U.S. Department of the Interior
Bureau of Reclamation
Research and Development Office
Science and Technology Program

Determining Hydro Generation Start/Stop and Cycling Costs

Research Bulletin
S&T Project 1880

Mission Issue

Assigning realistic costs each time a hydropower generator starts, stops, and cycles allows operators to determine the most cost efficient and effective way of operating hydro generators. Determining a justifiable cost for these operating conditions is essential to insuring the long-term viability of hydro generation.

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Problem

There is growing concern in the hydro industry that hydro generation costs associated with the integration of non-dispatchable renewable energies such as wind and solar is not well understood, but the costs are significant and there is justification to provide budgetary compensation to hydropower facilities for providing these services. Hydropower's operational characteristics make it a valuable resource to support non-dispatchable renewable energy; however, this support results in more frequent start/stops and unit cycling that comes with a cost. This research effort continues ongoing research work identifying and quantifying these costs.

Solution

As the hydro industry in whole is interested in this topic, there is a benefit to Reclamation to work with our hydro generation partners on this research project. This helps leverage Reclamation's efforts and costs. Reclamation's participation in Centre for Energy Advancement through Technology Innovation (CEATI) International, Inc. Hydraulic Plant Life Interest Group (HPLIG) provides the access and structure needed for Reclamation to work collaboratively with other utilities and industry experts. Reclamation is able to participate and help direct HPLIG projects to ensure the results are applicable. HPLIG issued a request for proposals and selected HDR Engineering, Inc. to develop a standardize methodology to determine hydrogenerator start/stop and cycling costs.

"Reclamation is being called upon more frequently to start/stop and cycle units to support grid reliability, but the tools and methods available to understand the costs of these start/stops and cycles have been lacking. The development of this cost model will provide great value to Reclamation by delivering more reliable start/stop and cycling costs through a more user-friendly process."

Michael Pulskamp,
Power Resources Office Manager

More Information

https://www.usbr.gov/research/projects/detail.cfm?id=1880

Application and Results

A final report entitled *"Establishing a Standard Methodology to Evaluate Start/Stop and Cycling Costs and Impacts,"* No. T182700-03104 and an accompanying Excel spread sheet that implements the methodology is posted on CEATI website and is available to all CEATI members. All Reclamation employees have access to this report via Reclamation's CEATI membership.

https://my.ceati.com/en/project/technology-review-establishing-a-standard-methodology-to-evaluate-startstop-and-cycling-costs-and-impacts/2938/

The HDR investigators, under the direction of CEATI project monitors, developed a methodology to estimate the cost of increased starts and stops and other forms of variable operation at hydroelectric plants. This methodology was based on CEATI International's 2016 study: *"Effect on Hydropower Equipment from Variable Operations, with a Focus on Start/Stop,"* No. T152700-0391, which was supplemented over the course of this project. This 2016 report based many of its conclusions on a prior 2014 Reclamation research project and report entitled *"Hydrogenerator Start/Stop Costs."* Based on this past work the investigators developed a methodology for estimating costs of starts and stops and other forms of variable operation, such as ramping, synchronous condensing, and rough zone operation. The investigators also developed a Microsoft Excel model to apply the methodology and estimate an initial range of costs. The investigators identified areas of refinement for the methodology and model, and potential short- and long-term project next steps.

Future Plans

The intent of this project was to provide a range of results with clear next steps for reducing uncertainty, ultimately moving towards more definitive results in subsequent phases using larger datasets. For focusing future efforts, the cost components with the greatest contribution to the total costs are equipment replacement cost, water energy cost, and availability cost.

There are opportunities for improvement that will reduce uncertainty, increase confidence in the results, and support broader adoption of the methodology and model. Some of the high-level improvement opportunities include defining tighter boundary conditions for the operating scenarios, refining availability cost inputs, and refining equipment cost inputs.