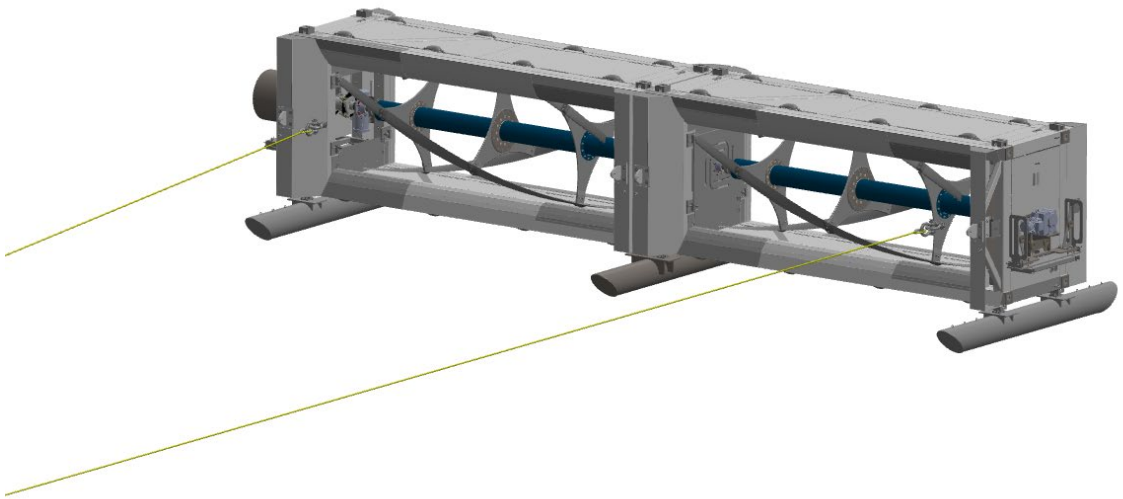
DE-EE0008948 – Modular RivGen



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Project Overview

Project Summary

Develop & demonstrate the RivGen 3.0 power system, a modular system of turbine generator units (TGUs). The system is optimized for lower flows and for installation as standalone units or as integrated vertical or horizontal arrays. System demonstration will include the installation of a single TGU unit as well as the installation of a two-unit connected array.

Intended Outcomes

- Increase system generation efficiency by > 25 percent from 14kW to 18kW at 2.0m/s for a single turbine module
- Design for interconnectivity between modules such that multiple units may be mechanically and electrically connected
- Develop a methodology suitable for modular installations and operations of arrays
- Deliver 25 percent reduction in LCOE for flow speeds of 2.0 m/s by a strategy of increased Annual Energy Production (AEP), and lowered Capital expenditures (CapEx) and Operational expenditures (OpEx)
- Develop use cases for early adoption in lower cost markets

Project Information

Principal Investigator(s)

- Ryan Tyler

Project Partners/Subs

- SANDIA – Development of hydrodynamic numerical models for river sites with installed Modular RivGen arrays
- NREL – CFD model development for independent validation of model predictions

Project Status

Ongoing

Project Duration

- 3/16/2020
- 5/15/2023

Total Costed (FY19–FY21)

$472,032

Project Objectives: Relevance

Relevance to Program Goals:

- Innovations developed as part of the Modular RivGen project will increase the viability of hydrokinetic systems for applications in lower flow regions and for installation within existing infrastructure
- Cost reductions will allow for increased market adoption
- Development of commercial use cases for Modular RivGen integration into critical infrastructure will increase overall grid resiliency
- Analytical tools and methods developed will increase the overall understanding of flow interactions and array impacts on waterways
- System modularity will allow rapid installation and removal and scalability for larger installations
- Full-scale installations will validate the manufacturing process, system costs, and system performance

Project Objectives: Approach

Approach:

- Identify market-based design requirements
- Utilize DNV and IEC standards (DNVGL-ST-0164, IEC TS 62600 series) as a basis for system design and performance evaluation
- Leverage manufacturing relationships to determine a strategy for cost reduction which includes: scaled production, system modularity, a focus on COTS components, and interconnected array-based system installations
- Develop analytical tools to increase system efficiency through rapid CFD iteration
- Leverage lab partnerships to increase model fidelity, validate results, and accelerate resource identification

Project Objectives: Expected Outputs and Intended Outcomes

Outputs:

- System design for demonstration
- Build, installation, and 6month demonstration of two-unit connected array
- Validated CFD models and developed hydraulic river models with commercial array installations
- Commercialization and permitting plan for Modular RivGen systems

Outcomes:

- Reduced system cost
- Increased system efficiency
- Proven installation methodologies for single unit and array installations
- Product validation

Project Timeline

FY 2020

Preliminary system design & Market studies
- *Market applications (coupling resource information with potential end users)*
- *Market-based system requirements*
- *Preliminary design developed*
- *System fabrication and operational cost estimates*
- *LCOE model development*

Competitive Down-select process

FY 2021

Lab assistance agreements
- *River modeling (SANDIA)*
- *CFD development (NREL)*

Test site validation
- *Site assessment & community engagement, Millinocket, ME*

Critical system design
- *Optimized fairing design for increased efficiency*
- *Reduced cost generator*
- *Simplified driveline*

FY 2022

Critical design review

Subsystem validation
- *Submerged lab-based generator testing (Summer)*
- *Device Integration (Summer)*
- *Mooring System Installation Tests (Summer)*

System demonstration
- *Single TGU in-river installation (Fall, Millinocket, ME)*
- *Two-unit connected array in-river installation (6month install, starting Fall 2022, Millinocket, ME)*

Project Budget

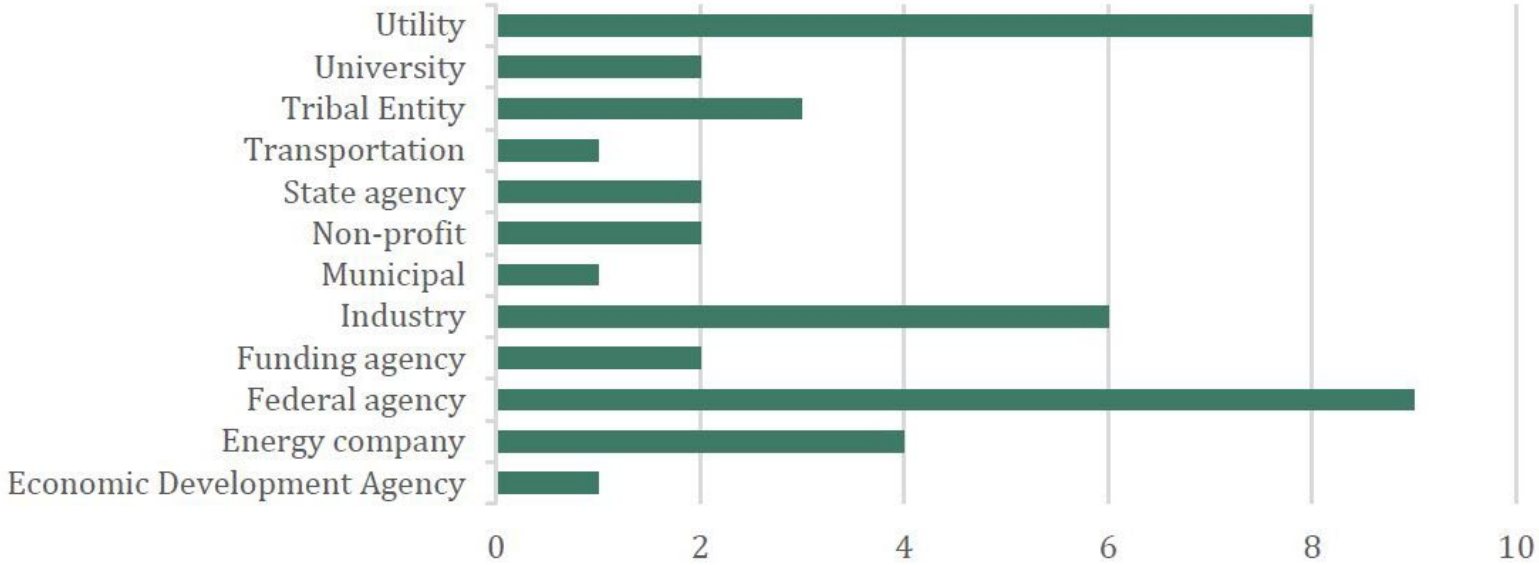
Total Project Budget – Award Information		
DOE	Cost-share	Total
$3,875,859	$968,965	$4,844,824

FY19	FY20	FY21	Total Actual Costs FY19–FY21
Costed	Costed	Costed	Total Costed
$0	$306,825	$168,207	$472,032

- Majority of project costs will be incurred during the system build and installation period (Summer 2022-Summer 2023)
- At this time, no budget modifications are anticipated

End-User Engagement and Dissemination

- Conducted interviews with 40+ stakeholders representing many industries, communities and native entities for market feedback on energy needs, awareness of hydrokinetic solutions, and willingness to adopt new technologies.
- Prepared outreach materials and investigated complementary funding opportunities
- Prioritized regions with available hydrokinetic resources, and favorable state policies and permitting regimes
- Outreach focused on river opportunities but also evaluated tidal and canals
- Site visits conducted to remote communities and commercial sites



Left: Number of interviews held segmented by stakeholder type. A total of 40 individuals were interviewed.

Performance: Accomplishments and Progress

- Subsystem cost reductions
  - Critical design review completed
  - Predicted CAPEX reduction of over 32% over baseline (RivGen 2.0 Power System)
- Development of ducting optimization algorithms
  - Increased performance improvements and system efficiency. Predicted improvements 30% higher than baseline target improvements
  - Independent validation of CFD models by NREL underway
  - Reduced LCOE by increasing AEP
- Design of submersible dynamometer for subsystem validation
  - Critical Design review completed
  - Validation of reduced cost generator options
  - Reduced CAPEX and improved OPEX predictions through lab-based testing
- Identification of priority markets and use cases

Performance: Accomplishments and Progress (cont.)

- There are no new patents or publications from the project at this time

Future Work

- Subsystem validation testing, generator (Aug. 2022)
- Complete test system build (Sep. 2022)
- Single module full scale test deployment (Oct. 2022)
- Full scale array validation (Oct. 2022 – Apr. 2023)
- Final System Design & Operational Lessons learned (May 2023)

Q&A