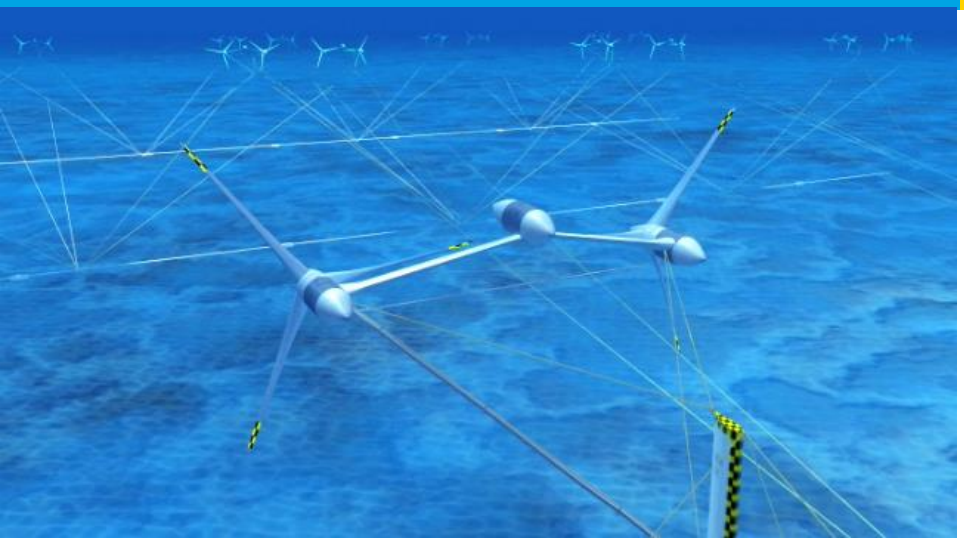

AQUANTIS™

DNV

Powertrain Engineers Inc.

PCCI Marine and Environmental Engineering

NAVSEA CARDEROCK

PENNSTATE ARL

SFOMC South Florida Ocean Measurement Center

Aquantis 2.5 MW Ocean-Current Generation Device- MHK

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Dehlsen Associates, LLC

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September 26,11

Purpose, Objectives, & Integration

- Principal Objective of the Aquantis Project
  - Developing technology to harness the energy resource in the Gulf Stream

- Primary Challenges
  - Achieving an acceptable cost of energy
  - Understanding the resource impact on system performance
  - Designing a structure that withstands the large hydrodynamic loads
  - Designing a moored platform with static and dynamic stability
  - Designing a robust system with 20-year life
  - Developing a cost-effective installation and maintenance strategy
  - Determining effective computational and experimental tools
  - Understanding potential environmental impacts

Technical Approach

- Key Issues and Methodology
  - Resource assessment
    - Assess existing Gulf-Stream ADCP data
    - Deploy instrumentation array to acquire better data
  - Stability, mooring, and anchoring
    - Use unsteady CFD and a rotorcraft code to develop hydrodynamic coefficients
    - Revise a proven Navy coefficient-based simulation tool for to assess platform stability (static and dynamic)
    - Use Orcina marine dynamic analysis software (OrcaFlex) for mooring
    - Determine installation and maintenance strategies
  - Cost-of-energy model
    - Revise an existing model based on wind power
    - Focus on capital and operational & maintenance (O&M) costs
    - Base all system decisions on cost of energy

Plan, Schedule, & Budget

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

Schedule:

- Initiation date: 10/01/10
- Planned completion date: 8/31/13
- Contract Award - Effective Date 09/01/2010 - date signed 09/15/2010 . Total Contract Cost - $4,005,625 (DOE Funded Costs - $2,400,000; Dehlsen Associates matching funded costs - $1,605,625) – period of performance 09/01/2010 through 08/31/2012 - Conditional award - upon successful completion of negotiations, the conditional status will be lifted.
- Modification 001 – date signed 08/11/2011 – continued conditional status, added provision 25: NEPA requirements, and added attachments for IP provisions, Statement of Project Objectives, Reporting Requirements, and Budget Information
- Modification 002 – date signed 09/14/2011 - removed conditional status, extended period of performance to 8/31/2013, changed method of payment to ASAP Reimbursement system
- Milestones _Go/No-Go : Next Steps

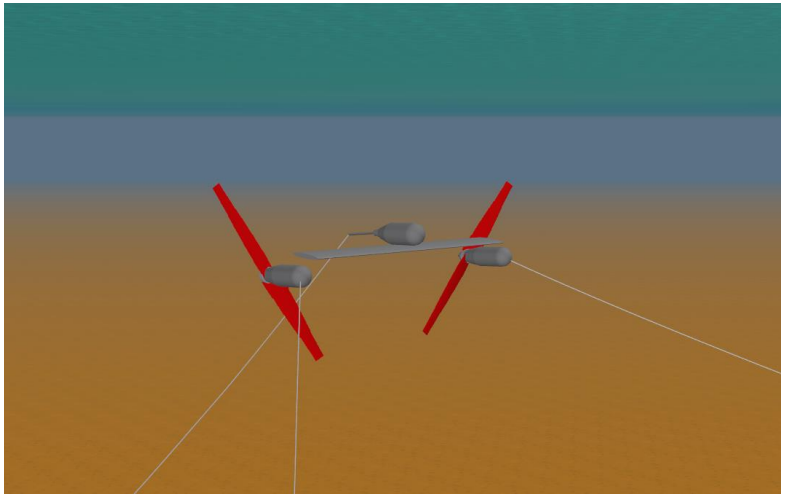
Siting Study for a Hydrokinetic Energy Project Located Offshore Southeast Florida	**Completion Status**	
Summary of Tasks		
Task 1. Dynamic Stability and Simulation	**10%**	
Task 2. Fabrication and Instrumentation	**0%**	- Beginning Nov. 15th'2011
Task 3 Experimental Validation: Tow Tank Test	**0 %**	- Tow Tank Test begins March 15th '2012
Task 4. Documentation	**2%**	

Budget:

Budget History-MHK					
FY2010 (10/01/10 - 09/30/11)		FY2011 (10/01/11 - 09/30/12)		FY2012 (10/01/12 - 09/30/13)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$243,000	$0	$1,200,000	$800,000	$957,000	$805,625

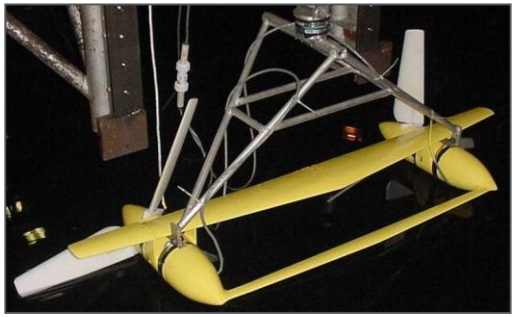
Accomplishments and Results

- Stability, Mooring, and Anchoring
  - Prepared Top Level Requirements defining system requirements with an emphasis on position control, ease of Aquantis Inspection, Maintenance and Repair (IM&R), cost reduction
  - Mooring System Analysis using ORCAFLEX
    - Iterative design resulted in preference for two forward semi-taut anchor legs, one rear vertical leg
  - Developed IM&R methods and scenarios to all development of associated costs



Accomplishments and Results

- Stability, Mooring, and Anchoring
  - Static pitch plane stability has been performed for platform configurations utilizing 2 rotors (2.5MW) and 4 rotors (3.2MW)
  - Static pitch plane stability requires determination of a mooring point(s) in which the hydrostatic forces (in-water weight and buoyancy) of the various major components are balanced about the mooring point to producing zero platform pitch throughout the Gulf Stream current flow range (0 to 2.5 m/s)
  - Develop target weights and buoyancy values for all major components and establish required locations for center of gravity and center of buoyancy that satisfy pitch plane stability criteria
  - Investigated various platform net buoyancy-to-drag (rotor thrust) values to obtain mooring line lengths from the platform to ocean floor. Net buoyancy values in the range of 1,100 to 1,800 kN appear to be most practical in terms of providing viable platform structural and cost characteristics. This results in net buoyancy-to-drag ratios in the range of 0.20 to 0.33 at the design current of 1.6 m/s



Accomplishments and Results

- Stability, Mooring, and Anchoring
  - Investigated weight, buoyancy and mooring point location for the following platform configurations
    - 2-rotor platform with an airfoil-shaped wing structure above the nacelles and buoyancy pods located aft above the wing to provide static pitch plane stability
    - 2-rotor platform with a high net buoyancy wing structure above the nacelles
    - 4-rotor platform with a simple shaped wing structure located between and on the nacelle centerline
    - 4-rotor platform with a simple shaped wing structure above the nacelles
    - 4-rotor platform with a 3-legged buoyant truss structure with nacelles mounted between truss frame members
  - Variants on the 4-rotor platform include:
    - 4-rotors mounted down-wind of the support structure (wing or truss)
    - 4-rotors mounted up-wind of the support structure
    - 2-rotors mounted down-wind and 2-rotors mounted up-wind

Challenges to Date

- Challenge: designing the Aquantis system without full knowledge of the Gulf Stream resource—including extreme loads and knowledge of the seafloor properties
  - Mitigation Approach: acquire new and better resource data
- Challenge: designing the Aquantis system to maximize the rated power and to minimize the expense of the anchoring
  - Mitigation Approach: vary the number of turbines, the diameter of the turbines, the number of anchors, and the number of mooring lines
  - Mitigation Approach: acquire better knowledge of the seabed floor

Challenges to Date

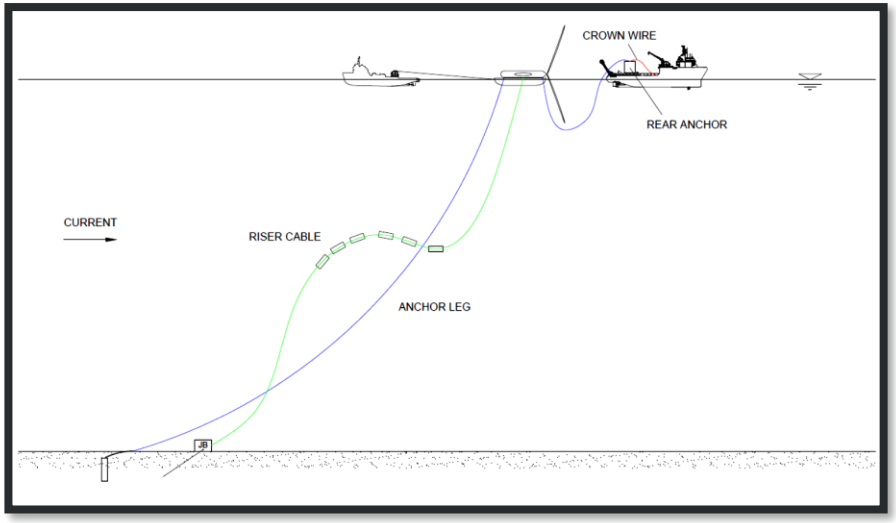
- Challenge: designing the Aquantis system to achieve the weight and buoyancy characteristics—with proper mooring line attachments and turbine locations—that allow for stability at all speeds
  - Mitigation Approach: (1) Use the Navy coefficient-based simulation tool and Orcaflex to evaluate different concepts; and (2) develop a proper small-scale test to measure pitch and yawing moments as a function of angle of attack, and simulate a moored platform in a current

Challenges to Date

- Challenge: determining the installation, operational, and maintenance costs for the Aquantis System

Mitigation Approach:

(1) Consideration of IM&R capability early in design spiral
(2) Components selection to reduce maintenance requirements
(3) Evaluate buy vs lease options for vessels



Next Steps- Milestones

Design Milestone	Target Date	TRL	Status
1. CONCEPTUAL DESIGN	• May 5-7, 2011	5	Complete
2. FINALIZE CONFIGURATION	• Sept. 15, 2011	5	
3. PRELIMINARY DESIGN	• TR1 - Oct. 18th, 2011	5	
4. BUILD 1:20 SCALE MODEL	• TR2 - Nov 15th, 2011	6	
5. TOW TANK TEST OF MODEL	• TR3 - Mar 15th, 2011	6	
6. CRITICAL DESIGN REVIEW	• TR4 - Oct. 15th, 2012	6	
7. FULL SCALE DRIVE TRAIN	• TR5 - Nov. 15th, 2012	6	
8. AT SEA TEST OF MODEL	• TR6 – Feb. 21st, 2013	6	
9. BUILD FULL SCALE PROTO	• TR7 - Mar. 15th , 2014	7	
10. AT SEA TEST OF FULL SCALE PROTO	• TR8 - June 21st, 2014	7	