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A holistic approach towards optimal planning of hybrid renewable energy systems: Combining hydroelectric and wind energy

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Hydropower with pumped storage is a proven technology with very high efficiency that offers a unique large-scale energy buffer. Energy storage is employed by pumping water upstream to take advantage of the excess of produced energy (e.g. during night) and next retrieving this water to generate hydro-power during demand peaks. Excess energy occurs due to other renewables (wind, solar) whose power fluctuates in an uncontrollable manner. By integrating these with hydroelectric plants with pumped storage facilities we can form autonomous hybrid renewable energy systems. The optimal planning and management thereof requires a holistic approach, where uncertainty is properly represented. In this context, a novel framework is proposed, based on stochastic simulation and optimization. This is tested in an existing hydrosystem of Greece, considering its combined operation with a hypothetical wind power system, for which we seek the optimal design to ensure the most beneficial performance of the overall scheme.