1.2.2.501 HydroWIRES Topic A— Improving Hydropower Benefits by Linking Environmental and Power System Trade-offs Through Flow Release Decisions

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Project Overview

Project Summary

- This project sought to create conceptual and quantitative links between energy and the environment to find hydropower energy-environment win-wins. Specifically, the project team linked environmental outcomes and power system outcomes through hydropower flow releases so tradeoffs between generation and flexibility and the environment could be assessed.

Intended Outcomes

- This project created a science-based scaffolding that allows for tradeoffs between energy and the environment to be assessed. We envisioned success in this project to be creation of frameworks and identification of research gaps that would facilitate assessment of tradeoffs between energy and the environment.

Project Information

Principal Investigator(s)

- Brenda Pracheil (ORNL)
- Vishvas Chalishazar (PNNL)
- Thomas Mosier (INL)
- Tom Veselka (ANL)
- Jordan Macknick (NREL)

Project Partners/Subs

- Shaun Carney (RTI International)

Project Status

Completed

Project Duration

- 1 October 2019
- 30 September 2021

Total Costed (FY19–FY21)

$2M

Project Objectives: Approach

Approach:

Project objective:
Document and characterize linkages between environmental impacts of hydropower and operator decisions so a framework for evaluating energy-environment tradeoffs can be assessed

Function/ Service*	Min Flow	Max Flow	Ramp Rate	Prescribed
Load-following	Mod. limit	Mod. limit	Sig. limit	Sig. limit
Reactive supply	Mildly limit	Mildly limit	Mildly limit	Mildly limit
Frequency regulation	Mod. limit	Mod. limit	Mod. limit	Mod. limit
Spinning reserve	Mildly limit	Mod. limit	Sig. limit	Sig. limit
Non-spinning reserve	Mildly limit	Mod. limit	Sig. limit	Sig. limit
Replacement reserves	Mildly limit	Mod. limit	Sig. limit	Sig. limit
System black start	Mod. limit	Mod. limit	Sig. limit	Sig. limit
Firm capacity	Mildly limit	Mod. limit	Mod. limit	Sig. limit

*As defined by EPRI (2012)

Do interactions between hydropower services and environmental flows impact environmental outcomes or grid reliability?

- *Ancillary services may limit positive environmental outcomes*
- *Environmental flow requirements may limit ancillary service provisioning*

Project Objectives: Expected Outputs and Intended Outcomes

Outputs:

1) Environmental Flow Requirement Dataset (HydroSource)
2) Energy-environment linkage diagram linking flow- to power system and environmental outcomes Three case studies illustrating tradeoffs between energy and environment (Final report– in review)
3) Workshop report describing research gaps and future directions for energy-environment tradeoff research (Internal report)
4) Final project report that includes descriptions of two prototype tools
5) One peer-review manuscript published, two in review, 3-4 more expected

Outcomes:

- Merge energy-environment perspectives for better environment and power system outcomes
  - Lay groundwork for understanding interactions between environmental flow requirements and ancillary services
  - Create conceptual pathways for quantitative evaluation of energy-environment tradeoffs

Project Timeline

FY 2020

- Create initial energy-environment linkage framework
- Create Environmental Flow Requirement Dataset

FY 2021

- Publication of Energy-Environment Linkage Diagram
- Energy-Environment Tradeoff Workshop report
- Final project report
- Completion of two prototype tools for helping to assess energy-environment tradeoffs

Project Budget

FY20	FY21	Total Actual Costs FY19–FY21
Costed	Costed	Total Costed
$800K	$1200K	$2000K

End-User Engagement and Dissemination

- Presented at virtual CEATI conference in 2021
- Project featured in NHA “Fireside Chat” discussion on the role of hydropower in the future electricity grid with former WPTO Director Alejandro Moreno as part of National Hydropower Day 2021
- End-users of this project outputs are energy-environment researchers seeking to find ways to trade-off energy-environment outcomes
- The project had Technical Advisory Group that included members experienced in FERC hydropower licensing negotiations of environmental flow requirements

• Project results are being disseminated in project final report, peer-reviewed publications, and making information available on HydroSource.

Performance: Accomplishments and Progress

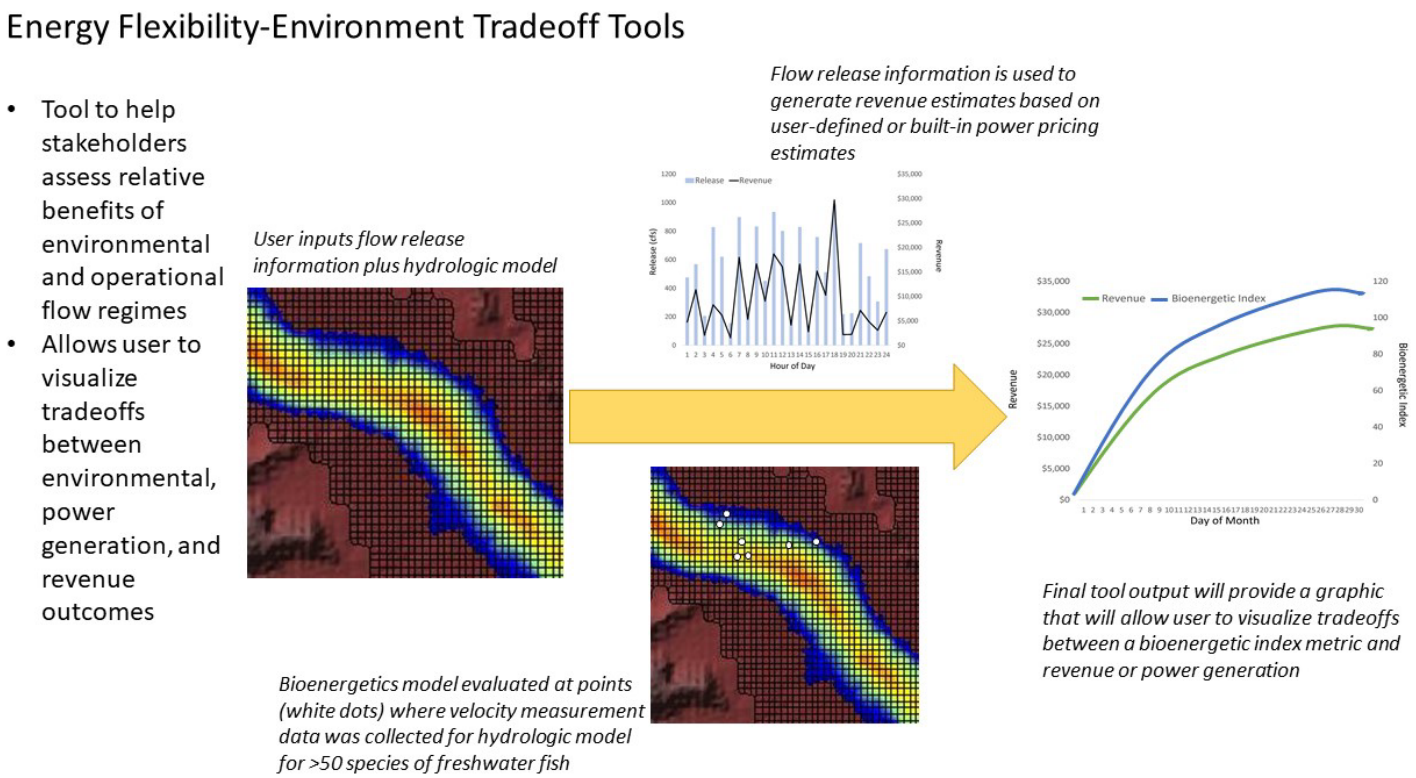
- Detailed dataset on environmental flow requirement containing >5,000 individual flow requirements from 50 FERC hydropower licenses (96 facilities)
- Interactive diagram detailing links from flow to power system outcomes and flow to environmental outcomes
  - Included dataset of models and tools needed to make quantitative links between flow and outcomes
- Merging power system and environmental perspectives to understand interactions between ancillary services and flow requirements
- Dual-dynamic processing model to find win-wins (increased generation revenue, increased fish survival)
- Two prototype energy-environment trade-off assessment tools

Performance: Accomplishments and Progress (cont.)

- Report on research priorities for Energy Flexibility-Environment trade-offs as part of Norwegian Ministry of Energy MOU on hydropower
- Peer-reviewed journal articles published and in review
  - Jager, De Silva, Uría-Martinez, Pracheil, Macknick. *In press*. Shifts in hydropower operation to balance wind and solar will modify impacts on biodiversity. *Water Biology and Security*
  - Pracheil, Chalishazar, Bockenauer, McCoskey, Jackson. Balancing hydropower environmental and power system requirements for a decarbonized electricity grid. *In review*
  - Roni, Mosier, Durvasulu, Li, Alam, Lawson, Steindorf, Chalishazar, Pracheil. Hydropower flexibility valuation tool for flow requirement evaluation. *In review.*
- Dataset
  - Cameron, Pracheil. 2022. Hydropower environmental flow requirement dataset.

Future Work

- Follow-on project began 1 October 2022: Energy-Environment Tradeoff Toolkit
  - Uses prototype tools and conceptual frameworks created in this (Topic A) project



Q&A