Researchers find inconsistencies in studies evaluating small hydropower projects

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Credit: Sharon Klein

Hydropower can move beyond enormous, Earth-altering infrastructure. Despite a growing trend of dam removals to preserve and restore ecology and indigenous ways of life, small hydropower projects have the potential to contribute more to a renewable energy future because they can be reliable, flexible and cost-effective, according to a review from the University of Maine.

Small hydropower projects are defined by the U.S. Department of Energy as any that produce less than 60 MW, though the exact classification of subclasses within the "small" range can be debatable. UMaine researchers Sharon Klein, associate professor at the School of Economics, and Emma Fox, Klein's former graduate student, categorized the cost and performance metrics used to evaluate the different types of small hydropower projects and compared the results of these metrics across 13 different studies of small hydropower projects conducted in multiple countries across four continents.

"This literature review was an important first step in the research we conducted for the National Science Foundation-funded Future of Dams project. We were creating a benefit-cost model of small hydropower in New England and wanted to know what results other researchers had found. It turned out, no one had yet published a full review of the metrics we were seeking to calculate, and it was a lot of work to harmonize data from multiple studies to be comparable," Klein says.

Klein and Fox pinpointed four major types of small hydropower design: reservoir-based dams, which block the flow of water downstream and release it through turbines; run-of-river, which can involve a dam but channels the water from the stream to the turbines in a way that ensures downstream flow equals upstream flow; pumped storage dams, which draw water from a lower reservoir to an uphill holding tank and release it through turbines to meet peak demand; and in-stream turbines, which are placed directly in the flow of water and require no diversion or impoundment of the river.

Each style has its advantages and disadvantages. Some styles of small hydropower projects, like the run-of-river and in-stream turbines, can be less disturbing to habitats and fish passage, but more conventional styles like reservoir-based dams are generally more reliable.

"There are so many different styles of small-scale hydropower dam and so little consistency in the literature on benefit-cost assessment for these generating assets," Fox said. "It was difficult to find points of comparison."

Still, the data showed promising general trends in small hydropower projects, like decreasing cost of energy and increasing benefits-cost ratio with increasing power capacity. However, the researchers also found a lack of consistency in the reported detail, assumptions, definitions and data inputs across the studies that makes it difficult to effectively compare them.

The researchers conclude that although small hydropower projects may still contribute to the renewable energy marketplace, scientists will need more publicly available, user-friendly cost estimation tools with site-specific input data in order to effectively implement them.

"Because small hydropower impacts are so site-specific, our study really highlights a need for more investigations of small hydropower costs and benefits—not only financial, but also cultural and ecological—in more locations that use consistent and comparable metrics, assumptions, and inputs," Klein says.

The study is now available online and will be published in the journal *Renewable and Sustainable Energy Reviews* in November 2022.

More information: S.J.W. Klein et al, A review of small hydropower performance and cost, *Renewable and Sustainable Energy Reviews* (2022). DOI: 10.1016/j.rser.2022.112898

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