Transforming Hydropower Operations with Cutting-Edge Data Integration

Hydropower is a long-standing source of flexible, reliable, domestic power generation. However, maintaining cost competitiveness and the functionality of aging hydropower assets presents significant challenges for the hydropower community. The Hydropower Fleet Intelligence (HFI) project at the US Department of Energy's Oak Ridge National Laboratory (ORNL) is addressing these challenges by compiling and analyzing disparate datasets to provide actionable insights for key US hydropower stakeholders.

Currently, utility and industry consortia datasets separately track the cost, reliability, and condition of US hydropower assets at the unit level. The HFI project integrates these and other datasets to enhance operators' understanding of the correlations and tradeoffs between reliability, efficiency, cost, and operations and maintenance (O&M) practices. Additionally, the project evaluates the usefulness of various data sources, identifies gaps in data collection, and promotes smart O&M practices by developing and sharing research findings and software tools that enable real-time monitoring and targeted maintenance based on actual equipment conditions.

Integrating Essential Data

The ORNL research team employs the following key methods to achieve Hydropower Fleet Intelligence project objectives:

- **Data Sufficiency Assessments:** Evaluations of existing facility-scale and industry-wide databases—such as the Electric Utility Cost Group (EUCG) cost database, the Hydropower Asset Management Partnership (HydroAMP) asset condition database, and the North American Electric Reliability Corporation's Generating Availability Data System—focusing on asset health, outage performance statistics, and data quality and adequacy

- **Standardized Data Integration and Management:** Development of standardized processes for maintaining and integrating various data types across hydropower facilities to ensure comprehensive operational insights

- **Data Improvement Guides:** Creation and implementation of guides to enhance the quality and use of existing datasets while standardizing data collection and management practices

KEY OUTCOMES

STANDARDIZED DATA COLLECTION across hydropower facilities

DEVELOPED STATISTICAL MODELS for facility health and operational planning

CREATED A GUIDE to improve quality and usefulness of existing datasets

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- **Hydropower Operational Data Analytics:** Development of asset reliability modeling methods, statistical tools to gauge the health of hydropower components, and machine learning tools for operational data integration and asset health forecasting to enhance operational insight and planning capabilities

- **Collaboration with Industry Partners:** Creation of long-term partnerships with industry organizations (e.g., the EUCG Hydropower Committee and Hydropower Research Institute) and hydropower operators to improve data accessibility, conduct pilot-scale testing of methods, and encourage wider participation

Optimizing Operational Efficiency

The HFI project has significantly contributed to modernizing hydropower O&M by developing methods to provide detailed insights into asset health, failure rates, and maintenance needs. Models developed by the HFI project aid in better maintenance planning, reducing unexpected outages and outage downtimes, and extending assets' lifespans. Additionally, HFI researchers developed a data improvement guide for the HydroAMP database, enhancing the reliability and clarity of asset condition assessments.

Collaborations with industry partners have yielded substantial benefits. Alongside the EUCG Committee, ORNL produces annual benchmarking reports that offer valuable insights into O&M costs and operational efficiency. ORNL also works with hydropower operators to access data, develop and evaluate guidance on standardized data collection and management practices, and conduct pilot-scale assessments of data analysis methods.

The project has made data analytics for hydropower applications more accessible by publishing software modules that support prototypical data management practices and advanced analytics technologies for hydropower O&M. Specific use cases, such as the examination of dispatch variability effects on O&M costs, provide tangible insights and strategies for operators. These efforts enable hydropower decision-makers to optimize O&M practices and enhance their facilities' reliability and efficiency.

CONTACT

Pradeep Ramuhalli

Group Leader
Modern Nuclear I&C Group, Nuclear Energy and Fuel Cycle Division
Oak Ridge National Laboratory

ramuhallip@ornl.gov
865-341-0035

ornl.gov/ waterpower