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NETWORKING

APP WMW

TOUR VIRTUAL

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A modelling approach for Offshore Wind Farm Feasibility with respect to Ecosystem-based Marine Spatial Planning	[1]Kemal Pınarbaşı; [1]Ibon Galparsoro; Daniel Depellegrin; [1]Juan Bald; [2]Germán Pérez-Morán; [1]Ángel Borja.	[1]AZTI [2]Tecnalia [3]National Research Council – Institute of Marine Sciences (CNR-ISMAR)
Project Wave Energy in the Southern Europe (WESE)	[1]Juan Bald, [2]Teresa Simas, [3]Yago Torre Enciso, [3]Dorleta Marina, [4]Patxi Etxaniz, [4]Borja De Miguel, [5]Pablo Cervantes, [5]Pablo Ruiz, [6]Tuula Mäki, [7]José Chambel Leitão.	[1]AZTI [2] WavEC Offshore Renewables [3] Biskay Marine Energy Platform (BiMEP) [4] IDOM Consulting, Engineering and Architecture, S.A.U. [5] Asociación Centro Tecnológico, Naval y del Mar de Cartagena (CTN) [6] AW-Energy Oy Ltd (AWE) [7] HIDROMOD – Modelação em Engenharia, Lda

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NOVEL METHODOLOGY FOR THE HOLISTIC ASSESSMENT OF WAVE ENERGY DESIGN OPTIONS

eman ta zabal zazu

Universidad del País Vasco | Euskal Herriko Unibertsitatea

Pablo Ruiz-Minguela | Tecnalia
Jesús María Blanco | University of Basque Country, UPV/EHU

ABSTRACT

Despite significant efforts in last decades Wave Energy technologies have not reached commercial maturity yet [1]. Wave Energy is not competitive with other renewable energy sources due to its poor performance, reliability levels and high costs. Conventional methodologies focused on Technology Readiness Levels (TRL) have proved insufficient to guarantee Wave Energy technologies meet their technical and economic goals.

Systems Engineering methods [2] have been successfully applied in other industrial sectors (e.g. automotive and aerospace) to develop innovative products meeting very diverse and demanding customer requirements. Likewise, multicriteria analysis [3] has been applied to inform the decision-making process in early design phases of complex engineering problems, particularly when alternative solutions can be heterogeneous.

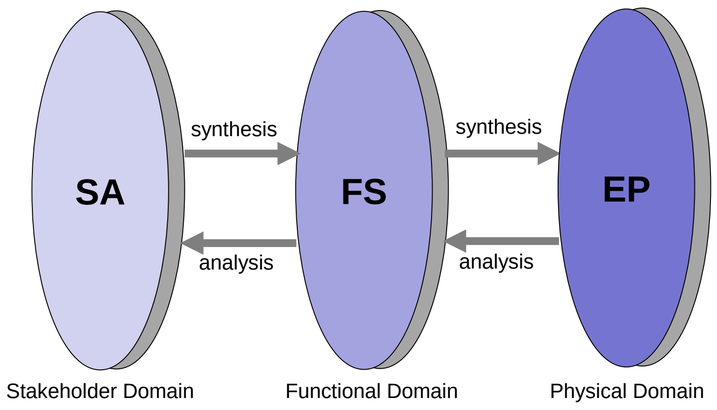
This poster presents a novel methodology for the holistic assessment of wave energy design options based on sound systems engineering and multicriteria analysis principles.

This approach is particularly useful during the first stages of technology development where up to 75% of the final product cost can be committed [4].

DESIGN METHODOLOGY

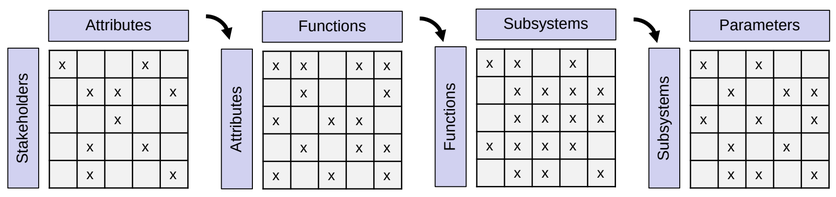
REQUIREMENTS FULLY TRACED THROUGH THREE DOMAINS OF THE DESIGN WORLD

- **Stakeholder Domain**, defined by the Stakeholder Attributes (SA) the customer and associated stakeholders would like to see in their system.
- **Functional Domain**, where requirements are transformed in a comprehensive Functional Specification (FS).
- **Physical Domain**, in which the Engineering Parameters (EP) emerge. They describe the physical embodiment to achieve the above functions.



MAPPING PROCESS VIA WEIGHTING AND RELATIONSHIP MATRICES

Combination of well-established Systems Engineering tools: Quality Function Deployment (QFD), Analytical Hierarchical Process (AHP), Design Structure Matrix (DSM)

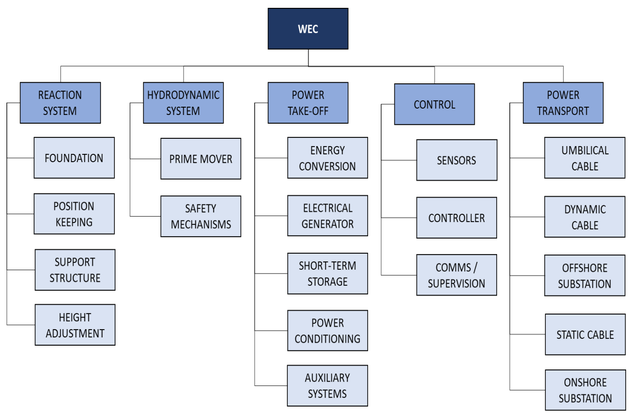


APPLICATION TO WAVE ENERGY

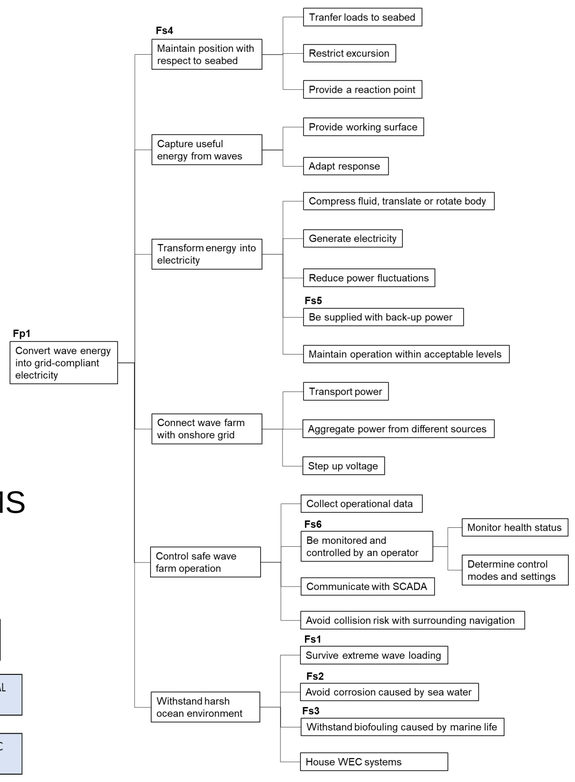
MAIN STAKEHOLDERS GROUPS

Group	Stakeholders	Roles
Financiers	Sponsors Lenders Government	Provide economic resources or incentives to develop the project
Condition setters	Regulators Independent bodies Pressure groups	National, regional and local bodies and groups setting conditions, required to be consulted or influencing the direction of the project
Developers	Project developer Construc. company Operating company Suppliers Insurance company	Direct interest in how things are managed on the project. Provide key resources, advice, services or assets
Energy users	Off-taker Grid operator Consumers	Direct participation in the flow of energy

HIERARCHY OF WAVE ENERGY SYSTEMS



FUNCTIONAL ANALYSIS



MAPPING OF STAKEHOLDER ATTRIBUTES TO COMPONENTS

Stakeholders Attributes		Prioritisation Rating	C1.1 Foundation	C1.2 Position Keeping	C1.3 Support Structure	C2.1 Prime Mover	C2.2 Variable Configuration	C3.1 Energy Transmission	C3.2 Electrical Generator	C3.3 Short-term Storage	C3.4 Power Conditioning	C3.5 Auxiliary Systems	C4.1 Umbilical Cable	C4.2 Dynamic Cable	C4.3 Offshore Substation	C4.4 Static Cable	C4.5 Onshore Substation	C5.1 Sensors	C5.2 Controller	C5.3 Comms/Supervision
A1.1	Energy production	9,2%	2	2	15	10	10	10	10	17	13	7	6	6	16	6	11	4	3	3
A1.2	Controllability	6,8%	5	6	5	5	14	10	10	21	13	9	6	6	14	6	11	8	12	12
A1.3	Availability	9,2%	3	9	14	14	14	13	15	9	7	8	6	11	12	6	9	10	8	8
A1.4	Profitable business	11,2%	9	21	32	29	28	21	23	25	17	19	18	21	30	18	21	24	10	13
A2.1	Economic growth & job creation	4,9%	6	13	18	15	10	9	9	11	11	4	12	13	26	12	19	6	2	1
A2.2	Climate change mitigation	5,4%	0	0	9	9	9	9	9	16	16	6	9	9	27	9	18	0	1	2
A3.1	Capital costs	8,1%	12	17	28	23	14	13	13	15	12	3	18	21	32	18	25	12	4	5
A3.2	Operational costs	7,3%	2	11	14	9	10	11	9	7	10	11	2	3	10	2	5	12	12	11
A3.3	End-of-life costs	4,4%	10	21	10	9	8	5	5	3	14	4	10	11	28	10	19	8	1	0
A3.4	Financial costs	6,0%	12	21	20	17	20	19	17	23	18	11	10	11	18	10	15	16	6	7
A4.1	Survivability	11,2%	16	39	36	29	30	17	17	19	11	23	10	13	12	10	11	28	12	17
A4.2	Commercial risks	7,3%	6	15	14	13	18	11	9	17	9	9	6	7	10	6	7	14	16	9
A4.3	Acceptability	9,1%	18	37	28	27	22	19	15	11	9	19	16	17	24	16	19	22	4	13
	Totals	**100,0%**	**8,24**	**17,58**	**20,48**	**17,59**	**17,35**	**13,72**	**13,35**	**15,62**	**12,13**	**11,47**	**10,25**	**12,02**	**19,50**	**10,25**	**14,43**	**14,12**	**7,58**	**8,81**
			3,4%	7,2%	8,4%	7,2%	7,1%	5,6%	5,5%	6,4%	5,0%	4,7%	4,2%	4,9%	8,0%	4,2%	5,9%	5,8%	3,1%	3,6%
			18,9%			14,3%		27,1%					27,2%					12,5%		
			Reaction System			Hydro-		Power Take-Off					Power Cabling					Control		

FUTURE WORK

- Validate the stakeholder, functional and physical domain analyses.
- Develop Utility Functions to model fundamental relationships between EPs and Value.
- Identify wave energy design alternatives with greatest potential.

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Parque Científico y Tecnológico de Bizkaia
Astondo Bidea, Edificio 700.
E-48160 Derio - Bizkaia (Spain)
www.tecnalia.com

Contact Information:
Pablo Ruiz-Minguela
Head of Wave Energy
Tel.: +34 946 430 850
jpablo.ruiz-minguela@tecnalia.com

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