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Overcoming the marine energy pre-profit phase: What classifies the game-changing "array-scale success"?

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ABSTRACT

Tidal current and wave power have made substantial progress towards commercialisation. Based on the successful testing of full-scale prototypes, pioneering tidal arrays are currently implemented by means of direct agreements between developers/investors and device manufacturers. The top-ranked risks for commercial projects (identified as *achieving funding* and *uncertainty in device performance*) are directly intercorrelated as investor confidence mainly depends on track records of continuous device operation. Before becoming recognised as a fully mature electricity generation method, marine energy needs to prove a range of referenceable project cases. The attainment of this *array-scale success* will represent a major turning point for the global marine energy business and is expected to finally trigger large-scale deployment.

1. Introduction

Marine renewable energy arises in an era of global interest in carbon-free electricity generation. After significant technological advances in the wave and tidal sector in the last years, the industry is now moving from full-scale prototype testing to the phased implementation of the first tidal arrays ranging from 5.6 to 86 MW [1–3]. These demonstration projects are mainly based on bilateral agreements between developers/investors and leading device manufacturing firms. The

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global potential of marine energy and the planned investments are substantial. In the UK, The Crown Estate has leased 37 wave and tidal sites with a total capacity of 1800 MW [4]. The UK Department of Energy and Climate Change stated that up to 300 MW of generation capacity might be deployed by 2020 [5]. For the period up to 2050, installation capacities in the multi-gigawatt range are indicated [6].

Taking into consideration these figures and the projected machinery ratings, the number of devices to be tendered, deployed and operated will be in the range of several thousands. According to RenewableUK, presently, 12 full-scale devices with a total output of 9 MW are undergoing sea trials in UK waters [7].

In the course of this research, the interviewed experts provided estimations for risk levels focusing on the realisation of virtual tidal current or wave power reference projects (capacity ~40 MW, implementation ~2025, investment ~120 m€). The top-ranked risks were identified as *achieving funding* and *reliability* (i.e. *uncertainty in device performance*).

2. Objective of the research

Considering a business environment in which other renewables operate price-competitive to conventional sources and the appearance of new forms of hydrocarbon extraction, the market entry of marine energy is seen as a one-off chance. To enhance the success rate, stakeholder-wide co-ordination and collaborative interaction are required. The top-level driving factors for achieving full-commercial power generation by marine energy were determined by Bucher [8] in the course of a system dynamics-backed analysis of cross-category expert interview data as (i) *strong and long-term commitment from government*, (ii) *array-scale success*, and (iii) *cost reduction*.

As the singular characteristics of government regulations are outside the range of this research, focus is put on the interim milestone *array-scale success*. The effective preparation and conduction of this game-changing task is seen as the decisive strategic objective at this time.

The research is oriented around the hypothesis:

> "*Regular commercial marine energy array projects will be realised under institutional financing and according to international procurement principles. To ensure investor confidence, the reliability of the technological concept has to be proven in advance. The application of co-ordinated strategic principles, identified in the course of expert interviews and by system dynamics analyses, facilitates achieving the array-scale success which represents the key interim milestone towards commercialisation.*"

To rapidly overcome the present pre-profit phase, the strategic orientation of all active stakeholders needs to be regularly evaluated in order to identify joint objectives and to put corresponding measures into practice. Ideally, the future supplier market will be composed of numerous manufacturing companies offering comparable high-class technology under competitive pricing.

3. Research principle and methodology

The underlying idea for our research approach is inspired by a strategic rule known in the theory of games as *look ahead and reason back* [9]. In the present context, *look ahead* is defined by focusing on the reason for the existence of any large-scale power scheme – market competitive electricity generation – and in this case by marine energy. A main principle applied is to comprehensively integrate a wide spectrum of stakeholder positions in a transparent and unbiased and manner based on system dynamics modelling techniques. This multi-disciplinary attempt allows an all-encompassing appraisal by avoiding concentrating in a limiting manner on stakeholder-specific views or interests.

For the survey, a four-page questionnaire with a total of 90 questions was elaborated, out of which 48 were yes/no questions and 42 were of a qualitative character, referring to stakeholder-related experience. By contacting 136 selected representatives from 15 stakeholder groups, we received 71 feedbacks, out of which originated 11 personal and 15 telephone interviews as well as 20 filled-out questionnaires. Two received questionnaires had to be discarded because they were rather

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