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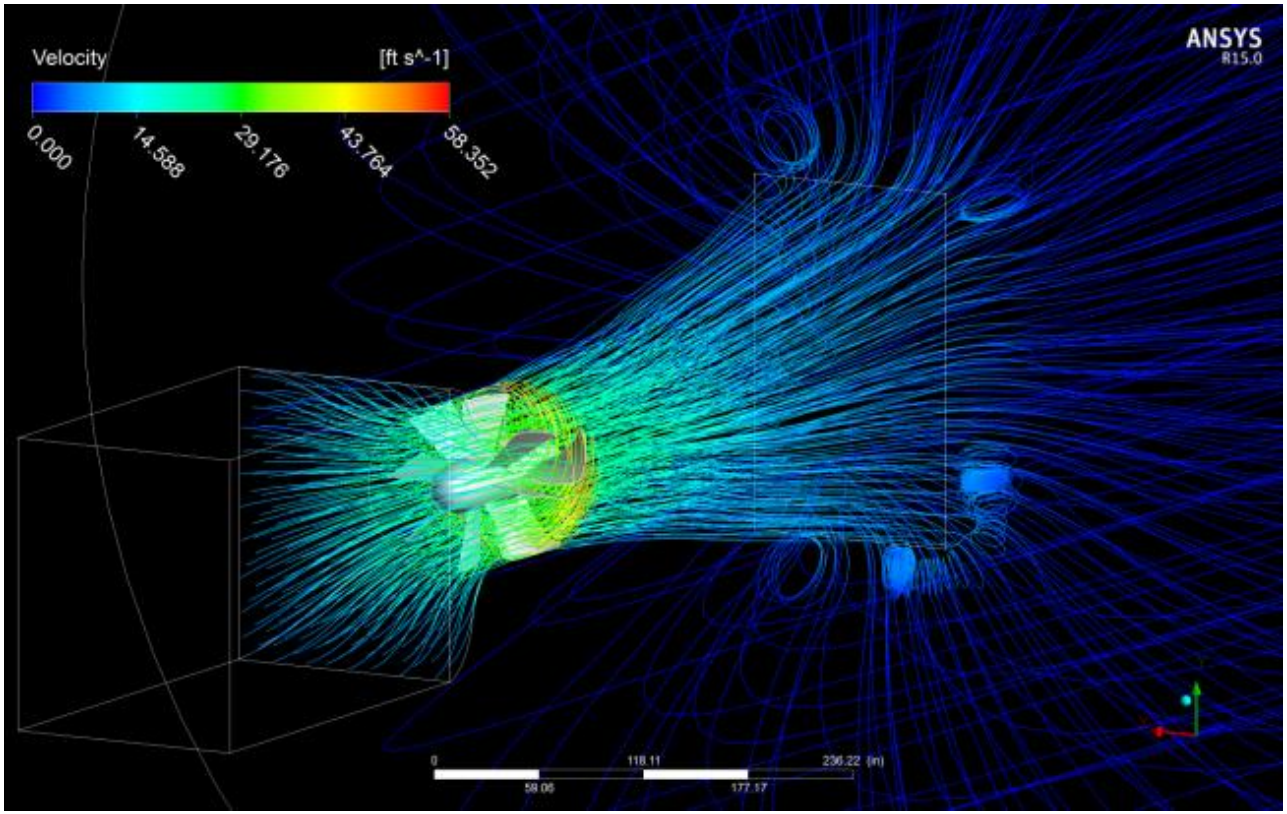

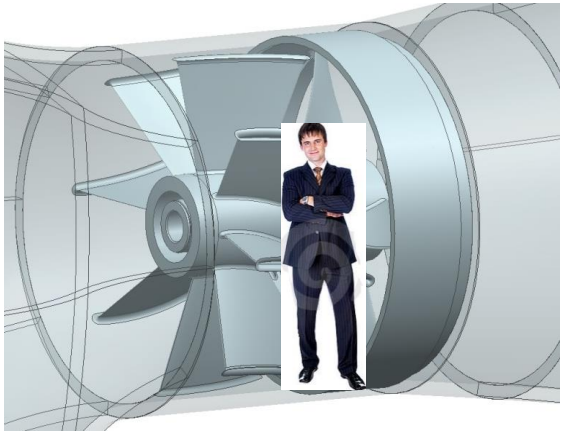

REAL WORLD DEMONSTRATION OF A NEW, AMERICAN LOW-HEAD HYDROPOWER TURBINE

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Project Overview

Real World Demonstration of A New, American Low-Head Hydropower Turbine: Fabricate, install and operate an interchangeable Modular Bulb Turbine™ at a low-head hydropower project site at an existing non-powered dam.

The Challenge:

- Growth in the low-head hydropower sector has been stymied over the decades for a variety of reasons, the most critical being the high LCOE associated with building low-head, lower power hydropower plants.
- New turbine systems, inexpensive civil structures and low-impact installation methods are needed to ensure the robust development of the greatly untapped low-head hydropower sector.

Partners: Mechanical Solutions Inc.

Next Generation Hydropower (HydroNEXT)

Optimization

- Optimize technical, environmental, and water-use efficiency of existing fleet
- Collect and disseminate data on new and existing assets
- Facilitate interagency collaboration to increase regulatory process efficiency
- Identify revenue streams for ancillary services

Growth

- **Lower costs of hydropower components and civil works**
- Increase power train efficiency for low-head, variable flow applications
- Facilitate mechanisms for testing and advancing new hydropower systems and components
- Reduce costs and deployment timelines of new PSH plants
- Prepare the incoming hydropower workforce

Sustainability

- Design new hydropower systems that minimize or avoid environmental impacts
- Support development of new fish passage technologies and approaches
- Develop technologies, tools, and strategies to evaluate and address environmental impacts
- Increase resilience to climate change

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The Impact

- Reduce the civil engineering costs associated with installing and maintaining small hydropower projects
- Validate this full-scale commercial technology to successfully deploy hundreds of commercial units at over 20 low-head hydropower sites resulting in approximately 350-400 MW of new, low-impact hydropower generation in the United States
- The valuable knowledge gained, and lessons learned, from this proposed project will also work to advance the industry as a whole given the large untapped potential of the small hydropower sector.

1. Design & Pre-Assembly Activities

- **Licensing and Permitting:** Obtain all necessary licenses and permits (e.g. Federal Energy Regulatory Commission [FERC] license, Clean Water Act [CWA] Section 401 and 404 permits, U.S. Army Corps of Engineers [USACE] 408 permit)
- **Preliminary Full-Scale Design:** Validate the scale model and existing full-scale hydraulic and mechanical design based on the scale model testing results
- **Critical Design:** Finalize the full-scale turbine hydraulic flow path design yielding the final flow path component geometry and performance curves
- **Civil and Structural Design:** Prepare final design drawings and applicable construction specifications in support of civil, structural, mechanical, and electrical construction activities.

2. Fabrication, Assembly, and Civil Site Preparation

- **Hardware Procurement:** Identify all hardware required for assembly and installation, and procure materials
- **Assembly:** Test and assemble generator frame modules, modular bulb turbines, turbine frame modules, and large frame module (LFM), and prepare for shipment.
- **Site Preparation Activities:** Drive sheet pile for LFM shelf, remove silt, pump in tremie concrete section, form/reinforce/place concrete section, and prepare LFM mountain face on upper pool site of weir.

3. Installation, Performance Testing, Commissioning, and Startup

- **Installation:** Install the LFM, complete construction of reinforced concrete cap on weir, install turbine and generator sub-modules
- **Testing and Commissioning:** Perform hydraulic (IEC 62006) and operational tests (PTC-18)
- **LCOE Analysis:** Calculate LCOE of the full-scale turbine and compare to an original equipment manufacturer turbine.

Accomplishments and Progress

- Completed drilling program at site – SEP16
- Rock property lab test completed NOV16
- Negotiating EPC contract now

Project Test Site – Topic 1.2
Braddock Lock and Dam - 5.25 MW
Seven (7) units rated at 750 kW each

Project Plan & Schedule

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- Project original initiation date May 2016 and project planned completion date May 2018
- USACE agreements required by FERC that were to take 90 days actually took 365 days
- Multiple milestones from Tasks 1.1 to 1.6 (which is securing all contractors for project construction)

Project Budget

Budget History					
FY2017		FY2018		FY2019	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$375K	$375K	None to date	None to date	None to date	None to date

- No project budget variances to date
- Approximately 75% of Budget Period 1 has been spent to date

Research Integration & Collaboration

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Partners, Subcontractors, and Collaborators: Mechanical Solutions Inc.

Communications and Technology Transfer: NA

Next Steps and Future Research

FY17/Current research: Preliminary and final full-scale design

Proposed future research: **Milestone: 1.1.e – Issuance of River and Harbors Act Section 408 Permit**
Milestone: 1.2 – Component, equipment and system test plans complete
Milestone: 1.3 – Preliminary design complete
Milestone: 1.4 – Critical design review complete and delivery of report documenting results
Milestone: 1.5 – Civil and structural design complete. Release ready for construction drawings of civil, structural elements to support turbine for procurement