EDRIVE - MEC

EPSRC Supergen Marine Grand Challenge

1st April 2016 – 31st March 2019

IAB 29th March 2017

Bilbao

PTO Design Challenge

PTO and power conditioning system requirements:

- convert energy from motion in **multiple directions**,
- **react large forces** or torques whilst operating at **low velocity**,
- **variable voltage and frequency**,
- exhibit **high reliability, availability and efficiency over a wide range of loads**.

Aim

develop an integrated electrical power take off system with non-mechanical speed enhancement, integrated and reliable flexible power electronics, providing adaptive control over a range of operating regimes, taking into account nominal and extreme load conditions.

Academic Partners

- University of Edinburgh
  - Markus Mueller, Aristides Kiprakis, Henry Jeffrey
  - Richard Crozier, Adrian de Andres, Ben McGilton (PhD)
- University of Newcastle
  - Nick Baker, Volker Pickert, Steve McDonald
  - 2 PhDs
- TU Delft
  - Henk Polinder
- Universidad de Chile
  - Roberto Cardenas
- UNAM, Mexico City
  - Rodolfo Silva Casarin

THE UNIVERSITY of EDINBURGH
School of Engineering
Institute for Energy Systems

Industrial Partners

- Albatern – UK
  - David Findlay, Edinburgh
  - www.albatern.co.uk
- Carnegie Wave Power, Australia
  - Tim Sawyer, Cornwall, UK
  - http://carnegiewave.com/
- Columbia Power Technolgies, USA
  - Ken Rhinefrank, Corvallis, Oregon, USA
  - http://columbiapwr.com/
- Tecnalia, Spain
  - Ainhoa Pujana, Bilbao, Spain
  - http://www.tecnalia.com/en/energy-environment/index.htm
- Turbopower Systems, UK
  - Nigel Jakemen, UK
  - http://turbopowersystems.com/

New Industrial Partners

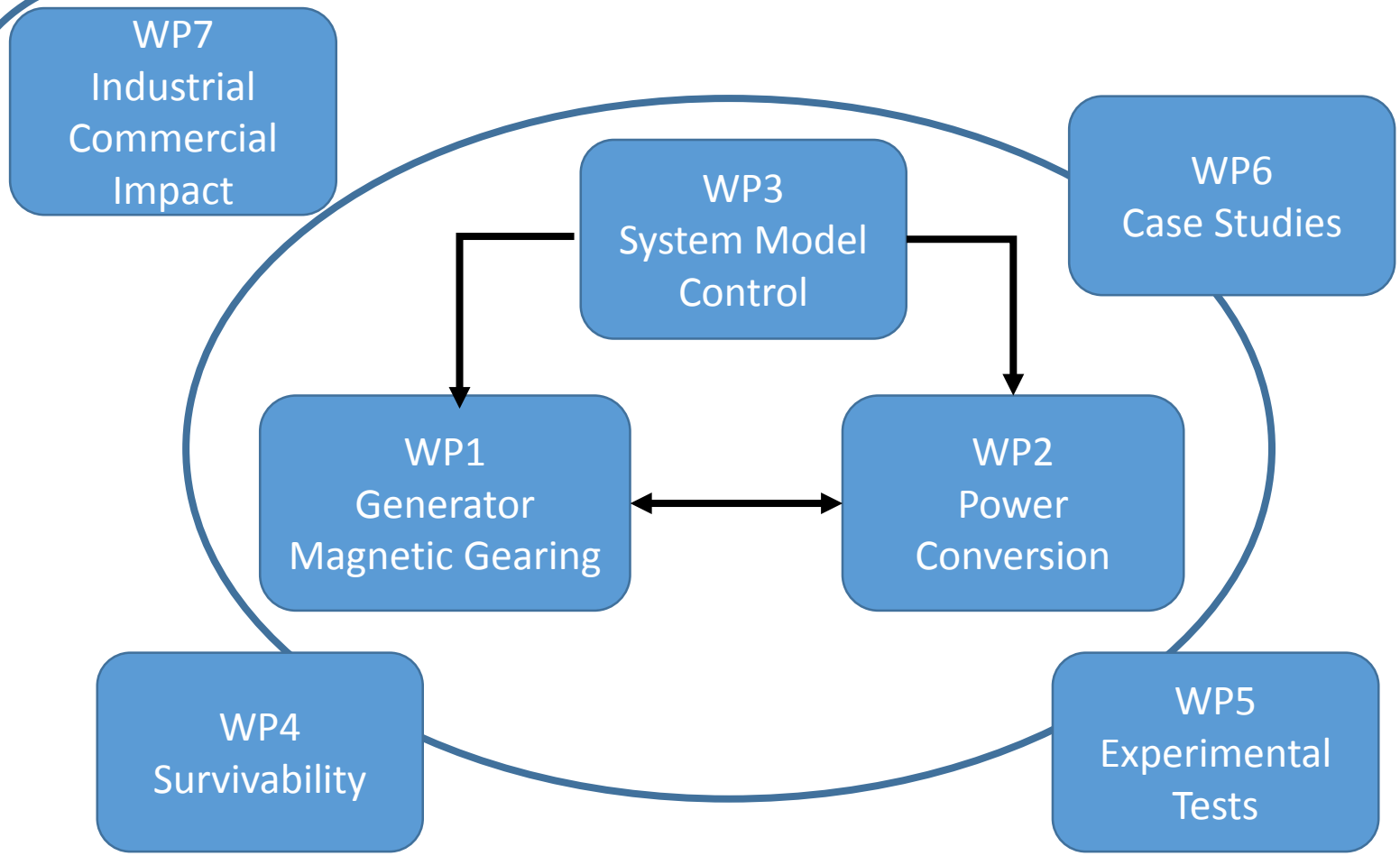
- Laminaria, Belgium
  - Andrea Foschini
  - http://www.laminaria.be/

- Supply Design, UK
  - Craig Britton
  - http://www.supplydesign.com/

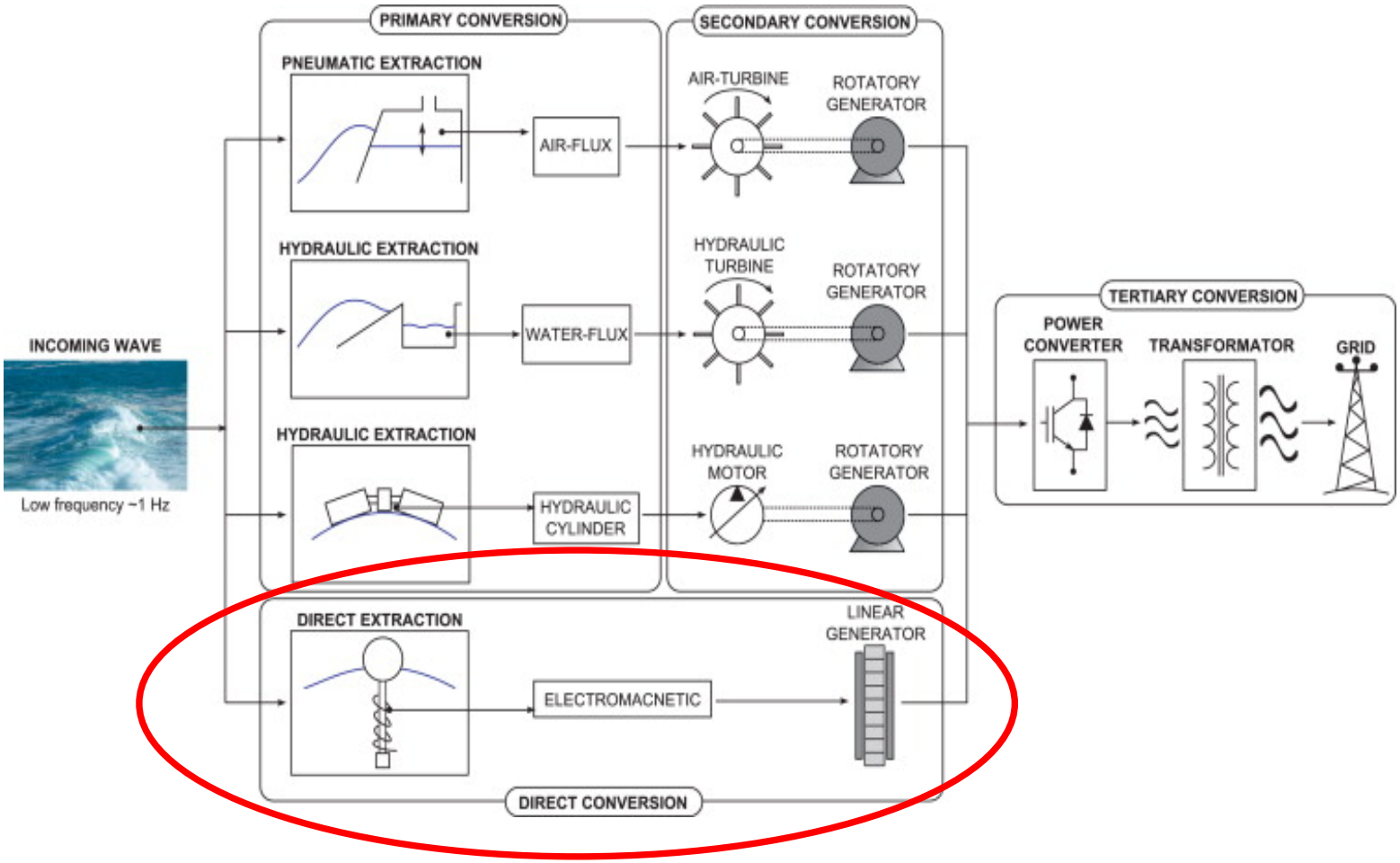
Interaction with Partners

- Knowledge Transfer
  - Inform industrial partners of new technology.
  - Industrial partners inform academics of real engineering design challenges.
  - Learn from shared experience.
- New partnerships
  - Academic to industry, industry to industry
  - Apply for additional funding
    - Wave Energy Scotland
    - H2020 – still have 2 years!
    - Innovate UK

WP Interactions

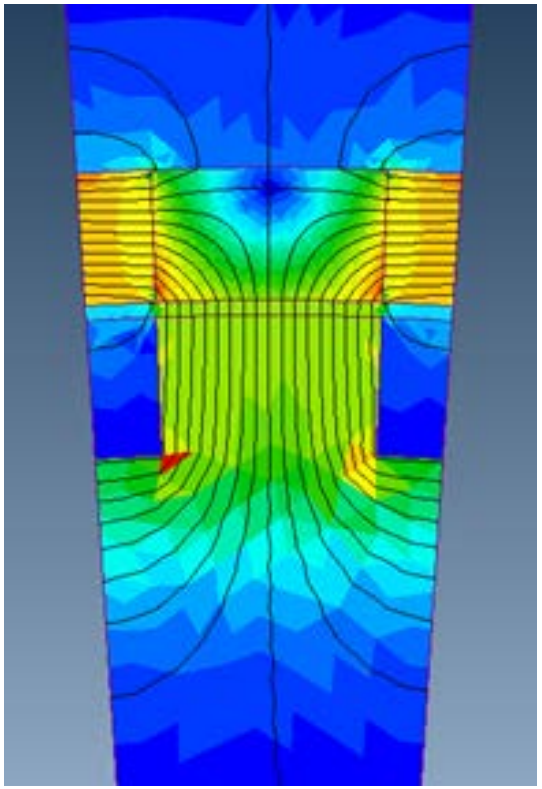


PTO Options


PRIMARY CONVERSION
SECONDARY CONVERSION
PNEUMATIC EXTRACTION
AIR-TURBINE
ROTATORY GENERATOR
AIR-FLUX
HYDRAULIC EXTRACTION
HYDRAULIC TURBINE
ROTATORY GENERATOR
WATER-FLUX
TERTIARY CONVERSION
POWER CONVERTER
TRANSFORMATOR
GRID
INCOMING WAVE
Low frequency ~1 Hz
HYDRAULIC EXTRACTION
HYDRAULIC MOTOR
ROTATORY GENERATOR
HYDRAULIC CYLINDER
DIRECT EXTRACTION
LINEAR GENERATOR
ELECTROMACNETIC
DIRECT CONVERSION

Electrical Conversion

- Electrical machines work best with **high speed rotary motion**
- Eg 3000rpm electrical machine active diameter of 200mm has an air gap speed of **30 m/sec**.
- Typical WEC **linear oscillatory** velocities ~ **0.5-2m/s**



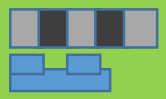
EDRIVE options

Too big

Large machines

small machines

Slow machine



Speed amplification

high electric loading

Poor efficiency

Power factor ?

control

Power conditioning

WP2 converter

Magnetic Gear

WP1 machine

Variable Spring

Integrated

WP 3 control

External

Not direct drive

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