Hydro Studies Summary
EXPLORING PUMPED HYDRO ENERGY STORAGE IN QUEENSLAND

Overview

Queensland's energy system is transforming in line with global action to reduce climate change, with more renewable energy powering homes and businesses than ever before.

As part of the Queensland Energy and Jobs Plan, released in September 2022, the Queensland Government has committed to renewable energy targets of 70 per cent renewable energy by 2032, and 80 per cent by 2035.

To meet our targets and secure Queensland's future energy system, more clean energy storage is crucial.

For many years, the government has been exploring the requirements of the state's energy system as levels of renewable energy increase.

The Queensland Hydro Study (completed between 2017 and 2020) evaluated opportunities for different energy storage technologies to support Queensland's energy system. The study also identified the most prospective sites for large-scale, long duration pumped hydro energy storage (PHES) facilities.

The Hydro Studies Summary, released in 2024, provides an overview of the Queensland Hydro Study, and outlines the government's site selection process for long duration pumped hydro projects.

Queensland Government

Queensland Hydro Study

The Queensland Hydro Study was completed over three stages. As each stage progressed, understanding of Queensland's energy storage requirements in a highly renewable system were refined.

Stage 1 (2017)

Examined the role of hydro/pumped hydro in Queensland, assessed prospective sites and identified 16 potential sites for further study.

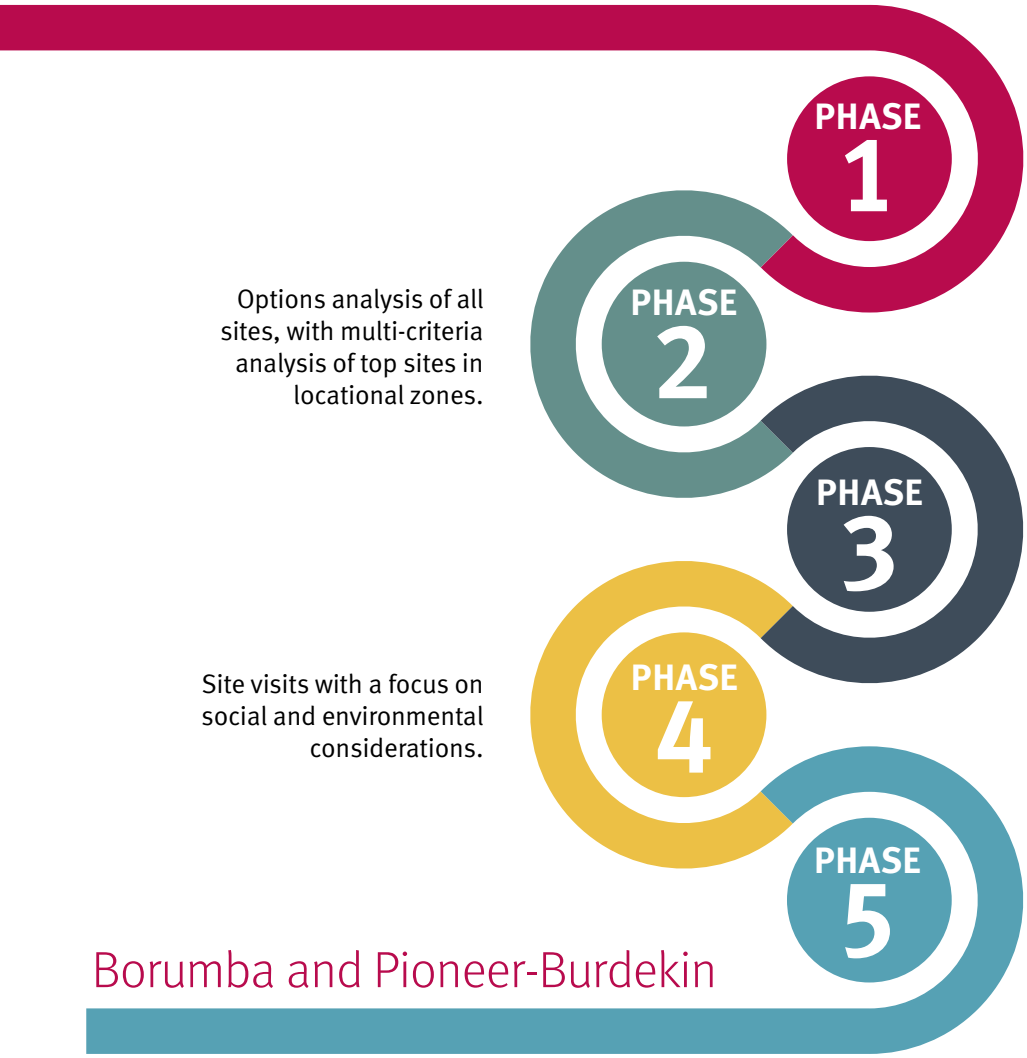
Stage 2 (2018)

Reviewed the four conventional hydro and 12 PHES sites from Stage 1 and prioritised eight of these sites for further study. The PHES sites evaluated in Stage 2 were small-scale with medium duration (up to 350 megawatts (MW) and eight hours storage duration).

Stage 3 (2020)

Commissioned after recognising that long duration PHES could potentially provide low-cost system reliability and security in the context of increasing variable renewable energy generation. The analysis evaluated the case for large-scale, long duration PHES and completed desktop studies on prospective PHES sites.

Stage 3 study



Shortlisting of Australian National University (ANU) Atlas and historical studies.

Options analysis of all sites, with multi-criteria analysis of top sites in locational zones.

Desktop studies considering technical design and geotechnical, environmental and hydrological considerations.

Site visits with a focus on social and environmental considerations.

Concept studies of the most prospective sites.

Borumba and Pioneer-Burdekin

The Stage 3 analysis found that Queensland's two most prospective PHES opportunities were located at Lake Borumba and in the western Pioneer Valley. Detailed feasibility assessment and investigations at the Borumba PHES site were announced in June 2021.

Following energy market modelling performed for the Queensland Energy and Jobs Plan, the scale of Queensland's energy storage requirements (at least 6,000 MW of long duration storage) became apparent. To meet this need, the Queensland Government announced investigations at the Pioneer-Burdekin site, which has the potential to deliver up to 5,000 MW of long duration energy storage capacity.

What is energy storage?

Energy storage describes the process where energy is captured and stored so it can be provided to Queenslanders when it is needed.

In a system with a large amount of renewable energy generation, energy storage is important as it allows clean energy to be shifted from times when wind and solar are plentiful, to times of low renewable energy generation.

Energy storage also provides a range of non-energy services that help manage the power system, such as voltage and frequency support, inertia and system strength. These services are increasingly important in energy systems with high levels of renewable energy generation.

Energy storage technology options

As part of the Queensland Hydro Study, the government evaluated the following storage technologies to provide system reliability and security services:

- PHES
- Batteries
- Conventional hydroelectricity
- Flywheels
- Synchronous condensers
- Concentrated solar thermal
- Compressed air energy storage
- Demand response
- Hydrogen
- Low-capacity factor gas generation

The study identified pumped hydro as the lowest cost and most reliable low emission technology to deliver large-scale, long duration energy storage.

Without long duration PHES, pathways to net-zero emissions are more expensive, too slow or rely on step-change technology improvements beyond forecasts.

Exploring PHES

PHES is the world's largest battery technology, accounting for about 97 per cent of installed global energy storage. As such, PHES is the perfect backup for other renewable energy sources like wind and solar.

Long duration pumped hydro assets provide "deep storage" with the ability to supply energy over an 18 to 24 hour period, or longer. Long duration pumped hydro stores energy while renewable generation is plentiful and discharges it when there is insufficient generation to meet demand.

PHES uses electricity from the grid or nearby renewables to pump water from the lower reservoir into the upper reservoir when energy prices are low. When energy is needed, water is released from an upper reservoir back into the lower reservoir, passing through a turbine.

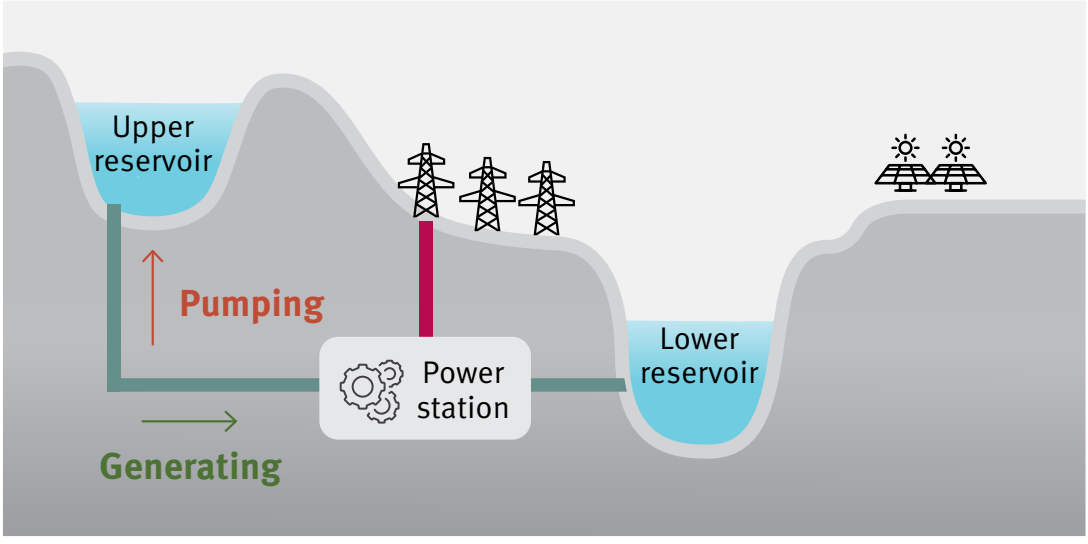
Because of this "closed loop" system, PHES is less dependent on variable river flows since the only water losses are from evaporation or seepage. This also makes PHES developments more resilient to the impacts of climate change.

PHES facilities are large-scale projects which generally take seven to 10 years to develop and involve significant construction activity over several years.

PHES schemes have a long design life, for both electro-mechanical plant and civil works, which is not currently available from competing technologies.

PHES schemes also have a long operational life, unlike other competing energy storage technologies.

For example, Queensland's only operational PHES, located at Wivenhoe Dam, has been in operation for four decades.



WHAT IS PUMPED HYDRO?

Watch our video to find out more

Queensland's best large-scale, long duration PHES sites

The two most prospective PHES sites in Queensland, Borumba and Pioneer-Burdekin, offer the best opportunities to meet the state's energy storage needs while minimising potential adverse impacts.

Large infrastructure developments typically lead to some measure of impact on local communities during construction and operation. PHES developments are no different, with impacts needing to be balanced with the wider benefits of increased renewable energy, emissions reduction and economic development.

What's next?

Following the government's financial investment decision in June 2023, early supporting works have commenced at the Borumba project site. An environmental impact assessment process is also being undertaken to further investigate the environmental, social and economic impacts of the project.

At the Pioneer-Burdekin site, work is now underway on geological, hydrological, environmental, social, cultural heritage and native title studies. Queensland Hydro is engaging with local communities to understand and limit potential impacts.

The government is committed to engaging with stakeholders early and often to ensure the best outcome is achieved for all.

If developed, the Borumba and Pioneer-Burdekin PHES projects will ensure Queensland achieves its targets to be powered by cleaner, cheaper, reliable renewable energy. Bringing more renewable energy into our electricity grid will be critical for protecting our natural environment and enviable lifestyle and growing jobs in new and existing industries as Queensland becomes a renewable energy superpower.

Characteristic	Borumba	Pioneer-Burdekin
Scale and duration	Up to 2,000 MW x 24 hours	Up to 5,000 MW x 24 hours
Local opportunities	Well situated near the Southern Queensland Renewable Energy Zones (REZs)	Well situated near the Central and Northern Queensland REZs
Commerciality	Attractive capital costs per gigawatt hour (GWh) driven by technical characteristics	Attractive capital costs per GWh driven by economies of scale and technical characteristics
Environmental considerations	Impacts avoided where possible. Offsets provided for inundated areas.	Careful site design allows protected areas to be avoided
Hydrology	Large catchment supports scheme reliability	High rainfall area supports scheme reliability
Social and community	Project footprint primarily on state owned land	50 homes affected
Geotechnical	Preliminary onsite investigation supports scheme viability	Desktop analysis indicates viable conditions, on the ground assessment underway in 2024

More information

To learn more about pumped hydro and to download the Hydro Studies Summary, scan the QR code or visit energyandclimate.qld.gov.au

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