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3-Party Covenant Financing of 'Semi-Regulated' Pumped Hydro Assets

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The need to decarbonise and the intermittency of wind and solar resources means there has been a significant revival of interest in pumped hydro projects globally. But pumped hydro schemes face significant development hurdles including environmental approvals, community reactions to inundation, access to shared transmission networks and the inevitable financing issues associated with very capital-intensive, ultra long-lived assets – frequently in liberalised energy systems characterised by incomplete and missing markets.

Compounding matters, dam costs – a crucial element of pumped hydro schemes – have a long history of overruns. The worldwide median dam cost overrun is 27% with an average of 97%. In Australia, the 2000MW // 350GWh Snowy 2.0 project now has a $12 billion total budget, as does the 2000 MW / 48GWh Borumba project (in real terms).

At one level, the capital-intensive nature of pumped hydro, ultra-long useful lives, long payback periods, the complexity of navigating biodiversity and community challenges and the *iron law of mega-projects,* viz. over time, over budget, every time (Flyvbjerg, 2017) might suggest 'capital-lite' options such as short-duration batteries and open-cycle gas turbines (OCGTs) might dominate market-based firming investment commitments. And thus far in Australia's National Electricity Market (NEM), they have.

But on the NEM, of the 3GW of batteries that reached financial close thus far, and the further 4GW of projects are seeking financial close during 2024 are all dominated by two-hour storage configurations due to energy market prices and plant costs. There is no question that two-hour (and in time, four-hour) storage assets help with power system resilience. But short duration storage provides limited support for inter-day intermittency.

The last line of defence with respect to power system security in NEM planning models typically comprises a large fleet gas turbine plant to manage inter-day and seasonal intermittency. Gas turbines will unquestionably play a vital role. But there are limits to

Australia's natural gas pipeline network. Simshauser and Gilmore (2024) find more than 40 days of structural gas supply shortfalls for the gas turbine fleet in New South Wales and Victoria if no additional intermediate-duration pumped storage is available following NEM coal plant closures – primarily due to gas infrastructure constraints.

Shifting VRE output through space (networks) and time (storage) 'at scale' is therefore of utmost importance to ensure the defensive role of the gas turbine fleet is tractable. The energy density and cost of utility-scale batteries or the accumulation of household-level storage – as we currently understand existing costs and storage capacity of such assets – pales into insignificance compared to large-scale intermediate-duration pumped hydro schemes, even after accounting for elevated dam costs.

Commitment decisions on additional intermediate-duration storage need to be made imminently given the increasing tasks facing power system planners and operators in a decarbonising power system. Battery cost projections frequently exhibit potential for very material reductions. Should these materialise they will reduce, but not eliminate, requirements for intermediate-duration storage and pumped hydro schemes.

However, there is a commercial complexity for pumped hydro plant in Australia. The NEM's organised spot electricity market coordinates plant scheduling and unit dispatch while the forward derivatives market is intended to tie the economics of the physical power system to Resource Adequacy and new capacity investment. Rising forward 'swap' prices (i.e. two-way Contract-for-Differences or 'CfD') signal looming energy shortages vis-à-vis baseload (now VRE) plant, while rising $300 Cap prices (i.e. one-way CfD) signal looming capacity shortages, viz. peaking plant. While the NEM adequately telegraphs for short duration storage (i.e. negative prices, frequency control markets, $300 Caps), it does not have a market signal for 'intermediate duration storage' because it such duties are currently not required – at least not within the functioning timeframes of the forward market (i.e. 3 years).

In consequence, the NEM's organised spot and forward markets currently guide investments to 'capacity over storage'. That is, all else equal, investors would *currently* favour a 1000MW, 8 hour pumped hydro over a 500MW, 16-hour configuration even though the former involves higher underlying capital outlays (i.e. same storage costs, higher plant costs through additional installed capacity). Yet as Gilmore (2024) finds, the optimal median-term storage requirement for marginal pumped hydro plant is between 16 and 23 hours.

In this article, we analyse a 2,000 MW // 48GWh (i.e. 24-hour) pumped hydro scheme in Australia's NEM. We assume the plant has a useful life of ~100 years with an all-in capital cost of ~$11 billion. Our focus is on corporate financing with an objective of radically reducing the operating cost of storage capacity additions by observing, then modifying, existing market conventions. Our emphasis is on intermediate (i.e. inter-day) duration storage and while we focus on pumped hydro, our constructs apply readily to any technology, including intermediate duration batteries. Our aim is to help bridge intermediate storage economics with what are likely to be transitioning forward markets and relative forward market prices.

Our results can be summarised as follows. Conventional on-balance sheet financing appears uneconomic for intermediate duration storage given the current market setup, even for the most successful vertically integrated merchant utility. Missing and incomplete markets warrant policy inquiry. We examine on- and off-balance sheet debt facilities across merchant

and semi-regulated industrial organisation involving a (regulated) market for storage reserves. Our modelling culminates in a ‘3-Party Covenant’ (‘3PC’) financing involving the credit-wrapped issuance of zero-margin Commonwealth Government Securities set in an ultra-long duration, semi-permanent structure. Such financing appears capable of *radically reducing* the equilibrium ‘price gap’ that exists between existing market benchmarks for plant capacity, and intermediate duration storage. This mechanism could reduce the annualised capital costs and the levelised cost of storage by more than 35%.

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