All Electric Drives for Marine Energy Converters

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Marine Energy Issues

- High operation and maintenance costs
- Extreme environments
  - Highly variable conditions
  - High saline environment
- Remote locations
- Low frequency
- Multiple device types

Project Objectives

The EPSRC, SuperGen Marine e-Drive project is aiming to advance the next generation of marine energy converters through:

- Purpose designed, dynamic wave to wire models
- Advanced power electronics
- High efficiency, high density machines
- Non-mechanical speed enhancement (magnetic gears)

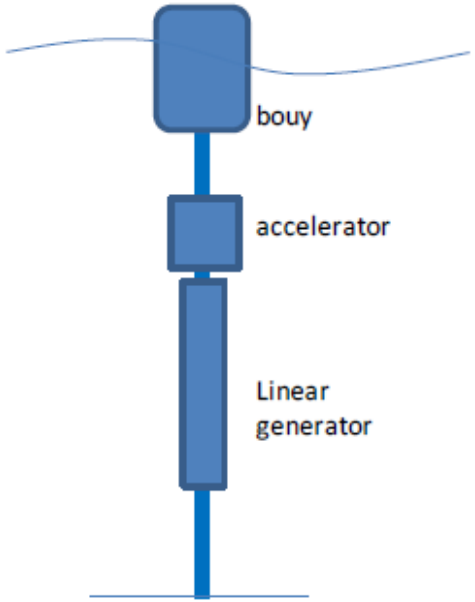
e-Drive Partners

THE UNIVERSITY *of* EDINBURGH

Wave to Wire Model

Currently producing a model capable of analysing the combined dynamics of full system components including:

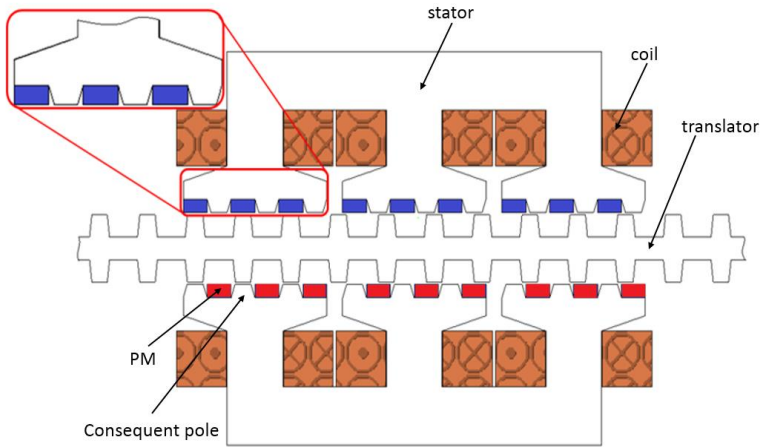
- Hydrodynamic action of the primary mover
- Magnetic gear translator interaction
- Generator with control function



Machine Design

Focus on new machine design: Consequent Pole Linear Vernier Hybrid Permanent Magnet (CPLVHPM) machine.

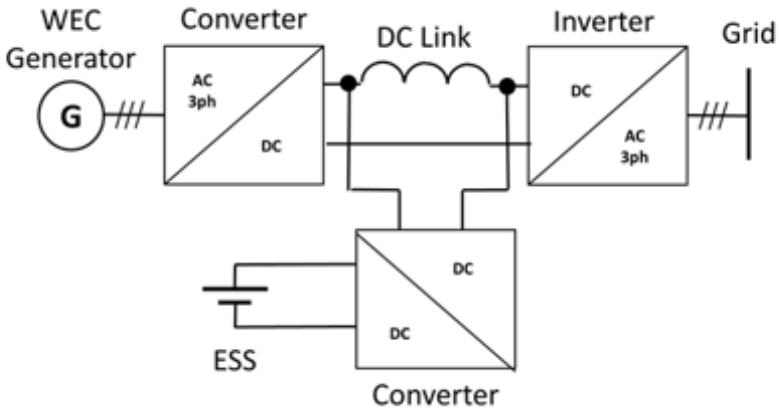
- While reducing high cost magnetic material, maintains high density and power factor. Additionally increases frequency due to the translators gearing effect.



Power Electronics

PTO reliability is being improved by adopting a modular approach and by optimising the converter design for the e-Drive application.

Custom designed systems incorporate reactive power control for a wide operating range and energy storage for fault tolerance.



Gears – The Problem

- Traditional mechanical gears are a leading cause of downtime with the highest associated costs to repair.

- Opting for a direct drive system requires a physically larger system due to high pole number, increasing installation complexity. Additionally, studies have shown that the required power electronics result in comparable down times.

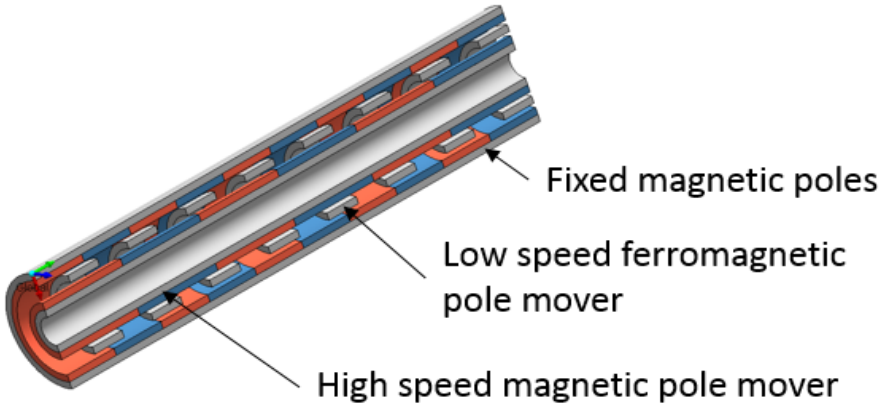
- Intermediary power take off systems, such as hydraulics, are proposed as an alternative but often suffer from poor efficiency and O&M issues.

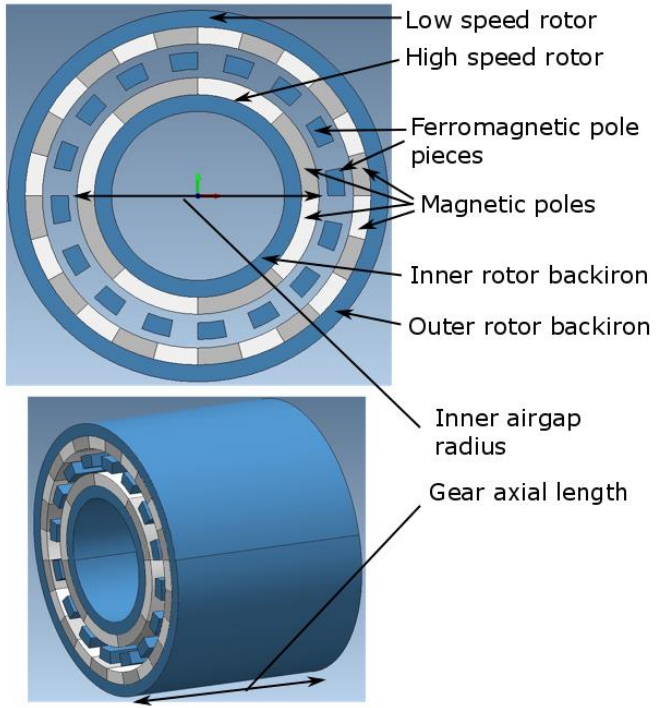
Magnetic Gears – The Solution!

- Contactless torque transfer
  - ➢ No wear
  - ➢ No lubrication requirements
  - ➢ No acoustics
  - ➢ Additional sealing options for marinisation
- Machine sizing
- Overload protection

Magnetic Gears – Design

- Modelling tools developed for rapid design and optimisation (FEMM, Matlab, MagNet)
- Papers released covering design process (fixed parameter & genetic algorithm)
- Currently designing combined magnetic gear – generator systems for prototype testing





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