RECLAMATION Managing Water in the West

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The Knowledge Stream
Research Update

How Much Does it Cost to Start/Stop a Hydrogenerator?

Determining start/stop costs for hydropower generators to support integrating renewable power into the grid

Bottom Line

Integrating renewable energy into the power system requires existing energy sources to provide additional services to ensure the reliability of the power system. These additional services, such as increased starts/stops, have both direct and indirect costs directly correlated to capital costs, maintenance, and operation. This project strives to determine realistic costs realized by hydro utilities when incorporating renewables into their energy portfolio.

Better, Faster, Cheaper

Being able to assign costs for each time a hydropower generator is started/stopped allows planners to determine the most cost efficient and effective way of operating powerplants and integrating wind and solar energy into the power grid. Understanding the associated costs allows the utilities to have an improved understanding of costing for the services they provide over the life of equipment to support renewables.

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Problem

Having power available anytime you want to plug in a device is a tough balancing act, juggling energy demands with power production—on a minute-to-minute basis. Traditional powerplants using coal need a long time to ramp up to produce energy and cannot change output quickly. Wind and solar energy production rely on natural cycles, so their availability may not match demands. Hydro generation has unique characteristics that make it attractive as a source of variable power. Hydro can be started, stopped, and load-changed more easily and economically than steam generation. In fact, many hydrogenerators are operated in just this way—as a variable supplement to base-loaded powerplants.

Thus, hydropower generators can be held in a reserve mode, ready to deploy to meet demands in a more flexible manner, but these operations also must consider many factors such as water operations, water availability, and generator maintenance.

Starting and stopping generators help to balance power availability and assist in integrating wind and solar energy into the power system. However, just like driving your car in stop-and-go traffic, which causes more wear and tear on your engine, more frequent starts/stops can increase the cost of operation and maintenance. When a generator is called upon to start from dead-stop (not spinning) to become available for service, there are impacts on staff, equipment, and water supply. These impacts have real effects on operation and maintenance practices and overall plant costs. As more starts/stops are required, these costs increase and should be accounted for. It may be appropriate for the increased costs to be incorporated into power rates charged to customers.

The question is: how much of an increase is there, and how are these costs determined? Powerplant operations are complex, spanning a wide range of factors. Because each plant is unique, no single start/stop cost factor can be applied to all plants. The fossil fuel generation industry has done extensive research into costing unit cycling, but very little reliable information exists in the hydroelectric industry about start/stop costs.

John W. Keys III Pump-Generating Plant, Grand Coulee Dam, Columbia Basin Project, Washington.

The available studies approach the costing task in different ways and, currently, there is no industry standard for which cost factors should be included or how to derive the cost of each factor.

Thus, a start/stop cost model is needed that addresses all potential cost factors and that provides a reasonable framework for calculating start/stop costs at a powerplant—to use at Reclamation powerplants and, possibly, to be adapted industry-wide.

Solution

As part of this Reclamation Science and Technology Program research project, a model was developed that includes cost factors of increased maintenance, accelerated equipment degradation, lost generation opportunity, lost water, and reduced efficiency. This model was then used to calculate start/stop costs for a pilot plant, resulting in a cost of approximately $274 to $411 per start/stop, depending on assumptions used. These figures should be used with caution, representing only one generating unit at one plant. However, these numbers are consistent in magnitude with other industry studies that use different assumptions and methods.

The control room at Flatiron Powerplant, Colorado-Big Thompson Project, Colorado.

This research includes a sensitivity analysis that identifies which cost factors are most important to overall start/stop costs, thus providing direction for future emphasis in refining costs. The model and methods developed in this research can be applied at other Reclamation powerplants. Experience at other plants will improve the model and broaden the base of data analyzed, better ensuring a reasonable start/stop cost.

Application and Results

For the pilot plant test study, the Flaming Gorge Powerplant on the Green River in northeastern Utah, and part of the Colorado River Storage Project in the Upper Colorado Region, was selected. Start/stops have significantly increased at the powerplant in the last several years. This test study found that some cost factors are more significant than others and that the relative importance of factors may depend on the site.

Right Powerhouse, Grand Coulee Dam, Columbia Basin Project, Washington.

Future Plans

The results of the hydro model data project provide a good starting point in working with other hydropower producers, power marketing administrations, and renewable energy integration model builders in creating more accurate models. The results of this study can be used to direct future research and as a template for start/stop cost analysis at other Reclamation plants. Full-fledged data collection for improving integration models (planning and/or real-time dispatching) will require significant improvement in Reclamation's data collection and reporting systems. This improvement can be coordinated with another initiative to establish standard operations reporting data throughout the hydropower industry.

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

Mike Pulskamp
Renewable Energy Program Manager, Reclamation's Power Resources Office

Collaborators

- **Reclamation's Power Resources Office and Flaming Gorge Powerplant**
- **National Renewable Energy Laboratory**
- **Centre for Energy Advancement through Technological Innovation (CEATI)-Hydraulic Plant Life Interest Group**
- **Bonneville Power Administration**

More information

www.usbr.gov/research/projects/detail.cfm?id=6144