Overhead transmission

Considering the options

WIMMERA RENEWABLE ENERGY SOLUTIONS

Understanding the option to underground transmission lines is of interest to us all so we commissioned a detailed study.

It found the underground solution for WiRES could cost from 5 to 10 times more than an above ground option.

An underground cost would be unfeasible for WiRES and its potential benefits for the Wimmera would not be realised.

Determining the right transmission solution

To consider the different options for transmission, WiRES used the following key selection criteria: cost, environmental impact, cultural impact, social factors, existing and future land use, and infrastructure requirements.

What options were considered?

The Wimmera region is home to some of Victoria's best wind resource. However, the renewable energy that it can produce is stranded by a lack of transmission infrastructure.

In developing WiRES, we conducted early studies into several possible design solutions. This included:

- overhead
- underground
- alternating current (AC), and
- direct current (DC) options.

Technical studies

We understand there can be a preference for underground construction.

That's why we fast-tracked technical studies into these alternatives to select the right solution for the right reasons.

Lattice towers vs monopoles

Transmission projects at the scale of WiRES are traditionally planned at higher operating voltages, such as 500 kV. Our assessments found that a 330 kV solution is feasible for WiRES.

At this voltage, WiRES can use smaller infrastructure in the form of steel monopoles of generally 35-45 metres high, reducing the project's impact on the landscape. By contrast, lattice towers are 60-80 metres tall.

While the use of monopoles comes at a slightly higher cost, achieving this reduced visual impact outcome meant we chose to use them instead of large steel lattice towers for WiRES. All above ground options were then assessed based on using monopoles.

Image: Existing monopole transmission line near Bulgana

Summary of options

WiRES considered three scenarios and asked third party experts to analyse each option.

Based on that independent analysis - and the overall viability for each scenario - WiRES is committed to progressing Option B – 330 kV using overhead AC for the project.

A summary of the merits of each transmission option is provided below.

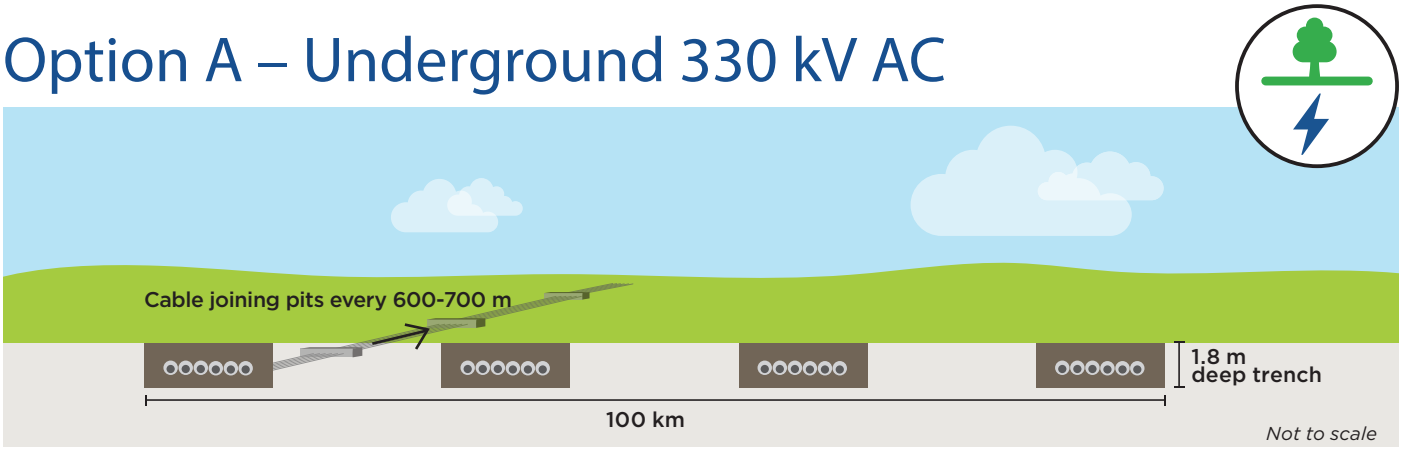
Alternating Current (AC) vs Direct Current (DC)

WiRES has considered both AC and DC options.

The majority of electricity transmission in Australia operates using alternating current (AC), allowing electrons to flow in both directions along a conductor. This differs to direct current (DC) transmission, where electrons flow in a single direction along the conductor.

AC and DC installations cannot connect directly to one another, whether in the home or on an industrial scale. To connect them, a conversion is required through special conversion plant which changes from one system to the other.

Option A – Underground 330 kV AC



Requirements:

- Four underground 330 kV circuits, comprising six insulated copper cables per circuit (24 cables in total).
- A 100 km long, 1.8 metre deep trench - filled with special backfill that is thermally rated to allow the cable to operate at full capacity.
- Reactor stations every 40-50 km along the route, constructed on a level drained bench of approximately 50,000 square metres.
- A 32 metre wide easement with heavy restrictions on land use.
- Cable joining pits every 600-700 metres along the easement that are sterilised for most other land uses and accessible at all times. This is because cable is supplied on drums of approximately 1 km, which must be joined together in a sterile environment that is accessible for its operating life.

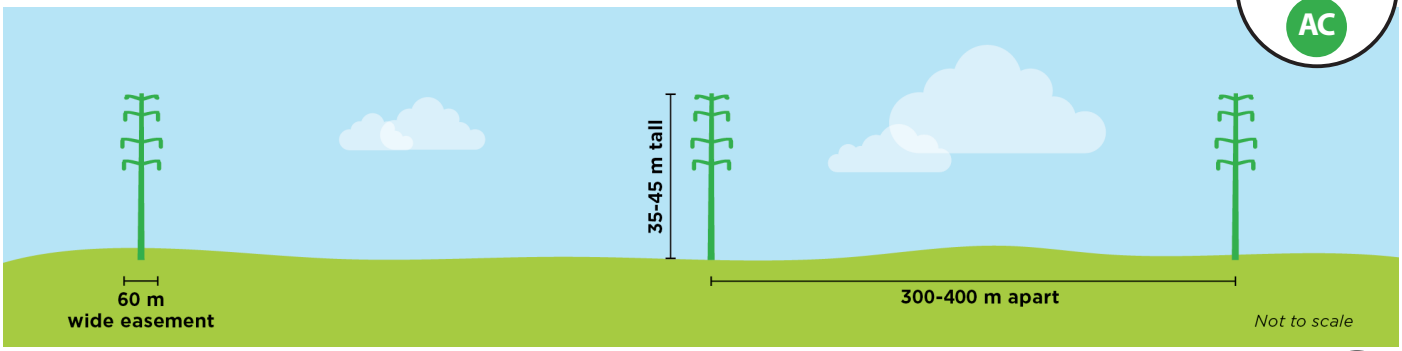
Benefits:

- Significantly reduced visual impact once in operation, although some above ground infrastructure would still be required, including access tracks.
- Smaller easement required, reducing footprint on land.
- Reduced perception of proximity to magnetic fields.
- A general perception that land values would not be adversely impacted.

Challenges:

- Heavy restriction on land uses in the easement area. This includes restrictions on any vehicle that could damage or compress shallow cable bays and restrictions on any roots systems over 300 mm.
- Cable joints are required every 600-700 metres and need to always be accessible, with clear pads of approximately 10 x 3 metres that cannot be crossed or cropped.
- Cable faults are difficult to locate and time-consuming to repair compared to overhead lines.
- Magnetic fields are not shielded by cables being underground. EMF readings at ground level are typically equal to or higher than equivalent overhead transmission lines because the energised cable is closer.
- It can take several years longer to source and install underground transmission lines due to a lack of manufacturing supply and specialist labour.
- Studies conducted for WiRES found that an underground 330 kV AC design will cost from 5 to 10 times more than an overhead design, subject to geological and engineering investigations.

Option B – Overhead 330 kV AC



Requirements:

- 330 kV AC transmission lines.
- Each transmission line would be in a double circuit configuration, meaning one set of three conductors on each side of the pole for six sets of conductors in total.
- Each set of conductors would be in a 'twin conductor' arrangement, meaning that two conductors are attached to the pole at each point rather than one conductor.
- The pole, double circuit, twin conductor arrangement is required to carry the proposed 2 GW of renewable energy from the Wimmera at 330 kV. The general arrangement is shown in the picture on the front of this factsheet.
- The transmission line would require steel poles generally 35-45 metres tall (on average). The poles will be spaced 300-400 metres along the easement corridor.
- An estimated 60 metre wide easement with some restrictions on land use related to the height of vehicles, irrigation, spraying, excavation and construction.

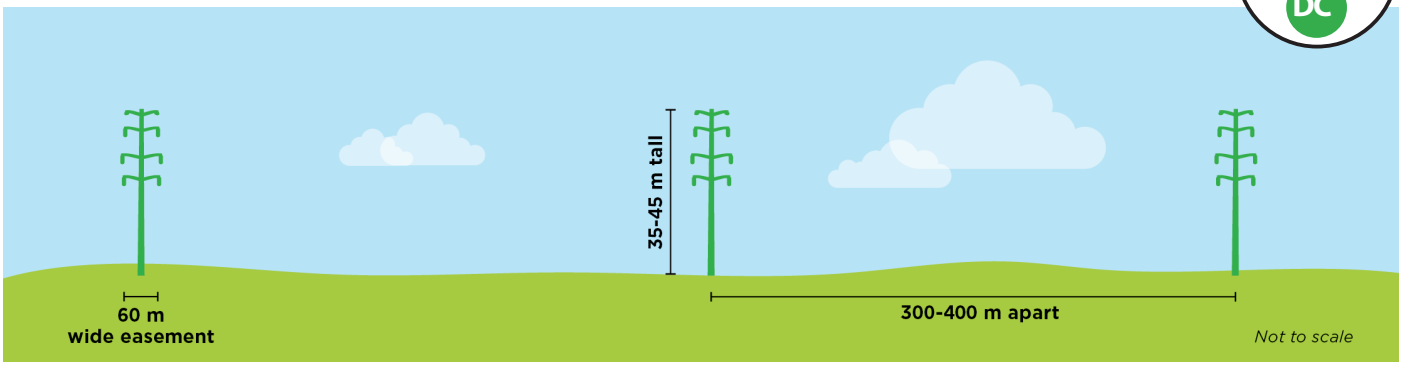
Benefits:

- High capacity per wire (conductor) installed because of its ability to dissipate heat to air.
- Easy to inspect by sight and easy to access should repairs be needed.
- Cost-effective compared to alternative solutions.
- Less impact on sensitive land areas and vegetation as they can span greater distances.
- Reduced impact and duration of construction.
- Studies for WiRES found that an overhead 330 kV AC design will cost approximately $3.5 million per km.
- Reactor stations are unlikely to be required for overhead construction.

Challenges:

- Visual impact, particularly of supporting structures like poles. Steel monopoles are selected to reduce visual impact compared to larger steel lattice towers.
- Perceived increased risk from climate events such as storms, floods and fires.
- Perceived impacts to land value.

Option C – Overhead 330 kV using DC



WiRES explored the feasibility of DC solutions for the project. DC transmission has some distinct advantages over AC for both underground and overhead installations, but also some critical limitations that make it an unsuitable solution for WiRES.

Benefits:

- More efficient transmission, with less energy loss over distance. While all transmission systems lose energy to the surrounding environment as the energy travels along the conductor, DC generally has the lowest losses.
- Lower build cost for the transmission line itself because DC is more efficient transmission - this means a lower requirement for conductors, with flow-on efficiencies in the size of structures for an overhead design.
- These efficiencies apply to underground DC installations too and would bring the cost of underground cable down by as much as 40% compared to underground AC.

Challenges:

- DC installations cannot connect directly to the AC transmission system in Australia. A conversion process is required for the two systems to work together.
- The cost of a DC to AC conversion plant is estimated at $1.4 billion for the WiRES project.
- This cost is for the converter stations alone and does not include the transmission line.
- This cost would apply to both overhead and underground DC designs, making DC financially unfeasible for WiRES.

For more information about the project

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Version 3: Feb 2026

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