A Systematic Approach to Categorizing Water-Hydropower-Grid Adaptation Studies to Identify and Facilitate Collaborative Opportunities and Research Needs

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Background/Objectives. The U.S. electricity system is evolving rapidly, with changing markets, penetration of new renewable energy sources, and changes in demand profiles. To continue to be reliable and resilient, the power grid needs to be flexible to handle the high variability and uncertainty in net load that is part of this evolution. Hydropower is a generation technology that can support highly variable grid conditions at a competitive cost and with minimal carbon emissions. At the same time, hydropower is also facing some adaption needs in response to climate change impact on water resources. Hydropower is represented and valued differently in power system and water models, and these unaligned flexibility concepts can ultimately lead to missed opportunities in developing and implementing adaptive technological strategies. A systematic approach to categorizing and contextualizing water-hydropower-grid adaptation projects is needed to identify synergies and gaps across projects and inform collaborative opportunities and future priorities. The objective of this presentation is to clarify the concept of hydropower flexibility (and adaptation) in a way that can bridge gaps between the tools used by and expectations of water managers, hydropower operators and power system operators.

Approach/Activities. We developed a qualitative multisystem and multiscale approach to define hydropower flexibility types and document modeling methodologies to represent each flexibility type. The approach can be leveraged to highlight the value, facilitate compatibility and complementarity, and inform on the generalization of the technology innovation and adaptation strategies. As a proof of concept, a workshop held in the Spring of 2021 convened technical experts from ongoing and recently completed projects under the DOE Water Power Technologies Office HydroWIRES Initiative to clarify the diversity in considered flexibilities within projects. The approach was applied to the 14 participating projects that address hydropower adaptation and associated flexibility from different angles. The visualization of the approach clarified the contribution of projects to hydropower flexibility (flexibility of what to what), and the differences in tools and modeling toolchains to identify gaps and collaborative opportunities. Regional characteristics and context of applications which impact the availability of data and time sensitiveness for decision-making fine tune the approach. We demonstrated that while those latter are most often considered first, the flexibility concept and modeling fidelity are necessary attributes for successful science dissemination.

Results/Lessons Learned. We observed diversity across the 14 projects. The following attributes were identified to characterize state of the art for water-hydropower-grid adaptation and associated flexibility needs: flexibility concept; modeling fidelity in representing water, power and facility processes and interactions; regional characteristics such as generation portfolio, environmental regulations, markets and hydroclimate, and finally context of application such as reliability studies, maintenance scheduling, or day ahead scheduling. The associated visualization provides an overview of modeling and conceptual gaps necessary to move forward in developing efficient and actionable water-hydropower-power grid adaptation strategies.