Dispatchability and energy storage costs for wave, wind and solar photovoltaics

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At 70% dispatchability, defined as the minimum power that can be guaranteed per unit of power delivered, a hybrid system consisting of solar PV, wind, wave energy and energy storage requires less than half the capital cost of a similar hybrid system without wave energy.

Introduction

Wave Swell Energy Ltd (WSE) commissioned CSIRO to provide an independent analysis of the cost benefit for using wave power as a reliable supply of renewable energy (Osman et al., 2022; Hayward 2021). Previous studies have suggested that the strength, and reliability of wave power along Australia's southern coastline has the potential to contribute a significant proportion of Australia's renewable electricity supply (Griffin and Hemer, 2010). This study assessed three sites in Victoria and South Australia, focussing on the ability of wave energy to compensate for wind intermittency and solar photovoltaic (PV) seasonal variability, and so improve grid stability and reduce the cost of guaranteeing electricity supply.

Objective

The study determined if the lower variability and intermittency of wave power, compared to solar and wind generation, can provide a technical and commercial advantage when used with a vanadium redox flow battery energy storage system (BESS) and solar or wind power. It covered the use of WSE's wave power technology alone or in hybrid configurations with solar PV and/or wind power, using redox flow battery storage. The issue of monetising the reliability of renewable energy generators is quite new, so our analysis quantified the concepts being discussed in the power industry. The analysis had previously been applied to tidal energy (Osman et al., 2021) and has been adapted for application to wave energy. The algorithms have been integrated and optimised to allow for the rapid assessment of multiple generator configurations and costings.

Findings

The advantage of thinking in terms of dispatchability is that it allows the energy storage costs of providing dispatchable capacity from a particular renewable energy mode to be compared against other dispatchable power generators. For example, the dispatchability required to meet AEMO's Integrated System Plan is approximately constant at 80%. This implies that the renewable power components should each include sufficient energy storage capacity to guarantee supply for about 80% of the average power generated. Different renewable energy components will require different energy storage modes and capacities to achieve 80% dispatchability with appropriate time responses. When estimating the cost-effectiveness of renewable energy modes, the combined energy storage and renewable energy generator costs can be readily compared by assigning a dispatchability factor to each renewable energy mode. Figures 1 and 2 show the BESS capacities and system capital costs required to achieve various levels of dispatchability from hybrid renewable energy systems.

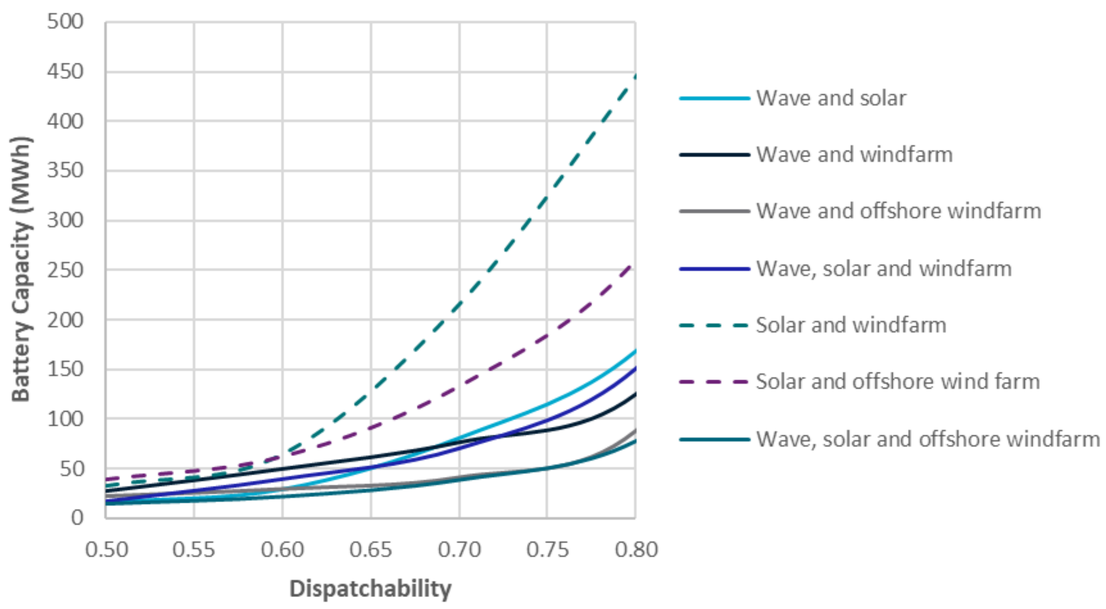

Figure 1: Energy storage capacities required for a range of hybrid renewable energy resources to achieve from 0.5 to 0.8 dispatchability based on 1 MW average power renewable energy systems.

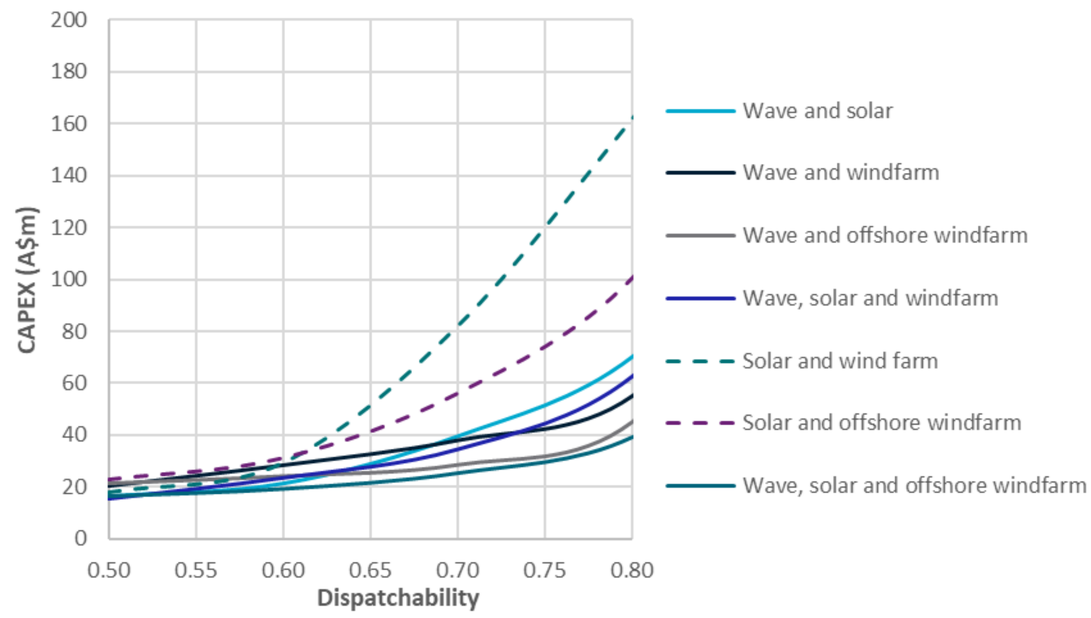

Figure 2: Required capital cost estimates for a range of hybrid renewable energy resources to achieve from 0.5 to 0.8 dispatchability based on 1 MW average power renewable energy systems.

Conclusion

For the locations modelled, BESS combined with hybrid generation has the potential to provide higher levels of cost-effective renewable energy security than any single renewable energy generation mode can provide. The advantage that wave energy confers becomes most evident in hybrid systems using BESS with dispatchability greater than 36%, where wave energy was essential to achieve the lowest capital cost.

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FOR FURTHER INFORMATION

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