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Driving energy systems with synthetic electricity prices

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The electricity market across Europe, which is key driver of energy systems, has been subject to structural changes in the last years, in order to favor the penetration of renewables and foster decarbonization. A substantial guiding principle was the establishment of the Target Model, configurating a new era of the energy as a trading product. The corollary of this is that the market price became more dependent on socioeconomic disturbances and highly unpredictable events, such as financial, geopolitical and health crises. As a consequence, the variability of electricity prices has been substantially increased across all scales (intra-day, seasonal and long-run). In order to embed this major facet of uncertainty within energy systems modelling, we introduce a generic stochastic simulation framework to represent the market dynamics as a random process across scales. Key challenge is capturing the behavior of electricity prices that are characterized by significant peculiarities, such as volatility and spikes, as well as double periodicity, across seasons and within the intraday cycle. Further challenges are induced by the limited statistical information under the Target Model structure, and the need to implement within the synthetic data abnormal yet persistent shifts, as observed during the recent energy crisis. To stress-test our methodology, we simulate the quite different statistical response of the electricity prices in Greece and Portugal – two countries with similar economic conditions, fiscal compliance, and financial sector development.