



Hydropower Manufacturing and Supply Chain Analysis

Jason Cotrell

National Renewable Energy Laboratory

Jason.cotrell@nrel.gov, 303.384.7056

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Project Overview: Tremendous Hydropower Potential Exists Domestically and Globally

Title: Hydropower Manufacturing and Supply Chain Analysis

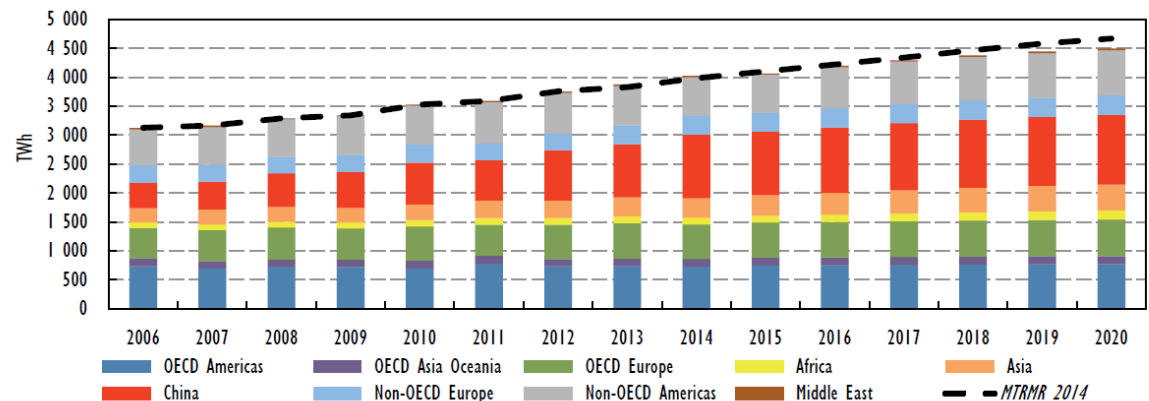
The Challenge: Hydropower has tremendous domestic and global growth potential, but growth has plateaued domestically.

Project Objective: Provide data and insights to inform investment strategies, policy, and other decisions to promote economic growth and manufacturing.

Partners: National Renewable Energy Laboratory (NREL) and Oak Ridge National Laboratory (ORNL).

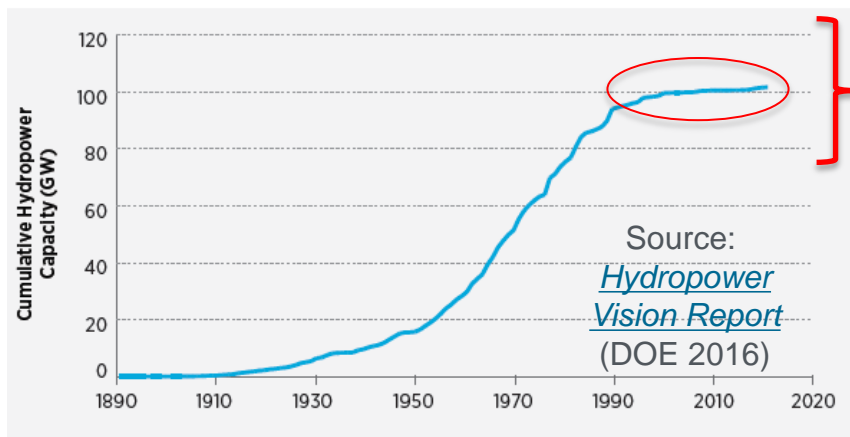


Source: [Hydropower Vision Report](#) (DOE 2016)



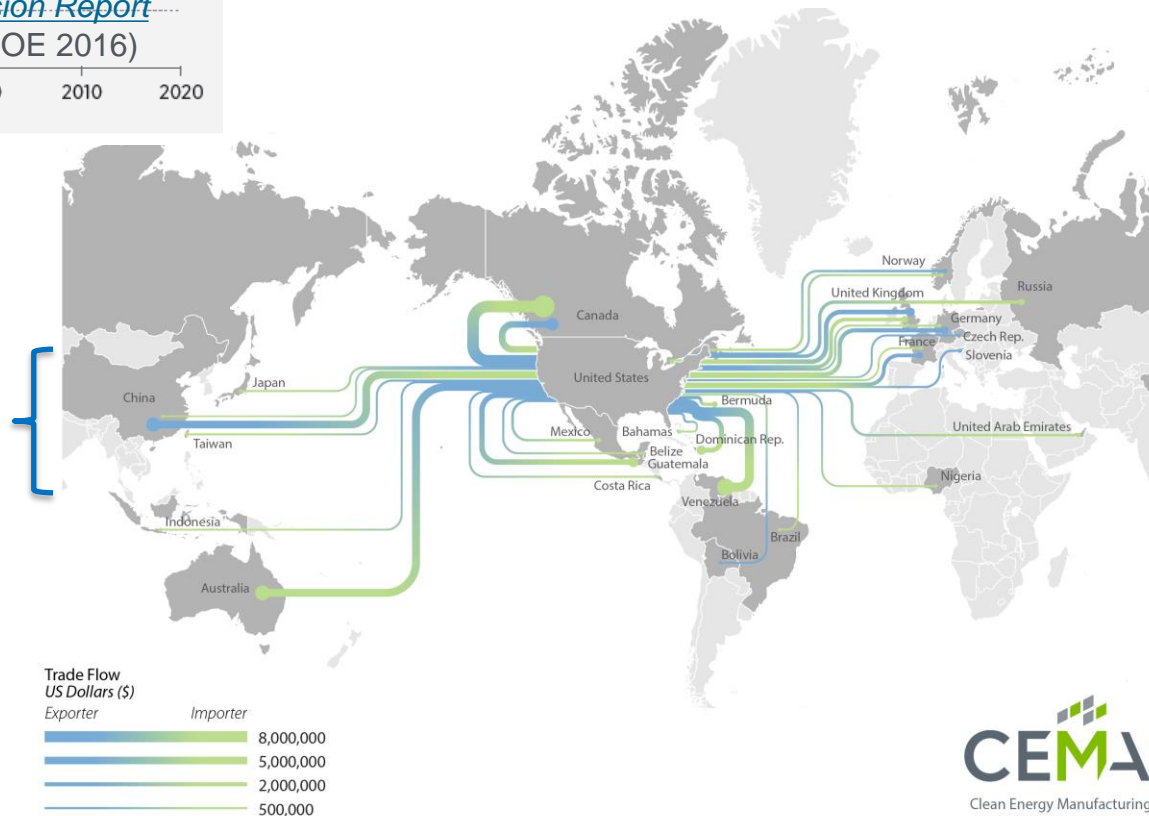
Source: [Renewable Energy Medium-Term Market Report 2015](#) (IEA 2015)

Project Overview: Notable U.S. Supply Chain Opportunities Exist



Recent domestic capacity growth provides little incentive for manufacturing investments.

Opportunities exist when considering a global perspective.



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 of evaluate and address environmental impacts
- Increase resilience to climate change

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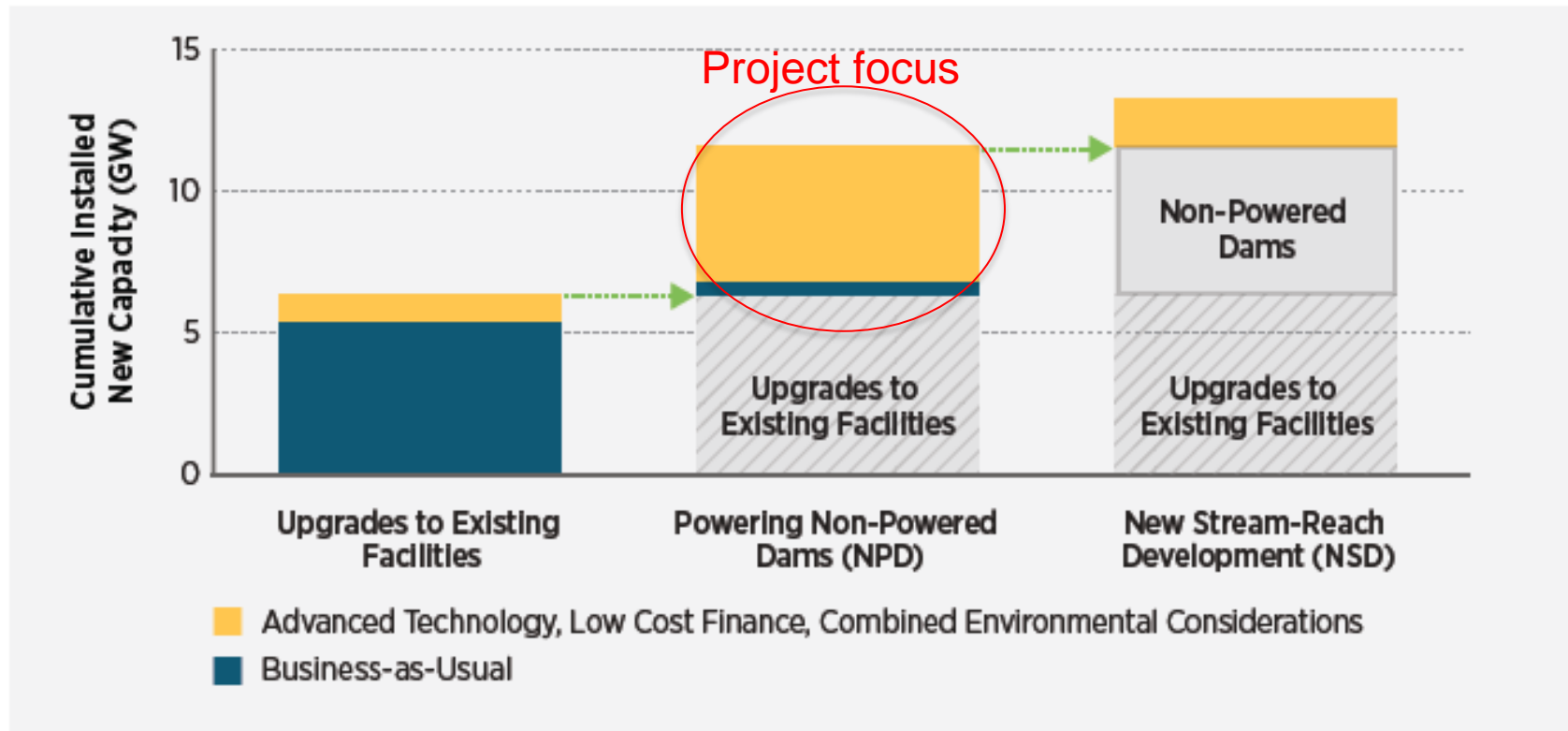
The Impact

Domestic supply chain investments will be delivered to the hydropower industry and decision makers that lead to:

1. Cost reductions through manufacturing
2. Technology innovations
3. U.S. jobs

Specific Project Objectives

- Identify supply chain constraints, and quantify market levers, such as commodity costs, labor rates, manufacturing volume logistics, and other factors.
- Identify market opportunities, and research needs.

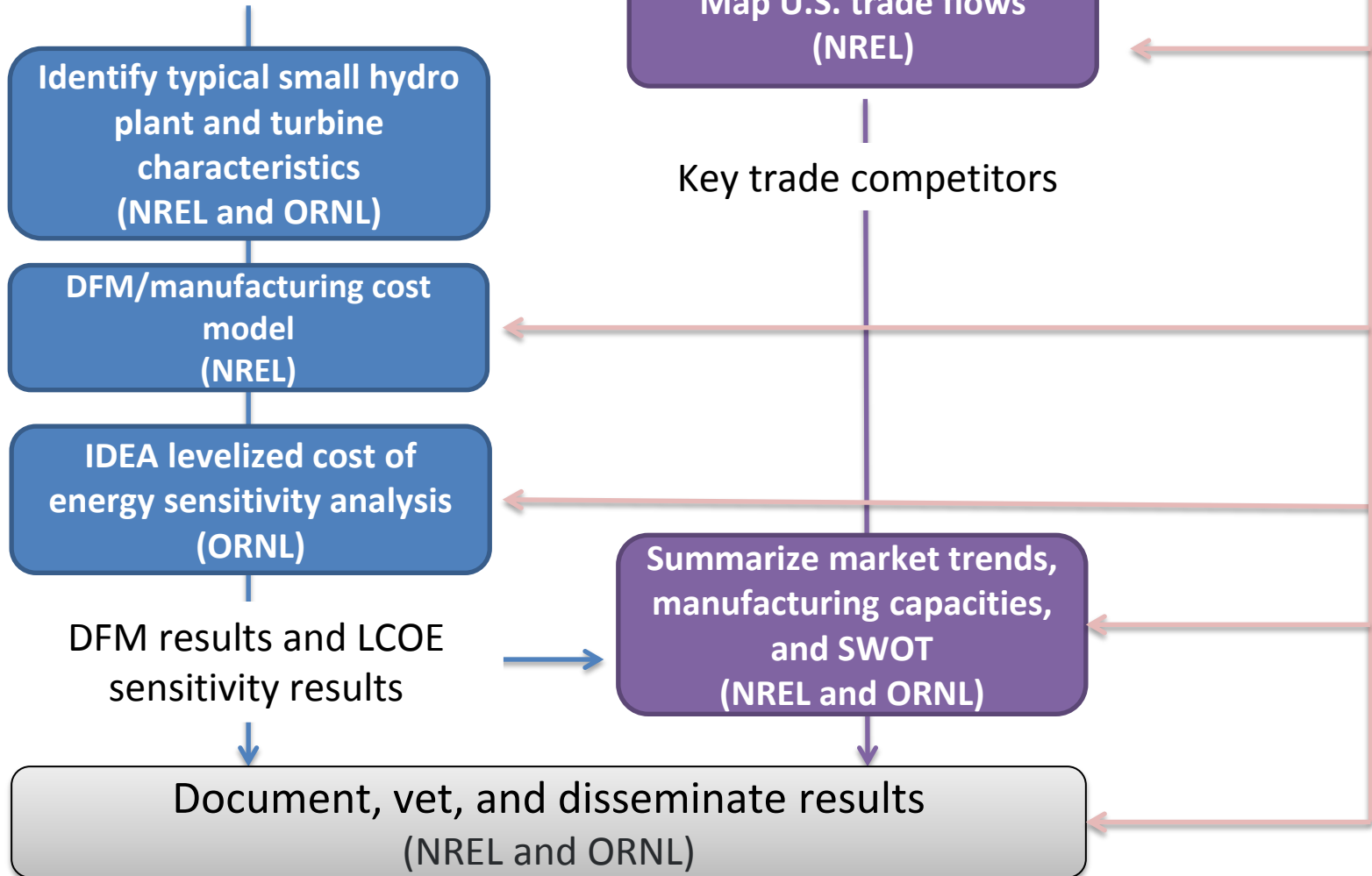


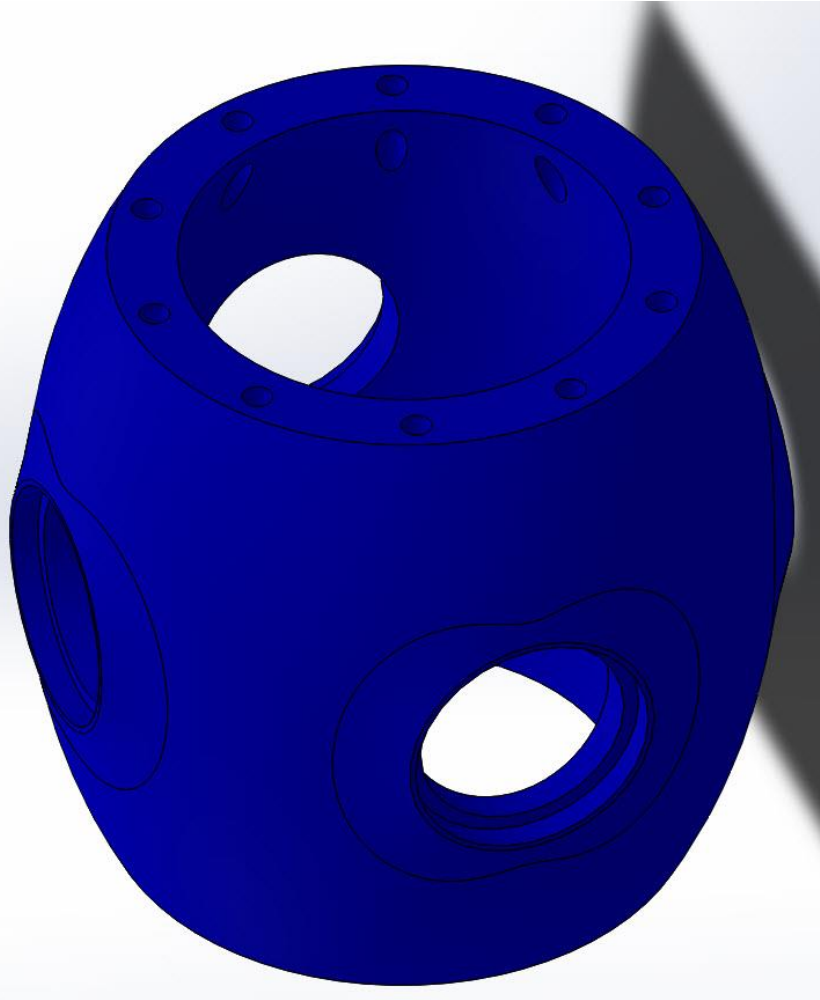
Source: [Hydropower Vision Report](#) (DOE 2016)

Design for Manufacturing (DFM) and manufacturing cost analysis

Analysis of other factors

Industry interviews





- DFM model provides bottom-up estimates of significant manufacturing processes
 - Mold Development → Casting → Machining
 - Inputs such as Material Costs (\$/lb) and Labor Costs (\$/hr) can be considered for sensitivities
- Provides insights regarding
 - U.S. and foreign cost levers
 - Export opportunities and import threats
 - Effects of parameters such as manufacturing volume on cost

What are the cost drivers, why, and how can technology address them?

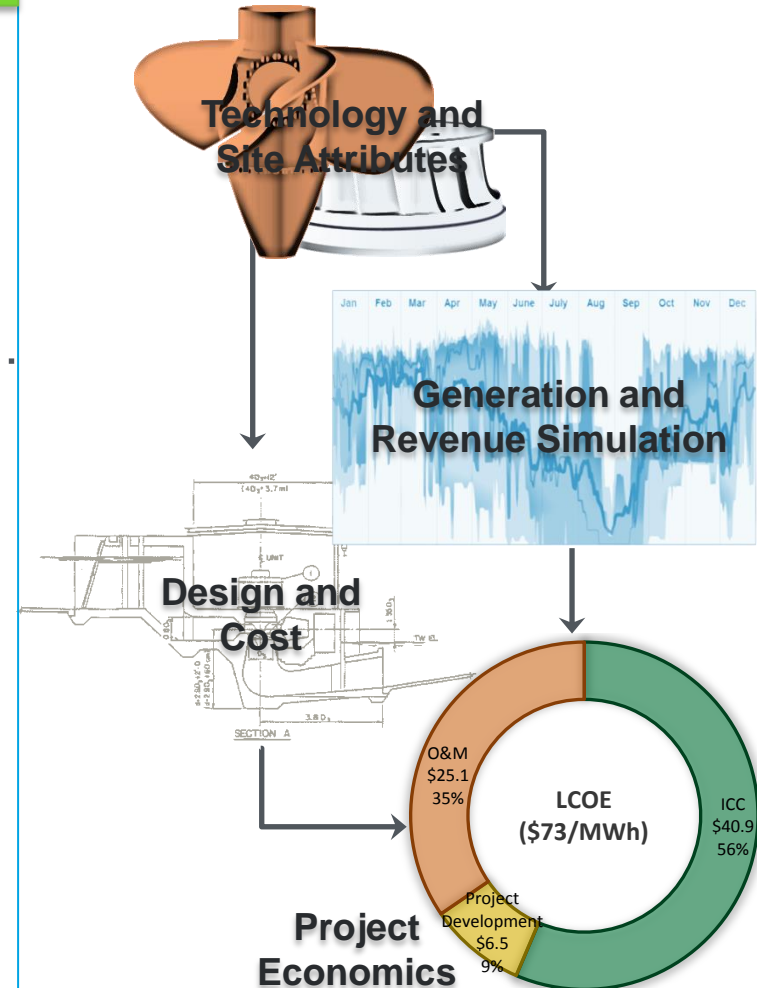
Approach: (1) Industry Engagement
(2) Build DOE Modeling Capability

Challenge: hydropower design is site specific... and so are technology and policy impacts!

Solution: leverage 100+ years of global small hydropower experience to couple site-specific modeling of equipment, civil design, and performance to economics

Outcome: Small Hydropower IDEA Model

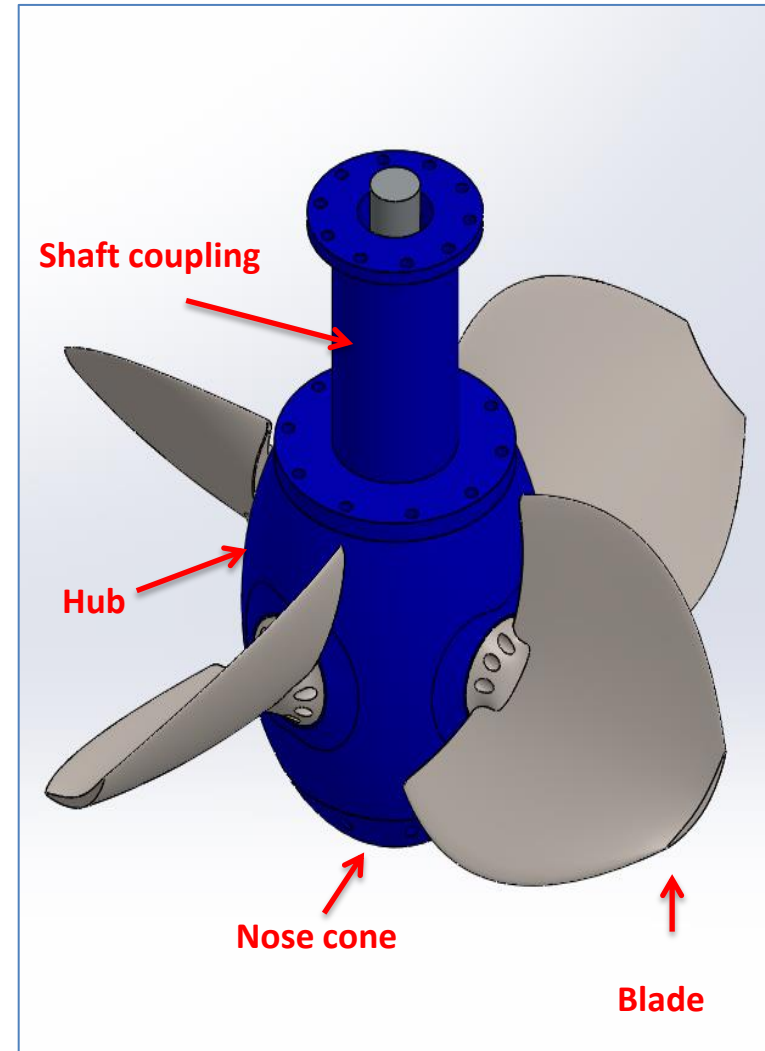
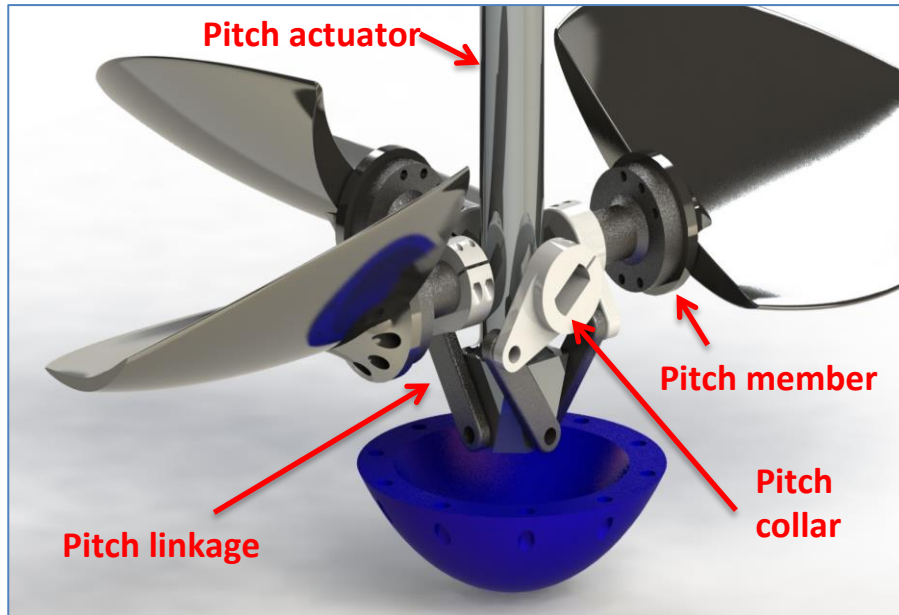
Small Hydropower Integrated Design and Economic Assessment (IDEA) Model: Granular, reconnaissance-level, research focused, design, cost, performance estimation. Focus on US small, low-head resources.



Identified a representative turbine and components:

- 2 x 5-MW Kaplan-style turbines
 - Four-blade, variable-pitch design
 - Runner diameter: 11.5 ft (3.5 m)
 - Hub diameter: 4 ft (1.2 m)

Created the CAD model and began Design for Manufacture and Assembly analysis



Budget History

FY2014		FY2015		FY2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
0	0	\$150k (NREL) \$150k (ORNL)	0	\$100k (NREL) \$100k (ORNL)	0

No significant
variances from
planned budget.

Project Schedule

<u>Milestone Name/Description</u>	<u>End Date</u>	<u>Progress</u>
Q1: NREL staff will hold a Clean Energy Manufacturing Analysis Center (CEMAC) hydropower project kick-off meeting with ORNL staff to further define specific roles under this work package by December 31, 2015.	12/31/2015	Complete
Q2: Hydropower components—NREL will conduct a literature review of manufacturing of conventional hydropower components by March 31, 2016.	3/31/2016	Complete
Q3: NREL will send a summary presentation of project progress and revised detailed work plan for FY16/17 by June 30, 2016.	6/30/2016	Complete
Q4: NREL will schedule a webinar with DOE to discuss the current results of trade flow analysis, cost model support, and characterization of foreign competition by September 30, 2016.	9/30/2016	Complete
Q1 2017: NREL staff will provide to the DOE Wind and Water Power Technologies Office and ORNL staff summary slides of the evaluation of qualitative and quantitative factors that affect manufacturing location decisions by December 30.	12/30/2016	50%
Q2 2017: NREL will provide an annotated comprehensive summary presentation to DOE of project results by March 31, 2016.	03/31/2017	20%
Q3 2017: NREL will provide a final report of project results, 10–20 pages long, ready for DOE review by June 30, 2016.	06/30/2017	5%

All milestones have been met on time.

Partners, Subcontractors, and Collaborators:

- Oak Ridge National Laboratory is a key project partner.
- Project leverages other skills and capabilities developed for other Clean Energy Manufacturing Analysis Center (CEMAC) projects.

Communications and Technology Transfer:

- Blog post of trade flow preliminary results (November 2016)
- Submitted abstract to HydroVision International (June 2017)
- Comprehensive final report

FY17/Current Research:

- Q1: Complete an analysis of a representative turbine using the manufacturing cost tool.
- Q2: Complete an evaluation of the qualitative and quantitative factors that affect manufacturing location decisions.
- Q3: Draft a final report of project results.

Proposed Future Research:

- The results of this foundational study can be used to inform the *Hydropower Vision* road map and future research.
- Stakeholder vetting will help identify opportunities of specific interest for future research.