

## Reduction of System Cost Characteristics Through Innovative Solutions to Installation, Operations, and Maintenance DE-EE0007347

Marine and Hydrokinetics Program

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## Project Summary

C-Power is developing a wave energy converter (WEC)--the StingRAY H2--that converts ocean waves into megawatt-scale electric power. Nine innovative (IO&M) technical and design opportunities (Focus Areas) were identified in the Project proposal to improve the StingRAY's lifecycle cost. The Project goal is to demonstrate the techno-economic viability of the StingRAY H2 WEC with a 12-month test at WETS.

## Project Objective & Impact

Goal: demonstrate techno-economic viability of StingRAY H2 WEC by:

- establishing IO&M costs based on operational and research data
- implementing and testing innovative IO&M-centric design improvements
- demonstrating the StingRAY H2 WEC in 12-month grid-connected, open-ocean test
- identifying specific cost reduction pathways for future implementation.

The impact is the implementation of cost-reduction strategies that advance the StingRAY H2 towards commercialization.

## Project Information

### Project Principal Investigator(s)

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### Project Partners/Subs

US Navy, Thompson Metal Fab, Smith Monroe and Gray, Cardinal Engineering, Applied Motion Systems, DNV-GL RC, Raytheon, Siemens, Trelleborg, Votaw, and SKF (Kaydon)

### Project Duration

- Project Start Date: May 6, 2016
- Project End Date: September 30, 2022

## Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

Foundational  
and  
Crosscutting  
R&D

Technology-  
Specific  
Design and  
Validation

Reducing  
Barriers to  
Testing

## Foundational and Crosscutting R&D

- Drive innovation in components, controls, manufacturing, materials and systems with early-stage R&D specific to MHK applications

Design innovations to improve CapEx and OpEx, availability and system life:

- Integration of novel small airgap, large-diameter, direct-drive rotary generator
- Revised sealing system
- Removal of end-stops
- Improvements in ballasting capabilities and materials cost
- Enhanced SCADA capabilities
- Implemented mooring and umbilical modularity

## Technology-Specific Design and Validation

- Validate performance and reliability of systems by conducting in-water tests of industry-designed prototypes at multiple relevant scales
- Improve methods for safe and cost efficient installation, grid integration, operations, monitoring, maintenance, and decommissioning of MHK technologies

Innovations to improve IO&M costs, safety and complexity:

- Simplified ascent and descent ballasting
- Umbilical redesign allows installation without dive operations
- Facilitated manufacturing, shipping and IO&M operations and costs with design improvements

## Total Project Budget – Award Information

DOE	Cost-share	Total
\$4,150K	\$9,338K	\$13,488K

## FY17      FY18      FY19      Total Actual Costs (Q1 &      FY17–FY19 Q1 & Q2 Q2 Only) (October 2016 – March 2019)

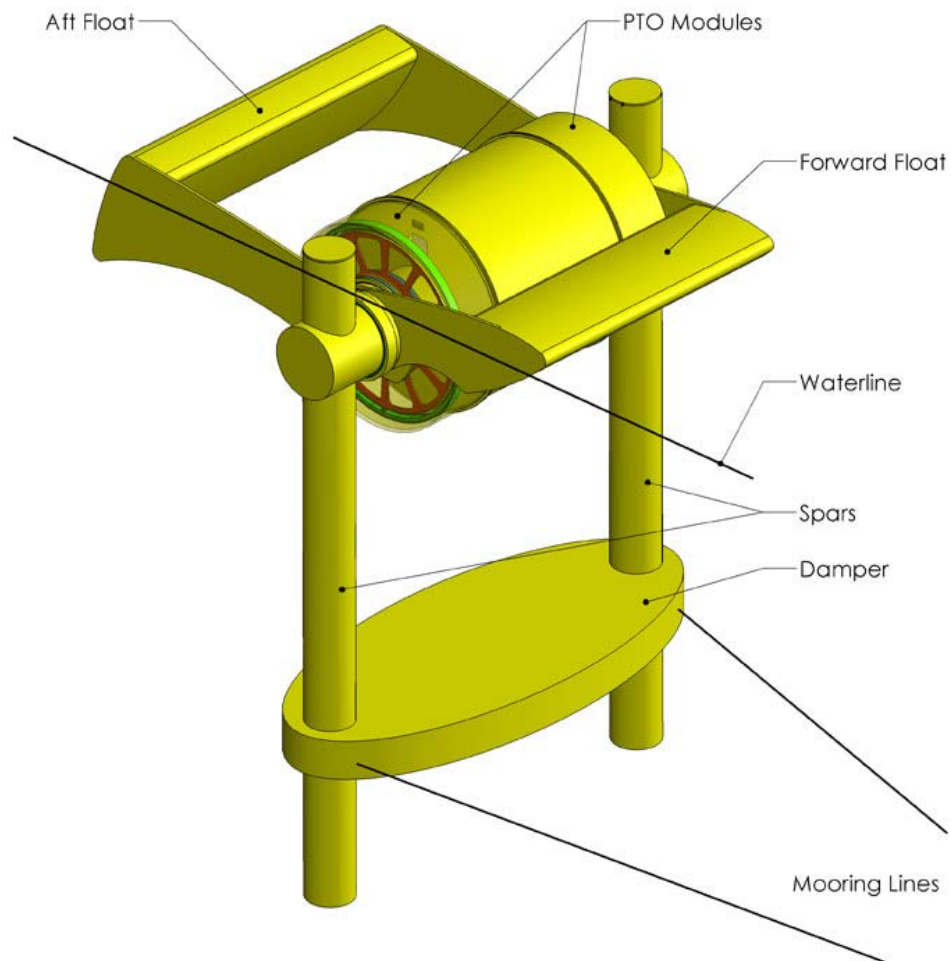
Costed	Costed	Costed	Total
\$296K	\$445K	\$917K	\$1,658K

# End-User Engagement and Dissemination Strategy

- End-user engagement has been guided by potential participants in targeted markets
  - Ultimate target is an array of megawatt-scale devices in offshore wave farms
  - Near-term target is smaller capacity, remote applications
- Engagement included business development and technology shaping discussions with potential customers and suppliers within utility and industrial markets, reinforcing need for:
  - cost-effective energy generation
  - non-complex, safe operational processes and designs that offer long service lives and reliability
- Formed Corporate Advisory Board to help guide manufacturing and operational decisions
- Project information has and will continue to be disseminated through public presentations







Project baseline: StingRAY H1 WEC



# Management and Technical Approach

- Analyze IO&M process and cost issues with baseline StingRAY H1 WEC
- Create and prioritize list of design and process improvements
- Perform desktop study to establish confidence in the impact of the identified WEC design and IO&M process improvements
  - Capital cost
  - Operating cost and complexity
  - Risk
- Utilize experienced marine operations and component supplier partners to implement improvements, produce fabrication-ready design, produce IO&M plans, and manufacture StingRAY H2 WEC
- Integrate findings and knowledge from related projects into design and operations
- Identify and mitigate project and technical risks, aided by third party review
- Demonstrate design and process improvements in 12 month open-water deployment
- Analyze and disseminate test and project results
- Establish pathways for future cost and process improvements



## Milestones - Budget Period 2 (27 months)

- EDRs complete - 1Q17
- Hull architecture complete - 3Q18
- Generator validated (6399) - 1Q19
- Long lead items ordered - 2Q19
- Design for fabrication and planning complete - 3Q19

## Challenges

- Revision of HECO SRD-UL-1741-SA-V1.1 requiring NRTL inverter certification
- Unanticipated systems interaction during design for fabrication
- Foss shipyard closed – 3Q18
- Engineering errors discovered during Critical Design Review process
- Marinization of re-utilized electric plant components

- Technical accomplishments are in close agreement with SOPO
- Design integrates latest innovations, including those from other projects, and is ready for fabrication
- Manufacturing, IO&M, and Test Plans completed
- Cost breakdown structure (CBS) completed
- Continuing Application, including fabrication drawings, for BP3 submitted.
- DNV GL issued an updated Statement of Feasibility

# Technical Accomplishments

Design/Process Improvement	CapEx	OpEx	Availability	System Life
Serviceable seals	-65%	-90%	2%	0%
Simplified ascent & descent ballasting	0%	-50%	1%	0%
Hard ballast replacement	-80%	-25%	1%	0%
Mooring & umbilical modularity	10%	-50%	1%	0%
Transit ballasting optimization	-10%	-60%	2%	0%
PTO "lockout"	10%	-15%	5%	10%
Improved shipyard handling (primarily mass reduction)	-25%	-30%	0%	0%
Improved deployment logistics	0%	-20%	1%	0%
Optimized IO&M cost and strategy	-5%	-30%	1%	5%
Reduced shipping / transit costs*	TBD	TBD	TBD	TBD

- Go recommendation received
- Risk register has been updated referencing critical design review conducted with the WETS project team to identify further improvement prior to fabrication

## Budget Period 3 high-level tasking

- Full BP3 NEPA approvals
- component fabrication begins -1Q
- component fabrication complete -3Q
- assembly complete -5Q
- H2 installed at WETS – 6Q
- testing complete H2 removed – 10Q
- H2 decommissioned – 11Q
- OWDOP and test reports issued -12Q

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