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The Bluefield Pumped Hydro Energy Storage Atlas

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Abstract

The Australian National University (ANU) has released its Bluefield pumped hydro energy storage (PHES) Atlas.[1] The Atlas lists 1500 sites across Australia where a PHES system could be constructed in conjunction with an existing reservoir.[2] The new Bluefield Atlas complements ANU's existing Greenfield Atlas (Stocks et al. 2020, Stocks et al. 2021) which lists 4,000 off-river PHES sites that are not linked to existing reservoirs, thus requiring two new reservoirs.[3] Basically, for the Bluefield Atlas we searched near every existing reservoir in Australia to find a potential matching reservoir site to form a PHES pair. Only one new reservoir is required for a Bluefield site.

Introduction

Pumped Hydro Energy Storage (PHES) entails two reservoirs spaced a few km apart at different altitudes (Blakers et al. 2021). On sunny and windy days water is pumped uphill from the lower to the upper reservoir. On calm days or at night, the water returns downhill from the upper to the lower reservoir to generate power. The same water goes up and down hill for 50 years or more.

Australia needs a lot of storage to support variable solar and wind electricity on the way to reaching its target of 82% renewable electricity by 2030.[4] PHES excels for overnight and longer storage, while batteries are preferred for storage periods of minutes to hours (Blakers, Lu, Stocks 2022).

Water and land needs for enough PHES storage to support a 100% renewable energy system are small (Blakers, Stocks, Lu and Cheng 2021). About 3 litres of water per day per person is needed for the initial fill of the reservoirs and to replace evaporation, which is about 20 seconds of a morning shower. About 3 square metres of land per person would need to be flooded, which is about the area of a double bed.

The Atlas

Bluefield PHES Atlas users can pan and zoom to visualise potential reservoirs in detail, at a resolution of 30 metres. Clicking on a reservoir produces a popup with detailed information about the reservoir, while clicking on the tunnel route connecting the two reservoirs produces a popup with information about the PHES system as a whole.

1 https://re100.eng.anu.edu.au/bluefieldatlas/

2 See Blakers, Stocks, Lu and Cheng (2022)

3 https://re100.eng.anu.edu.au/index.html

4 https://www.alp.org.au/policies/powering-australia

The reservoirs in the Atlas are all outside national parks and urban areas. None of the 5,500 potential sites in our Bluefield and Greenfield Atlases requires a new dam on significant rivers.

Reservoir sizes shown in the Atlas range from 2 to 500 Gigawatt-hours (GWh) of energy storage. For comparison, the Kidston[5] and Snowy 2.0[6] (Fig. 1) PHES systems presently under construction are 2 and 350 GWh respectively, while the two PHES systems recently announced by the Queensland Government are 50 GWh (Borumba[7]) and 120 GWh (Pioneer-Burdekin[8]).

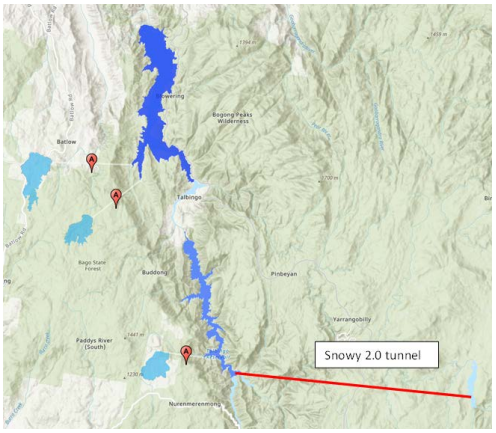

Figure 1: Class A, 500 GWh sites near Snowy 2.0

Each of the PHES systems in the Atlas is assigned a cost class (A through E), where an A-class system is expected to have half the capital cost of an E-class system per unit of storage. Australia has about 300 times more PHES storage potential than needed to support a 100% renewable energy system. We can afford to be choosy, and only develop the very best sites.

The PHES Atlas is routinely accessed by Government and companies. The Queensland Government recently announced the 5 Gigawatt Pioneer-Burdekin PHES system located at a site identified in our Atlas.

PHES provides about 95% of global energy storage. It is a highly credible, low-cost, mass-storage option to support rapid deployment of solar and wind. However, most of the existing PHES storage is co-located with hydroelectric schemes. The vast scale of storage opportunities that do not require new dams on rivers was unknown until our Atlas was released.

Findings in the Atlas

We found many interesting Bluefield sites. Large numbers of excellent sites of all sizes exist adjacent to Snowy 2.0 in the Snowy Mountains. This includes three 500 GWh potential reservoirs, which are more than enough to support a 100% Australian renewable energy system.

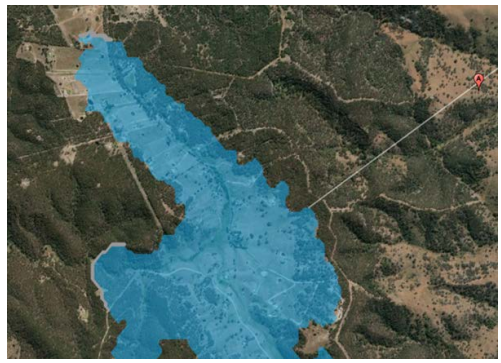

Figure 2: Detail of a Class A, 50 GWh site at Lake Windamere

5 https://genexpower.com.au/250mw-kidston-pumped-storage-hydro-project/

6 https://www.snowyhydro.com.au/snowy-20/about/

7 https://qldhydro.com.au/projects/borumba-pumped-hydro-project/

8 https://qldhydro.com.au/projects/pioneer-burdekin-pumped-hydro/

NSW: Lakes Pindari, Wyangala, Windamere (Fig. 2), Burrendong and Chaffey have attractive Bluefield sites to support NSW Renewable Energy Zones.

ACT: Canberra's main water supply dams, Cotter and Googong, both have possibilities.

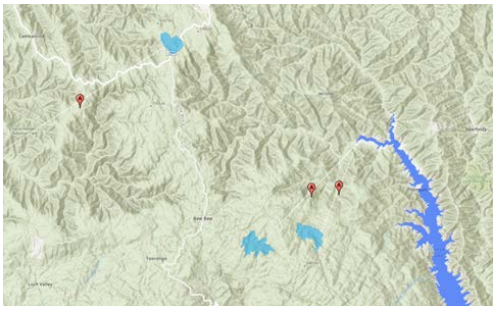

Figure 3: Three Class A 150 GWh sites at Thomson and Upper Yarra reservoirs

Victoria: Sites at Tarago, Maroondah, Nillahcootie, Rocky Valley, Upper Yarra and Thomson (Fig. 3) can support large-scale offshore Victorian wind.

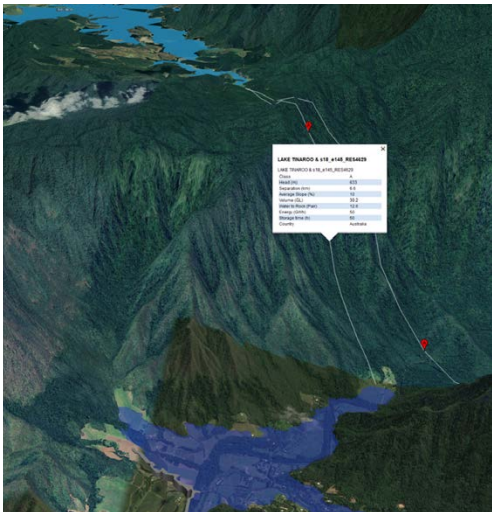

Figure 4: Class A 50 GWh site at Tinaroo near Cairns with information popup

Queensland: Teemburra, Eungella, Borumba, Cressbrook, Tinaroo (Fig. 4) and others support Queensland's vast solar and wind energy potential.

WA: Harvey, Brockman and Dandalup reservoirs near Perth can support Western Australia's transition to renewable energy. However, PHES sites in the west are not nearly so good or plentiful as in the east.

Figure 5: Tasmania has many options

Tasmania: has dozens of excellent options (Fig. 5).

Conclusion

All of these sites and many more can be browsed by users, and detailed information for each site is available at the click of a button.

Acknowledgements

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