

**Submission
No 213**

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

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I would like to deal with the technical aspects of undergrounding transmission lines.

At first glance and without any technical information, undergrounding a transmission line seems like a permanent and easy solution. Unfortunately, it is not that simple and undergrounding long transmission lines is not a solution that is technically feasible, cost effective nor environmentally acceptable for the following reasons.

1. Limits on length of AC underground cables due to capacitance of the cable.

Alternating current underground cables have a maximum length which is determined maximum current the cable can carry and the reactive power required to keep the cable energized.

Underground cables are constructed from a center conductor, an insulation system and an earth armored sheath. This construction has a high surface area between the conductor and sheath with only a short distance between the two. As a result, the cable capacitance (ability to store energy in an electric field) is very high compared to an overhead transmission line. The high capacitance requires a high energy to establish an electric field every half cycle. This high energy requires electric current just to keep the cable energized. The longer the cable, the more current is required and, if the underground cable is too long, keeping the cable energized requires all the current that can be supplied by the size of the conductor. The maximum length of an ac cable is only 10s of kilometers, not hundreds of kilometers.

2. The voltage in the cable is determined from a not so obvious effect known as the Ferranti Effect. This effect is counter intuitive but real.

The Ferranti arises from the fact that capacitive current (often referred to as reactive power) is out of phase with the applied voltage. As a result, the voltage at the end of a cable can be very significantly above the voltage at the source end. The Ferranti Effect is proportional to the square of the length of the cable and as a result, the Ferranti effect can be very significant over relatively short distances and requires cable insulation to be upgraded at great cost.

2. Long cables must be direct current and require expensive AC - DC and DC - AC converter stations. Undersea cables are always DC because DC cables have a constant electric field which only requires charging when the cable is first energized. DC cables are not effected by the Ferranti Effect.

3. Underground cables must have joints between cable lengths and access must be maintained. Cable faults are possible even for underground cables. Access along the full length of the cable must be maintained for the life of the cable so that any repairs can be located and repaired. Repairs require excavations which are dangerous to work in, take a long time to make sufficiently large to be a safe workplace and result in significant environment damage.

4. Underground cables can not be maintained, upgraded.

Overhead transmission lines have a corridor in which they can be repaired, upgraded, moved, rebuilt at end of life or even removed. In the Hunter Valley, there are numerous examples where overhead lines have been moved at the request of mining companies. Underground cables can not be upgraded or moved. Repairs are time consuming and cause significant environmental disturbance.

5. Installing underground cables causes far more environmental damage, both initially and ongoing than overhead transmission lines.

Overhead transmission lines are strung between towers. Environmental disturbance is required only at tower structures. Where the line is installed in hilly terrain, the distance between towers can be considerable and require no access directly between towers. Typically, modern overhead transmission lines are strung using helicopters. Underground cables are extremely heavy and bulky and require large continuous excavations and continuous access roads for very large heavy machinery. Excavations and roads continue up hill, down hill, through drainage lines, creeks and rivers. Particularly in hilly country the environmental damage to install underground cables is significantly more than the environmental disturbance required for overhead transmission lines.

6. The cost of installing underground cables is prohibitive compared to overhead transmission lines.

I thank you for the opportunity to place this submission.