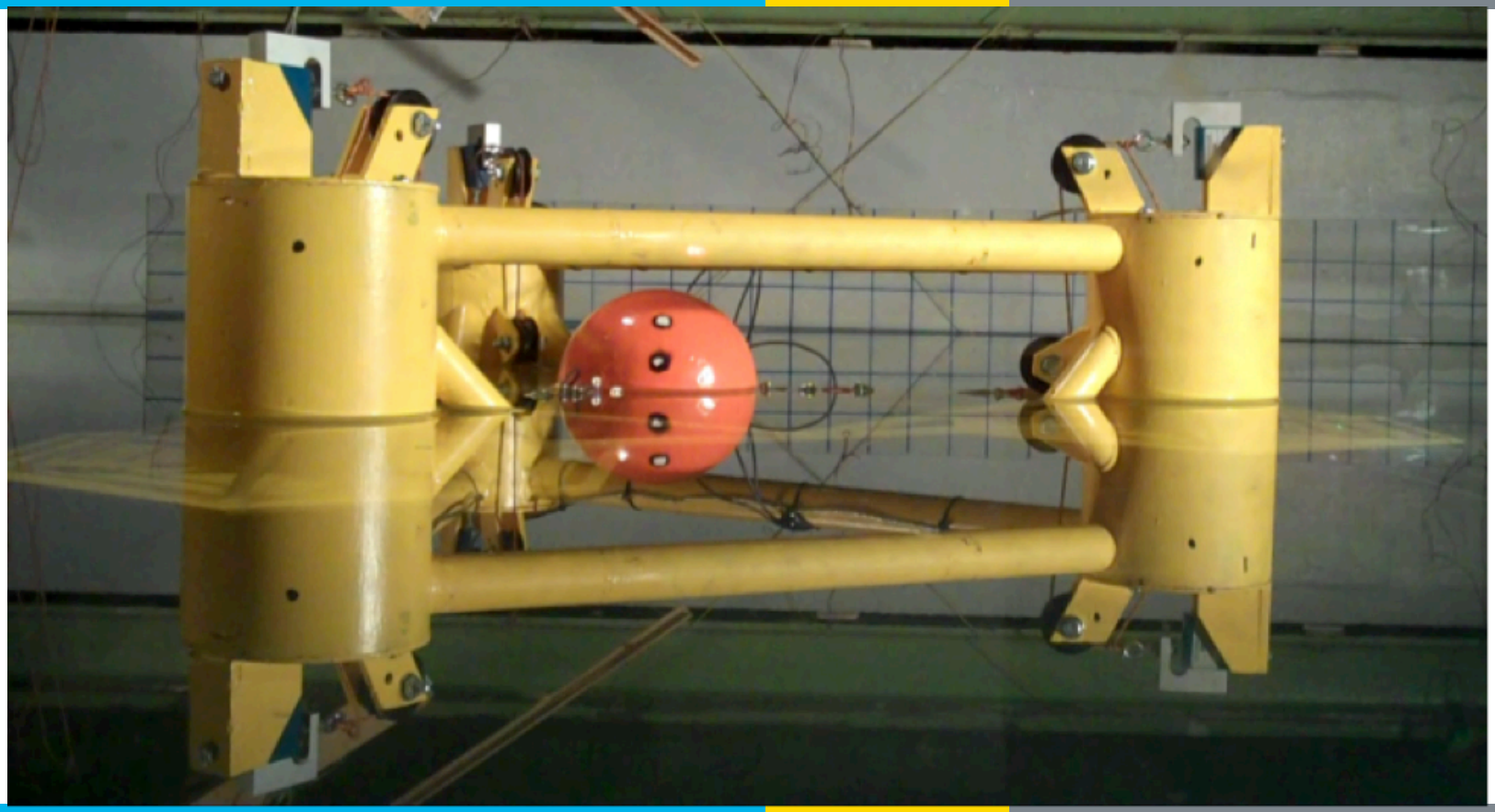
Water Power Peer Review

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



WindWaveFloat

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Purpose, Objectives, & Integration

Project Goal:

- To assess feasibility of integrating wave PTO with a floating offshore wind structure - the WindFloat:
  - maximize power output
  - share infrastructure
  - reduce overall LCOE

Research objective:

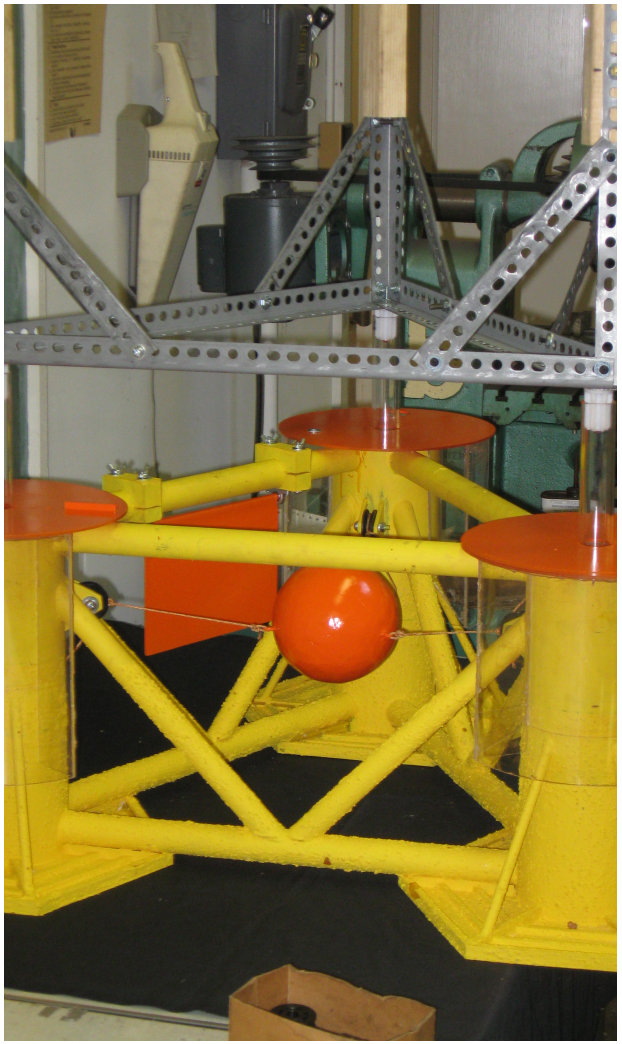
- To understand power output, capacity and cost of a WWF

Research integration:

- To remove limitations of stand alone wave energy conversion devices
  - costly mooring and installation
  - variable energy output
  - relative environmental footprint

Technical Approach

- Assessment of worldwide available wave energy technologies for suitability with WF
- WindWaveFloat wave tank model tests designed to provide confidence in numerical tools
- Four different PTO's examined
  - Oscillating Water Column
  - Spherical Wave Energy Device
  - Oscillating Vertical Flaps
  - Point Absorbers



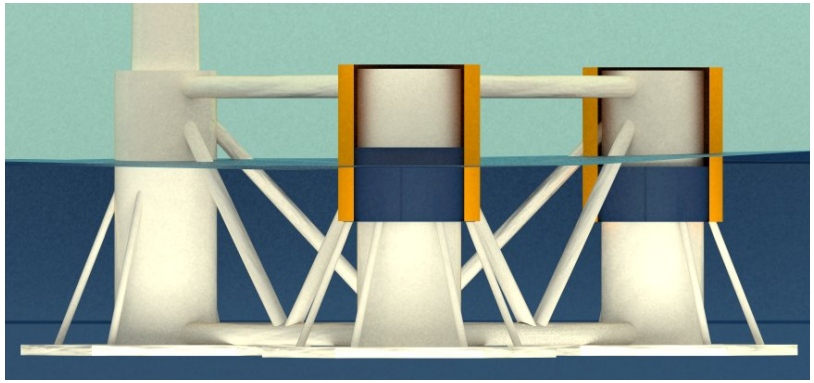
Technical Approach

Oscillating Water Column

- Create a chamber around columns 2 and 3
- Compressed air runs through a wells turbine to create electricity
- Robust and existing technology

Challenges

- Significant wave loading
- Efficiency losses can be significant



Technical Approach

Spherical Wave Energy Device (SWEDE)

- Single point energy absorber connected to all three columns
- Spherical floater - no distinct natural frequency
- Multiple PTO can be used

Challenges

- Design Failure Mode with large floater stuck inside WindFloat

Oscillating Vertical Plates

- Flat plates oscillating around the main beam
- Simple PTO from direct torque input
- Opportunity to rotate flaps out of storm conditions

Challenges

- Significant loads on critical element of the structure

Technical Approach

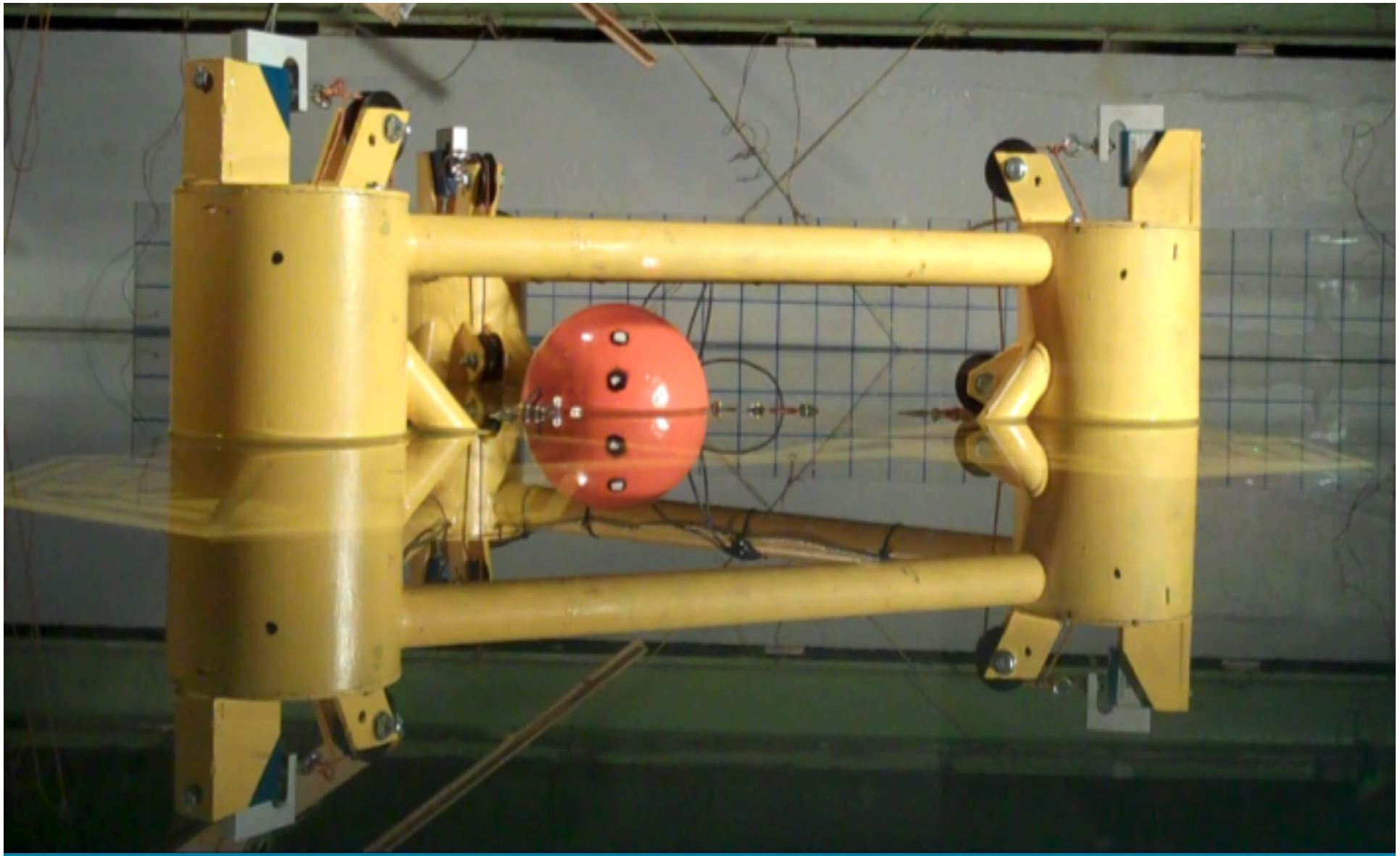
Point Absorbers

- Three independent point absorbers
- Simple PTO using sping

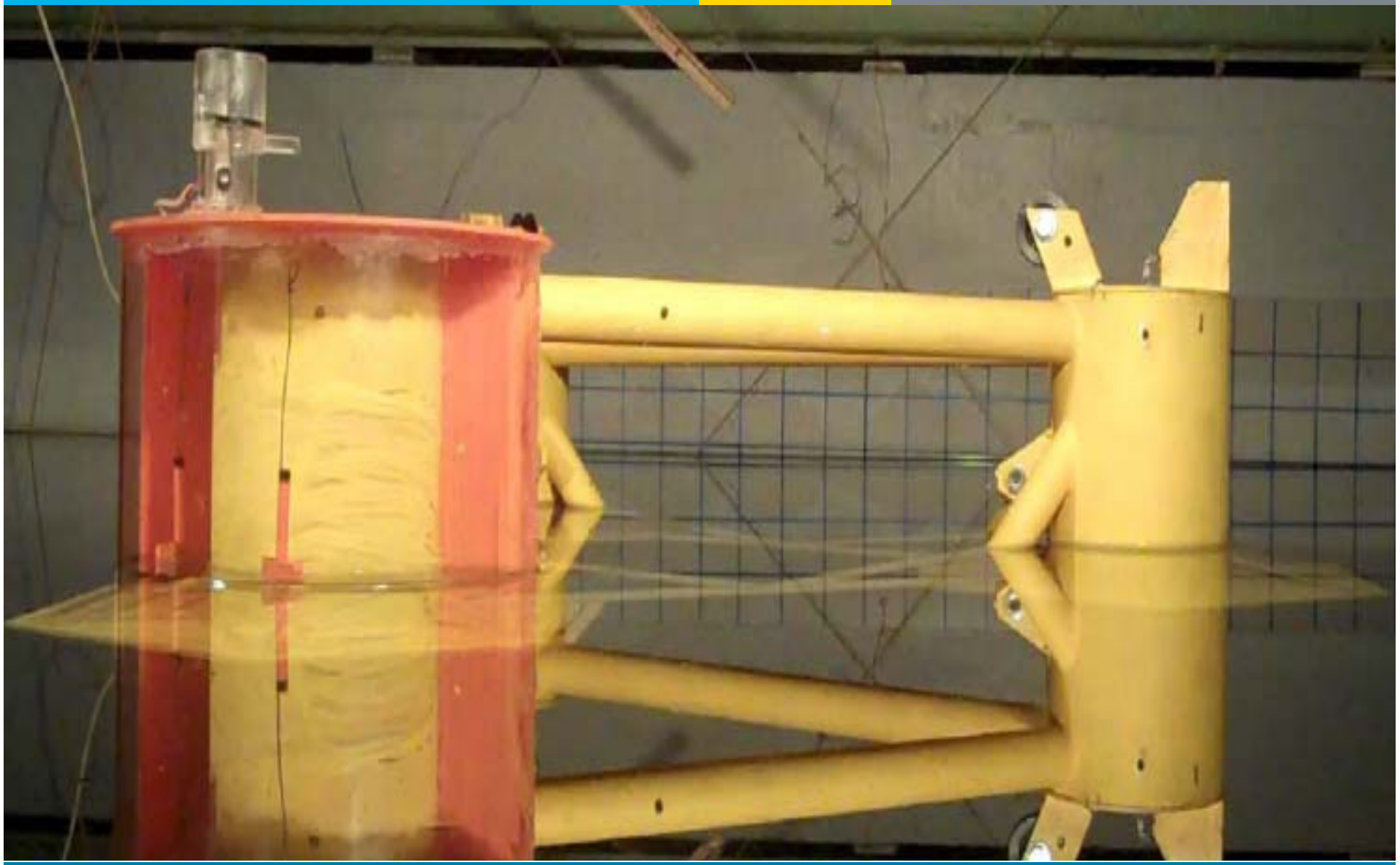
Challenges

- Power output

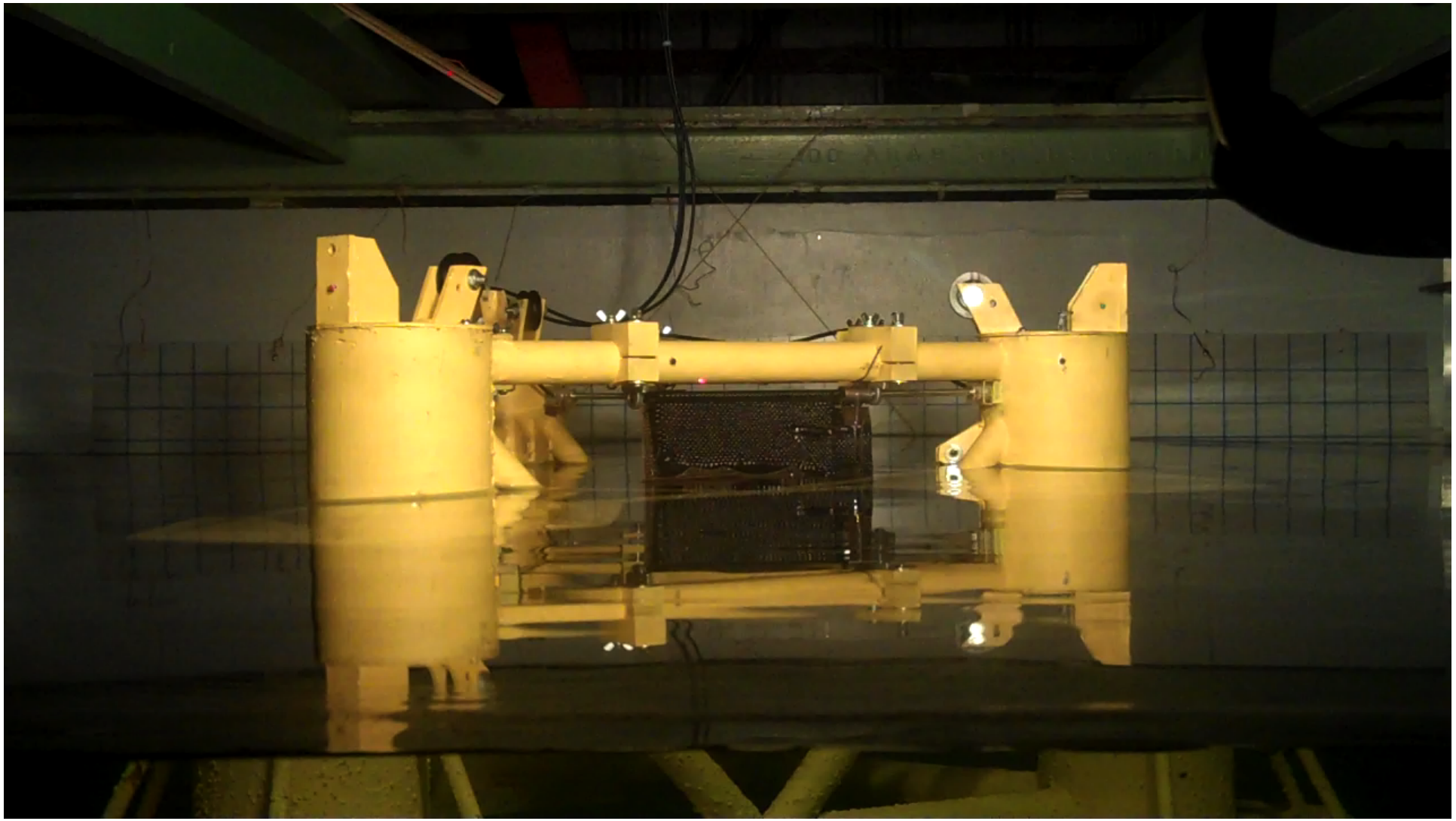
SWED Testing



OWEC Testing



Flaps testing



Plan, Schedule, & Budget

Schedule

- Initiation date: Apr 2010
- Planned completion date: Dec 2011
- Milestones
  - 08/10 Wave energy PTOs report
  - 10/10 Wave tank tests
  - 08/11 System performance report
  - 12/11 Approach to permitting a hybrid device
  - 03/12 Final report

Budget:

- No variances
- 100% project budget has been expended to date

Budget History					
FY2009		FY2010		FY2011	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
-	-	$907K	$1,044K	$452K	$387K

Accomplishments and Results

Objective	Status
ST1: Develop & validate hydrodynamic models	Completed: Validation through wave tank testing
ST2: Define operational envelope	Completed: System specification defined
ST3: Quantify energy production	Completed: System power output defined
P1: LCOE estimation	Completed: LCOE determined
P2: Structural design	Completed: Structural design confirmed – verified via WindFloat prototype
P3: Environmental impact analysis	Completed: Permitting analysis report
P4: Electrical competibility	Completed: Design criteria for grid integration

Challenges to Date

- Most wave energy conversion PTOs hardly affected the motions of the WindFloat platform
  - Minimal impact on wind energy generation
  - More extensive analysis required
  - More study required to understand impact of irregular waves
- Efficiency of the conversion of the harnessed mechanical energy (or pneumatic in the case of the OWC) not taken into account
  - Specific, non-generic PTOs will need to be examined for greater granularity
  - Geometry of the wave energy device could be optimized to improve its performance

Next Steps

2012 Plans

- Complete Final Report

Future Research

- Include investigations into potential to integrate energy storage into the WindFloat/WindWaveFloat