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Off-River Pumped Hydro – Site Searching Method and Results

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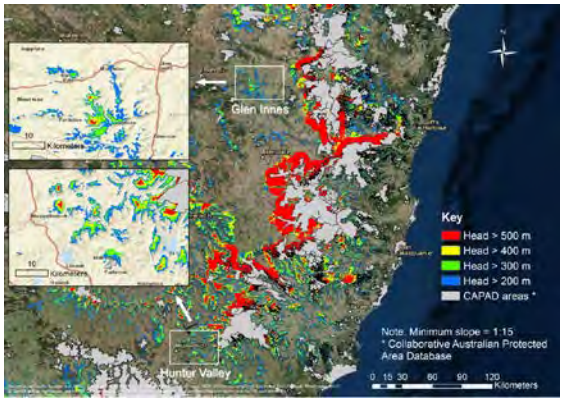
As the proportion of wind and solar photovoltaics (PV) extends into the 50-100% range over the next decade, a combination of additional interstate high voltage transmission, demand management and local storage is required to stabilise the grid. Pumped Hydro Energy Storage (PHES) constitutes 97% of electricity storage worldwide and is the subject of this study. Off-river PHES opportunities are far more prevalent than river-based sites. Unlike conventional "on-river" hydro power, off-river (closed loop) PHES requires pairs of reservoirs that are generally 10-100 hectares in size, rather like oversized farm dams, located away from rivers and national parks in hilly country. These sites are separated by an altitude difference (head) of 200-900 metres.



The site finding algorithm is based on a series of input datasets that are used to calculate potential pumped hydro locations. These input datasets include locating areas with potential upper and lower reservoir locations by narrowing the land area to be searched as seen in Figure 1.

The algorithm can be applied to specific regions of interest or as broadly as narrowing best areas for pumped hydro for an entire country. The methods for site searching also apply restrictions such as limiting site finding to areas outside of protected and urban land.

Figure 1 Areas of with potential upper and lower reservoir locations at 200m,300m,400m and 500m head.

The next stage of the searching algorithm includes locating the specific area with upper or lower reservoir potential. This involves using GIS generated input data such as a virtual stream network, pour point data, and then watershed area calculations to create the dam and reservoir areas as seen in Figure 2.

The pour point data is the source data for creating dam wall heights of 10m, 20m, 40m or 80m measurements and is used for our source of site indexing.

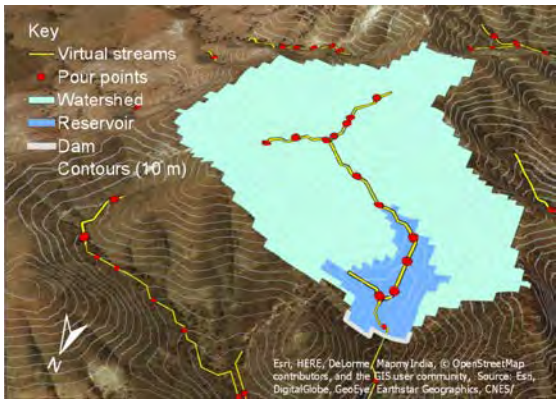


Figure 2 Sample watershed area with potential dam and reservoir created along the pour point locations designated at every 10m contour.

This study is unique to Australia and for much of the world in that it highlights suitable locations for both upper and lower reservoirs. Many other pumped hydro studies have targeted pumped hydro suitability based on existing water bodies. Off-river searching has enabled identifications of orders of magnitude more sites than are required to balance a 100% renewable grid.

Figure 3 is a national atlas of pumped hydro energy storage in Australia. As shown on the atlas, the prospective pumped hydro sites are concentrated in:

- Great Dividing Range, Qld, NSW and Vic (the eastern states)
- Flinders Ranges, SA
- Darling Scarp, WA (the southwest of WA)
- Macdonnell Ranges, NT (in central Australia)
- Kimberley & Lake Argyle, WA and NT (the north of WA and NT)
- Hamersley Range, WA (near Pilbara, the northwest of WA)
- Tasmania (outside national parks), “Battery of the Nation”

The total storage potential of the 22,000 sites is equivalent to 67,000 GWh assuming an average hydraulic head of 400 m, which is far beyond the storage requirements (500 GWh roughly) to support 100% renewable electricity in the Australian energy markets.

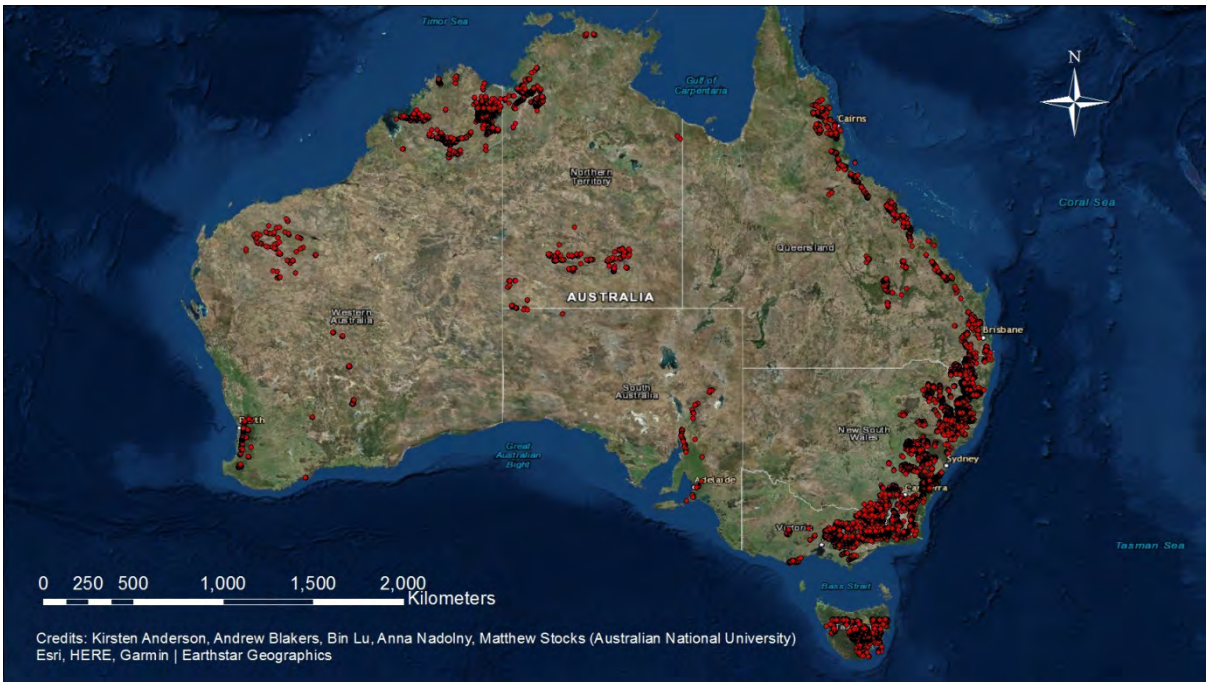


Figure 3 A national atlas of pumped hydro energy storage in Australia. Each red dot on this map represents a possible pumped hydro site identified from the modelling. Number of sites = 22,000.