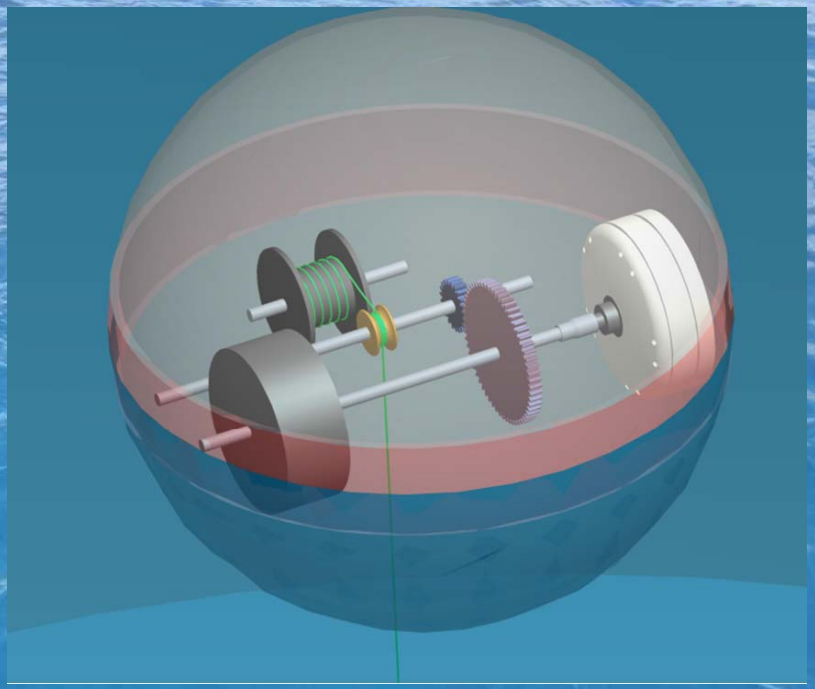
A Buoy Array for Ocean Wave Power Generation



September 28, 2010
University of Central Florida
College of Engineering and Computer Science

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Principle Investigators

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  - Professor / Interim Chair – Electrical and Computer Engineering Division
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Researchers

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- Carlos Velez
  - Master's student – Aerospace Engineering
- Steven Helkin
  - Master's student – Mechanical Engineering
- Karan Kutty
  - Master's student – Electrical Engineering

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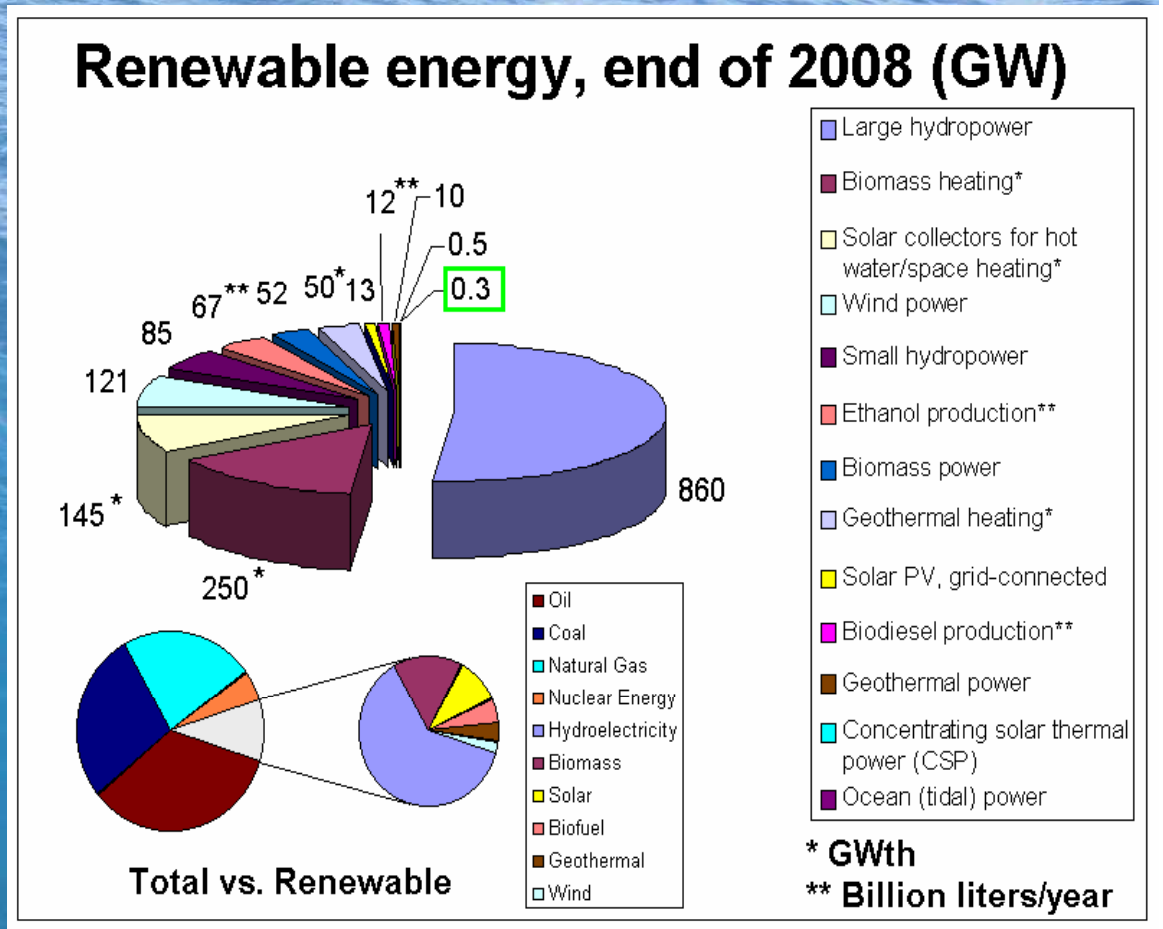
Sponsors

- Florida Energy Systems Consortium
  - $150,000 two-year project, completed
- Harris Corporation
  - $10,000 one-year continuation project

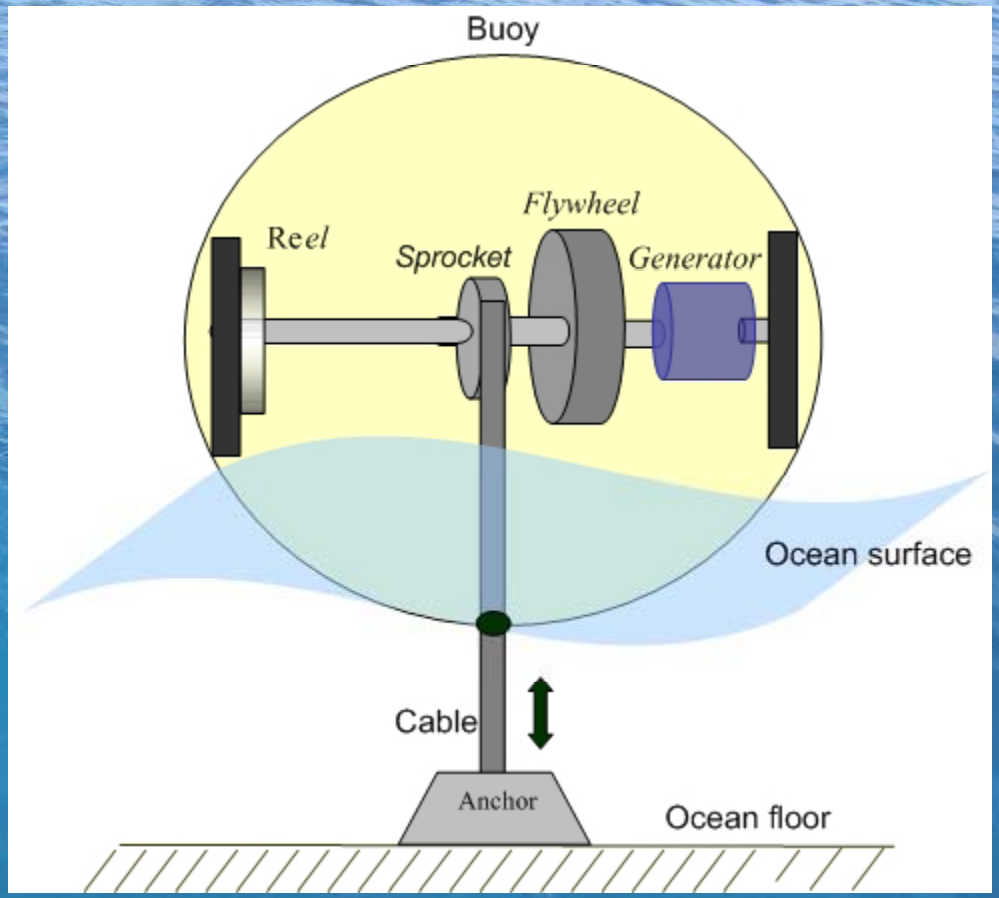
Wave Energy

- Very few designs in use today
- Water has ~1000 times greater power density as air
- A 1-meter wave: 9.5 kW of power (per meter of shoreline)



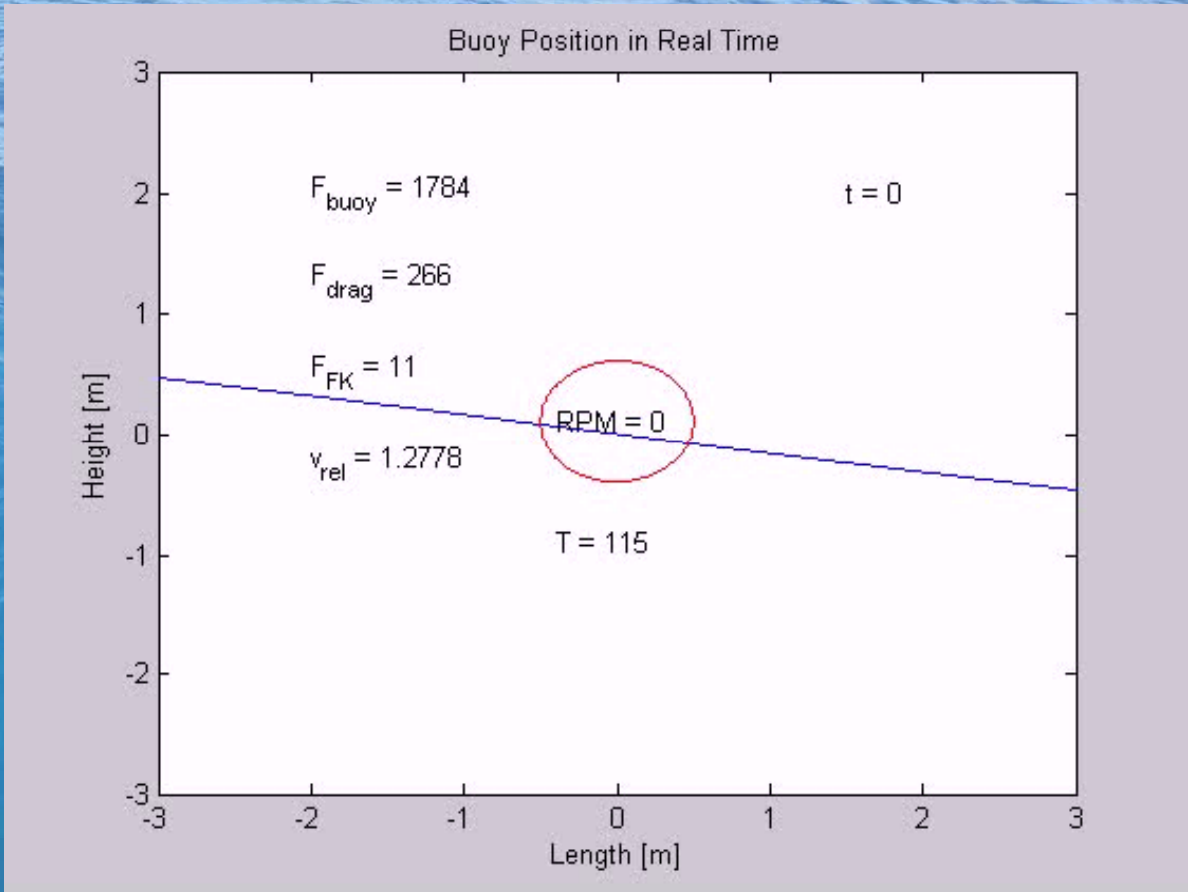
Conceptual Design

- Wave point absorber
- Rotary generator
- Flywheel energy storage



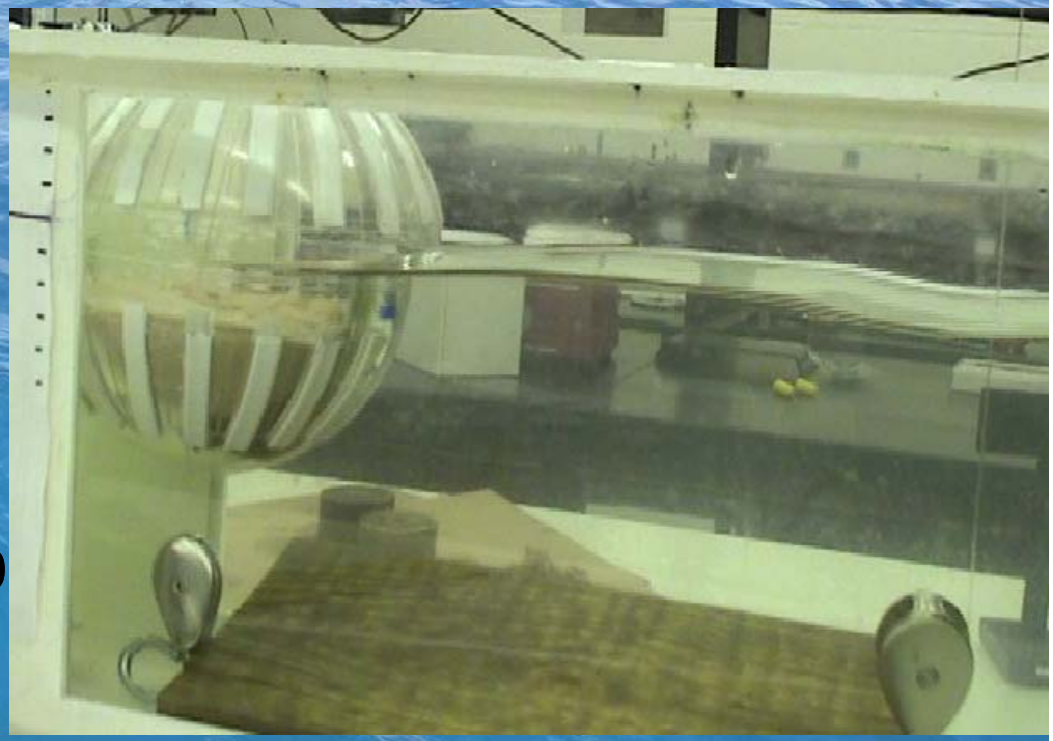
Modeling & Simulation

- Calculates
  - Shaft RPM
  - Power
  - Cable Tension
- Adjustable inputs allows for system optimization



Hydrodynamic Analysis

- Buoyancy force, and resulting motion
- Effect of buoy size and weight on buoy's response to waves.
- Data was used to help validate the hydro-dynamic simulation



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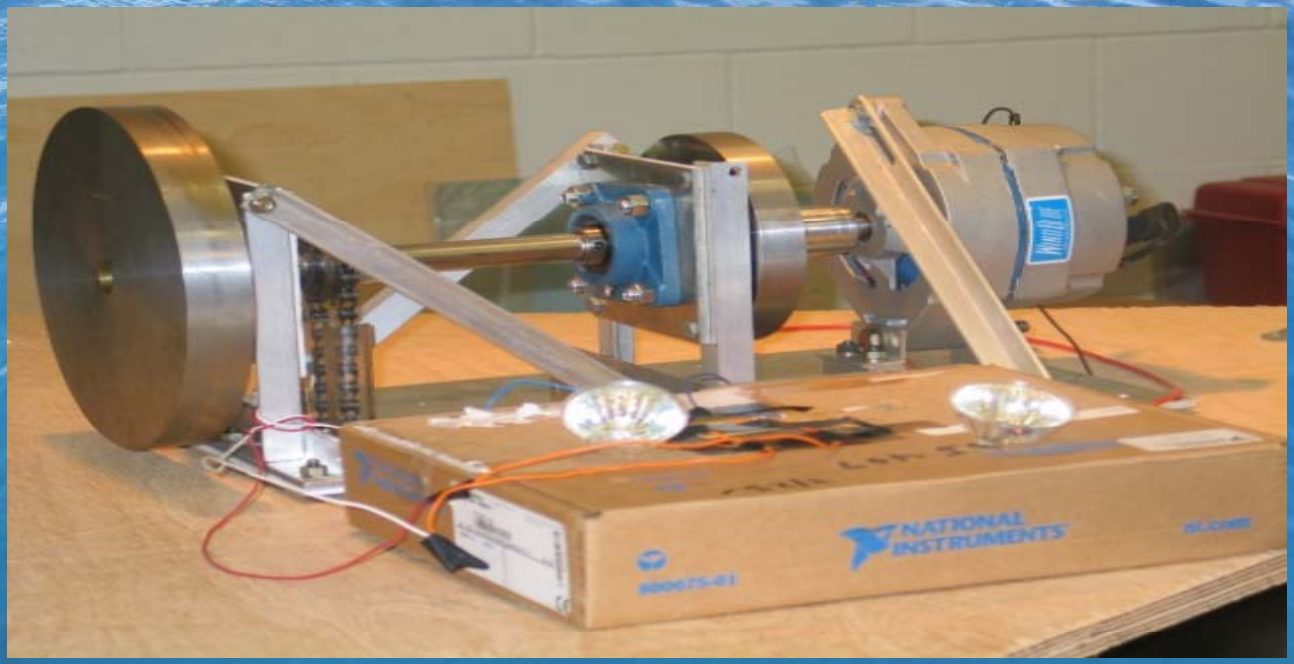
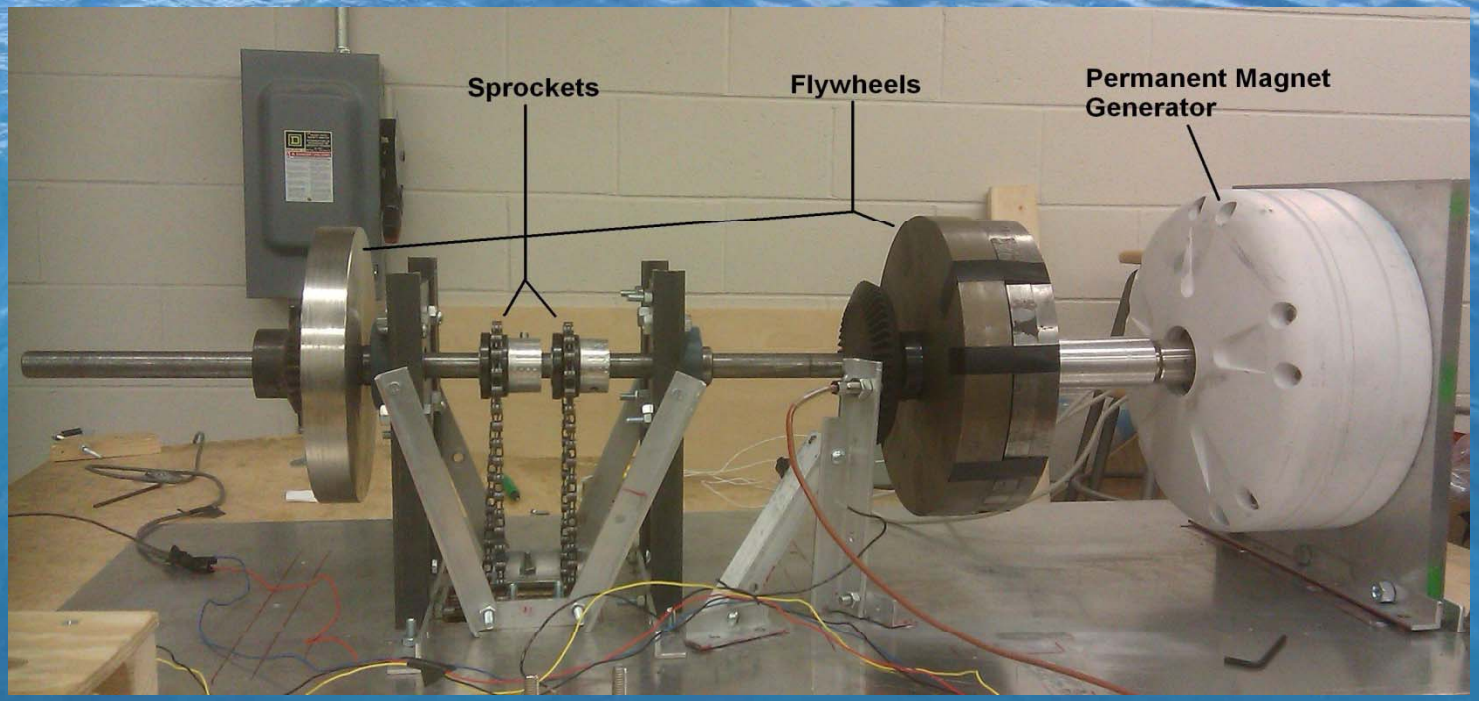
First Generation Prototype

- Proof of concept
- Average Power: 37 Watts



Second Generation Prototype

- Larger flywheel & improved generator
- 4:1 RPM
- Avg. Power: 206 Watts



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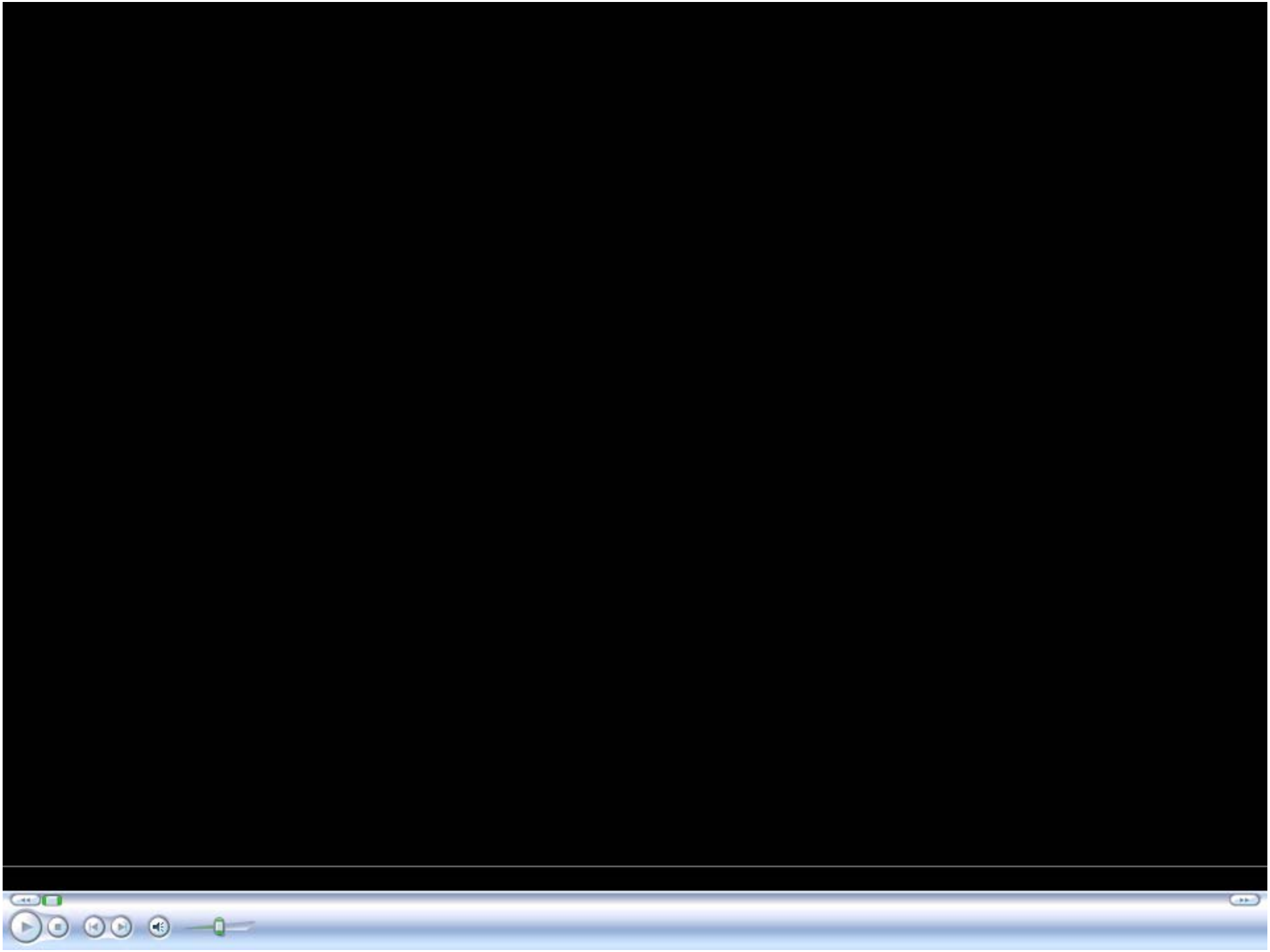
Experimental Platform

- Hydraudyne 6 DoF Platform
- Sinusoidal input
  - Amplitude: 10.0 cm
  - Frequency: 0.30 Hz



Data Acquisition

- Shaft RPM
  - Rotational energy
  - Theoretical efficiency
  - Shaft stresses - acceleration & shaft inertia
- Voltage Generated
  - Power produced
  - Actual system efficiency
- Tension in the Wire
  - Shaft torque
  - Force input

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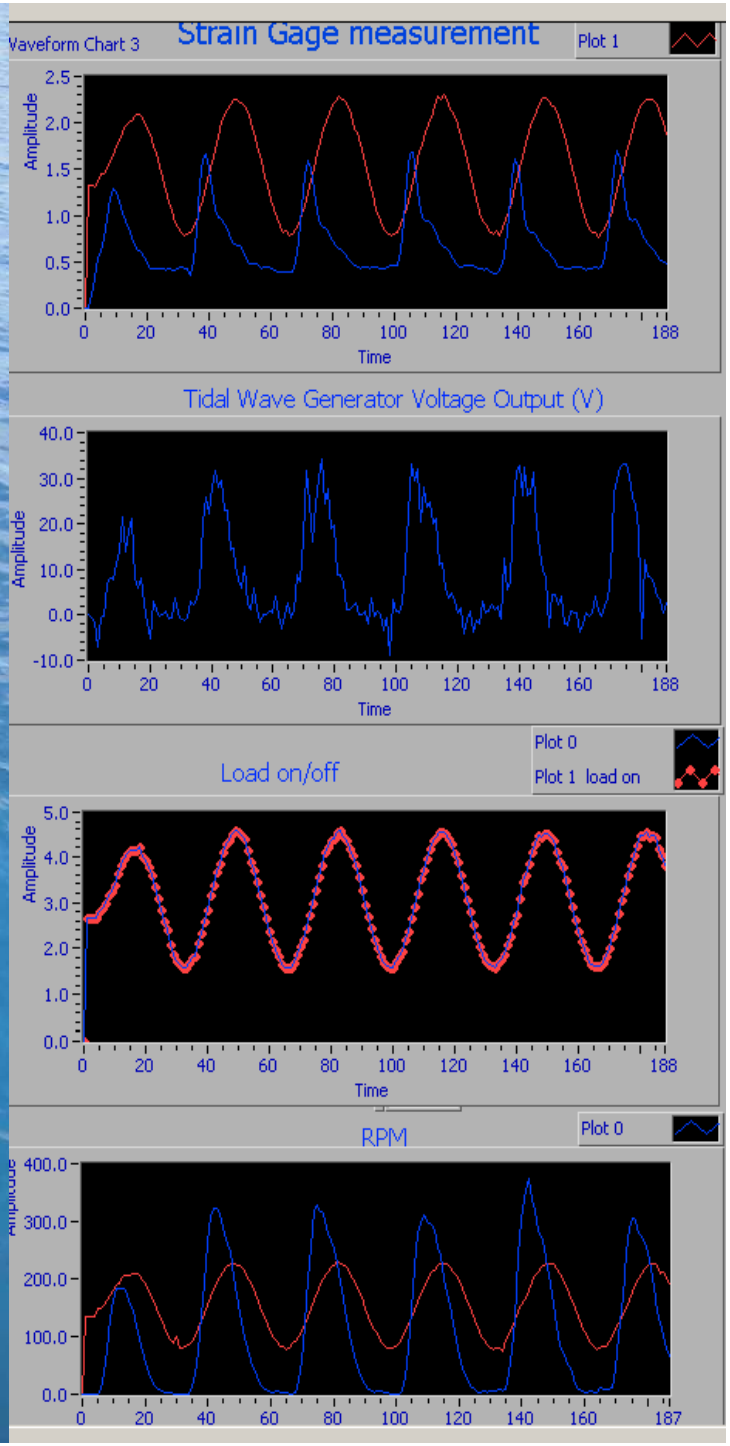
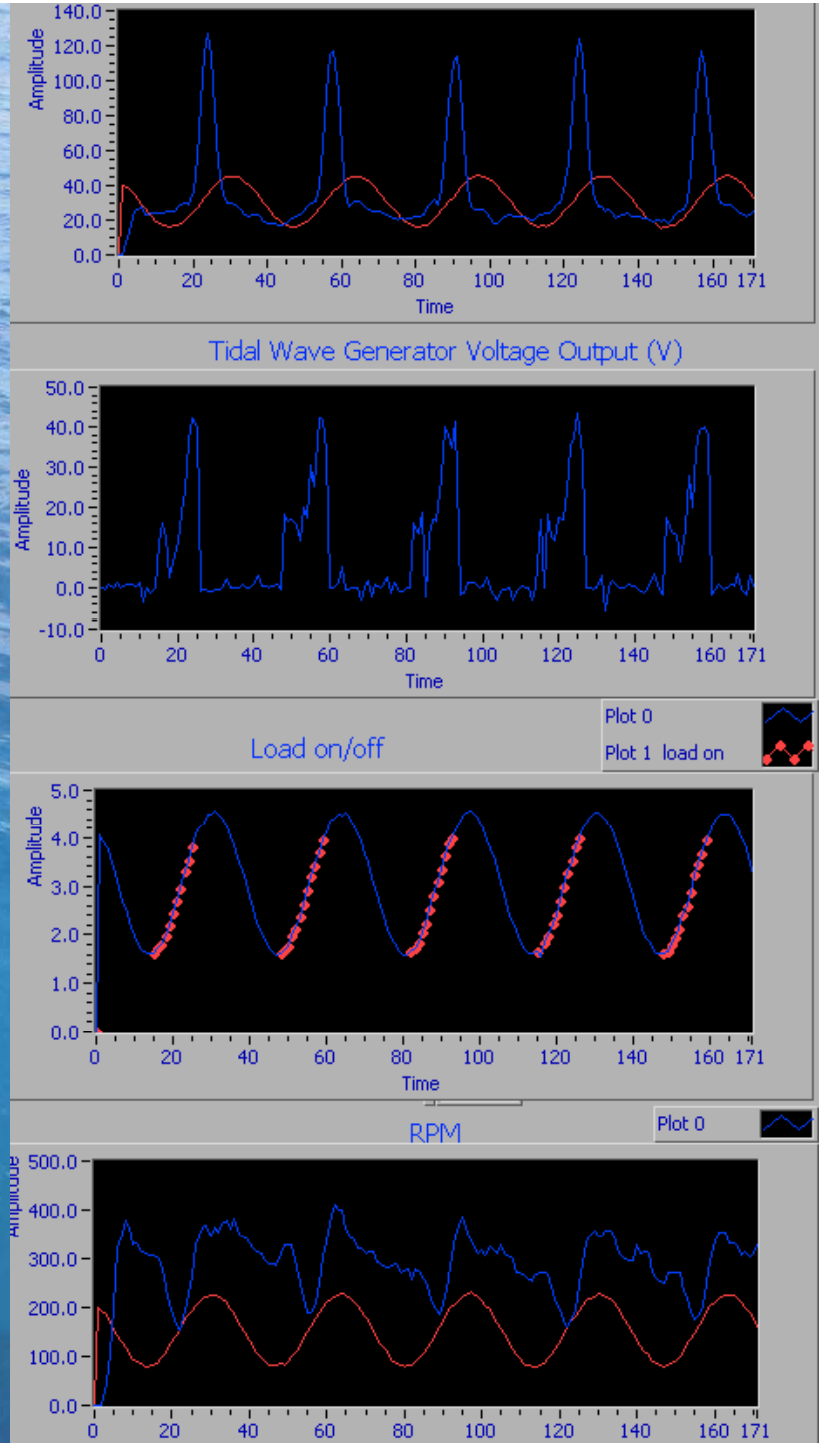
Optimization

- Generator load
  - Always on
- Effect
  - Rotation not conserved
  - High power output
  - High tension



Optimization

- Generator load
  - Dynamic control
- Effect
  - Continuous rotation
  - Higher Power output
  - Lower Tension

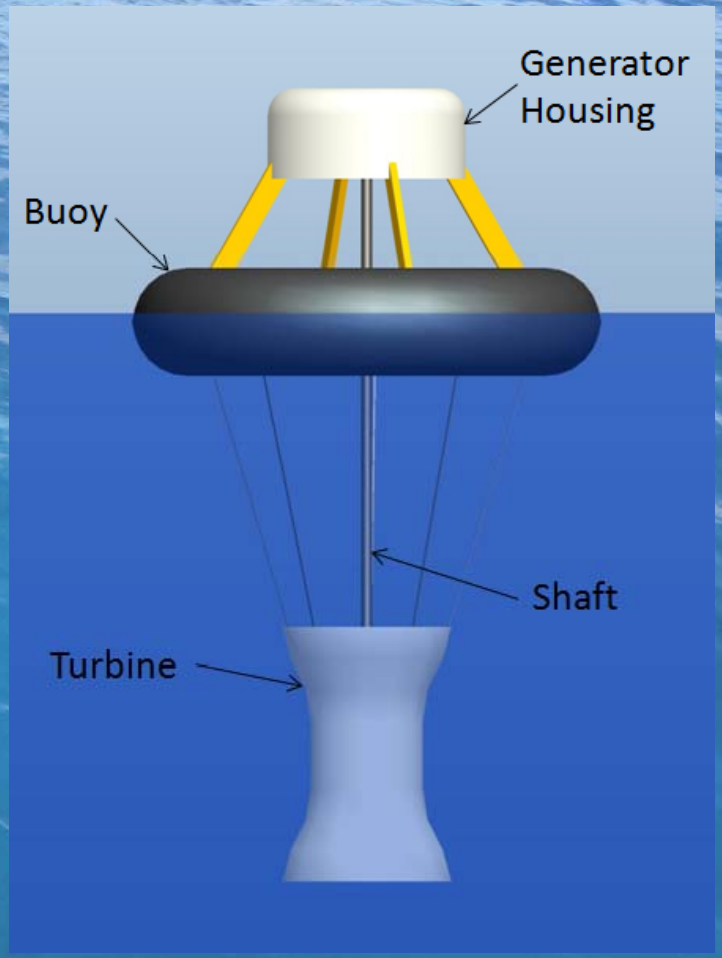


Design Drawbacks

- Difficult to protect against corrosion
- Only takes advantage of upward motion
- Requires spring to keep tension in cable

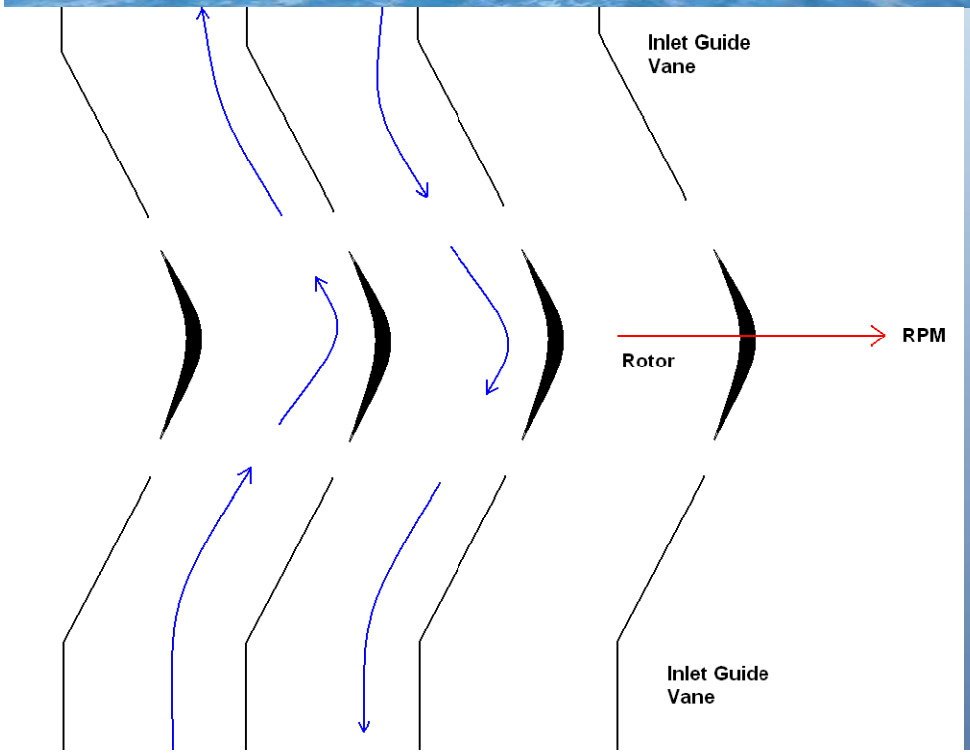
Future Project Overview

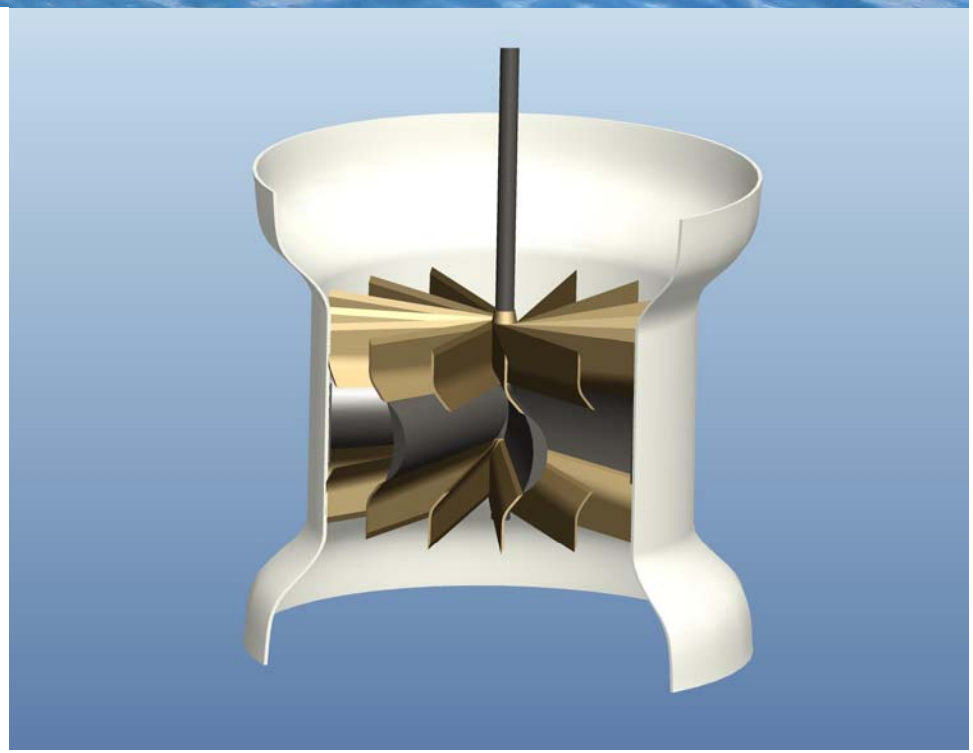
- Ocean waves heave floating buoy
- Relative fluid motion develops torque
- Torque results in power



Bi-directional Turbine

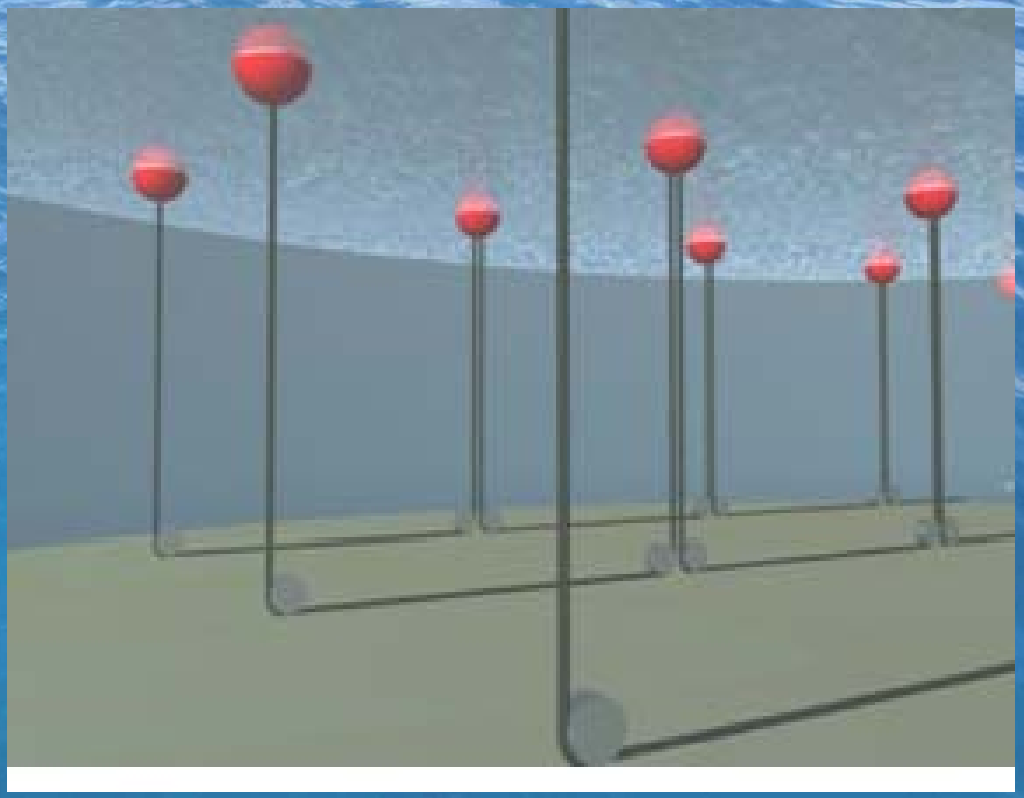
- Impulse turbine
- Symmetry results in uni-directional torque





Applications

- Wave farm array to provide power to grid
- Power for offshore platforms
- Power for sensor buoy



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Conclusion

- Research findings from initial prototypes have lead to a more evolved design

- Collaboration with Harris Corp. will result in an ocean-ready prototype by April 2011

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Acknowledgments

- Florida Energy Systems Consortium
- Harris Corporation
- University of Central Florida