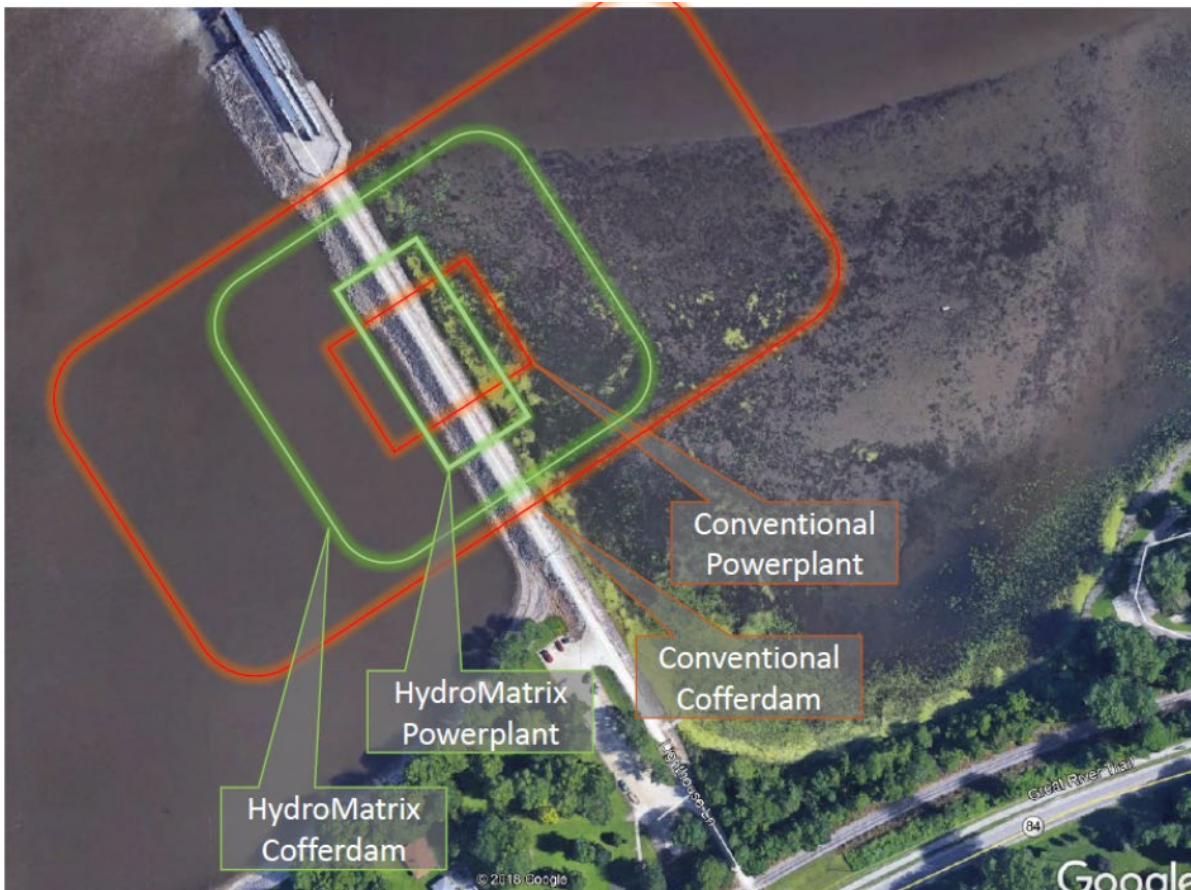


WBS 1.5.1.507 Cost Data Collection & Modeling for Hydropower



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Presentation Date: July 27, 2022

Project Overview

Project Summary

- This project encompasses the **data collection, modeling, and analysis of the costs and performance of hydropower plants in the USA**. The project addresses the “lack of access to information and metrics to support hydropower decision making” (WPTO, Multi-Year Program Plan). The project and associated activities **provide necessary capabilities to track and quantify the impacts of research activities on the economic competitiveness of hydropower technologies** to address the challenge of “limited opportunities for new, affordable hydropower growth given existing technologies” (WPTO, Multi-Year Program Plan). Project has focused on NPD and NSD* so far.

Intended Outcomes

- The outputs of this project include **improved LCOE baselines and reduction targets, updated datasets and knowledge on national hydropower costs** (including environmental mitigation) for use by researchers and policymakers. The expected outcome of the project is to **improve decision-making processes and management of river resources for multiple objectives through hydropower cost data availability and accessibility, and publicly available cost analysis tools**.

Project Information

Principal Investigator(s)

- Gbadebo Oladosu

Project Partners/Subs

- Other Participants:
 - Colin Sasthav; Joseph Werble; Will Tingen; Patrick O’Connor
- Small Hydro Consultants (Subcontractor)

Project Status

Ongoing

Project Duration

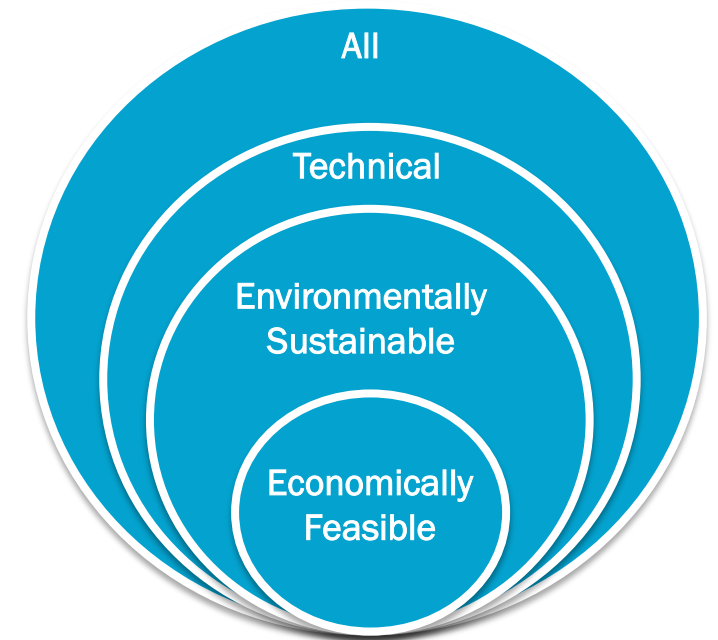
- Project Start Date : 10/01/2018
- Project End Date : 09/30/2024

Total Costed (FY19–FY21) : \$1,258K

Project Objectives: Relevance to Program Goals

- **Challenges Addressed (WPTO, Multi-Year Program Plan):**
 - “Lack of access to information necessary to support decision-making”
 - “Limited opportunities for new, affordable hydropower growth given existing technologies”
- **Project Objectives:**
 - Improve capabilities to **analyze multifaceted types of hydropower data to better identify opportunities and weigh trade-offs**
 - Support the development of systems and standards to **improve access to integrated water data and information relevant to hydropower stakeholders**
- **Project provides cost data and analyses essential to:**
 - Understand the **drivers of costs using existing technologies**
 - Understand the cost implications of environmental mitigation
 - Benchmark the **cost-effectiveness of new technologies**
 - Evaluate potential hydropower cost reductions through technology R&D
 - **LCOE is a key metric for overall project costs evaluation**

Categories of Hydropower Potential



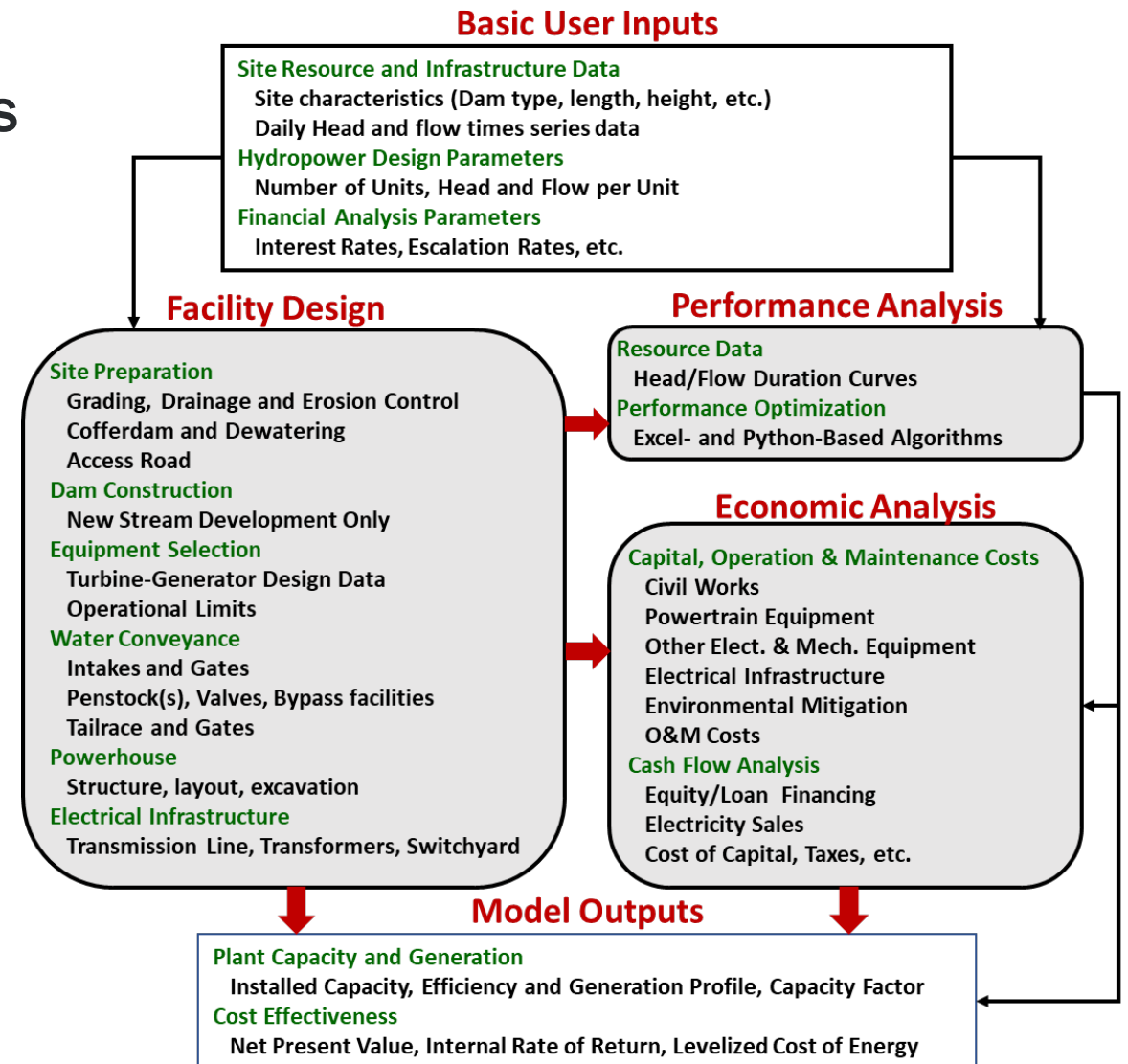
Gap between environmentally sustainable and economically feasible hydropower potential is **driven by costs**

Project Objectives: Approach

- **(smHIDEA) Small Hydropower Integrated Design and Economic Assessment Model**
 - Bottom-up model for detailed simulations of the pre-feasibility costs of hydropower projects under baseline and innovation scenarios
- **(BCM) Parametric Baseline Cost Models for Hydropower**
 - Using empirical data for existing plants
 - Using bottom-up simulation results from HIDEA
 - Aimed at rapid cost evaluation with limited data
- **Other methods as needed:**
 - Data analysis, Clustering analysis, Literature review, GIS, etc.

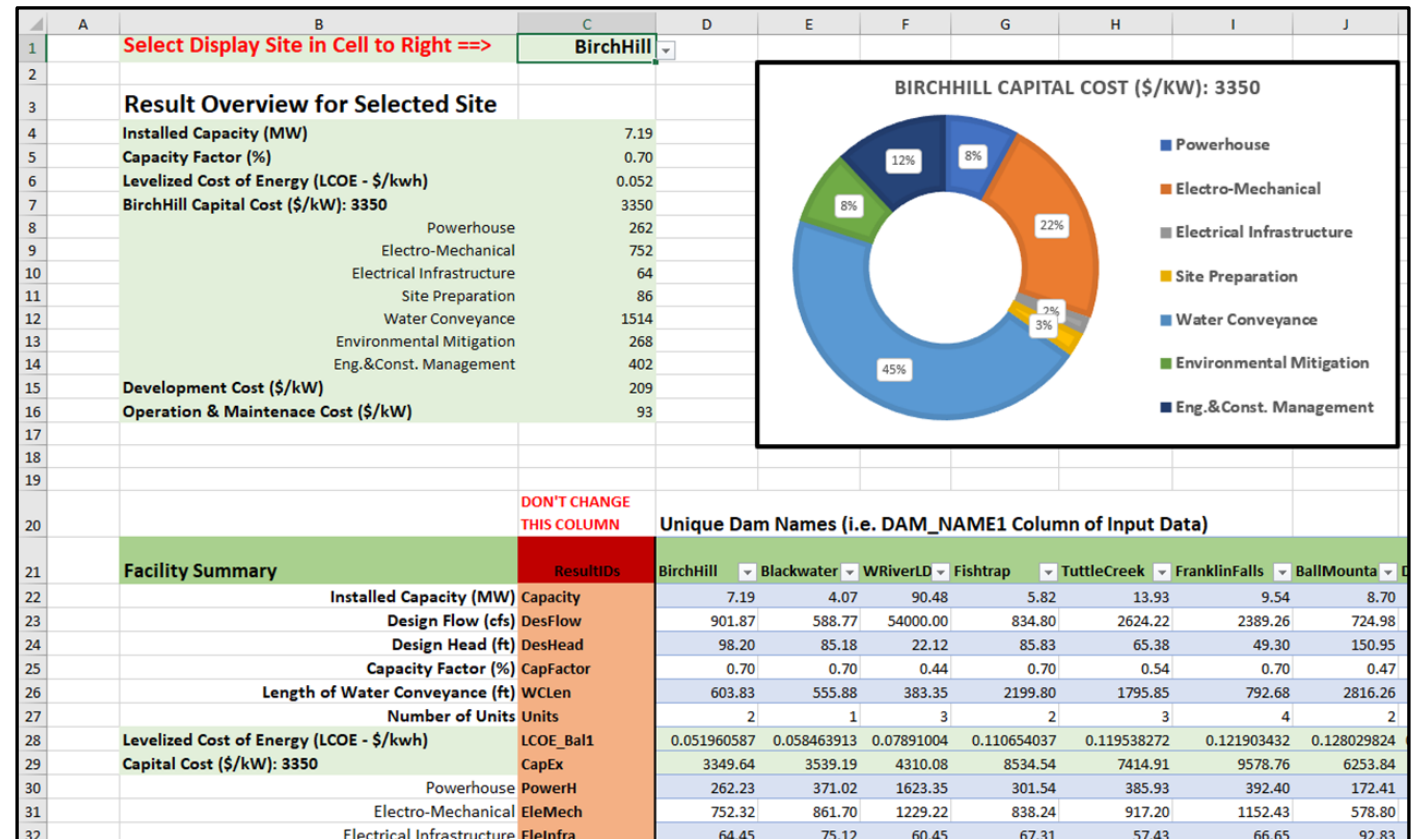
Bottom-up simulation of hydropower performance and costs using the smHIDEA model

- Model supports comprehensive facility design & cost analysis based on user inputs
 - Workbook-based model
- Model significantly enhanced since 2019:
 - Daily resource data from external workbook
 - Performance optimization on 200 half percentiles of the flow duration curve
 - VBA code of existing modules re-written and new modules added
 - Added ability to use exogenous data for designs not captured in model
 - Enables simulations of new designs until specifications can be added to model
 - Etc.



Parametric model for rapid cost analysis of NPD sites

- Equations were estimated from detailed simulation results of the HIDEA model
- Model will be integrated into a workbook for **public use**
- Workbook will include default cost estimates for 3000+ NPD sites
- Users can generate new cost estimates based on own data



Project Objectives: Expected Outputs and Intended Outcomes

Outputs:

- **4 Technical reports (2 Proprietary):**
 - Cost analysis of options for NPD development
 - Exploration of FERC Form-1 hydropower data
- **2 Journal articles:**
 - Cost of environmental mitigation for hydropower
 - Environmental design modeling of hydropower
- **2 Databases:**
 - Mitigation cost data from FERC EIA documents
 - Hydropower data from FERC Form-1 database
- **Cost analysis support to other projects:**
 - SMH project tasks, Hydropower Market Report, NREL-led Annual Technology Baseline, Evaluation of the cost effectiveness of two new turbine technologies (**proprietary**)

Outcomes:

- Short-term:
 - Provide **insights** into the technological needs for developing new hydropower in the US.
- Medium-term:
 - **Reduced cost/time and greater certainty** in federal/state authorization processes for hydro development
 - **Publicly available analytical tools for cost assessment** to support R&D and other needs
- Long-term/Impact:
 - **Improved hydropower decision-making processes** and management of river resources
 - Support for **graduate training & research** to increase manpower for hydropower in the US

Project Timeline

- Project uses a quarterly schedule of tasks and deliverables.
- Progress is monitored through quarterly reports and check-in calls with the WPTO lead.

FY19

- Compilation of data on the costs of environmental mitigation requirements for hydropower projects
- Draft and submission of journal article on costs environmental mitigation for hydropower projects
- Preliminary engineering design & costs for SMH-style NSD (subcontract)**

FY20

- Clustering analysis to identify reference sites for NPD cost analysis
- Major enhancements to smHIDEA model to support cost analyses needs
- Draft report on cost reduction analysis of hydropower options at NPDs

FY21

- Publication of ORNL report on cost analysis of baseline and innovation cases for NPD sites
- Updated NPD data for the NREL-led Annual Technology Baseline
- NSD site selection for cost analysis
- Published paper with Ph.D. student on environmental design of ROR hydropower

- Risks for this project are related to data availability. Analytical approaches are adapted to the available data.

Project Budget

FY19	FY20	FY21	Total Actual Costs FY19–FY21
Costed	Costed	Costed	Total Costed
\$513K*	\$386K	\$359K	\$1,259K

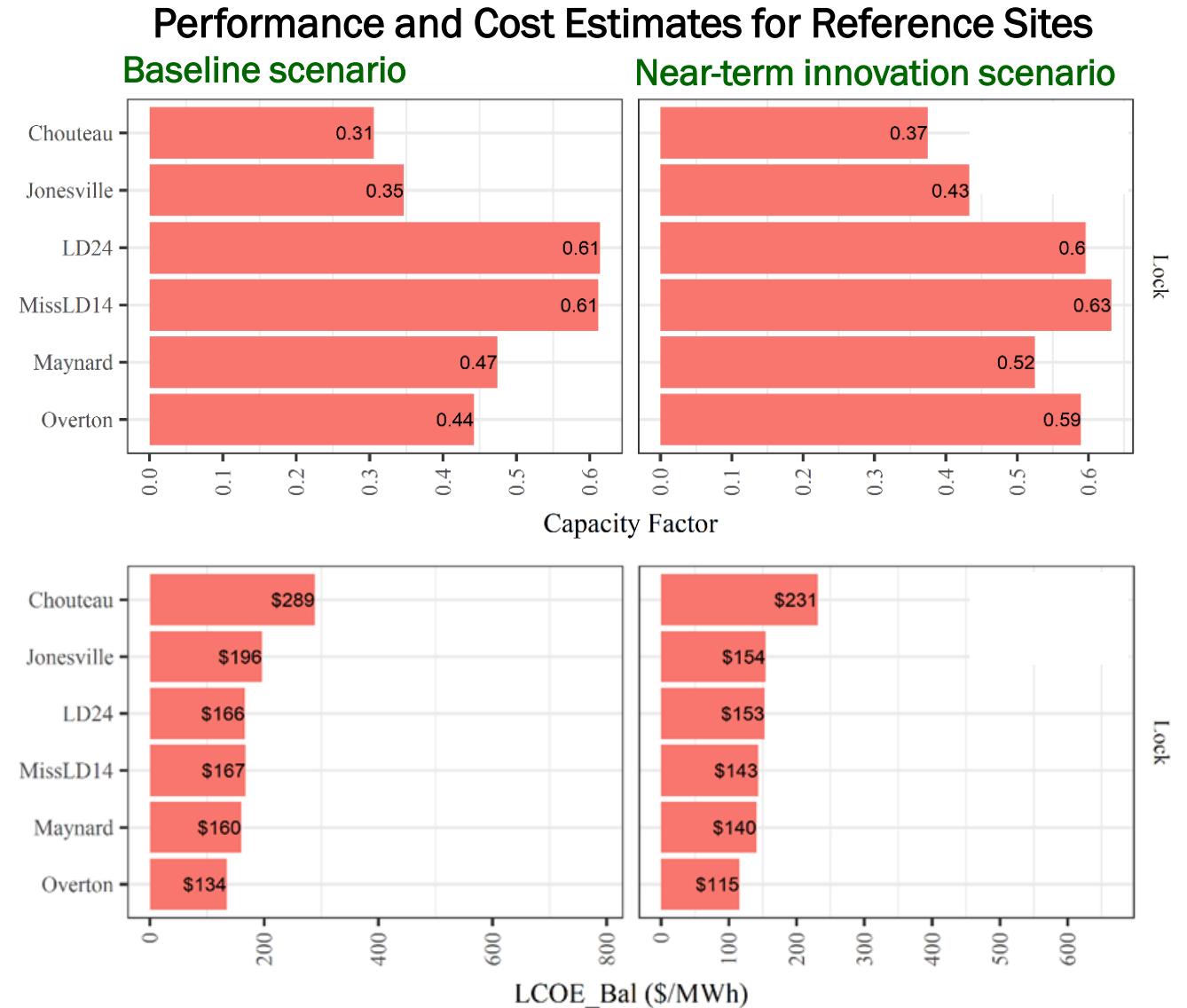
- Larger budget in FY19 due to a subcontract for preliminary engineering design & costs for SMH-style NSD jointly with the SMH project*

End-User Engagement and Dissemination

- **Beneficiaries of project outputs include:**
 - DOE/WPTO, researchers, policymakers, and the broader hydropower community
- **Project engages with industry and disseminates information through:**
 - Reports, presentations at workshops/conferences and journal articles
 - 2 Technical reports published
 - 2 Proprietary CRADA reports provide support to private industry
 - 2 Journal articles submitted & published during the review period
 - Presentations as part of interactions with hydropower stakeholders
 - Publicly available databases of collected data and simulation results
 - 2 Public databases made available on ORNL Hydro Source
 - Updates to hydropower cost data for the ATB, etc.
 - Support to other WPTO activities:
 - Hydropower Market Report, Standard Modular Hydropower, Annual Technology Baseline (ATB), etc.
 - Sub-contracts with private companies to help identify and characterize innovations

Performance: Accomplishments and Progress

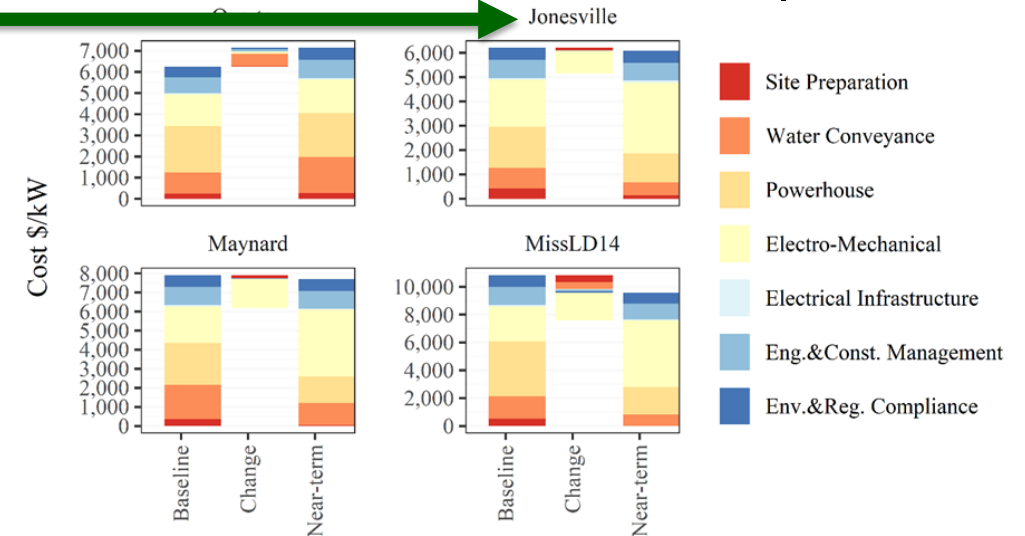
- Cost analysis of hydropower options at 20 reference NPD sites
 - Evaluated baseline costs of **most common technologies**
 - Evaluated potential cost reductions from **near-term innovation options**.
 - Data from this analysis was used to update the Hydropower section of the **Annual Technology Baseline (ATB) in 2021**
- Similar analysis for NSD is ongoing.



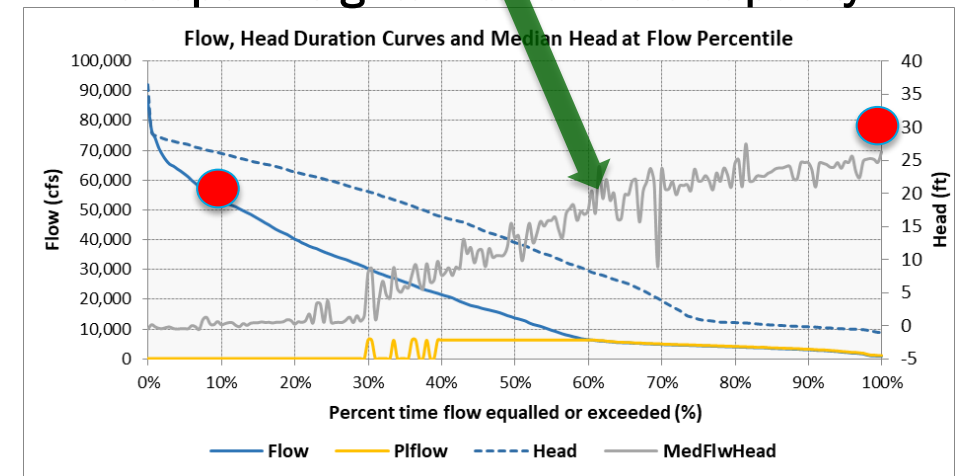
Performance: Accomplishments and Progress (contd.)

- **Example: Jonesville Lock & Dam**
 - 3 previous preliminary permits issued
 - Previous estimates suggested ~122 MW of potential
 - Baseline analysis found less than 20 MW of feasible capacity **based on existing technologies**
 - Near-term innovation analysis estimated increases in capacity factor & decreases in LCOE
 - LCOE reduction potential of about \$42/MWh
- **Bottom-up analysis results help to identify the technological needs for developing potential hydropower resources**

Baseline vs. Near-term Innovation Capital Costs



Flow-dependent head duration curves provide deeper insights into feasible capacity



Performance: Accomplishments and Progress (cont.)

- **Technical ORNL Reports:**

- 2020 Cost Analysis of Hydropower Options at NPDs

- <https://info.ornl.gov/sites/publications/Files/Pub145012.pdf>
 - Highlighted in 2022 WPTO Summary of Accomplishments

- Form 1 Exploration Report/Database:

- <https://info.ornl.gov/sites/publications/Files/Pub169067.pdf>;
 - <https://hydrosorce.ornl.gov/dataset/ornl-hydropower-cost-database-extract-ferc-form-1>

- Supported cost simulations for two proprietary CRADA reports on new turbine designs

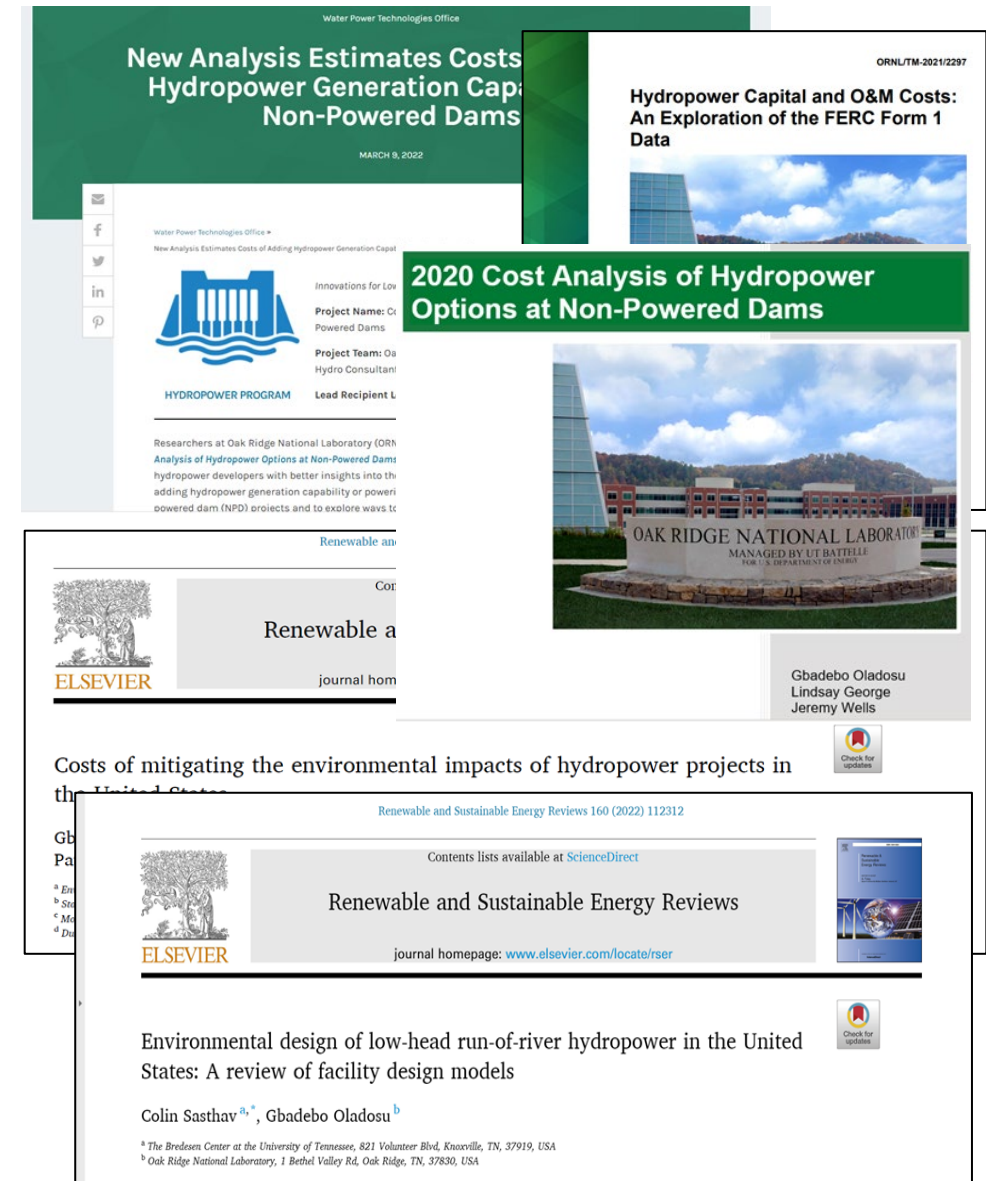
- **Journal articles**

- Costs of mitigating the environmental impacts of hydropower projects in the United States
 - Review of facility design models for low-head run-of-river hydropower was published

- **Support for graduate hydropower research**

- Student completed Ph.D. program in May

- **Presentation at Hydrovision 2022 (July 12-14)**



Future Work

- Complete analysis of Baseline costs for reference NSD sites
 - Evaluation of sites to select up to 20 most viable sites completed
 - Initial simulations for a few sites completed
 - Data gathering and simulations for remaining sites underway
 - Complete report on the NSD analysis



Middle Yuba River: Dam width changes with head:

- Affects location of dam & powerhouse
- Type of water intake (short/long diversion or instream)
- Cascade plants or single plant along river



Future Work (contd.)

- **Complete public workbook for cost analysis of NPD sites**
 - Focusing on 3000+ most promising NPD sites
 - Complete draft journal article on the NPD extension model
- **Potential activities in 2023 & 2024**
 - Provide updates to 2023 ATB for NSD sites based on simulation results
 - Develop publicly available model for cost analysis of hydropower at potential NSD sites
 - Evaluate the cost implications of new technological options:
 - Improving the feasibility of technical potentials at NPD & NSD sites
 - Incorporate better data on the costs of environmental mitigation requirements

Thanks

- **Acknowledgments**

This material is based upon work supported by the US Department of Energy under the Water Power Technologies Office and performed at Oak Ridge National Laboratory under contract number DE-AC05-00OR22725. The views in this paper are those of the authors, who are also responsible for any errors or omissions.

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Q&A