



## Hydropower Digital Twins

Water Power Technologies Office  
Hydropower Program

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## Concept:

A digital twin is a mathematical replica of a physical system. Its ability to accurately represent characteristics can be used to make more effective operational and asset management decisions. WPTO is currently soliciting research proposals from the national labs. The research is focusing on laying the groundwork to make “right – sized” digital twins available to the hydropower industry rather than one off, highly site specific efforts.

## Impact:

The development of tailored Hydropant models enables a wide range of potential analysis:

- Capital Investment Planning
- Maintenance Optimization
- Reliability/Security via abhorrent data identification
- Dispatch Optimization and Process Scheduling
- Market Entry Assessment



## Application:

It is important to note that the Digital Twin effort is not designed to replace experts and existing decision making processes (particularly in the early years) as the concept matures and gains acceptance they can be granted more independence.

# Digital Twin Foundations (FY21 Effort)

## United States Effort:

Lead: TBD based on Lab Call

- 1: Developing a Request for Information
- 2: Establish Digital Twin Value Proposition
- 3: Foundational Mathematical Archetypes (Below)

## Norwegian Effort:

Lead: SINTEF (Need to Confirm)

- 1: Fill out Request for Information
- 2: Engage with team for larger follow on FY22 effort
- 3: (Potentially) Host US delegation at NTNU's test facility.

### Topic 1: Hydropower Digital Twin Foundations

Topic Budget: \$550,000

Duration: 1 year

#### Topic Goal:

Lay the groundwork for the deployment and use of hydropower digital twins.

#### Topic Details

For the last hundred years, the hydropower industry has acted as the backbone of both the power sector and the broader water nexus. However, for the hydropower industry to continue to maximize its value, industry needs new capabilities need to help it negotiate the increasing complex landscape. One new tool that can support industry is Digital Twin (DT) capabilities, a system with the potential to impact efficiency, reliability and value by providing unprecedented system performance and operation insight. For the purpose of this proposal DTs are defined as mathematic models (which can include but may not be limited to: numerical, dynamics, systems, and/or engineering physics) representations of a hydropower system/subsystem.

While DT capabilities have been developed in other sectors, the tool has not yet been effective in the hydropower industry due to the site-specific nature and diverse operational history of hydroplants. Through this lab call, the Water Power Technologies Office's Hydropower Program seeks proposals for new projects focused on (1) expressing the value proposition of hydropower Digital Twins from a variety of stakeholder perspectives, and (2) laying the groundwork for the full development/deployment of a hydropower digital twin in subsequent years.

Proposals should outline the process and scope for three primary focus areas:

#### Focus Area 1: Setup Industry Engagement

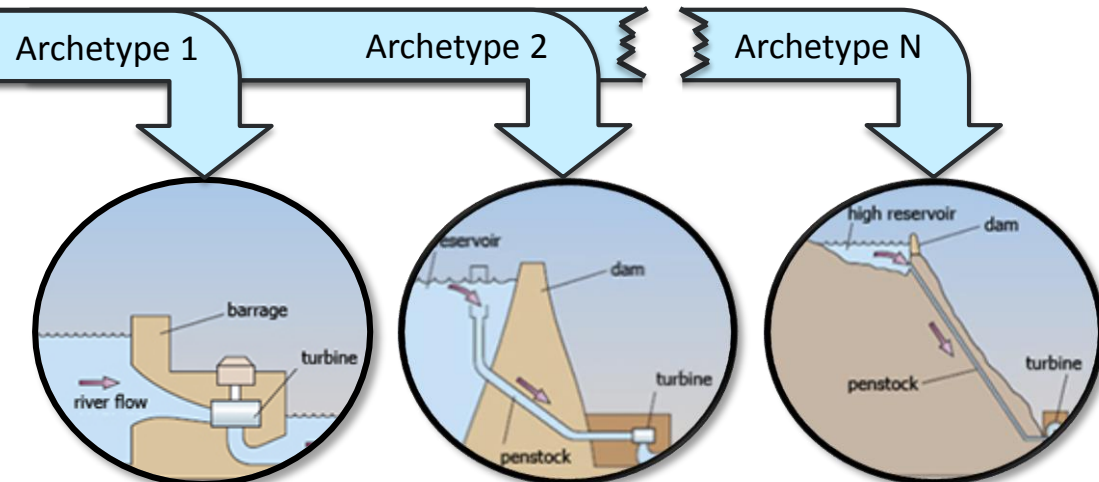
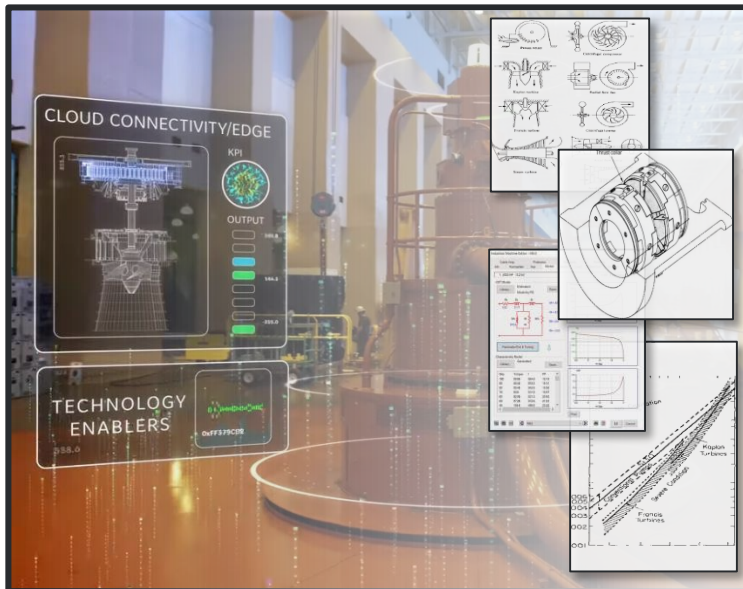
Develop a Request for Information (RFI) that captures the broad range of stakeholders that effective DT capabilities for hydropower would impact. This RFI should capture important factors including but not limited to: desired application, uptake appetite, and perceived value.

#### Focus Area 2: Establish Digital Twin Value Proposition

Produce a report that consolidates not only the state of the art/industry in digital twin technology, but also articulates the value proposition of DT capabilities (based on site specificity, system scale, characteristics captured, etc.) and highlights the RFI results.

#### Focus Area 3: Develop Coupled Numerical Model(s) to create Right Sized Digital Twins

Proposed a method to develop "right sized" hydropower DT archetype frameworks which can be used in the following year(s) to create DT(s). Archetypes refer to different permutations of the DT which allow it to be more representative of different categories of facilities (examples of this distinction include but are not limited to: Kaplan/Francis, ROR/Storage, and Peaking/Base-load). These should be binned and constructed in such a way to allow for relatively easy customization from their exemplary frameworks to site specific applications. This proposed research should detail the focus/intended use of the DTs and the associated value proposition(s). Furthermore, the proposal should outline how the twin characteristics (scale, system/sub-system breakdown, etc.) supports this value proposition as well as what information/capabilities is necessary from a targeted hydroplant to develop and implement the twin. It should be noted that the "right-sized" nature of DT archetypes refers to the fact that the DT resolution/specificity should be informed by both the value proposition and the level of information available to populate the DT.





## United States Effort:

Lead: TBD based on Lab Call

1: Customize archetypes to produce DT(s) for a hydropower system(s)

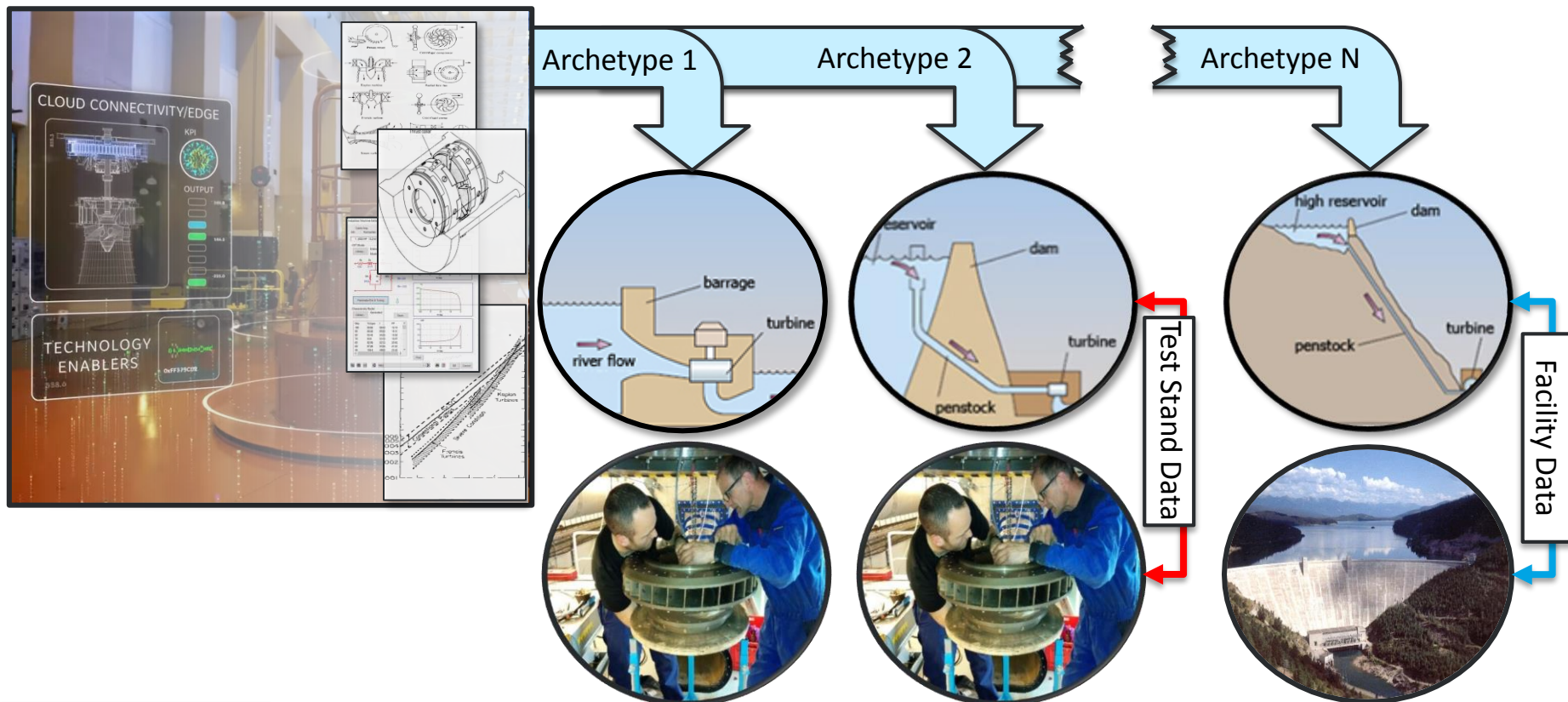
2: Refine and Populate Archetypes

## Norwegian Effort:

Lead: SINTEF (Need to Confirm)

1: Review Archetype Formulations

2: Leverage Waterpower Laboratory to provide data to populate Archetypes



**1: Questions on the Digital Twin Concept/Timeline?**

**2: Thoughts on the application and associated value proposition for hydropower digital twins. Is there something we are missing? Do you see value on this capability?**

**3: Discussion of entities who want to participate in the DT research along with what they want to contribute to the effort.**

# Questions?

## Contact Information

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