A SOLUTIONS APPRAISAL TOOL TO ADDRESS THE ENVIRONMENTAL IMPACTS OF TIDAL LAGOONS

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1. EXTENDED ABSTRACT

The deployment of renewable energy is regarded as a strategy to combat climate change. There have been a number of global agreements aiming to mitigate climate change, the most recent of which was the 2015 Paris Agreement. Often overlooked is the vast amount of marine renewable energy available around the world's coastlines. In particular tidal range energy is a largely untapped resource which has benefits including reduced uncertainty through use of proven technology, a high level of predictability [1], the ability to phase shift energy to provide base load supply [2] and a long expected life span (100 years) [3]. The key barriers to development of tidal range energy have been environmental concerns and high capital cost [4], [5].

Tidal lagoons are often presented as environmentally friendly alternatives to tidal barrages [5], but this does not mean their environmental impacts can be overlooked. Recent developments in the UK lagoon industry such as the awarding of a Development Consent Order to Swansea Bay tidal lagoon [6], mean it is now more important than ever to consider the environmental impacts of tidal lagoons and what solutions are available to address them. This is challenging considering there are no operational tidal lagoons in the world yet. This study aims to:

1. Identify the key impacts through industry engagement
2. Find available solutions through systematic review
3. Select and analyze solutions using Multi Criteria Decision Analysis (MCDA), Cost Benefit Analysis (CBA) and Ecosystem Service Valuation (ESV).

1.1 What are the key impacts and benefits of tidal lagoons?

Extensive industry engagement with the UK tidal lagoon industry highlighted a number of key environmental impacts and benefits arising as a result of tidal lagoon deployment. This engagement included an online questionnaire to influential individuals in decision making roles within 21 different government, conservation, regulatory and practitioner organizations. In addition to this, semi-structured interviews were conducted with developers active in the lagoon industry, in which a total of eight developers participated. Using percentage mention, impact scoring and multiple choice selection along with coding of open ended questions and interview transcripts, the perspective of the UK tidal lagoon industry was outlined. The key environmental impacts of lagoons according to industry opinion are 'sediment regime alterations' and 'hydrodynamic changes', with key benefits including 'flood defense and control', 'leisure and recreation' and 'area regeneration'. More information on the methodology and results of this engagement can be found in reference 7. In addition, further information on categorization of impacts and a framework on the environmental impacts of tidal lagoons can be seen in reference 8.

1.2 What solutions are there to address the key impacts?

There are currently no man-made, energy generating, tidal lagoons in the world and as such there are no blueprint guidelines on solutions to address their environmental impacts. However, there is a vast quantity of literature available from other industries addressing similar impacts in the coastal, ocean and river environments.

A systematic review following the PRISMA (Preferred Reporting Items for Systematic Meta-Analysis) and Collaboration on Environmental Evidence Guidance was conducted. The purpose of this review was to investigate the extent and relevance of the existing research on solutions options which could be applied to address the environmental impacts likely to arise as a result of tidal lagoons.

An initial search uncovered a total of 1114 papers, 688 papers after duplicates removed, 129 papers after abstract screening and 77 papers after full text screening. The 77 papers included in final analysis included viable solution options, over half of which require only small shifts in their development stage or adaption to lagoon application to be realistic options for implementation in the future tidal lagoon industry [9].

1.3 How can solutions be selected and analyzed?

The key outcomes of the authors' previous research include a database of environmental impacts likely to arise as a result of tidal lagoons and a database of solution options. This inventory of information is only useful if it can analysed and applied so the next stage is to determine ways of selecting and analyzing different solution options.

In order to select combinations of solution options to be analysed a MCDA was used, this included criteria on: solution cost, solution stage of development, relevance to tidal lagoons, expected solution success, number of direct and indirect impacts it addresses and level of uncertainty. Using this method a combination of solution options were selected, with one solution for each key environmental impact. These solutions were then analyzed in terms of the wider environmental implications using a cost benefit analysis and ecosystem service assessment and valuation. Using guidance from the Green Book [10], solution combinations were assessed in terms of how their deployment would change the wider ecosystem service provision of tidal lagoons. This was compared to a baseline scenario of a lagoon with no environmental solution options implemented.

1.4 Conclusion

In conclusion the research aims to further the tidal lagoon industry into deployment by highlighting the key environmental impacts likely to arise, the potential extent and relevance of existing transferable solutions and how these can be selected and analysed. Figure 1 provides a summary of the methodology.

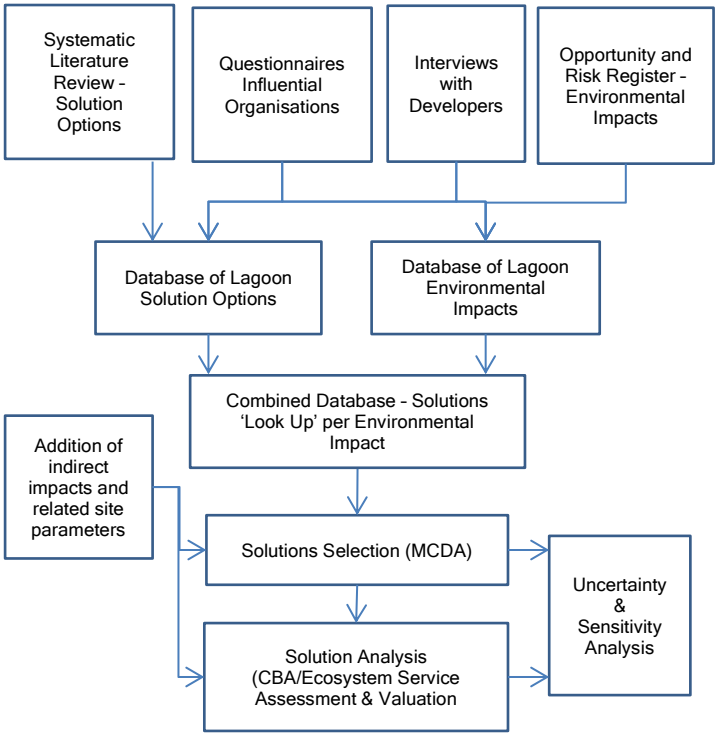

Figure 1 Schematic summary of methodology

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