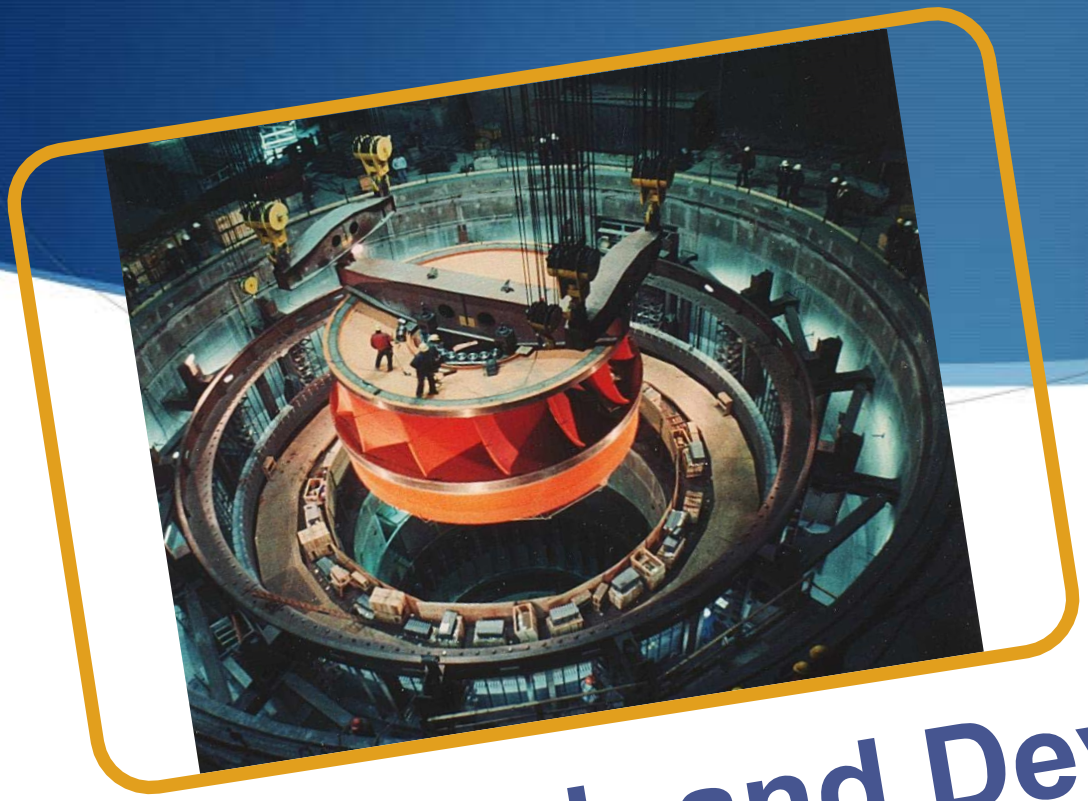


Research and Development Roundtable

National Hydropower Association

Green Bay, WI

October 27, 2016

Batting Order

- Brenna Vaughn-Hydro Research Foundation
- Paul Jacobson- Electric Power Research Institute
- Fred Carter- Sciaky, Inc.
- Daniel Rabon- Department of Energy

HYDRO RESEARCH FOUNDATION

Game Plan

- What is hot in hydro?
  - New findings on sediment and what it all means
  - Fish findings
  - Additive Manufacturing
  - Who is going to advance the ball?
  - How does it all tie together for the big win?

HYDRO RESEARCH FOUNDATION

Game Plan Second Half

- Game Changing R&D Discussion
  - You. Yes you, audience members…grab your pencil, take notes and be ready…half of the time together is for you, your questions, and a conversation about how we move R&D forward, what we need and how we collaborate. This is your fair warning.

HYDRO RESEARCH FOUNDATION

Kick-Off
Sediment and Fish

Paul Jacobson

Senior Technical Leader

Electric Power Research Institute

pjacobson@epri.com

Hydro Research Foundation

Second Inning
Additive Manufacturing

Fred Carter

Process Engineer

Sciaky, Inc.

Fcarter.Sciaky@psi-corp.com

HYDRO RESEARCH FOUNDATION

Third Down
Research and Workforce

Brenna Vaughn

Managing Director

Hydro Research Foundation

brenna@hydrofoundation.org

HYDRO RESEARCH FOUNDATION

Highlights of HRF R&D

- 27 Competitively Awarded Research Grants (70 total)
- How to access these fantastic findings: Open EI or HRF Website
- Fish Entrainment/Survivability
- Dissolved Oxygen Collaboration
- Program Proposals Welcome

HYDRO RESEARCH FOUNDATION

Research Areas

- Areas of interest prioritized with industry
- Large variety of research topics
- Available online

Hydro Research Foundation

Numerous Career Options & Opportunities

- Over next few years between 40 & 50% of hydro workforce is eligible to retire
- Wide variety of skills needed
- 8,000-10,000 technical positions such as engineers, operators, and maintenance workers

HYDRO RESEARCH FOUNDATION

Development of Workforce

- Research Awards Program
  - Workforce development at the graduate level
- Hiring for Hydro- February 22nd Portland, OR
  - Recruiting for trades, crafts and vocational students
- Hydro Think Tank May, 2017
  - Utility specific research to develop the undergraduate workforce

HYDRO RESEARCH FOUNDATION

Forth Quarter
Department of Energy

Daniel Rabon

Hydropower Technology Manger

US Department of Energy's Wind and Water Power Technologies Office

Daniel.Rabon@EE.Doe.Gov

HYDRO RESEARCH FOUNDATION

Second Half

Research and Development Discussion

HYDRO RESEARCH FOUNDATION

Water Power Technologies Office

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Hydropower Overview

NHA Hydraulic Power Committee

October 27, 2016

Green Bay, WI

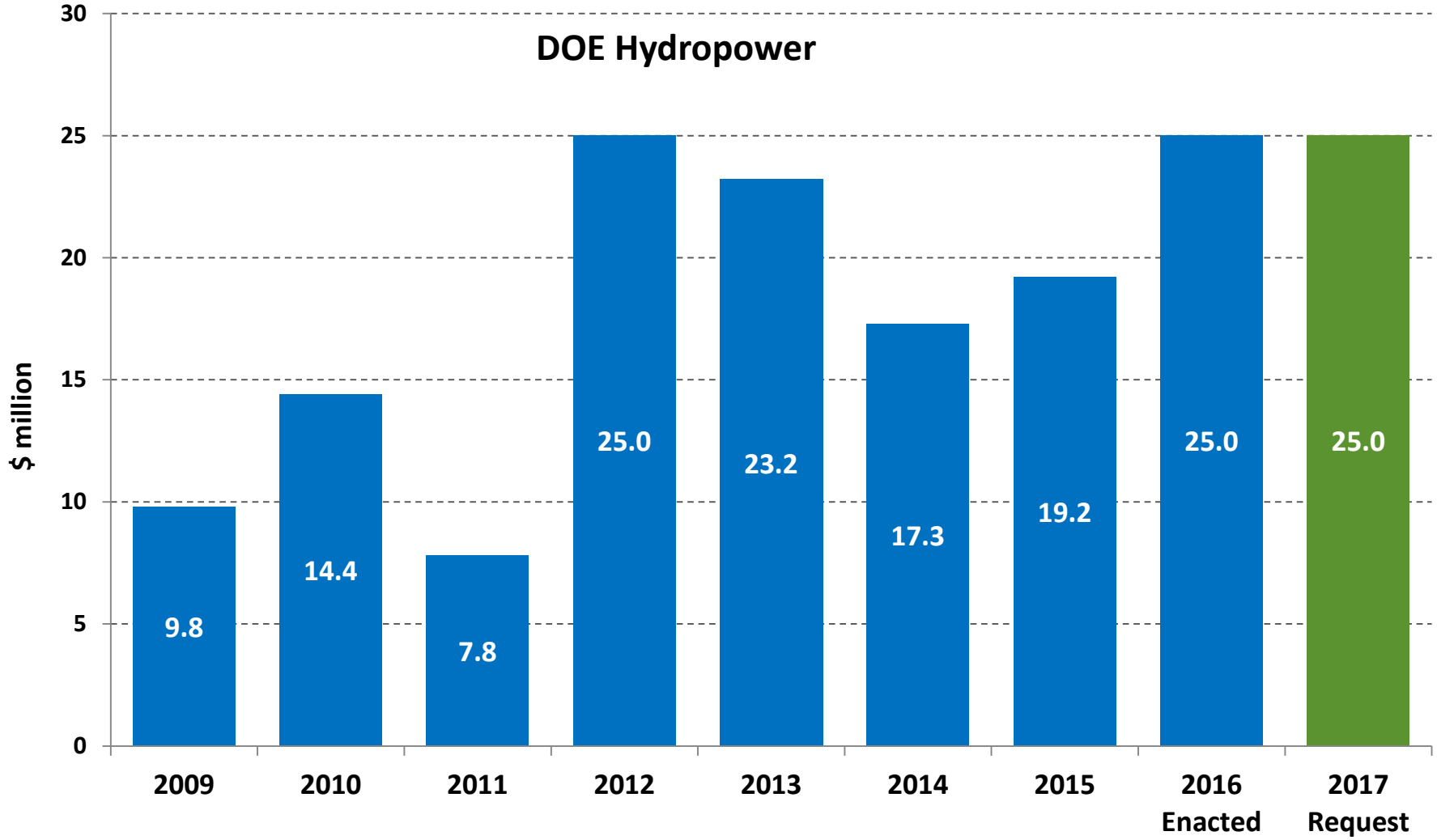
Daniel Rabon

Technology Manager

Hydropower Program

DOE Hydropower Program
Funding History

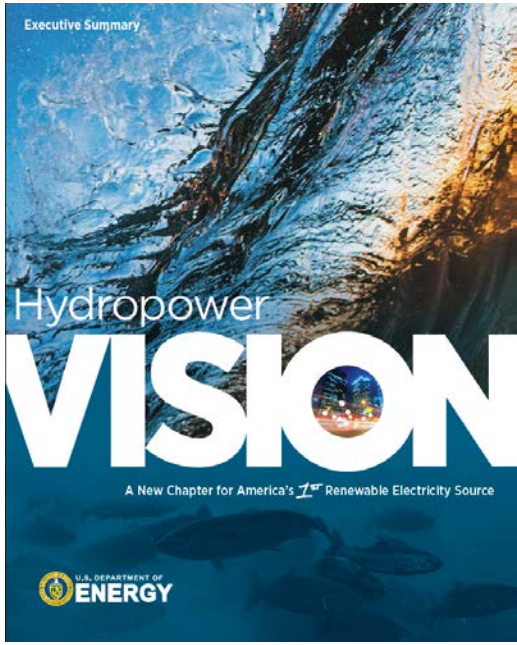
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Hydropower Vision

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- *Hydropower Vision* is a bottom-up analysis applying **economic, technical, and sustainability criteria** to look at the potential for innovation and growth in traditional hydropower generation and storage through 2050.
  - Analytical, not goal based and contains NO policy recommendations
  - Builds on *Wind Vision*, which helped galvanize the wind industry to work together on progress
- *Hydropower Vision* established in collaboration with key stakeholders (**300 experts from over 150 organizations**), representing Government, NGO's, Researchers and Industry; significant inter- and intra-agency concurrence and independent review.



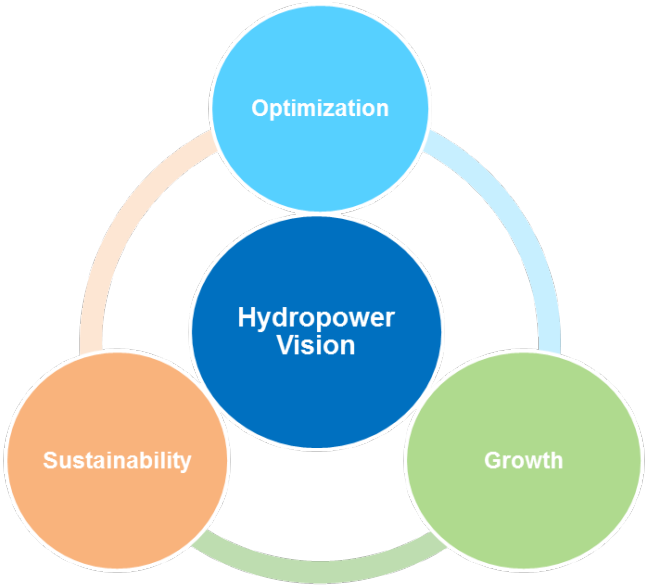
- **Includes a detailed roadmap** developed with 5 critical action areas and a set of 64 detailed actions needed to support scenarios.
- A **$9.8M Funding Opportunity Announcement** (FOA) was released in conjunction with *Hydropower Vision* to support innovation in Non-Powered Dams (NPD) and Pumped Storage Hydro (PSH).

***Hydropower Vision: A New Chapter for America's First Renewable Electricity Source* released July 26, 2016**

Hydropower Vision
Key Takeaways

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- **Three potentially cost-effective opportunities for hydropower by 2050, beyond the existing baseline of 80 GW of hydropower generation and 22 GW of PSH**
  - 13 GW of new hydropower capacity without significant risk to sustainability (Upgrades, Non-powered Dams, and New Stream Reach Development)
  - 15 GW of additional hydropower capacity with breakthroughs required to mitigate sustainability risks in new stream-reaches
  - 36 GW of new, flexible, low-cost Pumped Storage Hydropower (PSH)
- **Hydropower can provide system benefits and enable growth in variable generation; PSH is the lowest cost grid storage option currently available.**
- **Impacts of optimizing and expanding existing and new hydropower by 2050**
  - Total impact: 5.6 billion metric tons GHG reductions and $209B savings (cumulative)
  - Total jobs: 197,000 jobs (33,000 direct, 81,000 indirect/manufacturing, 83,000 induced U.S. jobs)
  - Incremental impact: 700 million metric tons GHG reductions, $24.5B savings, and 76,000 jobs (10,000 direct, 26,000 indirect/manufacturing, 40,000 induced U.S. jobs)

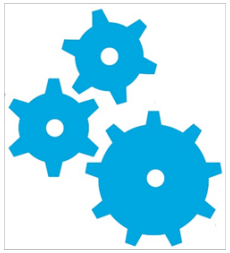


Hydropower Vision - *Roadmap Actions For All Stakeholders* *(Government and Private Sector)*

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

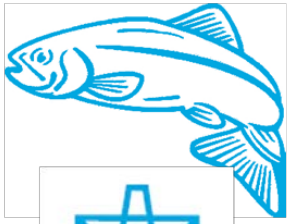
1.0 Technology Advancement

Action 1.1—Develop Next-Generation Hydropower Technologies
Action 1.2—Enhance Environmental Performance of New and Existing Technologies
Action 1.3—Validate Performance and Reliability of New Technologies
Action 1.4—Ensure Hydropower Technology Can Support Increased Use of Variable Renewables



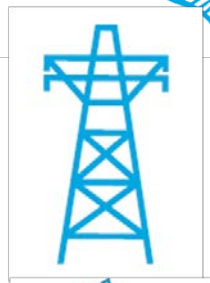
2.0 Sustainable Development and Operation

Action 2.1—Increase Hydropower's Resilience to Climate Change
Action 2.2—Improve Coordination among Hydropower Stakeholders
Action 2.3—Improve Integration of Water Use within Basins and Watersheds
Action 2.4—Evaluate Environmental Sustainability of New Hydropower Facilities



3.0 Enhanced Revenue and Market Structures

Action 3.1—Improve Valuation and Compensation of Hydropower in Electricity Markets
Action 3.2—Improve Valuation and Compensation of PSH Services in Electricity Markets
Action 3.3—Remove Barriers to the Financing of Hydropower Projects
Action 3.4—Improve Eligibility/Participation in Renewable and Clean Energy Markets



4.0 Regulatory Process Optimization

Action 4.1—Provide Insights into Achieving Improved Regulatory Outcomes
Action 4.2—Accelerate Stakeholder Access to New Science and Innovation for Achieving Regulatory Objectives
Action 4.3—Analyze Policy Impact Scenarios
Action 4.4—Enhance Stakeholder Engagement and Understanding within the Regulatory Domain

5.0 Enhanced Collaboration, Education, and Outreach

Action 5.1— Disseminate Material Regarding Hydropower as a Renewable Energy Resource
Action 5.2—Compile, Disseminate, and Implement Best Practices and Benchmarking in Operations and R&D
Action 5.3—Develop and Promote Professional and Trade-Level Training and Education Programs
Action 5.4—Leverage Existing Research and Analysis of the Federal Fleet in Investment Decisions
Action 5.5—Maintain the Roadmap in Order to Achieve the Objectives of the Hydropower Vision

DOE Hydropower Program
Funding Methods

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

The Program executes budgets using two primary methods:

- Direct funding to National Laboratories
  - Argonne National Lab (ANL)
  - Idaho National Lab (INL)
  - National Renewable Energy Lab (NREL)
  - Oak Ridge National Lab (ORNL)
  - Pacific Northwest National Lab (PNNL)
- Competitive Selection Process
  - Funding Opportunity Announcements (FOAs)
  - Small Business Innovation Research (SBIR)
  - Small Business Vouchers (SBV)

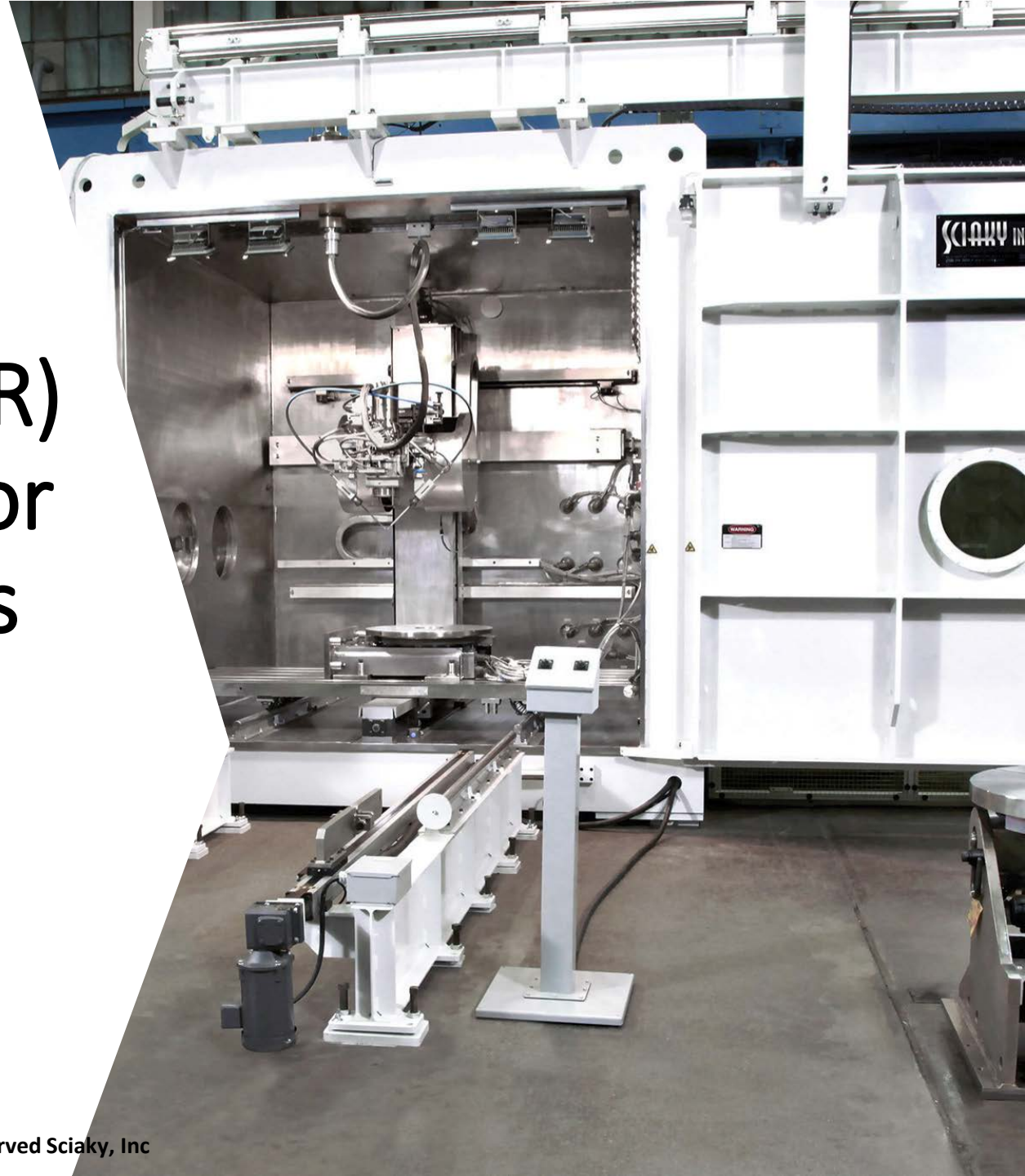
DOE Hydropower Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- How can DOE better collaborate with industry?
- What are the issues you would like to see DOE confront?
- Where is the largest need for R&D investment?
- How can DOE R&D work be better communicated to industry?

High Deposition Rate (HDR) Additive Manufacturing for Hydropower Applications

Presenter: Fred M. Carter III



SCIAKY INC
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NHA
National Hydropower Association

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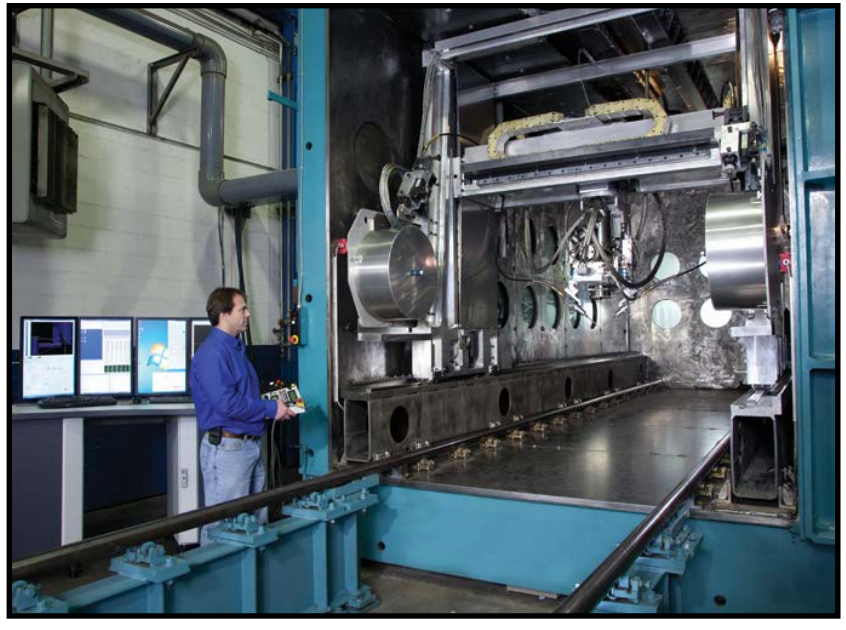
Introducing **Sciaky Inc.**



Located in Chicago, IL
146,000 Sq. ft. Manufacturing Facility
History in Design and Manufacture of Precision Welding Systems
Leader in High Deposition Rate Additive Manufacturing

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Introducing **Sciaky Inc.**

Products and Services

- Electron Beam Welding (EBW) Systems
- Electron Beam Additive Manufacturing (EBAM)
- Advanced Arc Welding Systems
- Resistance Welding Systems
- AM & Contract EB Welding Services
- Field Service & Spare Parts
- Installation &Training

Primary Markets

- Aerospace Industries
- Defense Industries
- Research & Scientific Industries
- Commercial & Mining Industries

VX-200 Electron Beam Machine

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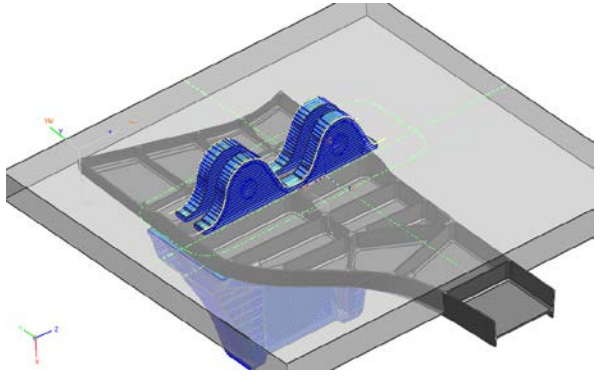
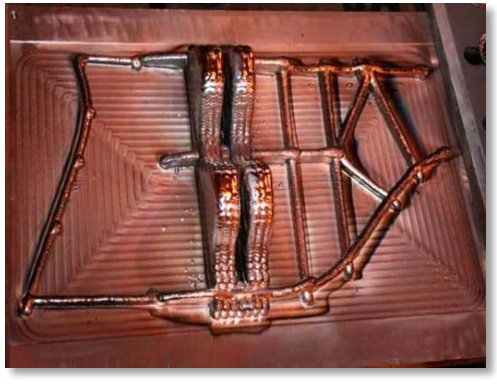
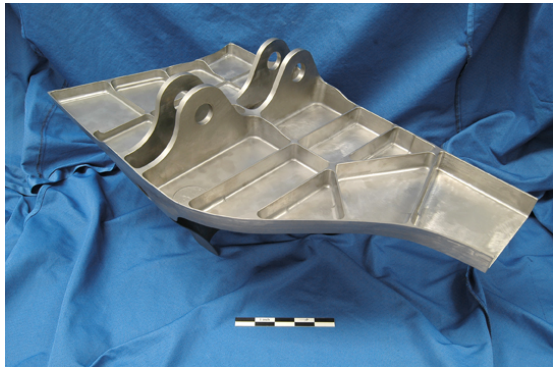
EBAM™ Process Workflow







Path Planning and Deposition Simulation → Deposition Process → Post Deposition Machining → Finished Part

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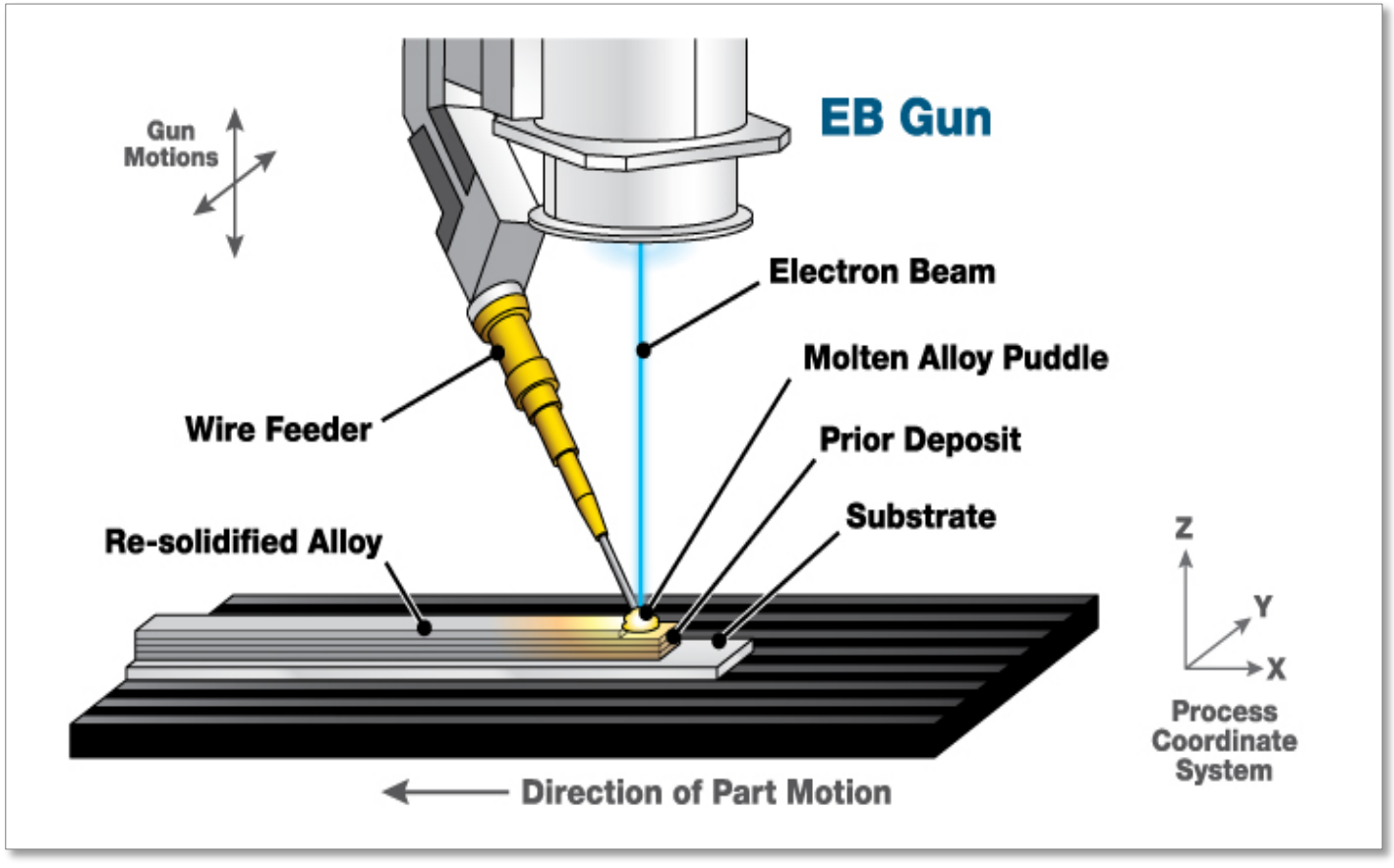
EBAM™ Deposition Process



Energy Source

- Pierce-Type Electron Beam Gun
- Vacuum Atmosphere (1x10^-4 Torr)
- Power up to 42 kW – 60kV

Input Materials

- Wire feedstock (.035”-.125 dia.)
- 2x Wire Spools (0-280lbs capacity)
- Substrate Plate, Tube, or Round

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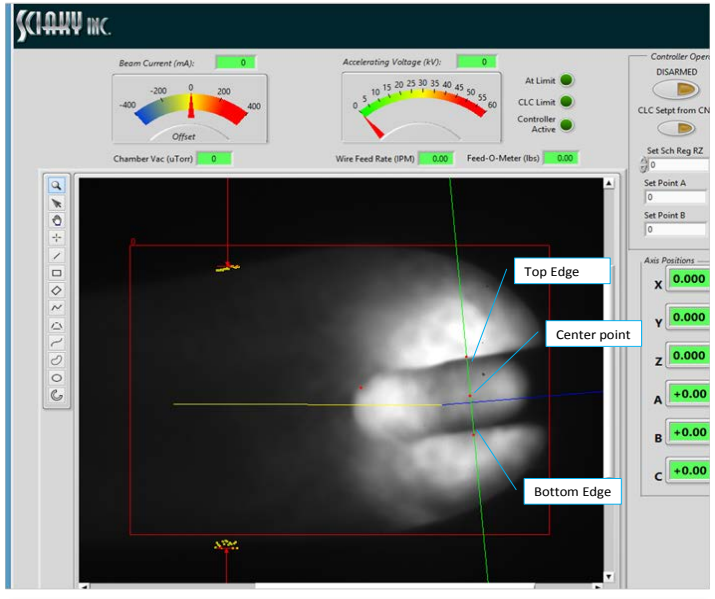
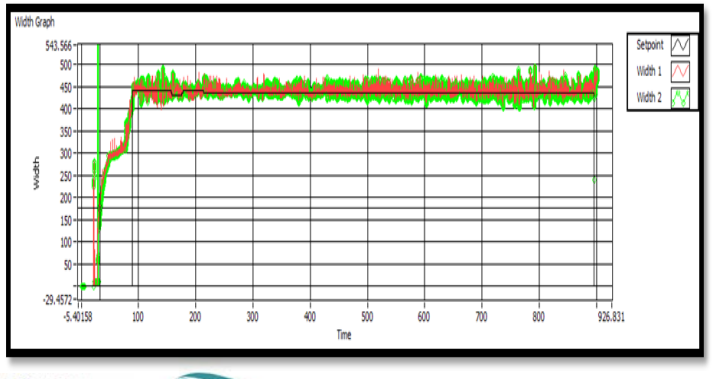
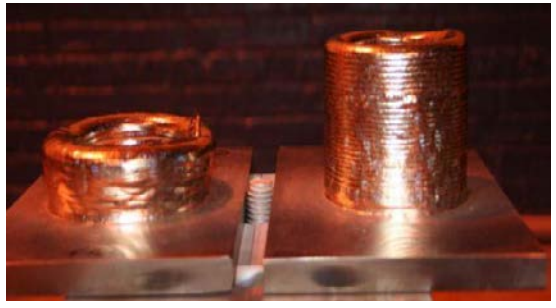
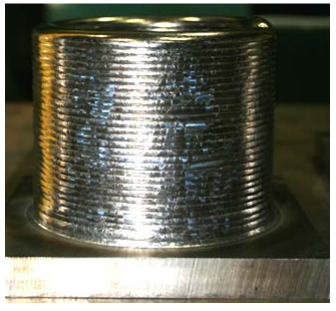
EBAM™ Closed Loop Control



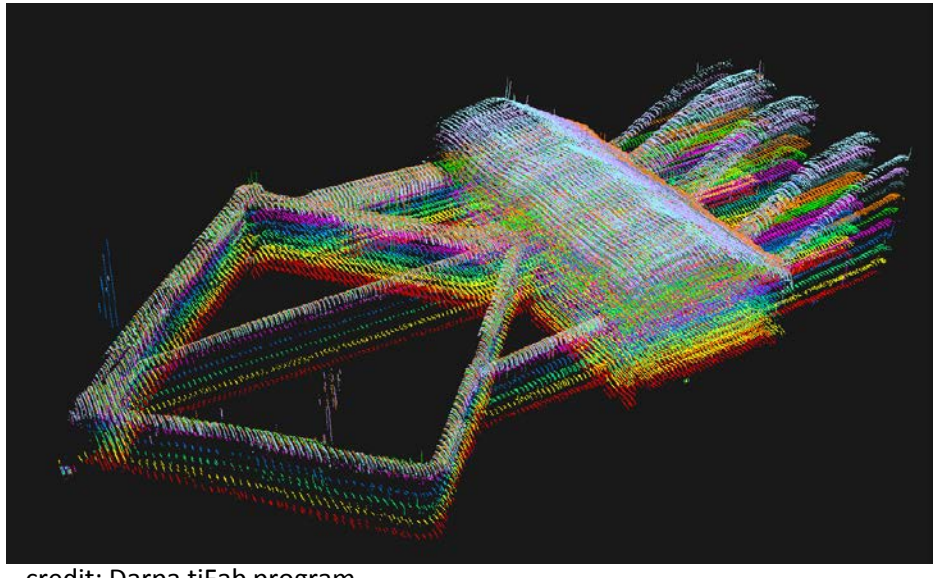




Without CLC With CLC



CLC & Auto Wire Positioning



credit: Darpa tiFab program

Important Process Benefits that the EBAM process with CLC allows:

- Consistent Layer Geometry
- Automated and adaptive Real-Time Process Controls
- Automatic Process Variable Acquisition and Recording
- Part-to-part repeatability

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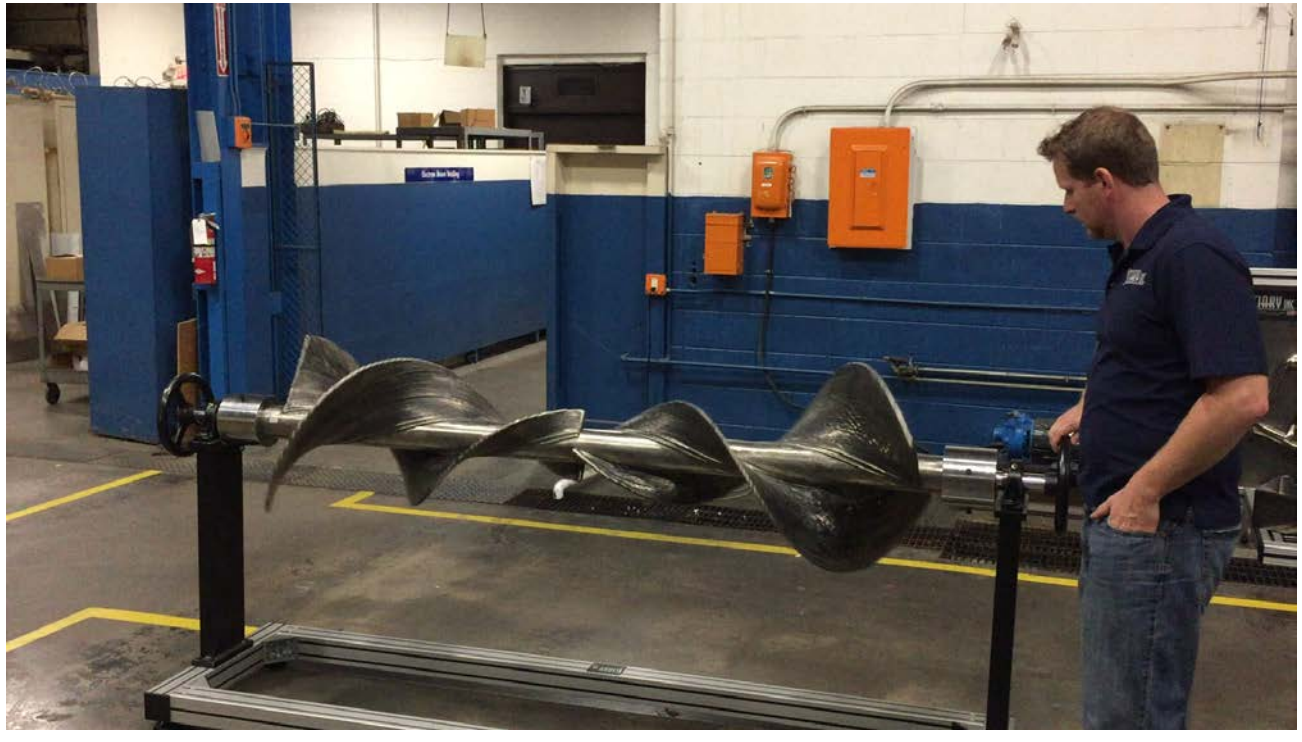
EBAM™ and Hydropower Applications



- High Deposition Rates (15-30 lbm/hr based on material)
- Ability to produce graded or mixed material structures
- Large build envelope compared with other additive technologies
- Eliminate non-recurring cost of tooling and engineering design modifications
- Material Savings 20-75%
- Reduced Machining

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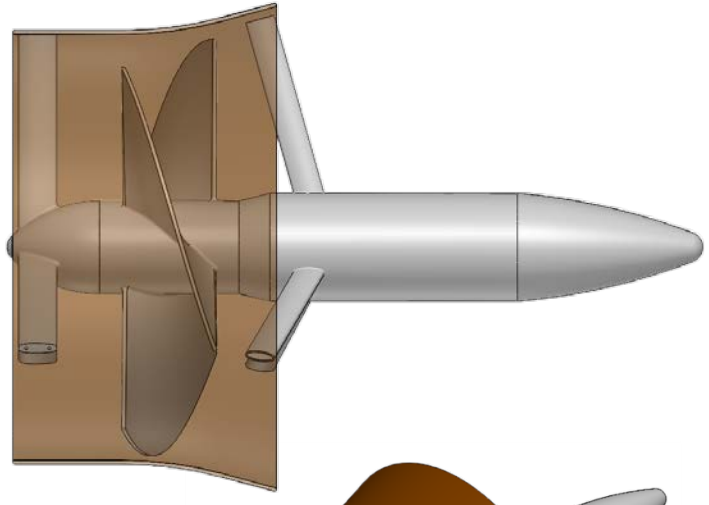
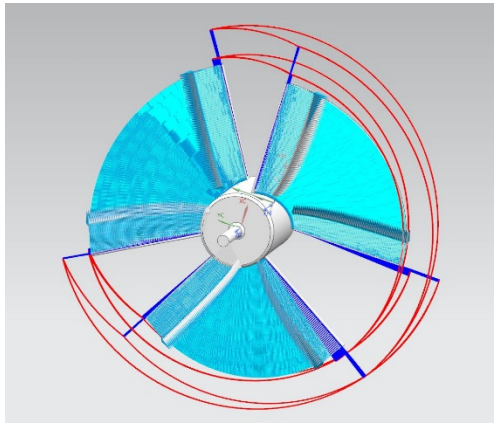
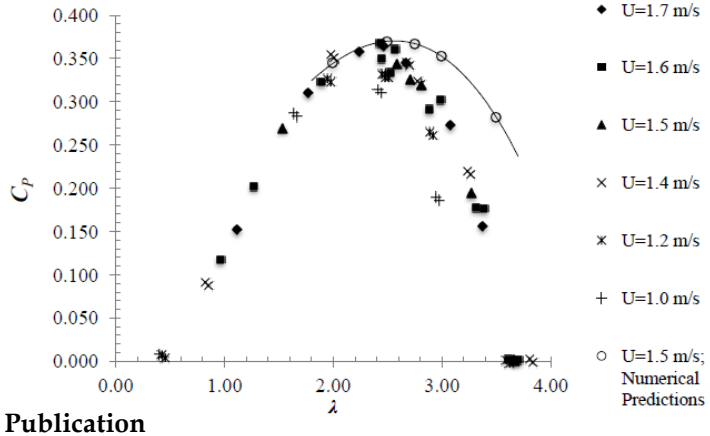
HRF Graduate Research: Hydrokinetic Turbine Runner







- Manufacture and Experimental Testing of Portable Micro Hydrokinetic Turbine
- Peak efficiency at flow speed of 1.5 m/s
- Tested at NSWCC Circulating Water Channel
- Scale Runner 3D printed with Inco 625 on 304 SS round

Publication
Title: Experimental and Numerical Characterization of a Full-Scale Portable Hydrokinetic Turbine Prototype for River Applications
Publication: Renewable Energy Dec, 2016

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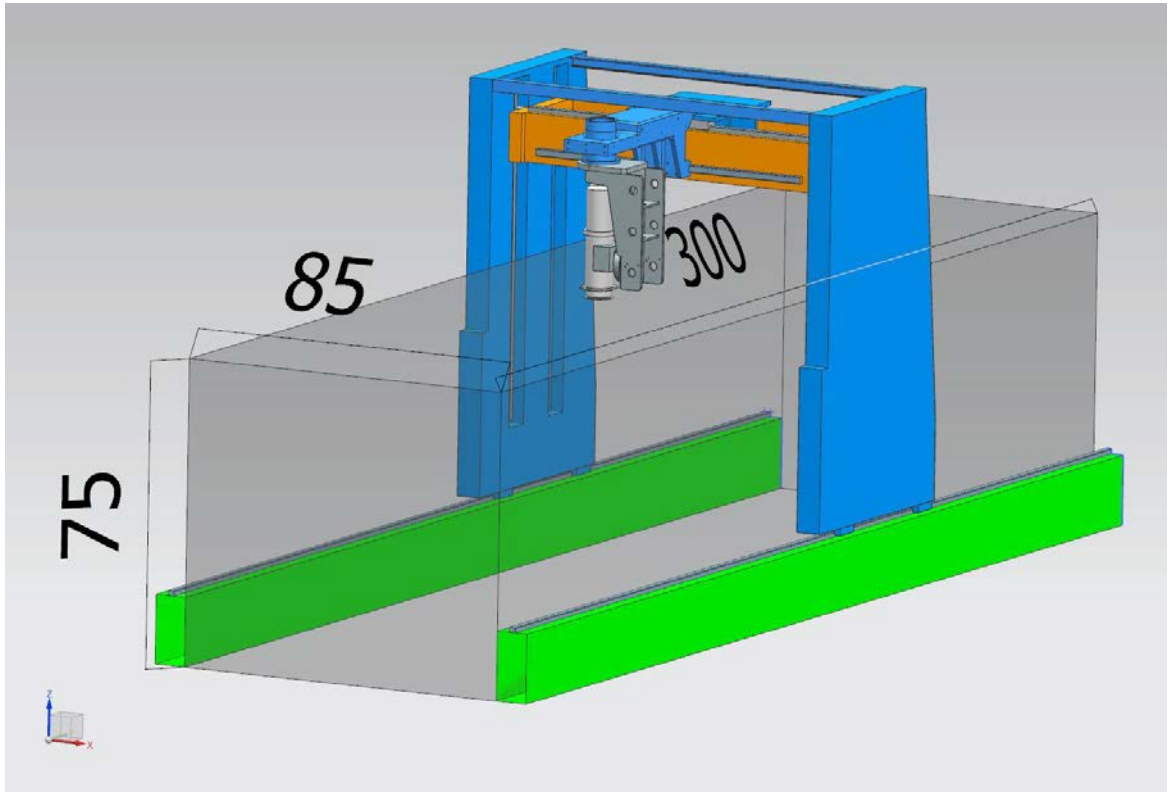
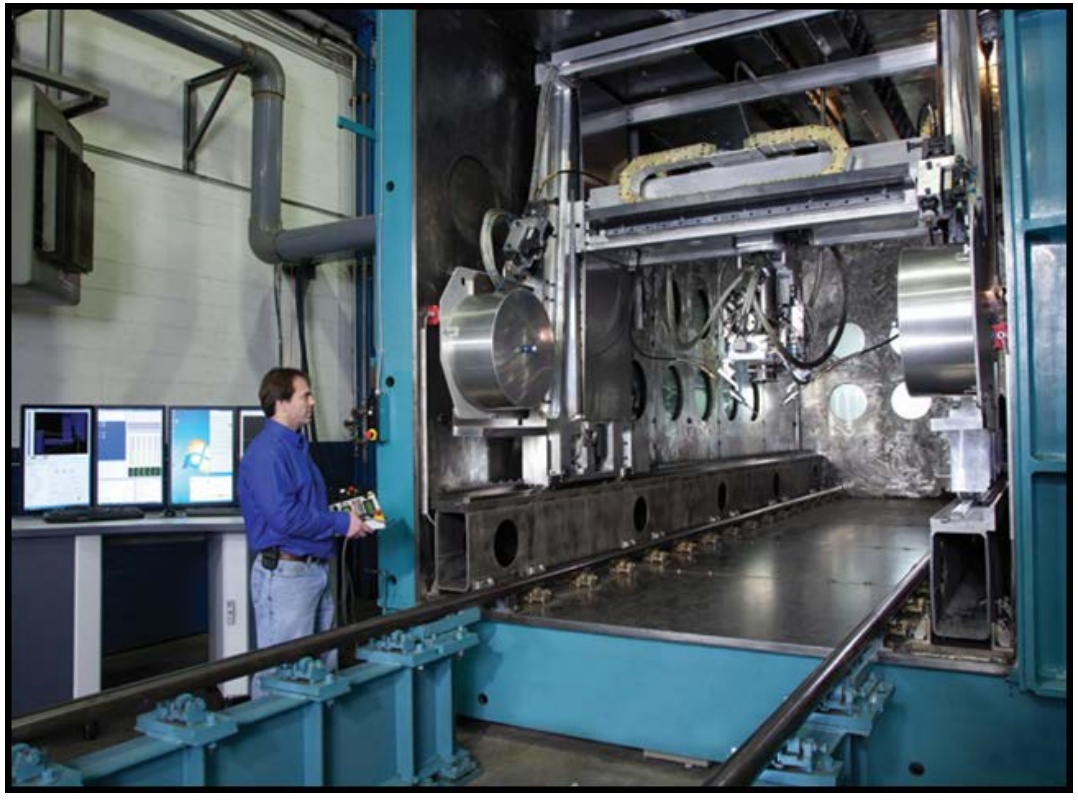
EBAM™ VX300 Size and Capability





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Thank You!

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