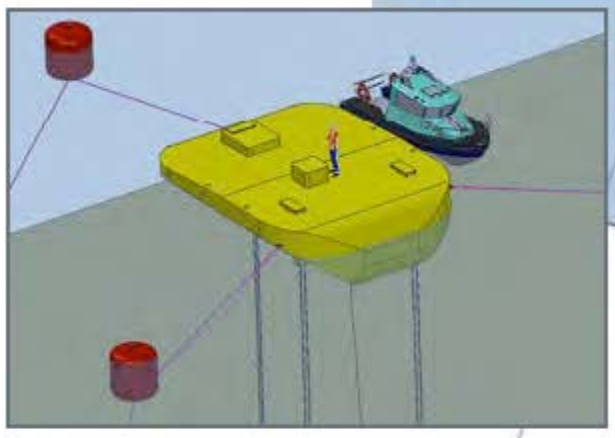
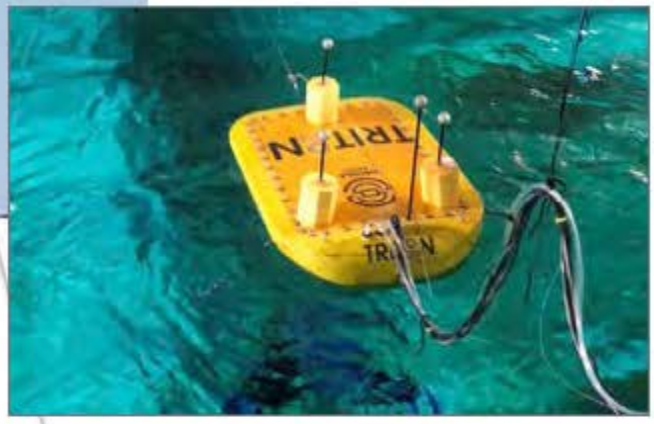




Demonstration of an Advanced Multi-Mode Point Absorber for Wave Energy Conversion

DE-EE0007819.0000

OSCILLA power

Marine and Hydrokinetics Program

Tuesday October 8th

Dr Tim Mundon

Oscilla Power

Project Overview

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

Project Summary

- To design, construct, deploy and prove performance of the Triton-C community scale wave energy system. The Triton-C is a 100kW rated power system based on Oscilla Power's two body, multi-mode Triton WEC architecture. The Triton architecture comprises a ring shaped reaction structure that hangs below a surface float via three tendons. Wave action on the float generates relative motion between these two bodies which is then converted to electrical power by the drivetrains.

Project Objective & Impact

- The Triton-C is intended to provide power to remote and isolated communities or facilities that currently have exceptionally high energy costs and uncertain energy security.
- This project will develop specific features for this application; a long travel rotary drivetrain with advanced controls for maximum AEP; a simple self-deploying installation approach; remote health monitoring and control for high reliability & survivability.
- The Triton-C will provide a test platform for these proposed technologies, which are expected to ultimately increase AEP and decrease OPEX/CAPEX across the industry.

Project Information

Project Principal Investigator(s)

Dr Timothy R Mundon

WPTO Lead

Carrie Noonan, TPO

Project Partners/Subs

Glosten Associates,
Applied Control Engineering
Janicki Industries
University of Maine
Powertrain Engineers

Project Duration

- April 2017
- June 2021

Alignment with the Program

Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

Foundational and Crosscutting R&D

Technology-Specific Design and Validation

Alignment with the MHK Program

Foundational and Crosscutting R&D

- **Drive innovation in components, controls, manufacturing, materials and systems with early-stage R&D specific to MHK applications**
- Develop, improve, and validate numerical and experimental tools and methodologies needed to improve understanding of important fluid-structure interactions

Development of an innovative long travel rotary drivetrain that allows Triton-C, and potentially other smaller WEC technologies, to be practical in fully energetic ocean environments.

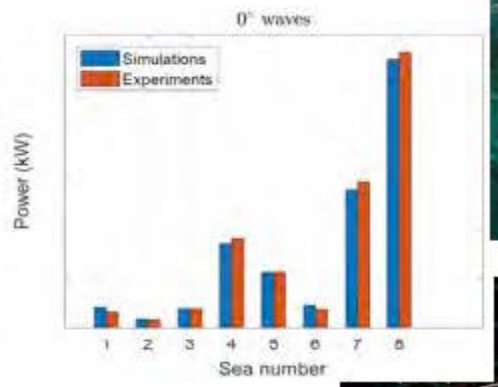
Research on, and characterization of, tendon abrasion and fatigue has helped to identify suitable materials and approaches that maximize longevity.

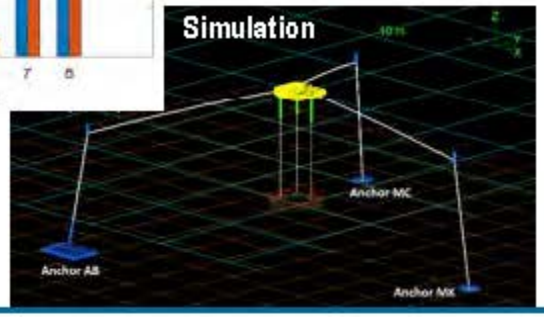
Alignment with the MHK Program

Foundational and Crosscutting R&D

- Drive innovation in components, controls, manufacturing, materials and systems with early-stage R&D specific to MHK applications
- **Develop, improve, and validate numerical and experimental tools and methodologies needed to improve understanding of important fluid-structure interactions**

Validated by physical model testing, this project has demonstrated that time-domain models based on linearized potential flow hydrodynamics can produce fairly accurate predictions of power, motions, and loads (to within approximately 10%), even in large wave conditions where nonlinearities begin to occur.





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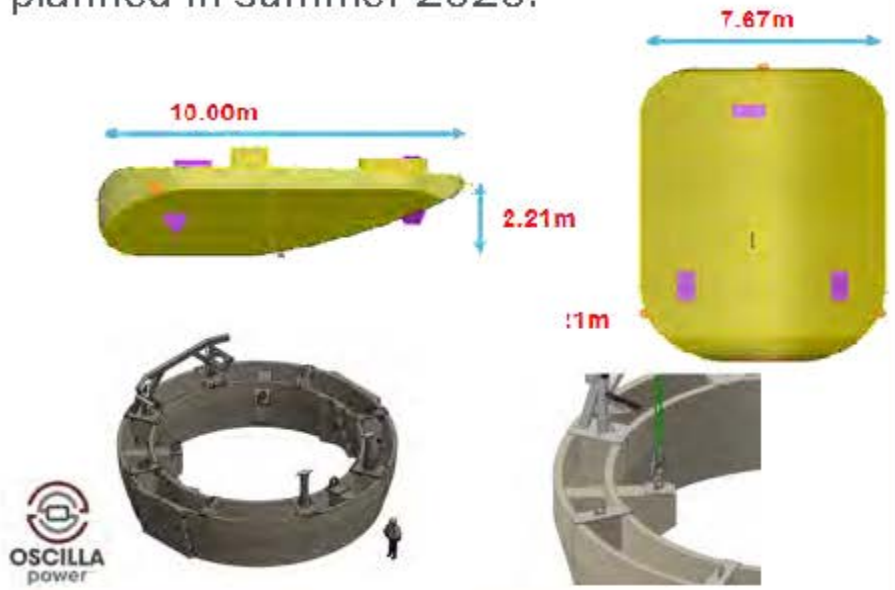
Alignment with the MHK Program

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

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
- Support the development and adoption of international standards for device performance and insurance certification

Through this project, a full-scale prototype (100kW, 10m x 7m) Triton-C WEC has been designed and is currently under construction, with deployment planned in summer 2020.



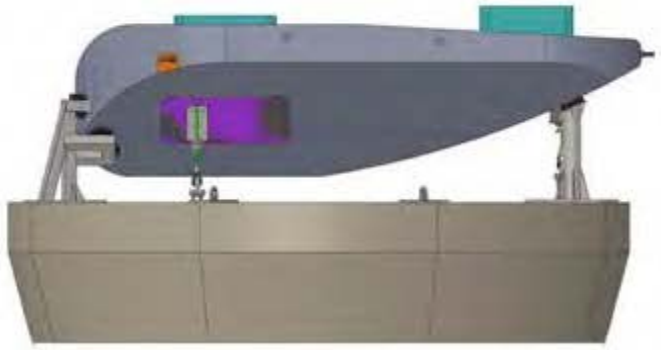
Triton Evolution through multiple stage & scale gates across DoE projects

Alignment with the MHK Program

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**
- Support the development and adoption of international standards for device performance and insurance certification

This project has developed an innovative installation process for the Triton-C that allows the hull and reaction ring to be mated together and towed to site as a single unit, and uses the drivetrains to deploy the ring at an operational depth.



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Alignment with the MHK Program

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
- **Support the development and adoption of International standards for device performance and Insurance certification**

By applying IEC standards through the design and performance evaluation of the WEC, this project will help to evaluate the applicability and usability of these standards and guidelines.

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Alignment with the MHK Program

Data Sharing and Analysis

- Support the early incorporation of manufacturing considerations/information into design processes

By applying a complete design, build and deploy process for a full-scale WEC, the feasibility of certain approaches, components and technologies can be established and disseminated to the industry.

- MHKDR (all project information as per SOPO, with 5yr embargo)
- Conference presentations & publications.
- Journal Publications
- Patent publication

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Project Budget

10. Budget History

Total Project Budget – Award Information		
DOE	Cost-share	Total
[$5,341K]	[$4,644K]	[$9,990K]

FY17	FY18	FY19 (Q1 & Q2 Only)	Total Actual Costs FY17–FY19 Q1 & Q2 (October 2016 – March 2019)
Costed	Costed	Costed	Total
[$281K]	[$928K]	[$1,174K]	[$2,382K]

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Management and Technical Approach

- **Technical Approach:**
  - *Performed stage-gated technology development approach*
    - *Concept*
    - *Front End Engineering Design (FEED)*
    - *Detailed Design*
  - *Validated concept with 1:10 scale physical model*
  - *Identified risks through NREL process, and developed mitigation strategy*
    1. *Tendon fatigue & wear (Completed separate design & physical testing)*
    2. *Hydraulic system loss (Designed for redundancy and added brake)*
    3. *Umbilical failure (Addition of on board load bank)*
    4. *Electrical system failure (Addition of mechanical dynamic brake)*
  - *Completed parallel FEED for composite float to develop long-term cost reduction approach*
  - *Identified key vendors early, collaborated to develop mfg plan*
  - *Identified experts in field to validate concept approach*

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End-User Engagement and Dissemination Strategy

- **Key stakeholders:**
  - DOE
  - Industry
  - Research / Academia
- **Dissemination Approaches**
  - MHKDR (all project information as per SOPO, with 5yr embargo)
  - Conference presentations & publications.

    METS, OREC, EWTEC, IMREC,
  - Journal Publications

    IMEJ (in preparation)
  - Patent publication

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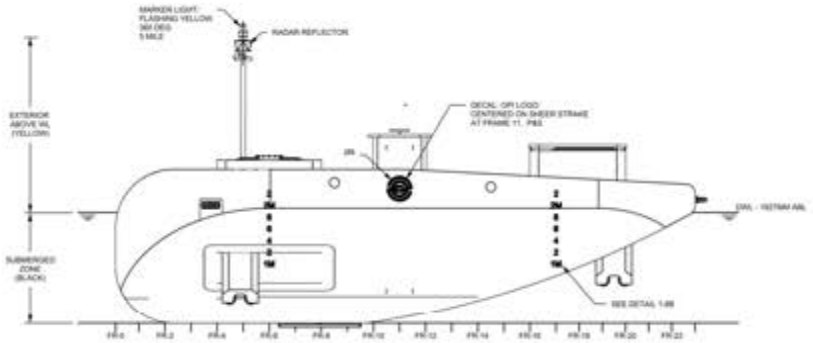
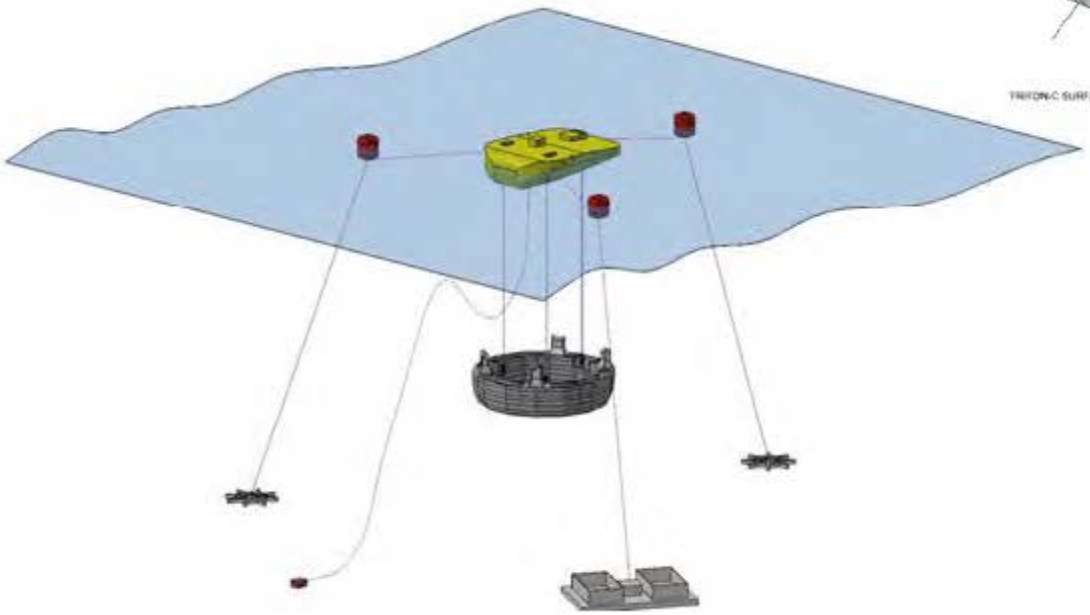
Technical Accomplishments

- *Completed the detailed design for the Triton-C WEC*





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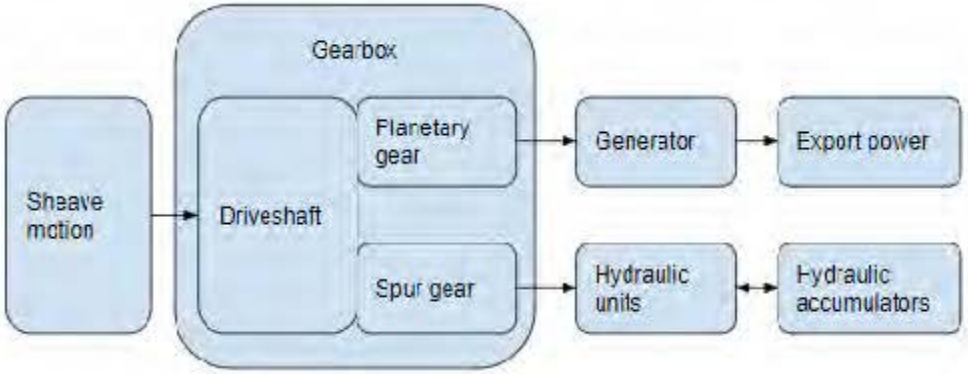
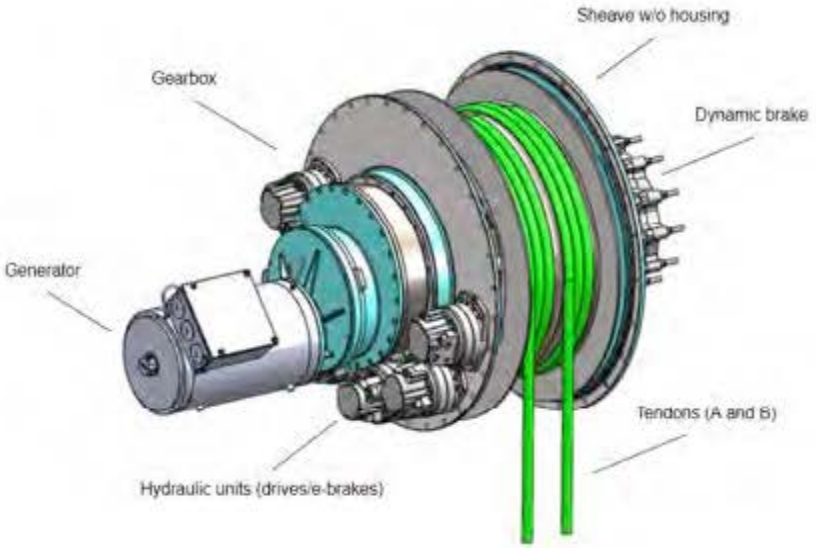
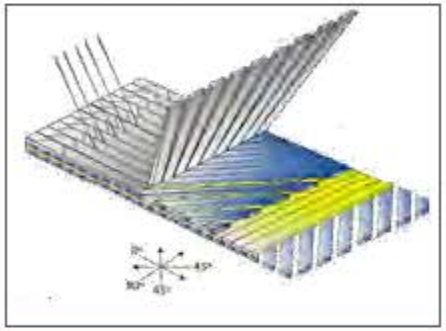
Technical Accomplishments

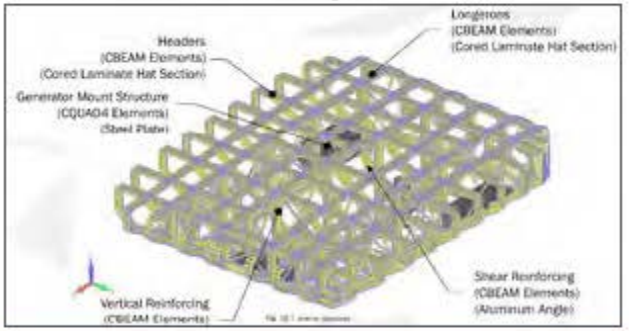
- *The development of a long travel hybrid rotary drivetrain*





- *Alternative composite construction approach will be substantially lighter and lower cost for small volume (5+ units) manufacturing*





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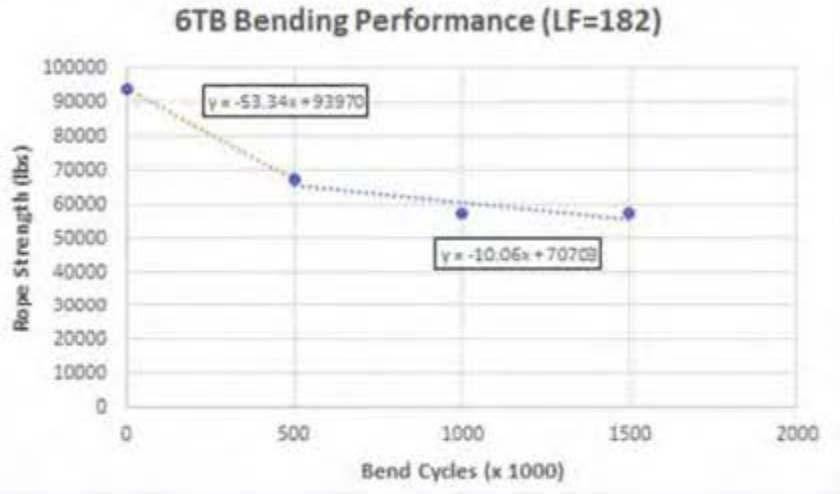
Technical Accomplishments (Cont.)

- ***Greater understanding of the system dynamics and what parameters drive power capture***
  - *Mass/MoI ratio between ring & hull*
  - *CoG location*
  - *Reaction ring hydrodynamic mass*
  - *Drivetrain travel*
  - *Hull Geometry*

- ***A design for a flexible tendon system that allows reliability, simplicity & replacement***
  - *Custom tendon construction*
  - *Experimentally proven*
  - *Risks characterized*



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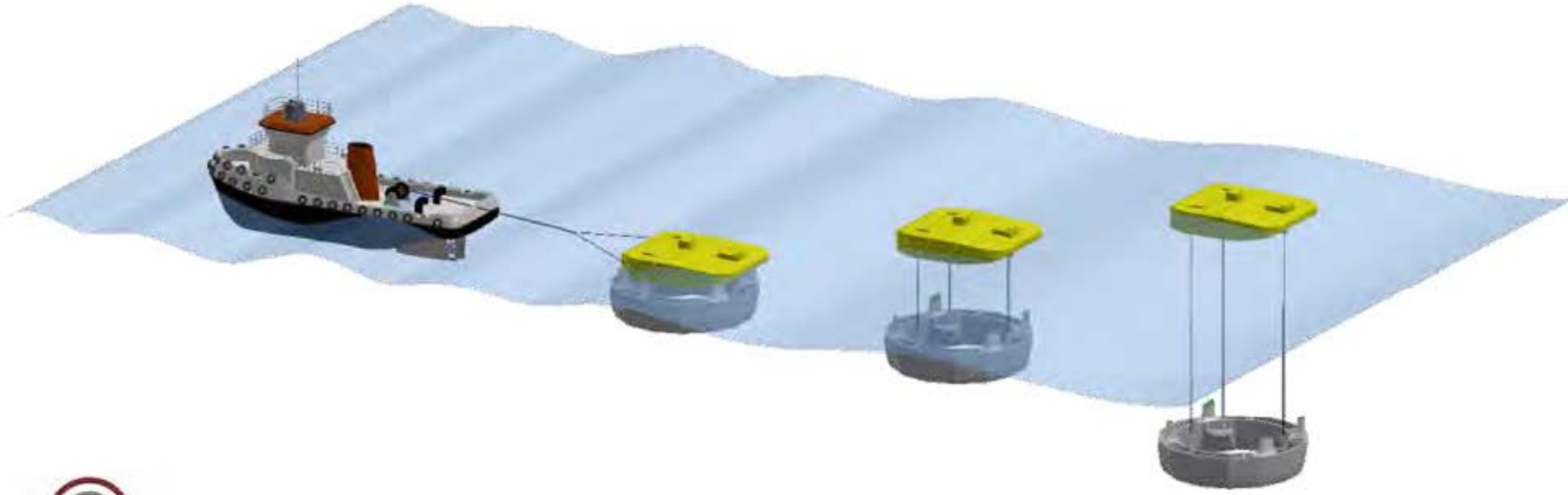
Technical Accomplishments (Cont.)

- *An installation & assembly approach that enables simple and low-cost installation and recovery with vessels of convenience*



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Progress Since Project Summary Submittal

- Hull & drivetrain construction is well underway.

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Progress Since Project Summary Submittal

Future Work

- Complete construction of the Triton-C (expected mid 2020)
- Test and validate installation approach through deployment of the system at the Navy WETS site in Hawaii
- Validate power performance & operations
- Test control algorithms on the hardware in order to maximize device power capture.
- Recover system and transport back to Seattle
- Complete measurements of system wear and revise calculations of OPEX and reliability
- Complete final reporting and LCOE metrics

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