Bringing energy and the environment into harmony.

HydroAir™
OWC turbine

Next Generation PTO

9th Oct 2014
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Contents

- HydroAir™ Test facility
- Electrical PTO
- Variable Radius Turbine
- Prototype turbine
- DOE Project overview
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Cranfield HydroAir™ Test-Facility

- Initially commissioned in 2005
- Upgraded in 2010
- Validated CFD methodology
- Test vehicle for control strategy development
Test Facility: How Does it Work?
PWG Test-Facility

- Total swept volume: $16.43 \text{ m}^3$
- Max flow rate of $5.88 \text{ m}^3/\text{s}$
- Monochromatic and polychromatic wave capability
- Enabled control source code to be developed and advanced through a sponsored Eng.D program
Test-rig Upgrade (2010): VRT-1

- Reduce mechanical losses
- Reduce aerodynamic losses
- Test-rig representative of the real system
- Improve accuracy & repeatability of instrumentation measurements
HydroAir™ - Power Take Off System

- An innovative power conversion device for use in Oscillating Water Column (OWC) technology
- The high efficiency device consists of:
  - Advanced air turbine
  - Generator
  - Power electronics
Electrical Equipment

CONVERTER SYSTEM

Machine Bridge

Network Bridge

Filter

Precharge supply short
form only

Control Supplies
1 PH 240V loads
Fan 0.5A
Turbine Brake 1.2A
Anti Con Heater 1.5A
Compressor 6A

36A 3ph
8A 1ph
10A 1ph

415V/3 PH+N
From M1 Power
Switchboard

18 kW
415V
Local Isolator
VRT Development History

- Collaboration with Cranfield University since 2004
- Sponsoring of 5 PhD students
- DTi Project
- BERR Project
- Test facility commissioned 2005
- Patent GB2440344A
- Prototype commissioned 2010
- Ongoing Work
  - CFD optimisation
  - Control strategy

VRT-2
**Turbine Developments—VRT**

**Differences**
- Guide-vane twist
- Radial offset
- Number of blades (Rot/GV)
- Turning angle (Rot/GV)
- Hub-Tip ratio
- New blade profiles
- New duct shape
- New duct principles
- New duct shape
- New duct principles

**Similarities**
- Similar blade profiles
- Similar overall duct shape
- VRT principle
- Similar blade profiles

**VRT**
- Original VRT (2005-06)
- VRT-1 (07-08)
- VRT-2 (08-09)
- VRT-U (10-present)
Prototype Assembly

Lowering the outer ducting

Fully assembled

Turbine Rotor Assembly
Prototype Installation: Port Kembla
Next Phase: VRT-U:
Funding Opportunity Award

The FOA released by the DOE in the USA has 3 Topics for development

- Topic 2 – Next generation Power Take Off (PTO)

Scope: Proposed projects shall design a PTO sub-system or individual PTO component(s). A prototype of the PTO sub-system or PTO component(s) should be fabricated and tested independent of the system. At a minimum, this prototype will be tested in a laboratory facility under controlled or relevant conditions to validate its ability to achieve the component performance metric(s).

D-R awarded @ 20% cost share on the 16th April 2014
Wave Energy Test Site (WETS) Hawaii

- 2 Test sites identified for deep water applications
- Water depth ~ 70M
- Permit agreed for 2MW
**Logistic Challenges**

Supply Chain Management (SCM)

- **Power Generation Equipment**
  - Generator
  - VFD
  - Control and Instrumentation Equipment

- **Composite manufacturers**
  - Ducting
  - Rotor Blades
  - Guide-vanes

- **Assembly location**
  - West coast at D-R Chula Vista site (Hawaii Test site location)
  - East coast at D-R Wellsville site (PICO in Azores test site location)
Most Client Alliances in Industry ~ 50

Validation of the Dresser-Rand Value Proposition

Note: Partial List
Conclusion

- Marine renewables business development to provide world-class power generation solutions for a carbon constrained world … Establish a leadership position for environmental solutions in marine energy with O&G customers
- Support for new up and coming technologies requiring Power Take Off systems
- Support mechanisms are still in place to make this an attractive value proposition
- D-R core clients and competitors are showing interest so we will be collaborating with them
- Opportunity to complete the HAT PTO for Hawaii/PICO will be a huge step forward