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Hydroelectric management on the Rio Chama: Balancing competing ecological priorities through non-consumptive flow management between the El Vado and Abiquiu reservoirs

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Management of dammed river systems is a complex problem. Spatial and temporal impacts result in complex system tradeoffs, and shareholders have competing objectives. Dynamic modeling can provide improved information as decision-makers attempt to optimize the value of river flows. This paper models the direct and indirect economic impacts of a small reservoir-dam-river system and applies this framework to an existing Bureau of Reclamation dam and generator in the upper Rio Grande basin.

Over past decades, concerns for river habitat preservation have reduced the production of peak-demand energy from hydroelectric plants. Over the same period, as U.S. power markets incorporate solar and wind generation, the demand for flexible, quick-ramping energy during evening hours is increasing. Hydroelectric power can reduce greenhouse gas emissions by making grid integration of solar and wind power less costly and by directly substituting for dirtier alternative power sources.

Economic modelling of market and non-market values associated with the system permits optimization of hydroelectric power to reduce emissions and support intermittent renewable integration without sacrificing ecological goals. A system dynamics model of the dam allows a cost-benefit analysis of dispatchable energy production in the presence of constraining daily, weekly or monthly ecological flow requirements.

The case study suggests that constrained economical dispatch of existing small hydropower generators may be optimal both economically and ecologically. This model provides a scalable framework for incorporating the ecological benefits of hydropower flexibility into the cost-benefit analysis that drives maintenance, upgrade and decommissioning decisions for existing U.S. hydroelectric dams.