Hydropower Fleet Modernization Portfolio

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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
Hydropower Fleet Modernization Portfolio

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.
Hydropower Fleet Modernization Portfolio

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.
Hydropower Fleet Modernization Portfolio

Cybersecurity:
- Congressional Appropriation requiring EERE submit a “multi-year program plan” to “bring cybersecurity into early-stage R&D”
- Focus on articulating the State of the fleet

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
Strategy

• 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 data-driven 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 data-driven 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

**PREDICTIVE APPLICATIONS**
- Predictive O&M
- Controls
- Optimization
- Cybersecurity

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

**PRESCRIPTIVE APPLICATIONS**
- Prescriptive O&M
- Reduce Downtime
- Improve Life Expectancy
- Enhance Resiliency

Digital Twins not only finds and fixes problems for a specific hydropower plant...

...but also proactively identifies similar problems and prescribes fixes well-in-advance to other hydropower plants.

FUTURE DIGITAL TWINS OPEN COLLABORATORY

Academia

Owners

Utilities

National Labs

Offsites

Next-Generation Hydropower
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
Strategy

• **Maintenance** - 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 risk-based decisions and machine learning
Strategy

• **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
## Agenda Overview

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<td>Fleet Modernization, Maintenance, and Cybersecurity Activity Area Overview</td>
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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.