Research Update

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Bottom Line

This research project identifies the shortcomings of hydropower representation in existing power system models and explores techniques for more accurately modeling hydropower. Improvements in how both production cost and capacity expansion models represent hydropower are identified.

Better, Faster, Cheaper

A greater understanding of the true flexibility and capacity of Reclamation hydropower facilities will allow for the integration of variable renewable energy while maintaining western grid stability.

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Addressing Hydropower Modeling Changes in Power System Models

Improving hydropower modeling to support grid integration of renewable energy

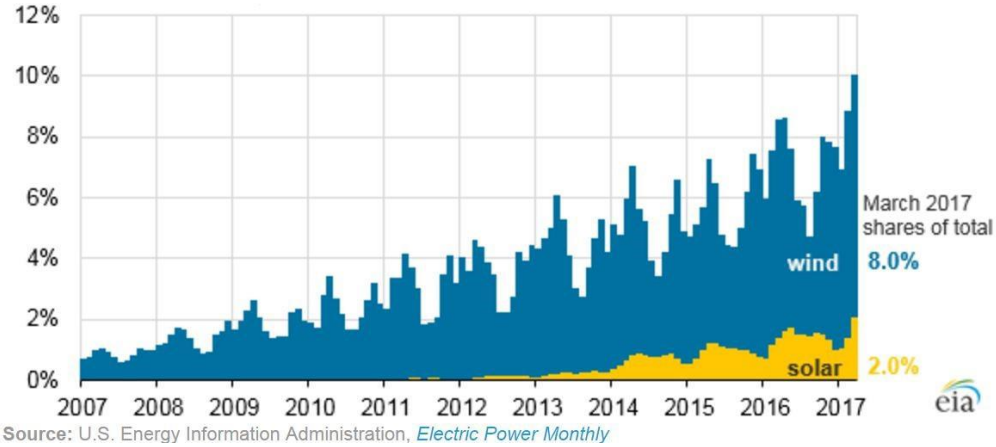
Problem

Hydropower facilities can provide a key source of flexibility for maintaining electric grid stability—particularly those with a high penetration of variable energy generation such as wind and solar. As more variable renewable generation sources come online, a better understanding of the capabilities and limitations of hydropower resources is important for efficient grid planning. However, modeling hydropower facilities is difficult due to a wide variety of constraints that can be broadly categorized as environmental (e.g., those imposed to limit negative impacts on the environment), operational (e.g., limitations of the generation equipment), and regulatory (e.g., binding obligations to water users).

Solution

Through an interagency agreement conceived by Reclamation's Research & Development Office, Reclamation economists teamed up with the National Renewable Energy Laboratory (NREL) to research ways to improve the modeling of hydropower facilities by cataloging and accommodating these constraints in power system models.

This research identified many potential opportunities to better represent hydropower in power system models. This study focuses on three such opportunities: (1) incorporating better hydrological data; (2) improving existing representations and constraints for hydropower facilities; and (3) linking power system models to watershed models (specifically RiverWare).



Monthly net electricity generation from wind and solar as share of total US electricity generation (Jan 2007 - March 2017): In the past decade, variable renewable energy generation has increased from less than 1% to nearly 10% of total US generation.

Solution *(continued)*

In experimental model runs all three improvement categories independently demonstrated an increased ability to accurately represent the capabilities of hydropower facilities in power system models relative to the status quo. Notably, a power system/watershed model was developed for 10 large reservoirs on the Columbia River that demonstrated significant improvements in the modeling of actual hydropower flexibility versus a power system only model. This flexibility allowed the system to reduce the curtailment of hydropower generation by shifting it to times with fewer variable generation resources and resulted in total production costs savings of $4 million (or 2%), and a $2-3/MWh reduction in marginal electricity prices, averaged across the simulation period.

Application and Results

As penetration levels of solar and wind continue to increase, power system flexibility will become increasingly important, creating a rising need to better understand and model the true capabilities of the hydropower generation fleet. Understanding and accurately modeling the limitations and capabilities of hydropower will enable better preparation for future integration of variable energy sources.

Future Plans

Reclamation plans to continue the fruitful collaboration with NREL and build off of this current work. Future objectives include: continued model development for accurately representing hydropower; characterizing additional technologies (including pumped storage and in-stream hydrokinetic technologies); improved resource assessments (especially performance upgrade opportunities and potential for new capacity); applying hydropower facility-level operating data to improve operability parameterization; and improved economic representation of hydropower in capacity expansion models.

Collaborators

National Renewable Energy Laboratory
Reclamation Power Resources Office

More Information

https://www.usbr.gov/research/projects/detail.cfm?id=200

https://www.usbr.gov/research/projects/researcher.cfm?id=2337