## **Table of Contents**

I.	Nome	nclature	iv
Π	. Indice	28	. <b></b> viii
11	I. Abbro	eviations	X
1	Intro	duction and Scope of Work	1
2	State	of Research and Technology	4
	2.1 W	ave Power and its Utilisation	4
	2.2 PT	O Control Strategies	6
	2.3 Ну	drostatic Drive Trains for Wave Energy Conversion	9
3	Nume	erical Modelling of Wave Energy Converters	13
	3.1 Int	roduction to Monochromatic and Multichromatic Waves	13
	3.2 W	ave Induced Forces on Bodies	16
	3.3 Ni	americal Modelling in Frequency Domain	18
	3.4 Nu	Imerical Modelling in Time Domain	19
4	Wave	Power Resource at Deployment Sites	23
5	Hydr	odynamic Analysis	26
	5.1 Tv	vo-Body Heaving Buoy	26
	5.1.1	Frequency Domain Analysis	
	5.1.2	Time Domain Analysis in Multichromatic Waves	29
	5.1.3	Comparison of PTO Control Strategies	33
	5.2 Bo	ottom Hinged Flap	35
	5.2.1	Frequency Domain Analysis	35
	5.2.2	Time Domain Analysis in Multichromatic Waves	38
	5.2.3	Comparison of PTO Control Strategies	40
6	Desig	n and Simulation of Hydrostatic Drive Train Concepts	44
		nction Structure of a Hydrostatic Drive Train	
	6.2 D	rive Train Topologies	46
	6.3 Te	est Bench of a Closed Loop System	47
	6.3.1	Efficiency with Constant and Variable Speed Operation	48
	6.3.2	Drive Train Efficiency in Stationary Conditions	51
	6.4 M	odelling and Parameterisation of Main Components	53



Friction Losses of Cylinders	. 53
Losses of Axial Piston Units	
•	
• •	
· · ·	
• •	
OT Concept for Central Electricity Generation (C-OL-DA)	. 83
mparison of the HDT Concepts	. 87
to Wire Simulation in Multichromatic Waves	.91
vo-Body Heaving Buoy with CL-PS System	. 92
System Design of the Hydrostatic Drive Train	
Operational Behaviour in Sea State 1 ( $H_s = 1.5 \text{ m}, T_p = 9 \text{ s}$ )	. <b>9</b> 3
Annual Performance	
ttom Hinged Flap with OL-DA System	. <b>9</b> 9
Lever Design and Arrangement of Cylinders	. 99
System Design of the Hydrostatic Drive Train	
•	
nclusions of the Wave to Wire Simulations	120
sment of HDT and Grid Connection Costs	122
sts of Hydraulic Components	122
sts of Electrics, Power Electronics and Grid Connection	123
sulting Drive Train and Grid Connection Costs	124
are of Drive Trains and Grid Connections on Costs of Energy	
usion and Outlook	130
graphy	. xii
	Losses of Axial Piston Units Losses of Hydraulic Accumulators Losses of Generator and Inverter Pelton Turbine DT Concepts for Decentral Electricity Generation Open Loop – Direct Accumulation (OL-DA) Open Loop – Switchable Accumulation (OL-SA) Closed Loop – Power Split (CL-PS) Open Loop – Low Pressure Control (OL-LPC) DT Concept for Central Electricity Generation (C-OL-DA) mparison of the HDT Concepts to Wire Simulation in Multichromatic Waves vo-Body Heaving Buoy with CL-PS System System Design of the Hydrostatic Drive Train Operational Behaviour in Sea State 1 ( $H_s = 1.5 \text{ m}, T_p = 9 \text{ s}$ ) Annual Performance ttom Hinged Flap with OL-DA System Lever Design and Arrangement of Cylinders System Design of the Hydrostatic Drive Train Operational Behaviour in Sea State 4 ( $H_s = 2.25 \text{ m}, T_z = 6.5 \text{ s}$ ) Annual Performance ve Bottom Hinged Flaps with C-OL-DA System System Design of the Hydrostatic Drive Train Operational Behaviour in Sea State 2 ( $H_s = 3.75 \text{ m}, T_z = 8.5 \text{ s}$ ) Annual Performance system Design of the Hydrostatic Drive Train Operational Behaviour in Sea State 2 ( $H_s = 3.75 \text{ m}, T_z = 8.5 \text{ s}$ ) Annual Performance system Design of the Hydrostatic Drive Train Operational Behaviour in Sea State 2 ( $H_s = 3.75 \text{ m}, T_z = 8.5 \text{ s}$ ) Annual Performance sts of Hydraulic Components sts of Hydraulic Components sts of Hydraulic Components sulting Drive Train and Grid Connection Costs are of Drive Trains and Grid Connection Costs are of Drive Trains and Grid Connection Son Costs of Energy <b>lusion and Outlook</b>

.

A.1 Typical Morphology of Wave Energy Converters	1
A.2 Details of Test Bench and Specimen	2
A.3 Control of the OL-LPC Switching Valve	3
A.4 Array Layout of C-OL-DA System	4