]. Failing to address this issue will likely result in substantial opposition to overhead transmission projects, thus delaying the transition to renewable energy and increasing the associated construction costs.

To address these challenges, it is imperative that consumer and community organisations have greater transparency at all stages and aspects of REZ transmission development. This includes meaningful consultation regarding route selection, technology choices, benefits, costs, and risks associated with hosting energy infrastructure before final network decisions and route selections are made.

Community engagement should commence at an earlier stage, ideally during the drafting of the ISP, allowing for the inclusion of community perspectives from the outset. CEIG acknowledges and commends the efforts made by AEMO in this regard, particularly the establishment of the ISP Consumer Panel. CEIG has also expressed our support for the initiatives proposed by the AEMC in their draft Determination on Enhancing Community Engagement in Transmission Building[26], as well as AEIC's discussion paper on Community Engagement Review[27]. Furthermore, CEIG emphasises the importance of state governments taking responsibility for setting standards to guarantee high quality and effective community engagement.

Early and regular engagement with communities ensures that the comprehensive impacts of decarbonisation are acknowledged, and that societal and environmental advantages are maximised. These practices provide avenues for community input well before specific investment decisions are finalised. Such an approach is indispensable for fostering and maintaining trust, avoiding substantial community opposition, and identifying and addressing potential risks before they significantly impact project timelines and efficiency.

[25] Energy Grid Alliance (Aug-22) Acquiring Social Licence for Electricity Transmission
[26] CEIG (Sept-23) Enhancing community engagement in transmission building – draft Determination
[27] CEIG (Sept-23) Community Engagement Review - Discussion Paper

Numerous stakeholders have voiced significant concerns about the existing regulatory framework's capacity to facilitate a just and equitable transition to renewable energy due to the lack of public policies[28]. Electricity transmission planning will increasingly be influenced by a broader range of public policies, social licence, environmental policies, and climate priorities, both at the state and federal levels. Policies must serve as catalysts for transmission planners to incorporate these objectives substantially into the planning process.

Future consideration should be given to undergrounding transmission lines, but it is not currently a feasible option

Although undergrounding transmission may present several challenges, there are areas and locations where the undergrounding of sections of transmission lines should be considered and more thoroughly investigated, especially where the impacts and threats of overhead lines to sensitive regions may warrant consideration of undergrounding[29]. However, we do not consider undergrounding bulk transmission infrastructure at the scale required to be a feasible option currently and should therefore only be considered in select circumstances.

CEIG thanks the Committee for the opportunity to provide feedback on its Inquiry and looks forward to continued engagement on those issues. Our Policy Director can be contacted at marilyne.crestias@ceig.org.au if you would like to further discuss any elements of this submission.

Yours sincerely,

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[28] Energy Grid Alliance (Aug-22) Acquiring Social Licence for Electricity Transmission
[29] Squadron Energy (July-23) Inquiry into feasibility of undergrounding transmission infrastructure