Kyle DeSomber, P.E., PMP Mechanical Engineer



Hydropower Fleet Modernization Portfolio Overview

- Hydropower Fleet Modernization key interest areas
 - Maintenance
 - Digitalization
 - Cybersecurity
- Strategy
 - Performance Goals (from MYPP)
 - Objectives (from MYPP)
- Implementation and Progress
 - Research Priorities (from MYPP)
 - Key Accomplishments
 - Future Work
- Agenda Overview
- Reviewer Introductions

Maintenance:

- Process to ensure asset performance, reliability and safety.
- Maintenance operations are a combination of site-specific requirements as well as risk mitigation efforts.
- Significant history of industry activity



Key Takeaways:

- Hydropower facilities are operating in ways not typical of the past, understanding maintenance implications is essential to a reliable fleet.
- Quality data is foundational to making effective decisions but it is not enough!
 Standardized processes must be put in place to make sure the data is used properly.

Digitalization:

- Digital transformation can provide hydro plants with the information and actionable capabilities necessary to operate in the modern electrical and water system.
- Value sensitivity and articulation is critical to effort success



Key Takeaways:

- Understanding the current state of the art/fleet is critical to effective focus of research efforts.
- Hydropower facilities have unique operational attributes, legacy characteristics and system requirements that digital technologies can help empower but must be efficiently tailored to ensure an economic and valuable role.

Cybersecurity:

- Congressional Appropriation requiring EERE submit a "<u>multi-year program plan</u>" to "<u>bring cybersecurity into early-stage</u> <u>R&D</u>"
- Focus on articulating the State of the fleet

WIRED BUSINESS CULTURE GEAR IDEAS SCIENCE SECURITY TRANSPORTATION

Security News This Week: An Unprecedented Cyberattack Hit US Power Utilities

Exposed Facebook phone numbers, an XKCD breach, and more of the week's top security news.



Key Takeaways:

- The cybersecurity landscape is non-uniform and changing more rapidly than hydro fleet assets.
- Hydroplants have unique operational attributes, legacy characteristics and failure mechanisms
- Effective and "Right-Sized" guidance is key for effective cybersecurity implementation by industry

Strategy and Objectives







Increasing Age

Increasing Grid Demands

Increasing Connectivity

- Create mechanisms to classify diverse hydropower plants by mechanical and cyber-physical systems and identify exemplary facilities and best practices.
- Research advanced technologies and data evaluation approaches to improve equipment longevity and condition-based repair.
- Develop cross-cutting digitalization systems and advanced sensor suites to empower datadriven decisions on operations and maintenance (O&M) and asset management.
- Create cybersecurity tools and studies to articulate the cybersecurity target, risk, and recovery landscape in order to enhance the security of critical dam infrastructure.



Hydropower Fleet Intelligence (HFI)

- Develop and demonstrate standard process to make datadriven decisions on operations and maintenance (O&M) for cost-effective hydropower generating unit asset management under evolving contexts
 - Enhance and coordinate disparate cost, condition, operation, and reliability information to maintain or improve hydropower value and reliability
 - Demonstrate metric-based, data-driven decision-making enhanced hydropower asset management outcomes for multiple use-cases
- Motivation: Need for rationale and methodology to:
 - benchmark the cost and performance of the asset fleet
 - manage risk by allocating resources and duty among assets
 - Data-driven asset management decisions require efficient and automated processes for acquiring, qualifying, archiving, analyzing, and sharing hydropower data and results





DIGITAL TWINS: A Driver to Modernize the Hydropower Industry

Digital Twin

...but also proactively identifies similar problems and prescribes fixes

well-in-advance to other hydropower plants.



PREDICTIVE APPLICATIONS



Hydropower Plant

Digital Twins not only

plant...

finds and fixes problems

for a specific hydropower

- Predictive O&M
- Controls
- Optimization
- Cybersecurity

Digital Twins obtains sensors data, performs analytics, develops strategies, and sends output to the plant.

 Prescriptive O&M Reduce Downtime

Life Expectancy

Improve

• Enhance Resiliency

FUTURE DIGITAL TWINS **OPEN COLLABORATORY**



Wear and Fatigue Lab Call

- \$1 Million to develop Wear and Fatigue Models (WFMs) for FY22
- WPTO is seeking proposals for new projects focused on developing industry accessible WFMs representing critical hydropower **components**
 - Economically efficient transition for combining old robust systems in hydropower, having minimal data, with modern data rich systems
 - Avoid one-off models that do not translate across the industry
- Components is open ended
 - WFMs may inform Digital Twins and/or Hydropower Fleet Intelligence
- Schedule
 - Concept Slide Pitches Labs presented May 30, 2022
 - DOE Provided Feedback June 6, 2022
 - Final Proposals Received June 30, 2022

Cybersecurity Projects

- Hydropower Cybersecurity Risk/State of Fleet (PNNL)
 - Outlines the needs/trends of hydropower cybersecurity and to recommend future impactful research options for WPTO
- Hydropower Cyber-Physical Reference Framework (PNNL, ANL, NREL)
 - The focus of this work was to produce a series of representative categories of hydropower digital structures to hydropower digital systems
- SerialTap for Hydropower Cybersecurity (PNNL)
 - A system to detect abnormalities in serial communications which can indicate cyber intrusions
- Hydropower Fleet Cybersecurity Response and Recovery Guide (PNNL)
 - Assist plant operators in detecting anomalous cyber activities, defending against those adverse actions, and recovering quickly
- Hydropower Cybersecurity Value-at-Risk Framework (NREL, ANL)
 - Assist plant operators understand risk probabilities of cyber attacks based on operations of the facilities and how best to use resources to mitigate risk

Cybersecurity Lab Call

- FY22 \$1.5 Million Lab Call for Cybersecurity for Hydropower and Dams
- Two topics:
 - Research to identify critical cybersecurity threats that may interrupt Hydropower and Dams' operations and develop mitigation strategies
 - Develop cybersecurity best practices for Hydropower and Dams including developing standards for implementation
- Estimate Number of Projects Funded: 4-6
- Expected Project Duration: 12-24 months
- Schedule
 - Concept Slide Pitches Labs presented May 23, 2022
 - DOE Provided Feedback June 7, 2022
 - Final Proposals Received June 30, 2022

- <u>Maintenance</u> Evolve strategies to enhance predictive and Smart Maintenance with evolving operational schemes
- Fix-as-fails Maintenance occurs when a system fails
- Scheduled Maintenance occurs on a fixed intervals
- Predictive Maintenance Based on condition monitoring and inspections
- Smart Maintenance Incorporates riskbased decisions and machine learning



- Digitalization Data logging and sharing through modern technologies, this includes developing models, data acquisition methods, simulations, and predictions though advanced algorithms and machine learning.
- Challenge How do we modernize robust systems in service for 50+ years?



• Cybersecurity -

Corresponding to both digitalization and operations, all links of shared information need to be assessed and secured from spillage and attacks.



Implementation and Progress

- Maintenance
 - FY21 \$650K
 - FY22 \$650K continued and \$1M Lab Call
- Digitalization
 - FY21 \$1M
 - FY22 \$1M continued and \$1M Lab Call
- Cyber Security
 - FY-21 Funding: \$850k
 - FY-22 Funding: \$1.85M (\$1.5M for Lab Call and \$350k for continued funding -Hydropower Cybersecurity Value-at-Risk (NREL & ANL)

Implementation and Progress – Completed Efforts

- Completed Efforts FY21 Cyber Security
 - Hydropower Cybersecurity Risk/State of Fleet
 - Hydropower Cyber-Physical Reference Framework
 - SerialTap for Hydropower Cybersecurity
 - Hydropower Fleet Cybersecurity Response and Recovery Guide

Implementation and Progress – Continuing Efforts

- Maintenance Continuing Efforts FY22
 - Hydro Fleet Intelligence
 - Data Availability Checklist Template
 - Validation of methodology with industry partners
 - Using additional industry partnerships, benchmark data/digitalization technology
- Digitalization Continuing Efforts FY22
 - Hydropower Digital Twin
 - Development of one-dimensional digital twin, partnership with Norway (NTNU)
 - Industry partnership to develop
- Cyber Security Continuing Efforts FY22
 - Hydropower Cybersecurity Value-at-Risk Framework

START (ET)	END (ET)	PRESENTATION TOPIC	ORGANIZATION	PRESENTER
10:00 AM	10:25 AM	Fleet Modernization, Maintenance, and Cybersecurity Activity Area Overview	WPTO	Kyle DeSomber
10:25 AM	10:50 AM	Digital Twin	PNNL ORNL	Osman Ahmed, Hong Wang
10:50 AM	11:15 AM	Hydropower Fleet Intelligence	ORNL	Pradeep Ramuhalli
11:15 AM	11:25 AM	BREAK		
11:25 AM	11:50 AM	Cybersecurity Value-At-Risk Framework	NREL, ANL	Anuj Sanghvi

Agenda Overview Continued

11:50 AM	12:15 PM	Hydropower Cyber-Physical Reference Framework	PNNL, ANL, NREL	Ken Ham
12:15 PM	1:00 PM	LUNCH BREAK		
1:00 PM	1:25 PM	Hydropower Cybersecurity Risk/State of Fleet	PNNL	Marie Whyatt
1:25 PM	1:50 PM	Hydropower Fleet Cybersecurity Response and Recovery	PNNL	Darlene Thorsen
1:50 PM	2:15 PM	Reviewer Debrief	Reviewers	

Reviewer Introductions

- This will be a slide that introduces the review panel and thanks them.
- I will insert this slide after you send your draft to me and Tim.

