Mauro Bonfanti - S244465 - 33° PhD cycle - mauro.bonfanti@polito.it - Poster session 2018

Design of a Hydraulic Power Take-Off Demonstration Test Rig for Renewable Energy Applications

Mauro Bonfanti

The Hydraulic Power Take-Off (PTO) - The PTO includes all those components between the **prime mover** of a renewable energy device and its **electric generator** that contribute to the **energy conversion**

Renewable Energy Device

Hydraulic PTO

- High torques and low speeds
- Robust power conversion system capable of handling highly variable powers with high torques
- Acceptable efficiencies

Electric Power Generation

Project aim

Build a demonstration test rig of a high efficiency PTO system for the management of renewable sources in isolated grids. The application in an isolated grid poses the challenge of managing the variable power flows deriving from renewable sources, inserted in a grid that is in itself weak and sensitive to load variations.

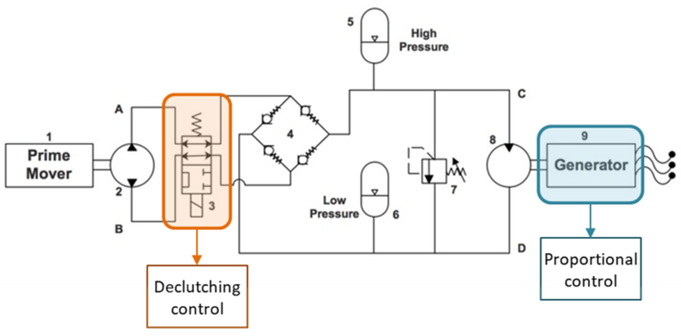
Device requirements

- Stabilization of power fluctuations deriving from renewable sources and in particular from the oscillating/pulsed wave source.
- Regularization and management of power output from renewable sources.
- Management of the high forces and torques necessary to absorb the mechanical energy.
- Need for systems operating with the necessary reliability in a marine environment.
- Need for compactness (weights and dimensions) of on-board systems.

Test rig requirements

- High conversion efficiency (>85 %).
- High internal energy storage capacity.
- Regularisation of the energy input from the renewable source.
- Stabilization of the power flows of the isolated grid/smart grid.
- Compactness guaranteed by hydraulic technology in relation to the forces and torques that can be applied.
- Intrinsic reliability of hydraulic technology.
- 50 kW rated power
- Scalability pursued with members of the same family, which ensure similar performance and reliability.

PTO architecture



Device requirements
(ISWEC case study)

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PTO architecture and components
PTO control laws
Wave to wire numerical model
Numerical simulations
Performance optimization

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Design requirements satisfied?

No → back to PTO architecture and components

Yes ↓

Test rig requirements

↓

Test rig configuration
Commercial components
Test rig numerical model
Numerical simulations
Performance optimization

↓

Design requirement satisfied?

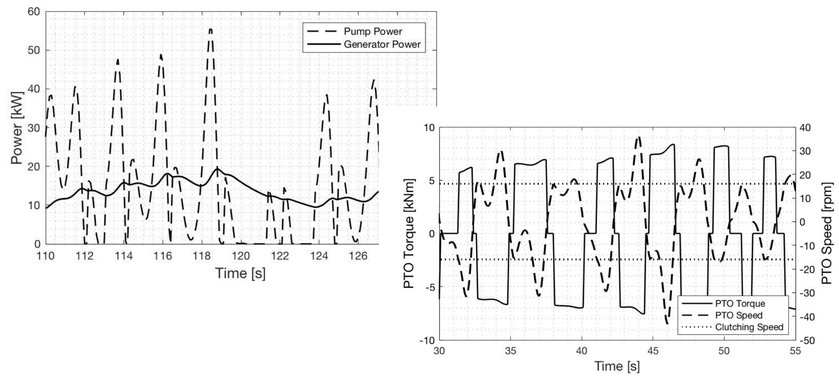
No → back to Test rig configuration

Yes ↓

Hardware In the Loop test rig

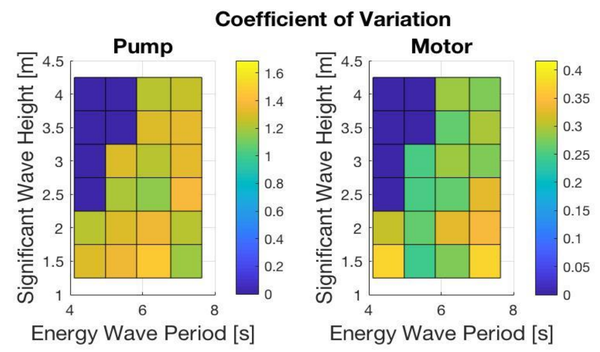
Numerical simulations

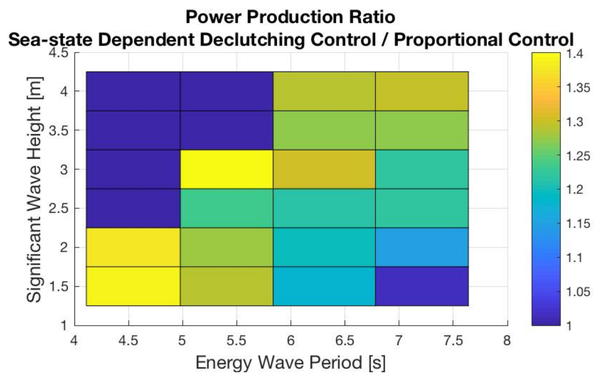
- Different sea states
- Different control parameters



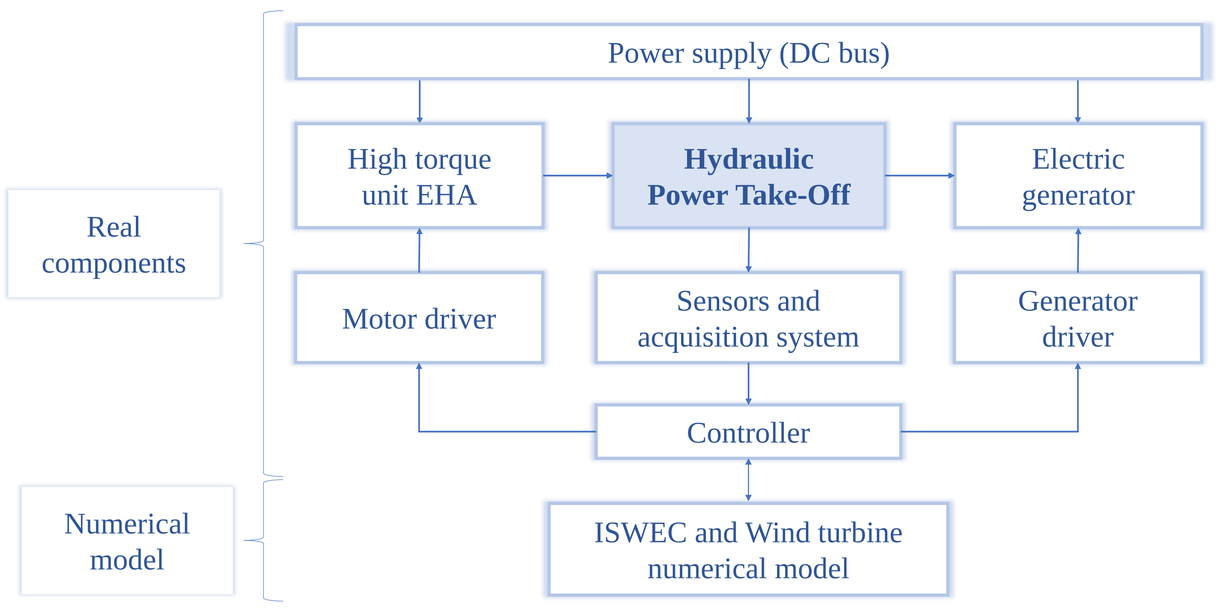
Performance optimization

- Two different control laws
- Improve Power quality (Coefficient of Variation) and extracted power





Test rig architecture



Future work

- Test rig simulations
- Real time control logic applied on ISWEC