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Assessment of soft and hard linking approaches of integrated water-energy simulation

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The strong synergies between water and energy use are becoming increasingly evident nowadays. It is becoming more and more apparent that significant benefits can be gained if both resources are managed in an integrated manner, which can be critical to improve efficiencies, reduce trade-offs, and find better and more sustainable solutions to future energy and water resources scarcity problems. Two types of approaches have drawn attention to integrate water and power system models, namely soft-link and hard-link approaches. Soft-linking approaches involve iterations, wherein the two system models are simulated independently, and their outputs (e.g., water available for hydropower generation) are passed to the other model until convergence is reached. In hard-link approaches, both the water and power systems are simulated with a single optimization model. More research to understand better the implications of different water-energy linking approaches, their computational cost, flexibility, and scalability are critically needed.

In this work water and energy system network models are linked with varying levels of integration (i.e., gradually moving from soft to hard link approaches) to demonstrate the advantages and disadvantages of the different types of links. The water and energy model includes multi-purpose storage reservoirs, irrigation, and domestic water users, renewable energy sources, and conventional power generators. Results show that soft linking approaches are more suitable for water-energy systems with fixed reservoir operation rules. Hard linking approaches are proven to be more suitable for cases with well established water and energy markets and can be computationally cheaper than soft linking approaches. Better joint simulation will help investigate better ways to manage and invest in water-energy systems.