Pioneer-Burdekin
Pumped Hydro Energy Storage Project

Detailed Analytical Report

Executive Summary

The Executive Summary is written in three parts to cater to the time and information needs of its different audiences:

1 **Project snapshot**
A brief summary of the Project need, what it will deliver, its location and expected benefits

2 **DAR synopsis**
Presents DAR key findings as short summary points with recommendations

3 **DAR summary**
Further details the Project's need, scope, technical assessment findings and implementation planning

Acknowledgement of Country

Queensland Hydro acknowledges the Traditional Custodians of the lands, skies and waters on which the Pioneer-Burdekin Project is based, the Yuwi and the Widi peoples.

We acknowledge their Elders of yesterday, today, and tomorrow's ongoing inherent spiritual connection to their Traditional Country, and their responsibility to care for it.

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1 Project snapshot

The Pioneer-Burdekin Pumped Hydro Energy Storage (PHES) Project (the Project) will drive Queensland's economic prosperity through a timely and well-managed transition to a decarbonised electricity network. Reliable, affordable and clean electricity is fundamental for consumer confidence, business growth, and economic stability and protecting the global competitiveness of Queensland's energy-intensive industries.

The Project will transform Queensland's electricity system by providing long duration energy storage, enabling ready supply of clean, reliable, secure and affordable electricity to Queensland's households and businesses as coal-fired generators retire and the network decarbonises.

Inversely, adopting a reactive approach to electricity network transition could have far-reaching implications for Queensland's economy, alongside the negative social and environmental impacts of global warming.

The least cost pathway to energy transition

Variable renewable energy (solar and wind) generation provides electricity at the least cost for consumers within a decarbonised electricity network. Queensland's strong solar resource and evening wind profiles provide a competitive advantage. However, its intermittency is a challenge for network reliability, security and investment, requiring careful planning.

The Project will help address these challenges by providing long duration storage and essential system services to replace those traditionally provided by coal-fired generators. PHES uses excess variable renewable energy during periods of high wind and solar generation to pump and store water (acting like a massive battery). This stored water is released to promptly generate electricity when wind and solar generation falls short of demand. Long duration energy storage is crucial for ensuring a reliable electricity supply during prolonged times of low wind and solar generation. It also provides a market for excess electricity during periods of high variable renewable energy generation, improving investor confidence in new variable renewable energy projects.

Urgency to act

Queensland coal-fired power stations are approaching end of life

Queensland's power generation currently relies heavily on coal-fired power generators that will need to be carefully managed through to the end of their technical operating life.

62%
of Queensland's electricity is currently provided by **coal-fired power stations**

By 2037 over **50%** of the state's 8,000 MW of coal-fired generation capacity will retire needing replacement with an **affordable low emission source**

Queensland's **2023-24 average** daily consumption is **153,700** MWh[1]

Due to the development timeframes of pumped hydro, urgent action is necessary to replace the large volume of power generation capacity provided by coal-fired power stations to align with scheduled retirement dates. Without a proactive and coordinated approach to address system service gaps, market volatility will impact network reliability and drive up electricity costs for Queensland's industries and residents.

Reliable clean energy is essential to Queensland's global competitiveness

Queensland's energy-intensive industries (such as manufacturing, mining, and resources) must cut carbon emissions to stay globally competitive. Their shareholders and customers are demanding action, with many organisations committing to carbon reduction and/or net zero targets. Jurisdictions such as the European Union are imposing tariffs on carbon-intensive imports to encourage cleaner production. Continued reliance on emissions-intensive electricity will limit export opportunities and disadvantage Queensland's exports compared to countries moving faster towards net zero.

Queensland has the opportunity to become a major exporter of low carbon products (eg green aluminium and steel) by decarbonising the electricity network and is in the unique position to deliver a coordinated energy transition through the orderly maintenance of the coal-fired generation fleet while long duration pumped hydro storage is developed.

[1] Annual electricity consumption – NEM (AER, 2024).

The urgent need to meet committed global, national and state targets

The greatest threat to Australia's natural environment, including protected species and the Great Barrier Reef, is from climate change. Climate change has created the need to reduce emissions and has led to committed targets at an international, national, state and industry level.

Commitments to decarbonise and achieve net zero emissions across the global economy have grown in momentum since the International Treaty on Climate Change in Paris in 2015 (UNFCCC, 2016). This acknowledges the collective need to reduce worldwide carbon emissions to prevent the worst impacts of climate change. Staged goals set out a path to reach economy-wide transition to net zero by 2050. The Queensland Government and the Commonwealth have enacted legislation to achieve this:

- Queensland is committed to:
  - a 75 per cent emissions reduction by 2035 and net zero by 2050, legislated under the *Clean Economy Jobs Act 2024*.
  - generating 70 per cent of electricity from renewable energy sources by 2032 and 80 per cent by 2035, legislated under the *Energy (Renewable Transformation and Jobs) Act 2024*.
- The Australian Government is committed to reducing greenhouse gas emissions by 43 per cent on 2005 levels by 2030 and to achieve net zero by 2050, legislated under the *Climate Change Act 2022*.

Currently Queensland contributes around 30 per cent of Australia's greenhouse gas emissions and relies heavily on fossil fuels (gas and coal) for electricity generation. The Project will accelerate Queensland's transition to renewable energy by reducing greenhouse gas emissions, providing certainty for Queensland industry and our international trading partners.

About the Detailed Analytical Report

The Detailed Analytical Report (DAR) evaluates the Project's feasibility and its benefits, costs and impacts through detailed technical assessments and establishes the case for investment. Developed by Queensland Hydro as Project Owner, the DAR's robust governance and assurance arrangements ensure Project assessment is based on sound analysis and Queensland Government cross-agency input.

The DAR has been developed in accordance with the DAR Requirements Letter from the Department of Energy and Public Works (DEPW)[2] and Queensland Treasury to the Queensland Hydro CEO, dated 11 December 2023 (DEPW, Queensland Treasury, 2023). Where the requirements align, the DAR aligns with the business case phase of the Queensland Government's Project Assessment Framework (Queensland Treasury, 2015) and Business Case Development Framework (DSDILGP, 2021).

The DAR separately assesses three Reference Project Options each providing 120,000 MWh of energy storage within a relatively small footprint, with different generation capacities ranging between 2,500 MW and 5,000 MW across durations between 24 hours and 48 hours. The largest, Reference Project Option 1, can continuously generate 5,000 MW across 24 hours.

The Queensland Government is positioned to determine the Project's optimal generation capacity. This decision will be informed by this DAR and a System Level Analysis undertaken by the Department of Energy and Climate (DEC) and Queensland Treasury. The analysis will assess the state's electricity system needs, focusing on delivering clean, reliable, and affordable energy. Together, the DAR and the System Level Analysis will guide the Queensland Government's investment decision.

[2] The former DEPW is now the Department of Energy and Climate (DEC).

How PHES works

PHES is the only renewable, technically proven long duration storage that can meet Queensland's energy storage needs at the scale required to meet coal-fired generator retirement and transition timeframes. With its 100 year asset life, it is the most cost-effective long duration energy storage technology and is expected to stay competitive even as battery prices drop and new technologies emerge.

Figure E-1 describes how PHES schemes work. Long duration PHES is capable of storing significant volumes of energy, providing a reliable market for excess variable renewable energy generated from solar and wind farms. This energy is released to address intra-day demand peaks as well as multi-day periods of low solar and wind generation.

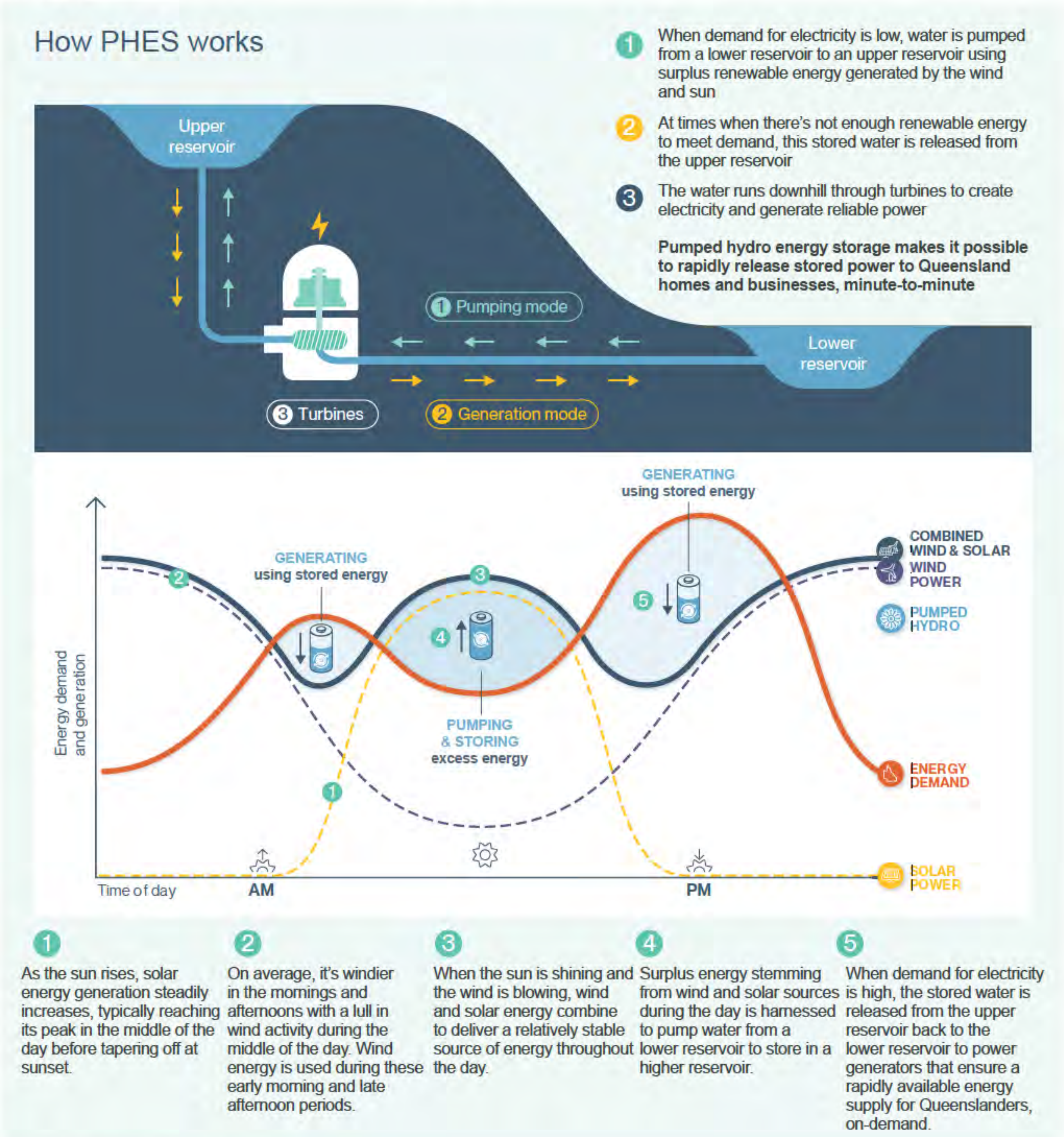


Figure E-1 How PHES works

Pioneer-Burdekin Pumped Hydro Energy Storage Project

The Project is located 70 kilometres west of Mackay in north Queensland in the Mackay Regional Council local government area. The Project's generation and storage capacity were determined through system modelling used to inform the Queensland Energy and Jobs Plan (QEJP) (DEPW, 2022).

Why PHES at Pioneer-Burdekin?

Location benefits

- Enhances grid capacity, security, and reliability in North Queensland
- Proximity to high-quality wind and solar resources in the Central and Northern renewable energy zones
- Geographically separate from the Borumba PHES Project providing electricity system diversity
- Provides critical system strength for the North Queensland network

Site benefits

- Topography supports high generation and storage capacity with a small surface footprint
- High annual rainfall supports scheme reliability
- Offers better opportunity to manage environmental impacts than other sites
- Both reservoirs can be built as conventional, low-cost valley dams
- Its high storage potential, together with the Borumba PHES Project, minimises the need for additional long-duration PHES projects
- Site investigations at depth indicate suitable geotechnical conditions

Figure E-2 Why PHES at Pioneer-Burdekin?

The Project will store renewable energy through the construction of:

- an upper and lower reservoir and associated dam and spillway structures[3]
- power waterway tunnels to convey water underground between the two reservoirs through the power station
- power station housing the transformers, pump turbines and associated equipment
- main access tunnel providing maintenance access to the power station
- cable tunnel containing transmission cabling connecting the power station to Powerlink Queensland's switchyard
- the realignment of Mackay Eungella Road
- supporting construction and operational infrastructure.

The Project's connection to the National Electricity Market (NEM) is outside the Project's scope, with the switchyard and transmission connection to be delivered by Powerlink Queensland.

[3] The dam infrastructure constructed for the Project will be exclusively used for the PHES and is not intended to provide a water supply or recreational function at this stage.

The Project will:

Enable Queensland's transition to **renewable energy** by providing storage, dispatchable generation and essential system services needed for a **reliable** and **secure** electricity network

- Provides **long duration energy storage** at the scale and pace needed for retiring coal-fired generators
- Stimulates investor confidence in **wind and solar** projects by providing demand at times of high energy generation
- **Centralised management** of long duration storage supports continuous supply of **clean electricity** and **stabilises energy prices** during high demand and extended periods of low variable renewable energy supply
- Together with the **Borumba PHES Project** in south Queensland, provides network redundancy, while meeting the electricity network needs of **central** and **north Queensland**

Deliver **clean**, **reliable** and **affordable** electricity to Queensland's **2 million** households and **465,000** businesses, and future generations

- Reduces the average household electricity bill by between **$20** and **$36 annually**
- Enables Queensland's energy intensive industries to **produce lower** carbon products, enhancing global competitiveness
- Attracts **new industries** with access to decarbonised electricity a key driver for where businesses locate and invest

Meet global and legislated **targets** to **decarbonise** and avoid the worst impacts of climate change

- Avoids **5.7** to **9.8 million tonnes /year** of CO_2 emissions by enabling coal-fired generator retirements and **reduced reliance** on gas.
- Contributes to the achievement of **global commitments** and Queensland and Australian Government legislated targets

Deliver **economic benefits** to the Mackay region and the state during construction and operation

- Training and skills development for **local residents**
- Supply chain and service opportunities for **local businesses**
- Attract **new business** and **industry** to the region
- Up to 2054 the Project is expected to add:
  - **700** to **950** jobs annually across the region to 2054
  - **2,300** to **2,700 workers** on site at the Project's construction peak
- **$14,479 million** to **$16,598 million** to the regional economy
- **$15,042 million** to **$17,084 million** to Queensland's economy

2. Synopsis

Reference Project Options

Three Reference Project Options were designed and assessed in the DAR. Figure E-3 illustrates the scope of each Reference Project Option.

All share the same surface footprint to deliver 120,000 MWh of energy storage capacity without impacting the surface of Eungella National Park, but differ in their pumping/generating capacity and staging.

Reference Project Option 1

Reference Project Option 1 offers the highest generation capacity. It delivers 5,000 MW with 24-hour storage across two 2,500 MW stages, delivered consecutively, as efficiently as possible. This option maximises system reliability.

Reference Project Option 2

Reference Project Option 2 provides the lowest generation capacity with 2,500 MW across 48 hours from one underground power station. This enables multi-day storage from a lower capital expenditure.

Reference Project Option 3

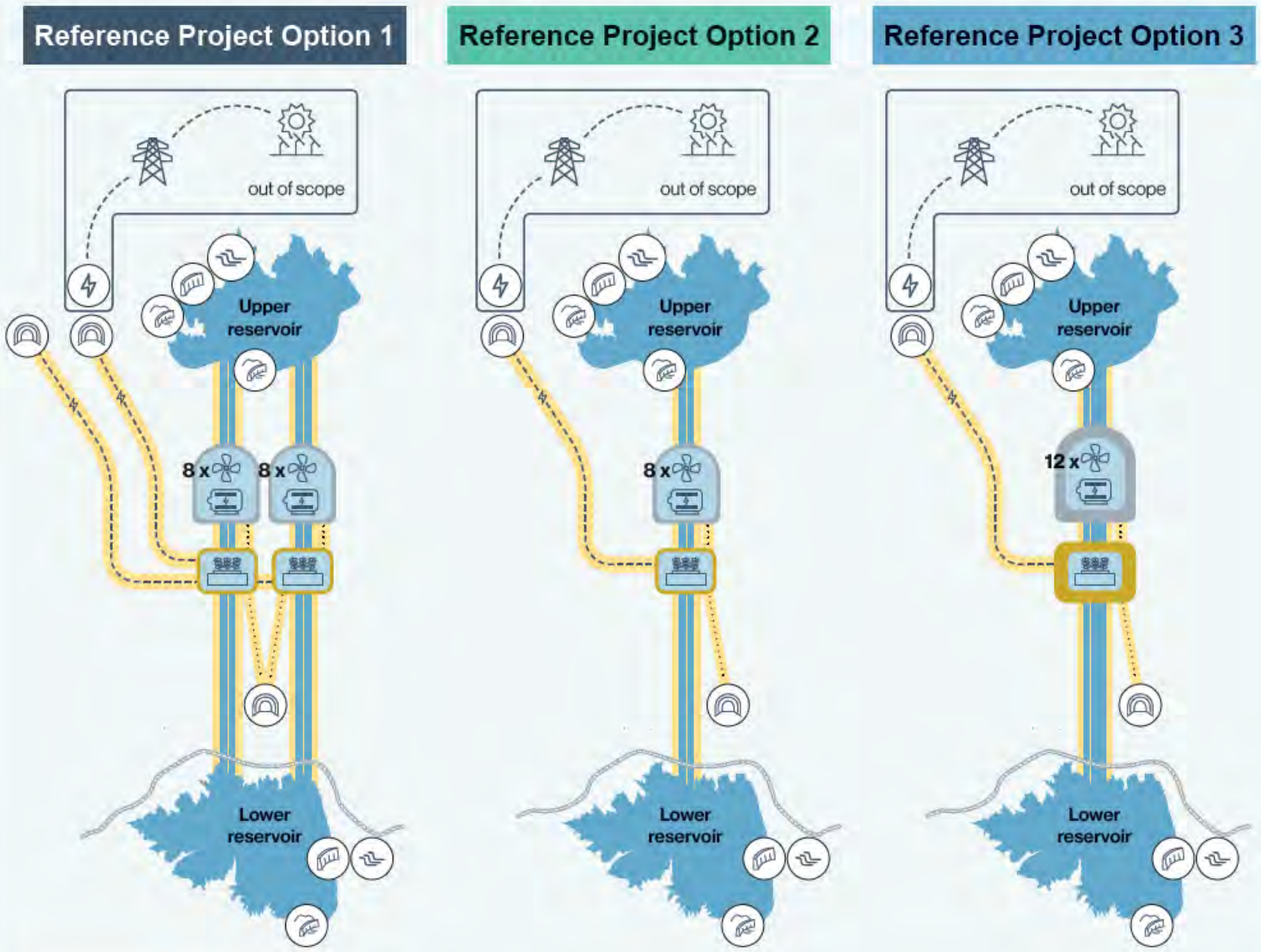
Reference Project Option 3 provides 3,750 MW across 32 hours using a single underground power station. This enables a higher generation capacity option from a lower capital expenditure.

Both Reference Project Options 2 and 3 offer an option to expand generation capacity later to meet future system needs without disrupting Stage 1 operations. This is possible if additional lower and upper reservoir outlet valves are constructed in Stage 1 to connect Stage 2 infrastructure in the future without the need to dewater reservoirs or impact operations.

Each Reference Project Option is the result of thorough site investigations and extensive engineering design, leveraging experience from major design consultants (SMEC, AFRY, and Water2Wire with GHD, Stantec, Mott MacDonald), hydropower asset Owner's Advisors (Verbund (Austria) and Landsvirkjun Power (Iceland)), and Queensland Hydro's Technical Review Panel to ensure robust design. Value engineering investigated cost and schedule improvement opportunities, with feasible opportunities adopted.

Additional to the Reference Project Options defined in the DAR Government Requirements Letter, a fourth option was investigated with less storage and a smaller surface footprint. While this option offers a lower capital cost, its cost per kilowatt hour (kWh) is much higher compared to the other Reference Project Options. Additionally, its limited storage capacity reduces its long-term benefits, especially if additional generation capacity is required in the future. Due to its higher unit cost and the reduced storage for a electricity network with high penetration of solar and wind, this option was not fully considered within the DAR.

Reference Project Options scope



Storage	Main dam · Saddle dam · Spillway
Road realignment	Realignment of Mackay Eungella Road
Underground infrastructure	Tunnel portal · Main access tunnel · Cable tunnel · Powerhouse cavern · Transformer cavern · Waterway tunnels
Electro-mechanical	Pump turbine · Motor generator · Transformer
Supporting infrastructure (not illustrated)	A range of temporary and permanent works including access tracks, office accommodation, cement batching plants and workers' camps.
Transmission	Switchyard (out of scope) · Transmission (out of scope)
Variable renewable energy	Variable renewable energy generators (out of scope)

Figure E-3 Reference Project Options scope

DAR findings confirm all three Reference Project Options are technically feasible, able to be delivered and address service needs. With a consistent surface footprint, environmental and social impacts can be reliably mitigated or offset. However, the high capital cost of Reference Project Option 1 impacts its financial viability, favouring the smaller generation capacities delivered through Reference Project Options 2 and 3.

Key findings that support this include:

- **The Project meets the service need delivering critical long duration energy storage to manage renewable energy variability** and provide essential system services to the electricity grid. Reliable, affordable and clean power is vital for the state's economy and lifestyle, securing supply for heavy industries and emerging sectors like hydrogen, while avoiding gas peaking price fluctuations.
- **The Project will add between $14,479 million and $16,598 million to the Mackay region's gross regional product**[4] and is expected to generate between 700 and 950 jobs annually as a result of increased economic activity between 2024 and 2054. At a state level it will add between $15,042 million and $17,084 million to Queensland's gross state product.
- **The Project is in the public interest and could significantly benefit stakeholders across various regions and timeframes.** With a clear, actionable plan, with strong government backing, it found no impediments to the Project's development. Potential stakeholder, consumer rights, access and equity impacts identified are manageable through careful planning supported by ongoing stakeholder engagement.
- **Once fully operational, the Project is highly reliable with 120,000 MWh storage capacity.** Even during the most severe historic drought, with a 50 ML environmental flow, it can continuously generate 21 hours for Reference Project Option 1, 42 hours for Reference Project Option 2 and 31 hours for Reference Project 3. Reliability also remains high in the dry climate scenario (refer to page E26).
- **All identified environmental issues offer a pathway for resolution.** Key approvals-related issues for the Project (such as potential impacts to matters of national environmental significance (MNES) and matters of state environmental significance (MSES), water quality and its downstream receptors and groundwater in Eungella National Park) can be addressed by design and other measures including offsets. While the DAR demonstrates these issues can be addressed, further assessment and design to refine and optimise these measures will be undertaken in the procurement and approvals phase.
- **The Project will require environmental offsets to address some environmental impacts.** Offsets to address residual impacts on MNES and MSES are likely to comprise both direct (on-ground) and indirect (financial or in-kind) offsets. The presence of greater glider and endemic protected species such as the Eungella spiny crayfish, Eungella honeyeater and Eungella day frog are key given their limited geographic range in determining suitable offset sites.
- **Negative social impacts are felt most by those living closest to the Project.** If the Project proceeds, many Dalrymple Heights and Netherdale landholders will be displaced. Some landholders who sold their land to Queensland Hydro have moved, bringing forward social impacts and loss of community connection which are likely to continue as more residents move. Queensland Hydro is actively engaging with the local community, has launched the Wellbeing and Resilience Program, offering health outreach and psychological services and will continue to support and collaborate with the community to manage impacts and maximise benefits.
- **Support increases outside the Project area.** Local opposition to the Project is not unified and centres on concerns for displaced landholders and changes to the area's natural values. Many local and regional businesses are positive and seeking economic benefits.
- **Reference Project Option 1 fails to recover its significant capital investment through revenue.** While it offers positive economic, social, and environmental benefits, it results in a negative net present value (NPV) of $4,337 million (P50) and $6,865 million (P90). Without the System Level Analysis clearly demonstrating Queensland's need for a 5,000 MW PHES scheme, Reference Project Option 1 cannot be deemed commercially viable.
- **Reference Project Options 2 and 3 are viable and deliver significant benefit to Queensland and its electricity network at a substantially lower capital cost.** Both present positive NPVs of $2,532 million (P50) and $701 million (P90) for Reference Project Option 2 and $2,682 million (P50) and $686 million (P90) for Reference Project Option 3.

[4] Economic outcomes were evaluated across a 30-year period from 2024 to 2054.

Project costs

Table E-1 provides P50 and P90 cost estimates (real)[5] for each Reference Project Option.

Table E-1 P50 and P90 capital costs ($million, FY2024, real)

Cost element	Reference Project Option 1		Reference Project Option 2		Reference Project Option 3	
	P50	P90	P50	P90	P50	P90
Capital	24,985	27,670	17,027	18,934	19,443	21,537

Table E-2 P50 and P90 capital cost per MW and kMW ($2024, real)

Cost element	Reference Project Option 1		Reference Project Option 2		Reference Project Option 3	
	P50	P90	P50	P90	P50	P90
$million /MW	5.00	5.53	6.81	7.57	5.18	5.74
$/kWh	208	229	142	158	162	179

Cost estimates were determined through a detailed Class 3 cost estimate based on first principles leveraging other major infrastructure projects including pumped hydro, current labour rates (with uplift for shift and underground works), budget quotations for key items, Project schedules and the Queensland Hydro organisation chart.

P50 and P90 cost estimates and schedule dates

The Project's cost estimates and program schedule are presented at both P50 and P90 level in the DAR. These represent different levels of confidence in the predicted outcome:

- **P50 estimate:** There is a 50 per cent chance the actual outcome will not exceed the estimate for cost in a cost estimate or the scheduled date for a program.
- **P90 estimate:** There is a 90 per cent chance the actual outcome will not exceed the cost estimate or scheduled date. This is a more conservative estimate.

P50 and P90 estimates involve subject matter experts identifying risks and their probabilities, running simulations with varied inputs, and sorting the results to see where 50 per cent and 90 per cent of the scenarios fall below the estimated value or schedule date.

[5] Real refers to the Project costs and revenues estimated as at a base date and applied throughout the evaluation period. The impact of inflation or other price increases are not considered.

Project delivery

- **With support from Australian and international partners, Queensland Hydro can deliver the Project.** Queensland Hydro was formed to develop, deliver, operate and maintain large-scale long duration PHES for the state. Their team has been established to offer deep experience in hydropower, dams, project development and delivery, asset operations and maintenance. Based on the Project's scale and lessons learned from the Borumba PHES Project, Queensland Hydro recognises the significant skilled resources needed to support design and delivery of the Project. To do this, Queensland Hydro plan to augment its team with an integration partner to support Project delivery.
- **Potential for third party investment.** The long operational life and revenue potential for the Project lends itself to third party investment. Queensland Hydro recognises the value an experienced hydropower developer and owner could bring to the team and welcome the opportunity for collaboration. It aligns with our core value of "We Deliver Together" recognising the level of collaboration required to deliver a project of this scale.
- **All Reference Project Options will achieve first power by end of 2035** as estimated by the Project's risk adjusted schedule (P50). P50 estimated dates for full operations are 2035 (Stage 1) and 2038 (Stage 2) for Reference Project Option 1, 2035 for Reference Project Option 2 and 2036 for Reference Project Option 3.
- **Queensland Government support is essential for timely subsurface access to Eungella National Park.** A key schedule risk and critical path action is access to the national park for geotechnical investigations and PHES construction and operations. This protected area falls under the *Nature Conservation Act 1992* which currently has provisions allowing the use of a national park for a service facility (such as a communications tower, electricity transmission, pipeline for oil or gas, water supply pipeline or sewerage facility). Amending the act to allow for investigation, construction and operation of a PHES may provide a solution.
- **To expedite primary approvals and improve understanding of geotechnical conditions a split *Environment Protection and Biodiversity Conservation Act 1999* referral will be sought.** This will be across three works packages (exploratory works, Mackay Eungella Road realignment, and main works). This is expected to secure exploratory works approvals 12 months earlier than a single referral, providing critical geotechnical information to inform main works design and achieve first power sooner. Delays in environmental approvals are a key construction schedule risk.
- **The Project requires a combination of freehold and state-owned non-freehold parcels.** Queensland Hydro is responding to voluntary acquisition requests for impacted properties, with 56 properties acquired to date.

The Project footprint impacts 60 per cent of residential dwellings in Dalrymple Heights and Netherdale, making land and property impacts a major concern. A Resettlement Policy Framework and Resettlement Action Plan are being developed to ensure adequate housing and improved living standards for displaced residents.

- **Negotiations with native title holders are ongoing.** [redacted]
- **No historic or Aboriginal cultural heritage sites have been found in the Project area.** While some local sites have community-valued historic significance, none are formally registered or protected.
- **Completing the lower reservoir just before the wet season could shorten fill times by almost a year.** There is a 50 per cent chance the Project will have enough water to meet a first power milestone in 2035 within one wet season after completing the lower reservoir, with a 50 megalitre (ML) a day environmental bypass flow.
- **Market interest is high subject to timeframes, works packaging and delivery model certainty.** Access to skilled workforce will be a key challenge which can be managed by the market with Project certainty, clear timeframes communicated to the market, and careful planning by the Project. During the procurement and approvals phase (following DAR submission) Queensland Hydro will continue to develop the Project's transaction and delivery strategy.
- **The main works are proposed to be delivered using a four package approach.** This includes two dam packages (upper and lower), Original Equipment Manufacturer (OEM) and PHES main works. A collaborative Incentivised Target Cost (ITC) contract is recommended for the dams and PHES main works packages. Queensland Hydro will appoint design contractors separately and transfer these to the preferred dam and PHES delivery partners. The OEM will be contracted and retained by Queensland Hydro throughout all Project phases, fostering a long-term strategic relationship and benefiting design and technical collaboration. The preferred procurement approach for the exploratory works, realignment of Mackay Eungella Road and main supporting works will be identified in the procurement and approvals phase.
- **High impact risks that could delay schedule dates** include timely access to Eungella National Park, cultural heritage agreements and Indigenous Land Use Agreements and environmental approvals. Industrial relations deploying over 2,000 workers onsite and organisational capability and capacity are also high rated risks.

Recommendations

Given the Project's strategic importance to state and federal energy transition goals with its role in delivering clean, affordable and reliable electricity, it is recommended the Queensland Government:

Recommendation 1

Select a preferred Reference Project Option considering DAR findings alongside the Queensland Government's System Level Analysis, noting:

Reference Project Option 1: 5,000 MW (Stage 1 at 2,500 MW + Stage 2 at 2,500 MW)

- Financial, commercial and economic analysis shows the majority of the PHES benefits are achieved with 2,500 MW and 3,750 MW. The additional cost of providing 5,000 MW does not deliver comparable financial benefits for the Project and broader economic benefits for the region and state. This is evident with Reference Project Option 1 reporting a negative NPV of $4,337 million (P50) and $6,865 million (P90).
- In the absence of the System Level Analysis demonstrating Queensland's need for a 5,000 MW PHES scheme, Reference Project Option 1 is not considered viable and should be modified to a smaller capacity (see Reference Project Options 2 and 3).

Reference Project Option 2: 2,500 MW

- With the lowest capital investment of the options considered in the DAR, Reference Project Option 2 delivers significant regional and state-wide economic benefits, with a gross regional product (GRP) of $14,479 million (NPV), approximately 13 per cent less than the GRP of Reference Project Option 1. This option provides a strong financial return and a positive NPV of $2,532 million (P50) and $701 million (P90).
- Reference Project Option 2 is deemed viable and should be considered alongside the Queensland Government's System Level Analysis.

Reference Project Option 3: 3,750 MW

- Reference Project Option 3 delivers 50 per cent greater energy capacity than Reference Project Option 2 within a single cavern, delivering exceptional value on both a capacity ($/MW) and storage ($/MWh) basis.
- Reference Project Option 3 delivers a sound financial return with a positive NPV of $2,682 million (P50) and $686 million (P90), and strong regional and state economic benefits with a GRP of $15,368 million (NPV), only 7 per cent less than the GRP of Reference Project Option 1.
- Reference Project Option 3 is deemed viable and should be considered alongside the Queensland Government's System Level Analysis.

Recommendation 2

Approve the preferred Reference Project Option to progress towards delivery in the form of a final investment decision, subject to the Project obtaining its primary approvals.

or:

Approve the Project to proceed through the next stage of development with the following actions, ahead of further consideration by the Queensland Government on a final investment decision before commencing delivery:

- progress towards obtaining regulatory approvals, including the regulatory approvals required to carry out the exploratory works, main works and the Mackay Eungella Road realignment
- progress resettlement following the approval of the Resettlement Policy Framework and the Resettlement Action Plan
- engagement of design and delivery partners to support update of the Project design and delivery plan (with execution of delivery phase contracts subject to securing all required approvals and receiving a final investment decision from the Queensland Government).

Recommendation 3

Amend the Nature Conservation Act 1992 to facilitate subsurface access to Eungella National Park to investigate, construct and operate a PHES to achieve Project milestones.

Recommendation 4

Confirm the approach to obtaining *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approvals following a benefit and risk assessment of a split versus single referral approach and their respective abilities to achieve government objectives.

If a split EPBC Act referral approach is confirmed:

- Approve Queensland Hydro's continued development of the Project to protect the schedule and meet critical path milestones as outlined in the Implementation Plan (Chapter 20). This includes design development, packaging and delivery model confirmation, social impact management, environmental investigations and approvals planning.

If a single EPBC Act referral approach is confirmed:

- Approve Queensland Hydro's continued development of the Project against a revised implementation schedule, cost estimate, economic and financial analysis and an updated Implementation Plan. This includes design development, packaging and delivery model confirmation, social impact management, environmental investigations and approvals planning.

Recommendation 5

To ensure prudent financial management of the Project costs, approve:

- Queensland Hydro to optimise Project design through continued value engineering and design development, documented in a basis of design and updated in the Project Management Plan.
- Funding and financing strategy development led by Queensland Treasury and supported by Queensland Hydro to support the efficient delivery of the Project in line with Queensland Government priorities.
- Queensland Hydro to engage with Queensland Treasury to investigate options for third party private investors, such as existing hydropower owner-operators, to take a minority stake in the Project to add further expertise to the Queensland Hydro team in executing Project development, delivery and planning for operations.

3. DAR summary

The case for long duration storage investment

Firmed variable renewable energy provides the most efficient and least-cost pathway

Australian Energy Market Operator's (AEMO) Integrated Service Plan (ISP) (AEMO, 2024) and CSIRO's GenCost report (Graham et al, 2024) identify the most cost-effective pathway to transition the electricity system is variable renewable energy (solar and wind) as the primary generation source supported by firming such as pumped hydro energy storage. Variable renewable energy sources are inherently variable, with:

- system reliability risks during sustained periods of low wind and solar generation
- transmission congestion and spilled electricity when variable renewable energy supply exceeds consumer demand
- reduced system strength and inertia as the proportion of synchronous generation provided by coal-fired power stations declines
- short term fluctuations in their output requiring increasing volumes of frequency control ancillary services.

The ISP recommends a coordinated response to transition to a low emissions power network with variable renewable energy generators firmed with energy storage and connected with transmission infrastructure. Figure E-4 identifies the key action areas that require coordination and identifies how long duration PHES addresses these action areas.

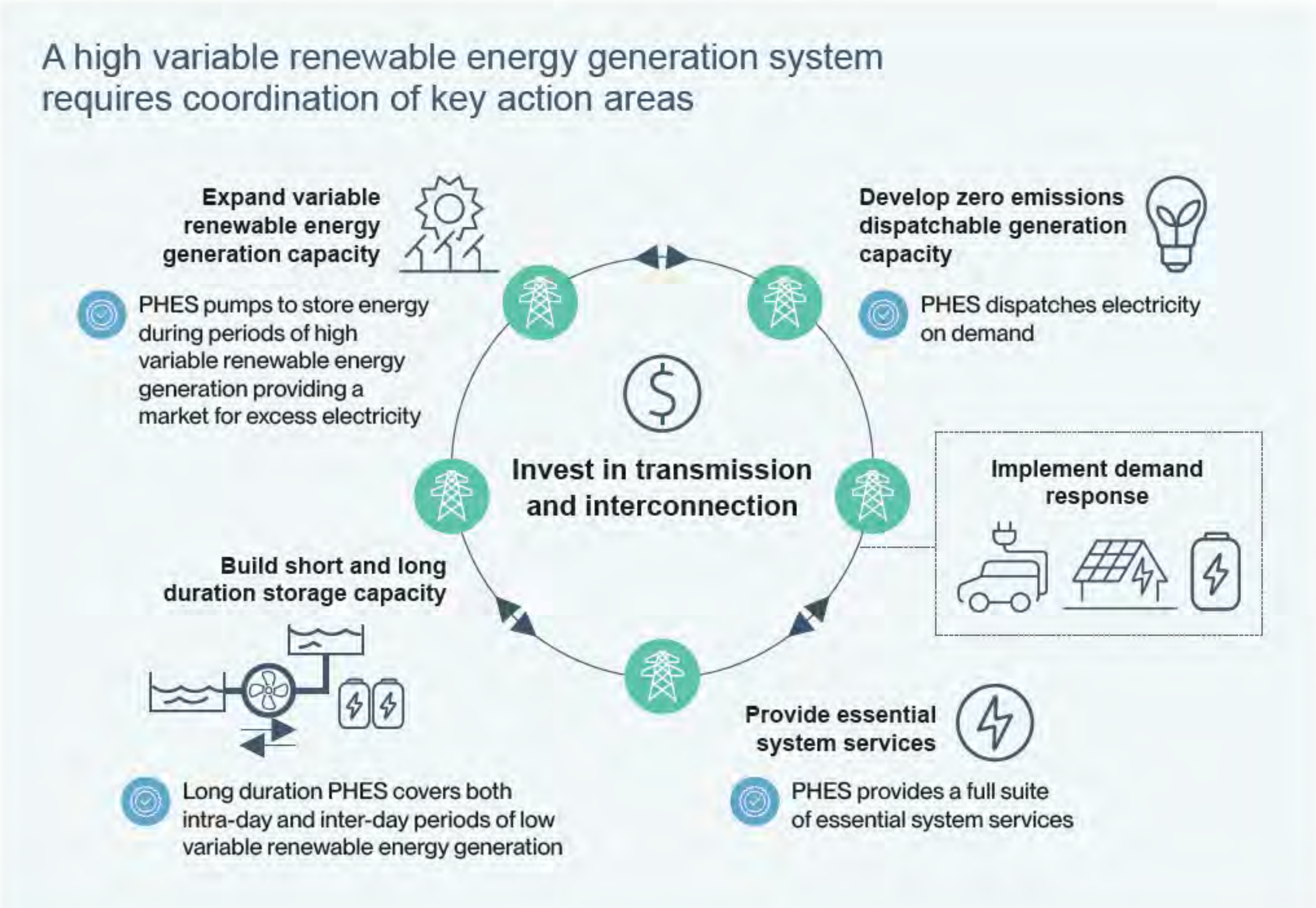


Figure E-4 Key action areas requiring coordination for a reliable and secure high variable renewable energy electricity network

Long duration storage needed for sustained periods of low wind and solar generation

Variable renewable energy generation and electricity demand vary by time of day, weather and season. In Queensland, solar generation peaks late-morning and wind generation peaks overnight, with gaps in the morning and evening where variable renewable energy generation is significantly less than electricity demand. Reliable, dispatchable generation and energy storage are essential to balance supply and demand. Both short duration (batteries) and long duration (PHES) storage cover intra-day peaks and troughs by storing excess energy and releasing it when needed.

Long duration storage is particularly important in managing multi-day periods of low wind and solar generation. Operational data from Queensland's large-scale solar generators across 2022 and 2023 shows solar output on average represents around 22 per cent of total output, however, across multiple days it can be considerably less, especially in the winter months. Long duration storage is essential to manage low variable renewable energy output over multiple days as short duration storage depletes quickly and cannot recharge without excess electricity.

Why more short duration storage and gas generation are not the solution?

Despite growing investment, battery energy storage systems do not provide enough storage for sustained periods of low variable renewable energy output. Short duration energy storage operators take advantage of electricity price fluctuations, charging when electricity prices are low, and discharging to the grid when electricity prices are high, which is suited to managing intra-day peaks and troughs. Coordinating batteries to discharge in series to maintain reliability over a longer period of time is unlikely, with each battery operator responding to the same market signals.

When variable renewable energy generation is insufficient for cost-effective charging, generation shortfalls can quickly emerge, straining reliability. Dispatchable generation capable of meeting demand over an 18 to 24-hour period is needed for reliable electricity supply.

Increasing gas usage could help address energy shortfalls, but this would further expose Queensland's electricity consumers to gas volume constraints in the Australian market and global gas price volatility. It would see greater carbon emissions than energy storage. This is inconsistent with reaching decarbonisation targets and providing least-cost electricity to consumers.

Variable renewable energy growth is limited without long duration storage

Without sufficient long duration energy storage, the coordinated replacement of retiring coal-fired generation capacity is unlikely to be efficient or cost-effective. As coal usage persists and variable renewable energy supply grows, market conditions will mean negative prices during peak renewable energy generation resulting in energy spills. The inflexible operating range and slow start up time of existing coal generators will have difficulty responding to market conditions. Embedding long duration storage in the electricity network with sufficient transmission creates demand when renewable generation is high, helping stabilise both daytime and evening electricity prices and improve confidence in variable renewable energy investment. Without large-scale long duration energy storage, variable renewable energy investments are less attractive, and a stubborn reliance on gas-powered generation will persist.

Long duration storage is a market gap and substantial network reliability risk

Of the requirements for a low carbon, cost efficient and reliable electricity system, long duration energy storage in Queensland is a significant gap. Although various technologies are attracting private investment for short duration energy storage and zero emissions generation, long duration storage projects are unlikely to proceed without government intervention.

Drivers for government investment in long duration energy storage

Strategic state-owned investment in transmission, generation and energy storage assets will deliver a coordinated, cost-effective transition for Queensland and the NEM. Long duration energy storage is crucial for a reliable renewable network, however private PHES projects all typically provide less than 12 hours of storage. Government investment in long duration storage is needed due to:

- **Investment in large-scale long duration storage[6] is limited by market design:** The current market favours flexible, peaking generators that respond quickly to spot price changes, a role short duration storage can fulfil. Long duration storage lacks fair valuation mechanisms and secure revenue, discouraging private investment.
- **Scale of investment to replace up to 8,000 MW of coal-fired generation capacity:** Queensland needs to replace 4,000 MW of coal-fired generation by 2035, with some forecasts indicating this could be up to 8,000 MW with both environmental and economic drivers. The transition to low-emission energy sources complicates this task, requiring coordinated government effort to meet retirement dates and emissions targets.

[6] The Project will provide what CSIRO describes as long multi-day storage covering durations between 24 to 100 hours which provides an energy insurance and reliability role (CSIRO, 2023).

Why long duration PHES?

PHES complements Queensland's energy transition in a holistic way, providing the technical and operational functions critical for efficient market operations. It is a mature technology with established domestic and global industries capable of delivering energy storage systems at the scale and pace to meet electricity network needs.

Operational flexibility
PHES rapidly adapts to market demand and variable renewable energy fluctuations, reaching full operations (pumping or generating) within a single NEM dispatch interval (less than 5 minutes). It can also be controlled centrally to adjust output to complement other generation sources, making it well suited for a transitioning market.

Dispatchable generation
PHES's large generation capacity and long duration storage can consistently meet demand during low variable renewable energy generation and peak times, regulating market volatility and reducing consumer costs.

Energy demand
Large-scale PHES supports technical and market operations by storing excess low-cost energy during high variable renewable energy output and easing the strain on the grid during times when variable renewable energy generation drops and electricity demand spikes.

Essential system services
In variable renewable energy-reliant systems, providing essential services is crucial for reliability. Fixed speed turbines offer system strength and inertia, supporting grid operations. These services need strategic placement for stability. PHES enhances reliability with voltage control, frequency control ancillary services and system restart ancillary services for recovery from a catastrophic event. It can also function as a synchronous condenser to provide system services while not generating electricity.

System reliability
At large scale, PHES provides exceptional support to the reliable supply of energy. Deep storage capability provides insurance against energy shortfalls and can quickly reduce the energy system's reliance on gas.

Supports industry investment
PHES maximises variable renewable energy use and supports decarbonisation by purchasing energy during oversupply. It sustains a viable market for variable renewable energy expansion, boosting investor confidence in achieving necessary generating capacity.

Cost effective and less complex
Despite high initial costs, PHES offers long-duration storage at a lower unit cost than other technologies. While battery energy storage systems may become cost-competitive in the future, this is uncertain with no guarantee of this occurring in time to meet the state's long duration energy storage needs. Also, PHES operations are centralised and less complex to control than battery alternatives. The urgency to decarbonise requires immediate action and cannot rely on possible technological advancement.

Ultra-long operating life
PHES provides enduring electricity network benefits, far greater than other technologies and extending beyond the scope of current market and financial models, making its multi-generational impact hard to quantify.

Queensland's policy response – PHES is the cornerstone to energy transition

Policy drives energy system transformation – it sets the targets and the pathway of how the energy system will transition to meet targets and replace coal-fired generation (market design and optimal mix of transmission, generation and storage). It also identifies the range of benefits and strategic outcomes sought in the transition. Policy sets the strategic direction and desired outcomes. Key themes across relevant federal, state and local government policies include:

- the international commitment to reduce carbon emissions
- the increasing pressure on trade and investments to achieve net zero
- fiscal policies and commercial incentives to achieve net zero
- industrial electricity consumer's commitment to net zero
- renewable energy targets and investment certainty
- investing in complementary and emerging technologies
- equitably expanding the clean energy workforce, ensuring benefits are provided to local and regional communities.

The Project is strategically important to meeting global, federal and state energy transition targets as a key initiative in Queensland's coordinated approach to decarbonisation.

Pioneer-Burdekin PHES Project description

The Project will be Queensland's largest long duration PHES site providing 120,000 MWh of energy storage.

The Project is co-located near both the Central and the North and Far North Queensland regional energy zone regions, with strong solar and wind resources, and will provide critical storage and dispatchable generation services to the NEM.

The Queensland Government's Hydro Study identified the Project site for its high generation and storage potential from a relatively small footprint, avoiding the need for multiple PHES sites to provide the same energy storage (DEC, 2024). This substantially reduces the cumulative environmental impact of achieving the long duration storage needed for a reliable and secure low-emission electricity network.

Queensland Hydro Study

The Queensland Government's Hydro Study evaluated opportunities for energy storage technologies, particularly pumped and conventional hydro, and informed the development of the Queensland Energy and Jobs Plan (DEC, 2024). Between 2017 and 2020 (see Figure E-5), the study assessed around 2,000 sites for:

- storage capacity sufficient to facilitate increased variable renewable energy uptake and assist in maintaining system reliability and security as coal-fired power stations retire
- ability to be developed and connected in a timeframe that aligns with coal-fired power station retirement
- technical and commercial viability
- potential contribution to reducing wider energy system costs, including system cost reductions from co-location of PHES sites in renewable energy zones.

The Queensland Hydro Study's final stage identified Borumba and Pioneer-Burdekin as preferred sites across a range of economic, social and environmental considerations. Due to their potential capacity, they avoid the need to construct multiple smaller PHES facilities with a larger cumulative impact area across Queensland.

The Queensland Government decided to proceed with detailed analytical studies at Borumba Dam initially, followed by Pioneer-Burdekin.

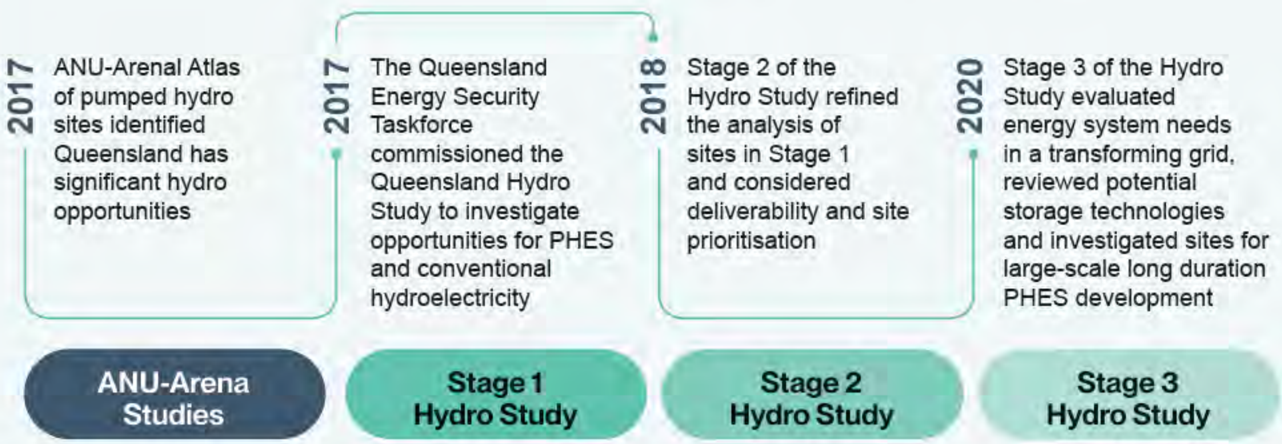


Figure E-5 Queensland Hydro Study development stages (DEC, 2024)

The Project area will support Project infrastructure (dams, roads, tunnels, power stations), construction requirements (laydown area, quarries and batching plants, accommodation and offices) and potential areas for environmental offsets. It also includes an area for a second upper reservoir.

The Project uses a single upper reservoir but will require land for a second to allow for future flexibility and storage capacity post-2035. This ensures long-term reliability and security across the asset's 100+ year lifespan. In the near term, this area will support temporary construction infrastructure.

Reference Project Options

The DAR assesses three Reference Project Options, designed to deliver the maximum energy storage capacity (120,000 MWh) without impacting the surface of Eungella National Park.

All Reference Project Options share the same surface footprint but differ in pumping/generation capacity and staging. These options were defined in the DAR Requirements Letter to allow for Queensland Government assessment of the optimal Project option that achieves the overall power system objective of low emission, reliable and affordable electricity (DEPW, Queensland Treasury, 2023).

Reference Project Options were assessed for technical feasibility, cost, potential benefits and impacts and implementation considerations and found to be technically feasible and deliverable.

Design development

Figure E-6 identifies the Project's key design drivers. The Reference Project Option designs result from technical site investigations and extensive engineering design analysis for the Project site. The Project's design locates surface infrastructure in areas of lower conservation value to minimise impacts to higher ecological value areas. Ongoing environmental assessments and geotechnical investigations will further refine the Project's design.

Design maturity meets the requirements to inform a cost estimate suitable for an investment decision. The level of Project definition predominantly meets a Class 3 under Association for the Advancement of Cost Engineering guidelines (AACE, 2020), noting that the level of definition developed for the access roads and provision of required geotechnical information is considered less than a Class 3.

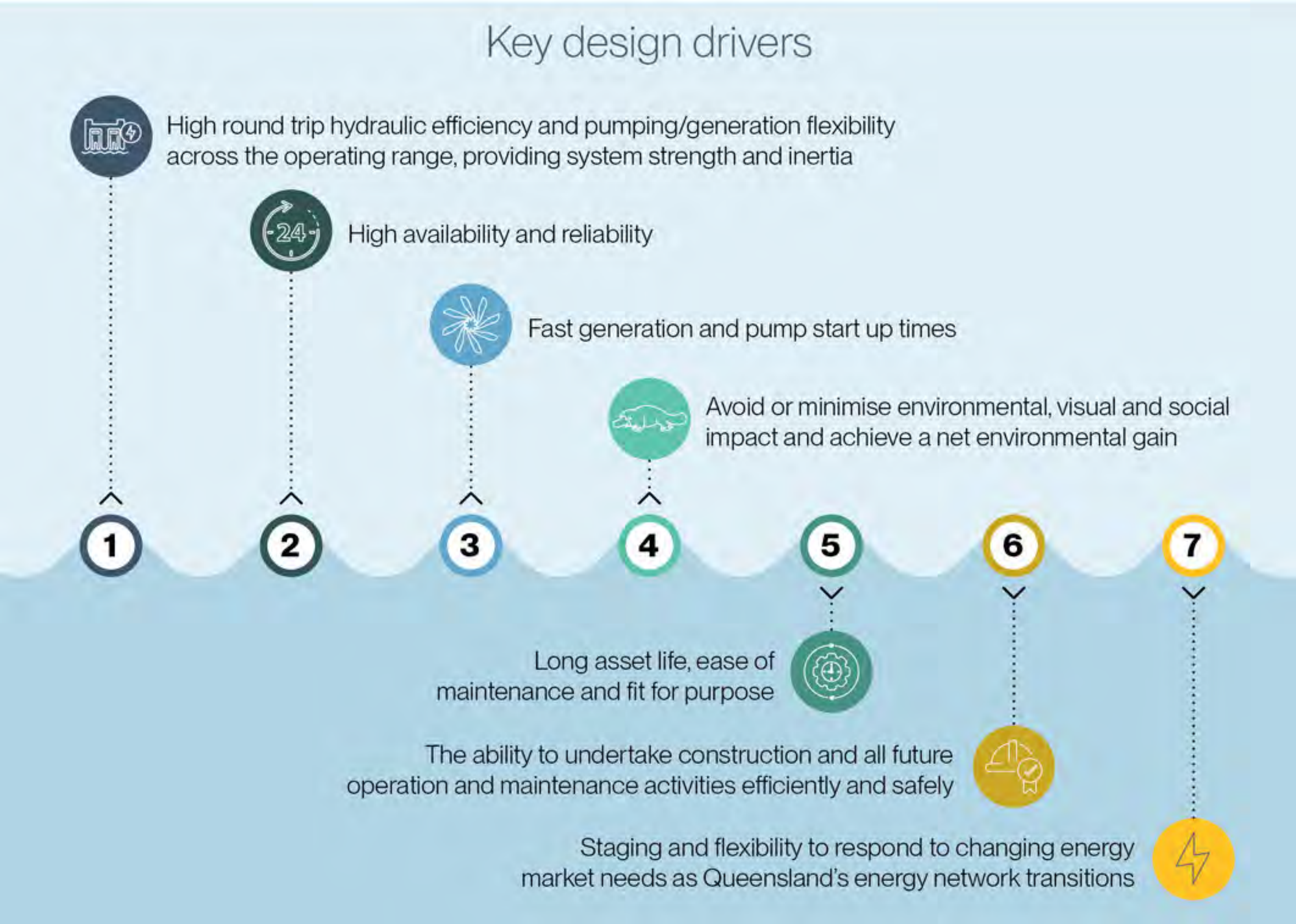


Figure E-6 Key design drivers

Reference Project Options key parameters

Table E-3 presents the key parameters of each Reference Project Option and Figure E-7 shows the Project's general arrangements.

Table E-3 Reference Project Options key parameters

Parameter	Reference Project Option 1	Reference Project Option 2	Reference Project Option 3
Generation capacity - total	5,000 MW	2,500 MW	3,750 MW
Generation capacity - Stage 1	2,500 MW	2,500 MW	3,750 MW
Generation capacity - Stage 2	2,500 MW	-	-
Storage capacity	120,000 MWh	120,000 MWh	120,000 MWh
Generation cycle time	24 hours	48 hours	32 hours
Generating/pumping units (at 312.5 MW/unit)	16	8	12
Underground power stations	2	1	1
Power waterways	4	2	3
Main access tunnels	2	1	1
Cable tunnels	2	1	1
Lower reservoir dam type	Roller compacted concrete (RCC) main dam, concrete faced rockfill dam (CFRD) saddle dam		
Upper reservoir dam type	CFRD main dam, CFRD saddle dam, sheet pile cut-off wall saddle dam		
Lower reservoir volume	80.77 gigalitres (GL)		
Upper reservoir volume	75.60 GL		
Net rated head	640.2 metres (m) (generating) / 665.9 m (pumping)		
Pump turbine type	312.5 MW fixed speed, reversible Francis pump turbine units		
Connection point voltage	500 kilovolts (kV)		

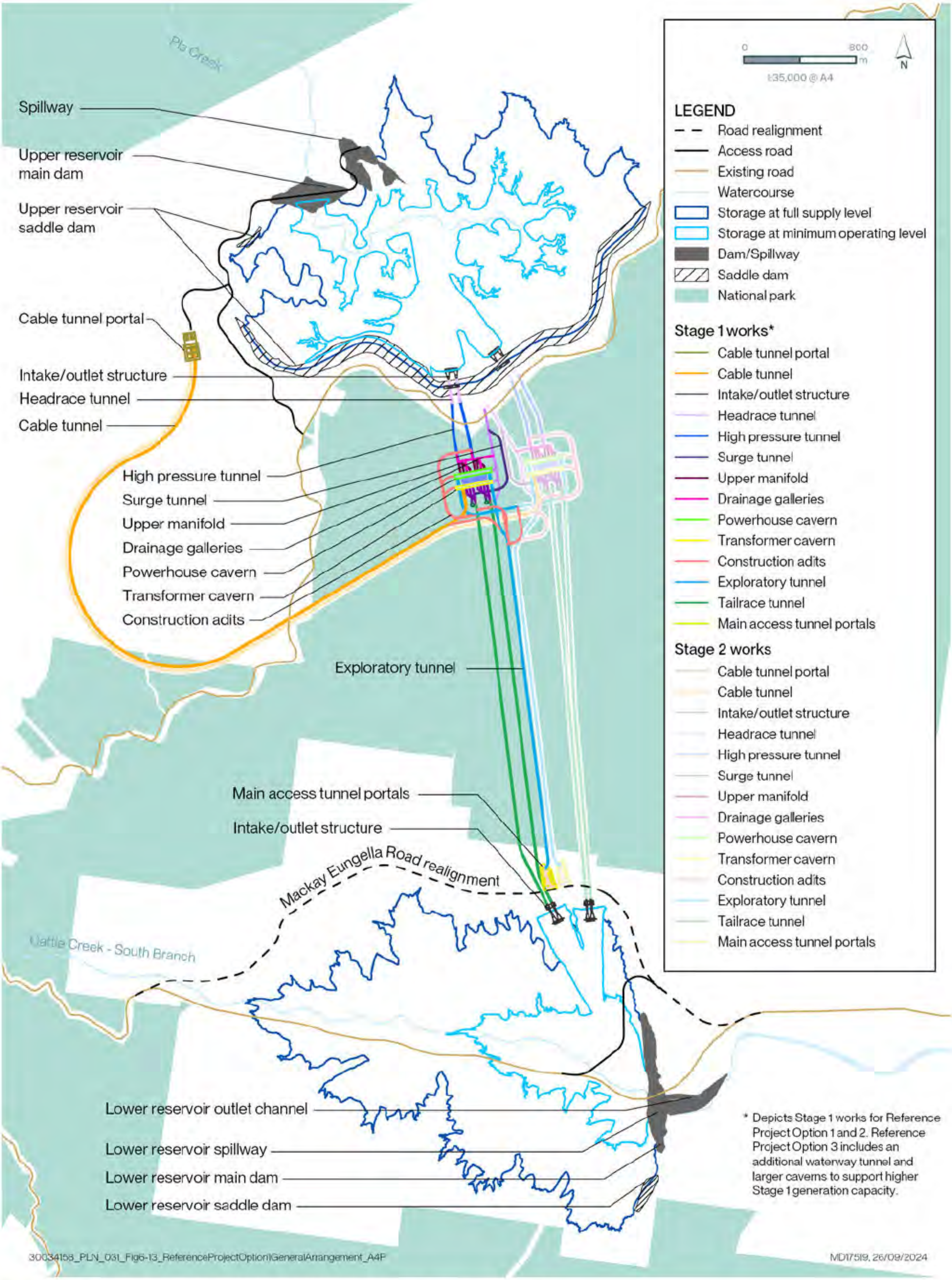


Figure E-7 Reference Project Options general arrangement

Key findings and Project benefits and risks

Reference Project Options were investigated and analysed to identify costs, risks, benefits and impacts. The DAR contains chapters detailing thorough analysis related to:

- hydrology and water management
- legal and regulatory requirements
- property, land tenure and native title
- public interest
- sustainability
- social impact
- cultural heritage
- environment and ecology
- economic
- financial and commercial
- risk assessment and management
- market considerations
- delivery model and implementation.

The multidisciplinary assessment of Reference Project Options has found the Project to be in the public interest and feasible. It will deliver a range of benefits to the local and regional area and to Queensland, the broader NEM and globally with the reduction of greenhouse gas emissions. Work to date demonstrates several challenges and risks that require careful and ongoing management.

Emission savings[7]

The Project will deliver estimated annual carbon dioxide equivalent savings of:

- **9.8 Mt for Reference Project Option 1**
- **5.7 Mt for Reference Project Option 2**
- **7.6 Mt for Reference Project Option 3.**

When considering long-duration storage's role in supporting renewable investment, emissions savings are much higher with indirect savings estimated at 38 Mt for Reference Project Option 1, 18.2 Mt for Reference Project Option 2 and 28.2 Mt for Reference Project Option 3.

Project benefits

The Project's fundamental benefit is its role in Queensland's transition to a renewable energy system, reducing greenhouse gas emissions and mitigating climate change impacts while securing clean, reliable and affordable electricity to the state's two million households and 465,000 businesses.

Electricity is a major input to economic activity throughout Queensland. Reliable, affordable, clean power is critical to Queensland's economy and lifestyle as Australia's largest consumer of energy and one of the largest consumers of electricity. The mining, manufacturing, residential, and commercial and services sectors are the state's largest electricity consumers and its network supports heavy and emerging industries like hydrogen production.

Up to 2049, the Project is also expected to save the NEM between $550 million and $680 million for avoided costs per annum including avoided capital expenditure, fuel costs, and fixed and variable operations, administration and maintenance costs. For an average Queensland household using 5.5 MWh each year (Frontier Economics, 2020) the Project could also lower electricity bills between $20 and $36 annually between 2036 and 2050. While energy market modelling has a 2049 horizon, cost savings are likely to extend well beyond this.

The Project will deliver significant benefit through its role in supporting reliable, secure and affordable electricity to meet demand in a decarbonised electricity network and reducing reliance on interstate power and price fluctuations. Reliable, competitively-priced electricity lowers operational costs and stabilises electricity prices for all consumers.

Figure E-8 shows, across a 30-year evaluation period (2024 to 2054), the Project will benefit both the Mackay region and state economies, increasing output and the number of jobs over an extended period through its delivery and operation and by encouraging new investment.

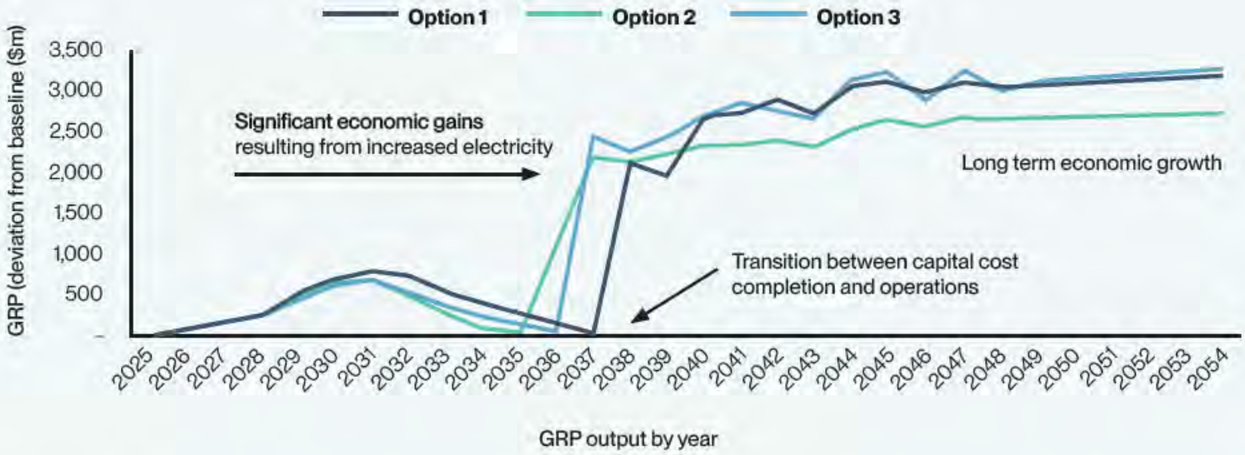
[7] This approach assumes coal continues to be relied upon, which implies that more carbon will be offset and does not consider gas use. This approach is consistent with the approach taken for Snowy 2.0 project

Economic benefits

Reference Project Option 1		Reference Project Option 2		Reference Project Option 3	
Increase to gross regional product (GRP) and gross state product (GSP) to 2054 with Project					
GRP increase	GSP increase	GRP increase	GSP increase	GRP increase	GSP increase
$16.6b	**$17.1b**	**$14.5b**	**$15.0b**	**$15.4b**	**$15.6b**

Increased economic outcomes to the regional economy are driven by:

- Project capital expenditure, supported by construction workforce, stimulates the economy through direct and flow on supply chain activity comprising between 21% and 30% of GRP uplift.
- Ongoing generation revenue stimulates the economy through direct and supply chain activity and comprising 70% to 79% of GRP uplift.
- The Project elevates Queensland's position as an attractive destination for investment (green premium) accounting for 0.27% and 0.30% of GRP uplift.



The Project's 100+ year design life means significant economic benefit will continue post the evaluation period delivering a significant legacy for the Mackay region and Queensland.

Mackay Local Government Area – additional jobs (full time equivalent/year)

Option 1	Option 2	Option 3
+950 jobs	**+720 jobs**	**+800 jobs**

Total avoided emissions to 2054
By investing in the Project, Queensland can reduce its reliance on coal-fired generators sooner by supporting the installation of renewable energy capacity.

Option 1	Option 2	Option 3
valued at **$3.97 billion**	valued at **$3.22 billion**	valued at **$3.66 billion**

*regional is defined as the Mackay Local Government Area

Figure E-8 Project economic benefit summary

The importance of Queensland's energy-intensive industry

Retaining Queensland's energy-intensive industries is vital for economic growth. A low carbon electricity network will help retain existing and attract new industries. As part of a high variable renewable energy system, the Project will provide reliable, secure renewable electricity, helping industries meet decarbonisation goals and boosting Queensland's economic performance. Queensland's top three resource-based companies are all committed to achieving net zero by 2050 with interim targets:

- **BHP Billiton:** Reduce greenhouse gas emissions by 30 per cent by 2030 (from 2020 levels)
- **Glencore:** Cut Scope 1 and 2 emissions by 50 per cent by 2035
- **Rio Tinto:** Reduce Scope 1 and 2 emissions by 15 per cent by 2025 and 50 per cent by 2030 (from 2018 levels).

Collectively each year, these three companies significantly boost Australia's economy with approximately:

- 92,000 employees nationally paid around $11 billion in wages and salaries
- $47.2 billion supporting suppliers
- $36 billion taxes, royalties and other payments to government.

BHP's projects contributed 10 per cent of Queensland's revenue in FY2023 (BHP, 2023). Mining accounted for about 17 per cent of Queensland's value add (before taxes and subsidies) (ABS, 2023).

Rio Tinto's 2023 annual report acknowledges the importance of PHES to its future competitiveness:

"processes requiring firm power, such as aluminium and steel production, will prize access to hydroelectricity or continue to rely on nuclear or fossil fuel-based electricity to offset variability in wind and solar energy. Existing operations with access to hydropower could see significant cost advantages, particularly if carbon penalties increase." (Rio Tinto, 2023)

This is illustrative of broader industry trends and demonstrates the private sector recognises the importance of clean energy to produce clean products.

Financial analysis

The financial analysis covers the Project's construction and operational costs and revenue over a 30-year evaluation period. Table E-4 presents analysis outcomes in $FY2024 present value (PV) terms. The commercial viability of the Project was assessed based on its P50 and P90 risk adjusted whole of life costs, terminal value and revenue.

Table E-4 P50 and P90 risk adjusted financial analysis outcomes (present value $million)

Cost element	Reference Project Option 1		Reference Project Option 2		Reference Project Option 3	
	P50	P90	P50	P90	P50	P90
Capital costs	(22,352)	(24,751)	(15,418)	(17,145)	(17,483)	(19,367)
Ongoing costs	(778)	(813)	(752)	(786)	(681)	(711)
Net revenue	8,674	8,674	8,317	8,317	8,771	8,771
Terminal value	10,118	10,025	10,385	10,315	12,075	11,993
NPV	(4,337)	(6,865)	2,532	701	2,682	686
Internal rate of return	4.42%	3.83%	6.44%	5.83%	6.38%	5.80%

Reference Project Option 1 results in a negative NPV of $4,337 million (P50) and $6,865 million (P90). Reference Project Option 2 results in a positive NPV of $2,532 million (P50) and $701 million (P90), and Reference Project Option 3 results in a positive NPV of $2,682 million (P50) and $686 million (P90).

Under Reference Project Option 2, generation output weighted price (OWP) and capacity factor are higher. Reference Project Option 1's Stage 2 capacity dampens prices earned by Stage 1.

This results in average gross margins around 6 per cent higher than in Reference Project Option 1, excluding premium markup on caps sold.

Reference Project Option 3 revenue results are similar, with a higher OWP than Reference Project Option 1 but lower OWP than Reference Project Option 2. Reference Project Option 3's average gross margins are higher than both Reference Project Options 1 and 2, as the higher volume under Reference Project Option 3 outweighs the higher average prices in Reference Project Option 2.

Environmental management

The Project's environmental assessment, informed by targeted field studies, provides higher confidence than is typically available at this stage of project assessment. The Project adopts an avoid, minimise, mitigate and offset hierarchy in its design and environment management and commits to deliver beyond environmental approval requirements to achieve net environmental gains. This is on top of the Project's significant environmental benefit in accelerating Queensland's transition to renewable energy, reducing greenhouse gas emissions and combating climate change.

While no approvals-related matters are identified where there is no path to resolution, several issues require careful management. Sufficient allowances have been made in the Project design, costs and risk allowances to ensure key issues are adequately addressed. There is high confidence the Project's most significant approvals-related concerns can be addressed through further assessment, design refinement and selection of proven mitigation measures, and where not able to be fully mitigated, the use of offsets. Key issues include:

- **Water quality:** The Project needs to manage downstream water quality and protect receptors, including high ecological value waters and the Great Barrier Reef. Preliminary modelling shows potential for fine sediment suspension in both reservoirs due to PHES operations. To manage this, a reservoir bypass system is being investigated to allow natural waterway flows of 50 to 100 ML/day (subject to inflows) around the lower reservoir into Cattle Creek downstream, reducing direct reservoir release. The bypass may also facilitate aquatic fauna passage. The Project is also evaluating other proven approaches to complement the bypass with the approach to be confirmed based on modelling, sedimentation studies and field data analysis.
- **Protected species:** Post mitigation using available measures, unavoidable impacts to MNES and MSES remain likely. The Project will address these impacts through a combination of direct (land-based) and indirect (in-kind) offsets and is preparing an Offsets Management Framework to adopt a strategic approach to offset delivery.
- **Groundwater:** Inflows to underground infrastructure, such as tunnels and waterways and water storage, can lead to localised changes in groundwater levels with potential impacts to groundwater dependent ecosystems. Proven mitigation techniques are available (ie grouting permeable sections of the underground infrastructure) to limit groundwater inflows. Together, ongoing field investigations, modelling and design refinements will identify the mitigations to adequately manage this issue.

The Project's visual amenity impact is a community concern. Visual simulations of the completed Project have been used in community engagement. Visual impacts of some above-ground Project features can be partially mitigated and mitigation options will be further developed in consultation with the community.

Ecological surveys of the Project area have identified platypus habitats. Platypus is highly valued by the local community, and any harm to them poses a significant reputational risk. Queensland Hydro will work with a platypus specialist, to develop a strategy to avoid, minimise or offset impacts.

A commitment to deliver net environmental gain

The commitment to delivering a net environmental gain will be achieved through conservation actions such as:

- expanding and restoring protected area estate
- improving connectivity for threatened species
- restoring degraded riparian vegetation and watercourses
- removing barriers to fish passage
- developing a strategy to relocate platypus while improving their habitat to support a larger and more resilient population.

Project approvals

The Project will require primary approvals (requirements under Commonwealth and state legislation) and secondary approvals (eg development approvals, environmental authorities, licences, approvals and permits at Commonwealth, state and local government levels).

For primary approvals, the Project will seek agreement from the Commonwealth for a split referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) across three works packages (Package 1: exploratory works, Package 2: Mackay Eungella Road realignment, and Package 3: main works). If agreed by the Commonwealth, this approach is expected to acquire exploratory works approvals 12 months earlier than if a single referral approach is adopted, enabling works to gather critical geotechnical data for main works tender design and enabling an earlier date for first power. A split referral process does however carry stakeholder and capital risk, with an estimated $1 billion in exploratory works at risk if main works approval is not secured.

This approach best meets timeframes, program dependencies and the different state assessment requirements for the packages. While all three packages of works are expected to be controlled actions under the EPBC Act, Packages 1 and 2 have lower potential impact to MNES and will be proposed to be assessed without the need for an environmental impact statement (EIS). Package 3 is expected to require assessment via an EIS with a full public consultation process.

Should a split referral approach be rejected by the Commonwealth regulator, or a change to current schedule focus of the approvals strategy, a referral approach packaging the exploratory works and main works into a single referral will be adopted. This would likely see EPBC Act matters considered under a single assessment undertaken by the Queensland Government. If a single referral approach is determined, a delay of up to 12 months is estimated.

Queensland Hydro recognises the potential for overlapping approval processes (within the Project as well as with the Borumba PHES Project) and will continue to engage with Commonwealth and state regulators to optimise approval packaging, timing and processes.

Property, land tenure and native title

The Project requires access to 115 land parcels to build and operate the asset. Most land needed for surface infrastructure is freehold tenure (103 out of 115 land parcels). Non-freehold land includes:

- watercourse land in the vicinity of Pla Creek and Cattle Creek [redacted]
- Eungella National Park which requires subsurface infrastructure installed for the tunnels, caverns and waterways. Queensland Hydro is exploring a range of options with the Queensland Government to gain the right to this access, including amendments to legislation, permits, works regulations, declaration of a State Development Area under the *State Development and Public Works Organisation Act 1971* or revocation of part of the national park.

Since the Project's announcement Queensland Hydro has been flexible as to how land access for technical studies is achieved and, at the request of landholders, voluntary acquisitions have been offered. As at 18 October 2024, Queensland Hydro has acquired 56 properties. Queensland Hydro has secured access to undertake investigations from 67 of the 82 (81 per cent) landholders required for the Project, either via consent to enter agreements or land acquisition initiated by that particular landholder. A resettlement strategy is being developed and will be implemented once the Project is approved to ensure fair acquisitions and improved living standards for resettled and host communities.

The Project may require further land for aspects not fully defined, such as for construction facilities and environmental offset areas.

Land acquisition and resettlement

The Project will impact 40 per cent of residential dwellings in Dalrymple and 80 per cent in Netherdale, making the management of socioeconomic impacts of land acquisition a high priority. Following an investment decision on the Project, a Resettlement Action Plan will be developed in consultation with the affected community to ensure adequate housing, improved livelihoods and living standards are met for displaced persons. Queensland Hydro will assess the impact on people and assets, engage displaced residents and develop resettlement packages.

Queensland Hydro will also develop a Resettlement Policy to align with the International Hydropower Association (IHA) Hydropower Sustainability Standard's environmental and social assessment and management performance criteria, which adopts a mitigation hierarchy that:

1. avoid impacts where possible
2. minimises unavoidable impacts
3. restores, offsets or compensates to mitigate impacts on the environment and community (IHA, 2023).

Cultural heritage

The Project spans the boundaries of two determined native title claims, being Yuwi and Widi, who are the cultural heritage parties for their respective areas. [redacted]

Queensland Hydro is currently in the process of commissioning both parties (and their respective technical advisors) to undertake more detailed Aboriginal cultural heritage surveys. These will be required as the Project progresses, culminating in developing a Cultural Heritage Management Plan. Obtaining sign off on this plan will be critical to commencing construction.

Queensland Hydro is also committed to working in collaboration with Yuwi and Widi to achieve outcomes that provide cultural heritage benefits. Queensland Hydro will continue to engage with both parties to identify and progress the most appropriate opportunities.

A historic heritage assessment identified 31 sites of potential historic heritage interest. These sites include the Dalrymple Heights School, Eungella Railway Station, and the site of the former Excelsior Hotel. While these sites are not listed on official heritage registers, they may hold local heritage significance and will be assessed in further detail, including site-based assessment, in future Project phases.

Hydrology

The Project straddles two separate catchments, managed under different water plans (both currently under review):

- lower reservoir on the south branch of Cattle Creek within the Water Plan (Pioneer Valley) 2002
- upper reservoir on Pla Creek within the Water Plan (Burdekin Basin) 2007.

Modelling indicates the Project can meet the water allocation security objectives, including for urban water supplies, and environmental flow objectives of both water plans. Further modelling will be required to confirm operational rules and compliance once new water plans are released.

Modelling indicates:

- the upper reservoir does not require any environmental bypass flows
- the lower reservoir needs to maintain a 50 ML per day environmental bypass flow (dependent on water plan finalisation) when inflows are received to ensure flows for downstream water users and the environment are not compromised.

Queensland Hydro will continue to work with the Department of Regional Development, Manufacturing and Water as the Pioneer Valley and Burdekin Basin water plans are finalised to ensure the Project's compliance with water plan requirements.

Scheme reliability

Modelling suggests the PHES is highly reliable after the first fill. Table E-5 shows each Reference Project Option's average operation at full generating capacity and a dry climate change drought showing high reliability even under severe drought and dry climate change scenarios.

Table E-5 Modelled average scheme operation at full generation capacity*

	Reference Project Option 1	Reference Project Option 2	Reference Project Option 3
Generation capacity	5,000 MW	2,500 MW	3,750 MW
Full storage duration	24 hr	48 hr	32 hr
Historical climate – severe drought	20.8 hr	41.6 hr	27.7 hr
Dry climate change	22.8 hr	45.6 hr	30.4 hr

*assumes a 50 ML environmental flow

The Project's social value and impacts

The Project benefits the public by providing social value across regions, stakeholders and timeframes. It ensures a reliable, low emissions electricity network as coal-fired generators retire, enhances the global competitiveness of Queensland's export industries and provides affordable electricity for households. It strengthens the network for future generations, helps protect from the worsening impacts of climate change, creates jobs, develops skills and improves regional infrastructure and services. Queensland Hydro's values include 'We Act With Care' and 'We Deliver Together' to maximise benefits and manage impacts.

The DAR's social impact evaluation (SIE) assessed the Project's positive and negative social impacts on communities within the investigation area (Eungella, Netherdale, Dalrymple Heights, Broken River and Finch Hatton), local area (Pioneer Valley Statistical Areas Level 2) and regional area (Mackay, Whitsunday and Isaac local government areas).

Most negative impacts are localised to the investigation and the local areas. The SIE identified a small closely-knit community with a strong sense of belonging and connection to the environment, that through recent events has become increasingly vulnerable. Concerns around the impacts of land acquisition, Project infrastructure and a large construction workforce are deeply felt. Queensland Hydro will need to provide extra support to the community during Project delivery and ongoing operations and work with the community to deliver additional benefits through the Community Benefits Framework.

A range of social impacts, usually seen later in the implementation and approval process, were brought forward by the Project's announcement. This includes early actions from Queensland Hydro agreeing to landholders' request to provide the option to voluntarily acquire their land (as an alternative to access agreements). Efforts are already being implemented to mitigate impacts including a Wellbeing and Resilience Program launched in early 2024 providing services including health outreach, telehealth and psychological services. Queensland Hydro has also committed to developing and implementing an exploratory works Social Assessment Management Plan in advance of an investment decision on the Project.

Queensland Hydro acknowledges the work needed to address impacts already being felt by communities closest to the Project and has committed to working closely with the Queensland Government to mitigate and offset the impact that the Project will have on the local area and wider communities. Several implementation actions are already underway, with community and stakeholder engagement ongoing.

Queensland Hydro's benefits sharing and enduring legacy commitment

Queensland Hydro is committed to investing in the local community over the long term. Queensland Hydro's Community Benefits Framework (Queensland Hydro, 2024), outlines the approach to realising an enduring legacy across community benefits, regional development and industry engagement. The framework is publicly available through the Queensland Hydro website and encompasses multiple programs that can be utilised by the local community, including community grants, sponsorship and community partnership programs.

Following a positive investment decision on the Project, the Community Grants Program will be launched, and a local Community Benefits Panel will be established. Community groups and organisations can then apply for funding to support a local community program, initiative or event. The role of the panel will be to review grant submissions and prioritise and recommend community applications to Queensland Hydro for funding support.

The Project includes community benefits funding of $35 million, with more to be invested across regional development to mitigate Project impacts and create legacy benefits beyond construction.

Social licence status

At a high level, regional stakeholders surveyed generally support the Project. Fifty-nine per cent of respondents to a survey undertaken in late 2023 were either somewhat supportive, supportive or very supportive of the Project (Micromex, 2023). Positive sentiment predominantly stems from positive perceptions of renewable energy and employment and economic opportunities for the local and regional areas.

The Project has the potential to secure social licence approval status at regional and state levels and to be tolerated by local communities with careful planning, engagement and follow-through on commitments, along with strong government support.

Sustainability

Queensland Hydro commits to Project sustainability and aims to align with the Hydropower Sustainability Standard (IHA, 2023), a global benchmark for sustainable hydropower projects, to demonstrate the Project's environmental, social and governance performance.

The DAR's sustainability assessment demonstrates the Project, at this early stage of development, is well-placed from a sustainability perspective. When assessed against the Queensland Government's Business Case Development Framework sustainability principles, the Project surpasses legislative and regulatory compliance across all assessment categories, except green infrastructure, which was compliant, reflecting the design's current maturity.

Queensland Hydro has identified areas, particularly in procurement and design, where sustainability can be further enhanced.

Implementation

Schedule

Figure E-9 provides a high-level timeline of Project activities with Project milestones detailed in Table E-6. Queensland Hydro has developed an implementation plan for the Project targeting first power and full commissioning as early as possible using a risk-based approach to schedule development.

Following submission to the Queensland Government, the Project will transition to the procurement and approvals phase. Priority tasks for the procurement and approvals phase, relate to obtaining regulatory and environmental approvals, procurement, land acquisition and commencing exploratory works and further Project definition and design.

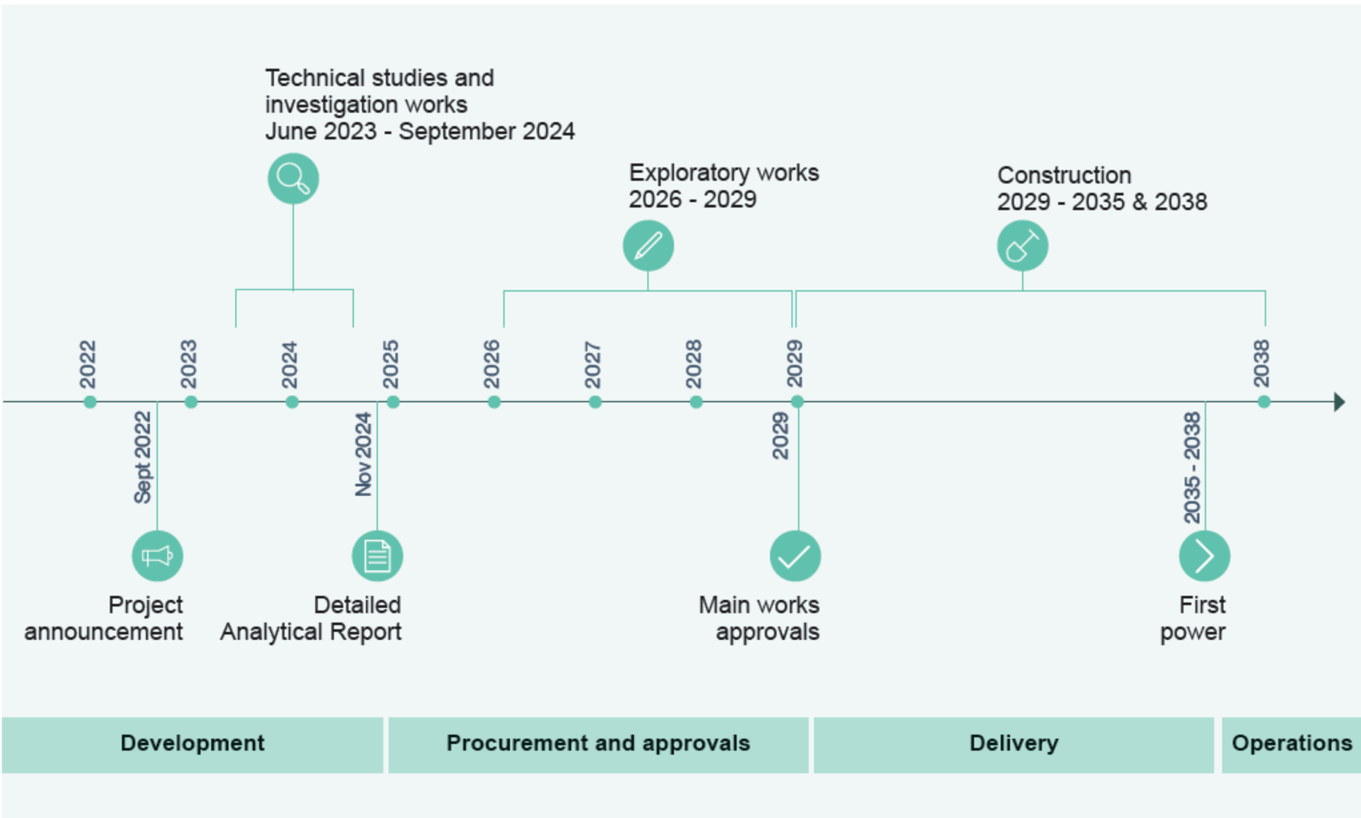


Figure E-9 High-level Project timeline

Table E-6 Reference Project Options - key external milestones (P50 baseline finish)

External milestone description (P50 baseline finish)	Reference Project Option 1 (5,000 MW)	Reference Project Option 2 (2,500 MW)	Reference Project Option 3 (3,750 MW)
Project investment decision	June 25	June 25	June 25
Exploratory works regulatory approval	September 26	September 26	September 26
Mackay Eungella Road realignment regulatory approval	May 27	May 27	May 27
Main works regulatory approval	May 29	May 29	May 29
Exploratory tunnel complete	May 29	May 29	May 29
Mackay Eungella Road realignment handover	January 32	January 32	January 32
Lower reservoir filling to minimum operational level	November 34	November 34	November 34
Stage 1 ready for first power	June 35	June 35	December 35
Stage 1 commissioning complete	October 35	October 35	February 36
Stage 2 ready for first power	March 38	-	-
Stage 2 commissioning complete	August 38	-	-

Figure E-10 illustrates the critical path which is consistent across all Reference Project Options.

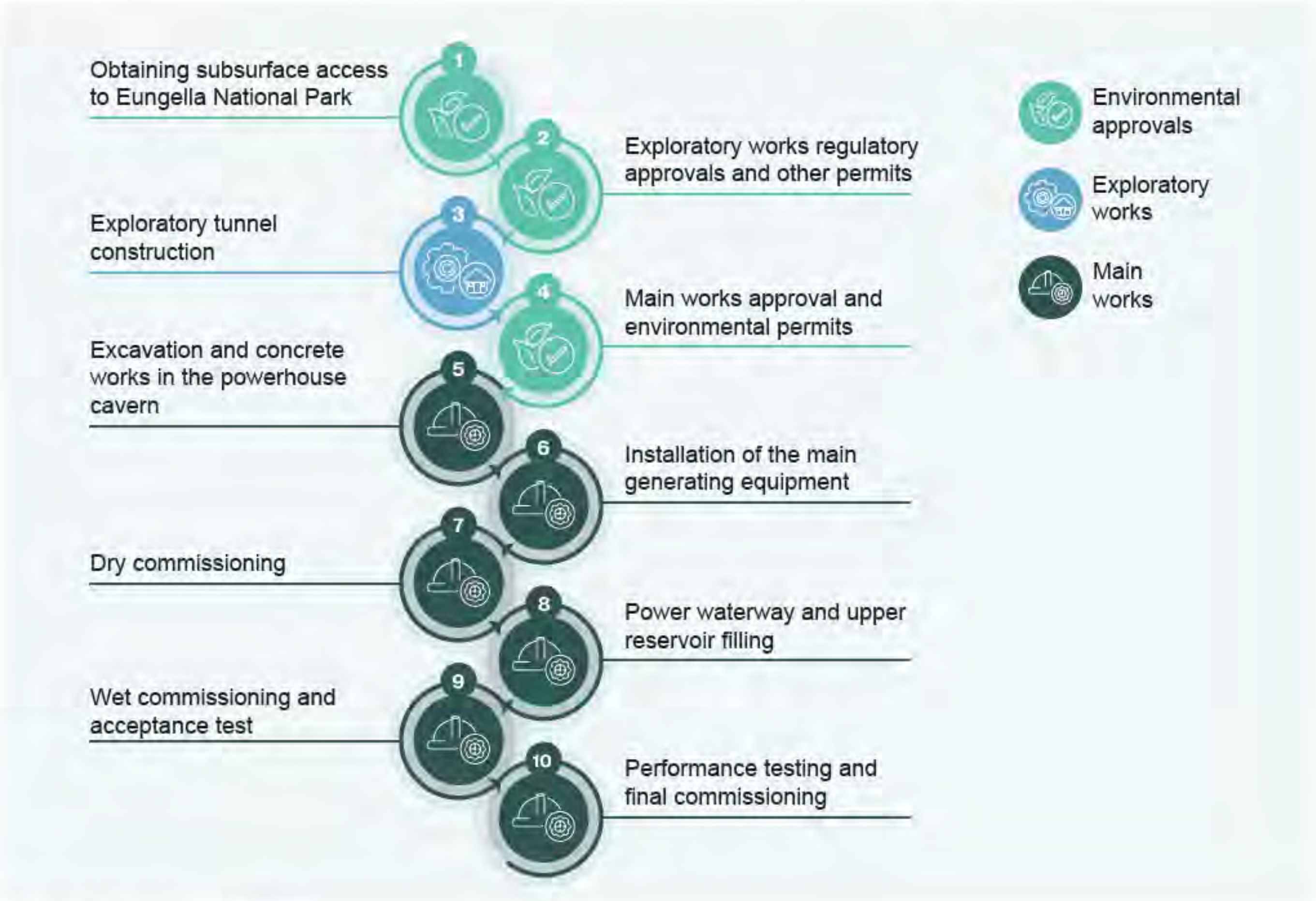


Figure E-10 Critical path

Achieving these schedule dates assumes:

- Geotechnical investigations, environmental surveys, procurement preparation, and design development continue post-DAR submission, prior to the investment decision.
- A split approval pathway to achieve first power by 2035 with this approach confirmed by March 2025 before submitting the exploratory works EPBC Act referral.
- Main works EPBC Act approval secured by May 2029.
- Decision to proceed with the Project and the preferred Reference Project Option by June 2025.
- Queensland Government facilitates subsurface access to Eungella National Park for geotechnical investigations and exploratory works by September 2026.
- Risk allocation for unforeseen geotechnical conditions.
- 18 months for the first fill, with a 50 per cent chance of reaching the required volume to commission turbines and achieve first power with a 50 ML/day environmental flow. Lower dam construction ends before the wet season, allowing two wet seasons for the first fill.
- 24/7 operation for site establishment, quarrying, dam construction, and underground excavation.
- PHES design supports the Powerlink Queensland and AEMO connection application process with network impact modelling, commissioning planning and negotiations occurring early to remove this process from the critical path.
- The transmission network connection provided by Powerlink Queensland will be ready to connect the Project to the grid.

Project risks that have been assessed as having a ‘high’ impact on the implementation schedule are detailed in Table E-7.

Table E-7 ‘High’ rated implementation risks

Risk	Mitigations
Access to collect geotechnical data: Delayed subsurface access to Eungella National Park impacting geotechnical investigation, design progress and exploratory tunnel construction.	Queensland Hydro is engaging with the Queensland Government to explore several options to attain right of access and use to establish and operate the Project’s infrastructure. Queensland Government support and intervention will be necessary to implement an acceptable and timely access solution.
Access to commence work: Delayed access to land to commence works as property acquisition takes longer due to landholders’ legal challenges or prolonged negotiations.	Reduced uncertainty for landowners by providing a voluntary acquisition process and derisking the land acquisition process.
Environmental approvals: Approvals for both exploratory and main works are not obtained at all or within Project timelines delaying main works mobilisation or with conditions that affect work site productivity.	High quality technical inputs into assessment documentation assured through independent expert review. Development of Approval Management Plan, Communication and Stakeholder Engagement Plan and Planning Environmental Management Plan. Ongoing agency engagement on referral strategy, timeframes and impact mitigation and offset strategies.
Main works construction: Geotechnical complexity or unforeseen ground conditions in main works underground construction result in lower production rates than those benchmarked and higher delivery costs.	Exploratory works phase will provide critical geotechnical data input into design development with the opportunity to relocate and optimise infrastructure based on new information.
Market capacity: Concurrent delivery with the Borumba PHES Project and dam safety improvement program results in insufficient contractors and workforce capability to deliver the works.	Government commitment and timing certainty, a favourable packaging and delivery approach and ongoing market engagement.
Native title and cultural heritage: Indigenous Land Use Agreement and Cultural Heritage Management Plan negotiations are prolonged, delaying start of works.	Proactively work with relevant First Nations stakeholders and government agencies including early and ongoing engagement with specialist support to negotiate Indigenous Land Use Agreement outcomes.
Industrial relations: The Project needs fly-in, fly-out, drive-in, drive-out workforce and underground work. Industrial arrangements may affect schedule and cost due to labour disputes or unfavourable terms like limits on 24/7 work, climate, rostering, and accommodation.	Specialist consultant engaged to advise on industrial relations (main works). Ensure active engagement by suitably experienced personnel to identify best alignment to Best Practice Industry Conditions and prepare an agreement.
Organisational capability and capacity: Queensland Hydro will deliver the Project in parallel with the Borumba PHES Project, creating a risk the organisation will not be able to secure sufficient experienced staff to manage the Project and integrate the works packages.	Engagement of an integration partner to provide essential technical, integration and project management skills to augment the Queensland Hydro team in Project planning and execution. Consideration of an experienced hydropower developer-operator as a private investor partner to the Project.
Community and stakeholder: Community opposition to the Project due to community perception of negative impacts on community lifestyle, property values, or local businesses.	Ongoing community engagement to identify and manage social impacts and benefits and deliver further community benefit through Queensland Hydro’s Community Benefits Framework.

There are several engineering, procurement and implementation opportunities to improve schedule outcomes that will be further explored, including early contractor involvement, design refinement and standardisation of documents and equipment with the Borumba PHES Project.

Reservoir first fill and full power

First power (wet commissioning of the first turbine) is a key Project milestone. Hydrological modelling was used to estimate when sufficient water will be available by considering historical rainfall onto the upper and lower reservoirs and historical inflows into the lower reservoir and under various environmental bypass flow and climate scenarios.

The assessment found there is a 50 per cent probability of achieving the required volume to commission individual turbines and achieve first power within:

- **one wet season** (4 months) with no environmental bypass flow
- **two wet seasons** (1.1 years) with 50 ML/day environmental bypass flow
- **two wet seasons** (1.3 years) with a 50 ML/day environmental bypass flow under a dry climate change scenario.

With most catchment inflows occurring during the wet season, completing construction just prior to a wet season is likely to reduce fill times by about a year compared to completing construction just after a wet season.

Once the Project achieves first power, the Project starts exporting electricity to and storing excess electricity from the NEM. As reservoirs continue to fill, the Project's capacity to generate and store energy will increase in line with the duration it can support full generation until full storage is achieved. There is a 50 per cent probability of achieving full operational capacity for 24 hours with 50 ML/day environmental bypass flow within:

- **five wet seasons** (4.1 years) for Reference Project Option 1 (5,000 MW)
- **three wet seasons** (2.3 years) for Reference Project Option 2 (2,500 MW)
- **four wet seasons** (3.3 years) for Reference Project Option 3 (3,750 MW).

The Project delivery schedule achieves completion of the lower reservoir ahead of powerhouse commissioning (critical path). This provides additional time for first fill, reducing the hydrology risk to Project operations.

Market conditions

Queensland Hydro engaged in market sounding activities for both the Borumba PHES Project and the Project, noting both projects have similar scope but with different timing, scale and location. Market sounding feedback and a review of the current market conditions concluded:

- There will be sufficient market interest and capacity to deliver the Project, although consideration will need to be given to workforce planning and securing design resources. There is a strong pipeline of dam upgrades to meet Australian National Committee on Large Dams requirements (with 20 projects in Queensland alone) with potential for increased competition for specific skills such as dam designers.
- Availability of skilled labour within the Mackay Region and competition with mining companies requires a strategic approach to workforce development and effort to bring workers from across Australia and potentially internationally.
- There has been a shift to collaborative delivery models for complex projects and there is market support for an approach in line with the Borumba PHES Project. Early contractor involvement is also sought.
- Client organisations have also been augmenting their teams with an integrator/delivery partners to provide key mega-project delivery and integration capacity and capabilities.
- To maximise competition, the Project should consider efficient staging approaches, manageable packaging sizes, workforce strategy and site access.

All participants stressed the importance of continued market engagement and regular updates on the Project's commitment to proceed, timing, and proposed approaches to procurement.

The Queensland market has a history of delivering multiple high value and labour intensive projects. Last decade three $20 billion coal seam gas projects were completed concurrently at Curtis Island with a combined peak workforce of 14,500. Early and regular market engagement is essential to ensure availability of resources.

Project resourcing

Figure E-11 shows Reference Project Option resourcing requirements through to the end of construction. The Project will deploy over 2,000 workers on site, including indirect and Owner's team resources, peaking in FY2031. Due to rostering arrangements, the total number of people employed by the Project at peak may be up to 50 per cent higher than this. Each of the Reference Project Options will deploy over 250 Owner's team resources, representing more than 10 per cent of the total workforce deployed to the Project.

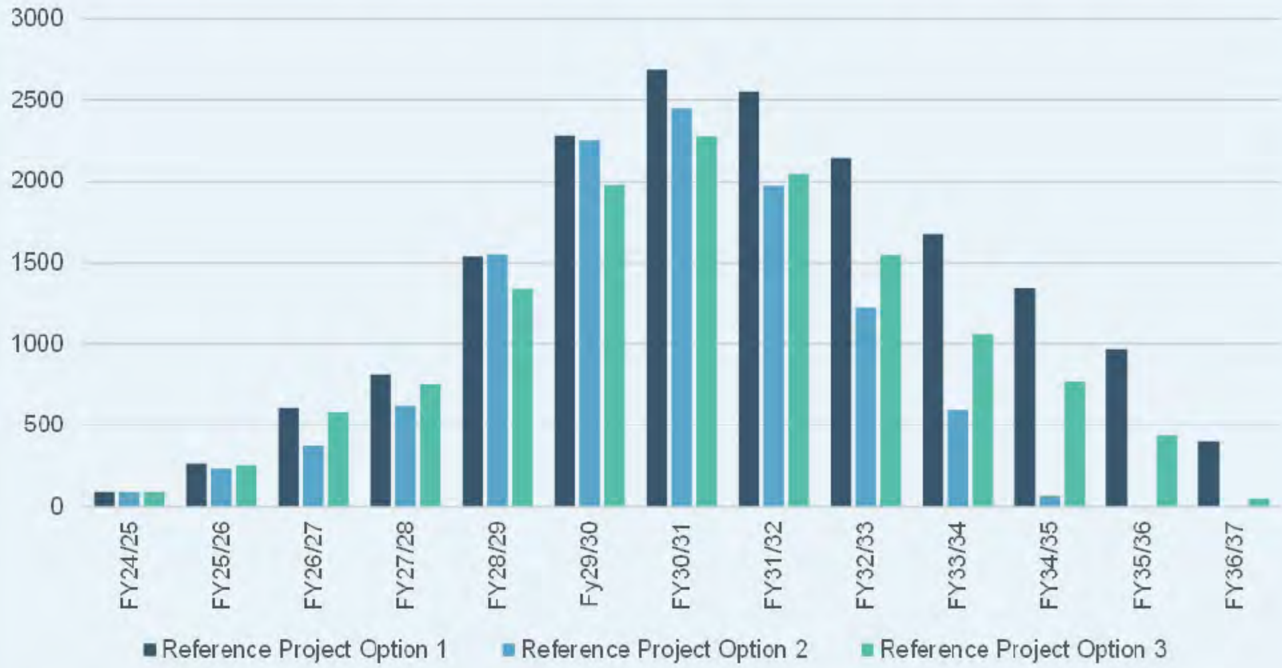


Figure E-11 Reference Project Option resourcing

Packaging and delivery model

Table E-8 reflects the Project's current packaging and procurement strategy based on DAR analysis. Packaging and delivery model selection is expected to be further refined during the Project's procurement and approvals phase. Project packaging and delivery model analysis undertaken for the DAR focused on the main works, identifying a four-package approach delivered through a collaborative ITC contract.

Table E-8 Project packaging and delivery planning

Package	Description
Integration partner	Provide essential technical, integration and project management skills to augment the Queensland Hydro team in Project planning and execution due to the Project's scale, particularly with concurrent delivery of the Borumba PHES Project.
Designers	Queensland Hydro will likely appoint designers of its choice and transfer these to the preferred dam and PHES delivery partners.
Exploratory works	Purpose is to obtain critical geological, geotechnical, hydrogeological information through geotechnical drilling and other site survey data to support further design development, improved costing and reduced construction risk. Includes supporting works such as access tracks and temporary bridges, camps and water supply. Includes construction of exploratory tunnel.
Main support works	Comprises works to facilitate main works such as permanent roads and bridges, camp supply and operations, and site power supply and communications. Procurement approach will be informed by timing and scope of relevant approvals.
Mackay Eungella Road alignment	Delivers a new 5.4 km four-lane, 70 km/h design speed road to Department of Transport and Main Roads standards to realign Mackay Eungella Road around the lower reservoir.
Main works	
Dam packages (two packages – upper and lower)	Includes the design and construction of dams (including quarried material supply and concrete supply) delivered through a lower dam package and an upper dam package. Expected to use ITC contracts.
Original equipment manufacturer	Supply and installation of electro-mechanical equipment. Will be contracted separately and retained by Queensland Hydro.
PHES main works	PHES main works (including tunnels, caverns) expected to use an ITC contract.

Project governance and organisational capability

Queensland Hydro is a publicly-owned entity established by the Queensland Government in 2022 to design, deliver, operate and maintain long duration PHES assets essential to the state's energy transformation. Currently focused on the delivery of the Project and the Borumba PHES Project (currently in the procurement and approvals phase), Queensland Hydro offers a team of industry experts with deep experience in hydropower, dams, project development and delivery, asset operations and maintenance.

Queensland Hydro's corporate governance structure supports PHES development, procurement, delivery and operation. The Project operates within Queensland Hydro's overarching governance frameworks, policies and procedures, with oversight and functional responsibilities held by the organisation, and reports to the Project Governance Committee.

Next steps

To complete the Project within the timeframes specified, several activities are proposed to occur concurrently to DAR submission and consideration by the Queensland Government.

Procurement and approvals phase activities

- Procurement planning
- Ongoing community and stakeholder engagement
- Ongoing land acquisitions
- Ongoing agency engagement on approvals process and national park access
- Ongoing site investigations (geotechnical, environmental)
- Exploratory works: develop design and submit referral
- Mackay Eungella Road realignment: develop design and submit referral
- Develop and implement Social Assessment Management Plan

Investment decision

- Finalise packaging and delivery model
- Ongoing community and stakeholder engagement
- Finalise land acquisitions and commence resettlement activities
- Obtain Eungella National Park access and agree ILUAs and Cultural Heritage Management Plans with Yuwi and Widi
- Engage designers for dams and Original Equipment Manufacturer
- Order electro-mechanical equipment, eg pump turbines
- Exploratory works: finalise design, complete procurement, obtain exploratory works approvals and complete support works
- Complete exploratory works, including exploratory tunnel
- Mackay Eungella Road realignment: finalise design, obtain approvals, complete procurement and commence construction
- Main works: finalise design, obtain main works approvals and complete procurement
- Obtain tertiary (contractor) approvals, permits and plans
- Main support works: procure and commence works

Main works award

Figure E-12 Procurement and approvals phase activities

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