Summary Report

MARINE ENERGY

Levelised cost of energy (LCOE) of marine energy in Chile study

marine energy research & innovation center

The LCoE study and local supply chain analysis was led by:

Within the framework of:

Financed by:

The LCoE study had the technical collaboration of

Marine Energy Research & Innovation Center - MERIC

Since 2015, MERIC develops applied research of international level, conducted by a multidisciplinary team of professionals committed with our mission.

Mission

Trigger sustainable development of marine energy in Chile, from an open R&D platform that strengthens applied research, looking for the creation of innovative approaches and solutions, minimizing marine energy extraction impacts and transforming Chile into a world reference on marine energy.

Vision

Enable marine energy sustainable development on extreme conditions and position Chile as world reference on marine energy.

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Of the main drivers pushing the development of the energy matrix in Chile, we should mention first: diversification and energy security, decarbonisation and the positioning of Chile as a world leader on this matter; and secondly, looking to the future, the export of green energy to neighbouring countries. Given that Chile has one of the largest marine energy resources in the world, marine energy might play a key role in achieving these goals. Additionally, tidal energy technologies are reaching a more mature development stage, which facilitates performing technical-economic assessments with less uncertainty.

The Levelised Cost of Energy (LCoE) study of wave and tidal technologies aims to identify technical-economic aspects of marine energy projects in Chile. On the other hand, this study comprises the identification of local actors to estimate local value capture and to identify opportunities and challenges in the supply chain. The LCoE tool enables comparisons of different energy projects regardless of technology deployed and project characteristics.

The study is divided into three main phases: first, a comprehensive global literature review of economic assessments and technologies, initial collaboration with technology developers, site and support infrastructure assessment and methodology definition. The second phase comprises supply chain analysis and the estimation of local value capture. The last phase includes the final calculation of the LCoE per site, scale and technology, and the socio-economic study.

During the literature review of studies developed around the world, it was possible to define a breakdown of the items comprised in the LCoE. The first stage also compiled all the information available regarding sites in Chile. This database of site information is the basis for the scenarios' definition of wave and tidal energy projects in the second phase.

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During the second phase the scenarios for different sites and technologies were defined, within a framework of collaboration with five international tidal technology developers and three wave energy technology developers. The tidal energy companies are: Sabella, Scotrenewables, Open Hydro, Atlantis and Tocardo. It should be mentioned that Tocardo and Open Hydro suspended their commercial operations during this study. However, Tocardo has restarted, with Dutch government support. Notwithstanding the above, the assumptions based on these two companies were used to calculate the LCoE. The wave energy companies that have been contacted for this study are: AW Energy, Oceantec, Albatern, Aquanet Power and Biowave.

Technology developers have shared technical and economic information of the several stages of a marine energy project: from equipment and device manufacturing to the operation and maintenance stage. The aspects defined in the scenarios include parameters related to support infrastructure, site characteristics, marine energy farm design, installed capacity and descriptions of the installation procedure.

In addition to the technical analysis of the sites, a community engagement analysis was performed. Restricted areas and special legislation were also identified. The main objective of this complementary study is to ensure the involvement of communities during the whole project life cycle. This process is quantified within the items of the Capital Expenditure (CAPEX) as "social compliance". The value attributed to this item involves significant uncertainty due to the lack of local experience.

The findings and outputs of the first and second stages have been validated by international experts from the University of Edinburgh, Offshore Renewable Energy (ORE) Catapult, Lloyd's Register, BVG Associates and Black & Veatch.

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The outputs of the LCoE for different project scales, sites and technologies are given in Table 1. The minimum and maximum values depend on assumptions made for each scenario. The level of uncertainty is based on information quality and other factors of the reference site. However, these levels of uncertainty are discussed and validated during a workshop with national and international experts. The table below shows and summarises final LCoE values for both technologies, tidal and wave.

Project scale	Variable	Wave		Tidal	
		Minimum	Maximum	Minimum	Maximum
Demonstration	Installed capacity (MW)	0,3	0,42	1	2
	LCoE (US$/MWh)	246	1414	228	2139
Medium scale	Installed capacity (MW)	3	4,2	10	10
	LCoE (US$/MWh)	124	884	132	673
Large scale	Installed capacity (MW)	30	42	50	100
	LCoE (US$/MWh)	106	714	71	374

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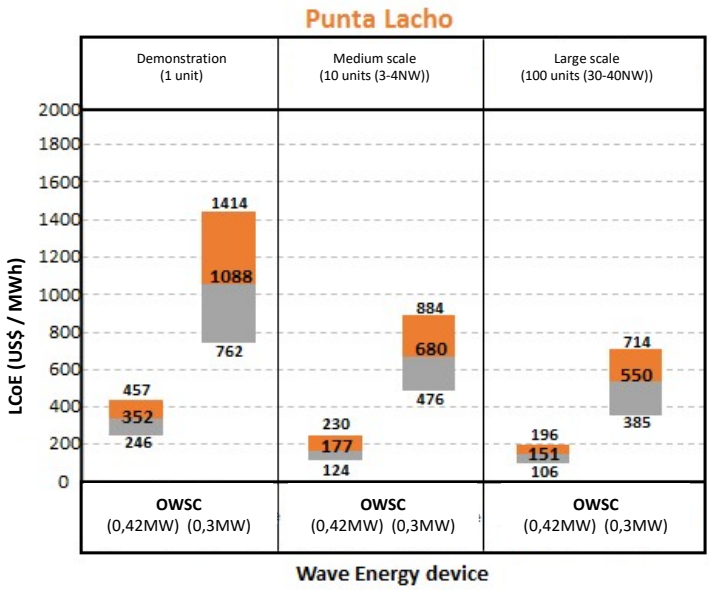
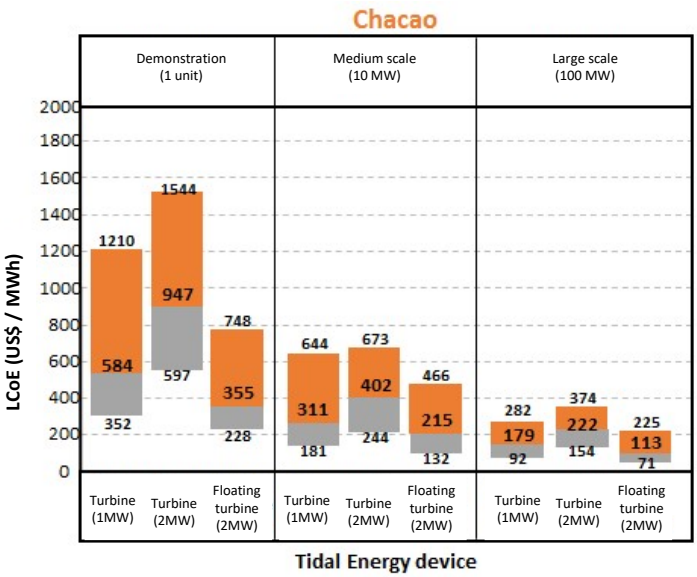
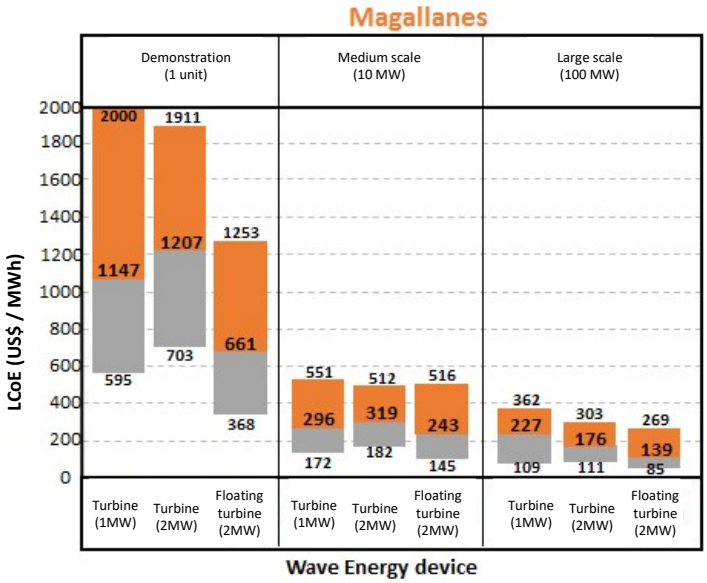
The following Figures show the results of LCoE for specific technologies (two types of wave energy technology and three types of tidal energy technology), scales (demonstration project, medium scale project and utility scale project) and sites.

The final Figure shows a comparison between wave and tidal energy in Chile with respect to the LCoE of marine energy in the world in different scales.



OWSC: Oscillating wave surge converter





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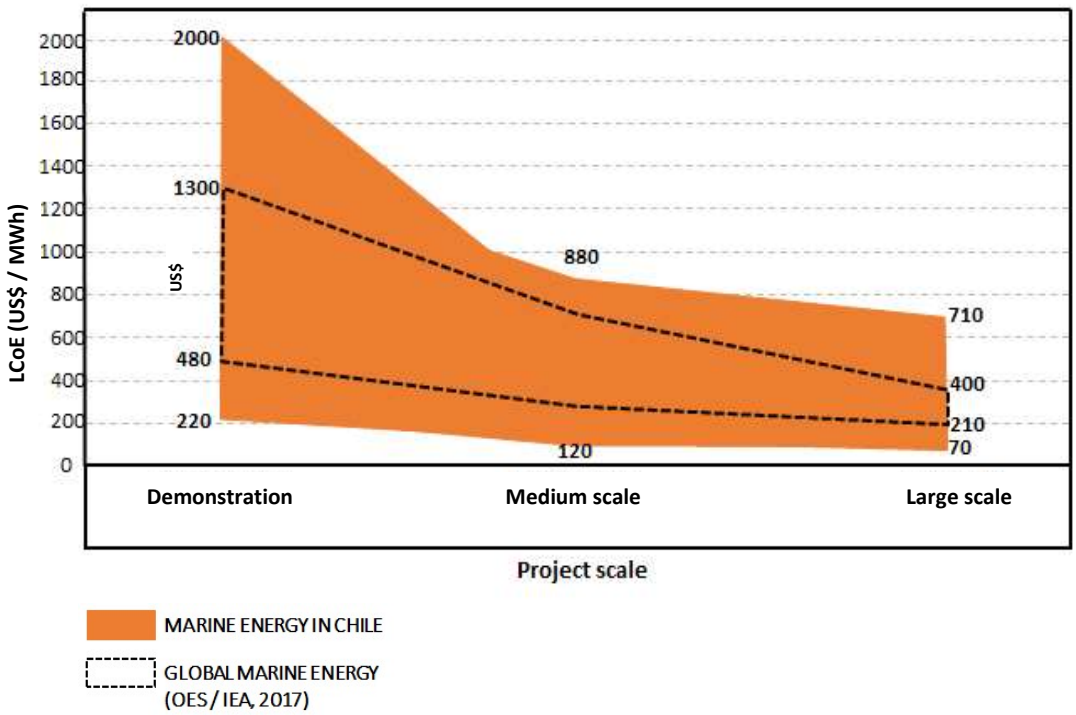

Finally, the supply chain analysis was performed in the second phase of this study. During a period of five months, 42 local supply chain actors were interviewed. These local companies are located in the following cities: Punta Arenas, Puerto Montt, Osorno, Valdivia, Concepción, Talcahuano, Valparaíso and Santiago. The main purpose of visiting these actors was to understand capabilities, costs and experience related to marine energy projects. According to the supply chain classification, it is possible to identify services and products with greater local value capture. Likewise, it is possible to recognise the largest challenges for the local supply chain and their impact on CAPEX and Operational Expenditure (OPEX). Using a semi-quantitative analysis, 60% of local value capture is estimated (Figure 3). Capabilities in the following activities can be highlighted: steel structure manufacturing and mooring system installation. Both items have a large impact on the CAPEX and the rest of the operational life of the devices.

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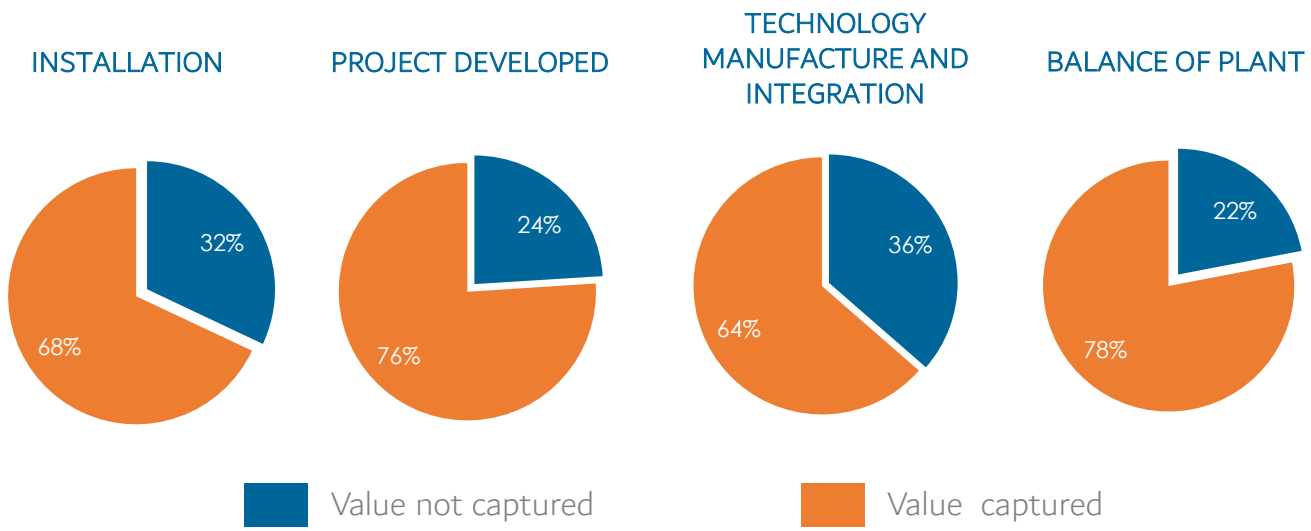

Parallel to the main objectives of this study, the international consultancy company Black & Veatch developed a socio-economic assessment of marine energy in Chile. The marine energy deployment assumption for 2050 is a range of 65MW to 260MW for pessimistic and optimistic scenarios respectively. Their analysis assessed the potential overall value of the marine energy sector, under the given deployment assumptions in Chile in 2050, to be between 44 billion and 183 billion CLP of Gross Value Added (GVA) with potential for between 1531.2 and 6242.7 full time employment (FTE) jobs to be created in Chile by 2050.

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