ASIA-PACIFIC
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Global Atlas of Pumped Hydro Storage to Support High Penetration of Renewable Energy

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Australia is currently installing renewable electricity capacity faster than anywhere else in the world (250W per person per annum), dominated by wind and solar. Australia's current build rate would enable Australia to achieve 50% renewable electricity in 2024 and 100% in the early 2030s. Numerous studies at regional, country and global levels have identified storage as a key enabler of variable renewable energy at these penetration levels. Pumped hydro, the largest source of electrical storage, will continue to have a major role in energy storage.

The RE100 group at ANU released the world's first global atlas of pumped hydro energy storage in 2019, identifying more than 610,000 unique sites around the world. This atlas identifies upper and lower reservoir locations outside protected and urban areas, determines the reservoir parameters for a range of storage sizes targets. A cost model is then evaluated with these parameters and a tunnel conveyance to determine the system cost. Economically vcompetiutive locations are eliminated and remaining sites are then ranked from A to E class. An A Class with 6 hours storage equates to a levelised cost of storage of US$40 per MWh making it well suited for time shifting with large scale solar. As can be seen in Figure 1, every region defined by UN geoscheme, except Micronesia, has sufficient resource to support 100% renewable electricity.

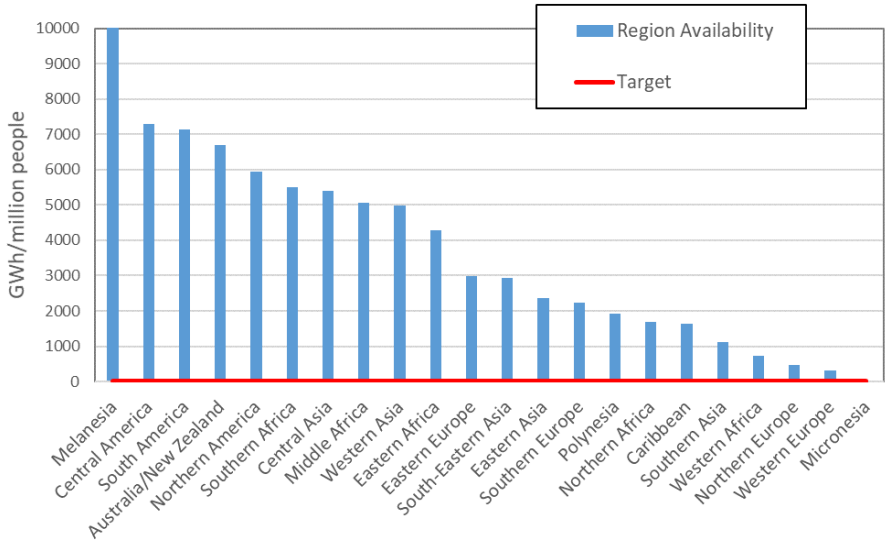

Figure 1. Regional per capita pumped hydro capacity. Most regions have more than 100 times more storage than the target needed to balance a 100% renewable grid (~20 GWh/million people[1]).

The atlas is hosted on the Australian Renewable Mapping Infrastructure (AREMI) website at https://nationalmap.gov.au/renewables/#share=s-oDPMo1jDBBtwBNhD. The distribution of sites in the Asia-Pacific region is shown in Figure 2. This provides full 3-D visualisation of every site around the world for user selectable system sizes from 2GWh to 150GWh. Zooming in to individual sites provides detail site characteristics including upper and lower reservoir latitude and longitude, head, water storage volumes and cost rankings.

Figure 2. Distribution of 15GW 18 hour storage sites in the Asia-Pacific region

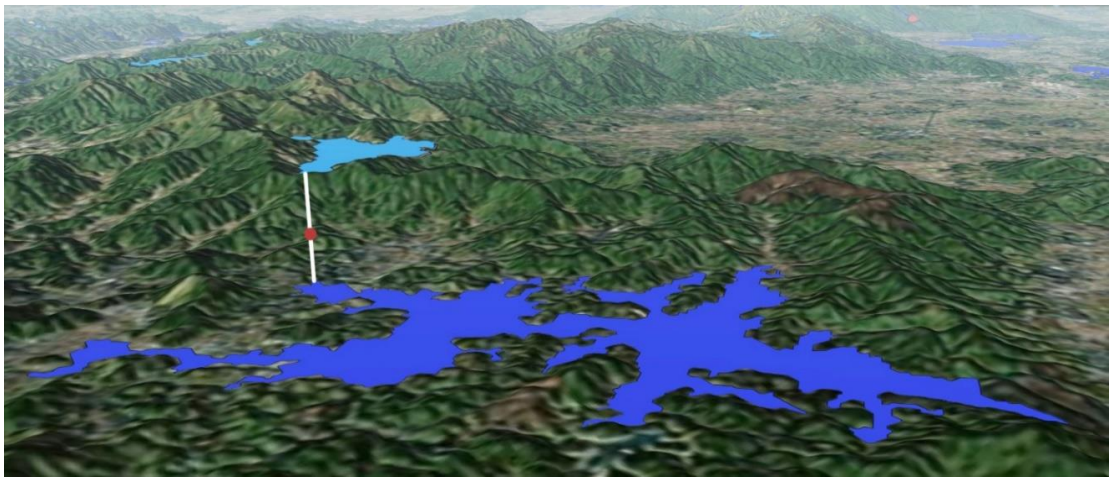

Figure 3. 3D visualisation of a Class-A off-river pumped hydro site in Southern China. Dam heights are adjusted to achieve the water volume required for the target energy storage.

In Australia, these additional constraints have significantly refined the number of feasible sites from our preliminary analysis. There are now 3000 potential sites that are considered economically viable. Considering Class A sites only constrains the resource further with 8% of this storage capacity ranked as lowest cost. Australian users benefit further with hosting on the AREMI website allowing users to overlay information such as wind and solar resources, and transmission lines to evaluate potential renewable energy zones or land use overlays including council areas or native title determinations. This provides users with excellent information prior to progressing to engineering evaluation.

References

[1] Blakers A., Lu B. and Stocks M. 2019 “100% Renewable Electricity for Australia” Energy 19 pp 471-482