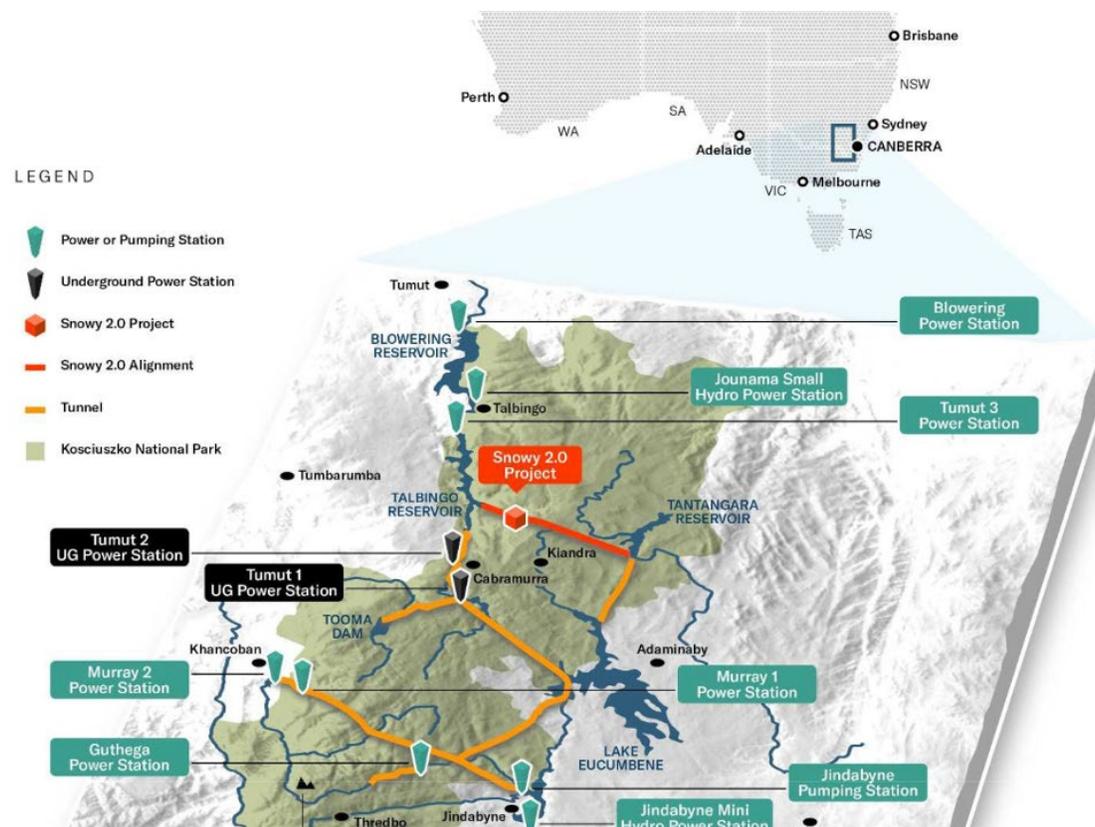


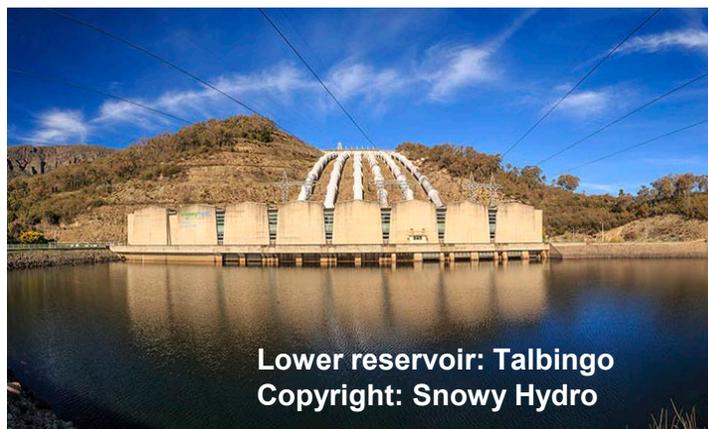
Pumped Storage in Australia – Motivation for the construction of the PSH Snowy 2.0

Dr. Klaus Krüger, Voith Hydro Holding, Germany

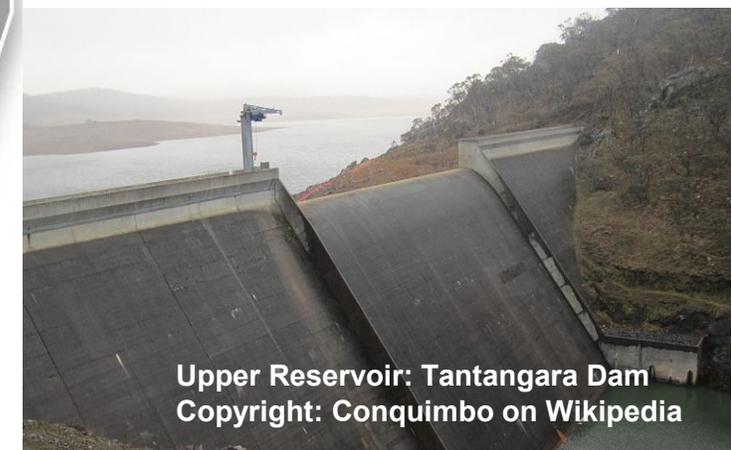
Thermal-Mechanical-Chemical Energy Storage (TMCES) Workshop, 3rd of August 2022, Arlington, VA



new pumped hydro
2000 MW and 350 GWh



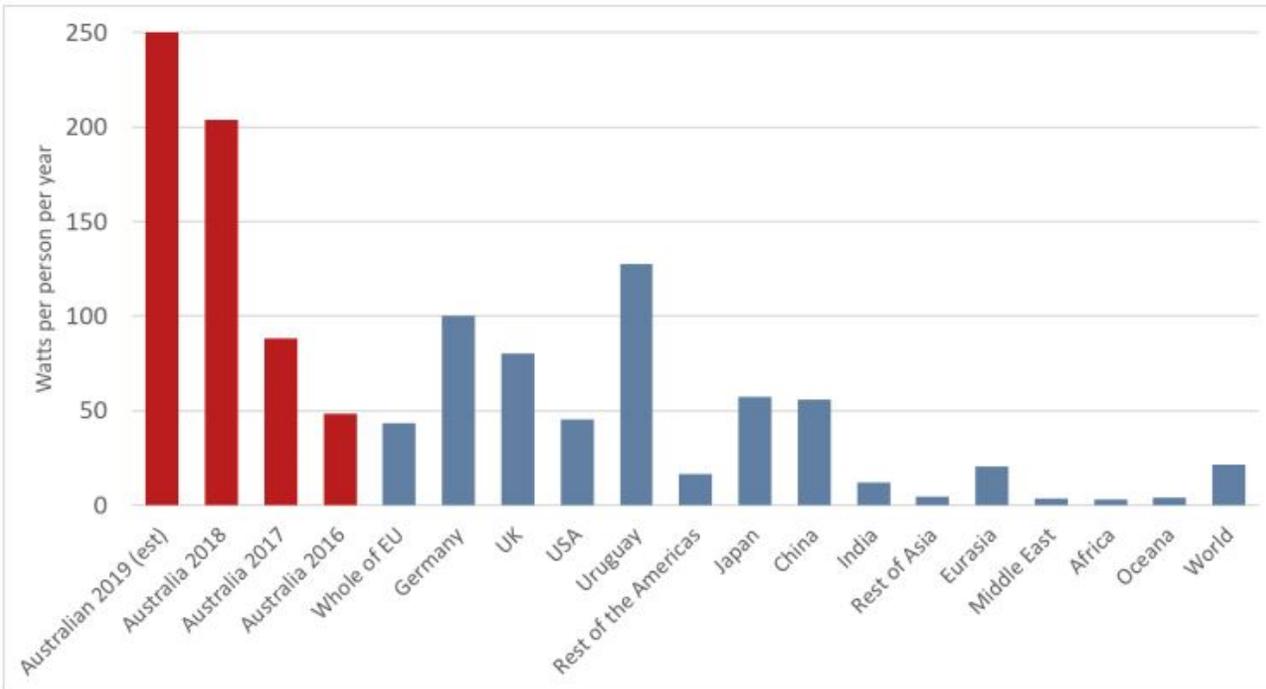
Lower reservoir: Talbingo
Copyright: Snowy Hydro



Upper Reservoir: Tantangara Dam
Copyright: Conquimbo on Wikipedia

Background information related to South Australia (SA)

Australia has currently the highest rate of wind and solar expansion per person per year

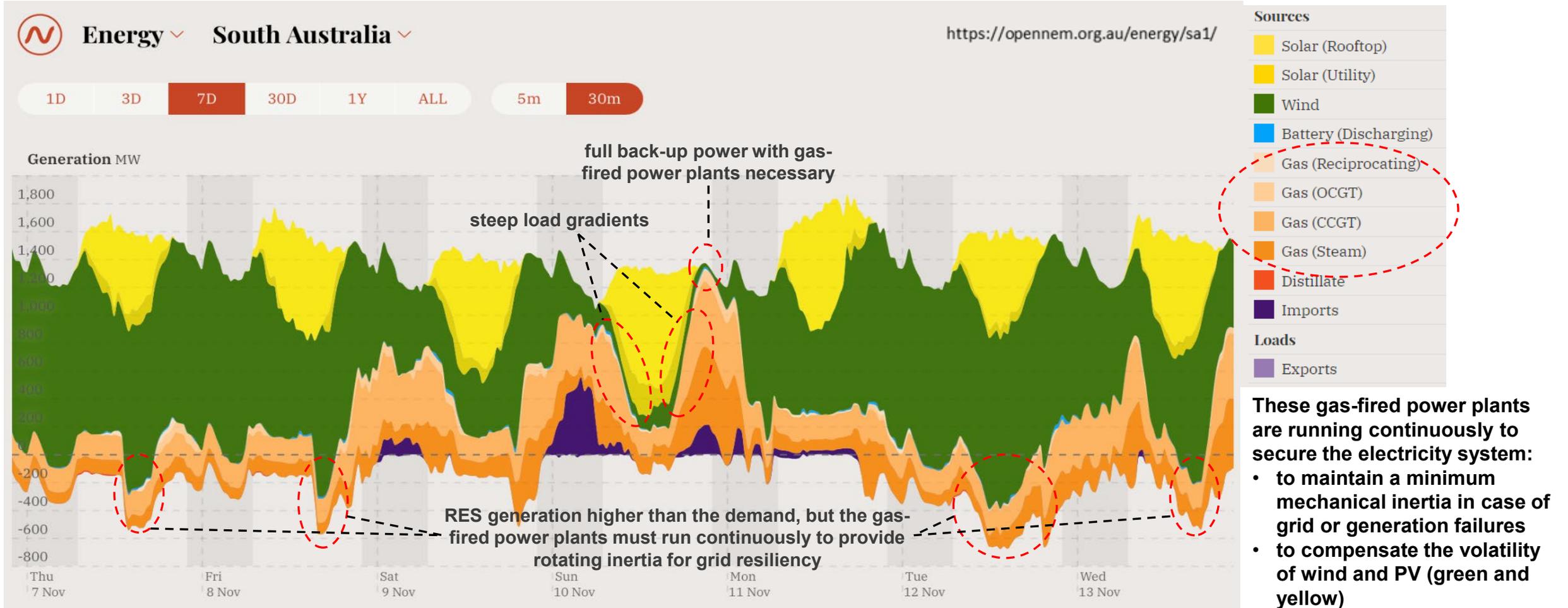


- In 2002, SA generated its electricity locally from brown coal (lignite) and gas, and imported around 30% of its annual needs from Victoria where brown coal production dominated. No production was from renewables.
- 2020 SA was generating 60% of its electricity from renewables and 40% from natural gas!



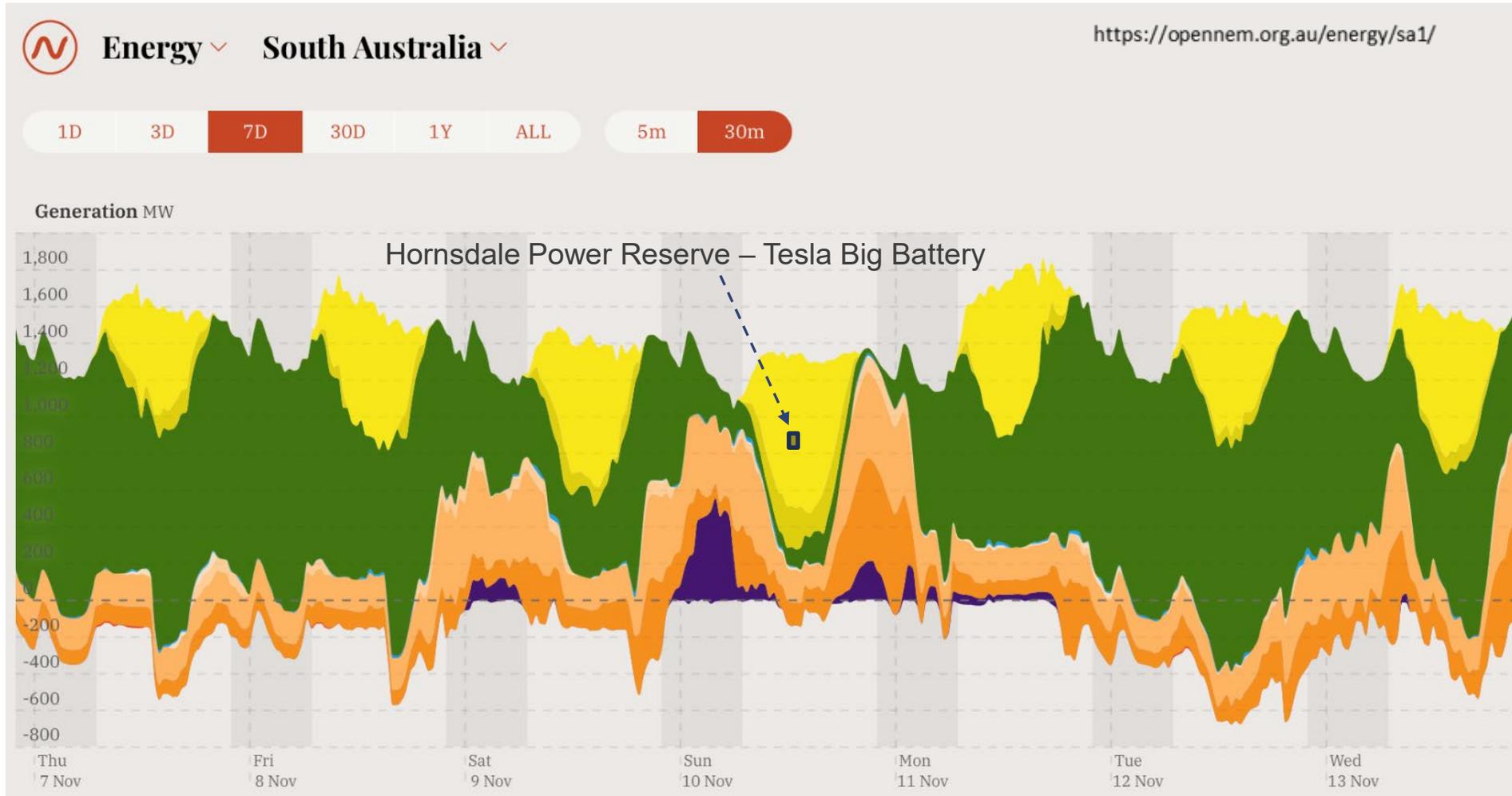
Source: <https://www.croakey.org/lessons-from-south-australias-impressive-renewable-energy-transition/>

Current situation in South Australia: RES intermittency and rotating inertia is controlled mainly by gas-fueled power plants



Motivation for bulk energy storage via PSH versus batteries

RES intermittency for one week

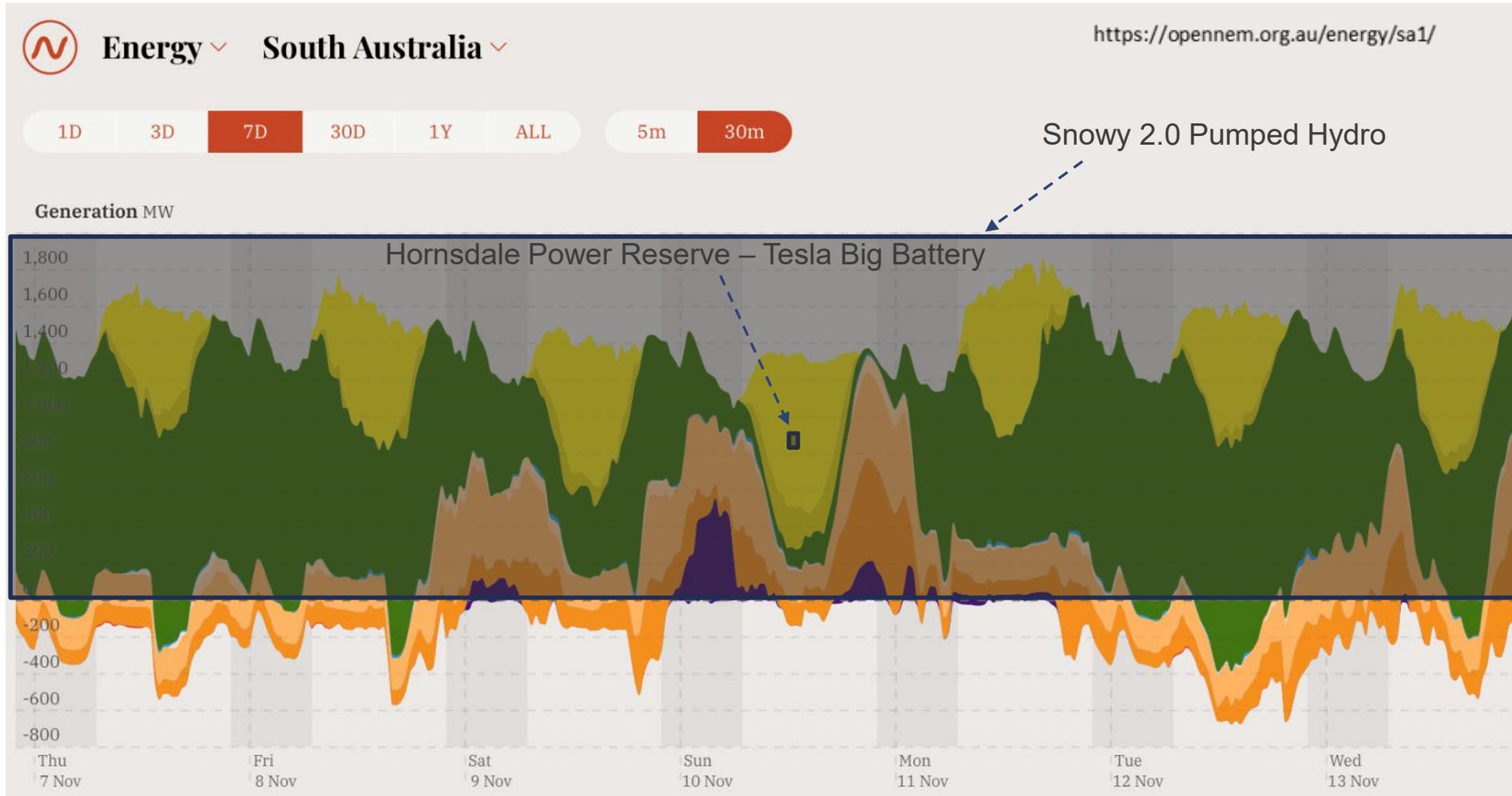


Source: <https://reneweconomy.com.au/revealed-true-cost-of-tesla-big-battery-and-its-government-contract-66888/>

Source: Matt Stocks, Australian National University, World Hydropower Congress, 16th of Sep 2021

Motivation for bulk energy storage via PSH versus batteries

RES intermittency for one week



Copyright: State of New Wales and Dep. of Planning and Environment 2019



Snowy 2.0: 2000 MW, 350,000 MWh,
5.1 bAUD, 11 USD per kWh

Source: <https://www.power-technology.com/projects/snowy-2-0-hydropower-project/>



Tesla big battery: 100 MW, 129 MWh, 56 mil €,
434 € per kWh

Copyright: smh.com.au

Source: <https://reneweconomy.com.au/revealed-true-cost-of-tesla-big-battery-and-its-government-contract-66888/>

Source: Matt Stocks, Australian National University, World Hydropower Congress, 16th of Sep 2021

Technical data and revenue streams of Snowy 2.0



- 2 GW of station power from six reversible Francis pump-turbines with 330 MW each, three of them with variable speed (DFIM)
- Challenging head range for single stage reversible pump-turbine: 610 m up to 700 m
- About 27 km of power waterway tunnels
- Power station cavern approx. 800 m underground
- Project schedule: 2019 – 2026

Foreseen revenue streams *):

- 40% with “capacity revenues” from peak-shaving of power and of extreme price volatility
- “Firming” of wind and PV, protection from wind and solar droughts and energy shifting business **) accounts for another 40% of total projected revenue
- The last 20% of the project’s value is provided by ancillary services, grid support and other minor sources that complement other technologies

*) Source: www.snowyhydro.com.au/snowy-20/documents/feasibility-study-economics-and-revenue-stream/

**) <https://ease-storage.eu/publication/energy-storage-targets-2030-and-2050/>

Lessons learned in regions with large shares of intermittent RES

- Without bulk energy storage systems, a very flexible and fast fossil fueled power plant fleet is necessary, which is running in parallel and designed to meet the maximum demand alone!
- Fossil fueled generation can only be substituted by intermittent RES in combination with flexible and long duration energy storage only → PSH is the most cost-effective solution for bulk electricity shifting.
- PSH is also able to supply instantaneous rotating inertia for the grid resiliency (in turbine, pump and spinning mode). This is crucial in case of grid or generation failures.
- The planning and construction of such hydro energy storage has to be started early in time otherwise one may face a similar situation like in South Australia:
 - Malcolm Turnbull, former prime Minister of Australia, wrote an opinion story that can provide additional insights: “**Energy storage is ignored crisis within the climate crisis**” *)

*) Source: asia.nikkei.com/Opinion/Energy-storage-is-ignored-crisis-within-the-climate-crisis



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