

# Design and Build of a 75 kW Linear Direct Drive Generator Prototype for Wave Energy Conversion

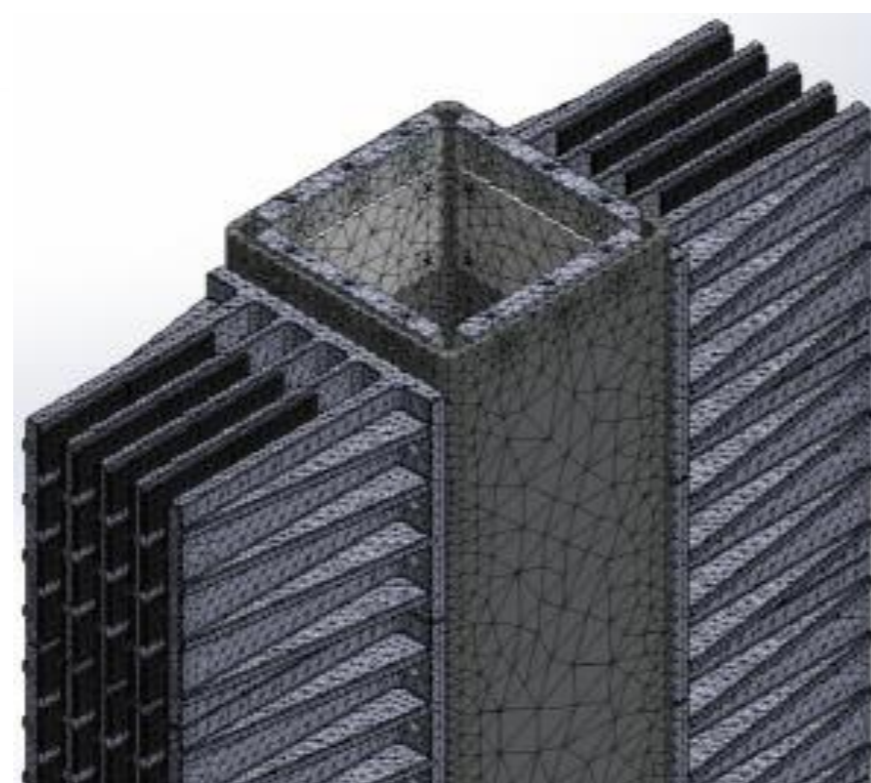
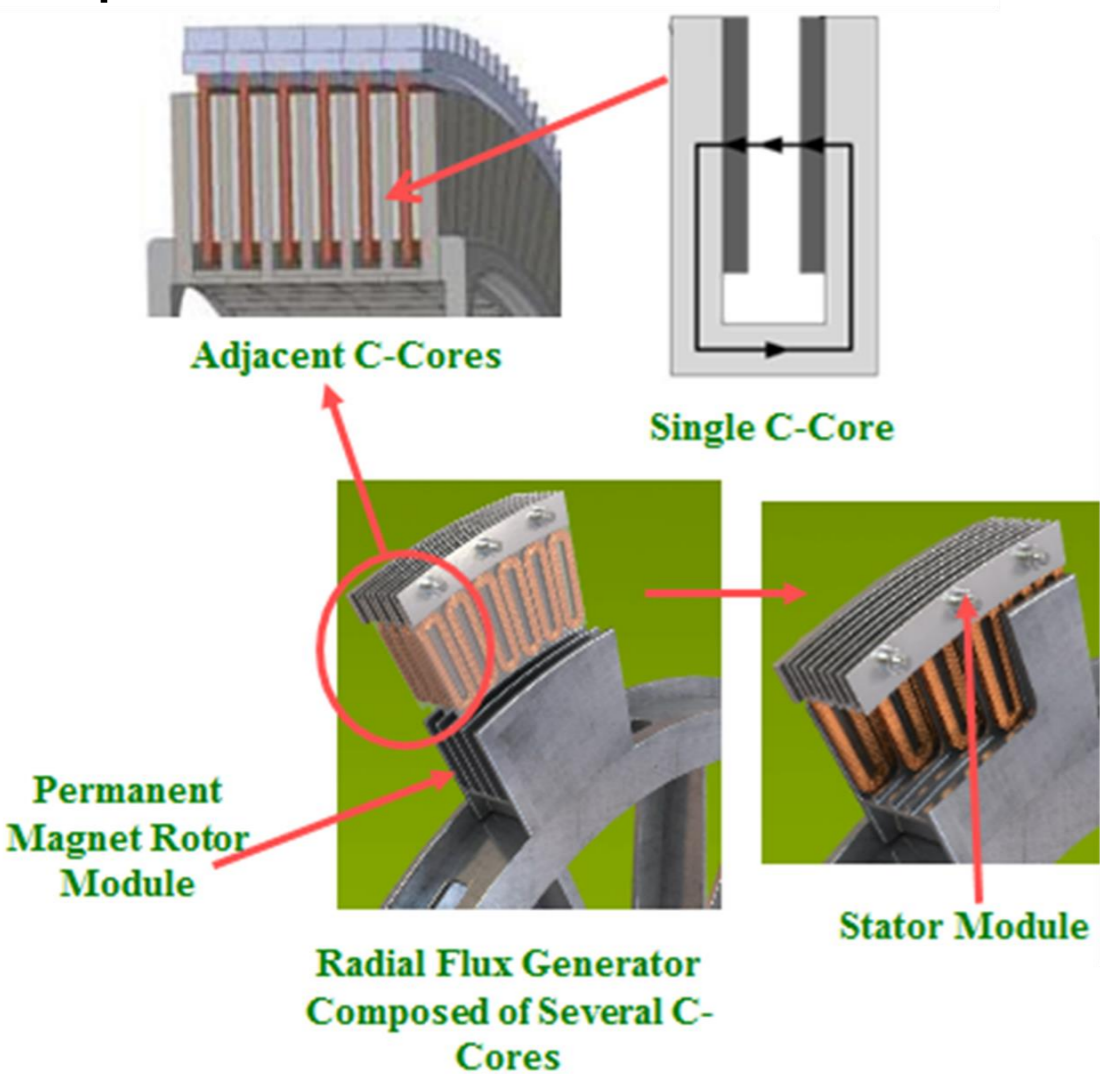
## Abstract

The simplification of drive trains and power take off systems for wave and tidal devices can reduce both construction and O&M costs as well as increase reliability and system efficiencies. Project Neptune is a Wave Energy Scotland Stage 3 Power Take Off (PTO) project, focusing on the development of the C-GEN medium to full scale direct drive generator topologies for the marine environment. Direct drive PTO's contain minimal complex mechanical components, thus potentially leading to a reduction in O&M costs and improved efficiencies over a wide range of load profiles.

## Machine Design

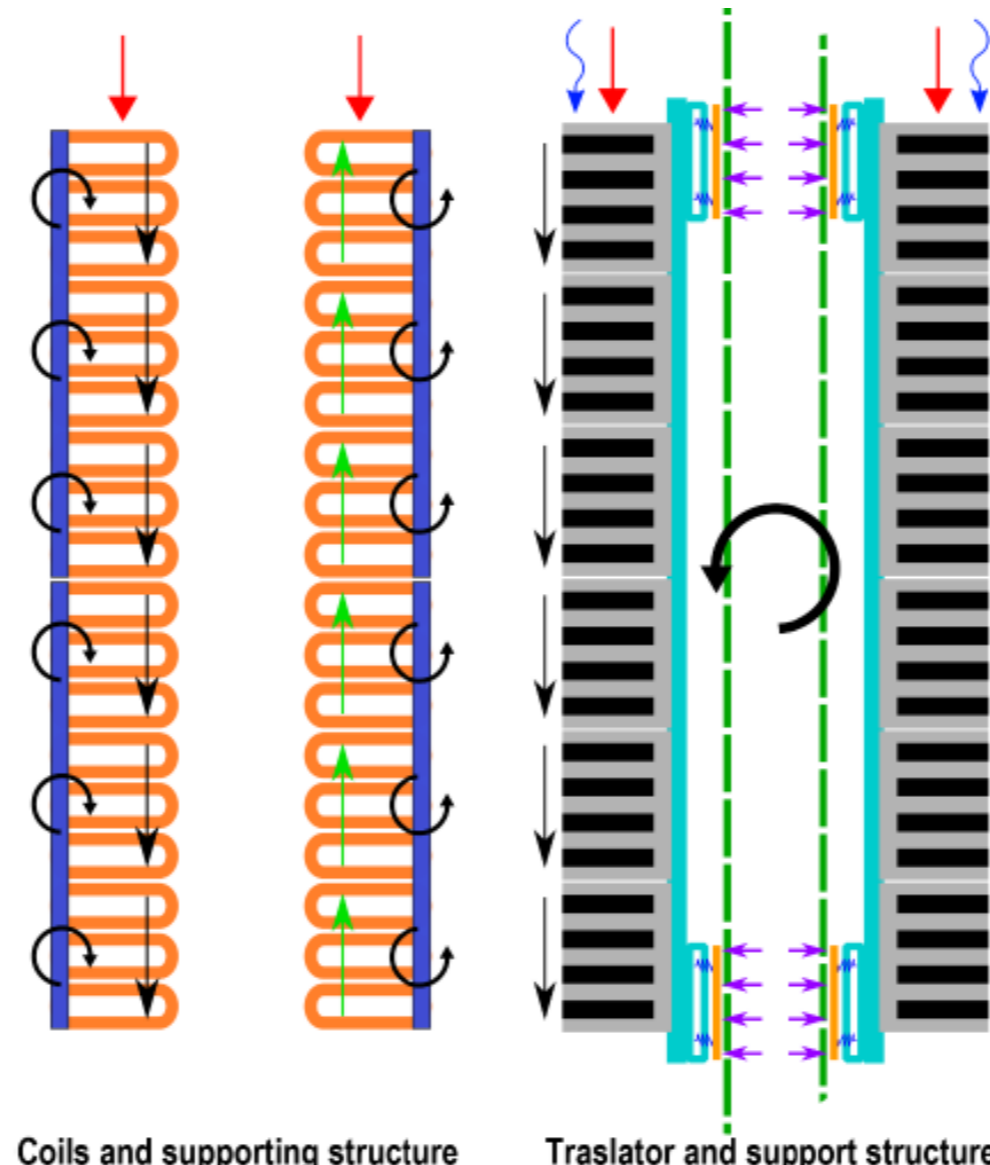
The C-GEN direct drive generator is a multi-stage Permanent Magnet Generator (PMG) that is applicable to direct-drive, slow or medium speed PTO applications and benefits from the additional aspects:

- No magnetic attraction forces closing the airgap,
- No cogging torque, and
- Air cored coils that allow for a high level of modularity leading to multi stage machines for higher energy availability and a reduction of O&M costs.



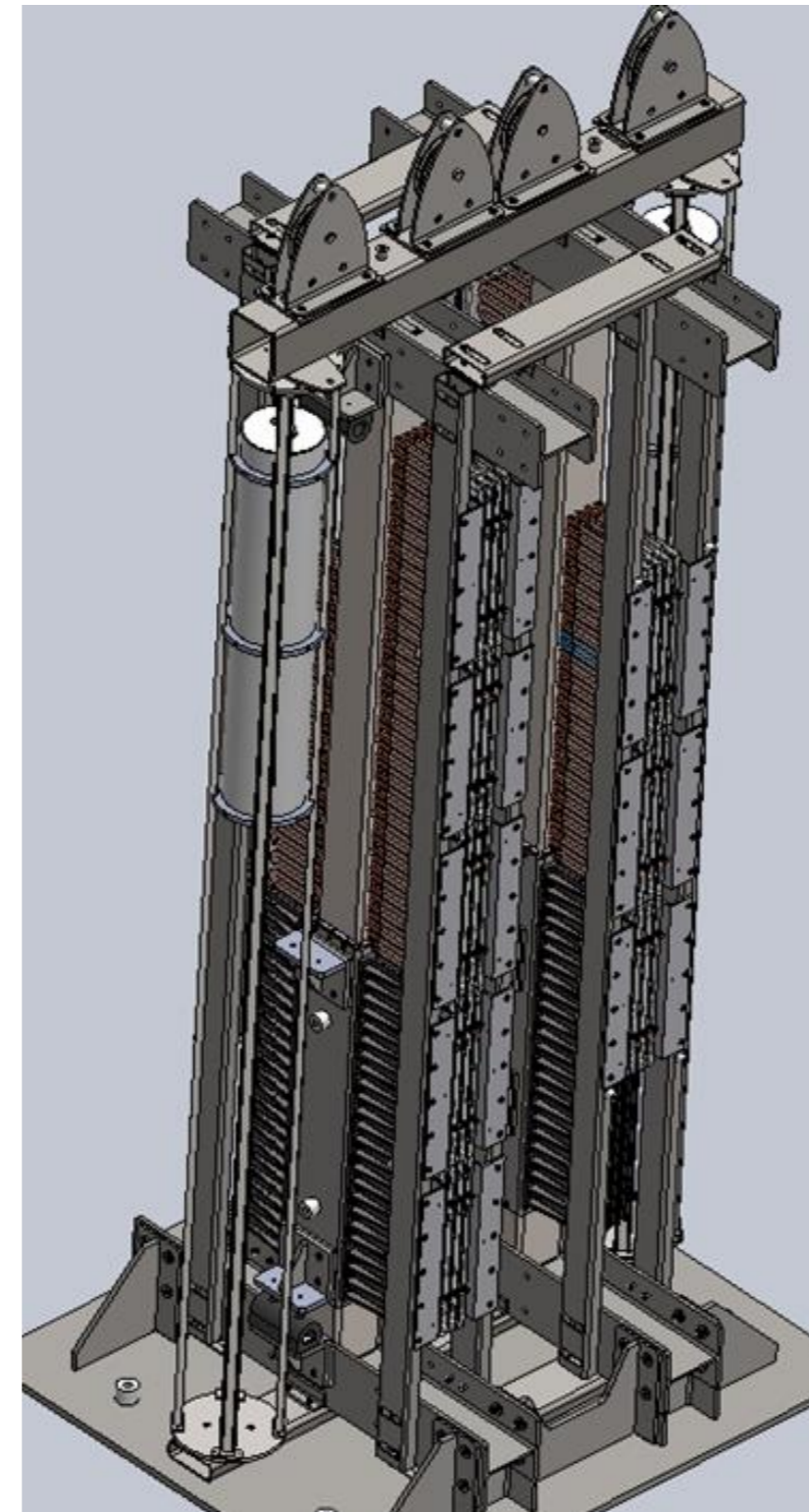
## Flooded Airgap

Based on thermal modelling and experimental results from various flooded machine studies, it has been proven that a flooded C-Gen topology is capable of withstanding more than 5 times overload, without concern over temperature rise in the windings. Rather than size the generator converter for extreme wave events and loadings, these conditions will be absorbed within the generator and through resistive loading.



## Machine Build

Over the course of this project, a 75kW C-GEN linear generator has been designed and built for testing within the offshore marine environment. To aid the survivability and efficiency of the generator system, polymer linear bearings, flooded airgaps and protective marine coatings have been utilised to remove complex mechanical bearings, seals and improving cooling.



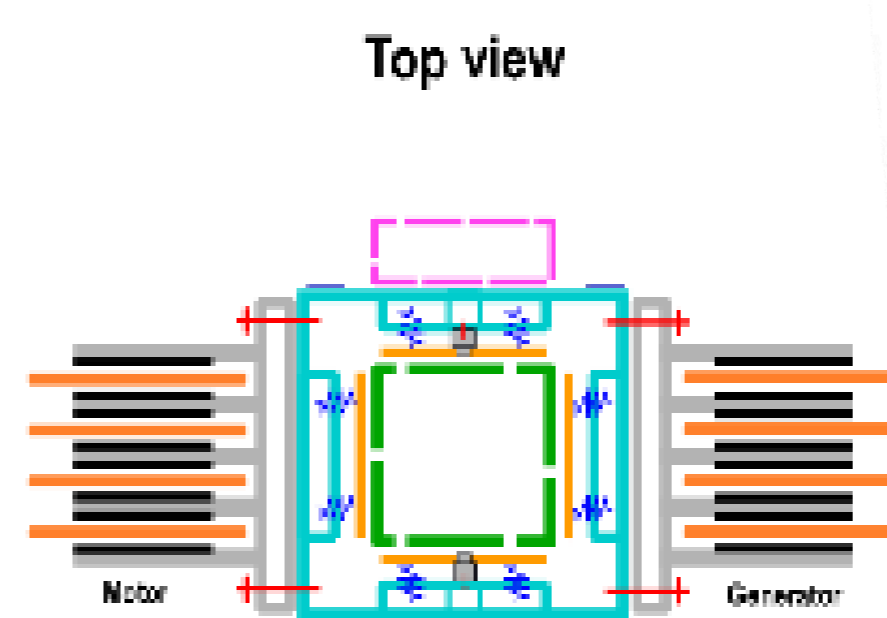
Above: Proposed test rig with two motors and two generator topologies



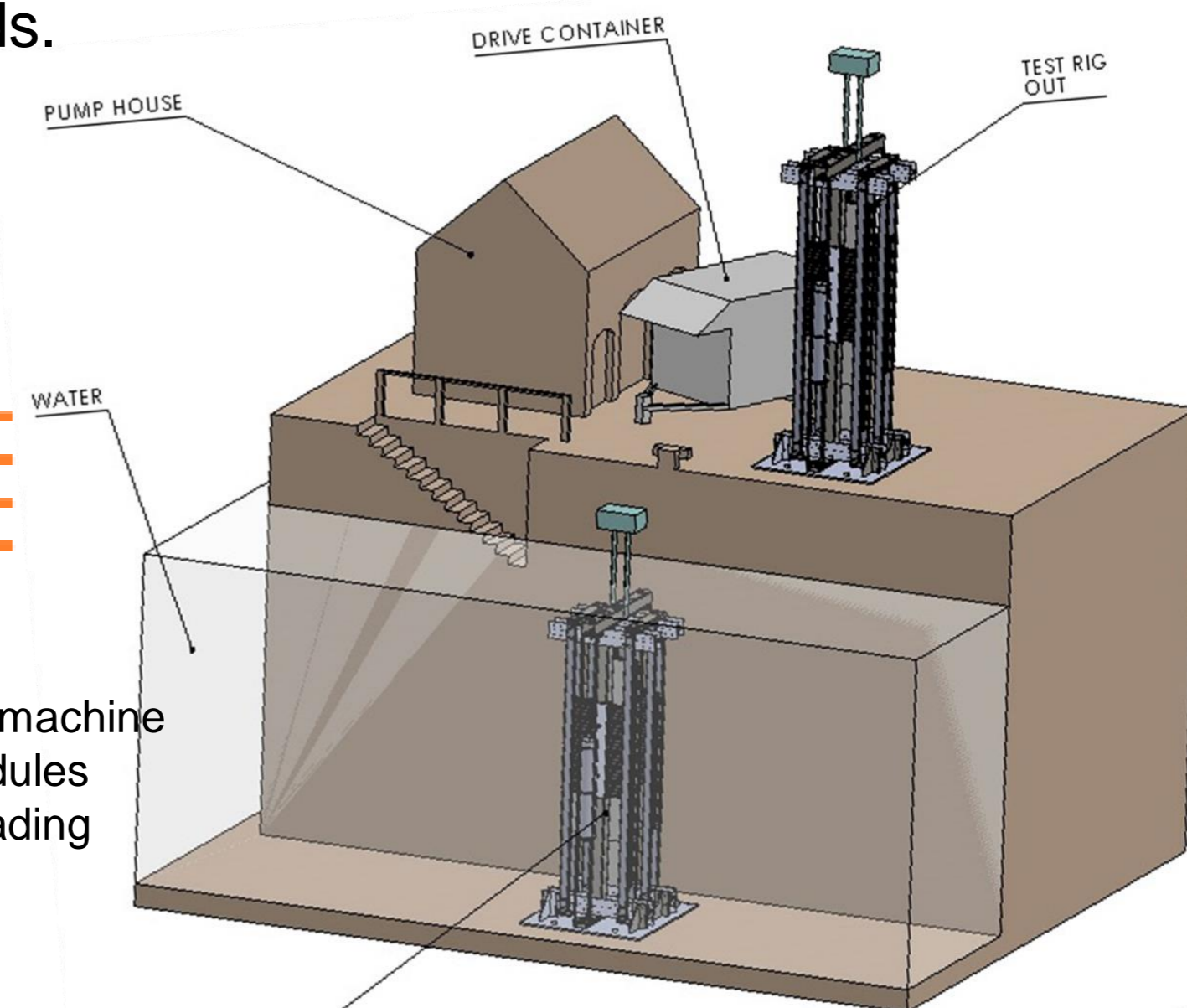
Top: Magnet module  
Bottom Wound coils  
Left: Coils potted in epoxy for module topology

## Testing

The fabricated machine is to be tested in 7m of sea water at Leith Docks as shown right. Testing of the generator assembly is to be completed by connecting it back to back with a C-GEN linear motor assembly to enable the emulation of varied wave loads.



Above: Schematic of top view of one machine  
Left: 3D meshed CAD of Magnet modules  
Below: Schematic of machine and loading



Above: Testing arrangement at Leith Docks  
Below: Bearing pad assembly fabrication

