

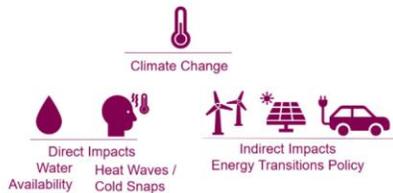
Diversity in Approaches to Hydropower Flexibility in Water and Power System Adaptation Strategies Under Climate Change Conditions

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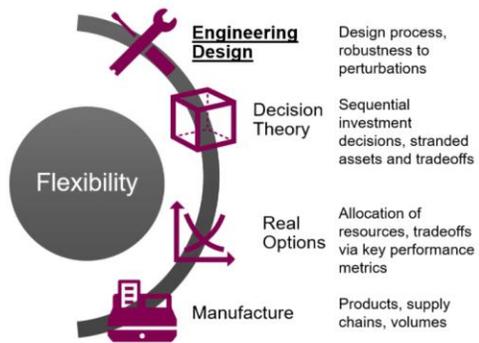


Climate Change Impacts and Policy Require Hydropower Adaptation

Hydropower flexibility will play an important role in decarbonization strategies while also being impacted by the direct impact of climate change on water resources.

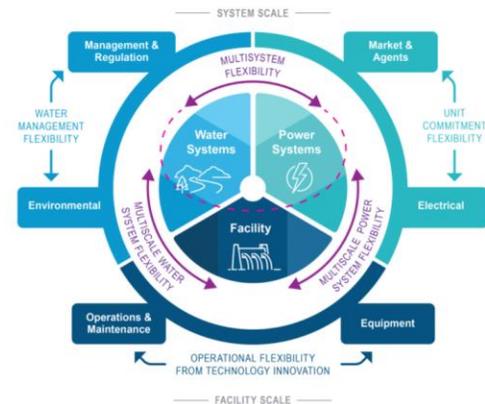


Flexibility Objectives Differ Across Adaptation Studies



Flexibility As An Engineering Design takes Multiple Definitions Across Hydropower Systems and Scales.

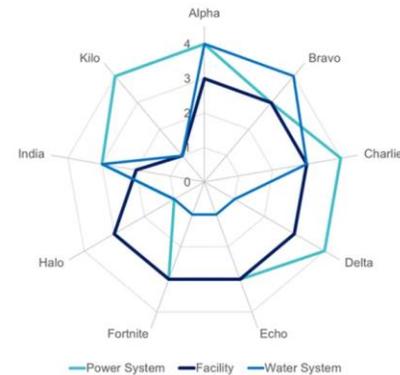
Water and Power systems are connected through hydropower plants. Adaptation Studies need to specify which flexibility they advance, e.g. flexibility of what to what.



A Framework to Describe the Advances in Hydropower Modeling Across Water-Power Grid Studies

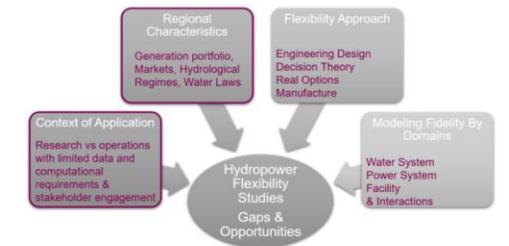
- Observed static boundary conditions**
Water system: observed flow
Power system: observed energy prices
Facility: observed unit generation, inertia, etc
- Simulated static boundary conditions**
Water system: simulated flow, no water management
Power system: simulated energy prices
Facility: simulated plant specific operations
→ ability to perturb boundary conditions
- Simplified dynamics, in process and/or scale**
Water system: simulated hydrology and water management with rule curves
Power system: zonal model, or nodal with limited number of nodes
Facility: process-based simulations of operations (e.g. penstock capacity, etc)
→ ability to perturb processes, limited responses
- Operational complex dynamics**
Water system: optimized water management across a river basin
Power system: stochastic optimization for over 1,000 nodes
Facility: unit loading optimization, controls, maintenance, etc.
→ perturbations and system responses in an operational setting

Hydropower representations in 9 anonymized flexibility studies with an engineering design perspective. Gaps represent challenges in immediate transferability across studies despite all advance flexibility of hydropower.



Extended Framework to Identify Gaps and Opportunities in Hydropower Adaptation Research

To integrate and transfer insight and methods across adaptation studies, application and regional characteristics also need to be specified



Moving forward

A systematic approach to categorizing and contextualizing Water-Power Grid Adaptation projects is needed to identify synergies and gaps across projects and inform collaborative opportunities and future research priorities.

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