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A stochastic simulation framework for representing water, energy and financial fluxes across a non-connected island

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Integrated modeling of hybrid water-energy systems, comprising conventional and renewable energy sources, pumped-storage facilities and other hydraulic infrastructures, which aim to serve combined water and energy uses, is a highly challenging problem. On the one hand, such systems are subject to significant uncertainties that span over all associated input processes, physical and anthropogenic (i.e. hydrometeorological drivers and water-energy demands, respectively). On the other hand, the everyday operation of such systems is subject to multiple complexities, due to the conflicting uses, constraints and economic interests. Taking as example a future configuration of the electric system of Ikaria Island, Greece, we demonstrate a stochastic simulation framework, comprising: (a) a synthetic time series generator that reproduces the statistical and stochastic properties (i.e. marginal distributions, auto- and cross-dependencies) of all input processes, at multiple temporal scales; and (b) a simulation module employing the hourly operation of the system, to estimate the associated water, energy and financial fluxes. This scheme is used within two case studies, i.e. the optimal design of key system components, and the real-time operation of a hypothetical energy market, involving different energy providers and associated electricity sources, conventional and renewable.