Feasible Alternatives

The Western Victoria Transmission Network Project

Energy Grid
ALLIANCE

Maximising the opportunities and benefits of feasible transmission alternatives will require bold and visionary leadership to re-imagine our future grid.

The Transition to Renewable Energy

The transition to renewable energy is great news for the climate and regional communities welcome the transition for the many benefits it provides our climate, agriculture and environment. Renewable Energy Zone (REZ) development across our nation will involve significant investment in transmission network infrastructure to transport electricity from the source of generation to electricity consumers. This infrastructure will in most cases be routed through regional areas and communities that often have limited capacity to absorb this new infrastructure. It is critical that communities are recognised as key stakeholders in this transition and are involved from project inception.

It is important that best practice planning, setback distances, constraints and resilience policies be investigated, considered and applied during initial investment tests, rather than a project proponent having to deal with the consequences of ill-conceived corridor selection, resulting in community backlash, cost blowouts and material project delays.

In the case of the Western Victoria Transmission Network Project (WVTNP), it is completely unreasonable that the Australian Energy Market Operator (AEMO) was not allowed to consider socioeconomic or environmental impacts during the Regulatory Investment Test for Transmission (RIT-T). This has allowed the WVTNP to enter the 'safe haven' of the Environmental Effects Statement (EES) process, the primary purpose of which is to avoid impacts in the first place. As AusNet Services (the proponent) can no longer avoid cumulative environmental impacts, they can only work to minimise potential impacts. This is not a least-regret approach. Had impacts and constraints been identified and considered during the RIT-T process, the current corridor would not likely have been selected. Feasible alternatives can provide the winning solution. This needs to be acknowledged and the project outcome changed.

It is important to recognise that transmission line projects of this scale have not been built for close to four decades. As such, there is limited knowledge of best practices and a notable lack of planning policy and framework supporting new transmission.

Our research has shown that existing planning policy and resilience framework relates to activities around existing infrastructure, not new. This results in reactive planning and mitigation measures rather than a proactive approach. When routing transmission lines, it is crucial that the path of least-regret is taken, and the most resilient approach engineered.

Victoria's future Renewable Energy Zones (REZs)

Feasible Project Alternatives

Route selection should try to avoid, minimise, or offset impacts on important environmental, social, cultural, landscape values and strategic land use conflict by utilising existing rights-of-way as a priority.

Replacing overhead High Voltage Active Current (HVAC) with High Voltage Direct Current (HVDC) on existing infrastructure and deployment of underground HVDC technology should be considered as preferred transmission options to avoid community and environmental impacts.

While HVDC solutions may increase initial project cost due to the need for converter stations, they would deliver greater lifetime benefits, including increased electricity throughput, less energy losses, improved reliability, less exposure to weather events, increased bushfire resilience, lower operating costs, less environmental impact and considerably less opposition.

This is illustrated in the following table.

What are the WVTNP feasible alternatives?

1. Leveraging existing transmission corridors
2. Converting existing transmission infrastructure to HVDC
3. Underground HVDC transmission

Comparative Analysis Ranking

- Superior Outcome
- Moderate Outcome
- Inferior Outcome

Project Considerations	Overhead HVAC Proposed Corridor C2 *Greenfield[1]*	Overhead HVAC Existing Corridor B3 *Greenfield & Brownfield[2]*	Overhead HVAC Existing Corridor B4 *Brownfield*	Converting Existing Assets to HVDC *Brownfield*	Underground HVDC *Green & Brownfield*
Capital cost	Moderate	Superior	Superior	Moderate	Inferior
Ongoing operating cost	Moderate	Moderate	Moderate	Superior	Superior
Lifetime Project Costs (30 years)[3]	Moderate	Moderate	Moderate	Moderate	Moderate
Triple bottom line[4]	Inferior	Moderate	Moderate	Superior	Superior
Fault finding/maintenance	Superior	Superior	Superior	Superior	Superior
Electricity throughput constraints	Moderate	Moderate	Moderate	Superior	Superior
Transmission losses	Moderate	Moderate	Moderate	Superior	Superior
Reliability and Security	Moderate	Moderate	Moderate	Moderate	Moderate
Resilience to climate change[5]	Moderate	Moderate	Moderate	Superior	Superior
Environmental impact	Inferior	Superior	Superior	Superior	Superior
Biodiversity impact	Inferior	Superior	Superior	Superior	Superior
Visual amenity impact	Inferior	Moderate	Moderate	Moderate	Superior
Cultural impact	Moderate	Superior	Superior	Superior	Superior
Land use conflict[6]	Moderate	Moderate	Moderate	Superior	Superior
Social impact	Inferior	Moderate	Moderate	Superior	Superior
Community opposition	Inferior	Moderate	Moderate	Superior	Superior

1. *Greenfield Site: Previously undeveloped sites for commercial development or exploitation.*
2. *Brownfield Site: Sites that have had previous development on them.*
3. *Lifetime Project Costs: Includes construction, ongoing operation, maintenance, economic impact due to power outages.*
4. *Triple bottom line: The triple bottom line is a sustainability-based accounting method that focuses on people (social), profit (economic) and planet (environment).*
5. *Resilience to climate change: Resilience from bushfire to communities and infrastructure, resilience to increased extreme weather events.*
6. *Land use conflict: Strategic agricultural land, urban growth, significant landscape, materially populated towns.*

1. Leveraging Existing Transmission Corridors

When faced with the need to expand transmission capacity, the first inclination of many transmission planners is to consider new lines. However, there are a number of options that can increase capacity significantly using existing rights of way (ROW). Many of these have the additional advantage that they face much lower regulatory barriers. Transmission planners would be well advised to give such strategies much more attention as concerns continue to arise about reliability, and as the need to move more power grows as a result of using electrification to reduce the carbon intensity of the economy.

Transmission capacity expansion using existing lines and ROW is a strategy that deserves greater attention. The need to acquire siting approval and ROW for a new line can materially increase a project timeline by many years, and in some cases may even lead to project cancellation. In Australia, the current planning process for large scale transmission takes around 7-8 years. This timeline is echoed globally. Community opposition to the creation of new ROW and socioeconomic and environmental impacts is seeing this timeline pushed out to 10 years or more.

Projects that use or expand an existing ROW face different regulatory pathways and typically result in different responses from the public and other entities than those that involve siting an entirely new line.

A well-conceived plan is crucial. Rather than construct transmission infrastructure the same way we did many decades ago, we must figure out how we can use land more efficiently, and whether that's transportation ROW or existing transmission ROW that could have more throughput, we need to open these opportunities and take progressive approaches to how we undertake transmission planning.

According to chief executive of Citipower and Powercor, Tim Rourke "*we need to carefully balance that by making sure we're maximising the infrastructure we've got in place from a cost perspective for customers, because once you build that, it's there for a long time*".

"So, while there will be a need for new transmission lines, we need to build the bare minimum, augment the existing assets as well as squeeze the last bit of capacity out them. Not only does this keep costs down, but it speeds up the time for renewable connections."

A fundamental flaw in the current regulatory framework is that RIT-Ts penalise the use of existing transmission corridors through the assignment of outage costs. This disincentivises the use of existing assets as outage costs will always be lower for greenfield sites.

Furthermore, there is a financial advantage for transmission companies to build in greenfield sites to expand their asset base with new infrastructure.

Credible Option B3 - Overhead HVAC

In 2017, AEMO commenced a Regulatory Investment Test for Transmission (RIT-T) to assess the technical feasibility and economic benefits of addressing limitations in the Western Victoria transmission network. This Project Assessment Conclusions Report (PACR) confirms the preferred option recommended in the Project Assessment Draft Report (PADR).

The PACR assessment found two options, B3 and ,C2 (the preferred option) to have the greatest net market benefits under the assessed scenarios and sensitivities. While the PACR only focuses on the top two options from the PADR, there are other options that also address the need.

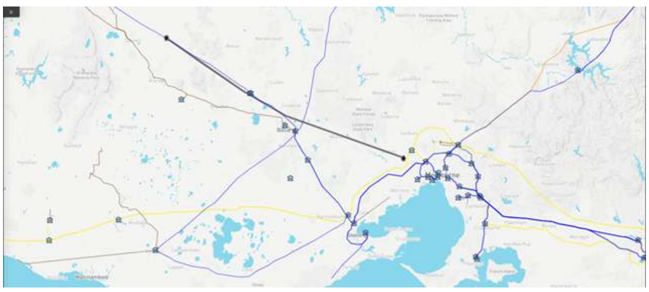
One of the top two credible options, know as B3 includes the following major components:

- Construct a new Moorabool to Elaine to Ballarat to Bulgana 220 kV double circuit transmission line, with a summer rating27 of 750 MVA per circuit.
- Retire the existing Ballarat to Moorabool 220 kV circuit No. 1, to allow the existing easement to be re-used for a new double circuit line.
- Cut in the existing Ballarat to Moorabool 220 kV circuit No. 2 at Elaine Terminal Station, to connect more renewable generation at Elaine Terminal Station.

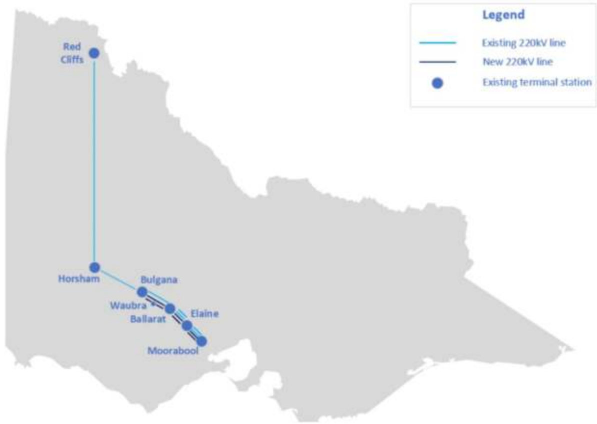
Following is a quick comparison of the final two options considered, C2 (preferred) and B2.

OPTION	**B3**	**C2** (AEMO preferred)
Expected commissioning year	2024	2025
Estimated capital cost	$335 million	$473 million
Estimated outage cost	$10 million	$4 million
Ongoing operating cost	$12.73 million 3.8% of capital cost	$16.55 million 3.5% of capital cost

Transmission Network Diagram Victoria (Option C2 shown in grey)



Credible Option B3 - Western Victoria RIT-T PACR



Compared to the Preferred Option C2, Option B3:

- Utilises existing transmission corridors, avoiding further land use change
- Minimises further project delays and fast-tracks unlocking of renewable energy, which is a win for AEMO, the proponent, investors in renewable energy generation and energy consumers
- Builds a more resilient network by avoiding highest risk bushfire prone areas. This supports AEMOs recommendations that building transmission lines along a bushfire prone transmission corridor would is an example of resilience deterioration
- Responds to credible or committed developments underpinned using existing easements to the maximum extent
- Avoids or minimises socio-economic impacts
- Avoids or minimises environmental impacts, protecting and conserving the environment
- Avoids further native habitat fragmentation
- Avoids or minimises further bushfire and fire-fighting risk to critical infrastructure and communities
- Avoids unnecessary impact on materially populated towns and residential areas
- Avoids further loss or fragmentation of productive agricultural land
- Improves security of supply to Melbourne by avoiding the creation of a supercritical generation flow between Ballarat and Sydenham
- Substantially minimises the risk the current proposed project may not proceed at all due to cumulative environmental effects and community conflict.

Option B3 would have allowed implementation of this project in sufficient time (by 2024). By applying international best practices, this option can be delivered faster and at less cost due to utilisation of existing transmission corridors.

Credible Option B4 - Overhead HVAC

Another credible option (B4) includes the following major components:

- Rebuild the existing single circuit Moorabool to Elaine to Ballarat to Bulgana 220 kV transmission line as a double circuit 220 kV transmission line, with a summer rating of at least 800 MVA per circuit.
- Retire the existing Ballarat to Moorabool 220 kV circuit No. 1, to enable existing easement to be re-used for a new double circuit line.
- Cut in the existing Ballarat to Moorabool 220 kV circuit No. 2 at Elaine Terminal Station, to pick up more renewable generation at Elaine Terminal Station.

Following is a quick comparison of options C2 (preferred) and B4.

OPTION	B4	C2 (AEMO preferred)
Expected commissioning year	2024	2025
Estimated capital cost	$367 million	$473 million
Estimated outage cost	$14.4 million	$4 million
Ongoing operating cost	$2.2 million 0.6% of capital cost	$16.55 million 3.5% of capital cost

Credible Option B4 - Western Victoria RIT-T PACR

Compared to the Preferred Option C2, Option B3:

- Utilises existing transmission corridors, avoiding further land use change
- Minimises further project delays and fast-tracks unlocking of renewable energy, which is a win for AEMO, the proponent, investors in renewable energy generation and energy consumers
- Builds a more resilient network by avoiding highest risk bushfire prone areas. This supports AEMOs recommendations that building transmission lines along a bushfire prone transmission corridor would is an example of resilience deterioration
- Responds to credible or committed developments underpinned using existing easements to the maximum extent
- Avoids or minimises socio-economic impacts
- Avoids or minimises environmental impacts, protecting and conserving the environment
- Avoids further native habitat fragmentation
- Avoids or minimises further bushfire and fire-fighting risk to critical infrastructure and communities
- Avoids unnecessary impact on materially populated towns and residential areas
- Avoids further loss or fragmentation of productive agricultural land
- Improves security of supply to Melbourne by avoiding the creation of a supercritical generation flow between Ballarat and Sydenham
- Substantially minimises the risk the current proposed project may not proceed at all due to cumulative environmental effects and community conflict.

Option B4 would have allowed implementation of this project in sufficient time (by 2024). By applying international best practices, this option can be delivered faster and at less cost due to utilisation of existing transmission corridors.

Notes:
- Option B4 – will have less market benefits than Option B3, but higher costs, due to its outage requirements, so this option will always have less net market benefits than Option B3. This ignores land acquisition cost biodiversity offsets etc.
- B3 needs a new wider easement from Ballarat to Bulgana where B4 is a simple replacement of existing infrastructure with a double circuit in same easement.
- B3 may still require an EES for new easement area, B4 would most likely not.

PREFERRED ALTERNATIVE

2. Converting Existing Transmission Infrastructure to HVDC

A sustainable electricity grid will likely need to move large amounts of low-carbon bulk power as part of a strategy to reduce emissions. That will require expansion of transmission capacity, and changes in the topology of the system, even as the use of distributed generation increases. In many cases, maximizing the capacity of existing transmission corridors may best be done by conversion to high-voltage direct current (HVDC). While typically not included in planning tools, such conversion is surprisingly cost-effective, even over relatively short distances, and, in some cases, may be the only way to achieve dramatic increases in the capacity of existing corridors.

HVDC transmission systems are emerging as the bedrock upon which the new energy system based on renewable sources is being developed and implemented. Renewable energy systems, such as solar and wind power projects, are often highly volatile and located in remote areas. The ever-evolving HVDC technology is gaining ground in the new energy economy with long-haul HVDC transmission lines that can transport power with maximum efficiency and minimal power losses.

HVDC transmission has become the power superhighway for large-scale integration of renewable power resources to offer interconnected grids, which are reliable and flexible enough to address the challenges of the new renewable energy economy. HVDC transmission grids enable load balancing between HVDC power superhighways and sharing of lines and converter stations in solar projects and offshore wind power stations.

HVDC transmission systems offer feasible solutions to the existing right-of-way challenges. One HVDC transmission system deployed overhead can prove to be more reliable than a double circuit AC transmission line[1]. HVDC infrastructure can improve the electricity transient efficiency by using insulated HVDC cables in underground and subsea applications, which can accelerate the right-of-way permitting processes. Moreover, HVDC transmission systems can also be installed adjacent to or on the existing AC lines, reducing the needs for right-of-way land use.

Converting existing transmission infrastructure to HVDC is an overlooked option for increasing transmission capacity.

1. GE Grid Solutions (pp 2): https://www.gegridsolutions.com/products/brochures/powerd_vtf/hvdc-systems_gea-31971_lr.pdf

Overhead HVAC Transmission. Able to be converted to HVDC

PREFERRED ALTERNATIVE

3. Underground HVDC Transmission

Deployment of underground HVDC transmission systems is considered as an economically viable and environmentally sensitive way of providing redundancy, reslilience and reliability in transmission networks.

An independent report, commissioned by the Moorabool Shire Council, confirm that utilising HVDC underground cables for the WVTNP is a viable, low-impact alternative to the HVAC overhead transmission lines currently being planned. Importantly, it also found that the underground option is significantly less than the 10 times greater as referenced by the AEMO Western Victoria Renewable Integration Project Assessment Draft Report (PADR).

Key finding of the report indicate that:

- HVDC underground cables are a technically feasible alternative that is likely to be more reliable and efficient for the movement of renewable energy to major centres whilst presenting significantly reduced impact to social and environmental factors.
- HVDC underground option will not be impacted by bush fires. Power does not need to be switched off during bush fires to aid firefighting, and the power transmission is highly unlikely to be disrupted due to smoke causing flashovers and potentially tripping breakers.

HVDC underground cables provide the lowest impact solution with:

- Little to no risk of underground cables causing fire or being affected by severe weather events
- Little to no impact to access e.g. for emergency services and aviation operations
- Minimal impact to private land or current land use once construction is completed as the easement could be designed to fit within existing road reserves
- Lesser impact on land use conflict with easements typically ranging from 2-4m wide
- While a larger volume of soil excavation will be required, vegetation is typically restored within a few years
- Significantly reduced impact to flora and fauna due to the possible location of the cable along roadways
- No visual impact concerning the transmission line as the cables are buried underground
- Equivalent or reduced visual and land-use impact from the converter station as it would be expected to occupy a relatively similar area as a typical AC terminal station with much of the equipment being housed indoors
- No audible noise along the transmission line
- Little to no electromagnetic field impacts

A recent review of the HumeLink Project Assessment Conclusions Report by the Victoria Energy Policy Centre (VEPC) indicated that using existing easements, or adjacent land, could save hundreds of $millions and minimise environmental and landholder impacts. The VEPC also recommended that undergrounding should be seriously considered, either in part or whole (with HVDC), particularly where land of high value is likely to be affected.

There are myths circulating that undergrounding HVDC is not feasible as multiple generators will need to connect along the length of the line, all requiring their own converter stations. This is misleading and represents a lack of visionary thinking. A more robust solution would be to create an underground HVDC backbone that bypass the urban growth corridors and avoids impacting materially populated regional towns and strategic agricultural land. These backbones would terminate at a more remote converter station, creating a single point of entry to the grid for renewable energy generation.

Shetland Interconnector - Underground HVDC

References

Review of the HumeLink Project Assessment Conclusions Report: https://243b2ed8-6648-49fe-80f0-f281c11c3917.filesusr.com/ugd/92a2aa_52bec342cb1e4c2292c4d259f4049f6d.pdf

High-Level HVDC Alternative Scoping Report: https://www.moorabool.vic.gov.au/files/content/public/about-council/large-projects-impacting-moorabool/western-victoria-transmission-network-project/wvtnp-high-level-hvdc-alternative-scoping-report.pdf

SOO Green HVDC Link: https://www.soogreenrr.com/

Case Study
SOO Green HVDC Link
www.soogreenrr.com

One project that is setting the new benchmark for renewable energy transmission is the is the SOO Green HVDC Link. SOO Green is the first transmission project in the US, that is going to be co-located underground along railroads and highways for its entire 350-mile route. the project consists of two slender HVDC cables that are buried in existing rights-of-way. Each cable is no greater in diameter than a wine bottle. It's out of sight and out of mind. Underground construction avoids landowner opposition, and it expedites the planning and approvals process because there are no land use, socioeconomic or environmental conflicts. What that means is it can be built fast. Co-location in existing corridors provide the advantage of speed in development, and speed is key, because as we know, everything in the climate and energy world is rapidly evolving and renewable generator investors are ready to get started. The weather is changing, technology is changing, and our future grid is changing.

This is the way transmission should be built — in an environmentally responsible manner that respects landowner rights and can be replicated across the country to building the grid of the future.

Community Benefits

Communities in Iowa and Illinois will benefit from the SOO Green HVDC Link because it will generate more than $2.2 billion in economic output, create thousands of construction, operations, and maintenance jobs, and spur additional economic activity throughout the Midwest. Additionally, communities will benefit from more than $1.5 billion in induced investment in new renewable energy component production.

The project will also generate revenue for local jurisdictions throughout its 50-year expected service life, supporting public services such as roads, emergency services and schools.

Resilience

Extreme weather patterns such as strong winds, extreme precipitation, severe droughts and unseasonably warm or cold temperatures can impact communities. With extreme weather comes heightened risks of strong winds and bushfires that have led to property damage, disruption of power transmission and loss of power in various regions of the country. Underground installation of transmission lines will avoid these risks and contribute to a stable, reliable and resilient grid that can withstand extreme weather patterns.

Environmental Benefits

As the first underground long-distance HVDC project in the United States, the SOO Green HVDC Link is pioneering a new model for sustainable transmission development that avoids environmental impacts associated with traditional aboveground transmission lines. By installing the conductor cable underground along existing railroad right-of-way and other transportation corridors, SOO Green reduces the need for tree clearing and eliminates threats to sensitive species such as migratory birds, bats or native plants.

The project utilises safe materials: the electricity-conducting cable is well-insulated, produced from non-flammable materials and does not require any cooling liquids or gels. The electric fields produced by the underground high-voltage lines will not harm humans, animals, plants or interfere with railroad operations.

Grid Benefits

In addition to bringing 2,000 megawatts of clean energy to market, SOO Green HVDC Link also provides essential system-level benefits to help ensure a reliable and resilient power grid. These benefits are realized by sourcing renewable energy from a broad geographic region in the Upper Midwest, by installing state-of-the-art conductor cables underground, and using advanced power conversion technology.

Conductor Cables

Newly available HVDC conductor cable technology enable the delivery of large quantities of wind and solar energy across long distances to urban load, centers with little line loss. These extruded cross link polyethylene (XLPE) insulated cables allow for simpler and less expensive splicing, easier handling in the field, a small installation footprint and high-power transfer capability. This cable technology enables the SOO Green HVDC Link project to be unaffected by severe weather incidents.

Power Converters

SOO Green HVDC Link will use innovative AC to DC and DC to AC converter stations known as self-commutated Voltage Sourced Converters (VSC) that provide important grid support functions and power transfer capabilities not previously available. VSC technology boosts reliability by providing highly responsive utility-scale reactive power, dynamic voltage support, black start and other grid services historically only provided by centralized coal, natural gas and nuclear generating stations. With the largest VSCs ever installed in the U.S, the 2,000-megawatt renewable energy-powered SOO Green HVDC Link will deliver functionality to the power grid similar to that of a large power plant, but without any adverse environmental or community impacts.

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Energy Grid Alliance was established with the purpose of engaging with energy transmission companies, industry regulators, market operators, relevant peak bodies, government and communities to establish best planning practices for new energy transmission infrastructure and to inform on the benefits of working with communities to acquire and maintain social license.

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