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ABSTRACT

Wave energy is one of the UK's largest renewable energy resources but has never been fully developed despite public support along with significant technical maturity. Wave energy start-ups still struggle to attract the private finance needed for commercial deployment. This study explores the bankability of UK wave energy startups, identifying the factors that determine their ability to access finance, and why the sector has struggled to bridge the gap between technology development and commercial viability. An exploratory pilot survey was undertaken with seven purposively selected UK wave energy experts. Descriptive statistics and average rank scores were used to analyse the data, which were interpreted by means of complementary theoretical lenses, namely the technology acceptance model, innovation diffusion theory, resource-based view and transaction cost economics frameworks. The findings reveal that revenue uncertainty is the primary bankability constraint, rated first by all seven respondents with an almost unanimous Likert agreement. Risk allocation came second, and technological capability last, which is an unexpected finding that challenges narratives that frame the failure to commercialise wave energy primarily as a technical problem. Policy was acknowledged to be inadequate, but was not considered a priority relative to financial and institutional barriers. The study finds that the bankability gap is driven more by financial and institutional factors than technological immaturity alone. Addressing this gap will require coordinated action through mechanisms for revenue certainty, risk-sharing instruments and the allocation of additional resources. It identifies practical implications for wave energy start-ups, investors and policy-makers. The limitations of the pilot design are acknowledged and directions for future research are suggested.

Keywords: bankability, wave energy, start-ups, renewable energy finance, revenue uncertainty, risk allocation, Valley of Death

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1 INTRODUCTION

1.1 Background

The United Kingdom has a large wave energy resource along its Atlantic and North Sea coastlines with a yearly capacity to generate more than 50 TWh of energy, and since the mid-1970s, due to the oil crisis, the UK government supported the sector and initiated resource studies and prototype testing (Jin and Greaves, 2021). Having a great natural wave resource and important international testing infrastructure, such as the European Marine Energy Centre, Wave Hub, and FabTest, made the UK have a distinctive position in the wave energy sector between 2010 and 2014 (Jin and Greaves, 2021), but it was unable to maintain that position. Even though the UK wave energy sector continues to attract policy interest, it is difficult to suggest that the sector has a strong commercial development. In 2017, the UK Government's Clean Growth Strategy identified wave energy alongside tidal stream as a nascent technology with the potential to contribute to carbon reduction and also support Net Zero 2050 targets, but in the strategy document, the UK government made it clear that these nascent technologies should prove that they have the ability to compete with other kinds of electricity generation (BEIS, 2017). This document demonstrates that, although wave energy is recognised as a strategic energy source for decarbonisation, the sector needs to attract long-term private investment. In 2020, the Wave Energy Road Map commented on wave energy by stating that wave energy had the potential to contribute 15 per cent to the UK's current electricity demand if the sector was supported by strategic policy and market measures and moreover the Wave Energy Road Map highlights the importance of niche markets that have the capacity to support the wider commercialisation and bankability of wave energy technologies (EPSRC and Supergen ORE Hub, 2020). However, there are still significant challenges in the wave energy sector, such as high costs, difficult installation and maintenance conditions in offshore locations, uncertainty in metocean analysis, and the need for strong policy support to enhance investor confidence. This background context establishes the rationale for the present study. The UK wave energy sector does not have technical challenges; despite the fact that the sector has strategic promise, it still has bankability challenges at every stage of development. Recent research on commercialisation highlights the challenges from the transition from public funding to private investment,

especially when there is a lack of standardised measures and criteria to evaluate the progress towards commercialisation (Wiegele and Jones, 2024). This demonstrates the present research focus on bankability. This makes the focus of the present study timely and important because the bankability of UK wave energy start-up businesses becomes central to explain why the sector has not yet turned its long-established potential into profitability.

1.2 Rationale

The academic literature lacks analysis of the development of bankability for early-stage UK wave energy start-ups in spite of public investment and policy interest. Existing literature identifies the financial challenges of the wave energy sector in broad terms, such as high capital requirements and policy uncertainty. However, there are other factors that should be taken into account which affect the early development stages of wave energy start-ups financeability, such as technical maturity, risk-sharing arrangements and financial structuring (Hannon et al., 2017; Hafner et al., 2020). This empirical gap leaves policymakers, investors and start-up founders without evidence-based assistance on the factors that influence the mobilisation of private finance.

A second gap is about the standards that investors use to conduct due diligence on wave energy. The literature on renewable finance addresses general risk factors, but it lacks information on the specific decision-making standards that apply to new, high-capex marine technologies with short-term operational records (Wells et al., 2013; Hall et al., 2017). Without this knowledge, it would be difficult to assess the investment process that applies to early-stage, capital-intensive wave energy startups.

Third, there is still not enough research on which public resources are best for assisting wave energy start-ups navigate the "valley of death" (Hannon et al., 2017; Iskandarova, 2016). There has not been a thorough evaluation of how effective prototype funding and revenue support programs are in converting R&D findings into projects that can be funded by financial institutions. Finally, the financing issues experienced by technology ventures in high-capex marine sectors are still not adequately studied compared to the wider scope of research on clean-tech ventures (Cook and Hall, 2012). This study addresses these four gaps at a crucial stage that the UK's Net Zero 2050 target necessitates the urgent and strategic mobilisation of private capital for wave energy (Jin and Greaves, 2021).

1.3 Problem Statement

The UK has one of the best wave energy resources in the world, but the industry has never been able to make the transition from publicly funded trials and demonstrations to commercially profitable organisations (Jin and Greaves, 2021). Since 2000, the government has spent almost £200 million on the projects of the wave energy sector, but many device developers have gone bankrupt, and there is no large-scale wave energy commercial deployment present (Hannon et al., 2017). This is a problem because the UK's current policy, regulatory, and financial system does not have a clear, evidence-based way to determine whether wave energy start-ups are bankable. Bankability is the key factor that differentiates between the start-up businesses that need funding for prototypes and businesses that can support themselves (Cook and Hall, 2012). But this distinction is difficult to reach for wave energy start-ups because of structural barriers. Financing structures designed specifically for commercially mature renewables do not address the uncertainties linked to pre-commercial marine technologies, including uncertain longevity, a lack of long-term performance data, and income sources dependent on politically regulated systems (Wells et al., 2013; Iskandarova, 2016). Public support programs have caused the commercialisation process by using tools that don't align with the problems that come up at each stage of technology readiness (Hannon et al., 2017; Wood, 2005).

This doctoral research focuses on a fundamental challenge about bankability which is that the theoretical and empirical analysis of the formation, limitations, and development of bankability for UK wave energy start-ups is inadequate and as a result, policymakers and entrepreneurs do not have enough evidence-based information to support them develop good strategies and standard measures. If the UK is unable to address this problem, it would risk losing its technological leadership in the wave energy sector, and the UK wave energy start-ups will face challenges in mobilising the private capital that is needed to make a significant contribution to the UK's decarbonisation goals.

1.4 Research aim

The objective of this study is to analyse the factors that influence bankability throughout the financing phases of UK wave energy start-ups and to identify risk

factors, business models, and stakeholder expectations that can enhance their investment readiness and promote technological innovation.

1.5 Research objectives

1- To look into how the nuances of bankability change as UK wave energy start-ups go through the different stages of financing.

2- To find the most important risk factors that affect how ready UK wave energy start-ups are to invest.

3- To figure out which business plans can help banks lend money to new businesses and support new technologies.

4- To analyse how different business models adopted by wave energy start-ups influence the investor confidence in their bankability potential.

5-To suggest strategies that primary stakeholders could implement to make the UK wave energy sector more bankable.

1.6 Research Question

How do the bankability nuances of UK start-ups in the wave energy sector affect their ability to access financial resources?

1.7 Research Sub-Questions

1- How do the nuances of bankability change as the UK wave energy start-up financing progresses through its different stages?

2- What risks make UK wave energy start-ups less likely to be ready to invest?

3- What business strategies could help early-stage bankability and technological innovation?

4- How do the business models of wave energy start-ups affect the investor confidence in the potential bankability?

5- What strategic choices could stakeholders make to make the UK wave energy sector more bankable?

1.8 Significance to Stakeholders

The primary stakeholders of UK wave energy start-ups are the ones who directly influence the progression of wave energy projects, financing and the commercialisation and development of the sector. These are: wave energy developers, investors, governments, regulators, test centres, academics and research institutions.

Beyond primary stakeholders, there are secondary stakeholders who also benefit from wave energy technologies, even though they do not contribute directly; they support the early development of the wave energy sector. For instance, Albatern, a Scottish wave energy company, collaborated with two aquaculture companies Mowi Scotland and Scottish Salmon Company, in powering fish farms by their wave energy converter WaveNet, as it can be seen from this partnership, niche markets support the wave energy sector development and at the same time contribute to carbon reduction (Jin and Greaves, 2021). As such, partnerships will strengthen reliability and boost investor confidence.

2 Literature Review

2.1 Bankability Challenges in Wave Energy Ventures

In wave energy start-ups, bankability" means that a business is able to obtain private investment by demonstrating to investors that the risks and returns are feasible because investor confidence is the one of the most important determining factor for establishing financial maturity in marine energy, which implies that fundamental factors such as technological maturity, revenue certainty, and regulatory stability have an influence on project bankability (Bucher et al., 2016). The complex structure of bankability differentiates wave energy from mature renewable energies, as they have standardised risk assessment structures.

One of the most important reasons why wave energy is not bankable is the high initial capital requirements of wave energy projects, and in return, they offer short-term financial benefits, which makes them risky investments for private investors (Coyle et al., 2014). The unpredictable nature of marine environments makes this capital intensity projects more problematic because the wave energy sector requires high-cost over-engineering to withstand extreme weather (Coyle et al., 2014). After the

global financial crisis in 2008, capital markets became more rigid, and due to the fragility of early-stage wave energy companies, the closure of pioneering companies such as Pelamis Wave Power was inevitable (Jin and Greaves, 2021).

The shift from public to private investment is a key turning point in the commercialisation of wave energy, and it highlights the challenges that marine energy projects experience even in the early demonstration stage, in securing private investment (Wiegele et al., 2024). Wave energy developers encounter funding challenges during the technology innovation phase when they need the prototype validation for commercial deployment, and this particular phase is called the 'valley of death' (Barry et al., 2024). This emerging financing gap, which is left by risk-averse venture capital, is filled by public funding in the UK (Coyle et al., 2014).

2.2 UK Policy Context and Financing Mechanisms

The UK policy ecosystem for marine renewables has changed over time due to a number of different funding mechanisms; for instance, the Renewables Obligation (RO) with technology-specific bandings provided support through Renewables Obligation Certificates (ROCs) (Wood, 2004; Coyle et al., 2014). However, especially marine renewable energy developers experienced significant "documentation requirements" when it came to getting licenses and connecting to the grid, which made them less likely to be successful in commercial operations (Wood, 2005)

Contracts for Difference (CfDs) have been developed to replace a previous system intended to ensure revenue certainty, but the effects of CfDs on pre-commercial wave energy technologies remain debatable. Furthermore, not only policy uncertainty but also the withdrawal of European funding sources worsens pre-existing bankability issues for marine renewable energy financing as a consequence of Brexit (Billarant, 2019). It is important for institutions and wave energy developers to work together because when policy tools and technology development stages do not align, it becomes harder to access funding in European countries and the UK (Corsatea, 2014).

2.3 Wave Energy Converter Commercialisation Barriers

The challenges confronting UK wave energy during the transition from innovation support to commercial deployment highlight broader systemic challenges that limit UK

innovation, such as poor knowledge transfer, inadequate stakeholder coordination, and rigid market-formation mechanisms (Foxon et al., 2005) whereas when the focus is only on the UK wave energy sector and it could be assessed that policy support since 2000 has not supported the sector's move toward commercialisation (Hannon et al., 2017). These studies collectively indicate that the technological challenges are not solely the reason for the weak development of UK wave energy, but it is also because of the weaknesses in policy design and innovation-system coordination.

The smart capital is not just capital; it also includes strategic advice and networks that are very important for pre-commercial companies that aren't profitable yet, and moreover, smart capital may assist startups by filling knowledge gaps and lowering transaction costs (Bjørgum et al., 2015). The variety of converter designs and the lack of a standard design model create uncertainty for investors because it is difficult to determine which strategies will be commercially successful (Thorpe, 1999), whereas stakeholder assessments demonstrated that technology developers, investors, and policymakers have differing views on barriers and opportunities (McLachlan et al., 2010).

2.4 International Perspectives and Comparative Insights

Even in countries with high levels of renewable energy commitments, such as Scotland and Sweden, wave power has not achieved commercial success due to multifaceted challenges (Karagjozi et al., 2016). Even though there are abundant resources, the investment challenges, such as elevated levelized costs of energy (LCOE) and the lack of established revenue sources, prevent the wave energy to reach its potential (Lavidas, 2019). Technical feasibility is not solely enough to establish economic viability without substantial cost savings and adequate policy frameworks (Khan et al., 2022).

3 Theoretical / Conceptual Framework

3.1 Technology Acceptance Model and Innovation Diffusion Theory

The Technology Acceptance Model (TAM) enables understanding how investors and the market perceive wave energy technologies. Wave energy bankability is based on both perceived commercial value and technological maturity. When it comes to wave energy bankability, perceived commercial value is shaped by the investors' views on the potential for revenue, and ease of use demonstrates how mature the technology is and how easy it is to use. Innovation Diffusion Theory outlines five categories of adopters, highlighting relative advantage, compatibility, complexity, trialability, and observability. Wave energy is not advancing quickly because it is more complex than more mature renewables, and it is not very visible because there aren't many operational projects (Odam, 2011).

3.2 Resource-Based View and Dynamic Capabilities

The Resource-Based View (RBV) states that having resources that are valuable, rare, hard-to-copy, and non-replaceable gives a company a competitive edge. For instance, wave energy start-ups need crucial resources, such as patented technology, standardised intellectual property, technical proficiency, and strategic collaborations to have a competitive advantage as a sector. Bjørgum et al. (2015) do not clearly support the Resource-Based View; however, their analysis of smart capital can be interpreted through an RBV framework, as it highlights the significance of investor knowledge, networks, and strategic support as resources that enhance start-up capabilities. Dynamic capabilities theory builds on RBV by focusing on how companies can change their capabilities when the environment transforms. This is important for addressing the technological uncertainty and transformation of policy frameworks (Hannon et al., 2017).

3.3 Transaction Cost Economics and Investment Decisions

Transaction Cost Economics (TCE) offers a valuable framework for clarifying the challenges of private investment in wave energy during periods of uncertainty. Wave energy projects have assets that are very specific, performance outcomes that are not always clear, and transactions that happen very rarely. All of these things make it more

expensive to contract, monitor, and share risk. From a TCE point of view, these factors make private investors more sceptical because they have difficulty to figure out the amount of capital they will generate in the future, how to deal with technical risk, and how to protect themselves from project failure. Corsatea (2014) suggests that institutional arrangements can diminish transaction costs by offering more standardised frameworks and risk-mitigation instruments, and also shows that the unpredictable marine environment makes things even more uncertain and makes it more expensive to figure out how much to invest. But TCE shouldn't be seen as the only way to explain how wave energy can generate revenue. It does a more effective job of explaining why investors might be hesitant than explaining how start-ups can build credibility through technical evidence, business models, and strategic partnerships. So, TCE is most beneficial when used with other perspectives that explain both the structural barriers to investment and the skills needed at the venture level to overcome them.

3.4 Valley of Death and Technology Readiness Levels

The “valley of death” is the funding gap between early development and commercial deployment. Barry et al. (2024) argue that this gap is especially apparent at TRL 5–7, where developers require significant amounts of capital for prototyping testing, but are not yet revenue-generating. Bucher et al. (2016) further note that bankability cannot be captured by TRL alone, since market readiness, regulatory clarity and supply chain development also influence the bankability of technology. Together, these studies indicate that bankability should be evaluated from a wider perspective than simply technology readiness.

4 Gap in the Literature

Even though more researchers are conducting research into challenges in marine energy, there are still significant gaps:

-Absence of empirical bankability frameworks specifically designed for wave energy enterprises. Bucher et al. (2016) pinpoint primary determinants of investor confidence; however, their analysis is purely theoretical, lacking practical metrics or validation via investor surveys or case studies.

- Fragmented theoretical implementation. No research has methodically combined TAM, Innovation Diffusion Theory, RBV, and TCE to develop a holistic model of wave energy investment decisions. Such integration could elucidate how perceived technological attributes, resource configurations, and transaction costs influence investor behaviour.
-Policy analysis over a short period of time. Hannon et al. (2017) were written before the Offshore Wind Sector Deal and the Marine Energy Programme were put into place. A comparative analysis of the effects of policy instruments on private investment funds and start-up survival rates would facilitate evidence-based policy design.
- Insufficiently examined non-financial bankability determinants. A more in-depth qualitative study is needed to find out how governance structures, management skills, strategic partnerships, and stakeholder engagement affect investor confidence.
- There aren't any studies that compare different technologies. There aren't many comparisons between wave energy and other new technologies, such as floating offshore wind, tidal energy, and green hydrogen. This makes it hard to learn from them. Business model innovation as a route to bankability remains under-researched in the literature, particularly regarding alternative revenue models, risk-sharing mechanisms, and hybrid public-private financing structures.

5 Methodology

5.1 Research Design

The research utilises an exploratory pilot survey design with structured ordinal instruments to gather and systematically evaluate expert opinions on barriers to bankability. The main tool is an online questionnaire that has Likert-scale questions and a task for ranking barriers, as well as questions about the individual participating in the survey. All data collected are either ordinal or categorical; no open-ended or qualitative data were obtained. This design facilitates descriptive statistical analysis of expert consensus and comparative prioritisation of competing barriers via mean rank scores. The research philosophy is interpretivist-pragmatist, acknowledging that bankability is a socially constructed assessment influenced by investor psychological factors, institutional expectations, and policy feedback (Hall, Foxon, and Bolton, 2017). The method uses structured ordinal measurement, but the results are interpreted

using analytical reasoning based on literature from the same area of study. This gives the pilot the level of insight they need for their exploratory goals.

5.2 Sample and Participants

The study utilised purposive expert sampling to enlist participants engaged in UK wave energy development, policy, or finance. Fifteen survey invitations were sent by e-mail, and seven people filled them out (46.7% response rate), and this rate is approximately the same as what you expect to receive from specialist surveys in energy finance research (Wells et al., 2013). Two of the seven respondents were Policy Advisors or Government Officials; two were Research or Test Centre Experts; one was an Academic Researcher; one was an Industry Consultant or Technical Advisor; and one was Other. Five were from Scotland, one was from England, and one was from Wales. There were different levels of experience: less than two years (n=1), two to five years (n=2), six to ten years (n=2), and more than ten years (n=2). There were four levels of involvement: directly involved (n=2), indirectly involved (n=2), relevant industry knowledge (n=2), and no relevant involvement (n=1). There were different levels of expertise in the stages: multi-stage (n=3), early R&D (n=2), prototype testing (n=1), and prototype plus R&D (n=1).

Wells et al. (2013) performed 14 comprehensive interviews to investigate barriers to renewable energy investment, and they demonstrated that even small purposive samples may produce valuable insights. A pilot study aims to test methods to produce initial evidence, and this pilot study with seven expert respondents is justifiable because the wave energy sector has a small sample size, and this present pilot study has an interpretivist framework. However, this sample size limits the effectiveness of statistics and the ability to generalise.

5.3 Survey Instrument

Microsoft Forms was used for collecting primary data through a short online survey (see Appendix A). The survey included questions about individuals' profiles, Likert-scale questions, and a task to rank barriers. Bankability literature was used to develop twelve Likert-scale items (Q6a–Q6l) to assess expert consensus on statements. The questions were evaluated on a five-point scale (1 = Strongly Disagree, 5 = Strongly Agree), and focused on four thematic domains: financial and revenue barriers,

technical and performance barriers, policy and regulatory barriers, and investor confidence and risk dynamics. The responses were based on previous studies that found that revenue certainty, investor perceptions, policy consistency, and risk allocation were all very important factors in making renewable energy financeable (Cook and Hall, 2012; Wells et al., 2013; Hall, Foxon and Bolton, 2017; Jin and Greaves, 2021). The barrier-ranking question asked individuals to rank nine bankability barriers in order of importance.

5.4 Data Collection Procedure

Data were collected in April 2026. Requests for participation were emailed to people verified through professional networks and sector organisations. The e-mail for participation described the purpose of the study and guaranteed the respondent of being anonymous, and also it included a direct link to the survey. Participation was voluntary and unpaid. Responses were automatically collected by the survey platform, with no personally identifiable information collected. Additionally, participant profiling questions were grouped together so that individuals could not be identified.

5.5 Data Analysis

Data analysis was conducted in two stages, the first stage was the descriptive statistical analysis of the Likert questions and the second stage was the calculation of average rank scores for the barrier-ranking task. The mean and median scores for each Likert question outlined a central tendency, and the frequency distributions showed the levels of conformity. In order to categorise the barriers, average rank positions were calculated by summing each individual rank across all respondents and dividing by the number of respondents, and this provided a ranking of the perceived importance of the barriers. The patterns that emerged from both stages were interpreted in the context of the theoretical frameworks and the literature specific to the sectors.

5.6 Ethics

Participation was voluntary, and respondents were informed of the purpose of the study and that they could withdraw from the survey. No personally identifiable

information was collected, and profiling data was gathered in order to ensure anonymity.

5.7 Limitations

The pilot design has a number of limitations. The small sample size (N=7) limits a statistically significant value and prevents robust inferential testing. Findings are not generalisable to broader wave energy stakeholder or investor populations, though this is acceptable for pilot research (Wells et al., 2013). There may be bias due to the geographic concentration of Scotland. Investors and wave energy start-up founders are a significant gap from the sample. The cross-sectional design captures expert opinion at a single time point, which does not allow analysis of the change in perceptions. There is a chance of self-selection bias, and the use of self-reported perceptions means that the findings are a reflection of expert judgement that may be subject to cognitive biases. In spite of these limitations, the pilot achieves its basic objectives of instrument testing, generating preliminary evidence and identifying themes for further study.

6 Findings

6.1 Respondent Profile

The seven respondents represented a range of UK wave energy expertise: Policy Advisors or Government Officials (n=2) Research or Test Centre Experts (n=2) Academic Researcher (n=1) Industry Consultant or Technical Advisor (n=1) Other (n=1). Experience varied from less than 2 years (n=1) to more than 10 years (n=2). In geographical terms five were in Scotland, one in England and one in Wales. Involvement levels were directly involved (n=2), indirectly involved (n=2), relevant industry knowledge (n=2), and no relevant involvement (n=1). Stage expertise varied: multi-stage (n=3), early R&D (n=2), prototype testing (n=1) and prototype+R&D (n=1). This profile points to a sample ideally suited to address issues related to the policy, technical and institutional aspects of bankability but less well placed to respond directly to investor decision-making or entrepreneurial financing challenges.

6.2 Theme 1: Financial and Revenue Barriers

The financial and revenue barriers were the most notable theme, and it had a composite mean of 4.18 out of 5. Item Q6a – Funding Challenges Mean 4.71 Median 5.0 5 Respondents – Strongly Agree 2 Respondents – Agree Revenue uncertainty limiting bankability (Q6b) scored a mean 4.71 and median 5.0. Item Q6l, which indicated that bankability constraints impact infrastructure development, and it had mean 4.71 and median 5.0, with two choosing Agree and five Strongly Agree. The main barrier to wave energy bankability, as the expert consensus suggested, is the lack of credible, predictable revenue streams to support debt service and investor returns.

6.3 Theme 2: Technical and Performance Barriers

Technical and performance barriers received mixed evaluation scores (composite mean 3.48 out of 5). Item Q6c: Technological capability limits bankability, Mean 2.71, Median 3.0. , Two chose Disagree, Five Neutral. Item Q6f, lack of performance data, had a mean of 3.00 and a median of 3.0, with two respondents choosing Disagree, three Neutral, and two Agree. The relative low importance of technical barriers is noteworthy and unexpected. It suggests the sector's bankability problem is not primarily immature technology, but financial and institutional structures.

6.4 Theme 3: Policy, Regulatory, and Institutional Barriers

Policy and regulatory barriers had the lowest composite mean of 2.86 out of 5. Item Q6d "Policy support is adequate" reached a mean of 2.71 and a median of 3.0. Three respondents selected Disagree, three Neutral and one Agree. This low score can be explained by the negative wording of the question and the perception of respondents that policy inadequacy is a barrier. Item Q6e on regulatory barriers had a mean of 3.00 and a median of 3.0, with two respondents choosing Disagree, three Neutral and two Agree. Mixed feedback may reflect heterogeneity in respondents' knowledge of a policy or suggest that policy inadequacy is necessary but not sufficient for bankability failure.

6.5 Theme 4: Investor Confidence and Risk Dynamics

Theme 4 evaluated investor confidence and risk dynamics. The overall score was the second highest, 3.86 out of 5. Q6h received the highest level of agreement and examined whether investor confidence affected the availability of finance. The mean for this item was 4.29 and the median was 4.0. Five respondents selected Agree and two respondents selected Strongly Agree . Q6k asked about dissatisfaction with the present risk allocation and had a mean of 3.57 and a median of 4.0. One respondent disagreed, one was neutral and five agreed, indicating that most experts think that current risk sharing mechanisms are not enough (Lamperti et al., 2019). The same pattern was seen in Q6g where the mean was 3.57 and the median was 4.0, showing concern in the mismatch between development stages and finance available. The mean for both Q6j and Q6i was 3.71 and the median 4.0. More generally, these results indicate that sufficient financing instruments need to be developed, particularly for the demonstration and scale-up phases.

6.6 Barrier Prioritisation Rankings

The barrier-ranking task revealed a clear classification with Revenue Uncertainty ranked first by all seven respondents, with an average ranking of 1.00, reflecting complete agreement. Second was Risk Allocation (average rank 3.43) followed by Organisational Technological Maturity (4.14), Investor Confidence (4.29) and Regulatory Requirements (4.43). Policy Support ranked sixth (5.29), Disparity between Financial and Developmental Stages seventh (7.00) and Lack of Clarity in Regulations and Agreements and Technological Advancements tied for eighth (7.71). The top two barriers were not technical barriers, but they are both financial and institutional barriers, which were Revenue Uncertainty and Risk Allocation. Finally, technological advances. It’s clear that technology isn’t seen as the main bottleneck. The results tell a consistent story. Bankability in UK wave energy is mainly constrained by financial and institutional issues, rather than by technical or regulatory complexity.

7 Discussion

7.1 Revenue Uncertainty as the Dominant Bankability Barrier

This overall ranking of revenue uncertainty as the top barrier, with near-unanimous Likert agreement (mean 4.71), establishes revenue predictability as the central constraint on wave energy financeability. Unpredictable revenue streams eliminate the perceived usefulness and reduce the observability as interpreted through TAM (Davis, 1989) and IDT (Rogers, 2003). This is exemplified by the Clean Growth Strategy (BEIS, 2017), where wave energy costs £310/MWh as opposed to £74.75/MWh for offshore wind in the 2017 CfD auctions, thus removing it from the mechanism that enabled offshore wind deployment. Cook and Hall (2012) argue that bankability is based on revenue certainty, while Ruehl and Bull (2012) and Thies et al. (2015) identify that significant technical advances have not been reflected in bankability: perceived usefulness is influenced by revenue certainty, and it is the main driver of investor interest.

7.2 Investor Confidence and Risk Allocation

Investor confidence (mean 4.29, rank 4) and risk allocation (rank 2, mean 3.57) are interpreted using Transaction Cost Economics (TCE) and Williamson (1985) identifies three drivers of transaction costs which wave energy has: asset specificity, uncertainty and information asymmetry such as specialised devices have limited additional uses, and technical performance is uncertain; developers have knowledge that investors cannot verify without costly due diligence (Wells et al., 2013). These conditions indicate a failure of governance. Current institutional arrangements allocate risks inefficiently and do not reduce transaction costs to a level that would increase the possibility for private investment in wave energy. Cook and Hall (2012) argue that bankability implies explicit risk allocation through contracts and guarantees; Lamperti et al. (2019) add that public risk-sharing is essential. The UK wave energy sector (Wells et al., 2013; Hannon, Skea and Rhodes, 2017) is affected by a lack of investor confidence, which is dependent on government support and policy consistency.

7.3 The Development Stage–Finance Mismatch

Moderate Likert agreement about the stage–finance mismatch (Q6g mean 3.57, Q6j mean 3.71) and its low rank (7th, average rank 7.00) suggest that experts observe this issue as real but a secondary factor. Murphy and Edwards (2003) define the Valley of Death as the gap between technologies that are too mature to be funded by government funds but are too risky to be funded commercially. Wave energy devices remain largely at Technology Readiness Levels TRL 4-7 and require high capital to undertake sea trials, but lack the performance data and revenue certainty to attract private capital. This is identified by Hannon, Skea and Rhodes (2017) as a critical weakness in the UK innovation system. The mismatch is defined as follows: the Valley of Death exists because revenue uncertainty and poor risk allocation make private capital unavailable. To bridge the gap, these upstream constraints must be addressed (Murphy and Edwards, 2003).

7.4 Policy and Regulatory Inadequacy

The low composite score for policy and regulatory barriers (mean 2.86) must be interpreted with caution. On Item Q6d, respondents disagreed that policy support is adequate (mean 2.71), which is consistent with literature documenting fragmented support and the absence of a deployment pathway (Hannon, Skea and Rhodes, 2017; BEIS, 2017). However, the low ranking (6th) suggests that policy is not the most immediate constraint. The RBV and Dynamic Capabilities provide an explanation in which Barney (1991) argues that competitive advantage comes from VRIN resources and Teece, Pisano and Shuen (1997) expand this with dynamic capabilities. The discontinuities in funding undermine dynamic capabilities and constrain VRIN accumulation due to policy inadequacies. Wood (2005) noted a “paperwork barrier” that diverted managerial attention from capability-building to compliance. Policy inadequacy is seen by experts as a necessary but not sufficient condition: it lays down enabling conditions but cannot by itself generate the revenue certainty investors require.

7.5 Technical Capability: A Nuanced Finding

The least apparent findings are the low Likert agreement on technological capability (Q6c mean 2.71) and last place ranking of technological advancements (average rank

7.71), suggesting that the bankability problem is not about technological maturity , but the main challenges are financial and institutional structures. Drawing on RBV and Dynamic Capabilities, firms have built important VRIN assets, such as specialised teams, proven designs, and operational know-how (Barney, 1991). Significant technical progress is reported by Jin and Greaves (2021), and component reliability maturity is confirmed by Ruehl and Bull (2012) and Thies et al. (2015). However, Barney (1991) and Teece, Pisano and Shuen (1997) suggest that VRIN assets need complementary financial resources and dynamic capabilities to be translated into commercial success. Wave energy companies lack patent capital, third-party validation and long-term revenue contracts. According to Lamperti et al. (2019), the green transition needs technological innovation along with financial and policy innovation, which suggests that public support should be directed to complementary resources to foster financeability.

7.6 Theoretical Synthesis: An Integrated Bankability Framework

The findings suggest that bankability issues do not occur in only one area, but in several, and are interlinked. At the perceptual level, TAM and IDT help explain investor uncertainty, as wave energy can be seen as lacking visible proof and having uncertain practical value, particularly in light of the LCOE gap identified by BEIS (2017). At firm level, RBV suggests that start-ups may have valuable technical capabilities, however, they often lack financial resources to prove credibility and attract funding (Barney, 1991). At transaction level, TCE helps to explain the difficulty in investment since asset specificity, uncertainty and information asymmetry can increase transaction costs, which is consistent with the strong ranking of revenue uncertainty and risk allocation in the findings (Williamson, 1985; Lamperti et al., 2019). Finally, the Valley of Death framework is a case in point that technologies at TRL 4-7 may have difficulty attracting private capital without public support (Murphy and Edwards, 2003). These levels in themselves appear to mutually reinforce each other whereby weak firm resources limit visibility and credibility further and consequently deepen the financing gap.

8 Conclusions and Implications

8.1 Main Conclusions

This pilot study led to four major conclusions. First, the leading barrier was the uncertainty of revenues, i.e. the lack of predictable revenue streams is the main obstacle for financeability. Second, risk sharing mechanisms and investor confidence are key mediators but the arrangements at present are viewed as inadequate. Third, in this pilot sample, technology was not considered the primary bottleneck. This challenges the narratives that attribute the failure of commercialisation mainly to technical issues. Fourth, policy inadequacy was recognised but rated below revenue uncertainty and risk allocation. Overall, the findings suggest that addressing the bankability gap requires greater attention to financial and institutional structures, not just technology development.

8.2 Practical Implications

The findings have practical implications for three groups of stakeholders. For policymakers, bankability could be enhanced by a dedicated wave energy allocation under the CfD regime, with calibrated strike prices, ring-fenced milestone-based demonstration funding, and public co-financing or revenue guarantees to take some of the early-stage risk. Blended finance structures mixing concessional loans and private equity could enhance bankability for investors, particularly when accompanied by anchor investment from public actors to attract follow-on private capital. Validation of performance by third parties at accredited facilities such as EMEC or Wave Hub could help wave energy start-ups with bankability, as could investor-ready documentation such as financial models and staged financing plans.

8.3 Limitations

There are several limitations to this pilot study. The sample of seven respondents limits statistical power and generalisability. Key gaps include lack of investor and founder perspectives, and the geographical concentration of respondents in Scotland. The cross-sectional design does not take into account changes in perceptions over time and expert judgements are susceptible to cognitive bias. Despite these limitations, the

pilot achieved its primary purposes by testing the survey instrument and discovering themes for further research.

8.4. Future Research

Four priorities are proposed for future research. First, a larger quantitative study, including investors and founders, would enable more robust analysis and stronger generalisation. Second, qualitative case studies of ventures based at EMEC or Wave Hub could illuminate more of the development of bankability in practice. Third, longitudinal studies might examine how views and financing needs change over time. Fourth, a formal bankability assessment framework can be a practical tool for developers, investors and policymakers. These directions matter in the context of the UK's Net Zero commitments; without more coordinated action on revenue certainty and risk allocation, wave energy could remain a promising but commercially unrealised technology.

A Reflective Account of the Pilot Study Research Process

This is a reflective account of my pilot study for the DBA programme on the bankability of UK wave energy start-ups. Instead of summarising the findings of the research, it is about what I did, why I made the choices I made, where I struggled, and what I learned from the experience. The process was hardly ever linear or predictable. I was wondering if I was asking the right questions, if I was collecting enough evidence, and struggled with the tension between the rigours of academic writing and the realities of doing research.

I have a professional background in export management & international supply chain management including trade logistics, supplier relationships and cross border commercial operations. This has nothing to do with wave energy but it was the personal factor that was the key driver in the decision to conduct research into the bankability of UK wave energy start-ups ; in other words, it was a conscious desire to gain insight into sustainable finance. I wasn't just looking for a DBA topic, I was looking for a real bridge between where I was and where I wanted to go. The bridge was bankability , which is how risk is structured, how trust is built between capital providers and investees, and what institutional conditions enable financing. These are questions that I had come across in trade finance and supply chain risk in my export management career. It felt like a natural extension to apply that lens to wave energy. The problem was credibility because, without an energy background, I feared that my contribution would be questioned. I responded by grounding the work in established theoretical frameworks and sector-specific literature, so rigorous approach substituted for lack of knowledge. What I learned is that career changes, when pursued honestly, lead to more detailed questions. I was not assuming it was technical, as those who have knowledge often assume. I asked whether it was financial and institutional – and that was exactly the right question.

The literature review was the most confusing part of the project. I expected to find a cohesive body of work on wave energy bankability. Instead I found fragments of information scattered across disciplines such as energy economics, marine engineering, innovation policy which are rarely addressing to each other. But none of the papers brought these strands together to explain why wave energy start-ups

cannot attract finance. So what I did was to map the literature across several domains and to work backwards from my research question to see what theoretical frameworks could explain the problem that I was investigating. It was not a neatly organised process. I read papers that had nothing to do with my project, and followed citation trails that led nowhere. The issue was when to stop searching and start synthesising. In academic culture, gaps in a literature review are taken as evidence of inattention, but comprehensiveness in a cross-disciplinary niche field is genuinely difficult to achieve. I chose to accept incompleteness and to prioritise depth where it counted most within the frameworks and empirical studies that were most directly relevant to bankability and to financing wave energy. Here's what I learned: a literature review is not a catalogue, it is an argument. The task is not to read everything, but to read purposefully and connect ideas in a way that builds towards the research question (Ridley, 2012). That change in understanding changed the way I wrote and made the review more coherent than any attempt to be comprehensive would have been. There are few more unsettling questions in business and management research than whether what you are doing is genuinely new. Frameworks such as the Resource-Based View and Transaction Cost Economics have been applied to hundreds of contexts. The pressure to prove something new can lead researchers to overstate their findings. I have resisted the temptation to claim a new theory, and have been explicit about where the novelty is. Prior research had explored general barriers to investment in renewable energy (Wells et al., 2013) and wave energy innovation systems (Hannon, Skea and Rhodes, 2017), but no study had investigated the bankability in the particular context of wave energy start-ups and no study had combined multiple theoretical frameworks to account for a multi-level failure in this context. The challenge was to state this without underselling or overclaiming, and it clarified for me what I was really adding. My answer was to reframe the contribution as a new synthesis: using existing frameworks in a novel empirical context, and showing how they work together to explain something that no single framework could explain on its own. The lesson I learned is that gradual contributions are valid as long as they are honest about their scope (Corley and Gioia, 2011). Integrity is being accurate about what you have done, rather than pretending to do more.

My methodological choices were as much a matter of specific circumstances as design. I wanted to do more of a broader study but the result was a pilot survey of

seven respondents from a list of fifteen invitations. The UK wave energy community is small and geographically concentrated and I found it more difficult than I had anticipated to recruit participants who had both the expertise and were willing to respond. So what I did was redefine the study explicitly as a pilot, not as a failure to get a bigger sample but as a deliberate choice to test instruments and generate preliminary evidence in a sector where there was no prior survey-based research. It made me think long and hard about what the data could and could not support. I could describe patterns and expert consensus, but I could not make statistical generalisations. The challenge was to resist the desire to overclaim from ordinal data. Means and rankings are often treated as more precise than they really are. I always used interpretive language and I always justified every empirical claim in theoretical reasoning rather than just letting the numbers speak for themselves. What I learned is that methodological honesty is not a sign of weakness; it is what separates credible research from false statements. A pilot study that knows it is a pilot study is more valuable than a small study pretending to be something larger (Teddlie & Tashakkori, 2009).

This research brought me into direct contact with pressures I had previously observed from a distance, such as how research choices are influenced by the pressure to publish in high-ranking journals, in ways that are not always openly discussed. The topics are selected not just because they are important but also because they are publishable. The temptation to take short-cuts when time was limited, such as accepting a smaller sample without fully acknowledging its limitations, or choosing a theoretical framework because it was familiar rather than because it fitted, existed every step of the way. What I tried to do was to hold the line on integrity at each of those points. I was transparent about the sample size. I picked frameworks because they explained the phenomenon, not because they were fashionable. The UK's Research Excellence Framework (REF) has institutionalised the demand for demonstrable societal impact (Watermeyer, 2014) and I was aware that framing the research around Net Zero would make it more legible to assessors. But the framing had to be substantively justified. Wave energy's relevance to Net Zero is real and the bankability gap is a real policy problem. The challenge was to make sure the impact framing reflected the evidence, rather than leading it. What I learned is that academic integrity is not one decision at the beginning, but rather a series of small decisions

made throughout, each one adding to or bringing down the credibility of the work. The core of the ethical problem in applied research is dealing with that friction (Resnik, 2015).

Looking back, conducting a pilot study has taught me more about the practice of research than any course or textbook could ever have. I learned that being an outsider to a field can be an advantage if you use it to ask different questions. I learned that a literature review is an argument, not a list. I learned that a relatively genuine study is better than a big overclaimed one. And I learned that the pressures of academic publishing can be comprehensive, impactful and original. The experience has not made the research process any easier, but it has made it more legible. I now know what I am doing when I do research and why it is important to do it carefully.

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Appendix A: Survey Questionnaire

Survey on the Bankability of UK Wave Energy Start-Up Businesses

* Required

Profile of the Respondent

Please choose the option that most accurately reflects your background. The responses are all anonymous.

1. Which of the following most accurately defines your title? *

- ◯ Founder / Start-up Manager
- ◯ Investor / Funder
- ◯ Policy Advisor / Government Official
- ◯ Industry Consultant / Technical Advisor
- ◯ Research / Test Centre Expert
- ◯ Academic Researcher
- ◯ Other

2. How long is the scope of your professional background in renewable finance, marine energy, or wave energy? *

- ◯ Less than 2 years
- ◯ 2 - 5 years
- ◯ 6 - 10 years
- ◯ More than 10 years

3. In which region of the United Kingdom is your organisation primarily located? *

- ◯ England
- ◯ Scotland
- ◯ Wales
- ◯ Northern Ireland
- ◯ Not headquartered in the United Kingdom, but actively operating in the UK market

4. Have you been directly involved in the financing, investment, or formal guidance for a wave energy project? *

◯ Yes, I am directly

involved ◯ Yes, I am

indirectly involved

◯ No direct involvement, but I have relevant industry

knowledge ◯ No relevant involvement

5. Which stage of the wave energy development process are you most experienced with? *

☐ Research and development in the

early stages ☐ Development and

testing of prototypes

☐ Pilot deployment or demonstration

☐ Pre-commercial or commercial scale-up

☐ Experienced in different stages of the development process

Bankability Factors

6. For Question 6, please use the following scale:
1 = Strongly disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly agree *

	1	2	3	4	5
Wave energy startups in the United Kingdom experience significant challenges in securing external funding.	○	○	○	○	○
The bankability of wave energy startups in the United Kingdom is significantly limited by revenue uncertainty.	○	○	○	○	○
The bankability of wave energy start-ups in the United Kingdom is affected by their limited technologic al capability.	○	○	○	○	○
The current policy support system is adequately reliable and constant to promote investment -related decisions.	○	○	○	○	○
The bankability of startups is subsequentl y weakened by regulatory	○	○	○	○	○

and licensing regulations.					
The lack of credible performance data negatively impacts the bankability of wave energy start-ups in the United Kingdom.	○	○	○	○	○
The stage of development of wave energy startups is incompatible with the type of finance that is available.	○	○	○	○	○

	1	2	3	4	5
The ability of wave energy startups to secure financing is significantly influenced by investor confidence.	○	○	○	○	○
The barriers to bankability are considerably different during the prototype, demonstration, and early commercial stages.	○	○	○	○	○
The current financing arrangements are more appropriate for early-stage innovation than for demonstration and scale-up.	○	○	○	○	○
Private investors and financiers are dissatisfied with the process by which risk is allocated.	○	○	○	○	○
The project infrastructure gets affected by bankability factors to a significant degree.	○	○	○	○	○

Barrier Prioritisation

7. Please rank the following barriers from most important to least important in shaping the bankability of UK wave energy start-ups. *

- Revenue Uncertainty
- Organisational Technological Maturity
- Regulatory Requirements
- Policy Support
- Lack of clarity in regulations and agreements
- Disparity between financial and developmental stages
- Technological Advancements
- Risk Allocation
- Investor Confidence

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