ACTIONING THE QUEENSLAND ENERGY AND JOBS PLAN

November 2022

CONNECTING

QUEENSLAND'S ENERGY FUTURE

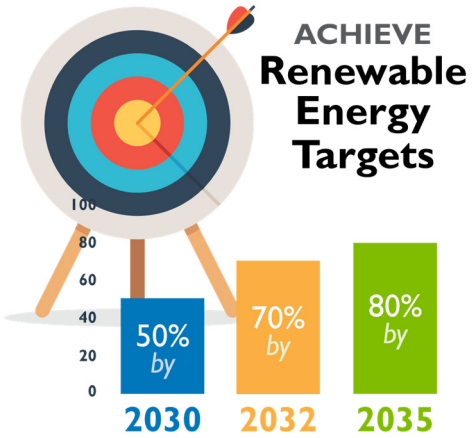
THE ROLE OF ELECTRICITY TRANSMISSION IN QUEENSLAND'S ENERGY FUTURE

As a Government Owned Corporation that owns, develops, operates and maintains the high voltage electricity transmission network, Powerlink's role is to serve Queenslanders. We do this by providing safe, reliable and affordable electricity to more than five million people and 238,000 businesses.

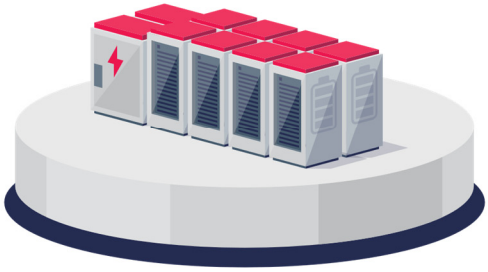
In September 2022, the Queensland Government released the Queensland Energy and Jobs Plan (QEJP) and the Queensland SuperGrid Infrastructure Blueprint (Blueprint). Powerlink's initial response to the actions set out in the QEJP and Blueprint are outlined in this document.

Powerlink has been working closely with the Queensland Government for more than 12 months, providing technical expertise and guidance on transmission-related topics and the scope and size of pumped hydro energy storage (PHES) projects.

The QEJP applies a whole-of-system planning approach, setting out the pathways and targets (as shown below) that will facilitate a low carbon economy in the future and ensure an orderly, least-cost transformation of Queensland's power system.



Connect an additional
22GW
WIND & SOLAR
in Queensland Renewable Energy Zones by 2035



Support growth of utility scale
BATTERY STORAGE

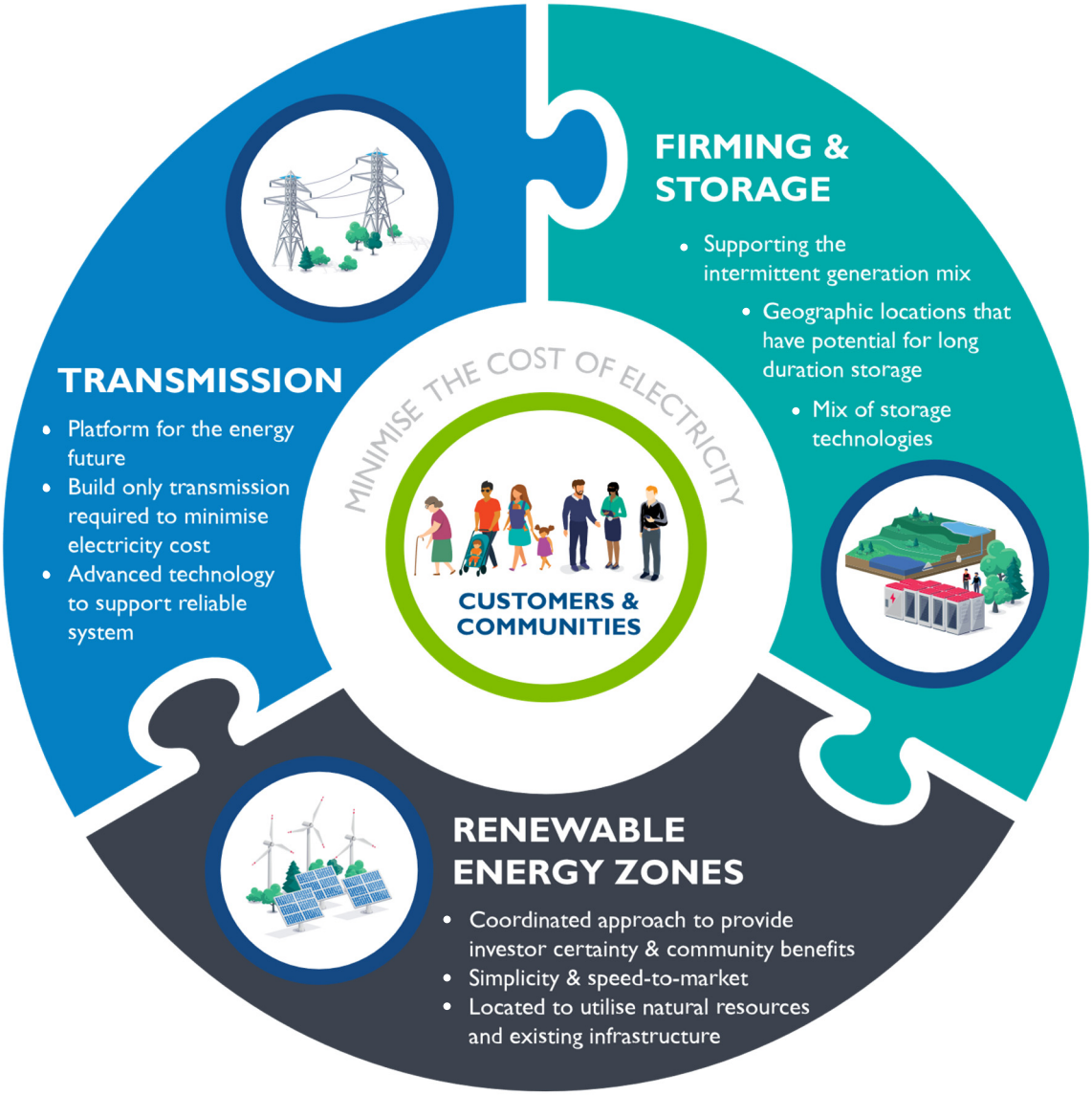
To achieve these targets, the Blueprint includes a number of interdependent elements spanning generation, firming and transmission.

An additional 22 gigawatts (GW) of new wind and solar generation will be developed and connected by 2035. This will be supported by a portfolio of firming resources that includes at least 6GW of long-duration PHES, batteries, neighbourhood and household customer energy resources, and low to zero emissions gas generation.

Transmission capacity is the other important interdependent element. As such, Powerlink will play an integral role in:

- Developing new Renewable Energy Zones (REZ), in addition to the North Queensland, the Southern Downs and Western Downs REZs already being delivered to enable a coordinated and cost-effective transformation (refer to Chapter 1 – Developing REZ in Queensland)
- Connecting the firming resources, in particular PHES (refer to Chapter 2 – The Importance of Firming and Storage)
- Upgrading the transmission backbone network in four stages over the next 10-15 years to transport huge volumes of renewable and stored energy (refer to Chapter 3 – Transmission Network Development Priorities).

Together, these elements will enable the rapid decarbonisation of the electricity sector as well as parts of the broader economy through electrification, including of industrial processes and the transport sector among others. It also sets the platform to pursue future opportunities, such as the establishment of hydrogen plants.



We know it is critical that all three of these elements are delivered – no one element on its own will successfully move us to a decarbonised economy. The integrated and interdependent nature of these elements and Powerlink's central role is discussed in more detail throughout this document.

Our focus is on continuing to work closely with the Queensland Government, community and industry on:

- supporting connection of new generation at locations with high resource quality relatively close to the transmission network
- developing REZs in a scale-efficient way to maximise hosting capacity and system strength at lowest cost
- utilising existing network capacity
- optimising the network design and project delivery timeframes around the proposed PHES facilities, new REZ developments, repurposing of existing coal generation and planning for expansion of the network for longer-term load developments
- adopting contemporary and emerging technologies to limit the initial scale of network investment required, minimising costs to customers, while delivering the required reliability.

Queenslanders want to know that affordability will be central to the energy future driven by the QEJP. Independent modelling commissioned by the Queensland Government shows the QEJP will deliver broad benefits to Queensland, including jobs, energy security and lower wholesale electricity prices.

Driven by increased amounts of renewable energy, wholesale electricity prices are forecast to reduce by 15% on average to 2040 compared to an alternative outlook without the Plan. This analysis includes investment in scale-efficient transmission as a key enabler to these outcomes.

We also know the critical role that community, customer and other stakeholder engagement will play as we deliver on our elements to achieve the QEJP objectives and goals.

The communities we co-exist with are looking to us to undertake effective and early engagement to provide information and the opportunity to influence and jointly shape how our planning and decisions impact on them in the short and longer term. We are committed to this.

We will also work closely with renewable developers and investors, existing generators and market participants, as well as regulators and industry stakeholders across the National Electricity Market.

SHARE YOUR VIEWS

We want to hear your views to guide the development of Powerlink's response.

Many customers and stakeholders will have a strong interest in the power system transformation and an interest in how the QEJP and Blueprint will be delivered.

This document shares our initial response to the QEJP to prompt conversations and input from our customers, communities and other stakeholders. Your input will help us expand our understanding and improve our decision-making as we progress our plans.

Chapter 7 includes key questions relevant to our planning and decision-making. We invite you to respond to these questions or raise other matters.

Please reach out to us, we value your input. You can contact us at qldenergyfuture@powerlink.com.au.

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1. DEVELOPING

RENEWABLE ENERGY ZONES (REZS) IN QUEENSLAND

Key insights
REZs allow Powerlink to optimise how and where renewable generation is connected and integrated within the existing system to achieve renewable energy targets at least overall cost to customers.
The REZ approach delivers benefits to communities and landholders by coordinating development to consider existing land uses and reducing infrastructure footprints and environmental impacts.
The REZ approach facilitates efficient network connection and speed to market for Powerlink's generation customers.

A COORDINATED APPROACH TO RENEWABLE ENERGY DEVELOPMENT AND CONNECTION

The Queensland SuperGrid Infrastructure Blueprint (Blueprint) modelling indicates that 25GW of large-scale renewable generation will be needed by 2035, of which around 3GW exists today.

Looking beyond 2035, it is likely that Queensland will need even more renewable generation, considering the additional electricity demand created by new industries such as hydrogen and electrification of existing sectors such as mineral processing and transport. The Australian Energy Market Operator's (AEMO) 2022 Integrated System Plan (ISP) Step Change scenario forecasts Queensland will require 48GW of renewable generation by 2050.

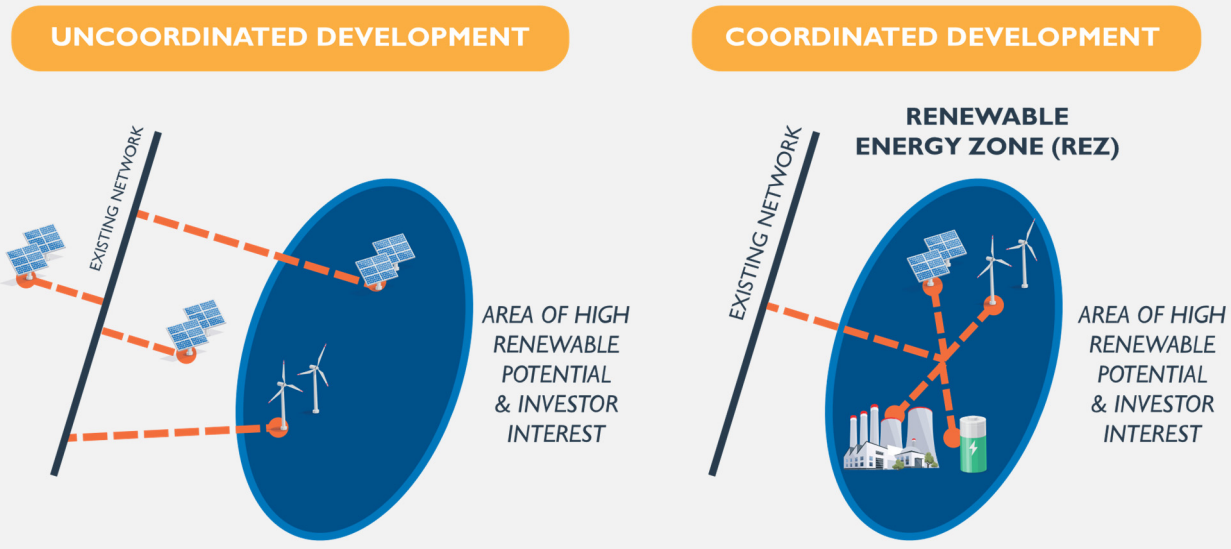
To be able to efficiently connect this amount of new generation will require a new coordinated approach to achieve renewable energy targets at the least overall cost to customers. Renewable Energy Zones (REZs) will provide this coordination.

WHAT IS A REZ?

A REZ is a geographic area with high-quality renewable resources like wind and solar, suitable topography and land availability to support the connection of renewable generators, and potential for coordinated development.

REZs enable the cost-effective development of a coordinated, large-scale approach to connecting multiple renewable energy developments to the transmission network.

The REZ concept allows Powerlink to optimise how and where renewable energy is connected and integrated within the existing power system to achieve renewable energy targets at least overall cost to customers. The REZ design also promotes cost-effective connections for generation customers and optimised provision of system services. Importantly, the REZ concept provides an opportunity to deliver benefits to communities and landholders within the REZ.



ENABLING REZ DEVELOPMENTS IN QUEENSLAND

Powerlink has a strong history of connecting renewable generation projects to its network. In the last six years we have connected 21 large-scale wind and solar generation projects with a combined maximum output of about 3,030MW.

We currently have four renewable connection projects under construction and commissioning, with a combined maximum output of 1,590MW. As at September 2022, 32 renewable applications are being processed representing approximately 11GW of generation. In total, we have more than 30GW of renewable generation projects in the initial project development stage.

Powerlink has already enabled the establishment of REZs across Queensland, underpinned by an approach that delivers benefits to generators, customers and communities. Powerlink is unlocking approximately 7.5GW of hosting capacity through projects:

- In May 2021, we progressed a $50 million upgrade ($40 million of which was funded by the Queensland Government) to Powerlink's existing network in Far North Queensland to unlock up to 500MW of renewable energy hosting capacity as part of Queensland's first REZ. The North Queensland REZ was the outcome of close work between Powerlink, CleanCo, the Queensland Government and renewable energy developer Neoen as part of the157MW Kaban connection. To support the North Queensland REZ, Powerlink is upgrading an existing 132kV transmission line between Townsville and Cairns to 275kV, a project that will provide additional benefits to customers in the Cairns area by making their electricity supply more storm and cyclone resilient.
- In 2021/22 we supported the development of the Southern Downs REZ, unlocking up to 2,000MW of hosting capacity in the region. This is being anchored by the MacIntyre Wind Precinct development by Acciona and CleanCo. The MacIntyre Wind Precinct is currently the largest renewable project to connect into our transmission network. Powerlink's role includes constructing 65 kilometres of new transmission lines and two new switching stations at a cost of $167 million.
- Also in Southern Queensland, the Wambo Wind Farm is a proposed renewable development located in the Western Downs local government area. Stage 1 of the project proposes 250MW of generating capacity and could be the foundation customer of the Western Downs REZ. Stage 2 of the project proposes an additional 250MW. The 275kV connection to the Wambo Wind Farm will allow for up to 2000MW of renewable hosting capacity in the area.
- Powerlink is progressing planning and engagement to support the development of the Banana Range Wind Farm in Central Queensland. The single circuit to double circuit connection upgrade will create a renewable hosting capacity of up to 1,500MW.
- The Gladstone reinforcement transmission line from Calvale to Calliope substations, as outlined in the Blueprint, would allow for up to 1,800MW of renewable hosting capacity in the region (refer to QEJP action 1.4).

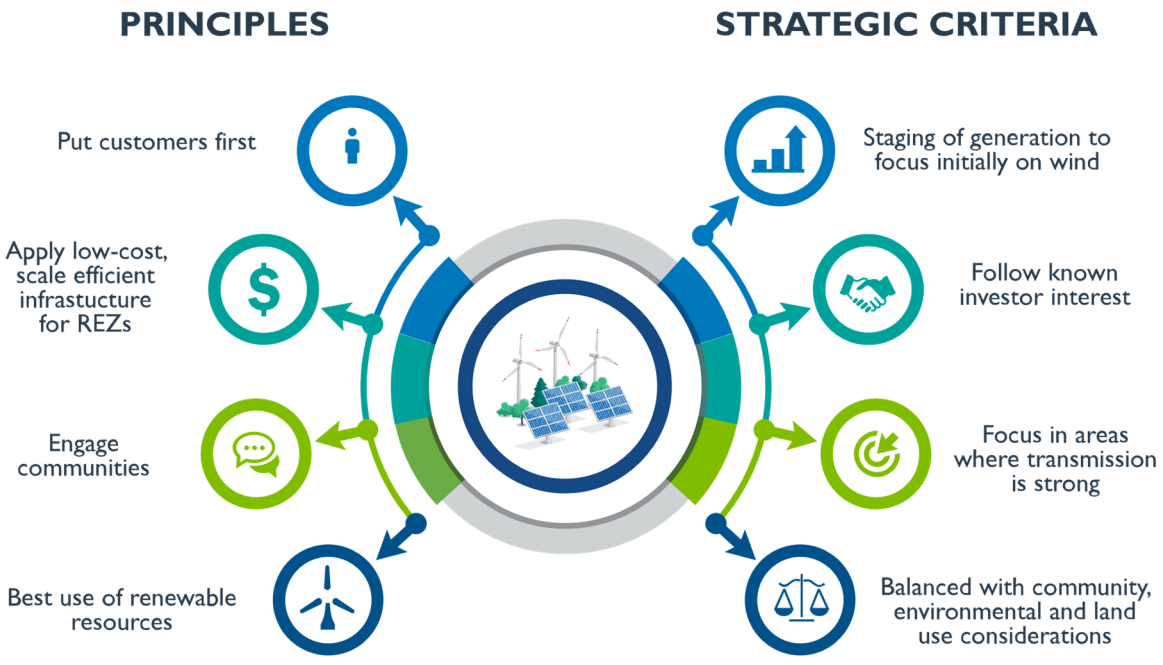
REZ BENEFITS

As the energy system transforms, Powerlink notes the Queensland Government is committed to implementing a market-led, generator-pays REZ model which promotes the appropriate allocation of risk and costs, and is delivered through non-regulated funds to the greatest extent possible. Powerlink supports this view with a REZ approach that delivers benefits to generators, customers and communities. Our approach will continue to be refined over the coming months with input from Government and key stakeholders.

Developers	The REZ approach delivers benefits by unlocking opportunities for generators to connect to the network, increasing the cost-effectiveness of connecting and optimising the capability of the system. Key principles are: • simplicity and transparency in the connection process • reduced individual proponent connection costs • clear and consistent community engagement requirements • aggregated Generator Performance Standards (GPS) methodology • speed and ease of connections.
Communities	Communities and landholders can benefit from a coordinated REZ approach, including: • a reduced infrastructure footprint enabling better environmental and land use outcomes • community investment funding can be pooled and scaled proportionately • coordinated local procurement, training and employment opportunities • improved engagement with a coordinated approach to sharing information and input about the proposed REZ development.
End-use Customers	The approach considers benefits for the end-use customer: • by implementing a market-led, generator-pays REZ model • by coordinating development in areas of high renewable potential, we can support cost-effective, scale-efficient renewable energy projects that provide energy at low prices per megawatt hour (MWh).

REZ PRINCIPLES AND STRATEGIC CRITERIA

Powerlink supports the Queensland Government in establishing Queensland Renewable Energy Zones (QREZ) to help put downward pressure on electricity prices by connecting cheaper renewable generation in a way that minimises costs for Queensland households and businesses.



OUR PROPOSED ROLE AS DESIGNATED PLANNING BODY

The process for QREZ development has been outlined in the Queensland Government's QREZ technical design paper. Under this process, it is proposed that Powerlink will be the Designated Planning Body (DPB) responsible for development of the declared QREZ (refer to QEJP action 1.4).

Under the proposed QREZ model, Powerlink (as the proposed DPB) will make recommendations on the QREZ infrastructure to be progressed for further development. Supported by the recommendations, the Queensland Minister for Energy will then declare the REZ, from which point the QREZ framework will be applied to the nominated area and infrastructure, with information released in a REZ Management Plan (RMP).

Further detail on the proposed DPB function is provided in the Queensland Government's QREZ Technical Paper.

NEXT STEPS

Developing REZs in Queensland

Continue engaging with communities and other stakeholders in areas with transmission developments already underway as part of a REZ. In addition, support the Queensland Government to engage with communities in new potential REZ areas to understand their values and priorities to ensure maximum benefits from REZ development.

Work with the Queensland Government to release a QREZ Roadmap for community engagement and feedback. The QREZ Roadmap will include the proposed approach for developing future REZs and the immediate and longer-term capacity proposed for each QREZ region (refer QEJP action 1.4).

Review our current community engagement strategy and approach for transmission infrastructure when developed as a coordinated REZ.

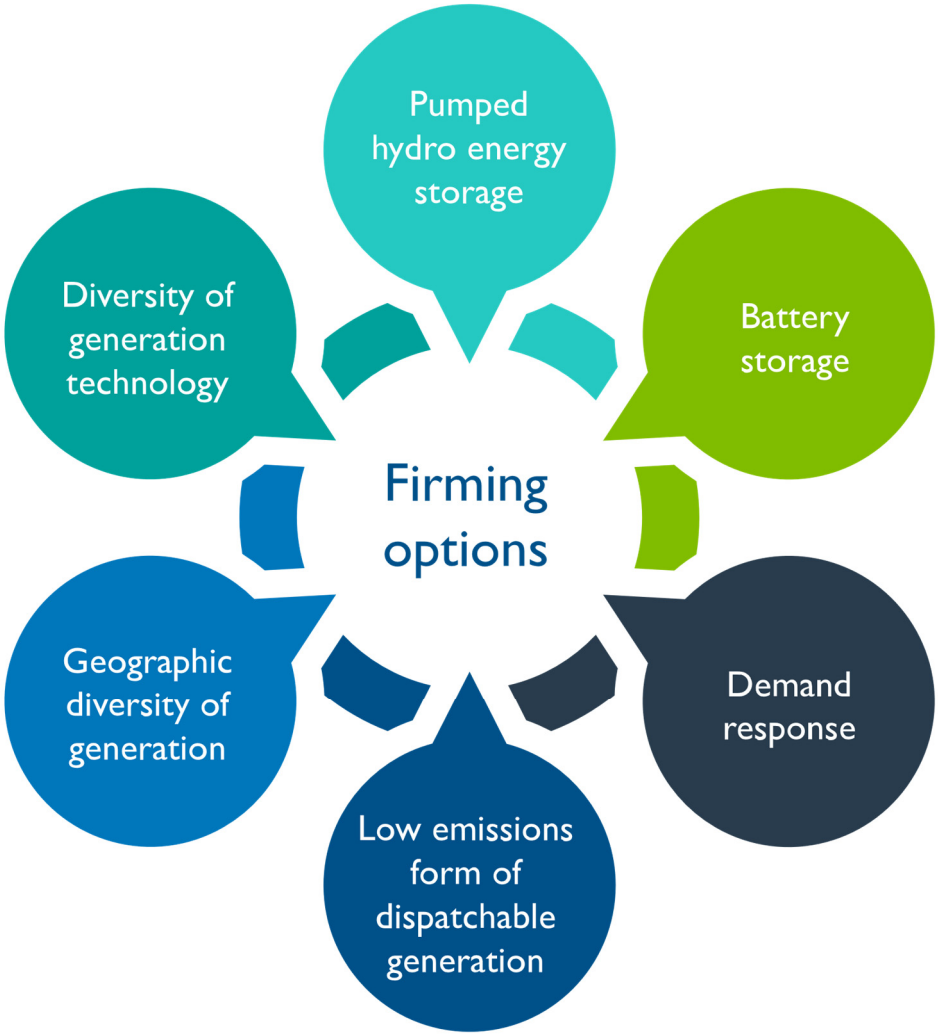
Continue to work with renewable energy developers to further understand generation opportunities aligned to the REZ development strategic criteria.

2. THE IMPORTANCE OF FIRMING AND STORAGE

Key insights
A portfolio of firming resources is required to provide a reliable system capable of zero emission electricity supply at minimum cost, including battery storage systems, gas turbines and a number of Pumped Hydro Energy Storage (PHES) facilities.
Energy storage technologies can provide a range of other network services. Powerlink is pursuing these for both batteries and PHES.
Transmission development is integral to unlocking Queensland's pumped hydro generation resources and integrating a diverse mix of renewable generation.

A PORTFOLIO OF FIRMING OPTIONS

Firming is a crucial element in a future power system with high shares of intermittent renewable generation. It ensures electricity can be delivered when needed and not only when wind and solar resources are available. A variety of options are available to provide energy firming as shown in the figure below:



Each of the options has different implications for the power system. The Queensland SuperGrid Infrastructure Blueprint (Blueprint) is underpinned by a portfolio of firming options integrated with the development of renewable generation, upgraded transmission backbone infrastructure and other system services.

POWERLINK'S ROLE IN FIRMING AND STORAGE

Powerlink is committed to supporting the portfolio of firming and storage technologies into the future. Our specific role varies according to different areas of the future power system.

The optimised network proposed in the Queensland Energy and Jobs Plan is enabled by Powerlink's strategy to leverage the flexibility of batteries, generation and loads to maximise the network's utilisation and facilitate network outages.

Initiatives	Forms of firming	Powerlink's role
Renewable Energy Zones (REZ)	• Diversity of generation technology • Geographic diversity of generation	• Manage the location, timing and composition of REZ to maximise benefits for communities and customers.
Batteries, gas turbines and flexible load	• Battery storage • Demand response • Hydrogen-ready gas turbines	• Signpost when and where these can most helpfully be implemented. • Establish frameworks and incentives to support their development and provision of support to the overall power system.
Long duration pumped hydro	• PHES	• Inform design and co-optimise with the transmission network. • Deliver right-sized upgrades of the transmission network in line with the capacity and timing of the pumped hydro facilities.

Transmission network	• Enabling all forms of firming	• Develop the transmission network to facilitate generation, storage and flexible load with adequate network capacity, losses performance and system conditions to operate securely and economically, which includes:
		  ○ constructing transmission lines
		  ○ providing system strength and inertia services
		  ○ using technology and techniques to maximise network capacity and operational flexibility.
		• Investigate further upgrades to the Queensland to New South Wales Interconnector (QNI) in line with the Australian Energy Market Operator's (AEMO) Integrated System Plan (ISP).

NETWORK SUPPORT OPPORTUNITIES FROM ENERGY STORAGE

Network support services are required to maintain the secure, reliable operation of the network.

These services include the provision of electrical attributes traditionally provided by existing synchronous thermal generators, which need to be replaced as this form of generation retires from service (e.g. system strength and inertia). Battery Energy Storage Systems (BESS) are a form of energy storage that can also provide additional services to those typically provided by thermal generators because of their very fast response. An example is to quickly charge or discharge to reduce the flow on a transmission line. This can have the effect of increasing the secure transfer limits when all network elements are in service relying on the action of the BESS should an unplanned outage occur that would otherwise overload the network.

If energy storage is strategically developed, it has the potential to provide a variety of network support services, provided they satisfy all three of the following requirements:

- *Location*: many network needs are location specific.
- *Technical specification*: ability to perform the necessary responses to provide the network support service, and integration with Powerlink's protection and control systems to trigger the response when required.
- *Contractual arrangements*: to enable the network support services to be procured cost-effectively when they are required.

To ensure the benefits from potential network support services are optimised, Powerlink is adopting a proactive approach to the integration of batteries. In partnership with CS Energy, Powerlink is facilitating Queensland's largest BESS at our existing Greenbank Substation, south of Brisbane.

Pictured: Greenbank Substation, south of Brisbane

The Greenbank BESS will provide a range of network support services including voltage support and response to network events to maximise the utilisation of the transmission system and offset the impact of network outages.

While network support services from BESS are not new, Powerlink is innovating its business model for the network service agreement in layering as many potential network services as possible and minimising the impact on the BESS operators' market activities. The 200MW/400MWh Greenbank BESS will be built, owned and operated by CS Energy, with Powerlink providing land and connection services.

The agreement with CS Energy is an outcome of our Expression of Interest process with battery proponents in 2021 and 2022 to collaboratively develop technical and contractual arrangements for the integration of batteries, and to allocate land and network connections for batteries in high-priority locations. Powerlink is currently seeking to contract with other proponents under similar arrangements.

Once developed and tested with the Greenbank BESS, Powerlink will use these technical and contractual arrangements with new and existing battery proponents looking to provide network services in Queensland.

NEXT STEPS

Firming and storage

Continue to work with the newly established government entity, Queensland Hydro, and the Queensland Government as the investigations of the PHES progress to co-optimise the design of the pumped hydro and the transmission network infrastructure.

Upon finalisation, make the technical and contractual arrangements for network support services available to new and existing BESS operators in areas where network services are required.

3. TRANSMISSION

NETWORK DEVELOPMENT PRIORITIES

Key insights
Powerlink's future transmission network will need to support a power system that operates in fundamentally different ways to today.
An upgraded transmission backbone will enable the efficient transfer of the volumes of renewable and stored energy required to meet Queensland's energy needs and provide a flexible platform to allow for future expansion as new loads emerge.
Powerlink will pursue opportunities to apply innovative technologies to support a reliable power system transformation at least cost to customers.
Powerlink will engage with stakeholders as we continue our analysis on the most economic and effective way to provide the necessary transmission network capacity and services.
Powerlink has commenced early work for the Borumba Pumped Hydro Project connection and will start stakeholder engagement for the Central Queensland connection in mid-2023.

NETWORK DEVELOPMENT
OVERVIEW

The Queensland Energy and Jobs Plan (QEJP) applies a whole-of-system planning approach that aims to find a least-cost pathway to coordinate the power system transformation. This includes optimising what is needed for the transmission network with the other elements of the QEJP.

Powerlink supports the QEJP to deliver an orderly power system transformation, maximising reliability and cost-effectiveness while avoiding market volatility as renewable energy generation increases.

We are aware that delays in delivery or insufficient transmission capacity will:

- risk new generation investment being constrained
- result in higher losses and marginal loss factors
- lead to underutilised deep storage assets.

Consequently, Powerlink is progressing early works to ensure flexibility in meeting forecast timelines for the initial stages of development, while also continuing our analysis to refine the specific design of the network and the staging of its implementation.

Our planning will be shaped by a range of technical, economic, environmental, social and market analyses, as well engagement with customers, landholders, generation developers and other stakeholders. Above all, as Powerlink exists to serve Queenslanders, our approach will be to pursue a least-cost power system transformation.

The Queensland SuperGrid Infrastructure Blueprint (Blueprint) is a point in time plan. Through detailed design and planning phases, we will continuously monitor underlying assumptions and adjust system plans as the market evolves and the quality of available information improves.

A new advisory board, the Queensland Energy System Advisory Board, will be established to support and provide advice to government on the energy transformation. This will include providing advice on the optimal infrastructure investment pathway biennially — in a whole-of-system context — as part of the Blueprint update, with the first update to be published in 2025. As Queensland's jurisdictional planning body, Powerlink will provide expert technical input to ensure transmission developments are fit-for-purpose and support the least-cost development. Providing transparency to our customers and stakeholders during this process will be a priority.

QUEENSLAND'S FUTURE POWER SYSTEM

The QEJP outlines a future Queensland power system that operates in fundamentally different ways to today.

2022	2035
3GW transmission-connected wind & solar generation	25GW wind & solar generation
8.1GW coal generation	Some coal-fired generation remains, repurposed for system strength & inertia
Firming & storage mainly comes from coal & gas	Firmed by at least 6GW of long-duration storage, 3GW of utility-scale batteries, 3GW of hydrogen-ready gas-fuelled plant
Low demand growth	Electrification of heavy industry
High amount of rooftop solar	Opportunities for greater flexibility on the demand side
	Continued rooftop solar growth

UPGRADING THE TRANSMISSION NETWORK

The transmission network will provide the platform to enable variable renewable generation and storage to reliably meet customer demand for electricity. The location and capacity of new renewable generation and storage assets will be different to the existing generators and will require the capacity of the main transmission backbone to be upgraded.

The QEJP is underpinned by the development of two large, long-duration Pumped Hydro Energy Storage (PHES) facilities which are currently in the feasibility study phase:

- Borumba in Southern Queensland (1,500-2,000MW/24hr)
- Pioneer-Burdekin in Northern Queensland (up to 5,000MW/24hr).

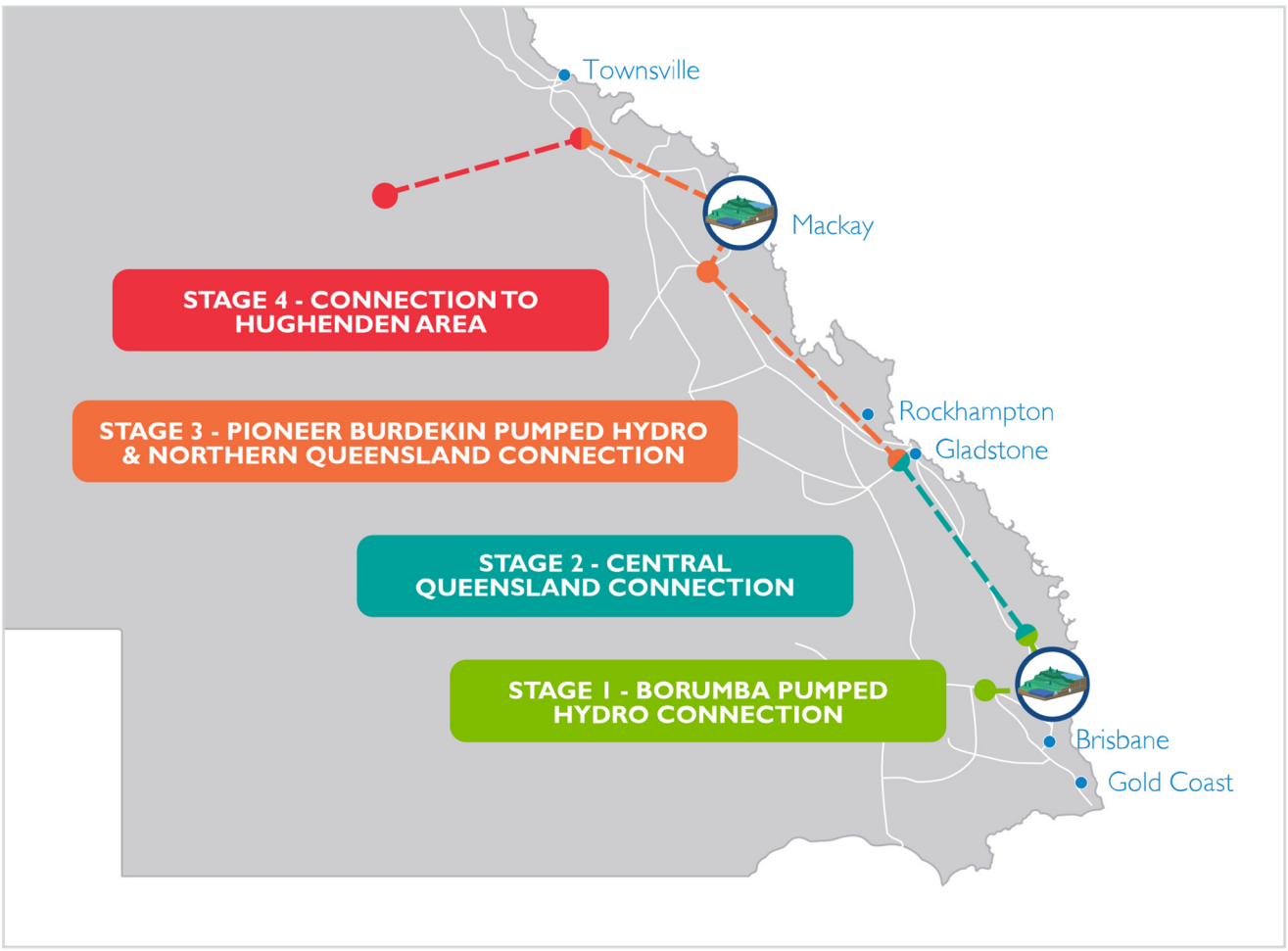
Powerlink's existing transmission network will need to be transformed to provide the capacity to transfer large amounts of power from renewable generation to storage, and from storage to load.

The QEJP presents a network strategy to develop a high-capacity connection and associated substations between Borumba and Pioneer-Burdekin PHES, and west to the Hughenden area – a zone with a high renewable energy potential. This will create a strong and high-capacity network across vast distances between the northern, central and southern parts of the state. This network will enable the efficient investment in renewable generation through long-duration storage to manage renewable energy droughts mitigating the need to significantly overbuild renewable generation to achieve the same outcome.

The exact location of the substations is subject to detailed design, including coordination with the location and design of the Renewable Energy Zones (REZs) and potential new load developments. The magnitude of the required power transfer capacity and distances involved determine the required transmission infrastructure, including the potential use of 500kV. Powerlink is currently undertaking detailed modelling of network needs to meet the policy objectives of the QEJP. While this modelling is ongoing, initial results support the investments identified in the Blueprint.

The upgraded network is proposed to be delivered in four stages (described below) with sequencing specifically aligned to match PHES facility timeframes. The delivery schedule will be adjusted or amended as projects progress and investment decisions are refined. Powerlink expects to conduct the stages in parallel to meet the required delivery dates.

Beyond these four stages of development, Powerlink will need to upgrade and refurbish other parts of the existing network, as described in Powerlink's Transmission Annual Planning Report. Powerlink will coordinate and optimise the overall portfolio of works to provide the required network services at lowest cost.



Proposed staging for the transmission backbone development

Project	Indicative Length	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32	32/33	33/34	34/35	35/36	Estimated Cost ($M)
Stage 1 **Borumba Pumped Hydro Connection**	140km	Design & Acquisition			Construction											**800**
Stage 2 **Central Queensland Connection**	290km	Design & Acquisition					Construction									**1,300**
Stage 3: Pioneer-Burdekin Pumped Hydro and Northern Queensland Connection																
3A **CQ to NQ (proposed near Nebo)**	470km	Design & Acquisition					Construction									**3,400**
3B **NQ to Pioneer-Burdekin Pumped Hydro**	70km						Design & Acquisition		Construction							
3C **Pioneer-Burdekin Pumped Hydro to location near Townsville**	210km				Design & Acquisition				Construction							
Stage 4 **Connection to Hughenden Area**	370km	Commissioning date to be determined														**1,700**
TOTAL ESTIMATED CAPITAL COSTS – TRANSMISSION BACKBONE UPGRADES																**7,200**

Note: Construction period includes test and commissioning.

Stage 1: Borumba Pumped Hydro connection

With a planned capacity of up to 2GW, Borumba PHES will require two connection points:

- Borumba to Powerlink's existing Woolooga Substation (approximately 60km)
- Borumba to Powerlink's existing Tarong or Halys Substations (approximately 80km).

These connections allow for ongoing power system security with planned outages for maintenance and project work, and facilitate more renewable connections.

A connection to Tarong or Halys Substation will provide access to high-quality renewables in south west Queensland to help supply the Borumba pumping load and facilitate strong intra-regional connections with the rest of the National Electricity Market (NEM).

The connection to Woolooga Substation allows for increased utilisation of the coastal 275kV Central to Southern Queensland corridor to supply load growth in South East Queensland (SEQ) while providing access to future renewable energy developments in the Wide Bay region.

Delivery of Stage 1 is planned to match the Borumba PHES commissioning works in 2029.

Stage 2: Central Queensland connection

Stage 2 will provide a 290km connection from Woolooga to Gladstone. This connection will support the supply of major load centres in Central Queensland and provide firming of REZ generation. More than 3GW of variable renewable generation is expected to be connected to the Central Queensland REZ.

The upgraded capacity combined with the strong connection to Borumba PHES (and subsequently the Pioneer-Burdekin PHES in Stage 3) will provide the region with access to firmed renewable energy to enable reduced reliance on coal-fired generation.

There is also strong interest in future load growth in the Central Queensland area, in the form of electrification of existing industry, as well as the development of hydrogen facilities. This connection provides a platform to expand to support future load growth in the area.

Delivery of Stage 2 needs to be coordinated with Stages 1 and 3, but due to development timeframes will need to be progressed in parallel.

Stage 3: Pioneer-Burdekin Pumped Hydro and North Queensland connection

The Pioneer-Burdekin PHES in North Queensland is currently being planned for a capacity of up to 5GW.

This requires a significant transfer capacity and multiple connections. The proposed development includes connecting towards the Townsville area in the north to join with future developments in the Hughenden area (Stage 4) and supply the load centres in Townsville (including potential new loads), and to the Central Queensland connection from Stage 2.

This is a very long connection at approximately 750km and will require extensive work in approvals and determining corridors and line routes, followed by construction. Under the proposed timeline, Stage 3 will be delivered in three parts, with the initial connection to the Pioneer-Burdekin PHES before its target operational date in 2032. Detailed planning, design and engineering works will be required to refine these parts.

Stage 4: Connection to Hughenden Area

A high-capacity connection to Hughenden aims to unlock the significant wind resource in the area and transfer it to load centres and pumped hydro sites for storage.

The timeframes associated with this stage are subject to the outcomes of the Government's approach to supporting the connection of the North West Minerals Province to the network.

SYSTEM SERVICES

Power system security requires services such as system strength and inertia and to ensure adequate voltage control, stability and ramp rates. The reduction of synchronous generation sources (such as coal-fired generation) changes the electrical characteristics of the energy system. Continuing to meet power system security into the future will require sufficient system services provided by a range of alternate sources.

As the System Strength Service Provider (SSSP) for the Queensland region, Powerlink is responsible for the timely provision of system strength to ensure the secure operation of the power

system and support the stable operation of significant amounts of inverter-based renewable generation. This will require significant investment across the industry in new and modified plant.

Powerlink will take a portfolio approach that will adjust as technology evolves. Repurposing existing coal-fired units as synchronous condensers, the new PHES facilities, and building new synchronous condensers will help maintain the required system strength. The system strength portfolio may include new greenfield synchronous condensers to support the secure operation of the power system and the connection of new inverter-based renewable generation. The locations for these are still being refined and the portfolio will be adapted as required.

Adapting the tuning of control systems as new resources connect and the adoption of grid-forming inverters (e.g. in Battery Energy Storage Systems) will help to mitigate the need for more extensive measures.

TRANSMISSION BACKBONE DEVELOPMENT COSTS

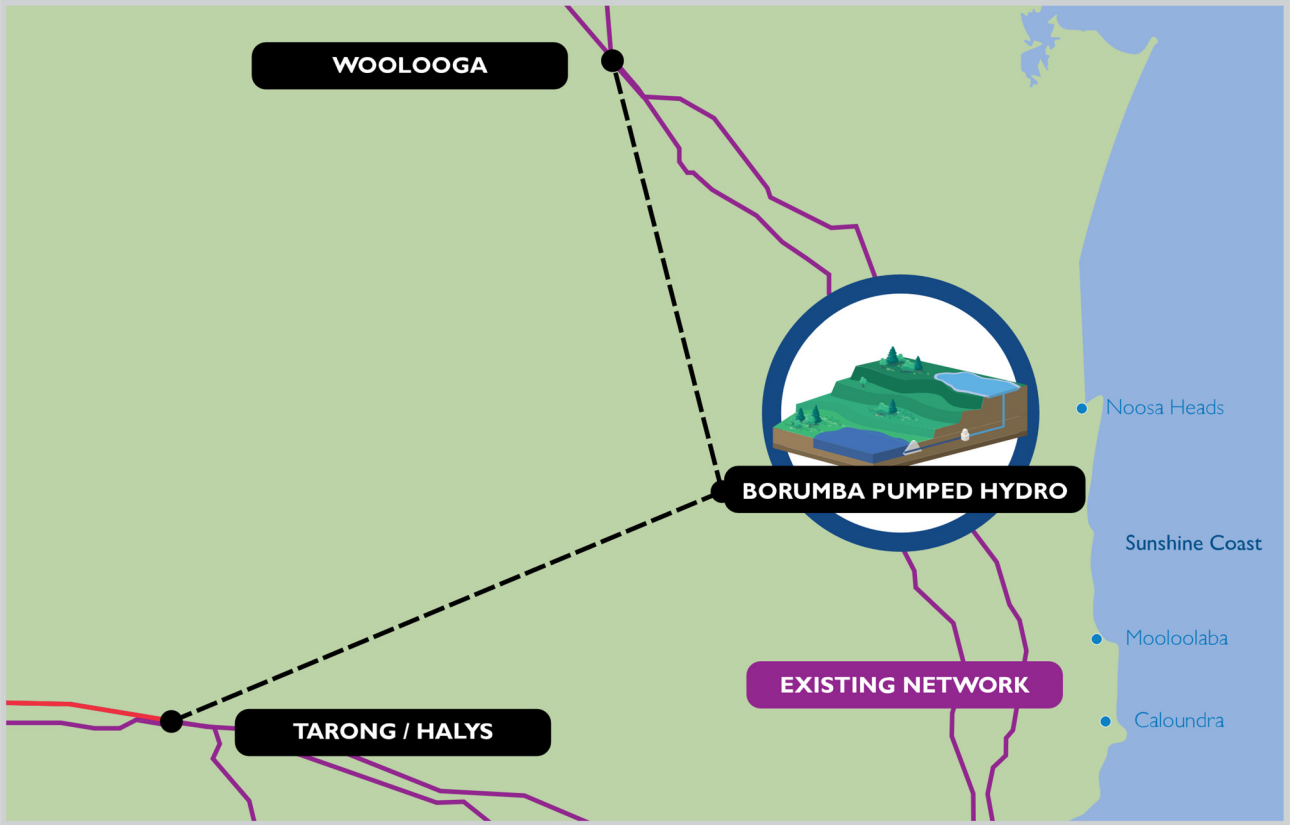
Powerlink has estimated the $7.2 billion transmission infrastructure costs for Stages 1 to 4 based on a unit cost basis, informed by recent work on 500kV Queensland-New South Wales Interconnector (QNI) upgrade options, and including estimated costs for easement acquisition, engagement, design and other enabling infrastructure. Powerlink checked the unit costs for reasonableness against the Australian Energy Market Operator's (AEMO) cost database.

These high-level estimates were derived for the purpose of strategic planning rather than investment decisions, using the best available information and adding contingencies to account for uncertainty. Over the coming years — and ahead of investment decisions — we will refine all cost estimates with more detailed design and planning, and with better information on transmission corridors through engagement with landholders, communities and other key stakeholders.

INITIAL DELIVERY FOCUS

The development of transmission connections for the proposed Borumba PHES (Stage 1) and corridor investigations and engagement on the Central Queensland transmission connection and the Pioneer-Burdekin Pumped Hydro and North Queensland connection (Stage 2 and 3) will be the initial focus of the upgraded transmission backbone (refer to QEJP action 1.1).

Powerlink has been engaging with local communities and other stakeholders in the Borumba PHES region since late 2021 to gain a better understanding of social, economic and environmental factors that might influence where the proposed corridors are located.



We will engage on potential transmission corridors for Stage 1 in November 2022 with a view to having recommended corridors in early 2023. Once a recommended corridor has been identified, we will undertake further cost analysis of the transmission connection to provide to Queensland Hydro.

Queensland Hydro will use this information as part of its Detailed Analytical Report (business case) anticipated to be completed in the first half of 2023.

Powerlink currently anticipates it will commence corridor investigations and engagement on the Central Queensland transmission connection and the Pioneer-Burdekin Pumped Hydro and North Queensland connection (Stage 2 and 3) in mid-2023. This will involve early engagement with the local community, landholders and Traditional Owners, followed by more detailed corridor investigations in late 2023 and early 2024.

The input we receive through stakeholder engagement will assist in identifying a recommended corridor that best mitigates the potential social, cultural, environmental and economic impacts of the transmission line development. We will undertake comprehensive technical and economic analysis ahead of any final investment decision (refer Chapter 5 – Approach to Network Approvals and Transmission Charges).

A NEW VOLTAGE LEVEL FOR QUEENSLAND

With the transition to variable renewable generation there is a fundamental change in how energy will flow across the transmission network. With renewable generation having lower capacity factors than the current generation fleet, achieving the same energy delivery requires far more installed capacity (approximately three times more). Times of high generation output will then result in much greater power flows than currently experienced.

The secure and economic operation of the future power system requires changes to the transmission network to efficiently move power between renewable generation, the proposed Borumba and Pioneer-Burdekin PHES and the state's load centres.

An upgraded high-capacity transmission backbone would enable the efficient transfer of large volumes of renewable and stored energy and provide a flexible platform for future expansion as new loads emerge. Given the capacity requirements, longer distances and future use, 500kV has been proposed.

Only sections of the network that are expected to require high transfers at long distances or become an integral part of a longer-term plan will be considered for 500kV. In other parts of the network with lower load transfer requirements, 275kV continues to be the most economic voltage.

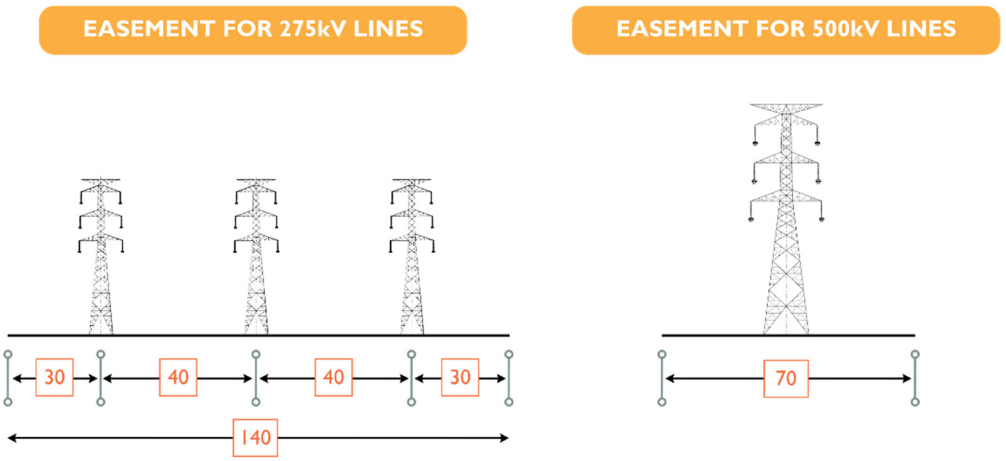
It would be complemented by the use of contemporary and emerging technologies to limit the scale of investment required to deliver the necessary reliability and resilience at lowest long-run cost to customers.

Powerlink has also considered alternative transmission options for the transmission backbone:

- High Voltage Direct Current (HVDC) is an economic option for high transfer capabilities over long distances but requires high-cost converter stations for any connections to the line and so is more suitable for applications where a very limited number of connections are required.
- A 275kV design to support the power transfers across the distances involved would consist of a minimum of two parallel 275kV double circuit lines instead of a single 500kV double circuit line.

The table below shows a comparison and rationale for the proposed development of the backbone transmission at 500kV.

Benefits deliverable by 500kV for the transmission backbone	
Higher power transfer capacity	500kV transmits up to three times more power per circuit than 275kV. The secure transfer level of one 500kV double circuit line would require a minimum of two parallel 275kV double circuit lines. While two parallel 275kV double circuit lines would have equivalent thermal capacity to one 500kV double circuit line, avoiding voltage instability becomes a critical design requirement for long transmission lines. For longer distances, three 275kV double circuit lines may be required. 500kV also requires less dynamic reactive power sources.
Lower transmission losses	Power transferred at higher voltages incurs lower network losses. Four parallel 275kV double circuit lines would be required to match the network loss performance of one 500kV double circuit line for the same power transfer.
Higher cost efficiency	The capital cost of one 500kV double circuit line is estimated to be about twice as much per kilometre as a 275kV double circuit line. However, only

	one 500kV double circuit line is required compared with a minimum of two 275kV double circuit lines. The ongoing operational and maintenance costs scale with the number of structures and lines and so would be greater for a larger number of 275kV double circuit lines compared to one 500kV double circuit line.
Less corridor required	A 500kV double circuit line requires a smaller easement than multiple 275kV double circuit lines sharing the same right of way. For example, one 500kV double circuit line is expected to need an easement half as wide as three 275kV double circuit lines. 
More expandable for future development	500kV provides Queensland with a greater ability to meet increased capacity for new and large electrification loads. A second 500kV double circuit line would increase the power transfer capability by up to 4,500MW. This compares to an increase of approximately 1,500MW from adding another 275kV double circuit line in the future.
More timely constructability	A 500kV design involves constructing around 1,500km of new transmission by 2035, which is challenging but achievable. Constructing multiple 275kV lines would lead to longer delivery timeframes.

While 500kV is new to Queensland, it is not new to the NEM. Victoria's 500kV network was developed more than 50 years ago and connects the LaTrobe Valley, Melbourne, and the Portland Aluminium Smelter. New South Wales also extensively uses 500kV. Many of the new high-capacity links committed or planned in the NEM are at 500kV to take advantage of the superior capacity and loss characteristics, and reduce the potential impacts on communities and landholders in easement and footprint sizes.

ALIGNMENT WITH THE INTEGRATED SYSTEM PLAN (ISP)

Both AEMO's 2022 ISP and the QEJP include a rapid increase in renewable generation expansion and the critical need for a portfolio of firming capacity. The QEJP has higher renewable energy targets and lower site-specific costs associated with PHES than the generic costs assumed in the ISP. This leads to different transmission outcomes as part of the least cost development of the power system.

The 2022 ISP comments that *"there may be opportunities for further medium and deep storage projects, for example pumped hydro sites, in locations that allow for lower cost development"* (p. 55). This supports what the ISP considers to be the NEM's most pressing need:

"The most pressing need in the next decade (beyond what is already committed) is for dispatchable batteries, pumped hydro or alternative storage to manage daily and seasonal variations in the output from fast-growing solar and wind generation." (p. 10).

The ISP is a point in time document and evolves with changing policy and technological developments. Powerlink is undertaking its own modelling for the detailed design of the required transmission needs to support the investment business cases. While this modelling is ongoing, initial results support the investments outlined in the Blueprint. We will continue to work with AEMO to incorporate updates as required into the 2024 ISP.

NEXT STEPS

Transmission network development
Progress early works activities for transmission connections for Borumba PHES (Stage 1) and Central Queensland (Stage 2) (refer to QEJP action 1.1).
Work with the State Government to establish a process for updating the Queensland SuperGrid Infrastructure Blueprint (refer to QEJP action 1.10).
Refine transmission cost estimates to consider more detailed design and planning and improved information on proposed transmission corridors through early and effective community engagement.
Continue to share information through joint planning with AEMO to develop the inputs, assumptions and methodology for the 2024 ISP.

4. ENGAGING
WITH QUEENSLAND COMMUNITIES

Key insights
Powerlink is committed to early, meaningful and authentic engagement with local communities, landholders, Aboriginal and Torres Strait Islander Peoples and other key stakeholders to shape the planning and delivery of transmission infrastructure associated with the Queensland SuperGrid Infrastructure Blueprint (Blueprint).
We will use insights from our community research to improve our engagement and community benefits approaches.
We will collaborate with agricultural and environmental stakeholders to improve land use and biodiversity outcomes.

POWERLINK'S EARLY ENGAGEMENT APPROACH

With the sheer breadth of change that comes with the new energy future, meeting the needs and expectations of the communities we work in is more important than ever. We have always held a strong view that engaging with local communities is an important part of providing our electricity transmission services safely, reliably and cost-effectively. This is front and centre as we look at the challenges and opportunities of the future.

Our infrastructure stays in service for up to 50 years, and partnering with host communities from Cairns down to the New South Wales border is important to building relationships based on respect and trust. Most importantly, we are focusing on partnering that delivers local community benefits for the longer term.

Early engagement in development of the transmission network improves our planning and decision-making. Our approach is outlined below.

EARLY ENGAGEMENT APPROACH

TARGETED STAKEHOLDER ENGAGEMENT	WIDER COMMUNITY ENGAGEMENT	DEVELOP CORRIDOR OPTIONS	FEEDBACK ON CORRIDOR OPTIONS	RECOMMENDED CORRIDOR OPTION
Engagement with key stakeholders including Councils, Traditional Owners and Peak Bodies.	Wide community and landholder engagement, to gain better insights into constraints and matters of interest.	Incorporate community feedback into consideration of corridor options.	Release Study Area and potential options, no Recommended Option at this stage. Community engagement to gain feedback on corridor options.	Develop and release draft Corridor Selection Report for community engagement and input. Show all options and Recommended Option.

COMMUNITY INSIGHTS

We recently undertook one of Australia's largest community sentiment research programs to ask Queenslanders about their views on renewable energy development and working with Powerlink. During 2021 and 2022, almost 1,800 community members from Southern, Central and Far North Queensland participated in the research.

The research showed strong support for renewable energy infrastructure, but limited understanding about the process involved in its development. This represents a risk that the 'real-life' experience of infrastructure development may not align with community expectations. It also presents an opportunity for Powerlink to better communicate and engage with communities on the various stages of infrastructure development.

The research found that while there are common drivers of trust across the regions, there are also subtle differences to consider.

Powerlink will continue to use these and other research insights to improve our engagement and better meet the expectations of Queensland communities as the QEJP is progressed.

REVIEWING OUR NETWORK DEVELOPMENT PROCESS AND COMPENSATION FRAMEWORK

Powerlink has commenced a review of our Network Development Process and compensation framework. The Network Development Process outlines how we engage, access and acquire land, and obtain relevant approvals for the development of Powerlink's infrastructure.

We recognise that our framework for paying compensation to landholders impacted by our infrastructure is of significant interest, even more so now given the sheer scale of development needing to be undertaken in Queensland as well as other states.

Our intent is to ensure our frameworks are fit-for-purpose, contemporary and reflect landholder and community expectations. We will directly involve landholders, community members and Aboriginal and Torres Strait Islander Peoples in these reviews.

THE ENERGY CHARTER COLLABORATION

The Energy Charter brings together like-minded energy businesses from across the supply chain to deliver better outcomes for customers and communities. The Energy Charter has allowed for collaboration between transmission businesses, landholder representatives, peak agricultural bodies and renewable energy advocates.

This collaboration saw the launch of the Landholder & Community Better Practice Engagement Guideline in late 2021. Our current collaboration focus is to undertake research to improve co-existence practices for agricultural landholders already affected or potentially affected by transmission infrastructure. A co-existence guideline will be released in early 2023 to further support our engagement work.

Powerlink is also actively engaging with environmental agencies and advocacy groups to deliver better outcomes in the intersection between biodiversity and renewable energy infrastructure.

COMMUNITY RELATIONS AND INVESTMENT

Powerlink will work with communities to identify opportunities to invest locally, as part of delivering the transmission infrastructure to support the Queensland Energy and Jobs Plan (QEJP).

Our Community Engagement Strategy reflects the principles and approaches underpinning this focus and includes a local investment approach with three pillars:

Powerlink has established a dedicated Community Relations team to support Powerlink in:

- gathering community views and using local knowledge as input into transmission infrastructure and Renewable Energy Zone (REZ) planning decisions
- working with renewable energy proponents to encourage community investment and involvement
- managing our ongoing, targeted community benefits and investment program.

ENGAGEMENT WITH TRADITIONAL OWNERS

Powerlink acknowledges and respects the ongoing custodianship and cultural connection that Aboriginal and Torres Strait Islander Peoples have to their traditional lands. We recognise the significant and integral role these interests play in our daily operations and we are committed to working in genuine partnership with their communities.

With an increase in future network development, one of Powerlink's priorities is to ensure we continue to meet our ongoing obligations under cultural heritage best practice guidelines and legislative frameworks. A key component of this is to implement our established cultural heritage agreement making approach, which ensures we work in partnership with Traditional Owners to identify and manage cultural heritage.

To increase our capacity to facilitate stronger relationships with Aboriginal and Torres Strait Islander Peoples, Powerlink has expanded the remit and resourcing of our Indigenous Partnerships team.

NEXT STEPS

Engaging with Queensland communities
Powerlink will engage with local communities, landholders, Aboriginal and Torres Strait Islander Peoples and other key stakeholders to shape the planning and delivery of transmission infrastructure associated with the Blueprint, including REZs and other network infrastructure.
Share the results of community sentiment research with Local and State Government, as well as stakeholders, and incorporate key findings into engagement and community benefits approaches.
Finalise and publish the co-existence guideline developed in collaboration with agricultural bodies through the Energy Charter.
Review our Network Development Process and compensation framework, in collaboration with landholders, community, Aboriginal and Torres Strait Islander Peoples and other stakeholders.
Collaborate with environmental agencies to improve the intersection between biodiversity and renewable energy infrastructure.

5. APPROACH

TO NETWORK APPROVALS AND TRANSMISSION CHARGES

Key insights
Powerlink is committed to minimising the overall costs of the power system transformation.
Transmission investment identified in the Queensland SuperGrid Infrastructure Blueprint (Blueprint) is intended to attract and facilitate the entry of cheaper renewable generation and storage to the market, ultimately lowering whole-of-system costs.
Powerlink is committed to implementing a market-led, generator-pays Renewable Energy Zone (REZ) model. This approach means that Powerlink can develop REZ infrastructure with less direct cost impact on Queensland households and businesses.
Powerlink will continue to apply the robust cost-benefit analysis arrangements, currently the Regulatory Investment Test for Transmission (RIT-T), set out in the National Electricity Rules, to assess the costs, benefits and most efficient options (including non-network options) to address network needs.

ELECTRICITY AFFORDABILITY AS WE MOVE TO THE FUTURE POWER SYSTEM

We recognise that energy affordability is a key consideration for all Queenslanders. As such, affordability and continuing to drive value for our customers is a key consideration in the decisions we make. This applies to the transmission component of electricity bills, and what we can do to influence broader, whole-of-system costs, to ease affordability pressures.

Today, Powerlink's transmission network charges for the regulated network represents about nine per cent of the total delivered cost on a typical Queensland residential electricity customer's bill. Transmission network charges represent a higher proportion of the cost of electricity for large energy users directly connected to our network, whose charges may vary according to location and network use.

With significant new transmission infrastructure identified in the Blueprint, Powerlink recognises that transmission charges will increase. However, we expect that such transmission investment will facilitate cheaper renewable generation and storage entering the market, producing lower overall whole-of-system costs in the longer term compared to an alternative outlook that does not include the Queensland Energy and Jobs Plan's (QEJP) coordinated development approach.

Independent modelling commissioned by the Queensland Government highlights that delivery of the plan should see wholesale power prices 15% lower on average out to 2040 and the average annual bill for a household will be $150 lower in 2032 and $1,495 lower for a small business when compared to an alternative outlook without the Plan.

The cost and price impact of investment to meet emerging transmission needs and build future capability needs to be carefully considered in the context of the overall benefits of Queensland's power system transformation.

Transmission investment is also expected to drive significant economic benefits by unlocking new clean energy industries, helping to decarbonise existing industry sectors such as mining and manufacturing and unlocking community investment and development. As industry sectors decarbonise by electrifying their processes their additional electricity demand will contribute to funding additional transmission investment.

ALLOCATION OF TRANSMISSION CHARGES AND COST-MINIMISATION APPROACH

Powerlink has actively investigated alternative and innovative user charging and funding arrangements for transmission investments that support the power system transformation and drive value for customers.

Delivering on the transmission needs to support the QEJP will require ongoing planning, justification and targeted development over many years. These investments will help secure Queensland's energy future for the longer term, attract further investment in our state and help decarbonise our economy.

An overview of Powerlink's proposed approach to user charging for REZ and transmission investments is outlined below.

Market-led REZ model	• Powerlink will use a market-led, commercial approach for REZ investments required to deliver the QEJP. • We will recover the cost of REZ infrastructure directly from renewable generation proponents connecting to the REZ. The cost of these transmission investments associated with the development of REZs and building future capability into our network will be developed on a non-regulated basis, with user charges paid by renewable proponents. • This approach means that Powerlink can develop cost-effective, scale-efficient REZ infrastructure with little or no direct cost impact on end-use customers (i.e. Queensland households).
Transmission investments	• Powerlink will continue to use the economic assessment framework set out in the National Electricity Rules (currently the RIT-T) to assess the costs, benefits and most efficient options (including non-network options) to address emerging regulated network needs and future capability. • We will target scale-efficient transmission investments and use our current competitive delivery model to ensure that customers pay only the prudent and efficient costs of the regulated transmission network. We will rigorously test every investment before we commit to it.

With the rapid changes in the power system outlined in the QEJP, there is a potential for some network investments initially made to provide non-regulated services, such as some REZ investments, to be re-purposed at a later time to provide broader network services to the regulated network. This has occurred previously where for example re-use of part of an existing generator connection provided the lowest-cost solution to meet a regulated network need. In these circumstances, Powerlink will undertake a transparent assessment to demonstrate the costs and benefits and test these against a range of other network and non-network options. Only if such a re-purposing is justified will these assets become regulated and paid for by end-use customers.

NETWORK APPROVALS

Powerlink is focused on ensuring the transmission network is developed prudently and efficiently, so that customers receive the maximum benefits of the power system transformation. To support this aim, we will reassess costs and benefits to the electricity supply chain of the proposed transmission network investment pathways presented in the Blueprint.

Under the National Electricity Rules, Powerlink is required to apply the relevant cost-benefit assessment to all proposed regulated investments with a capital cost above $7 million. This is currently the RIT-T and requires that Powerlink assess the costs and benefits to all those who produce, transmit, distribute and consume electricity in the National Electricity Market.

The RIT-T is designed to support the National Electricity Objective, which is "to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity with respect to: price, quality, safety and reliability and security of supply of electricity." On 12 August 2022, Commonwealth, State and Territory Energy Ministers agreed to

amend the *National Electricity Law* to include an emissions objective into the National Electricity Objective. This is likely to require a change to the RIT-T to recognise emissions reduction as a benefit under the RIT-T, and will provide greater alignment with the policy direction set out in the QEJP to decarbonise Queensland's electricity sector.

The QEJP's economic analysis outlined the benefits of a coordinated plan compared to an uncoordinated outlook without a Plan for the power system transformation. It will be important that our economic assessment to test individual transmission network investments reflects the overall strategy of the QEJP, not just each short-term network need in isolation. While such an approach will be challenging, it is an essential part of the analysis for major network augmentations. Each investment decision point is an opportunity to review and adjust the development pathway to ensure we make timely investments to suit the emerging needs of the power system transformation, while deferring investments to maintain flexibility where possible.

NEXT STEPS

Funding and pricing impacts

Continue to implement funding and financing models that support investment in transmission infrastructure and minimise costs to customers.

6. CHALLENGES AND OPPORTUNITIES

Key insights
Powerlink is developing approaches to address the challenges and opportunities in delivering its responsibilities under the Queensland SuperGrid Infrastructure Blueprint (Blueprint).
The operation of the future power system will leverage advanced technologies to manage increasing variability and uncertainty and ensure an ongoing safe, reliable and cost-effective electricity supply.
There are opportunities to increase local procurement and use supply chain management practices to obtain goods and services on time and at good value in a highly constrained and competitive environment.

ADDRESSING THE NEEDS OF THE FUTURE NETWORK

To develop and operate the future transmission network outlined in the Queensland Energy and Jobs Plan (QEJP), Powerlink will need to address a range of new challenges. Some challenges are inherent in the likely future topology of the transmission network and how it can be developed and operated safely, reliably and cost-effectively. Other challenges relate to how we can deliver the needed transmission network investments in a relatively short timeframe.

There are also a range of opportunities for Powerlink, our customers, and the communities in which we operate. An orderly transition relies on coordination of the timing of the transmission development with reductions in coal-fired generation, connection of sufficient amounts of new renewable generation with firming and storage to serve customers reliably and cost-effectively. The QEJP leverages on government ownership to provide this coordination with opportunities to adjust the timing across the portfolio and retain reserve capacity during the transition.

Customers, communities and other stakeholders will be front and centre as we address these challenges and opportunities.

DEVELOPING AND OPERATING THE FUTURE NETWORK

Developing a resilient future transmission network

The planning and development of the existing transmission network in Queensland benefitted from significant central planning of the large coal-fired power stations together with the existing pumped hydro facilities such as Wivenhoe. These existing large electricity generation centres typically have at least four high-capacity transmission circuits connecting them to load centres, often on geographically diverse routes.

This design has inherently provided a level of resilience that allows the network to be operated safely, securely and reliably, even under extreme climatic conditions such as bushfires and supercell storms. This degree of resilience could be justified given the high capacity factors and stable power flows from the dispatchable coal-fired generators.

With more diverse and intermittent generation sources in the future, planning and developing a suitably resilient transmission network will be an ongoing challenge for Powerlink.

Operating reliably and securely during contingencies

The future transmission network plan in Queensland is based on an upgraded transmission backbone with voltage levels up to 500kV (as described in Chapter 3 – Transmission Network Development Priorities).

A key challenge of introducing a new, higher voltage level is to ensure that the overall power system can continue to be operated reliably and securely while individual transmission elements are out of service, including for planned maintenance. For example, if one of the proposed 500kV circuits is planned to be out of service for an extended period, then an unplanned outage of another 500kV circuit must be taken into account to ensure that the system can remain in a secure operating state. This scenario will require significant use of the existing 275kV system to provide backup capacity.

This scenario may also require operational schemes to avoid overloads if a second contingency was to occur. This could include schemes to detect the second contingency and quickly run back generation or make other rapid changes in critical parts of the system. Powerlink will use

technology-based solutions to achieve similar reliability outcomes and seek to avoid substantial additional construction expenditure to minimise price impacts to customers.

Implementing technology for smarter network operation

As the power system becomes more complex, we need to implement smarter ways to drive better utilisation of network capability. Powerlink is undertaking a phased implementation of Wide Area Monitoring Protection and Control (WAMPAC), an advanced control system that can detect the onset of network disturbances and maintain power system stability. WAMPAC rapidly detects specific conditions over geographically diverse transmission assets and initiates appropriate action to adapt to system conditions such as changing the network configuration or altering generation or load characteristics of connections. Its speed enables it to be effective in sub-second timeframes and can remediate dynamic conditions to secure the network and avoid adverse operating conditions.

Operating a highly variable power system

Operational flexibility is also required due to the changing nature of the generation system. Historically, the transmission system has had relatively stable and predictable power flows with consistent generation patterns, resulting in consistent transmission line flows. This environment is rapidly changing with highly variable outputs from renewable generation meaning that Powerlink's operating model must adapt and be able to deal with highly variable transmission line flows.

Renewable generators and newly electrified industries that are responsive to market pricing signals will add further complexity to our modelling of power flows for network operation and contingency response. We expect new localised power system support services will be needed to enable access to the network to conduct routine maintenance and facilitate new connections. These services will manage power system conditions in day-ahead and hour-ahead timeframes, outside of traditional market services.

The complexity of power flow modelling and contingency planning is likely to amplify the need for increased real-time information sharing of what is happening on the distribution network. This will support Powerlink to optimise system strength, inertia and transmission power flows, and ensure resilience for non-credible events. Managing more complex network operations and the real-time dynamics of the power system will need to be supported with additional situational awareness tools, analytics and control systems.

PROJECT DELIVERY AND COST MANAGEMENT

Delivery of transmission network for Queensland Renewable Energy Zones (QREZ) and the Blueprint will require substantial infrastructure development. This challenging program of development represents the largest transmission construction program ever undertaken in Queensland. While the program implementation and scheduling will be staged to reflect investment certainty and assist delivery, there are a range of considerations to ensure effective implementation, including:

- early and meaningful engagement with the community, including landholders, Aboriginal and Torres Strait Islander Peoples and broader community, to support corridor development. This will include targeted community benefits arrangements.
- ensuring a coordinated, timely approach to planning and works approval processes between Powerlink and various Federal and State Government departments. This may include exploring opportunities to streamline and improve existing approval processes and regulations, where appropriate.

- early engagement with relevant partners, including contractors, industry and unions, to obtain committed labour resources at a time where major transmission construction projects are occurring across Australia, recognising a limited availability of transmission workers. This will require a visible forward program and some level of pre-commitment to works programs to secure strategic partners and resources
- early engagement with equipment suppliers and vendors to obtain plant and equipment in a timely and cost-effective manner.

Powerlink is already experiencing challenges in labour and materials, cost volatility, rising inflation and reduced price validity, and the current national and international renewable energy transformation will put pressure on delivery timeframes. Powerlink is working closely with contractors, suppliers and vendors to ensure we can meet the timeframes outlined in the Blueprint.

Procurement strategies to support program delivery

Like many other organisations, Powerlink is experiencing the impact of supply chain disruption as a result of the COVID-19 pandemic and geo-political tensions. To secure our supply chain for critical equipment, we have implemented strategies that include:

- amending our inventory philosophy from just-in-time to just-in-case for long lead and/or critical materials
- engaging early and providing visibility of future requirements to key suppliers
- reviewing our standards and specifications to standardise products where possible
- strengthening supplier relationship strategies with key suppliers
- reviewing contractual frameworks to accommodate market volatility.

It is important to note that multiple large infrastructure development programs are either in execution or being planned globally. As a recent example the United States Congress passed the “Inflation Reduction Act” wherein significant investment will be made to reduce emissions through developing clean energy solutions like solar and wind.

These investments impact our ability to source materials in a timely, cost-effective manner as international sources are in strong demand. To mitigate these risks, Powerlink is looking at opportunities to source locally or, where possible, encourage local manufacturing or capability development.

SUPPORTING LOCAL ECONOMIES

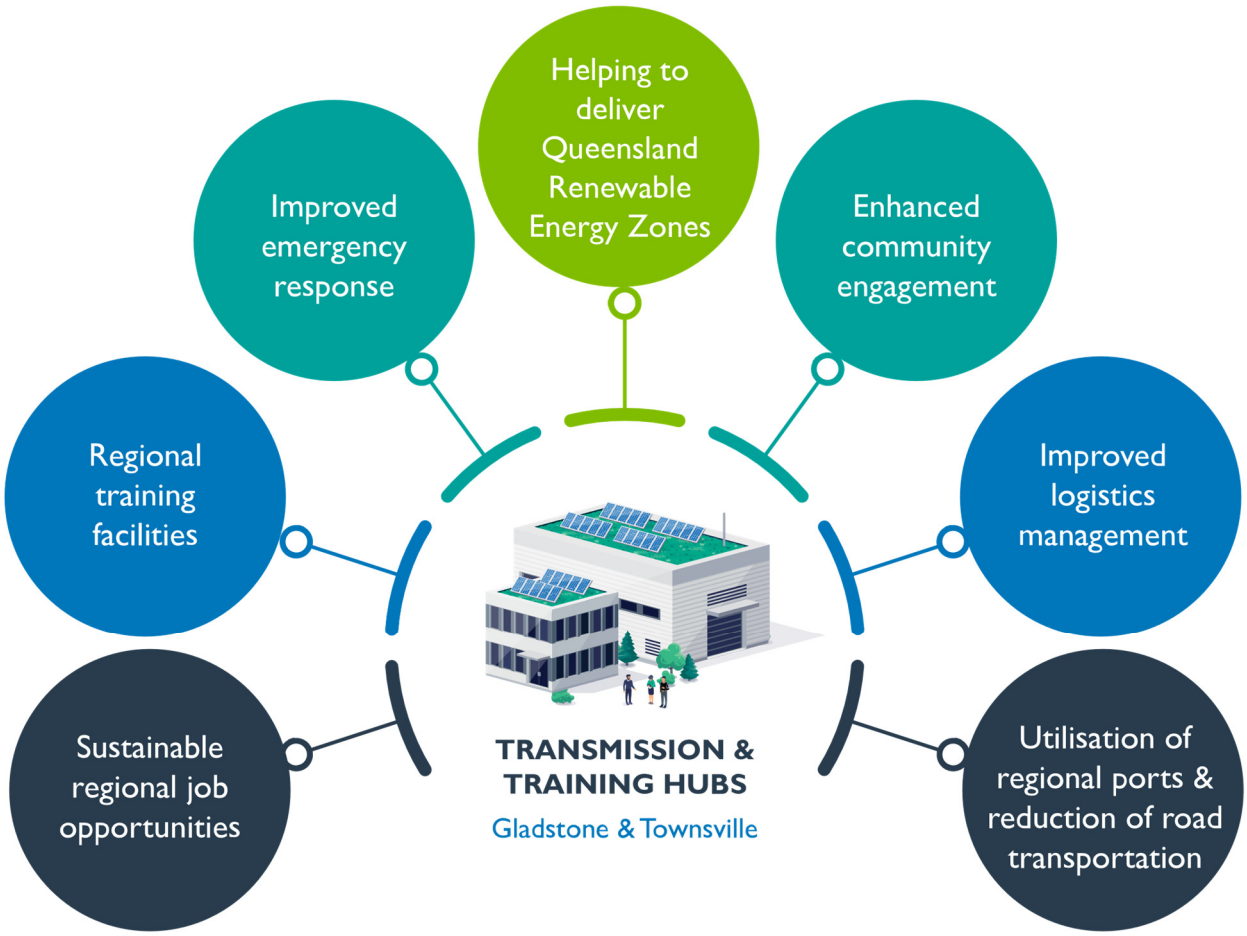
Deliver work programs through regional transmission and training hubs

The Queensland Government is investing $90 million to establish two new transmission and training hubs to drive local employment and training (refer to QEJP action 3.3).

The transmission and training hubs will be purpose-built facilities providing Powerlink's workforce with a regional presence to carry out increased workloads in Central and Northern Queensland and support training needed to deliver the energy transformation.

The hubs will provide multiple benefits to local communities in regional Queensland by promoting partnerships with Powerlink in training and employment opportunities, community engagement, and investment in community and social infrastructure.

The hubs will also support emergency response, logistics management and utilisation of regional ports to reduce road haulage and associated costs.



Engaging local suppliers

New transmission infrastructure and Renewable Energy Zone (REZ) development will boost investment in Queensland's regional economies, driving employment, energy and infrastructure outcomes. This will in turn support better social and economic outcomes.

In its transmission infrastructure development, Powerlink is strongly prioritising opportunities for local suppliers, to maximise their provision of support services, wherever possible. Powerlink has recently employed a number of local content suppliers in the construction program for a 275kV line development to Kidston in North Queensland and the MacIntyre Wind Precinct in the Southern Downs REZ. In addition to promoting local procurement opportunities, improved roads and telecommunications, Powerlink will work closely with Queensland communities to deliver local benefits and investment (refer Chapter 4 – Engaging with Queensland Communities).

NEXT STEPS

Address challenges and opportunities
Work with suppliers to strengthen supply chain commitments by securing production slots and increasing spares holdings.
Develop regional transmission and training hubs in Gladstone and Townsville (refer QEJP action 3.3).
Ensure that the construction programs for QEJP maximise the use of local content wherever possible. This includes working with contractors to engage with local suppliers and sub-contractors, to identify any suitable opportunities.
Powerlink will work with industry stakeholders to achieve an uplift of skilled resources and create local training and employment opportunities. This will involve securing partnerships and long-term commitments, considering the pipeline of works and mechanisms to retain resources in Queensland.

7. QUESTIONS

FOR OUR CUSTOMERS, COMMUNITIES AND OTHER STAKEHOLDERS

Meeting the needs of Queenslanders is critical to Powerlink's success. We will rely on input from customers, communities and other stakeholders as we progress our plans to deliver Powerlink's elements of the Queensland Energy and Jobs Plan (QEJP).

We invite you to provide input and feedback on the questions below. They are intended to generate input to inform our decision-making and planning. We also invite your questions and views on all other information presented in this document.

Developing Renewable Energy Zones (REZs) in Queensland

- How can Powerlink and renewable developers better coordinate their community engagement and benefits programs, in particular for REZs?
- How can Powerlink best deliver REZs to provide investment certainty and speed-to-market for renewable developers?

The importance of firming and storage

- What other factors should Powerlink consider with regards to firming and storage to optimise renewable development in Queensland?
- If you are a developer and operator of Battery Energy Storage Systems (BESS), what additional opportunities do you see to provide network support services that maximise the use of the BESS for market activities?

Transmission network development priorities

- What are the key aspects that Powerlink needs to focus on to ensure that we optimise the development pathway that delivers whole-of-system benefits?

Engaging with Queensland communities

- What are the key areas that Powerlink needs to focus on to improve the way our infrastructure co-exists with Queensland communities?
- How can we better engage and involve Aboriginal and Torres Strait Islander Peoples in Powerlink's future delivery program?

Approach to network approvals and transmission charges

- What other information would you value on how investment in transmission will impact on whole-of-system costs?

Challenges and opportunities

- How can Powerlink support local economies in delivery of the QEJP?

SHARE YOUR FEEDBACK

Please contact us soon at qldenergyfuture@powerlink.com.au to provide input, indicate your interest in providing future input or to seek more information.

Our planning is underway, so your feedback will be appreciated.

Thank you for your interest.

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