WAVE ENERGY PRIZE

U.S. DEPARTMENT OF ENERGY

WHY
Wave Energy?

Accessible ÷ **Renewable** ÷ **Predictable**

...and significant opportunities exist to reduce cost.

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Where is the domestic wave energy resource?

Annual Wave Power Density Across the US

low
high

NREL MHK Atlas

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IMPACT

Extracting just **5%** of the approximate 1,170 TWh/year of gross resource potential could result in wave energy powering **5 million** American homes with clean energy.

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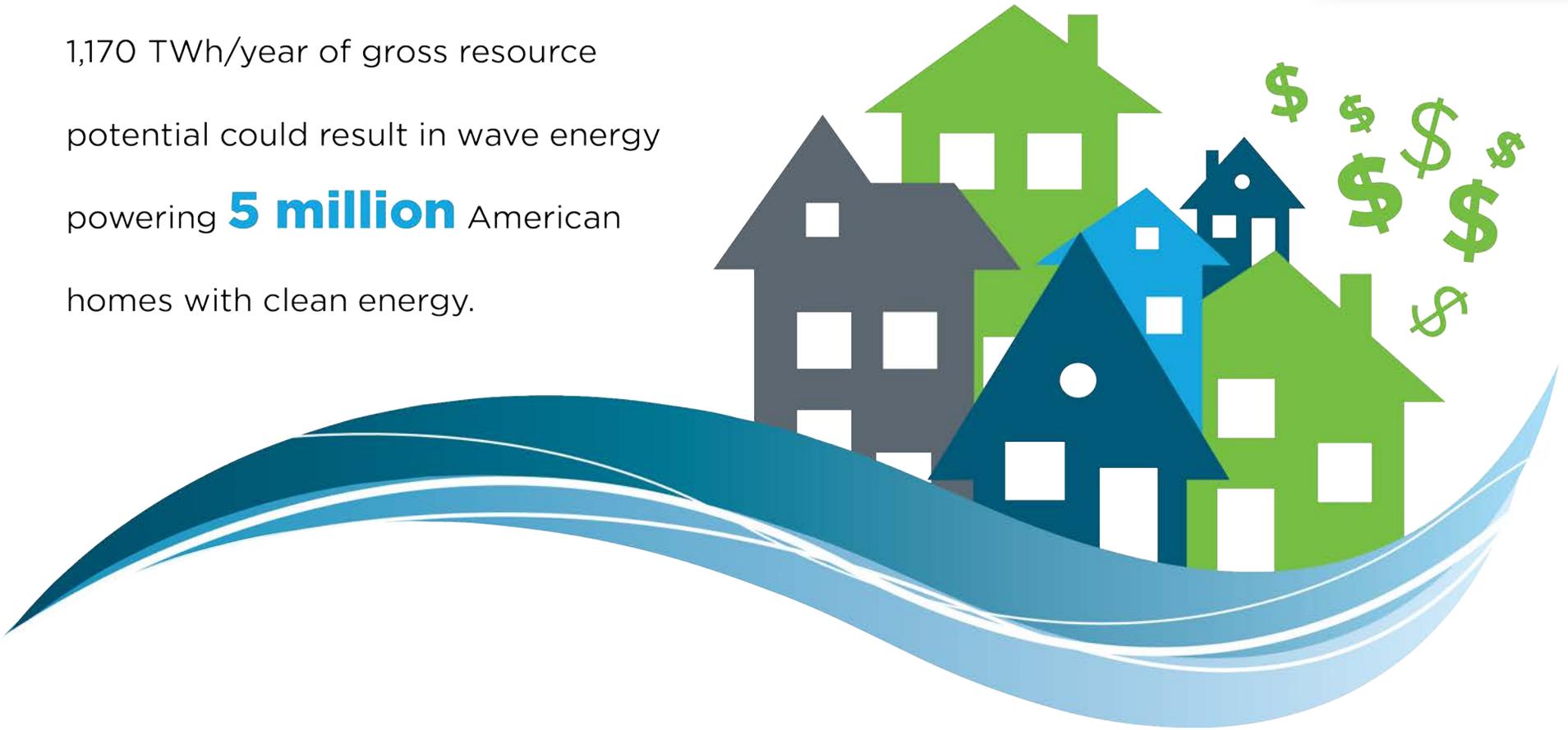
SPARKING
Innovation

Prizes drive **radical** technological leaps.

PRIZE$...

- Pay only for successes that meet ambitious prize goals;

- Create opportunities to showcase novel approaches from all developers-new and experienced;

- Bring out-of-discipline perspectives to bear; and

- Can mobilize more investment than the prize purse value.

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Q. WHAT IS
The Wave Energy Prize?

A. A DOE investment aimed at driving down the cost of wave energy that will:

Accelerate the development of game-changing technologies	**Create devices that can double energy capture from ocean waves for the same material cost**	Provide comparable test results from multiple device types

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Prize Goal:

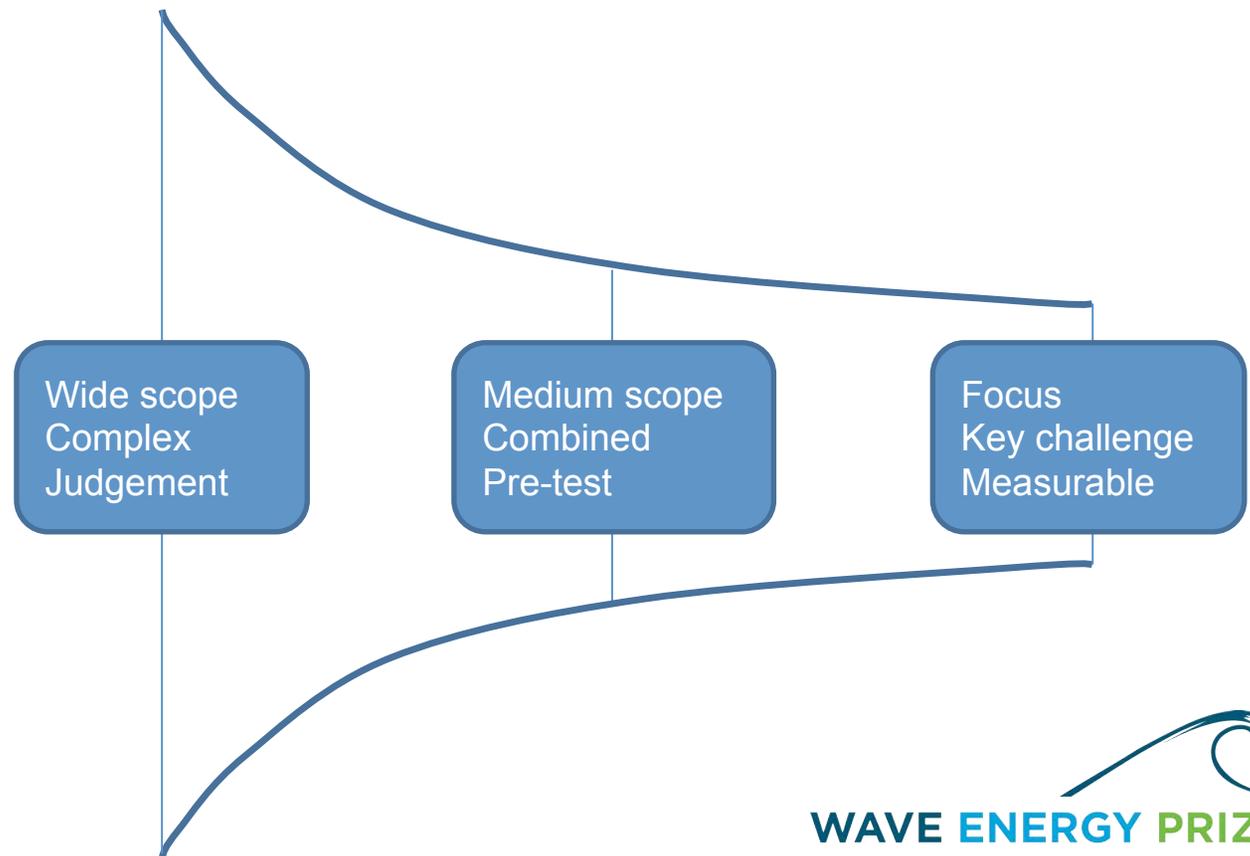## To Halve the Cost of Energy Produced by Ocean Waves

- Aggressive but achievable goal.

- If goal is met, it would represent a groundbreaking advancement over current devices.

- If further developed, the device(s) could provide the kind of radical technology leap required to deliver cost-competitive wave power.

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Development of the
Wave Energy Prize Metrics

Metric Criteria

- Objective
- Clear
- Transparent
- Measurable
- Relevant
- Holistic
- Embrace Complexity
- Embrace Diversity
- Embrace Novelty
- Include existing payers
- Welcome new players
- Tackle key challenges
- Focus
- Disruptive
- Prize Character
- Practicality
- Ready for the Unexpected

Wide scope
Complex
Judgement

Medium scope
Combined
Pre-test

Focus
Key challenge
Measurable

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The **ACE** Metric

The Prize has selected ACE as a proxy for LCOE for comparing low Technology Readiness Level WEC concepts

$$\text{ACE} = \text{ACCW} / \text{CCE}$$

Average Climate Capture Width (ACCW) = The absorbed power of the device (kW) divided by the wave energy flux per meter crest width in kW/m

Characteristic Capital Expenditure (CCE) = Total Surface Area (m^2) x Representative Structural Thickness (m) x Density of Material(s) (kg/m^3) x Cost of Manufactured Material per unit Mass ($/kg) for all applicable materials.

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Advancing through the Prize Funnel:
Four technology gates

REGISTRATION

Design
3 months
Develop design concept

TECHNOLOGY GATE 1

Selecting qualified participants
Up to 20 qualified devices for small scale testing

Technical Submission

Build and Model
5.5 months
1/50th scale device

TECHNOLOGY GATE 2

Determining Finalists and Alternates
Up to 10 finalists and 2 alternate devices for MASK Basin scale testing

1/50th Scale Testing, Numerical Modeling, Model Construction and Build Plan, and Revised Technical Submission

Build and Verify
4.5 months
1/20th scale device

TECHNOLOGY GATE 3

Verifying readiness for MASK scale testing prototype devices
Up to 10 finalists identified for testing at MASK Basin

Photo + Video Documentation

Test and Award
3 months
One week of testing per team

TECHNOLOGY GATE 4

Identifying the winner(s) of the Prize
Grand Prize Winner, $1.5M; 2nd Place Finisher, $500K; 3rd Place Finisher, $250K

1/20th Scale Testing

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2015

2016

TIMELINE

TECHNOLOGY GATE 1

All Registered Teams

Up to 20 Qualified Teams

Phase 1: Design

April	June	July	August	January

April

Wave Energy Prize registration opens on waveenergyprize.org

June

15th
Wave Energy Prize registration closes.

CLOSED

Announcement of Official Registered Teams!

July

15th
Technical Submission deadline for Teams.

July 16th through Aug. 13th
Technical Submissions reviewed and Qualified Teams determined.

August

14th
Announcement of Qualified Teams!

through Jan. 29th
Qualified Teams: develop a 1/50th scale model; generate numerical model simulations; complete the Scale Model Design and Construction Plan; and participate in small-scale tank testing for validation of their concepts.

January

29th
Results of small scale testing and 1/20th Scale Model Design and Construction Plan due from Teams.

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2016

TIMELINE

TECHNOLOGY GATE 2

TECHNOLOGY GATE 3

TECHNOLOGY GATE 4

Up to 10 Finalist & 2 Alternate Teams

Up to 10 Finalist Teams

Phase 2: Build

Phase 3: Test & Evaluation

| March	June	July	August	November
1st Announcement of Finalists and Alternates!	**15th** Finalists and Alternates submit build progress report for verification of test readiness.	**1st** Finalists verified for testing in the MASK Basin announced!	**1st through Oct. 10th** Finalists' 1/20th scale WEC devices are tested at MASK Basin; top ranking Teams determined.	**Awards ceremony and winning Team(s) announced!**
1st through July Finalists and Alternates construct their 1/20th scale WEC device.		**18th** 1/20th scale WEC models must be received by MASK Basin for testing.		

WAVE ENERGY PRIZE

Department of Navy Energy Program

SECNAV has set two priorities for Naval energy reform:
Energy Security and Energy Independence.

- **Energy Security** is achieved by utilizing sustainable sources that meet tactical, expeditionary, and shore operational requirements and force sustainment functions, and having the ability to protect and deliver sufficient energy to meet operational needs.

- **Energy Independence** is achieved when Naval forces rely only on energy resources that are not subject to intentional or accidental supply disruptions. As a priority, energy independence increases operational effectiveness by making Naval forces more energy self-sufficient and less dependent on vulnerable energy production and supply lines.
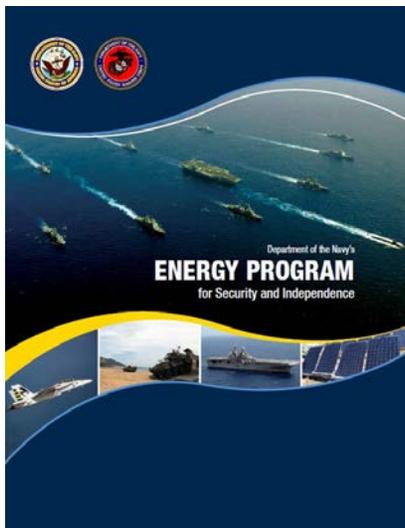
1. Energy Efficient Acquisition	Evaluation of energy factors will be mandatory when awarding contracts for systems and buildings.
2. Sail the "Great Green Fleet"	DON will demonstrate a Green Strike Group in local operations by 2012 and sail it by 2016.
3. Reduce Non-Tactical Petroleum Use	By 2015, DON will reduce petroleum use in the commercial vehicle fleet by 50%.
4. Increase Alternative Energy Ashore	By 2020, DON will produce at least 50% of shore based energy requirements from alternative sources; 50% of DON installations will be net-zero.
5. Increase Alternative Energy Use DON-Wide	By 2020, 50% of total DON energy consumption will come from alternative sources.

October 2010

Memorandum of Understanding

Dept. of Energy & Dept. of Defense

Framework & partnership between DOE & DOD

- Includes: renewable energy, basic research, & other areas of effort

- DOE is lead federal agency for development

- DOD partnering provides opportunity to accelerate deployment of technologies

  - Collaborate on S&T

  - Develop joint initiatives for energy technology research

  - Encourage professional exchanges & relationships

    between DOE & DOD

Memorandum of Understanding
Between
U. S. Department of Energy
And
U. S. Department of Defense

Concerning Cooperation in a Strategic Partnership to Enhance Energy Security

I. Purpose

The purpose of this Memorandum of Understanding (MOU) is to identify a framework for cooperation and partnership between the Department of Energy (DOE) and the Department of Defense (DOD), hereafter referred to as the Parties, to strengthen coordination of efforts to enhance national energy security, and demonstrate Federal Government leadership in transitioning America to a low carbon economy. This MOU covers, but is not limited to, efforts in the areas of energy efficiency, renewable energy, water efficiency, fossil fuels, alternative fuels, efficient transportation technologies and fueling infrastructure, grid security, smart grid, storage, waste-to-energy, basic science research, mobile/deployable power, small modular reactor nuclear energy, and related areas.

II. Legal Authority

DOE enters into this MOU under the authority of section 646 of the Department of Energy Organization Act (Pub. L. 95-91, as amended; 42 U.S.C. § 7256). DOD enters into this MOU under the authority of DOD Instruction 4000.19 "Inter-Service and Intra-Governmental Support" August 9, 1995.

III. Background

In the 2010 Quadrennial Defense Review, the DOD expressed an intent to partner with other U.S. agencies to research, develop, test, and evaluate new sustainable energy technologies. The DOD aims to speed innovative energy and conservation technologies from laboratories to military end users, and it uses military installations as a test bed to demonstrate and create a market for innovative energy efficiency and renewable energy technologies coming out of DOE laboratories, among other sources. The DOE is currently supporting a range of projects aimed at improving energy efficiency and renewable energy efforts across the military services.

Dated 22 July, 2010

Naval Surface Warfare Center Carderock

- Carderock Division provides cradle-to-grave technical support for surface and undersea platforms
- Navy's experts for maritime technology
  - 3,200 employees, 40 technical disciplines
  - Fundamental science to applied/in-service engineering

## Naval Architecture & Engineering Department

- Computational tools, model & field testing to develop and evaluate ship, submarine, propulsor & marine designs and concepts
  - Resistance & Powering
  - Propulsor Design & Development
  - Submarine Maneuvering & Control
  - Full Scale Trials
  - Maritime Systems Hydrodynamics
  - Hydromechanics/ Fluid Dynamics/ Computational Dynamics

As part of Naval Sea Systems Command, Carderock is uniquely chartered by Congress to support America's maritime industry.

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited

Maneuvering & Sea Keeping Basin (MASK)
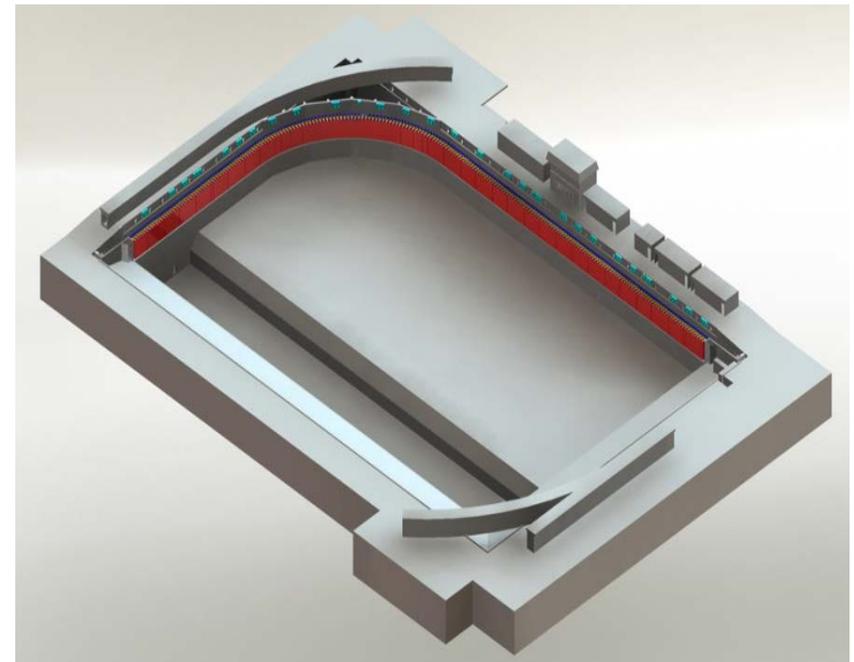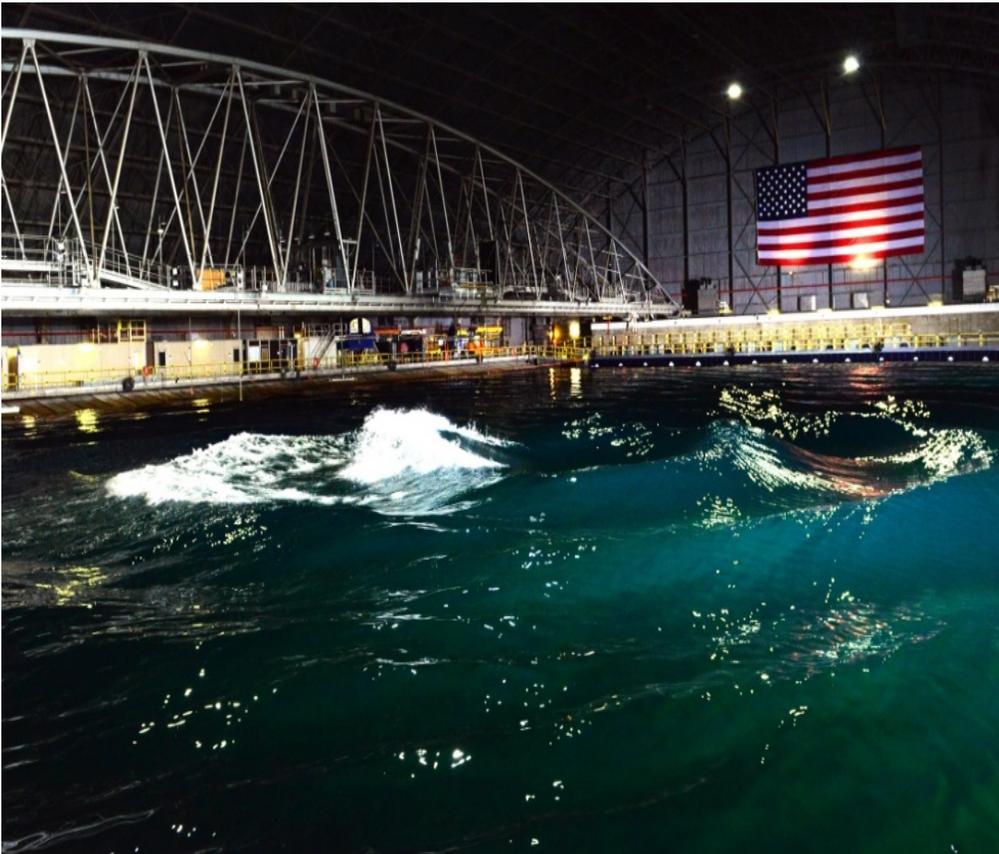
Along with the facility, NSWCCD is providing:
- SMEs in maritime systems
- Wave making & ocean environment expertise
- Instrumentation & data acquisition support
- Engineering design, test, & competition support

The MASK is:
- 240 feet wide, 360 feet long , 20 to 35 feet deep
- Over 12 million gallons of water.

WHY Participate?

- Win cash prize totaling more than **$2 million**

- Receive seed money to build revolutionary prototypes

- Qualify for testing at the nation's premier wave testing facility-the Maneuvering and Seakeeping Basin at the Naval Surface Warfare Center

- Help create the nation's renewable energy future

- Demonstrate performance compared to other device types to attract investment

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Hydrodynamic Performance Quality (HPQ)

- ACE is a reduced-content metric that relates average climate capture width and characteristic capital expenditure

- HPQ modifies ACE to account for further WEC device characteristics that will be ultimately important to LCOE and can be quantified during 1/20th scale testing program at MASK. These include:
  - Watch circle
  - Mooring force
  - Absorbed power ratio of peak to average
  - End-stop impacts
  - Absorbed power in realistic seas
  - Adaptive control effort

$$HPQ = ACE \times \{WC_{HPQ} \times MF_{HPQ} \times AP_{HPQ} \times ES_{HPQ} \times RS_{HPQ} \times AC_{HPQ}\}$$