Powering the Blue Economy™

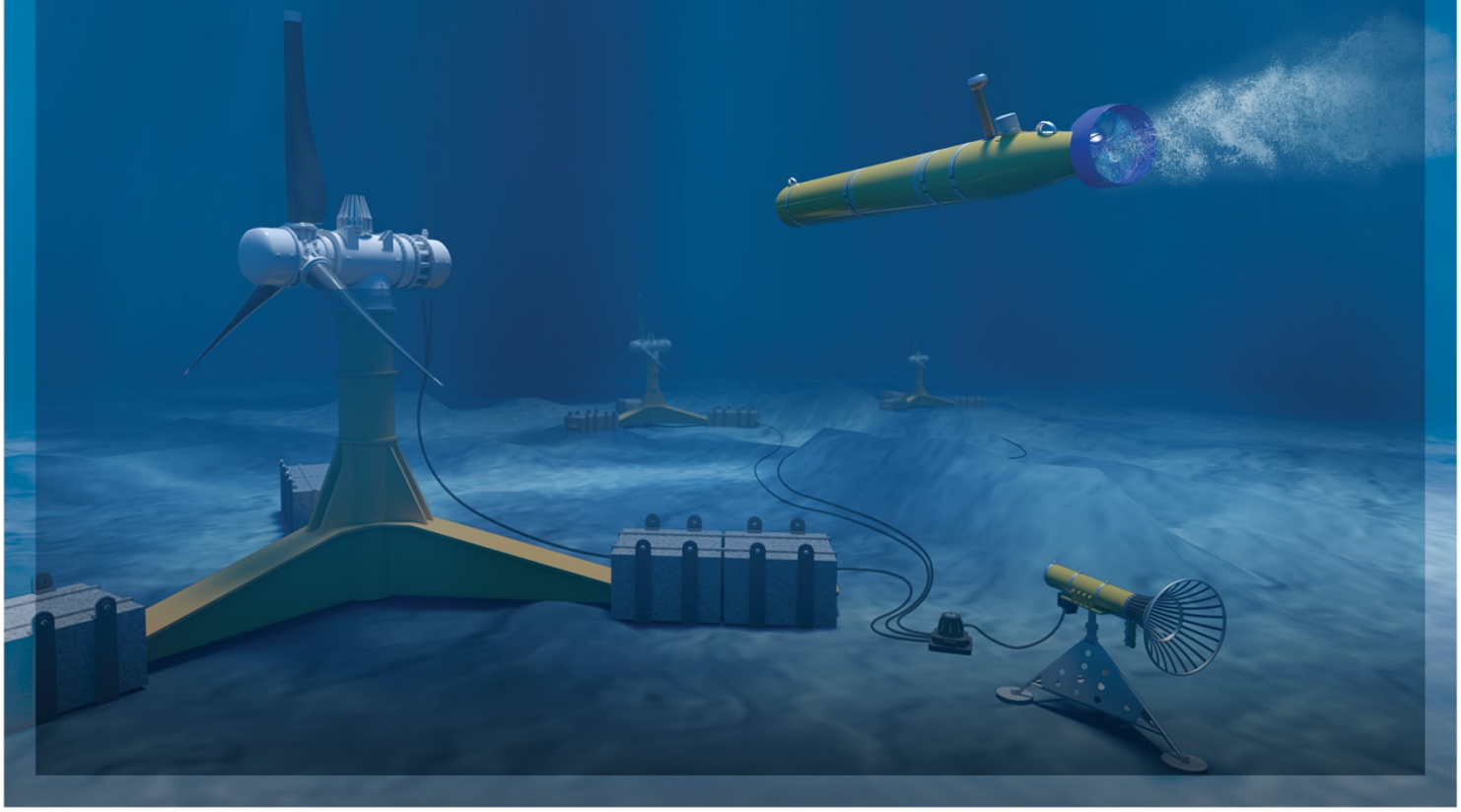
OCEAN OBSERVING PRIZE

AMERICAN MADE WATER PRIZE

U.S. DEPARTMENT OF ENERGY

DEVELOP COMPETITION

DESIGN Contest
Official Rules Document
October 2020



Preface

The U.S. Department of Energy's Ocean Observing Prize will be governed by this Official Rules document, which establishes the prize rules and requirements. The Prize Administrator reserves the right to modify this Official Rules document if necessary and will publicly post any such notifications as well as notify registered prize participants.

Table of Contents

Acronym List

- ADCP - acoustic Doppler current profiler
- AUV - autonomous underwater vehicle
- CTD - conductivity, temperature, depth
- DOE - U.S. Department of Energy
- GPS - global positioning system
- IOOS - Integrated Ocean Observing System
- NOAA - National Oceanic and Atmospheric Administration
- NREL - National Renewable Energy Laboratory
- PNNL - Pacific Northwest National Laboratory
- WEC - wave energy converter
- WPTO - Water Power Technologies Office

Introduction

The Powering the Blue Economy™: Ocean Observing Prize challenges innovators to integrate marine renewable energy with ocean observation platforms, revolutionizing our ability to collect the data needed to understand, map, and monitor the ocean. The Ocean Observing Prize is open to all eligible parties that have an interest in energy innovation to support ocean observing. Whether you are affiliated with an established company, a startup, an academic institution, or even just a team of like-minded individuals, you are invited to join the challenge and help address energy limitations in ocean observing.

This joint prize between the Water Power Technologies Office (WPTO) at the U.S. Department of Energy (DOE) and the Integrated Ocean Observing System program at the National Oceanographic and Atmospheric Administration (NOAA) seeks to develop new technologies that can help fill the data gaps making it difficult to realize the full potential of the blue economy. The Ocean Observing Prize includes a series of competitions with millions of dollars in cash prizes to encourage rapid innovation in the fields of marine energy and ocean observations. The Pacific Northwest National Laboratory and the National Renewable Energy Laboratory (NREL) are supporting DOE and NOAA on the development and administration of the prize.

This prize supports the Powering the Blue Economy initiative that seeks to develop new, marine-energy-enabled technologies to address and relieve power constraints in markets and applications in the blue economy. In addition to this prize, WPTO is funding research and development across a multitude of ocean observing systems, including through the Small Business Innovation Research/Small Business Technology Transfer programs and Funding Opportunity Announcements, as well as foundational research being conducted by the national laboratories.

Two discrete competitions make up the Ocean Observing Prize: the DISCOVER Competition (closed in April 2020) and the DEVELOP Competition. Within the DEVELOP Competition are the DESIGN Contest, BUILD Contest, and SPLASH Contest.

The Ocean Observing Prize: DEVELOP Competition invites teams to compete for up to $2.4 million in cash awards through three contests by designing, building, and testing innovative, functionally viable prototype systems suitable for hurricane monitoring that incorporate wave energy harvesting for self-charging of autonomous underwater vehicles (AUVs). Prototype systems may comprise one or two separate bodies, such as an AUV and docking station or a single self-charging AUV, so long as they adhere to the system requirements and rules outlined in this document. Prototypes emerging from this competition are not meant to be mature systems but should demonstrate basic functionality and potential for refinement into a commercially viable product.

This document serves as the Official Rules Document for the Ocean Observing Prize: DEVELOP Competition - DESIGN Contest. Official rules for the other two contests of the DEVELOP Competition will be released at a later date.

Ocean Observing Prize Eligibility Requirements

The competition is open only to: (a) citizens or permanent residents of the United States; and (b) private or non-federal government entities, corporations, or other organizations that are incorporated in and maintain a primary place of business in the United States with majority domestic ownership and control. Individuals can compete alone or as a member of a group. A representative of a private entity can register the entity to compete, so long as an entity is legally formed under the laws of a state or the laws of the United States with majority domestic ownership and control. See Appendix A for more information on the eligibility requirements.

If an entity seeking to compete does not have domestic ownership and control, the DOE Office of Energy Efficiency and Renewable Energy (EERE) may consider issuing a waiver of that eligibility requirement where the entity: submits a compelling justification; demonstrates the entity is incorporated in and maintains a primary place of business in the United States; and the entity otherwise meets the eligibility requirements. Entities seeking a waiver should include a justification along with their submission. EERE may require additional information before making a determination on the waiver request. There are no rights to appeal DOE's decision on the waiver request. See Appendix B for waiver details and instructions.

DOE employees, employees of sponsoring organizations, members of their immediate families (i.e., spouses, children, siblings, or parents), and persons living in the same household as such persons, whether or not related, are not eligible to participate in the Prize. Federal entities and federal employees, acting within the scope of their employment, are also not eligible to participate in any portion of the Prize. DOE national laboratory employees cannot compete in any stage of the Prize.

In keeping with the goal of growing a community of innovators, competitors are encouraged to form diverse, multidisciplinary teams while developing their submission. The HeroX platform provides a space where parties interested in collaboration can post information about themselves and learn about others who are also interested in competing in this contest.

Participation in the prior DISCOVER Competition is **not** required to compete in the DEVELOP Competition.

Additional Terms and Conditions

See Appendix A for additional requirements. COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL TERMS AND CONDITIONS IN APPENDIX A MAY BE DISQUALIFIED.

Ocean Observing Prize Overview

The Ocean Observing Prize seeks to accelerate the conceptualization, design, building, and testing of innovative systems that integrate ocean observing systems with marine energy technologies. This prize seeks to enable more persistent and pervasive ocean observing, which could have a growth multiplier effect in other blue economy sectors and simultaneously accelerate the maturation of the marine energy sector.

The goals of the Ocean Observing Prize are to:

- **Enable collection of valuable new data.** Proposed innovations should increase the spatial coverage, temporal resolution, and/or types of ocean and atmospheric variables that can be observed, collected, processed, and transmitted leading to improved understanding, monitoring, and management of the ocean.
- **Generate sufficient power from co-located marine resources.** Solutions must be able to generate sufficient power to meet the energy needs of end users from the ocean observing community and prove the viability of marine energy to power ocean observations.
- **Accelerate commercialization of marine energy systems.** Traditional development timelines of marine energy devices for the electrical grid can take many years to design, build, and test. By working at smaller scales and addressing ocean observing system energy needs, marine energy may find a faster path to commercialization.
- **Grow a diverse community of innovators.** This prize will help bring new innovators into the marine energy and ocean observing space. It will also help form new partnerships and collaborations between industry, academia, and government to create innovative ocean observing technologies powered by marine energy.

Two discrete competitions make up the Ocean Observing Prize: the DISCOVER Competition and the DEVELOP Competition. Within the DEVELOP Competition are three separate contests: the DESIGN Contest, BUILD Contest, and SPLASH Contest. Participation in the DISCOVER Competition is **not** required to compete in the DEVELOP Competition.

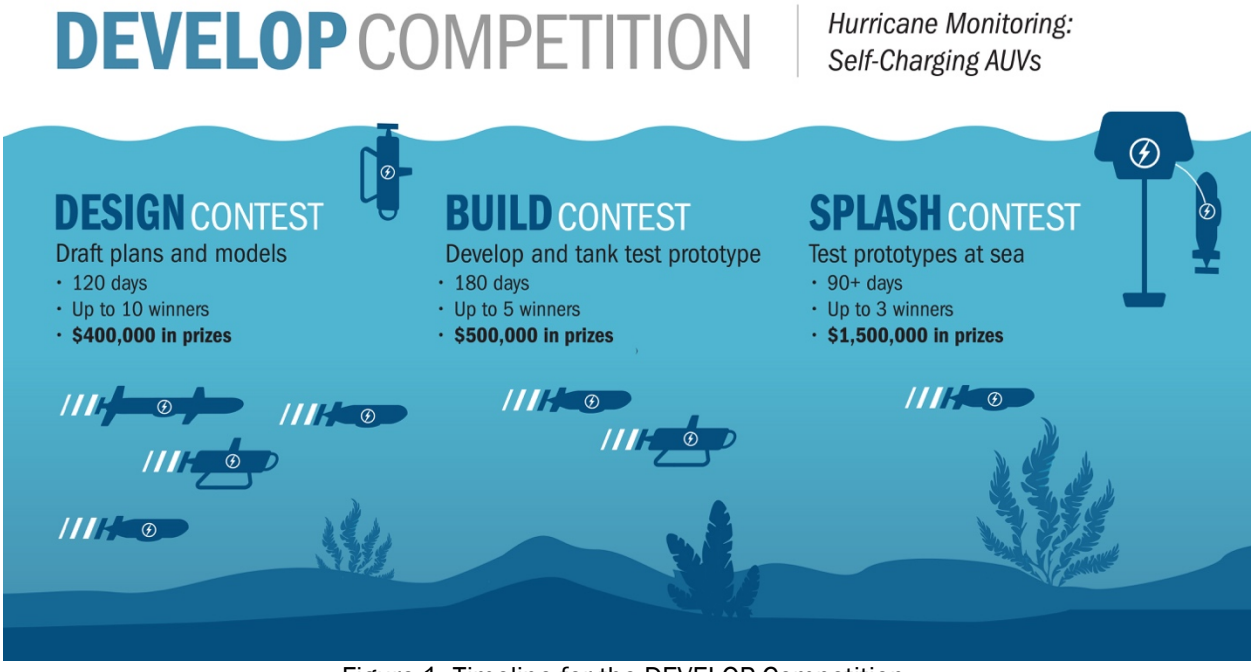


Figure 1. Timeline for the DEVELOP Competition.

DISCOVER Competition - CLOSED - 11 winners, $125,000 in prizes

The DISCOVER Competition was ideation-focused and sought ideas and concepts that integrated marine energy technologies with ocean observing platforms. Contestants applied into one of five thematic tracks for a chance at winning one of 11 awards providing up to $125,000 in cash prizes.

The DISCOVER Competition has concluded, and awards were announced in April 2020. The applications from the DISCOVER Competition were used to inform the topic and scope of the DEVELOP Competition. More information on the DISCOVER Competition and awardees can be found on the Ocean Observing Prize HeroX web page. Participation in the DISCOVER Competition is not a prerequisite for the DEVELOP Competition.

DEVELOP Competition - Up to $2.4 Million in Cash Prizes

The theme of the DEVELOP Competition is "Buoys and Autonomous Systems" and was informed by the DISCOVER Competition. Within this theme, competitors are tasked with designing and building prototype systems addressing the challenge of integrating wave energy harvesting into a self-charging autonomous underwater vehicle that could be used for hurricane monitoring. During the three contests of the DEVELOP Competition, contestant teams will compete for up to $2.4 million in cash prizes and other awards, such as access to state-of-the-art facilities and subject matter expertise. The total amount of support that will be awarded to participants is estimated at up to $3 million.

DEVELOP Competition Objectives

The primary objective of the DEVELOP Competition is to spur innovative designs that integrate wave energy harvesting with autonomous underwater vehicles. These designs could help ocean observing systems become more self-sufficient and help fill a gap for a necessary capability in resident autonomous vehicles. A secondary objective of this competition is community building. Through cash awards and other incentives, it will bring together a diverse community of ocean scientists, roboticists, marine energy technologists, and others to create an environment ripe for creative solutions.

In alignment with these objectives, the DEVELOP Competition attempts to bring together diverse, multidisciplinary teams to design, build, and test innovative, functionally viable systems that incorporate wave energy harvesting for self-charging of autonomous underwater vehicles. Prototypes emerging from this competition are not meant to be fully mature systems but should demonstrate basic functionality and potential for refinement into a commercially viable product that address a real-world challenge, such as hurricane monitoring, as outlined in this document. Each of the three contests in the DEVELOP Competition are structured to help contestant teams rapidly design and prototype their ideas while competing for cash prizes and other awards.

DESIGN Contest - Up to 10 Winners, $400,000 in Prizes

The DESIGN Contest tasks competitors to design systems that use ocean surface waves as an energy source for recharging autonomous underwater vehicles at sea for the purpose of monitoring hurricanes in the Atlantic Ocean. From the opening date, competitors will have approximately 3 months to design systems that meet the requirements and rules as laid out in this Rules Document. Submissions to the DESIGN Contest will be reviewed by a panel of experts in wave energy, marine robotics, and ocean science to assess design potential.

There will be up to 10 awards for a total prize pool of $400,000, but not to exceed $80,000 each, even if less than five winners are selected. The winners of the DESIGN Contest will be invited to participate in the BUILD Contest, in which they will build and test their prototype designs in a controlled environment in a test facility.

DESIGN Contest Key Dates

All dates subject to change; see the HeroX Ocean Observing Prize page for the latest dates.

Submission Open: October 19, 2020
Submission Close: February 16, 2021, at 5:00 p.m. EST
Judging and Review Complete: Anticipated March 17, 2021
Winner Announcement and Awards: Anticipated April 1, 2021

BUILD Contest - Up to Five Winners, $500,000 in Cash Prizes

The BUILD Contest invites the winners of the DESIGN Contest to build and test a functioning prototype of their design. This document outlines the official rules for the DESIGN Contest. The official rules for the BUILD Contest, along with details on the test site locations and scoring, will be released at a later date. Only the winners of the DESIGN Contest will be eligible to compete in the BUILD Contest.

A total prize pool of $500,000 will be awarded to up to five contestant teams at the end of the BUILD Contest. Only winners of the BUILD Contest are eligible to compete in the SPLASH Contest. It is expected that the winners will continue to refine their designs in the subsequent SPLASH Contest.

BUILD Contest Key Dates

All dates subject to change.

Submission Open: Anticipated April 2021 through September 2021
Tank Testing: Anticipated September 2021 through October 2021
Awards: Anticipated November 2021

SPLASH Contest - Up to Three Winners, $1.5 Million in Cash Prizes

The DEVELOP Competition will conclude with the SPLASH Contest, which will test prototypes in an at-sea environment. Only the winners of the BUILD Contest will have approximately 3 to 6 months to refine their prototypes after the BUILD Contest concludes and will then be expected to deploy their refined systems for at least 1 week at sea to verify their performance in real-world conditions.

A total prize pool of up to $1.5 million will be awarded at the end of the SPLASH Contest, with up to three awards.

SPLASH Contest Key Dates

All dates are subject to change.

Submissions Open: Anticipated November 2021 through February 2022
Testing at Sea: Anticipated March 2022
Awards: Anticipated April 2022

Background

The Blue Economy and Energy

Activities in the blue economy are frequently grouped into sectors, such as offshore aquaculture, maritime defense, offshore energy, ocean observing, and shipping. All these sectors require energy: fuel for ships, batteries for underwater vehicles, or high-pressure seawater for desalination systems. While some activities have access to cheap and reliable sources of energy, others do not.

Energy constraints limit operations and add costs to many blue economy activities. Removing or reducing these energy constraints through energy innovation could open new pathways for economic development, ocean exploration, and improved environmental stewardship.

In 2017, WPTO began investigating the potential of marine energy technologies, such as wave energy converters and tidal turbines, to meet the needs of blue economy activities. The potential markets were found to align with two themes that are detailed in The Powering the Blue Economy report[1]:

1. Providing power at sea to support offshore industries, science, and security activities
2. Meeting the energy and water needs of coastal and rural island stakeholders in support of resilient coastal communities.

Technologies that address these nongrid energy demands may prove to be economically viable opportunities in the near term for the marine energy industry. By pursuing such opportunities, there is a spill-over effect that is expected that advances marine energy technology readiness for more traditional utility-scale electrical grid markets as well as other unforeseen opportunities. Both ocean observing and underwater vehicle charging are identified as potential markets in the report.

Opportunities to Advance Ocean Observations

The ocean covers more than 70% of the planet and is, on average, deeper than 1 mile. It is so large that it controls and tempers global weather patterns, provides half the oxygen we breathe, and supports the fisheries that feed billions of people. Yet, because of its immensity, there is a struggle to effectively monitor and measure it on both temporal and spatial scales, hindering the ability to systematically manage and monitor the most critical resource on the planet. With a greater understanding of the world's oceans, we could better predict and track tropical storms that jeopardize lives; monitor fish stocks that communities depend on for sustenance; or alert coastal areas of deadly tsunamis that can destroy towns and villages.

Improved management of marine resources and the maritime domain can be accomplished through more persistent ocean monitoring and data collection, referred to as ocean observing. Ocean observing systems may comprise sensors that collect environmental data, platforms to host and power the sensors, and communication technologies that send the collected data to a ship or shore-based terminal to be processed into useful information.

The technologies used for ocean observing are numerous and vary significantly in terms of function, size, cost, and power consumption. Examples include autonomous underwater vehicles, buoyancy gliders,

[1] LiVecchi, A., A. Copping, D. Jenne, A. Gorton, R. Preus, G. Gill, R. Robichaud, R. Green, S. Geerlofs, S. Gore, D. Hume, W. McShane, C. Schmaus, H. Spence. 2019. *Powering the Blue Economy; Exploring Opportunities for Marine Renewable Energy in Maritime Markets*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, D.C. https://www.energy.gov/sites/prod/files/2019/09/f66/73355-v2.pdf.

profiling floats, weather and drifter buoys, and electronic tags on marine animals. Nearly all these systems rely on batteries, but batteries are by definition temporary energy sources and must be recharged or replaced periodically. For systems that are operating far offshore or deep underwater for sustained periods, recharging a battery becomes a challenging and costly endeavor.

These energy limitations force ocean scientists to make tough choices between what sensors they can host on a platform, how much data they can collect, how often they can communicate with the system or relay the data back to shore, and how often they must visit it once deployed.

Ultimately, the Ocean Observing Prize will incentivize new solutions that integrate marine energy with ocean observing instruments, platforms, and systems that reduce or eliminate the energy constraints hindering the ability to effectively monitor and manage the ocean. Improved ocean observations fueled by marine energy sources can promote growth in the blue economy and help provide a better understanding of the ocean and its value to humankind.

Buoys and Autonomous Systems

> "While modern AUVs are able to operate autonomously when on-mission and underwater, they still rely on manual intervention by a support vessel between individual missions…in situ recharging represents the next major evolution in subsea robotic capabilities. With these capabilities, future AUV systems will be able to reside at sites of interest for durations greater than a single mission, becoming resident AUV (RAUV) systems."[2]

Within the Buoys and Autonomous Systems theme there are many different ocean observing platforms serving a wide variety of missions. Through interviews of ocean scientists there emerged a clearly evident need to address the energy limitation of autonomous underwater vehicles.

AUVs come in many different shapes and sizes and are used for numerous purposes: from subsea pipeline inspections, to seafloor mapping, to fish tracking. Like electric cars, these systems are limited in their range and duration before their energy storage systems must be replenished. Unfortunately, replenishing energy storage systems on AUVs at-sea is far more difficult and costly than it is for electric cars. This energy limitation constrains AUV missions. If an AUV had access to a reliable source of energy for self-charging without the need for human intervention, it would change this paradigm and help enable a "resident" AUV.[2]

While a self-charging AUV would be a game changer for a number of applications and missions, interviews with ocean scientists suggest that such a system could help close an important data gap in hurricane monitoring. The DEVELOP Competition is structured around this real-world need.

[2] D. Manalang, J. Delaney, A. Marburg and A. Nawaz, "Resident AUV Workshop 2018: Applications and a Path Forward," 2018 IEEE/OES Autonomous Underwater Vehicle Workshop (AUV), Porto, Portugal, 2018, pp. 1-6, doi: 10.1109/AUV.2018.8729720.

DEVELOP Competition: Mission

The Ocean Observing Prize: DEVELOP Competition invites contestant teams to compete for up to $2.4 million in cash awards by designing, building, and testing novel, wave-powered, self-charging autonomous underwater vehicle systems that, with refinement, would be suitable for a 6-month deployment in the Atlantic Ocean to monitor hurricane formation. Prototypes built during this competition are not meant to be mature systems but should demonstrate basic functionality and potential for refinement into a commercially viable product. When designing systems, contestant teams must adhere to the contest rules and requirements specified in this document. Designs and prototypes will be assessed through the three contests of the DEVELOP Competition: DESIGN, BUILD, and SPLASH Contests.

In the following section, information is presented regarding how ocean scientists use existing ocean observing platforms, such as gliders and drifting floats, to study and forecast hurricane formation, path, and intensity at sea. This information is provided to contestant teams for real-world context and was used to inform the DEVELOP Competition rules, requirements, and scoring.

In the description of hurricane monitoring that follows, relevant System Requirements for the DEVELOP Competition are cross-referenced with the notation "*[Req. X]*" (where x is the requirement number). This cross-referencing of requirements provides additional context for contestant teams to better understand the motivation for the requirement. Not all requirements are referenced. See the System Requirements and Rules section of this document for the official rules of the DEVELOP Competition.

Hurricane Monitoring Mission Description

Tropical storms, cyclones, and hurricanes are extremely energetic storms that originate far out at sea. As these storms strengthen over warmer waters, they create high winds and large waves. When these storms reach the coast, they can devastate coastal communities through wind damage and flooding.

Society's ability to forecast the trajectories of these storms has improved significantly over the past two decades, yet the ability to forecast the *intensity* of the storms is still limited. Without the ability to provide communities with good intensity forecasting, evacuation plans and coastal protection efforts are adversely affected. For example, the difference between a Category 3 and 4 hurricane could be the difference between a storm surge of 9 feet and 18 feet above normal levels.

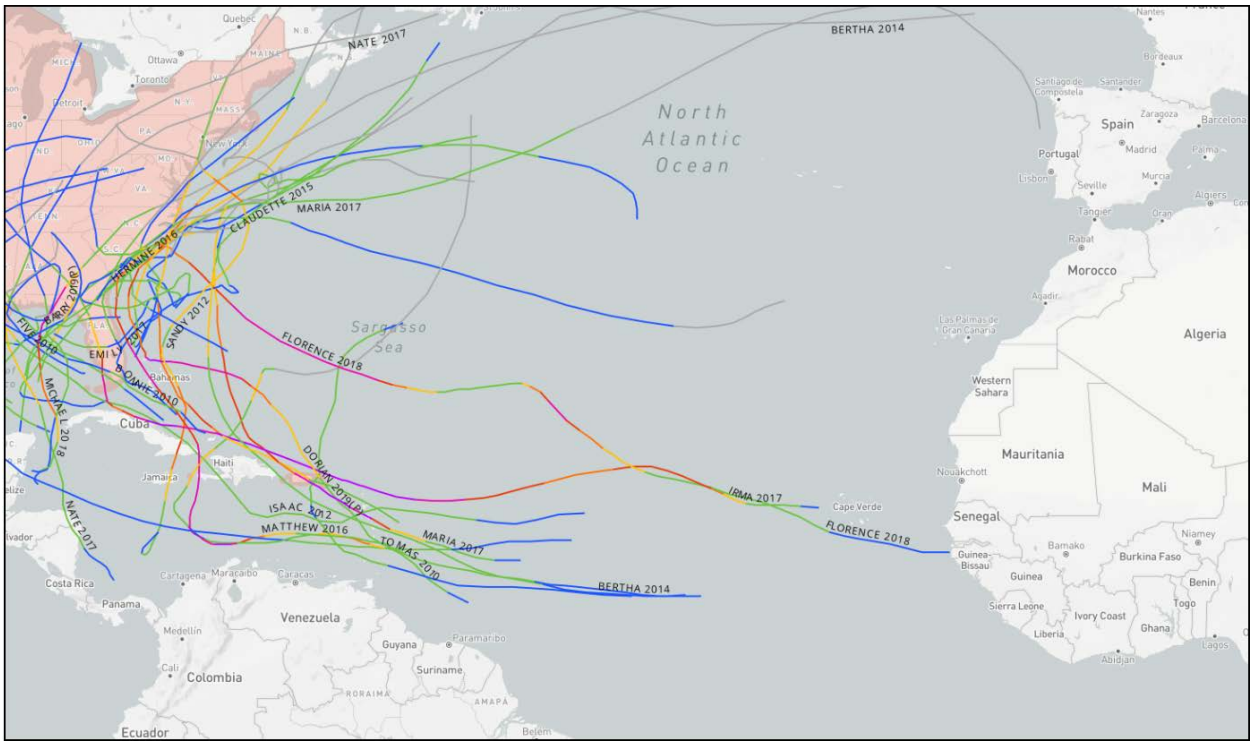


Figure 2. Major Atlantic hurricane tracks for the past decade. *Source: NOAA National Ocean Service*

Models can be useful for predicting the effects of storms, but they rely on accurate data collected from within the storms. Unfortunately, collecting in situ data on tropical cyclones and hurricanes is difficult for three reasons: (1) their stochastic nature makes it difficult to anticipate when and where they will occur, (2) storm environments are extremely energetic and create difficult operating conditions for people and robots, and (3) even with austere power management measures, existing systems struggle to operate in one location for the full length of a hurricane season. If these data could be collected, then scientists might better understand storms and improve the accuracy of intensity forecasting, ultimately saving lives and reducing the financial impact to coastal communities.

The data desired to inform these models would be basic ocean and atmospheric properties measured before, during, and after a hurricane. Those who model hurricane intensity desire ocean data of temperature, conductivity, wave motion, and current velocity. Desired atmospheric measurements are air temperature and air humidity, as well as wind velocities. Such properties are commonly collected using commercially available conductivity, temperature, and depth (CTD) and acoustic Doppler current profiler (ADCP) instruments (Requirements [Req.] 13 and 14)[3] Collecting these type of data requires a platform that can be quickly and safely deployed in advance of the storm and then loiter in a designated area until it approaches. Loitering could be as short as a couple days or as long as 6 months from June through November (the typical hurricane season in the Atlantic). Ideally, these ocean and atmospheric properties that characterize the air-sea interaction would be sampled at regular intervals by performing a controlled descent from the surface to approximately 200-meter (m) depths and then returning to the surface (Req. 3).

Some scientists have noted that during ascents, sometimes buoyancy gliders are unable to reach the surface when there is a plume of freshwater near the surface (Req. 5). Data collected by systems out at sea need to be precisely located temporally and spatially (Req. 15), and then delivered to scientists on shore. Ideally, this is done via satellite communication, at least once per day (Req. 16).

[3] Where applicable, relevant requirements and rules from this document are cross-referenced to the mission need. See the System Requirements and Rules section of this document for the official rules.

Particular areas of interest to scientists and researchers that study hurricane formation include the Gulf of Mexico, east of the Caribbean Sea, and in the Gulf Stream offshore of the Southeast coast of the United States as well as the mid-Atlantic region near New Jersey and Delaware. These locations are known to have essential ocean features and processes important to hurricane formation, such as mixing of deep cold water and warm surface waters. Some of these locations are in very deep waters, rendering systems that require moorings impractical and cost prohibitive (Req. 6). These likely deployment locations often have strong surface currents that could vary from 0.2 meters per second to more than 1.5 meters per second, often pushing platforms off their intended course (Req. 4). Existing gliders are unable to respond quickly to changes in course or explore areas of interest and lack the ability to overcome even a marginal surface current because of energy limitations. Responsive navigation is needed to respond to changes in mission needs and dynamic environmental conditions (Req. 15, 17, 23).

Current ocean observing platforms used for at-sea hurricane monitoring, such as buoyancy gliders and drifter floats, are typically shipped to deployment locations using commercial carriers like UPS and FedEx (Req. 2, 7). On shore, the platforms are often moved from the assembly location to the deployment vessel in the bed of a pick-up truck to avoid the need of specialized trucks. It is common practice to use any vessel of opportunity that could be chartered in the area to deploy the ocean observing platform. Such vessels used for deploying the platform vary in size but are typically less than 10 m long and will have between two to five crew members aboard (Req. 2, 8, 9). Existing platforms are often deployed and recovered with only two trained crew members (Req. 12, 19, 20, 21, 22).

Once the system is deployed it is unlikely to be visited again by a ship unless it is to be recovered, so systems must account for storm survivability, biofouling, and other issues that may affect the performance over the deployment duration. If platforms cannot perform as needed, this limits the amount of useful data that they can collect and jeopardizes the mission.

The current paradigm that ocean scientists struggle with is a balancing system power consumption and deployment duration. More frequent sampling, propulsion, or communications increase power consumption, which rapidly drains batteries and reduces the length of time the system can be deployed and increases the frequency at which it needs to be recovered (Req. 10). Power management is crucial to the system design to maximize data collection and deployment time. A system that possesses the ability to self-charge would change this paradigm and allow scientists to focus on maximizing data collection instead of minimizing power consumption (Req. 11).

> "Everything about autonomous platforms at sea comes down to power budget. This is our limiting factor."
>
> *—Ocean scientist studying hurricanes at sea using buoyancy gliders*

There are a variety of in situ energy harvesting options available to systems performing hurricane monitoring at sea: solar, wind, waves, currents, and even thermal gradients in the ocean. Regardless of the energy harvesting method used, the system should have a battery that is sufficiently sized to ensure that it maximizes uninterrupted data collection without jeopardizing loss of the system over the entire 6-month deployment (Req. 10).

Finally, the safety of humans and the environment is paramount when using ocean observing platforms. Technologies used are safe to handle by a trained crew and cause no adverse environmental impact (Req. 12, 18, 19, 20, 21, 22).

DEVELOP Competition: Prizes and Incentives

Throughout the DEVELOP Competition, awards and services will be provided to help contestant teams design and build a successful prototype, which are outlined in the following table.

Incentive	Description	DESIGN Contest	BUILD Contest	SPLASH Contest
Cash Awards	In the DESIGN, BUILD, and SPLASH Contests cash awards will be given to successful contestant teams based on performance in each contest. The awards provided after the DESIGN and BUILD Contests are intended to be used to help offset the costs of the prototype build and testing in subsequent contests.	Up to 10 awards totaling $400,000	Up to five awards totaling $500,000	Up to three awards totaling $1.5 million
Testing and Validation	The BUILD Contest will conclude with prototype testing and validation in a controlled environment. The SPLASH Contest will conclude with testing at sea. This testing will provide contestants with free access to state-of-the-art facilities, equipment, and subject matter experts to quickly validate their prototypes.		Test tank facility	At sea
Blue Economy Business Webinars	Contestants will have exclusive access to a series of webinars, to be provided by a third-party organization with expertise in entrepreneurship, on lessons learned in commercializing technologies in the blue economy, and how to build a business.	x	x	x
Mentoring and Coaching	Contestants will gain access to a diverse panel of subject matter experts who will serve as mentors to teams to help guide technology development, connect teams with other experts, or more generally help knock down barriers slowing the team's progress.		x	x
Investor Pitch Event	Through this competition, contestants will be given an opportunity to pitch their novel technologies to investors and industry leaders and receive invaluable feedback on their design and business case.		x	
Partnerships	The DEVELOP Competition will provide a forum for contestants to form relationships with a diverse community of stakeholders across the federal government, academia, and broader innovation ecosystem to include investors, ocean scientists, roboticists, and more.	x	x	x

DEVELOP Competition: System Requirements & Required Components

The System Requirements and Required Components detailed in this section are mandatory when designing prototype systems for the DEVELOP Competition. These requirements were informed by interviews with scientists and researchers that use autonomous platforms to monitor hurricanes in the ocean as well as the likely safety restrictions of possible test environments. These requirements will apply to all three contests under the DEVELOP Competition. Submissions that do not meet these requirements will be disqualified and rendered ineligible for any awards.

The following tables include System Requirements in the following categories:

- Physical Characteristics and Principal Dimensions
- Self-Charging and Power Management
- Data Collection and Communications Requirements
- Operations and Safety.

System Requirements: Physical Characteristics and Principal Dimensions

#	Requirement
1	Up to two separate bodies (a multibody design) may be used for the proposed system. The profiling body is defined as a standalone system element that houses the dummy payload package and CTD. Only the profiling body may move vertically within the water column while profiling. If a standalone system element exists that does not house the dummy payload and CTD, then it will be referred to as the nonprofiling body. See Req. 14.
2	The assembled system dry weight, measured in air, at the point of deployment must be less than or equal to 250 kilograms (kg). At the point of recovery, the system must be less than or equal to 250 kg within 5 minutes (to allow for water drainage) once recovery is initiated. If the design uses two separate bodies, both count toward the maximum weight limit.
3	The profiling body of the system must be able to withstand depths of at least 30 meters[4] for at least 30 minutes. See Appendix D for specifications on the dummy payload.
4	The system must have a minimum sustained speed of 0.5 knots for 30 minutes, and a top speed less than or equal to 6 knots. If the design uses multiple bodies, both must demonstrate this speed requirement.
5	All bodies of the assembled system must be positively buoyant in freshwater during deployment/recovery.
6	The system must not touch the bottom (e.g., no moorings or anchors).
7	The volume of the packaged system must fit within the dimensions of a double pallet-sized crate, with external dimensions of 117 centimeters (cm) by 240 cm by 122 cm (w x l x h). If the design uses two separate bodies, both count toward the maximum packaged volume limit.
8	The assembled system must be safe and stable while lifted during deployment and recovery and have at least one hard lift point that is easily accessible, or as many as needed to ensure stable orientation while lifted. If the design uses two separate bodies, each body may be lifted separately or together.
9	All bodies of the assembled system must have a maximum beam less than or equal to 150 cm.

[4] This is under NOAA's mission requirement of a 200-m depth. As pressure vessel engineering is a mature field, 30 m was chosen for safety in contest operations and reduced costs to competitors.

System Requirements: Self-Charging and Power Management

#	Requirement
10	The system must use batteries. The total energy storage capacity of the system, including all system bodies, must have a minimum capacity to continuously power the dummy payload and all thrusters while operating at maximum power consumption for 30 minutes, or 250 Watt-hours, whichever is greater. The maximum energy storage capacity of the complete system must be less than or equal to 1,000 Watt-hours.
11	System must use only wave energy for self-charging while in the water. Other methods of charging, such as plugging into a wall outlet or USB, are allowed while the system is onshore or in a boat.
12	The battery charging subsystem must have ground fault circuit interruption protection.

System Requirements: Data Collection and Communications Requirements

#	Requirement
13	System must accommodate the provided dummy payload package into the profiling body and provide it with energy harvested from waves. If wave energy harvesting is performed in a body separate to the profiling body, then there must be a method of power transfer between the two bodies (see Req. 1). See the provided specification sheet in Appendix D for details on the payload interfaces. The dummy payload package will be provided to contestant teams during the BUILD Contest.
14	System must incorporate a commercially available CTD instrument that is able to sample at the rated depth of the system.
15	The system must incorporate a global positioning system (GPS) module with sub 5-m precision and be able to relay its geospatial position over wireless communication. A clear view of GPS satellites may not be available during the BUILD Contest and should not be relied upon as the sole means of system navigation.
16	System must be able to transmit and receive data and commands wirelessly. At least two wireless communication subsystems must be used, one of which must be satellite communication. The other communication subsystem is up to contestant teams and must have an indoor range of at least 100 m when at the water's surface.
17	The proposed design includes navigation systems that can be utilized in a tank or at-sea environment. If multiple bodies are used, the bodies must be able to navigate independently and in a coordinated fashion.

System Requirements: Operations and Safety

#	Requirements
18	The system may not emit any materials or fluids other than air and water.
19	All propellers must have shrouds. The shrouds must surround the propellers and have at least a 5.1-cm distance between the spinning disk of the propeller and the edges of the shroud (front and back). Commercial thrusters qualify as is, as long as they are shrouded.
20	All conductive chassis surfaces on the assembled system must be electrically grounded.

21	System surface temperatures must not exceed an external temperature of 60°C for more than 5 seconds or be otherwise considered unsafe to handle because of high temperatures. High-temperature surfaces must be clearly labeled.
22	All systems must have a clearly marked kill switch that a support diver can easily find and activate while in the water. The switch must de-energize all propulsion components and devices on the system. The kill switch does not have to kill the onboard computer or control unit. Upon reactivation, the vehicle must return to a safe state (propellers do not start spinning).
23	The profiling body must be able to turn through 360 degrees of compass heading, in both directions, with a turn radius less than or equal to 7.5 m.

Required Components

The following table summarizes components that are required for prototype systems as specified in the Rules. Contestant teams should note the make and model for each required component in the Narrative of their submission package.

Required Component	Quantity Required	Note	Provisioning
Wireless communication subsystem	2	Contestant may choose. One subsystem must be satellite communication. For the other communication subsystem, its indoor range must be at least 100 m. BUILD Contest testing may be performed indoors without a clear view of the sky.	Contestant will acquire for BUILD Contest
GPS module	1	Contestant may choose. Sub 5-m precision. BUILD Contest testing may be performed indoors without a clear view of the sky.	Contestant will acquire for BUILD Contest
CTD instrument	1	Must be a commercially available CTD	Contestant will acquire for BUILD Contest
Power monitoring system and dummy payload package	1	Specifications provided in Appendix D and on HeroX resources page. Representative in dimensions and power consumption of an ADCP	Will be provided to contestant during the BUILD Contest

DESIGN Contest Rules and Requirements

The DESIGN Contest is soliciting designs of prototype systems that could be used for hurricane monitoring, as described in the Mission section, and meet all conditions in the System Requirements and Required Components section.

DESIGN Contest Prizes

- Up to $400,000 in cash prizes
- Up to 10 awards
- Prize awardees advance to the BUILD Contest of the prize

The winners of the DESIGN Contest will be invited to the next contest of the DEVELOP Competition, the BUILD Contest, where they will build functioning prototypes and test their systems in a controlled environment such as a wave tank. Winners of the BUILD Contest will be invited to participate in the SPLASH Contest (and the culmination of the first DEVELOP Competition), where they will test their designs at-sea.

Contestant teams may submit more than one design, so long as it is materially different from other submissions submitted by the contestant team. Designs from the same team that are not materially different, at the prize team's sole discretion, will be disqualified.

As an important note, teams are not expected to have mission-ready systems at the end of this competition. Instead, they will focus on developing minimally viable functioning prototypes that demonstrate core functionality and can be refined into mission-ready systems. All submissions must account for the key assumptions, as specified in Appendix C, as well as meet the System Requirements and detail the Required Components.

How to Enter

Go to the HeroX Ocean Observing page and follow the instructions for registering and submitting all required materials before the deadline in the key dates or as displayed on the HeroX website. Competitors also have the ability to form teams or find partners through the HeroX platform.

DESIGN Contest Key Dates

All dates are subject to change; see HeroX Ocean Observing page for the latest dates.

Submission Open: October 19, 2020
Submission Close: February 16, 2021, at 5:00 p.m. EST
Judging and Review Complete: Anticipated March 17, 2021
Winner Announcement and Awards: Anticipated April 1, 2021

Submission Package

There are five required items that make up a complete submission package for the DESIGN Contest that must be submitted through the HeroX platform to be considered an eligible submission. Each is described in more detail as follows.

Contestant teams may submit multiple unique designs that are materially different from one another. Each design must be accompanied by its own submission package. If multiple submissions from the same contestant team are too similar, only one will be scored and considered for award at DOE's sole discretion. A complete submission package includes the following:

1. **Overview Slide**. A slide that summarizes the design and basic information
2. **Narrative**. A written description of the system, team, and plan
3. **System Specification Sheet**. A reference sheet summarizing system features
4. **Design Tables**. Itemized tables providing power, weight, and cost details
5. **Technical Addendum**. Diagrams, design calculations, and simulation results.

Each element of the submission package is described in more detail in the sections that follow. The following table indicates which elements of the submission package will be made public.

Submission Package Element	Scored	Must Use Provided Template	Will be Made Public[5]
Overview Slide	No	Yes	Yes
Narrative	Yes	No	No
System Specification Sheet	Yes	Yes	No
Design Tables	Yes	No	No
Technical Addendum	Yes	No	No

Overview Slide

The Overview Slide is a public-facing summary of the submission. Contestants **must** use the template provided on the HeroX platform. The information used on this slide will be made publicly available to all contestant teams and spectators.

Narrative

The Narrative describes the prototype design in detail and addresses the scored statements. Contestants are strongly encouraged to use the template provided on the HeroX platform and in Appendix E when drafting responses to the scoring statements. The total length of the Narrative cannot exceed 5,000 words. The Narrative may include up to 10 supporting visualizations or graphics. Information contained in hyperlinks to external sources will not be reviewed or considered by the reviewers or judges.

System Specification Sheet

The System Specification Sheet summarizes basic information about the system, such as weights, volumes, battery capacity, wave energy harvesting performance, and so on. Contestants **must** use the form provided on the HeroX platform and in Appendix F. Information contained in hyperlinks to external sources will not be reviewed or considered by the reviewers or judges.

Design Tables

The Design Tables itemize system components and provide details on power consumption, weights, and costs. These three tables should supplement the Narrative. Contests are strongly encouraged to use the template provided on the HeroX platform and in Appendix F. Information contained in hyperlinks to external sources will not be reviewed or considered by the reviewers or judges. It is up to contestant teams to decide the appropriate level of detail to provide in these tables.

[5] Competitors who do not want the Technical Submission or other documents to be made public will need to mark them according to the instructions in Appendix A.

Technical Addendum

The Technical Addendum supports the Narrative with technical diagrams as well as design calculations and simulation results. The Addendum may be up to 1,500 words and include up to 15 supporting images, figures, or graphs. The content in this document is limited to technical diagrams detailing system designs as well as findings and methodologies from the modeling effort. Modeling is defined as any effort to analyze or simulate an intended design by delivering quantified results that are accurate and reasonable.

The document should include the following diagrams, at a minimum, to help reviewers assess contestant teams' designs:

- External and internal CAD models of the system, to include component placement, centers of gravity, center of buoyancy, lift points, and so on.
- CAD models of the wave energy harvesting method and power take-off
- A CAD model showing the system inside the packaged volume constraint
- The operating posture of the system as it sits in the water during both self-charge and sampling
- Block diagram showing electrical energy pathways and connections among system components
- Block diagram showing data pathways and connections among system components
- A summary of anticipated capture width (or capture width ratio) and recharge power calculations for the wave energy harvesting subsystem using the Key Assumptions in Appendix C.

Information contained in hyperlinks to external sources will not be reviewed or considered by the reviewers or judges.

Scoring

The content of the submission package will be reviewed by a panel of subject matter experts. Each reviewer will assess the submission package using 26 scoring statements, which have been organized into six scoring categories. Weighting for the criteria were determined from information gleaned from interviews and surveys with ocean observation users and indicate the relative importance of those features in a mission-ready system.

Each scoring statement assesses the degree to which the reviewer agrees or disagrees that the submission package reflects the scoring statement. Each scoring statement will be scored on a scale from 1–6 points, as shown in the following table.

1	2	3	4	5	6
Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

The following table shows each of the six scoring categories as well as the number of scoring statements, the unweighted point value for each, and the relative weight of that category in determining the total score. To determine the weighted point value for each category, simply multiply the relative weight by the maximum points available.

Scoring Category	Number of Statements	Maximum Points Available	Relative Weight in Scoring
General	5	30	10%
Principal dimensions	3	18	10%
Self-charging and power management	5	30	40%
Data collection and communications	3	18	20%
Maneuverability	6	36	10%
Operations and safety	4	24	10%
Total	26	156	100%

Each scoring category and its relevant scoring criteria statements against which submissions will be scored are provided in the following tables. The left-hand column is suggested content that contestant teams may want to provide to help reviewers determine a score. The right-hand column contains the scored statements that the reviewers will be using for each scoring category.

The suggested content provided is not mandatory and teams will not be judged against it; instead, these are examples of details to include to help guide responses. Contestant teams are welcome to use other information as they see fit.

General

Suggested Content You Provide	Each Statement Scored on a 1–6 Scale
• Design of the system • Description of expected modifications or feature enhancements to the prototype that would enable it to perform hurricane monitoring; see the Narrative template for more information • A build plan that includes an estimated budget and schedule with important tasks identified • State assumptions for relevant design calculations or simulations • Description of the team members skill sets, resources available, and other attributes as they relate to the build plan • Previous efforts or work performed by the team that are relevant to the build plan	• The proposed prototype design with some refinement shows potential to successfully complete a 6-month hurricane monitoring mission in the Atlantic • The proposed plan for the BUILD Contest is reasonable given available time and resources • The methods and assumptions used for modeling and/or simulations are clearly identified and appropriate • The team's drive, knowledge, and diverse experience provide a strong competitive edge and instill confidence that they will be able to build a functioning prototype for the BUILD Contest • This submission should be strongly considered for a DESIGN Contest prize (score only a 1 or a 6)

Principal Dimensions

Suggested Content You Provide	Each Statement Scored on a 1–6 Scale
• CAD models of the system showing all bodies and major components • CAD model(s) showing the system inside the specified volume constraint dimensions • Itemized list of components and subcomponents in the design weight table to justify dry mass and buoyancy • Description of the hull shape and design and how it accommodates the required components and system design requirements	• The submission demonstrates that the proposed design, including all bodies if a multibody system, when fully assembled and ready for deployment is less than 250 kg • The submission clearly shows that the proposed design will fit within the packaged volume constraints of 1,165 millimeters (mm) by 2,400 mm x 1,220 mm. If multiple bodies are used, they both must fit within the limits. • The proposed design is positively buoyant in any likely failure mode

Self-Charging and Power Management

Suggested Content You Provide	Each Statement Scored on a 1–6 Scale
• Design calculations for peak absorbed power, average absorbed power, and average power delivered to the battery or dummy payload and CTD • Description of the power management system and how it will appropriately control power to electrical components and the payload to ensure critical systems always have power	• The proposed design and documentation demonstrate an ability to provide sufficient and realistic charge rates for the battery using only harvested wave energy in various wave conditions • The proposed design demonstrates a power management system that will suitably manage onboard energy as necessary to ensure maximization of data collection

• Description of the battery energy storage and charging system and how it is sized relative to the wave energy harvesting method and system power consumption • Itemized list of components and subcomponents in the power table to justify power consumption • Description of the wave energy harvesting system to include its principles of operation, the power-take-off method, and survivability. See the Narrative template.	• The proposed design demonstrates that the total energy storage capacity of the system is appropriately sized relative to the expected charging rate of the wave energy harvesting system and the expected power consumption of the system while operating and collecting data during a week-long deployment • The proposed design provides and justifies a minimum average power consumption when in normal operation and collecting data for all electric components of the system • The wave energy harvesting method is described in sufficient detail for assessment, its design is based upon established engineering principles, and it will likely produce the anticipated power output
Data Collection and Communications	
Suggested Content You Provide	**Each Statement Scored on a 1–6 Scale**
• CAD models showing how the CTD and dummy payload fits within the system and that they are oriented correctly • Electrical block diagram showing the flow of power to the payload • Description of the power transfer method between the wave energy harvesting system and the dummy payload and CTD; if a multibody system, describe how power is transferred between the bodies • Description of the wireless communication method(s) that can be used in indoor and outdoor settings, their communication range, and how data will be received from the system • Description of the GPS system, its precision, and the method of timekeeping for the system	• The proposed design accommodates and delivers sufficient power to the CTD and dummy payload package. If the payload and CTD is stored on a body separate from the one used for wave energy harvesting, the system demonstrates a reliable method of power transfer between the two bodies. • The proposed design demonstrates at least two appropriate wireless communication subsystems that allows transmitting and receiving of data to shore while the system is at the surface, one of which uses satellites and the other having a 100-m indoor range. If multiple bodies are used, the design allows for data transfer to and from the profiling body • The proposed design demonstrates an ability to accurately and precisely record location and time stamp for navigation and data collection
Maneuverability	
Suggested Content You Provide	**Each Statement Scored on a 1–6 Scale**
• Description and justification of the depth rating of the system and how the system will self-monitor its depth/altitude • Description how hull and dry box cable penetrations will be sealed	• The proposed design is capable of controlled self-submersion to at least 30-m depth. If multiple bodies are used, this applies to the system body that carries the CTD and dummy payload package

• Description of the leak detection method if present • CAD models showing how the CTD and dummy payload fits within the system and that they are oriented correctly • Description of the navigation and control system and how it works with the steerage system. If there are two system bodies, then provide justification that they can navigate in a coordinated fashion and locate each other. • CAD models that clearly show the control surfaces of the system body or bodies that enable the degrees of freedom specified. • Description of the propulsion system and how it is sized to meet the speed requirement. You may wish to provide estimates of the drag force of the system to justify the thrust being provided through thrusters or other means of propulsion.	• The proposed design is capable of swimming at least 20 m in a straight line while submerged with minimal deviation off the intended course. If multiple bodies are used, this applies to the system body that carries the CTD and dummy payload package. • The system body of the proposed design that carries the CTD and dummy payload package demonstrates controllable motion in at least 3 of the 6 degrees of freedom to include thrust. The system body of the proposed design that carries the wave energy harvesting module demonstrates controllable motion in at least 2 of the 6 degrees of freedom to thrust. • The proposed system demonstrates the ability to control depth/altitude during profiling of the water column to the rated depth of the system. If multiple bodies are used, this applies to the profiling body. • The proposed system demonstrates an ability to control speed between a minimum sustained speed of 0.5 knots and a top speed less than or equal to 6 knots. If the design uses multiple bodies, both must demonstrate an ability to achieve this speed requirement. • The proposed design demonstrates viable navigation systems that can be utilized in a tank or at-sea environment. If multiple bodies are used, the bodies must be able to navigate independently and in a coordinated fashion.
Operations and Safety	
Suggested Content You Provide	**Each Statement Scored on a 1–6 Scale**
• Description of how the prototype design would be modified and converted into a mission-ready system • Description of the survival strategy of the system, either as the prototype or for the mission-ready system, that would enable it to survive hurricane-force conditions • Description of how the system will not emit any materials or substances and what measures will be used to ensure no adverse harm to the environment • Description of the assembly method, how long it will take, and what tools will be required	• The proposed design, with the suggested modifications for the final mission-ready system as identified in the submission package Narrative, is robust and/or presents a viable survival strategy that would avoid a complete system failure (unable to perform mission needs) • The proposed design is unlikely to emit, either intentionally or unintentionally, any harmful substances into the environment or otherwise have an adverse environmental impact • The proposed design demonstrates a feasible deployment and installation approach, and can be practically unpacked, assembled, and deployed in less than 24

• Description of how the system would be deployed, including how it would be lifted by crewmembers, how it would be lifted when on a vessel and put into the water, and how it would be recovered by a crew in a vessel	hours (measured continuously) from its packaged state • The proposed design has given careful consideration to human safety and has minimal risks to personnel that will be handling and operating the system

Determining Winners and Making Awards

The Prize Administrator screens all completed submissions and, in consultation with DOE and NOAA, assigns subject matter expert reviewers to independently score the content of each submission package. The reviewers will comprise federal and nonfederal subject matter experts with expertise in areas relevant to the competition. Reviewers will review the submission package elements according to the evaluation criteria described in the Scoring section of this document.

Reviewer Panel Scoring: The scoring of submissions will proceed as follows:

- Reviewers will review the submission package elements independently and assess the competitors' response to each statement for all scoring statements.
- Reviewers will score each statement between one and six, depending on the degree to which the reviewer agrees that the submission reflects the statement
- Each statement score will be added together to generate a total score for the submission, ranging from 26 to 156
- The total scores from each reviewer will be averaged to develop a final score for the applicant. This score will inform the judges' decisions on awarding prizes.

Interviews: NOAA and WPTO may decide to interview a subset of competitors. The interviews would be held prior to the announcement of winners and would serve to help clarify questions the reviewers may have. Participating in interviews is not required and interviews are not an indication of winning.

Final Determination: The Director of DOE's Water Power Technologies Office and the Director of NOAA's Integrated Ocean Observing System are the final judges of the competition and will make award determinations. Determination of winners will take the reviewers' scores and the interview findings (if applicable) into account.

BUILD Contest and SPLASH Contest Testing Expectations

The official rules of the BUILD Contest and SPLASH Contest will be released at a future date and will provide details on events and tasks, test site location, logistics, and other details. The information in this section is subject to change.

BUILD Contest

The BUILD Contest, which follows the DESIGN Contest, will provide successful contestant teams with the opportunity to build their prototype designs and test them in a controlled environment before moving onto sea trials in the SPLASH Contest. The BUILD Contest is meant to assess the functional performance and viability of prototype systems that show promise to be refined into commercially ready systems for hurricane monitoring.

Eligible contestants from the DESIGN Contest will have approximately 6 months to build their prototype designs and prepare them for testing during the BUILD Contest. At the end of the BUILD Contest, contestants will participate in a series of events of increasing complexity over approximately 5 days at a state-of-the-art testing facility. Each event will assess contestant designs against discrete performance-based tasks that reflect the DESIGN Contest scoring criteria statements and categories. Later events will combine greater numbers of tasks across multiple categories and increase in complexity. During the BUILD Contest testing, prototypes will be scored against scoring criteria similar to those provided in the DESIGN Contest where points are awarded proportionally to demonstrated capabilities and performance. It is anticipated that contestant teams will have at most 24 hours (measured continuously) to assemble their systems in preparation for testing in the facility.

SPLASH Contest

The SPLASH Contest will be the third and final contest in the Ocean Observing Prize: DEVELOP Competition. Successful teams emerging from the BUILD Contest will be eligible to enter the SPLASH Contest, wherein they will refine their designs over a 3- to 6-month period and then test the system at-sea for approximately 1 week. The SPLASH Contest is meant to assess endurance and performance of the system in real-world conditions.

During the week-long test, contestant teams will demonstrate all functional aspects of their prototypes systems in an integrated way, to include maneuverability, self-charging, data collection, and wireless communication, as represented in the DESIGN Contest scoring statements. The location of the test site will be announced at a later date.

Appendix A. Additional Terms and Conditions

Universal Contest Requirements

Your submissions are subject to following terms and conditions:

- You must post the final content of your submission or upload the submission form online before the relevant contest closes. Any other form of submission will not be accepted. Late submissions will not be accepted.
- By clicking submit in HeroX the competitor is agreeing to make their video and cover page public.
- All submissions that you wish to protect from public disclosure must be marked according to the instructions in the Records Retention Section. Unmarked or improperly marked submissions will be deemed to have been provided with unlimited rights and may be used in any manner and for any purpose whatsoever. The narrative, modeling documentation, letters of commitment/support, and résumés are not intended to be made public, however, see Records Retention and Freedom of Information Act in this Appendix regarding the Freedom of Information Act.
- You must include all the required submission's elements. The prize administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. Competitors may be given an opportunity to rectify submission errors due to technical challenges or to fix non-substantive mistakes or errors in their submission packages.
- Your submission must be in English and in a format readable by Microsoft Word, Excel, or a PDF viewer. Handwritten submissions will be disqualified.
- Submissions and competitors will be disqualified if any engagement with the Ocean Observing Prize – included but not limited to the submission, the HeroX forum, or e-mails to the prize administrator – contains any matter that, in the sole discretion of DOE or NREL, is indecent, obscene, defamatory, libelous, lacking in professionalism, or demonstrates a lack of respect for people or life on this planet.
- If you click "Accept" on the HeroX platform and register for any of the contests described in this document, you are agreeing to be bound by these rules in addition to the existing HeroX Terms of Use for all purposes relating to these contests. You should print and keep a copy of these rules. These provisions apply only to the contests described here and no other contests on the HeroX platform or anywhere else.

Competitor Eligibility

To compete in this contest the registered competitor must comply with the eligibility requirements below. Eligibility is subject to verification before prizes are awarded. The registered competitor is the individual or entity that registers to compete in HeroX.

- Private entities, non-federal government entities, and individuals can compete subject to the following requirements:
    - Private entities must be incorporated in and maintain a primary place of business in the United States with majority domestic ownership and control.
    - If a private entity seeking to compete does not have domestic ownership and control, EERE may consider issuing a waiver of that eligibility requirement where the entity: submits a compelling justification; demonstrates the entity is incorporated in and maintains a primary place of business in the United States; and the entity otherwise meets the eligibility requirements. See Appendix B for more information on the waiver process.
    - Academic and non-federal government entities must be based in the United States.
    - An individual prize competitor (who is not competing as a member of a group) must be a citizen or a permanent resident of the United States.

    - A group of individuals competing as one team may win, provided that the registered competitor is a citizen or a permanent resident of the United States.
- Entities and individuals publicly banned from doing business with the U.S. government such as entities and individuals debarred, suspended, or otherwise excluded from or ineligible for participating in Federal programs are not eligible to compete;
- Entities identified on a Department of Homeland Security (DHS), Binding Operational Directives (BOD) as an entity publicly banned from doing business with the Unites States government are not eligible to compete. See https://cyber.dhs.gov/directives/;
- Entities and individuals identified as a restricted party on one or more screening lists of Department of Commerce, State and the Treasury are not eligible to compete. See Consolidated Screening List
- This prize competition is expected to positively impact U.S. economic competitiveness. Participation in a foreign government talent recruitment program[6] could conflict with this objective by resulting in unauthorized transfer of scientific and technical information to foreign government entities. Therefore, individuals participating in foreign government talent recruitment programs of foreign countries of risk[7] are not eligible to compete. Further, teams that include individuals participating in foreign government talent recruitment programs of foreign countries of risk are not eligible to compete.
- As part of your submission to this prize program, you will be required to sign the following statement:

  I am providing this submission package as part of my participation in this prize. I understand that I providing this submission to the Federal Government. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the Official Rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the Federal Government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287.

Verification for Payments

The prize administrator will verify the identity and role of all competitors before distributing any prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The prize administrator will notify winning competitors using provided email contact information for the individual or entity that was responsible for the submission. Each competitor will be required to sign and return to the prize administrator, within 30 days of the date on the notice, a completed NREL Request for ACH Banking Information form and a completed IRS Form W-9. In the sole discretion of the prize administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity does not respond to notifications; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; (iv) the submission or person/entity is disqualified for any other reason.

---

[6] Foreign government talent recruitment program is defined as an effort directly or indirectly organized, managed, or funded by a foreign government to recruit science and technology professionals or students (regardless of citizenship or national origin, and whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to incentivize the targeted individual to physically relocate to the foreign state for the above purpose. Some programs allow for or encourage continued employment at U.S. research facilities or receipt of Federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

[7] Currently, the list of countries of risk includes Russia, Iran, North Korea, and China.

In the event of a dispute as to any registration, the authorized account holder of the email address used to register will be deemed to be the competitor. The "authorized account holder" is the natural person or legal entity assigned an email address by an Internet access provider, online service provider, or other organization responsible for assigning email addresses for the domain associated with the submitted address. All competitors may be required to show proof of being the authorized account holder.

Teams and Single Entity Awards

The prize administrator will award a single dollar amount to the designated primary submitter, whether consisting of a single or multiple entities. The primary submitter is solely responsible for allocating any prize funds among its member competitors or teammates as they deem appropriate. The prize administrator will not arbitrate, intervene, advise on, or resolve any matters or disputes between team members or competitors.

Submission Rights

By making a submission and consenting to the rules of the contest, a competitor is granting to DOE, the prize administrator, and any other third parties supporting DOE in the contest, a license to display publicly and use the parts of the submission that are designated as “public” for government purposes. This license includes posting or linking to the public portions of the submission on the prize administrator or HeroX applications, including the contest website, DOE websites, and partner websites, and the inclusion of the submission in any other media worldwide. The submission may be viewed by the DOE, prize administrator, and judges and reviewers for purposes of the contests, including but not limited to screening and evaluation purposes. The prize administrator and any third parties acting on their behalf will also have the right to publicize competitors’ names and, as applicable, the names of competitors’ team members and organization, which participated in the submission on the contest website indefinitely. By entering, the competitor represents and warrants that:

1. Competitor’s entire submission is an original work by competitor and competitor has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, likeness of any third party, musical recordings, clips of videos, television programs or motion pictures) in or in connection with the submission, unless (i) otherwise requested by the prize administrator and/or disclosed by competitor in the submission, and (ii) competitor has either obtained the rights to use such third-party content or the content of the submission is considered in the public domain without any limitations on use.
2. Unless otherwise disclosed in the submission, the use thereof by prize administrator, or the exercise by prize administrator of any of the rights granted by competitor under these rules, does not and will not infringe or violate any rights of any third party or entity, including, without limitation, patent, copyright, trademark, trade secret, defamation, privacy, publicity, false light, misappropriation, intentional or negligent infliction of emotional distress, confidentiality, or any contractual or other rights;
3. All persons who were engaged by the competitor to work on the submission or who appear in the submission in any manner have:
    a. Given the competitor their express written consent to submit the submission for exhibition and other exploitation in any manner and in any and all media, whether now existing or hereafter discovered, throughout the world;
    b. Provided written permission to include their name, image, or pictures in or with the submission (or, if a minor who is not competitor’s child, competitor must have the permission of the minor’s parent or legal guardian) and the competitor may be asked by the prize administrator to provide permission in writing;
    c. Not been and are not currently under any union or guild agreement that results in any ongoing obligations resulting from the use, exhibition, or other exploitation of the submission.

Copyright

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the competitor or that the competitor has acquired sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules; that the submission does not infringe upon any copyright or any other third-party rights of which the competitor is aware; and that the submission is free of malware.

Contest Subject to Applicable Law

All contests are subject to all applicable federal laws and regulations. Participation constitutes each participant's full and unconditional agreement to these Official Contest Rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds; the final award is contingent upon the availability of appropriations.

Resolution of Disputes

The U.S. Department of Energy is solely responsible for administrative decisions, which are final and binding in all matters related to the contest. Neither the U.S. Department of Energy nor the prize administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

Publicity

The winners of these prizes (collectively, "winners") will be featured on the DOE and NREL websites. Except where prohibited, participation in the contest constitutes each winner's consent to DOE's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media worldwide, without further permission, payment, or consideration.

Liability

Upon registration, all participants agree to assume any and all risks of injury or loss in connection with or in any way arising from participation in this contest. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees, and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential, and whether foreseeable or not), arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this contest delegated to the director of the Water Power Technologies Office, the director has determined that no liability insurance naming DOE as an insured will be required of competitors to compete in this competition per 15 USC 3719(i)(2). Competitors should assess the risks associated with their proposed activities and adequately insure themselves against possible losses.

Records Retention and Freedom of Information Act

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act. The following applies only to portions of the submission not designated as

public information in instructions for submission. If a submission includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose. The submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

> Notice of Restriction on Disclosure and Use of Data:
> Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a FOIA representative prior to the release of materials.

Privacy

If you choose to provide HeroX with personal information by registering or completing the submission package through the contest website, you understand that such information will be transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to you in matters regarding your submission and/or the contest unless you choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE and NREL are not collecting any information for commercial marketing.

General Conditions

DOE reserves the right to cancel, suspend, and/or modify the contest, or any part of it, at any time. If any fraud, technical failures, or any other factor beyond DOE's reasonable control impairs the integrity or proper functioning of the contests, as determined by DOE in its sole discretion, DOE may cancel the contest.

Any performance towards contest goals is conducted entirely at the risk of the competitor and DOE shall not compensate any competitors for any activities performed in furtherance of this prize. Although DOE may indicate that it will select up to several quarterfinalists, semifinalists, finalists and winners for each contest, DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If, in DOE's determination, no competitors are likely to achieve the goals of the program, DOE will select no competitors to be quarterfinalists, semifinalists, finalists, or winners and will award no prize money.

Program Policy Factors

While the scores of the expert reviewers will be carefully considered, it is the role of the prize judge to maximize the impact of contest funds. Some factors outside the control of competitors and beyond the independent expert reviewer scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the reviewers' scores, the below program policy factors may be considered in determining winners:

- Geographic diversity and potential economic impact of projects.
- Whether the use of additional DOE funds and provided resources are non-duplicative and compatible with the stated goals of this program and the DOE mission generally.
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other competitors.
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers.
- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefit to U.S. taxpayers.
- The degree to which the activities described in the submission package to this contest have been or will be performed in the United States.
- The degree to which the submission will accelerate transformational technological, financial, or workforce advances in areas that industry by itself is not likely to undertake because of technical or financial uncertainty.
- The degree to which the submission supports complementary DOE funded efforts or projects, which, when taken together, will best achieve the goals and objectives of DOE.
- The degree to which the submission expands DOE's funding to new competitors and recipients who have not been supported by DOE in the past.
- The degree to which the submission enables new and expanding market segments.
- Whether the project promotes increased coordination with nongovernmental entities for the demonstration of technologies and research applications to facilitate technology transfer.
- Whether submission content sufficiently confirms the competitor's intent to commercialize early-stage technology and establish a viable U.S.-based business in the near future.

National Environmental Policy Act (NEPA) Compliance

DOE's administration of the Powering the Blue Economy: Ocean Observing Prize is subject to NEPA (42 USC 4321, et seq.). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website, at http://nepa.energy.gov/.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all participants in the DESIGN Contest will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their participation in the prize competition. Participants may be asked to provide DOE with information on fabrication and testing of their device such that DOE can conduct a meaningful evaluation of the potential environmental impacts.
Return of Funds

As a condition of receiving a prize, competitors agree that if the prize was made based on fraudulent or inaccurate information provided by the competitor to DOE, DOE has the right to demand that any prize funds or the value of other non-cash prizes be returned to the government. ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE CONTEST.

Appendix B. Requirements for Requests to Waive the "Majority Domestic Ownership and Control" Eligibility Requirement

If an entity seeking to compete as the registered competitor, does not have domestic ownership and control, the entity should include a waiver request that addresses the following waiver criteria and content requirements below along with their submission. EERE may consider issuing a waiver of that eligibility requirement where the entity submits a compelling justification; the entity is incorporated in and maintains a primary place of business in the United States; and the entity otherwise meets the eligibility criteria. There are no rights to appeal EERE's decision on the waiver request.

Waiver Criteria

Entities seeking a waiver must demonstrate to the satisfaction of EERE that its participation: (1) has a high likelihood of furthering the objectives of this prize competition and (2) aligns with the best interest of the U.S. industry and U.S. economic development.

Content for Waiver Request

A waiver request must include the following information:

a. Entity's name and place of incorporation;
b. The location of the entity's primary place of business;
c. A statement describing the extent the entity is owned or control by a foreign government, agency, firm, corporation, or person who is not a citizen or permanent resident of the United States, including the applicable percentage of ownership/control;
d. A compelling justification that addresses the waiver criteria stated above;
e. A description of the project's anticipated contributions to the U.S. economy;
f. A description of how the entity has benefitted U.S. research, development and manufacturing, including contributions to employment in the United States and growth in new U.S. markets and jobs; and
g. A description of how the entity has promoted domestic manufacturing of products and/or services.

Waivers should be submitted to WPTOPrizes@ee.doe.gov.

Appendix C. DEVELOP Competition DESIGN Contest Key Assumptions

Each system must predict the wave energy harvesting performance of the proposed system using an appropriate modeling approach given the technology being assessed. The models will be used to evaluate the anticipated performance of each submission.

All submissions must evaluate their technology for each of the wave conditions listed under the Assumed Sea Conditions section with an assumed water depth of 5 meters (m). The assumed wave conditions are representative of a real-world wave climate in the Atlantic Ocean as well as what is feasible to test in a tank. The assumed conditions used for modeling may not be reflective of final testing conditions during the BUILD and SPLASH Contests.

Assumed Test Facility

The BUILD Contest of the DEVELOP Competition will be conducted in a wave basin or flume, with systems completing a series of events within the contest, to encompass self-charging and power management, data collections and communications, and maneuverability, as well as general endurance and reliability. The purpose of the BUILD Contest will be to identify promising systems for competition in the subsequent at-sea SPLASH Contest.

This facility will likely be a facility *of similar characteristics* to the following. The provided detail is not meant to reference a specific facility, but instead provide representative competition constraints to contestants.

Characteristic	Specification(s)
Length overall	40 m
Width overall	20 m
Maximum depth	2.5 m
Water salinity	Fresh
Water temperature (nominal)	55°F
Wavemaker	Paddles along two walls
Wave spectra	Within 10% accuracy at a single point
Wave directionality	+/- 30 degree
Beach absorption	>90%
Receiving	Loading bay and forklifts
Davit lift capacity	250 kilograms
Shore power availability	Standard 110-volt 50- to 60-hertz Hz wall plugs
Wireless internet	Unavailable
Cellular signal	Yes

Assumed Sea Conditions

For modeling and design purposes, the following sea conditions should be assumed. The Wave Conditions Table is representative of likely test conditions, which may not be the exact conditions experienced during testing in the BUILD or SPLASH Contest.

To ensure consistent modeling during the DESIGN Contest, each system must be analyzed using a time domain model assuming a Bretschneider spectrum, as defined here:

$$S(\omega) = \frac{5}{16}\frac{\omega_m^4}{\omega^5} H_s^2 e^{-5\omega_m^4/4\omega^4}$$

where ω is the wave frequency in radians per second, and ω_m is the most likely frequency of any given wave and H_s is the significant wave height in meters. Here, significant wave height means the average height of the highest one-third of all waves measured.

Sea State	Significant Wave Height (m)	Energy Period (seconds)	Time for Each Wave Condition (hours) (%)
W1	0.5	6	26.4 (22%)
W2	0.5	10	6 (5%)
W3	1.0	6	33.6 (28%)
W4	1.5	7	26.4 (22%)
W5	2.0	7	26.4 (22%)
W6	3.0	7	1.2 (1%)

Appendix D. DEVELOP Competition Dummy Payload and Power Monitor

Overview

Contestant teams wishing to compete in the Ocean Observing Prize DEVELOP Competition must incorporate the Dummy Payload and Power Monitor (DPPM) into their designs as outlined in this document. The DPPM serves two purposes: (1) mimic a commercial acoustic Doppler current profiler (ADCP) for monitoring water currents and (2) measure the power produced and consumed by the system. If contestants successfully design their systems to accommodate this DPPM, later modifications to the system to accommodate a real ADCP will ideally be less onerous. During the DESIGN Contest, only the designs of the DPPM will be provided. During the BUILD and SPLASH Contests, the physical unit will be provided to contestant teams to integrate into their prototype.

Detailed CAD models of the DPPM are available on the HeroX resources page.

Physical Dimensions

Physical dimensions will be based on a commercially available ADCP; please see the CAD drawings on the HeroX resources page for dimensions. The DPPM will be neutrally buoyant at the time of testing. The DPMM will be a 152-millimeter (mm) cylinder that is 262 mm long.

Figure C-1. The DPPM reference model

Mounting

The DPPM must be mounted in the profiling body such that the face of the instrument points directly down toward the ocean floor when the system is sampling. The face must be in contact with water with no obstructions to its field of view. The DPPM will have four 6.5-mm mounting points as located in the CAD drawings.

Connectors and Interfacing

The contestant team's power system will be integrated into the DPPM for power monitoring and scoring purposes. All power from the wave energy converter and battery will be actively monitored through two connectors: a four-pin power connector to measure current and voltage from the wave energy converter (WEC) and battery system, and an eight-pin connector to provide system ground and payload interfaces.

DPPM Power Connector Pins

1-1 WEC Power (output)
1-2 WEC Power (AUV System)
1-3 System Battery (+)
1-4 AUV System

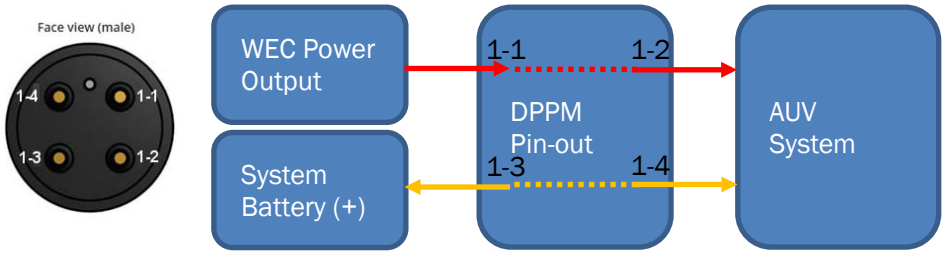


Figure C-2. DPPM Power Connector Pins

The DPPM will have a male Subconn 4-pin wet-mateable connector as specified here. To interface with the DPPM, contestants will use the power connector pin labels indicated in Figure C-2 with the labels in Figure C-3 to integrate their system to the DPPM.

Dummy Payload Connections and Power

The DPPM will be connected to the contestants profiling body with an eight-pin connector, as specified here.

The DPPM will have an eight-pin male connector with the following pinout. The contestant team's male connector should have the following pinout.

Payload Connector Pin Labels

2-1 Payload Power (+)
2-2 System Ground (-)
2-3 Reserved for judge's use
2-4 Reserved for judge's use
2-5 Reserved for judge's use
2-6 Reserved for judge's use
2-7 Reserved for judge's use
2-8 Reserved for judge's use

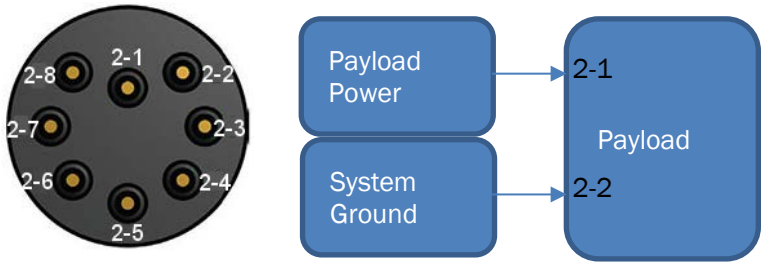


Figure C-3. Payload Connector Pin Labels

For all dimensions, connector locations, and orientation, consult the CAD drawing.

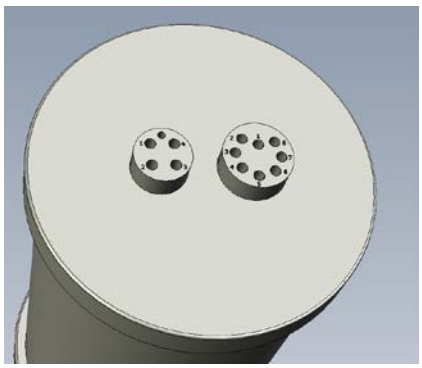


Figure C-4. connector placement

For scoring purposes, the dummy payload may be powered by applying 12—48 DC volts to the input of the DPPM (Pin 1) on a 100-watt (W) load. If the voltage drops below 12 volts (V), the DPPM will stop drawing power. The load will only be considered powered for scoring purposes when actively drawing 100 W.

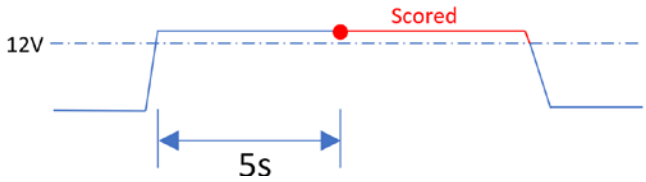
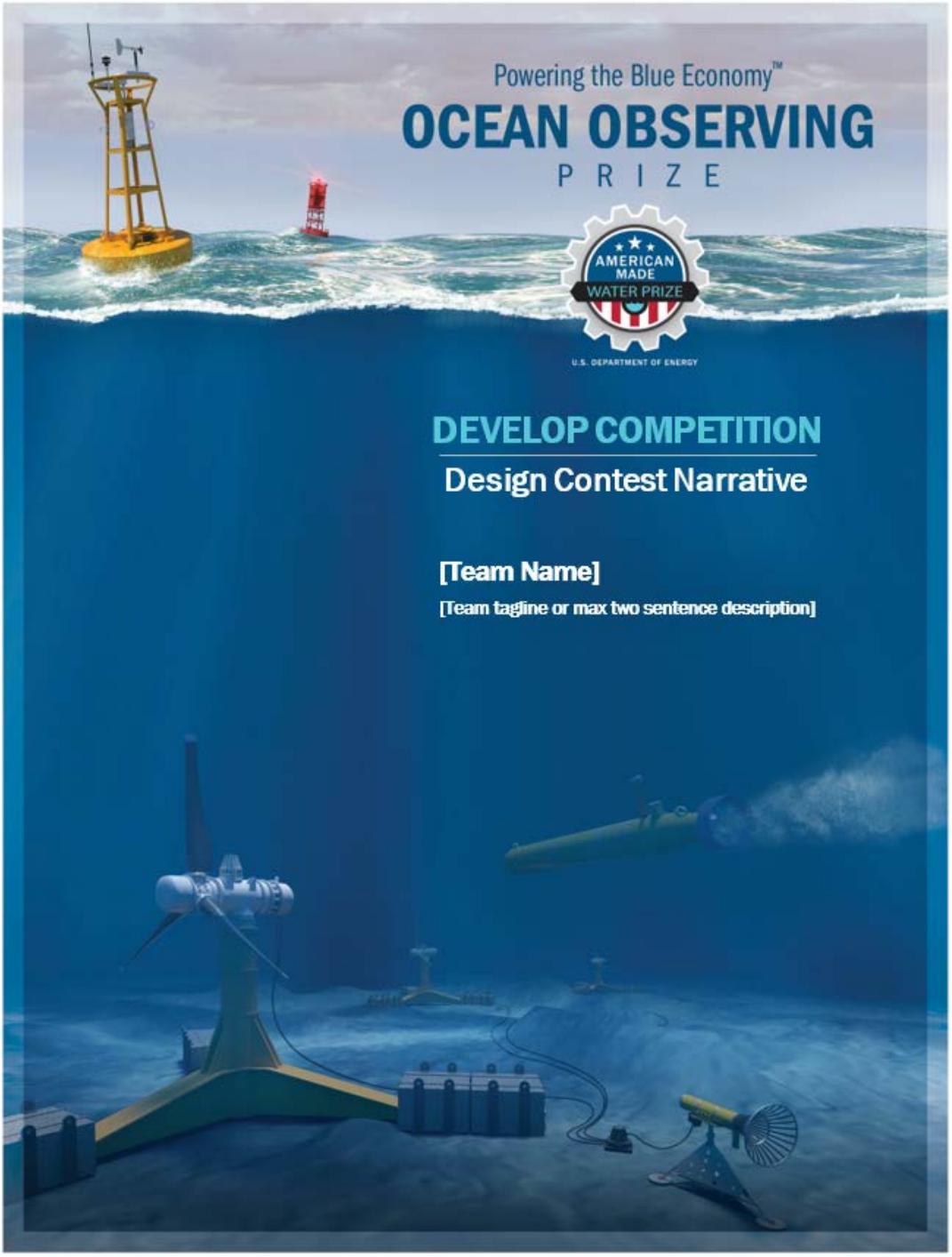


Figure C-4. Powering the payload

Internal Batteries

There shall be no batteries or other energy storage devices except those specified in the competition rules apart from small primary batteries integrated into clocks/global positioning system (GPS)/memory assemblies. If there are any questions on whether a given battery is allowable, email the prize administration team at OceanObserving@nrel.gov.

Appendix E. DEVELOP Competition DESIGN Contest Narrative Template



General

Design Philosophy

[Discuss the team's approach when designing the system, what elements the team focused on as most important, how the prototype is working towards a commercial system, etc.]

Market Opportunity

[Aside from the intended mission, discuss other ocean observing applications for the proposed design that the team thinks would be viable pathways to commercialization.]

Team Experience

[Describe the team, its relative experience, and available resources. Highlight unique attributes that set the team apart from the competition or give them an advantage over others.]

System Architecture

Hull Design and Structure

[Describe the hull design and component placement for the system. Describe the shape of the hull, principal dimensions, weights, materials used, depth rating, safety features, buoyancy, etc.]

Wave Energy Harvesting

[Describe the wave energy harvesting method, its principles of operation, anticipated power output, the power take-off method, etc.]

Propulsion

[Describe the means of propulsion for the system and justify that this method will be sufficient given the estimated drag and energy storage capacity of the system. Demonstrate that the system will be able to achieve the speed requirement.]

Payload and Sampling

[Describe how the system accommodates the selected CTD and the dummy payload package. Describe how the CTD and dummy payload package are situated in the system, how power is delivered, how data is collected and stored. Justify that the system will be able to control depth/altitude to collect data at specified depths.]

Communications

[Describe the communication subsystem to include such topics as: communication protocol, redundancy, data packet size, telemetry rate, range, and performance in indoor and outdoor settings.]

Navigation and Control

[Describe the navigation subsystem that allows the system to follow a course, turn, etc. Demonstrate the degrees of freedom desired for the system. Discuss the feedback and control method that allows the system to course correct. Discuss the different navigation methods for surface and subsurface operation. If a multi-body body system, describe how the two bodies will navigate in a coordinated fashion. Discuss the GPS subsystem chosen and its predicted performance. Discuss the method of how the system will control depth/altitude.]

Power Systems

[Describe the system's power subsystem to include the battery, charging components, waterproofing, voltages, etc. Describe the power management subsystem and its control strategy. Discuss how the required kill switch will affect the system. Justify the minimum average power consumption of the system while its operating and collecting data. Estimate the operating duration of the prototype system when in normal operation.]

Safety and Environmental

[Describe any potentially hazardous materials, components or fluids that may pose a threat to human or environmental health. Describe any safety features on the system to protect operators. Discuss the weight of the prototype system and how this will be safely handled by crew.]

Operations

Energy Harvesting

[Describe how the system will perform in different wave conditions, the estimated power output, and how the rate of charge will be sufficient for the system.]

Sampling and Data Collection

[Describe how the prototype system will perform profiling of the water column using the CTD and dummy payload and how the data will be handled on board and/or processed. Describe how the system will control depth/altitude while sampling. Justify the estimated power consumption while sampling.]

Communications

[Describe how the contestant team will send commands and receive data to the prototype system]

Assembly, deployment and recovery

[Describe in general terms how the system will be assembled from it's packaged-state, how long it is estimate to take, methods of safe deployment and recovery into and from the water using a vessel, and other aspects that relate to preparing the prototype system for deployment. Include how the system will be stored in the specified volume.]

Build Plan

Estimated Costs

[Describe the estimated costs for building the prototype. Contestant teams are not being scored on the cost of systems but in the accuracy of the information]

Tasks and Schedule

[Describe the major tasks that need to occur to build the proposed design, including the order in which they should occur and the estimated time to complete them.]

Risks and Mitigation Strategies

[Describe any perceived risks that the team might encounter in their build plan and how the team will effectively mitigate them]

System Modifications

[Describe future modifications to the prototype design that would make it suitable for the intended mission of a six-month deployment for hurricane monitoring in the Atlantic. This could include changes to the hull structure, control strategies, extreme sea-state survival strategies, material changes, etc.]

Appendix F. DEVELOP Competition DESIGN Contest System Specification Sheet Template

Powering the Blue Economy™: Ocean Observing Prize

Specifications Sheet

Please fill out only the relevant fields in the form below, describing the specifications of your system.

Upload Image

TEAM NAME

System Description

RESET SAVE

General Specifications

Crate Volume		m^3
Packaged Weight		kg

System Body	Profiling		Non-profiling	
Length Overall		cm		cm
Breadth		cm		cm
Height		cm		cm
Mass (dry)		kg		kg
Displacement		kg		kg
Buoyancy		kgf		kgf
Depth Rating		m		m
Number of Lift Points				

Performance

WEC Archetype -- Select --

System Body	Profiling		Non-profiling	
Characteristic Width		m		m
Capture Width*		m		m
Max. Recharge Power*		W		W
Ave. Recharge Power*		W		W
Battery chemistry				
Battery capacity		Wh		Wh
Number of Thrusters				
Max Forward Thrust		kgf		kgf
Rated Speed		m/s		m/s
Range at Rated Speed		m		m

Sensors and Communications

GPS Make/Model		/		
CTD Make/Model		/		

System Body	Profiling	Non-profiling
Wireless Comms		
Satellite Comms.		

*given the resource described in the Wave Conditions Table of the Rules Document

Appendix G. DEVELOP Competition DESIGN Contest Design Tables

The Design Tables are provided here for reference. Please use the MS Excel Workbook provided on the HeroX resources page for filling in each table.

Weight Table

Fill out **one table for each system body**. Use as many rows as necessary and include all components/subsystems. Subsystems can be grouped as needed, for example if components are located inside a pressure housing use this as one line item to ensure components are not double counted in weight or buoyancy. Assume freshwater for displacement weight. Use as many rows as necessary to justify system weight is below 250 kg. Do not modify worksheet formulas.

[Team Name] - Profiling Body

Category	Component	Qty.	Weight (kg)	Displacement (kg)	Buoyancy (kgf)	Description	Note
Propulsion	Motor Housing - EXAMPLE	2	0.4	0.5	0.98	Cylindrical PVC pipe	
	Propeller - EXAMPLE	2	0.02	0.02	0.00	Complex geometry	
Navigation					0.00		
					0.00		
Communication					0.00		
					0.00		
Sensors					0.00		
					0.00		
Hull	Foam - EXAMPLE	1	5	41	353.04		
	Metal frame - EXAMPLE	1	40	5	-343.23		
Payloads		1			0.00		
					0.00		
Other	Fasteners - EXAMPLE		2	1	-9.81	Assorted bolts, nuts, etc	
Total			47.42		0.98		

Power Table

Fill out **one table for each system body**. Use as many rows as necessary and include all components/systems. Subsystems can be grouped as needed. Do not modify worksheet formulas.

[Team Name] - Profiling Body

Component	Qty.	Nominal Voltage (V)	Capacity (Ah)	Battery Chemistry	Power (Wh)	Note
Battery - EXAMPLE	3	14.4	20	Li-Ion	864	

Category	Component	Qty.	Nominal Voltage (V)	Power draw (A)	Est. Duty Cycle (%)	Power (Wh)	Note
Propulsion	Thruster - EXAMPLE	2	16	5	100	160	At 2 knots
						0	
Navigation						0	
						0	
Communication						0	
						0	
Sensors						0	
						0	
Payloads	CTD - EXAMPLE	1	12	1	100	12	
	DPPM	1	14.4	6.9	100	100	
Other	Control System - EXAMPLE	1	5	4	100	20	
Total						292	

Est. Operating Hours = **2.96**

Cost Table

Fill out **one table for entire system**. Use as many rows as necessary and include all components/subsystems. Subsystems can be grouped as needed. Costs should be estimate of how much it would cost to acquire the component or subsystem, do not include labor costs for contestant team to install or assemble. Do not modify worksheet formulas.

[Team Name]

Category	Component	Qty.	Unit Cost (USD)	Subtotal Cost (USD)	Note
Propulsion	Motor Housing - EXAMPLE	2	$ 20	$ 40	Joe's Supply Co.
	Propeller - EXAMPLE	2	$ 35	$ 70	
Navigation				$ -	
				$ -	
Communication				$ -	
				$ -	
Sensors				$ -	
				$ -	
Hull	Foam - EXAMPLE	1	$ 100	$ 100	
	Metal frame - EXAMPLE	1	$ 1,500	$ 1,500	
Payloads				$ -	
				$ -	
Other	Fasteners - EXAMPLE		$ 75	$ -	Assorted bolts, nuts, etc
Total				$ 1,710	

Appendix H. DEVELOP Competition Contestant Resources

General

General resources include:

- The OpenROV Build Plans and Code Repository:
  - https://github.com/OpenROV/
  - https://openrov.dozuki.com/Guide/How+to+Assemble+OpenROV+v2.5/2
  - https://forum.openrov.com/t/build-your-own-openrov/2091

Modeling and Simulation

Modeling and simulation resources include:

- **MHKiT**. Open-source software developed in Python and MATLAB that provides marine energy technology developers with tools for data processing and visualization, resource assessment, device performance, and loads. https://mhkit-software.github.io/MHKiT/overview.html
- **WEC-Sim**. An open-source code for simulating wave energy converters. https://wec-sim.github.io/WEC-Sim/
  - Use in practice example: https://ieeexplore.ieee.org/abstract/document/7829405
- **Babarit (2015)** for measuring and modeling capture width: A. Babarit. 2015. "A database of capture width ratio of wave energy converters," Renewable Energy, Volume 80, Pages 610-628, ISSN 0960-1481. https://doi.org/10.1016/j.renene.2015.02.049.

Relevant Research Papers

The following research papers may be helpful:

- "Design of an Autonomous Underwater Vehicle (AUV) Charging System for Underway, Underwater Recharging"
  - https://calhoun.nps.edu/handle/10945/43069
- "Design considerations for engineering Autonomous Underwater Vehicles"
  - https://dspace.mit.edu/handle/1721.1/39893
- "Development and Design of a Compact Autonomous Underwater Vehicle: Zeno AUV"
  - https://www.sciencedirect.com/science/article/pii/S2405896318321529.