Wave Energy Scotland Annual Conference, 28 November 2017
Elevator Pitches

C-GEN Project Neptune, WES Stage 3 PTO

Markus Mueller

Lead Contractor:

THE UNIVERSITY of EDINBURGH
School of Engineering
Institute for Energy Systems

HAYWARD TYLER

ENGINEERING EXCELLENCE 1815 - 2015 200 YEARS

LAMINARIA

SUPPLYDESIGN

Carnegie wave energy

University of Strathclyde Glasgow

F D L

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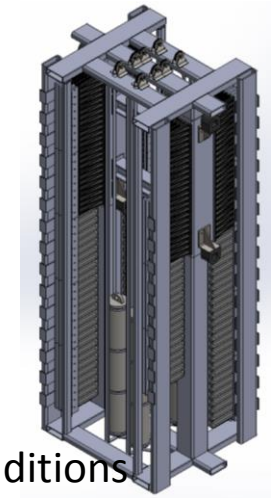
C-GEN Project Neptune

Project Summary



Demonstrate C-GEN Direct Drive
Integrated electo-mech design.
High degree of modularity.
High efficiency over all loads.
Reliability and Availability.
O & M Procedures.
Fully flooded operation.
Survivability in extreme & fault conditions

Challenges

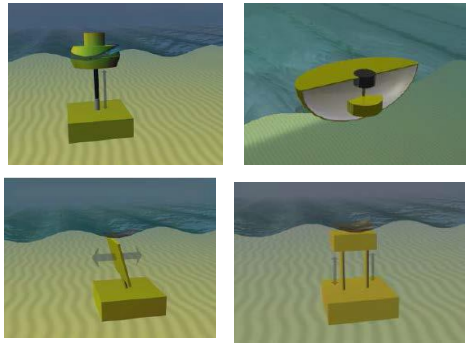
Marine Environment
- bio-fouling
- corrosion

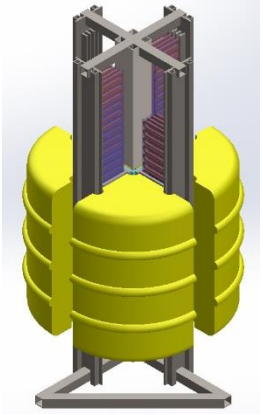
Installation

Operation & Maintenance

Technical product or integration offering

Direct Drive Power Take Off - linear or rotary.
Fully integrated into device.





Skills expertise within Project Neptune

Electrical & Mechanical Design.
Generator Manufacturing.
Production Engineering.

Skills, expertise, & technology required

Offshore Engineering.
Design for marine environment.
Installation techniques.
Offshore operations & logistics.

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HiDrive – Power Take-Off Stage 3

Jéromine MAILLET

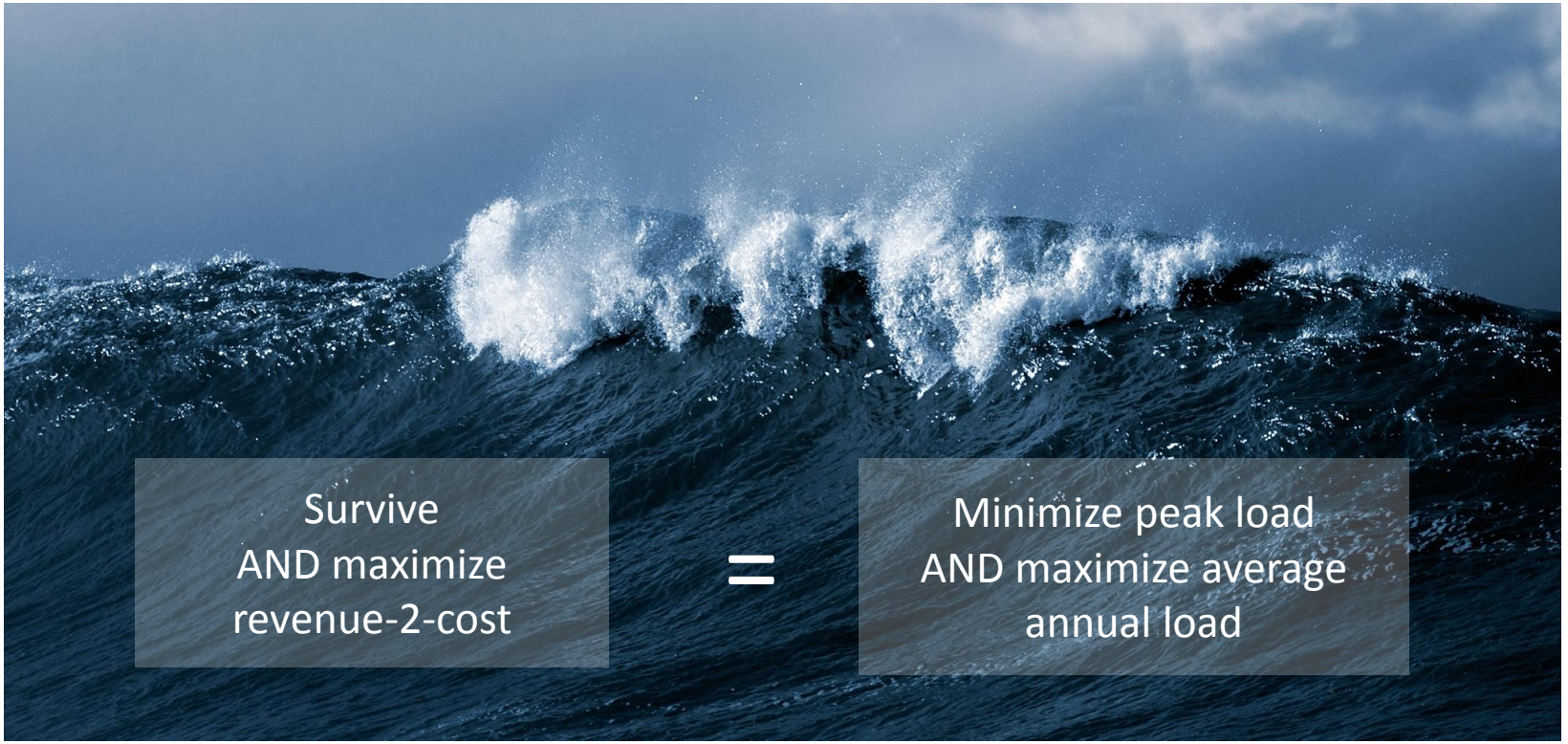
CorPower Ocean AB

HiDrive

Project Summary

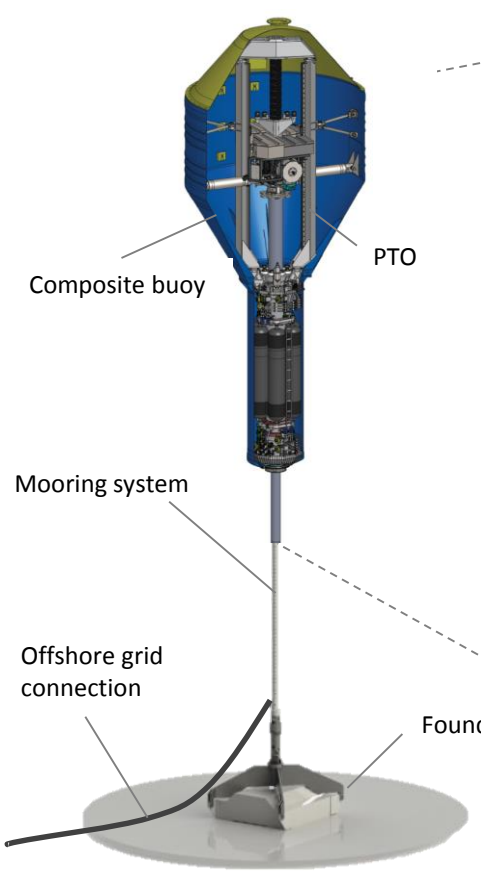
HiDrive

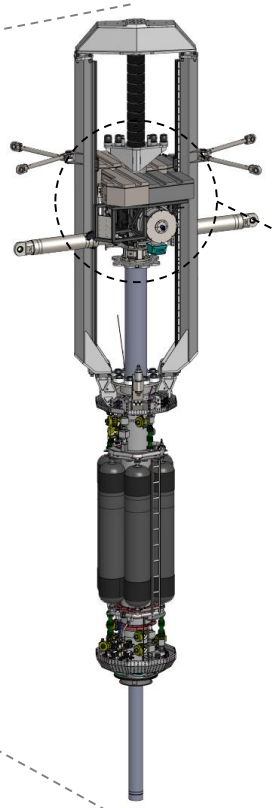
Challenges



HiDrive

Technical product





Stage 3 PTO

HiDrive

Skills expertise

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Quantor hybrid hydraulic PTO – Stage 3

Presenter: Jamie Taylor

Lead Contractor: Artemis Intelligent Power

ARTEMIS INTELLIGENT POWER

Quoceant
Specialists in Marine Energy & Technology

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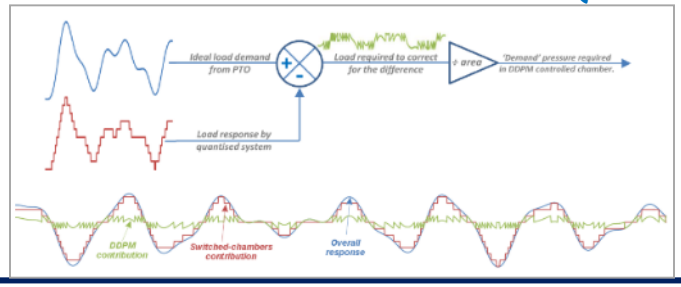
Quantor hybrid hydraulic PTO

(Stage 3)

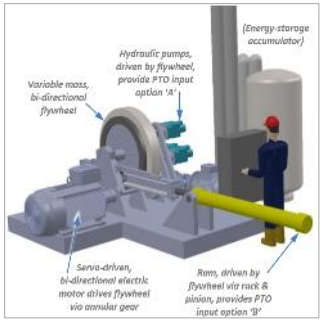
Project Summary

- *Quantor = (Pelamis) quantised PTO + Digital Displacement® hydraulics.*
- *Concept was lab-proven during Stage 2 project.*
- *Build WEC emulator with 100kW-scale Quantor.*



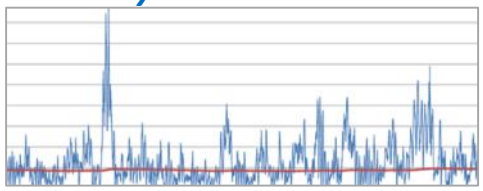
Challenges

- *Represent realistic inertia (WEC + added) in a lab.*
- *Represent range of WECs and range of seas.*
- *Build fully realistic Quantor PTO demonstrator.*
- *Develop component technology for present & future WEC scales.*
- *Show how this level of PTO refinement can make economic sense.*



Technical product or integration offering

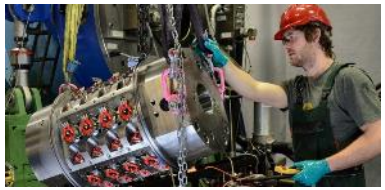
- *Very high instantaneous wave input power.*
- *High-efficiency, highly controllable, smooth output.*
- *Linear or rotary PTO front-end.*
- *Multiple configurations at any scale.*
- *WEC and non-WEC applications.*



Skills expertise or technology required

- *Requirements of WEC developers.*
- *Partnership(s) for future sea-going trials.*

For more info, speak to:
Jamie Taylor or Sarah Acheson



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Electro-**M**echanical **R**eciprocating **GE**nerator UMB PTO32

Luca Castellini
Energy R&D and BD Manager
lcastellini@umbragroup.com

UMBRA CUSCINETTI S.p.A.

UMBRAGROUP

GREEN MARINE ENERGY SUPPORT SERVICES

THE UNIVERSITY OF EDINBURGH

DOOSAN

BUREAU VERITAS 1828 BUREAU VERITAS

HMS

SUPPLYDESIGN

SEAPOWER scrl
Consortium with University of Naples Federico II

JGC

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EMERGE

Electro-MEchanical Reciprocating GEnerator

emerge (i'mɜ:dʒ): to appear, or to become recognized

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UMBRAGROUP

Project Summary

EMG prototype
- Design for marine environment
- Fabrication at Umbra's facilities

TRL 5

Bench tests
- Submerged in synthetic sea water
- Hardware-in-the-loop configuration

TRL 6

Sea trials
- Installation on point-pivoted buoy
- Use of floating barge for easy access

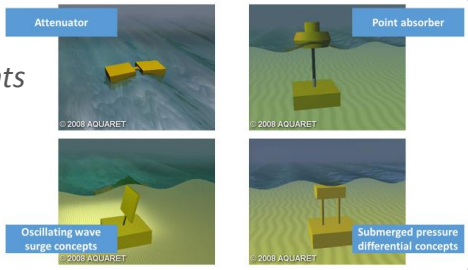
TRL 7

Challenges

- *Tight project timescale.*
- *Coordination of a big supplier group.*
- *Multi-disciplinary design.*
- *Custom-made parts*

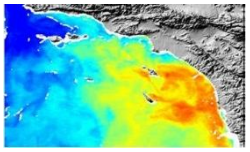
Technical product or integration offering

- *High efficiencies*
- *High reliability*
- *Lower space requirements*
- *Weight saving*
- *Costs reduction*



Skills expertise or technology required

- *Collaboration with deployment services.*
- *Construction of buoy and structures.*
- *Certification and third-party evaluation.*
- *Maintenance support and environmental monitoring.*



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Gator – The hydraulic PTO (WES PTO Stage 2)

Annicka Wänn










EXCEEDENCE
MAKING RENEWABLES COMMERCIAL

Pelagic Innovation

tfi

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

University of Strathclyde Glasgow

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Gator – Hydraulic PTO

- Unique polymer spring pump solution (robust, reliable, survivable)
- Suitable for wide range of WEC devices
- Appealing LCOE
- Commercial opportunity at scales 1kW, +10kW, +100kW, 1MW

Skills expertise or technology required

- Material fatigue testing experts
- 1/5th to 1/3rd scale WECs for sea trials in 2019
- Francis / Pelton turbine specialists
- Power management / grid integration experts
- Technology environmental impact study

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Inflatable Dielectric Elastomer PTO – WES-PTO Stage 2

Marco Fontana

Scuola Superiore Sant'Anna

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Inflatable Dielectric Elastomer PTO

Project Summary

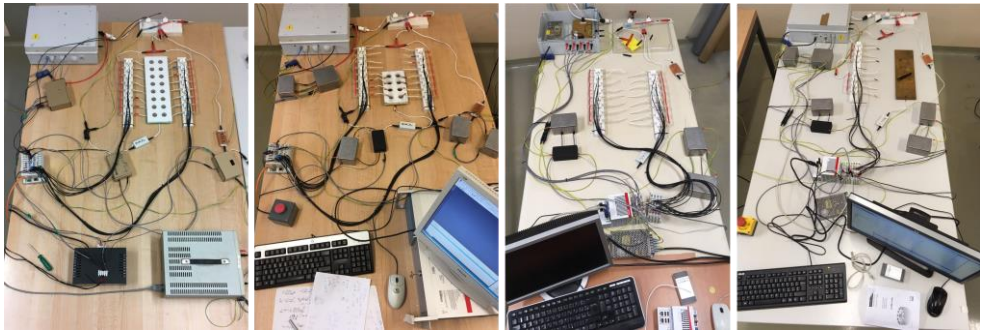
Objective STAGE II

Develop a new type of PTO based on inflatable dielectric elastomer generators.

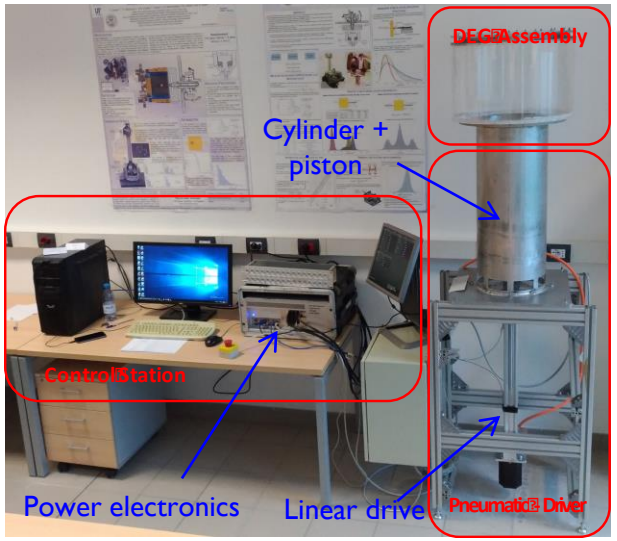
Main Achievements

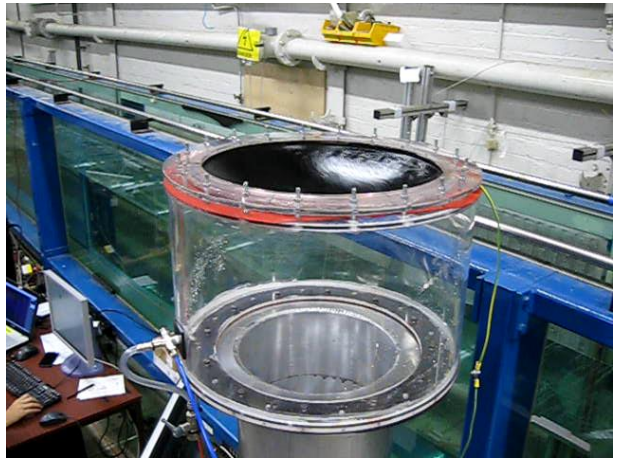
- **HIL demonstration** and testing (1:10 scale)
- **Reliability:** not sufficient for materials derived from other sectors but very promising figures for purposely produced materials (by Wacker and Parker);
- **Techno-economic assessment:** promising and robust projections for long-term which can guarantee LCOE below 150£/MWh, however there are still uncertainties on reliability.

4 test-benches for parallel fatigue testing



HIL Testing of PTO





Future developments

Objective

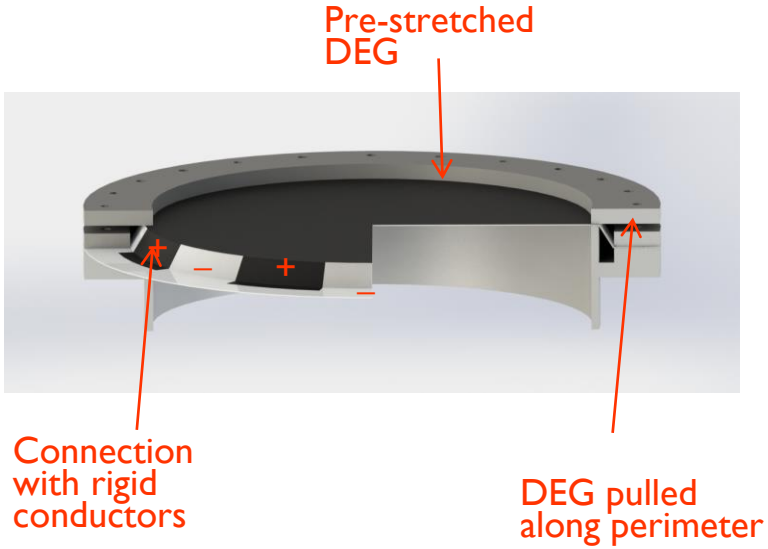
Upscaling to 1:5 – 1:8

Partnerships (additional)

- *Univ. Saarland:* expert of manufacturing of PDMS-based DEGs;
- *Parker Hannifin:* has invested on a facility to produce DE films (1.4 m in width);

Plan

- Intermediate scale HIL setup
- Including mechatronic systems for: *impedance tuning* and *overload protection;*
- Manufacturing and detailed FEED study
- Performance test campaign
- Advanced techno-economic assessment



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Title:	Power Electronic Controlled Magnetic Gear (PECMAG)
Programme:	Wave Energy Power Take-Off Stage 2
Presenter:	Michael Cowie & Paul Brewster
Lead Contractor:	Ecosse Subsea Systems Ltd
Collaboration Companies:	Bathwick Electrical Design Ltd Supply Design Ltd Pure Marine Ltd

ECOSSE Subsea Systems
Offshore Engineering & Deployment

BEDL Bathwick Electrical Design Ltd
Novel Magnetic Gear & Generator

SUPPLYDESIGN BESPOKE ELECTRONICS
High-Efficiency Power Electronics & Control

Pure Marine
Wave & Tidal Energy Technology Developer

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Power Electronic Controlled Magnetic Gear (PECMAG)

Project Summary

- Development of Linear All Electric Magnetic Gear PTO
- Stage 2 aims:
  - ¼ scale prototype and test rigs; gear and rectifier
    - 35kN gear
    - Integrated generator
    - 10kW AC Rectifier
    - 0.7m stroke
- Outputs: 1/20 (400W) and ¼ scale (10kW) test rigs
- Lab testing of key functionality and control features
- LCOE Modelling

Challenges

- Novel PTO - 1st of a kind linear gear
  - Assembly
  - Steep learning curve
  - Schedule and cost implications
  - Limited UK expertise of magnetic gear and permanent magnet generator assembly
- Electronics: developing skipping and automatic pre-engagement algorithms
- Maximising low sea-state efficiency

Technical product or integration offering

- New breed of highly efficient PTO that can be configured for WEC force, speed, stroke and power requirements
- Linear and rotary options
- No limit on stroke
- No limit on speed
- Electronics give high efficiency power capture and instantaneous control
- Inherently self-protecting system that can skip if required
- Efficiency to DC link averages 85% across 6 sea-states
  [Efficiency is King!]
- Contactless gear is more reliable
- Modular and redundant electronics – failure tolerant

Skills expertise or technology required

- Expertise in manufacture and assembly process
- Energy storage
- Marinisation of system