Queensland Hydro Study: establishing our potential

Pumped hydro sites in Queensland

The Queensland Government commenced the Queensland Hydroelectric Study in 2017 to identify opportunities to develop conventional hydroelectricity and pumped hydro across the state.

Assessment of the potential pumped hydro resource in Queensland has found that there are numerous sites that could supply the storage capacity the electricity system will need.

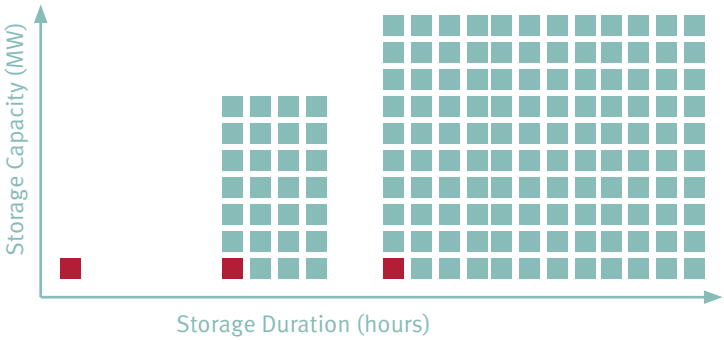
The potential pumped hydro energy storage (PHES) sites investigated as part of the Hydroelectric Study can be classified as 'medium size' or 'large-scale':

- Medium size projects typically have maximum generation capacity in the order of 300 MW[2] and maximum energy storage of 8 hours.
- Large-scale sites assessed have capacity of more than 1,000 MW (1 Gigawatt)[3] and storage duration of at least 24 hours.

To put the scale of these PHES projects into perspective, the typical dimensions of a PHES can be compared to the Hornsdale Power Reserve in South Australia, once considered the largest battery in the world.

In terms of energy storage, most medium sized PHES projects are over ten times larger than Hornsdale, and large-scale projects are over 100 times larger, with the largest projects equivalent to 300 Hornsdale batteries.

Figure: Comparison of PHES vs battery dimensions



Hornsdale

150 MW
× 1.3 hours

Wivenhoe

570 MW
× 10 hours

Large-scale PHES

- 1000MW 24 hours (24 GWh)
- 4× Wivenhoe
- 123 × Hornsdale

Queensland may need at least 2–4, 2000 MW sites with 24 hours storage to support Zero Net Emissions by 2050.

[2] For example the Kidston Pumped Storage Hydro Project currently being developed in north-west Qld is a 250 MW capacity PHES with 8 hours of storage.

[3] While the largest international projects can reach over 3000 MW of capacity (e.g. Bath County Pumped Storage Station in the United States), the largest existing PHES in Australia is Tumut 3, which has 600 MW of pumping capacity as part of a larger 1800 MW hydro scheme *(source: NSW Government, 2018)*.

Medium sized sites

Medium sized sites are able to provide a number of services to the electricity system including the 'time shifting' of energy on a daily basis and the provision of system strength and reliability services.

However, the generally shorter storage duration (typically 6–12 hours at maximum generation capacity) means these sites are generally not able to provide significant capacity to be used in the event of periodic shortfalls in variable renewable generation ('strategic reserve').

Medium-sized sites are of the size generally considered to be commercially viable by the private sector, and several projects of similar size have been proposed by project developers. These projects typically rely on selling electricity to the grid as an arbitrage product and as such provide a more limited replacement of dispatchable, baseload generation to support high volumes of renewable output.

Large-scale sites

Large-scale sites can provide all of the services offered by medium sized projects, but their longer storage duration (24 hours compared to 8 hours typical of medium sized projects) means that they are also able to provide strategic storage reserves to the system.

Strategic storage reserves are reserves of generation capacity required during periods when renewable generation is low (e.g. cloudy conditions persist for several days, limiting solar generation).

Despite the additional services provided by large-scale sites and the potential for scale economies compared to medium sized projects, these sites are unlikely to be developed by the private sector in the medium-term on a commercial basis due to long project lead times, greater complexity in approvals and high capital cost.

Photo courtesy of CleanCo

Site identification and assessment

Site selection criteria

Sites in the Queensland Government's Hydro Study were initially identified from a topographic perspective, identifying locations with potential for development of PHES based on local height differentials.

In addition to topography there are a number of site-specific considerations which affect the selection of potential PHES.

- Location and resource
- Technology and design
- Commerciality
- Environmental factors
- Social and community factors

All factors must be carefully considered before a decision to proceed with a project can be taken to ensure each project is economically viable whilst achieving broad acceptance amongst stakeholders (i.e. 'social licence').

This assessment is especially important for PHES projects, due to their large scale and the requirement in most cases to create additional reservoirs for water storage.

Assessment processes

Multi-criteria analysis (MCA)

Multi-criteria analysis is a common tool used in large infrastructure project planning and this technique was used in the Hydro Study.

This tried and tested method is used to assess a projects against multiple standard factors to ensure well informed decisions can be made.

Staged assessment of projects

PHES projects are large, complex projects that are characterised by long development, construction and operational timeframes. Projects of this nature typically follow a staged assessment process, with increasing levels of assessment detail and certainty around project parameters.

The precise design, cost and environmental and social impact of potential PHES projects is site-specific and requires detailed expert assessment. The Hydro Study has taken projects through initial assessments in a systematic manner, to ensure all options were considered and rigorously assessed before proceeding to more detailed assessment.

Commercial and technical assessments

Location and resource

Locational and resource issues are site-specific and have a major impact on the potential viability of projects. Assessments have considered height and horizontal distance between dams, potential reservoir storage capacity, water source and impact on local water supplies, civil works required (including tunnelling) and site logistics.

Technology and design

Technology and design issues vary from site to site, and assessments have considered factors such as project efficiency (including hydraulic and water losses), and the ability of the electricity transmission network to incorporate the PHES.

Commerciality

The scale of PHES projects and the site-specific nature of projects are the key factors impacting cost. Assessments of the cost of developing PHES projects considered a full suite of location and technology factors.

Environment and social assessments

Environment

Protection of the environment is one of the guiding principles in the development of PHES, and no project will proceed if environmental risks are too high. Environmental assessments included existing tenure and use of land, impact on flora and fauna, impact on waterways and requirements for environmental offsets.

Indigenous

The conservation values of Queensland's protected areas are indivisible from their cultural significance for First Nations peoples. Assessments have included Native Title considerations and the potential impact of projects on sites of cultural significance.

Community

While PHES projects are an important part of the future energy system, the size and scale of these projects can affect local amenity. Assessments included the effect of projects on the local community communities, including impact on existing community activities in the project area and impact on roadways during and after construction.