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Flexible hydro-solar-wind mixes for reliable power supply in West Africa

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The potential for solar power, wind power and hydropower in West Africa is immense, but remains largely underexploited. However, with solar and wind costs dropping, the stage appears set for a strong expansion of renewable power production in the decades to come, underlined by West African countries' pronounced policy focus on hybrid renewable power mixes for increasing electricity access.

Our previous research (Sterl et al. 2018) assessed the temporal synergies between solar and wind power potential in West Africa down to hourly resolution, and showed the possibilities for hybrid solar-wind power exploitation to be substantially more widespread than previously believed. Nevertheless, synergies between intermittent resources are not enough: the question remains how intermittent supply could be balanced to meet current and future power demand.

The hydropower sector presents one of the clearest opportunities for such balancing (Engeland et al. 2017). Several West African countries rely strongly on hydropower, and hydro capacity in the region is expected to increase strongly in the near future. Allowing hydropower to be used flexibly to meet peak demand and cover periods of low solar and wind power production could thus be a promising avenue in the West African renewable power sector (Danso et al. 2018).

Our current research focuses on exploring the potential interplay between flexible hydropower, solar power and wind power across West Africa, from national to regional scales. To this end, we developed a model (REVUB, "Renewable Energy Variability, Upscaling and Balancing") to optimize the hourly dispatch of hydropower resources from individual dams to balance variable solar and wind power supply with demand, while ensuring environmental flow requirements are met.

Using a hybrid data product comprising climate reanalysis, hydrological model results, and observational data as model input, we demonstrate that the potential for using hydropower to integrate solar and wind power into West African grids would be immense. The ECOWAS Renewable Energy Policy foresees solar and wind power to deliver less than 2% of demand by 2030, but our results show that the flexible operation of existing and planned dams in West Africa could allow for 5-10 times more solar and wind to be successfully integrated into the power mix. Differences in this potential between individual countries are strong, implying high importance for improved regional interconnections in the future to achieve high renewable penetration while ensuring supply-demand balance. This research thus highlights that moving from rigid to flexible dam management may represent an important lever towards leapfrogging fossil technologies in West Africa.

References:

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