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Barriers and drivers for tidal energy development: A case study of Ireland

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ABSTRACT

European states have set ambitious targets to meet their climate goals and decarbonize their energy sector. These included development plans for the marine environment, knowing its potential in harnessing Offshore Renewable Energy (ORE) through wind, wave and tidal resources. The latter is becoming highly attractive due to its predictability, reliability and potential to answer communities' energy needs, but it is still associated with several challenges that are often overlooked. This paper aims to identify the barriers and drivers for tidal energy development in Ireland following the recent policy changes. This is done through semi-structured interviews with key local and regional stakeholders in the ORE field, which are analysed following Braun and Clarke's Thematic Analysis approach.

The main challenges for tidal energy development revolve around the uncertainties and dynamic nature surrounding the existing regulatory framework in terms of marine spatial planning and planning processes, in addition to the technology's high cost, limited competitiveness and lack of resources in state agencies and departments. Moreover, community objections, socio-economic interests and supply chains issues play a key role in project delays. Nevertheless, the technology offers undervalued advantages in terms of its predictability and reliability, particularly in remote and island communities. Interviews revealed the need to provide better clarity and faster action at all levels of the ORE value chain. This cannot happen without providing incentives, enhancing awareness and community participation, and ensuring environmental sustainability.

As the identified barriers represent typical challenges encountered in other country-cases, Ireland can learn from leading EU and international countries to enable projects' commercialization, and can also lead by example for similar island nations.

1. Introduction

The marine environment has been gaining increased interest as an area of new developments, knowing its potential in harnessing Offshore Renewable Energy (ORE), in particular wind, wave, and tidal powers. While fixed offshore wind is being heavily deployed around the world due to its competitiveness and technological readiness, tidal and wave projects are moving slowly from pilot testing to pre-commercial farms [1]. In specific, tidal stream energy (also called tidal current, usually generated from the movement of water volumes and changing tides in constrained geographies) is emerging as a globally abundant, yet untapped, source of renewable energy that can support the clean energy transition due to its high predictability [2].

As the world, and the EU in particular, is aiming to gradually end their dependence on imported fossil fuels that are risking their energy security, tidal energy can support the diversification of energy supply through domestic sources that have the potential of creating jobs and contributing to economic growth [1,3]. Yet, its cost-reduction trajectory will require large-scale projects and investments in technology innovation and infrastructure, knowing the diverse configurations and different designs of tidal turbines [4,5] which result in complex approaches.

Ireland benefits from a sea area approximately seven times the size of its landmass, making it not only a Large Island Ocean Nation (LION),[1] but also among the top ORE resources around the world [6]. Over the past years, Ireland has committed to achieve a 51% reduction in emissions from 2021 to 2030, and net-zero emissions no later than 2050, in addition to reaching an ambitious target of 80% of demand from

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[1] Notion frequently used during the Ocean Day Conference in Cork, Ireland in June 2023.

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renewable electricity by 2030 [7–9]. This includes new capacities of around 9 Gigawatts (GW) of onshore wind, 8 GW of solar, and at least 5 GW of offshore wind [10]. Other policy statements for ORE have also set ambitious targets to deliver 20 GW by 2040; and at least 37 GW in total by 2050 in Irish exclusive waters [11]. In addition, the 2024 Climate Action Plan [9] has committed to support ORE development through a new state-led comprehensive regulatory and planning regime for the maritime area.

In 2024, Ireland's ocean economy generated around €8.39 billion in turnover, contributing directly to the economy in around €3.53 billion and employing approximately 49,000 people [12]. ORE technologies will thus contribute to that growth and play a crucial role in decarbonizing the energy sector, reducing dependence on fossil fuels, further improving the green economy and creating jobs. Yet, the associated social and environmental impacts of ORE developments are often overlooked and should be taken into account, as around 3.2 million people (or 60% of Irish population) live within 10 km (km) of the coastline [13]. This is complemented with a vast range of marine activities, aquaculture, leisure and sports as well as fishing.

In addition, climate change has led to extreme weather and coastal hazards over the past decade, which might cause major changes in environmental parameters [14,15]. It is thus becoming crucial to consider environmental aspects and biodiversity preservation as part of any future planning, including energy projects, to protect the island's ocean economy. This paper aims to identify the barriers and drivers for tidal energy development in Ireland. Its strength lies in being the first conducted assessment of the persisting barriers following the government's approval of the Maritime Area Planning (MAP) Act in 2021, and its decision to shift from a developer-led to a plan-led approach within the maritime area. This is done through semi-structured interviews with key local and regional stakeholders in the ORE field from both public and private sectors, including developers, national institutions and NGOs. Insights are analysed following Braun and Clarke's [16] Thematic Analysis and using NVivo software. Results are used to develop a pathway for technology commercialization and influence the upcoming policy review process.

In fact, the case of Ireland comes to complement other studies around tidal energy challenges in general (e.g.,[17,18]), and to prove that it sits in a wider context where barriers facing the technology's commercialization are typical in other cases as well.

This paper thus continues as follows: the following section provides a literature review of tidal energy barriers and policy enablers in general, before diving into existing literature on Ireland (section 2). Section 3 then details the ORE regulatory framework in an Irish context, followed by the paper's methodology (section 4), while section 5 presents the results of the interviews with a primary focus on the drivers and barriers to tidal energy development. The final section offers a discussion of those findings and suggests some future directions.

2. Literature review

2.1. Barriers and policy enablers for tidal energy development

Despite relatively abundant tidal energy resources around the world [17,19], only a few countries are actively involved in the race towards its commercialization. This is mainly due to major persisting bottlenecks including high costs, limited financial support and environmental concerns [20,21]. Leading countries are the UK, France and Canada, and are followed by the US, China, Japan and South Korea, most of which are coastal countries. Yet, and as policy moves at a slower pace than technological advancements, most of the literature tackling policy barriers in those contexts date to few years back, while some go to more than a decade, highlighting the important and timely aspects of continuous research around such topics.

In the EU, the growth in ocean energy technologies has been supported by strategies and directives that have set targets for ORE to be adopted by members states, including for tidal and wave technologies. The first pilot projects for tidal energy were put in waters almost a decade ago in Scotland, the Netherlands and France [22]. Yet, Magagna et al. (2010) [23] highlighted a series of barriers that are still facing these technologies in the continent, and that are related to technology readiness, established markets and financial support, environmental and administrative issues as well as grid availability. These were also recently mentioned in the EU 2024 research and innovation agenda for ocean energy [1] and in Boretti et *al.* (2025)'s [17] review of tidal energy technologies. Authors called for support mechanisms, policy incentives, increased research and development (R&D) and streamlined consenting processes to reach technology maturity.

In Sweden, Andersson et *al.* (2017) [24] noted that tidal energy policies are still immature and dependent on public support, and stress on the importance of clear political direction for such emerging technologies, including national targets and market incentives. This is complemented by Wright's (2016) [25] findings of the critical role of policy certainty and stability in the case of the Scottish marine governance framework, which will help overcoming issues related to investments, supply chain and Marine Spatial Planning (MSP). This adds to policy instability concerns in the broader UK context and the need for clear policy frameworks and revenue support [26–28] to overcome planning, human capital and supply chain risks.

Beyond the EU and the UK, Dong-Hui et *al.* (2019) [29] investigated tidal energy policy in South Korea and found that recent policy changes and the introduction of market incentive plans will contribute to the development of ocean energy. However, there are still many challenges to overcome such as policy uncertainty, low public acceptance and environmental assessments. Those are also mentioned in the case for China when reviewed by Liu et *al.* (2011) [30], in addition to drawbacks in installations due to high costs and the need for more research in this area. Finally, in Nova Scotia (Canada), Carlson et *al.* (2020) [31] shed light on the key role the numerous policy incentives introduced since 2009 have played in developing tidal energy projects (R&D, financial incentives and environmental impacts), stressing on the importance of having stable, consistent and predictable policy frameworks.

2.2. Knowledge about tidal energy in Ireland

Research around tidal energy potential in Ireland has been ongoing over the past years, and has aimed at providing clarity around a series of facilitating factors for projects' deployment. These focused on resource assessment and technical feasibility (despite still the absence of any devices in waters), assessment of environmental impacts, community participation and regulatory aspects, all of which constitute a framework of policy enablers and impact future policy design.

Nevertheless, most of this literature was published prior to the approval and operationalization of the MAP Act in 2021 which resulted in a new development and consenting process for activities in the maritime area, as well as prior to the shift from a developer-led to a plan-led approach. Most studies also preceded the issuance of the ORE Future Framework Policy Statement (2024) that has set Ireland's vision for 2030 and beyond.

To date, only a handful of studies covered the topic from a community and environmental impacts' perspectives [32–39]. Also, the assessment of the existing regulatory framework and its underlying barriers was tackled for all ORE developments rather than tidal energy in specific, and focused more on MSP [15,40] and offshore wind deployment [41,42], noting Ireland's ambitious and pressing targets set for 2030.

This paper thus aims to address this gap in the literature by highlighting the existing barriers and drivers for tidal energy development, which persist even after the MAP Act ratification and its subsequent policy documentation and frameworks, and which are key elements to progress in this area. As the MAP Act entered its review process in 2025 [43], It also aims to give an up-to-date assessment of the existing framework and influences future pathways.

From a resource perspective, research was triggered by a Sustainable Energy Authority of Ireland's (SEAI) assessment in 2005 to identify suitable areas for commercial tidal energy deployment [44]. The study resulted in the identification of 11 locations on the island having a viable potential tidal energy resource of around 0.915 TWh/yr. Later, Rourke et *al.* (2010) [45] reviewed marine current energy devices and their suitability for Irish waters, concluding that some areas might not be economically viable due to their limited velocities, being less than the 2 m/s velocity threshold. Moreover, Fouz et al. (2022a; 2022b, 2023) [46–48] investigated the tidal energy potential in the Shannon Estuary (west coast of Ireland), and provided a roadmap for selecting the most suitable locations and streamlining decision-making processes [48]. Additional modelling studies were conducted by Bryans et al. (2005) and O'Rourke et al. (2010) [49,50] to identify the theoretical tidal energy resource around Ireland, while Fouz et al. (2023) [48] focused on the latter solely in coastal areas. Furthermore, Coughlan et al. (2020) [51] spatially mapped seabed and sedimentary characteristics in the Irish sea, highlighting the geological and geotechnical constraints for offshore wind development.

The environmental impacts of potential tidal energy devices and their configuration were thoroughly investigated by Fallon et al. (2014), Nash et al. (2014) and Phoenix and Nash (2019) [32–34] focusing on the Shannon Estuary. Modelling results showed that arrays of turbines can have an impact on water levels upstream of the devices, and cause changes in the hydrodynamic characteristics as well as loss of habitats [32]. Spacing between turbines and their capacity can also play a role in attenuating water flows and reducing tidal range [33]. Incorporating hydro-environmental impacts of tidal energy devices in future modelling exercises would enable the identification of environmentally-acceptable levels of resource extraction [34], and assessing their impact on surrounding habitats and species, particularly seabirds [52].

On the social front, several studies investigated people's perceptions and acceptance to ORE and tidal devices on the island. When assessing the attitudes of fishermen towards ORE projects in both Ireland and Scotland, surveys by Reilly et al. (2015) [35] showed support for developing such projects (40%), and their ability to co-exist with fisheries (70%), but raised concerns around their potential environmental impacts. Yet, more support was seen among Scottish fishermen than the ones in Ireland. In Northern Ireland, and following the installation of the SeaGen tidal energy device in Strangford, public beliefs showed strong support for its deployment and made the technology visually familiar [36], but also highlighted the role place attachment considerations and place-related values can play in influencing community response [37]. Stakeholders living around the device shared common concern on the intensity of potential impacts the turbine could have on marine biodiversity, ecosystem services and human well-being [38], reflecting back on the role of community science in informing policy in the marine environment [39,53]. Increased attention is being made on the relationship between marine citizens and practitioners with the sea that drives marine management forward [39].

As for ORE regulatory framework, previous research assessed its development over the past decade, highlighting some of its challenges as well as its readiness to accommodate for future ORE projects, and reach the country's climate ambitions. Studies have also made the link between technology development and integrated MSP as a key instrument for marine management [40].

Among the first comprehensive assessments of Ireland's ORE regulatory framework was the one conducted by O'Hagan and Lewis (2010) [42] looking at the existing laws and policies and investigating the associated barriers that were hindering project deployment. These revolved around the complex, costly and time-consuming processes, along with grid connection, technical and planning issues. When combined, these increase investors' uncertainty and reduce developers' appetite to install devices. Authors recommended to streamline licensing and planning processes [42,54], reduce delays and costs, and consider a holistic approach for ORE rather than sectoral considerations. Additional challenges for stronger MRE penetration were explored by Lange et al. (2018) [41], including lack of efficacy in policy integration and enforcement, government oversight and community trust.

In fact, marine governance in Ireland has witnessed a significant evolution over the last two decades, promoting interdisciplinarity and participatory approaches [39], but several areas of improvements still exist. Troya et al. (2023) [55] tackled the topic from an aquaculture lens, criticizing its exclusion from new marine governance and consenting regimes, risking a fragmented sectoral approach. Authors called for integrating environmental criteria into planning decisions.

On a broader aspect, literature covered ORE governance from an MSP perspective [15,56–58], and the latter role in reducing conflicts, increasing certainty [59], and driving the use of offshore renewables through an ecosystem-based management approach [40]. Institutional barriers for integrated MSP on the island of Ireland were investigated by Ansong et al. (2022) [60], while Flannery et al. (2015) [61] explored political and institutional factors to advance transboundary MSP between Northern Ireland and the Republic of Ireland. Moreover, Carr (2019) [15] called for better regulatory coordination among stakeholders to provide a coherent and integrated plan moving forward.

3. Existing Offshore Renewable Energy regulatory framework in Ireland

Ireland's current ORE plans reflect a bigger commitment for offshore wind projects rather than other ORE technologies (tidal and wave energies), although the island was an early starter in investigating its tidal energy resources, being among the strongest tides worldwide [62–64].

Since the issuance of the SEAI assessment in 2005 [44], the Irish Government has embarked in issuing the necessary policies and legislations related to the management of the marine environment through a plan-led approach (Fig. 1), which will be explored in details in this section. In fact, the literature in section 2.1 has shown that the case of Ireland is somehow representative of a range of other coastal and wealthy nations, both in the EU and internationally. These have committed to benefit from their abundant offshore resources and started issuing the necessary policies and mechanisms for that. At the EU level, member states' policies were also driven and influenced by decisions and directives in this regard [1,54,59].

On the other hand, coastal communities across the island which lack access to affordable energy and endure high costs on fossil fuels for power supply could benefit from other examples around the world [e.g., [65,66]] to reduce their dependence and benefit from locally-produced tidal energy.

3.1. Offshore Renewable Energy Development Plan

Following a consultation that started in 2002, an Ocean Energy Strategy was developed by the Marine Institute and SEAI, with the aim to deploy around 500 MW of ocean energy by 2020 [42]. The plan was then supported by the Irish Government, first by including ocean energy in its 2007 white paper “Delivering a Sustainable Energy Future for Ireland”, and then by issuing the Harnessing Our Ocean Wealth marine plan in 2012 [67]. It also secured ORE funding of around €26 million between 2008 and 2011 [42,68,69].

The work to produce a dedicated framework for the sustainable development of Ireland's ORE resources continued in the following years. The framework was known under the name of Offshore Renewable Energy Development Plan (OREDP). After an initial scoping report in 2009, a full Strategic Environmental Assessment (SEA) was issued in 2010, followed by a Natura Impact Statement (NIS) in 2011 [69,70].

The first version of the plan, OREDP-I, was published in 2014 and aimed at identifying the opportunity for Ireland to make use of its ORE resources. As a result, it has updated the 2005 assessment, and identified

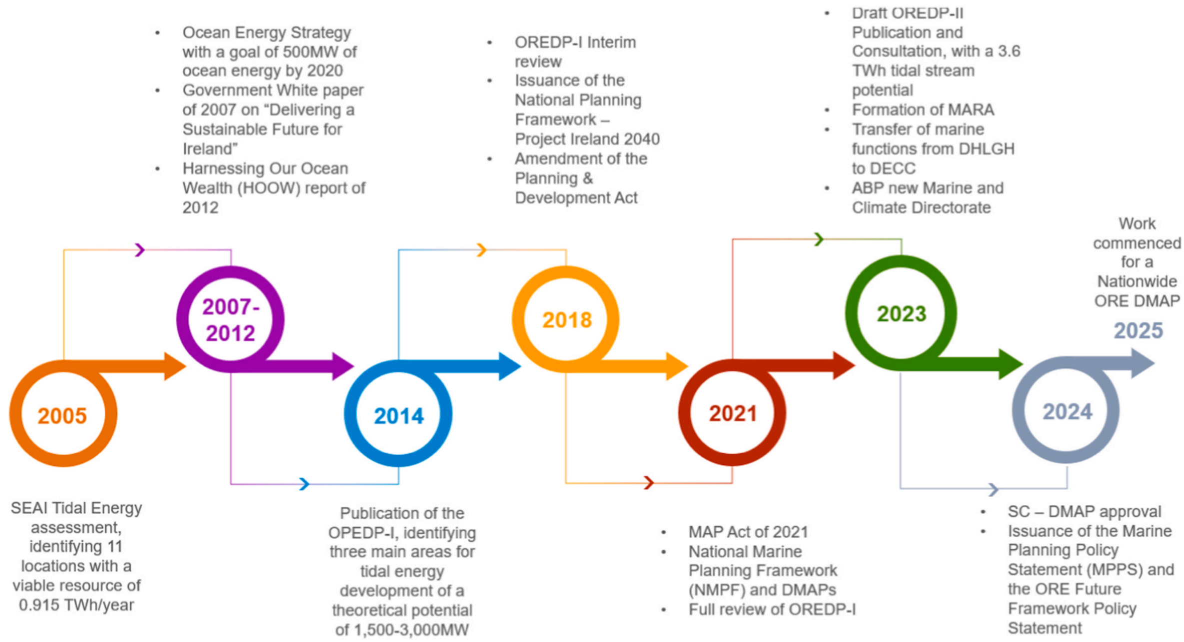

Fig. 1. Timeline of ORE Regulatory Framework development in Ireland.

three main areas that are suitable for tidal energy development in the South East coast (SEC), the Shannon Estuary (SE) and North West coast (NWC) [69]. A total theoretical potential ranging between 1500 and 3000 MW of tidal energy was estimated based on tidal current speeds equal to or exceeding 1.2 m/s and a water depth of 20 to 80 m below mean sea level. This was equally divided between the SEC and the NWC, while the SE had limited potential due to available commercial and environmental constraints. A similar assessment for offshore wind (fixed and floating) and wave energies was conducted.

The OREDP's SEA and NIS have highlighted an initial possibility to developing such tidal resources without likely significant adverse effect on the environment, on the basis that the identified mitigations measures will be considered and integrated in future plans [70,71]. As for the SE, commercial scale developments in the area are likely to cause adverse impacts on both the surrounding Special Protected Areas (SPAs) and species, and further studies are needed to investigate them.

The OREDP was bound to a 5-year review process. An interim review of the OREDP-I was conducted in 2018 along with its SEA prior to a full review in 2020, aiming to undertake an assessment of the plan progress, and the key actions needed to overcome existing challenges [72].

3.2. *Maritime Area Planning*

In parallel to the work around marine governance, the Irish Government has proceeded since 2019 in regulating the maritime area by updating the legislative and planning framework (known as the Planning and Development Act of 2000, and the Amended Act No. 16 of 2018) in accordance with the EU Directives around the Maritime Strategy Framework Directive (MSFD) (Directive 2008/56/EC) as well as Maritime Spatial Planning (MSP) (Directive 2014/89/EU).

The latter was transposed into national legislation with the issuance of National Planning Framework – Project Ireland 2040 in 2018, followed by the MAP Act in 2021. This was considered as the biggest reform in marine governance [73–77]. The National Marine Planning Framework (NMPF) was formally established in 2021, based on which planning of projects within the marine area, including state-led ORE activities, will be done in the future [76,77]. NMPF covers all marine-based human activities with the aim to balance between marine usage and environmental protection.

Under the MAP Act, all future ORE developments will follow a plan-led, ecosystem-based approach set by the state through the provision of Designated Marine Area Plans (DMAPs). These will establish multi-activity areas and promote specific activities while protecting the marine environment [11]. As a result, a first DMAP for the South-Coast (SC-DMAP) was approved in 2024 as Ireland's first spatial plan for ORE, including four maritime areas in the Celtic Sea where future fixed-wind ORE projects may be located by 2030 and beyond [78]. Work has also commenced on the preparation of a single nationwide ORE DMAP covering all of Ireland's maritime area, which will provide a spatial planning framework for ORE, and will include lessons learned from the SC-DMAP [79–82]. It is expected for this DMAP to be completed by the end of 2027 or early 2028, and to provide sufficient maritime area to deliver around 20 GW of ORE by 2040 (Fig. 2).

The operationalization of the MAP Act has also witnessed the formation of a new independent authority known as the Maritime Area Regulatory Authority (MARA), which will be responsible for the issuance of Marine Area Consents (MACs) and Foreshore Licenses moving forward. In consequence, the Government took a decision in 2023 to restructure marine responsibilities and transfer marine governance functions linked to Marine Planning, Foreshore and MARA from the remit of the Department Housing, Local Government and Heritage (DHLGH) to come under the Department of the Environment, Climate and Communications (DECC) [83,84]. Moreover, a new Marine and Climate Directorate has been formed within An Coimisiún Pleanála, Ireland's national planning body, to strategically oversee the new marine functions [9].

3.3. *Draft OREDP-II or National Spatial Strategy*

Concurrently with the marine governance update and MAP Act processes, the OREDP-I undertook its review process, and an interim report was published in 2018 [72]. The latter found that the OREDP is still fit for purpose and proposed to carry out a review of its SEA as well as a full review, which effectively started in 2021 [85]. As a result, the draft of the OREDP-II document, known as Ireland's National Spatial Strategy, was published in 2023 [85,86].

OREDP-II sought to consider significant developments in policy, technology, legislation and regulation, as well as in existing marine data since the publication of OREDP-I in 2014. In addition, it was influenced by the new government integrated marine planning framework [87],

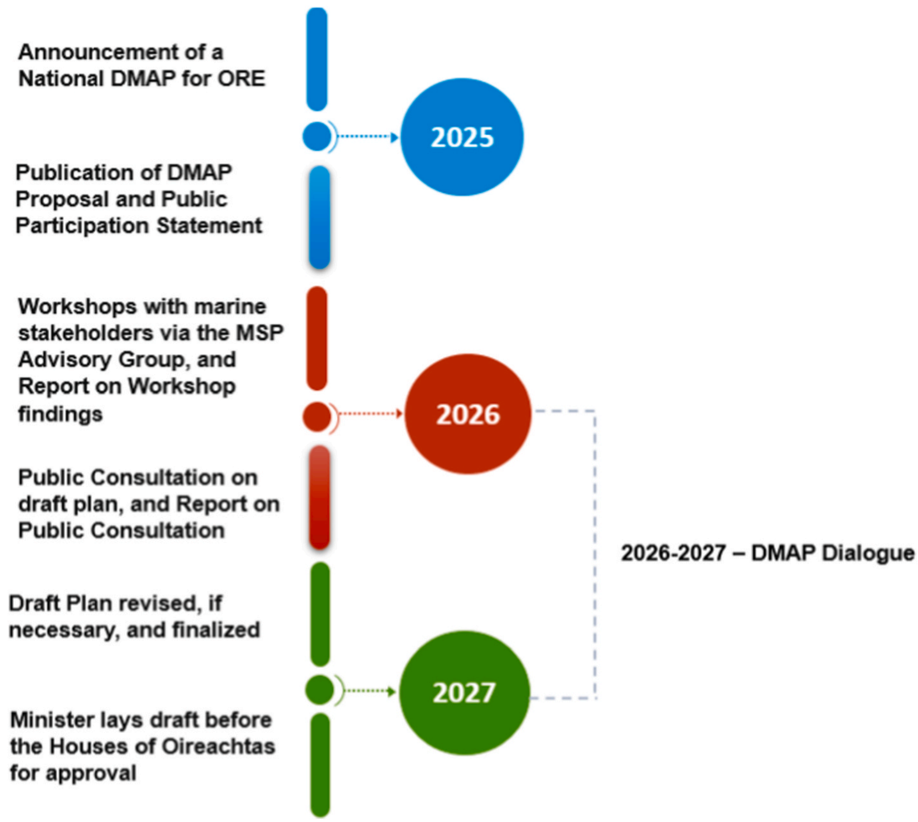

Fig. 2. Timeline of Ireland's nationwide ORE DMAP (2025-2027), adapted from the Department of Climate, Energy and the Environment (DCEE).

and is one of its cornerstones towards identifying the most suitable areas for ORE development [85].

On tidal energy, the National Spatial Strategy updated and confirmed OREDP-I zones previously identified as highly suitable for potential projects (mainly in the SEC, NWC and SE), later adopted in the Marine Atlas [88]. The estimated total technical resource potential for tidal stream increased from the first OREDP assessment to around 3.6 TWh.

3.4. *Marine Planning Policy Statement & Future Framework Policy Statement*

Building on all previous strategies and frameworks, the Government issued the Marine Planning Policy Statement (MPPS), which is the first of its kind in Ireland, and links to the 2015 Planning Policy Statement for land [89]. MPPS is an important step as it presents the needed structures for an integrated system towards forward planning, development management and enforcement elements, and is expected to be brought for approval at to the Houses of Oireachtas in 2026 [84].

Moreover, MPPS was followed by the ORE Future Framework Policy Statement [11] setting the vision for the post-2030 period through 29 actions aiming to develop Ireland's plan-led approach for ORE, while protecting the marine environment and safeguarding biodiversity. This will require not only issuing DMAPs, but also working on reinforcing the grid, strengthening the planning process and developing export markets.

3.5. *Offshore Renewable Electricity Support Scheme*

To reach the 5 GW offshore wind target by 2030, the Government launched specific auctions under the Renewable Electricity Support Scheme (RESS) and known as the Offshore RESS (ORESS). The latter is usually the second step to follow the receipt of a MAC, and is usually linked to a grid connection license.

A first ORESS was launched in 2022 through which a large proportion of the 5 GW target (around 3 GW) are hoped to be achieved before 2030 [90]. The results of the latter were announced in May 2023 [91], in which five projects out of the six applications are currently in the planning process.

Another auction phase, known as ORESS2.1, will aim to bridge the gap between what ORESS1 will deliver and the 5 GW target. This will move forward as per the plan-led approach, with around 900 MW procured in the SC-DMAP for fixed-bottom offshore wind [90,92]. The ORESS scheme expired by end of 2025, and a successor scheme must be designed by 2026 with a bigger role for MARA [11].

3.6. *Marine biodiversity and ORE*

One of the main goals of the national MSP through MPSS is to maintain healthy ecosystems and safeguard the marine environment, while driving the ocean economy and increasing the engagement with the seas [89].

In fact, Ireland falls under a set of European obligations to achieve Good Environmental Status and improve water quality either through the MSFD or the Water Framework Directive (Directive 2000/60/EC). Moreover, other EU Directives linked to biodiversity have been transposed into the Irish context, particularly the Habitats (92/43/EEC) and Birds (2007/147/EC) Directives. While the former requires the designation of Special Areas of Conservation (SACs), the latter identifies Special Protected Areas (SPAs). Ireland's SAC Network includes around 597,000 ha of marine and terrestrial habitats, which along with SPAs form the Natura 2000 network [93–95]. These are designed to meet very specific conservation objectives for a limited number of habitats and species.

It is also important to mention that both the SEA and the Environmental Impact Assessment (EIA) Directives have been integrated into national legislation with the aim of providing higher levels of protection of the environment [96,97]. While SEA applies to strategic and large-scale plans and programmes, the EIA applies to a particular project, and in the case of a surrounding Natura 2000 site, an Appropriate Assessment (AA) is required. These EU and national policies apply to all projects, including ORE and tidal energy projects. In this context, MARA is the competent authority under the MAP Act for AA when granting Marine Usage Licenses (MUL), while MACs require no EIAs as those projects will later apply for planning consent.

Finally, countries in the EU are obligated to designated 30% of their maritime territory as Marine Protected Areas (MPAs) in line with the Biodiversity Strategy. Ireland is lagging behind this target, with just around 9% of its waters designated as either SACs or SPAs, a recent increase from around 2.1% in 2022 [98,99]. This means that Ireland must triple its efforts to achieve this target by 2030.

An MPA bill to support this 30% target, including a 10% of strictly protected areas, has been in discussion over the past few years as a standalone bill [100], something that the Government is reconsidering to incorporate MPAs into forthcoming amendments of the MAP Act [43,101].

4. Method

This study follows a qualitative approach through semi-structured interviews with key stakeholders in the ORE field, which were selected based on their expertise and involvement in the marine environment in Ireland, or in the broader European context. A stakeholder registry was initially formed by identifying potential interviewees from both public and private sectors, national institutions, local agencies and NGOs. We then followed a snowball sampling approach [102] where interviewed stakeholders were asked to nominate or propose additional contacts for interviews, thus expanding the network and ensuring the most suitable participants are reached.

As a result, 20 Interviews were carried out between August 2023 and November 2025, and included representatives from Government Departments (2) and State Agencies (6) involved in the marine space, Environmental Conservation Bodies (4), Offshore Energy Industry Associations in Ireland and the UK (3), Tidal Energy Technology Developers or Manufacturers (4) and a firm with Community Engagement expertise in the ORE field (1). Each of the latter has a distinct mandate and responsibility within the marine or ORE spaces. State agencies included governmental authorities, institutes, regulators and local government entities, some of which benefit from financial and administrative independence. Despite the relatively moderate number of participants, the selected individuals reflect a representation of the landscape of personnel involved in tidal energy in Ireland, which is still relatively narrow.

Knowing the Irish focus of this study, priority was given to representatives of institutions (above the age of 18) working in Ireland and having direct or indirect involvement in ORE developments from a regulatory, technical, financial, social or environmental perspective. This was then followed by those representing bodies in the EU or the UK. An additional consideration was put on stakeholders' expertise in tidal energy, followed by other ORE technologies (offshore wind and wave).

As most of the interviewees were based outside of County Galway where this research is undertaken and in different places across Ireland, while others were located in the EU, the interviews were carried out in English online in order to standardize the interview process and keep the approach consistent. The majority of the interviews were recorded, while guaranteeing anonymity. Recordings were stored securely and confidentially in password-encrypted PCs, and password-protected back up storage devices, which were not made accessible to personnel beyond their owners in according with the University of Galway's Research Ethics Committee approved application (Ref # 2023.05.015).

Interviews were then analysed applying Braun and Clarke's [16] qualitative Thematic Analysis (TA) using NVivo software (NVivo 20 Release 1.7), according to the abovementioned five different professional categories. TA has been widely used as a foundational and powerful method (thus a technique, and not a theory) for qualitative research and data analysis [103,104]. It helps identifying and reporting key themes within a dataset through a systematic approach.

Although researchers have further developed, refined and delineated their technique in later years to introduce reflexive thematic analysis (RTA) [104–107], it still offers a theoretically flexible tool that can be adapted to any context [108], allowing reflexivity and creativity in knowledge production [106].

In this paper, we have followed the six key phases for conducting TA (Fig. 3), to identify main features extracted from the interviews, and to produce insightful findings [103,104]. After familiarizing with the data resulting from the interviews (recordings and notes, Phase 1), these were first randomly coded in NVivo according to the topic covered during the discussion (systematic data coding, Phase 2). In Phase 3, initial themes were then generated based on the overarching areas of focus. For example, all types of challenges highlighted during the interviews (e.g., lack of funding, regulatory bottlenecks, environmental impacts, etc.) were grouped under the theme of challenges, while statements around technological aspects (e.g., tidal or ORE in general) were put under a technology theme. Additional separate themes were created for the planning process, community engagement and roles of interviewed entities.

The generated themes were reviewed to gather those that fall under the same umbrella or topic (Phase 4). For instance, planning processes' challenges was brought under the main challenges theme, while technological aspects and community engagement activities were put under a broader ORE development theme. Finally, these themes were slightly refined and named in preparation for the analysis work (Phase 5).

5. Results

Informants' perspectives reflected the complexity of the ORE regulatory framework in Ireland on one hand and helped identifying the drivers and barriers for tidal energy development on the other, underscoring both the opportunities and constraints of such projects. Discussions highlighted issues related to current governance and permitting processes, technology drivers and challenges, market readiness (funding and R&D), community engagement and environmental considerations.

Despite the set of advantages that tidal energy technology presents to decarbonize the energy system, interviews were more focused on its

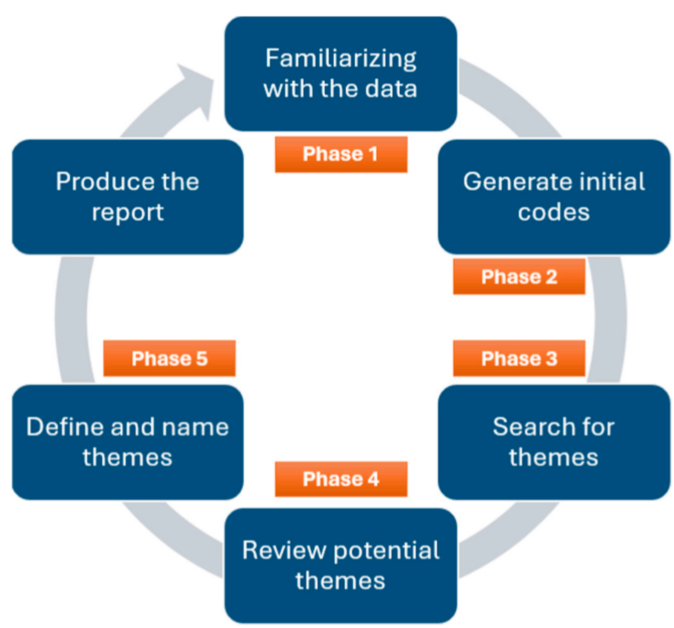

Fig. 3. Braun and Clarke's Process for Thematic Analysis extracted from Stevens [103].

challenges within the Irish context, considering the fluid and volatile nature of ORE development, resulting in a continuous uncertain environment. Fig. 4 shows a tree map representation of the identified challenges during the interviews, where the size (weight) of each challenge reflects the number of times it (codes) was mentioned, while Table 1 provides a list of the most recurrent subtopics that were mentioned under some of the main challenges or themes. Regulatory bottlenecks and technological constraints were widely mentioned, with 29 and 19 mentions (codes) respectively. These were followed by environmental impacts (12 mentions), permitting and planning challenges and lack of human resources (11 mentions each), and to a lower extent, by technology market streams (routes to market, 9 mentions), the need for more R&D support (8 mentions), economics of tidal energy (7 mentions) and lack of funding (5 mentions), among others.

Using NVivo, a deeper look into these challenges gave an idea on the interviewees' major concerns in relation to their expertise and professional categories (Fig. 5). For instance, analysis has shown that tidal energy developers/manufacturers focused more on challenges linked to the regulatory framework (15 mentions), the economic (9 mentions) and engineering constraints (7 mentions) of the technology as well as on the permitting and planning issues and lack of funding (3 mentions each). State Agencies mostly highlighted technology/engineering constraints (6 mentions) and environmental considerations (5 mentions) as main bottlenecks, followed by lack of resources (3 mentions) and, to a lesser extent, community objections (1 mention), while Government Departments' feedback was mainly focused on existing laws/regulations (4 mentions), and the need to develop Ireland's infrastructure (mainly ports and marine vessels, 2 mentions).

On the other hand, several ORE Industry Associations brought forward issues related to potential routes to market for tidal energy (6 mentions), fishing industry compensation and R&D support (5 mentions each), followed by engineering and regulatory aspects (3 mentions each), as well as lack of funding (2 mentions). As for environmental conservation bodies, their key challenges were focused on lack of human resources (7 mentions), regulatory framework bottlenecks (6 mentions) and environmental impacts (5 mentions) (Fig. 5).

Table 1
List of most recurrent subtopics mentioned under some of the main themes/challenges.

Regulatory-Laws	Technology-Engineering Constraints	Permitting-Planning Processes	Community Objections
Regulatory framework	Drivers for ORE	Permitting Process	Community acceptance
Designated Marine Area Plans (DMAPs)	ORE technologies	Planning application	Community engagement activities
OREDP-I	Offshore Wind	Bureaucratic delays	Fishing groups involvement/engagement
Maritime Area Regulatory Authority (MARA)	Tidal Energy		Community Benefit Funds
Marine Protected Areas (MPAs)			
Environmental Assessments			
Projects co-location			
EU Policies			
UK Policies			

5.1. Drivers of tidal energy development in Ireland

One of the utmost concerns for EU member states is to provide low-cost and reliable power supply to consumers, especially following the Russian invasion of Ukraine in 2022 and its repercussions on the EU energy market. There was convergence among interviewed stakeholders that ORE projects, particularly fixed offshore wind, are able to answer that concern in the medium term knowing the opportunity it offers, its technological competitiveness and market readiness for grid-scale projects [109–112]. While technological questions still arise around the potential of floating offshore wind and wave energies, tidal energy is

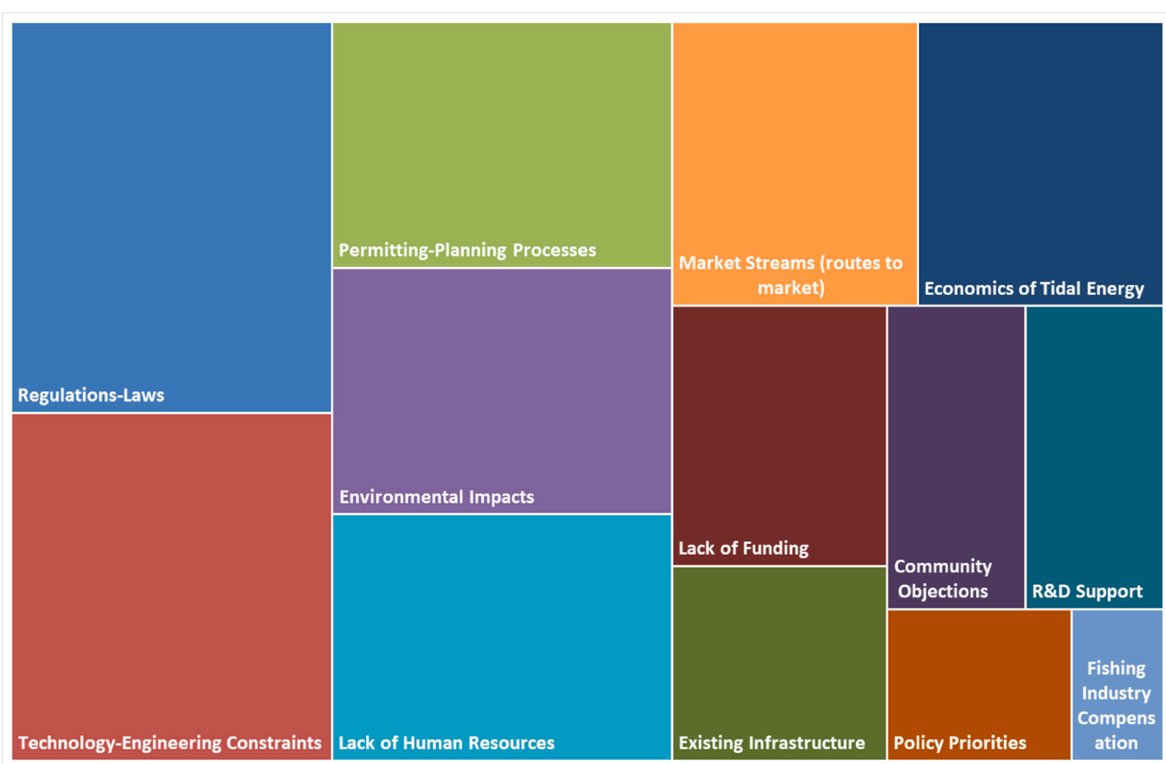

Fig. 4. Tree Map of the identified challenges for tidal energy development, the size (weight) of each challenge reflects the number of times it (code) was mentioned.

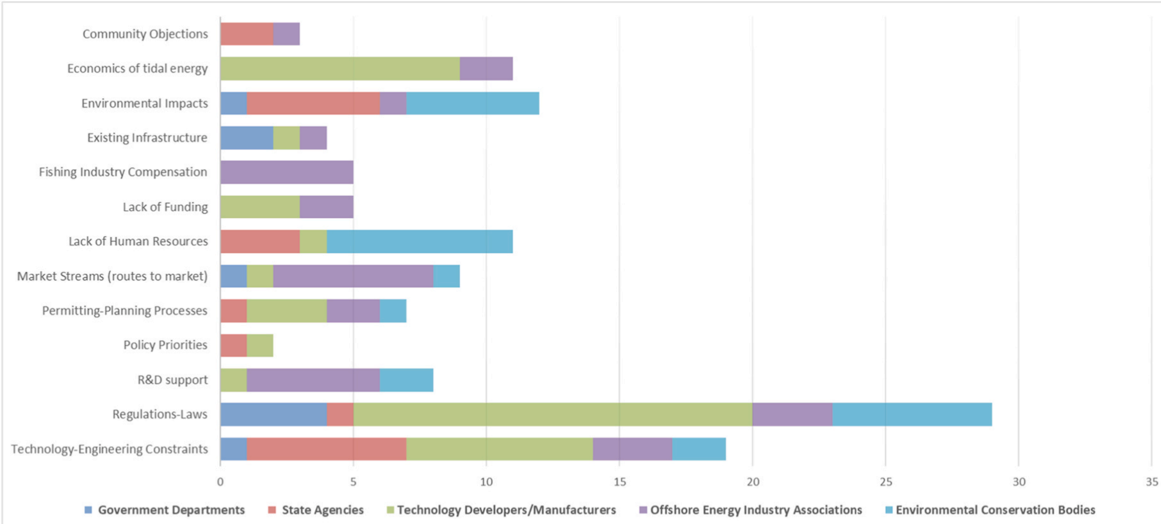

Fig. 5. Identified challenges categorised according to the count of coding references (mentions) in NVivo.

well positioned to compete with them despite persistent high costs and lengthy development processes [109].

Interviewees noted that there is a need to recognize that tidal energy might not play the same role that solar and wind played over the past decades [113], but still has advantages to offer as a proven technology that is thriving for support [109]. Issues related to market conditions, technology readiness, cost-effectiveness and supply chain will need to be considered to minimize risks [110,114].

In fact, interviewees emphasised that tidal energy offers a different value proposition compared to other ORE sources, which is predictability, something that is still undervalued in current market conditions [109,114,115]. The technology can produce power when solar and wind cannot, or when prices are high. Due to this reliability and consistency for years to come, it can provide grid stability and balancing on grids that have a high penetration or other less predictable energy sources. Several industry professionals shared experiences around potential niche applications for tidal energy, particularly in aquaculture, as well as in remote island communities and off-grid areas where cost of infrastructure (national grids) is high, and where reliance for power generation is on expensive and polluting diesel generators [109,114–116]. It was noted that tidal energy could even constitute a suitable solution for several use cases when combined with existing solar and wind projects, thus minimizing energy costs [109,114].

The biggest technological driver, according to interviewees, will be lower prices and stronger supply chain in the coming years [115]. The technology stands today, as an Industry Association representative [117] has put it, at a “make it or break it” position, where its potential has proven to be working, but still lacks both the political will and the needed financial support to reach readiness levels. This cannot happen without funding, long-term market visibility, setting deployment targets in national legislation, all of which bring more certainty for investors [117].

Moreover, there has been a clear recognition for wave and tidal energy potential in recent policy documentation and frameworks [116]. Despite primarily aiming for economic return, developers are also strong believers in the associated benefits of ocean energy, and the need to protect the marine environment and rely less on fossil fuels [118]. Moreover, there has been a nationwide industrial policy aiming to push industries to locate in Ireland, making the island a centre for R&D of emerging technologies [116,119]. This is supported by directives and reports at the EU level, which call for streamlining permitting processes and creating a one-stop shop for all ORE permitting requirements, including tidal energy [1,117,120,121].

These policy documents are complemented by increasing financial support both at the EU and national levels, through grant funding, revenue support schemes, feed-in-tariffs (FiT), the EU Innovation Fund and Horizon Europe projects, all of which aim to reduce the cost of capital and accelerate commercialization pathways of ORE [116,122]. Nevertheless, more confidence will need to be gained by emerging technologies in Ireland through proven long operational capabilities, increased funding, developed supply chains and capacity building of specialized engineers [116].

5.2. Barriers to tidal energy development in Ireland

5.2.1. Regulatory framework

Since its issuance in 2021, there has been recognition that the MAP Act, along with the appointment of MARA and the designation of the SC-DMAP, are the driving force behind all policy decisions in the ORE area and are sufficient for the its development moving forward [110,112,116,123,124]. DECC's role has been focused on setting up the needed structures and vehicles to facilitate the implementation of the act, including the issuance of DMAPs, thus moving from a developer-led to a plan-led, adaptive management approach [110,118,123,125]. Innovation and emerging technologies (wave and tidal in particular) will also constitute as essential part of future strategies [110].

Nevertheless, and despite being technology-neutral, interviewees highlighted that the current policy and regulatory framework is more focused on the development of offshore wind projects than other ocean energy (tidal or wave) knowing the urgency to reach 2030 targets [109–111,113]. Targets were framed to be aspirations [125], political [110,118], and challenging to meet [109]. Some also criticized the absence of both a clear pathway for tidal energy in terms of actions and targets, and an overarching plan for everything related to ORE [114,125]. An Industry Association representative [116] added that OREDPI has wrongly put a lot of weight on tidal and wave energies when issued back in 2014, while both sit further down in the list of government priorities [109].

Regulatory bottlenecks were a significant concern for many interviewees, particularly when it comes to the slow implementation of existing frameworks and policies, and the capacity of the country's national bodies to support these processes [111,126]. The lack of qualified resources within the different departments having a substantial marine experience has emerged as a major bottleneck during the interviews [79,109,111,124,125]. This is linked to the level of marine expertise, scientific support, and surveying skills needed to implement existing policies, something that MARA and An Coimisiún Pleanála are currently realizing. It was stated that this is pushing some agencies to outsource their assessments to external consultants, which are often prone to competition and commercial interests [125].

On the other hand, the current regulatory environment was criticized by some interviewees for only offering a planning framework but not a MSP, which is the most challenging part [118,123]. A Technology Developer/Manufacturer [118] highlighted that the MSP as a Directive has been in place for more than a decade, and that having it at the national level is a prerequisite for the ORE development journey, as its absence will only add obstacles to deliver Ireland's 2030 targets [109]. Moreover, a major drawback is that MSP follows a sectoral approach (for energy, aquaculture, etc.) rather than a geographical one [118], and is managed by different departments.

Interviewees noted that as Ireland's strives towards achieving its 2030 ORE targets, decision-making pathways and strategies in this area are still continuously adjusting in response to evolving information, environments, government priorities and stakeholder needs. While government departments framed this process as an adaptive management approach [110], where decision-making is influenced by continued learning and responsiveness, others referred to it as being volatile, unstable or unpredictable [79,109,114,116]. This was noted to be the cause of developers' pullbacks and lost confidence due to the continuous restructuring and amendments [79,125], as well as the huge investments needs as part of the process with no reassurances of reaching successful outcomes [118].

5.2.2. Planning system

Another bottleneck for ORE development (including tidal energy) mentioned by interviewees was linked to the planning and permitting system [115,117]. These were claimed to be lengthy [79,118,125], with the lead-in time extending sometimes to several years due to a high number of backlog applications. Interviewees also differentiated between delays, which could be understandable and resolved, and the uncertainties these could cause to investors on the longer run [118]. They called for more clarity regarding the planning pathways [114,118] and shorter processing times, particularly when it comes to the decisions around submitted MACs. Others focused on the need to ease consenting processes for pilot testing (test sites) of wave and tidal devices, along with the related grid connections, both of which are taking long time to get approved [79,113,116–118].

The establishment of new legislative frameworks and the formation of MARA were identified as crucial steps toward streamlining project approvals and implementation processes [109,111,127], as the regulator took responsibility of all foreshore leases issued in the past, and will enforce them moving forward [123]. Yet, this is bringing additional complexities and delays to the process and are hindering potential projects, especially when complemented with the current transfer of marine governance responsibilities from DHLGH to DECC, and the ongoing change of government policy in relation to DMAPs and MPAs.

As Ireland's ORE sector scales up, planning issues were noted to become more critical to manage by national institutions following the issuance of the MAP Act, and need to be supported with the necessary expertise to deal with increasing complexities [111]. For instance, since its formation in July 2023, MARA has become the prescribed body for all maritime planning applications and authorizations, in addition to compliance, enforcement (of MACs and MULs) and revenue collection responsibilities [128]. These responsibilities are not limited to one particular sector or activity in the maritime area, but spread across several sectors and stakeholders, and constitute a new way of approaching maritime activities [123]. A case in point is the example of the phase I offshore wind projects which were announced in May 2023 as part of the ORESS 2.1, prior to the formation of MARA [91]. These were given a MAC directly by the Minister. After receiving their MACs, they were eligible to apply for electrical (grid) connection, which deemed to be a competitive process. Currently, some stakeholders believe that the MAC should be the entry point to any potential project development [123], which means further responsibilities for MARA.

5.2.3. DMAPs

As the government current strategy is to proceed in facilitating the issuance of DMAPs, concerns were raised by several stakeholders regarding their progress beyond the SC-DMAP, and the need to have clarity around other regional DMAPs across the island [79,118,123]. Although a DMAP was planned for the west coast after the SC-DMAP, the process has stalled until lessons are extracted from the latter's experience [79], while the government is moving into a new approach of developing a nationwide ORE DMAP [80].

Since all ORE technologies will be subject to DMAPs according to government policy, interviewees insisted on the need to have a roadmap and clear guidelines on their future, and to have them planned geographically and not by sector [118,123].

5.2.4. Technological and infrastructure constraints

At the technical level, opinions converged on the fact that the engineering aspect of tidal energy still sits some steps behind compared to offshore wind, with the technology lacking optimum solutions and proven devices [111,116,127]. The size, as well as the energy generated from existing tidal devices are still limited, and this become more complex with the different types and configurations of these devices, making their maintenance challenging [115]. This was noted to be exacerbated by limited areas of enough tidal resources across the island [109,127].

Although the technology is proven, interviewees pointed out that there remains a need to have reliable devices that are economically and technically viable, and able to produce energy at scale [111,116], in order to provide certainty and routes to market [114,127]. This cannot be done without significant financial support both at the government and EU levels. An additional issue for wave and tidal is the lack of new entrants to the sector, in terms of developers and entrepreneurs, due to the difficulty in seeing successful projects in water, and lack of efficient support [116].

On the other hand, Ireland was seen as lacking the necessary supply chain infrastructure for tidal and wave technologies, in terms of ports facilities and vessels, among others [109,116,118,126]. In fact, providers of such services are mostly located outside Ireland, and even outside Europe, and the latter seem to have missed the opportunity of being the hub for such activities [109]. In addition, Ireland lacks sufficient testing facilities beyond the Lir National Ocean Test Facility in Cork [127], following the recent closure of the Galway Bay test site [116,129]. It also needs to consider grid constraints particularly on the west coast, in order to connect future ORE projects [125,126].

Despite those challenges, there is still an opportunity for Ireland to play a leading role advancing R&D in this area [109]. It is becoming increasingly important to develop an R&D policy and a well-promoted regime to provide support for emerging technologies, particularly for tidal and wave [116]. Knowing the recent drawbacks in test sites development, a more structured approach for R&D is needed. Furthermore, interviewees underscored the importance of technology collaboration programs in facilitating global research partnerships and enhancing the sustainability of ORE technologies [127].

5.2.5. Economic feasibility and market streams

The interviews were another opportunity to confirm the high costs of current tidal technologies and the associated economic challenges [109, 114–116]. Discussions revealed the need to develop devices that work efficiently with moderate Levelized Cost of Energy (LCOEs), although the latter does not account for tidal energy's predictability, which is one of its driving forces [109].

An additional aspect that is adding pressure on economics and increasing risks are the associated uncertainties that accompany the planning ORE projects in Ireland [118], and which translate in enormous costs that are bared by consumers. The longer the processes are continuously delayed, the higher the associated risks are, and the greater the costs.

The current enabling environment in Ireland does not offer incentives for developers to implement ORE projects [115]. Therefore, attracting cheaper forms of financing, providing guarantees and offering viable routes to market become crucial [109,115,116]. This could take the form of revenue support for individual test sites as well as tidal and wave pilot projects, where innovative technologies do not have to compete with mature offshore wind [113,116]. It could also aim for new public financial mechanisms in the form of grants, FiTs, Contracts for Difference and equity loans [117].

5.2.6. Community engagement

Interviewees emphasised the critical importance of early and extensive stakeholder and community consultation to mitigate potential impacts on marine users and local communities, and to build support for ORE projects [109–112,114,130,131]. It was identified as key to managing the complexity of these projects and achieving sustainable outcomes, as the lack of engagement often leads to objections, taking appeals and judicial reviews, and posing significant risks to those projects [79,124].

There was also emphasis on the fact that people in Ireland do not fully realize the expected transition in the island's offshore area and the scale at which it is going to happen in future years, with the government not yet clearly stating their vision to communities [111,125]. Projects are usually designed without understanding what the community vision is [132]. Yet, there is recognition of the importance of community engagement in the latest ORE regulatory updates since the MAP act, as any future project will need a "social license" to operate [112,116]. In fact, community engagement has been embedded in the community benefit funds that fall out of the ORESS processes [123], but still lacks a decision-making structure with communities [132].

Despite yet not having any device in Irish waters, it is expected that community aspects will constitute a major issue moving forward knowing people's resistance to change [118]. As an Industry Association representative [116] has put it, it is a "small ticking bomb ticking away", as most of the current planned projects are nearshore and might have an impact on people's views. Nevertheless, experiences shared by several interviewees has shown a general positive support for proposed ORE and tidal projects [79,117,118]. A State Agency representative [79] revealed positive feedback from communities around the Shannon Estuary when consulted regarding a potential tidal energy project in the area. People have shown wide support, but also raised concerns linked to jobs and cost of energy. Others noted that objections in coastal areas are linked to communities' cultural and heritage connections with the maritime area [117].

A Technology Developer/Manufacturer [109] also highlighted that the reason behind the success of their engagement activities was considering these processes as pure partnerships with communities rather than just engagement, and seeing it as mutually beneficial rather than an invasion of communities [132]. This helped to understand people's needs and design the project and allowed them to take ownership. This approach has to be neutral, participatory, considers local skills and engages with powerful voices [126], and has to provide a level of honesty and confidence [132].

Moreover, among the biggest challenges faced by stakeholders and industry developers is the engagement relationship with the fishing community [116]. While several stakeholders have noted positive feedback when engaging with fishing groups as a pre-existing socio--economic activity [79,109,110,114,117,118,126,131], others perceived disputes with them first around whether they represent the views of all fishing groups, and second around potential displacement due to ORE projects, and the need to compensate them for that [116,130]. Fishing groups also raised questions around coexistence potential between ORE and fishing activities [110].

One aspect of compensating communities was the CBF as a tool to engage communities and increase acceptance levels, and which will bring positive impact [114,116]. While CBF were implemented earlier as part of the ORESS process, they were recently moved to the MAC level following the appointment of MARA [123]. Yet, it remains unclear how the process will be structured, leaving it open for funding organizations to develop [116]. The are also seen by many as a problem-solving tool for developers [132].

5.2.7. Environmental considerations

A consistent emphasis across interviews was the critical importance of conducting rigorous environmental assessments to mitigate environmental concerns and potential impacts on local wildlife, particularly seals and fish populations, due to resulting noise from tidal devices [114,125,130]. Interviewees stressed the need to integrate the proposed draft MPA Bill into the legal framework to ensure effective biodiversity conservation, as proposed ORE infrastructure might overlap with potential MPAs [110,112]. Balancing the designation of 30% of Ireland's waters as protected areas (MPAs) while simultaneously advancing extensive ORE projects poses a dual challenge [111,125], knowing already poorly-managed Natura 2000 system.

While some Interviewees advocated for maintaining stable MPA boundaries to maximise conservation impact, others underscored the necessity of adapting MPA networks to facilitate ORE developments and address the increasing impacts of climate change on the environment [110,112]. Although it is not expected to be progressed in many locations across Ireland, co-location of ORE and MPAs will be possible, and no limitations will be put in place [112]. For example, one of the proposed offshore wind farms as part of Ireland ORESS phase 1 projects overlaps with a newly announced SPA in the Irish Sea.

Moreover, the lack of environmental data to support policy decisions was highlighted as a key bottleneck [79,124,125], calling to enable local councils to continuously collect and update environmental data, and make them readily available for any potential ORE planning application.

6. Discussion

6.1. Ireland as a representative case study within the wider EU context

The results of the Irish case study investigating the drivers and persisting barriers to tidal (and ORE) energy development following the recent policy changes show that Ireland constitutes a representative example when it comes to the uncertain future surrounding such projects both in the EU and internationally. In various aspects, it exhibits typical challenges encountered in a range of other country-cases. Reviewed literature in countries such as Sweden, Scotland, the UK, South Korea, China and Canada revealed barriers linked to the technology's high costs and readiness levels, limited financial support, environmental concerns, constrained routes to market, supply chain issues and policy uncertainty and instability, most of which were also mentioned during our interviews.

In Ireland, interviewees expressed optimism regarding the latest improvements in policy and regulatory landscapes and highlighted the need for qualified institutional resources to implement the ambitious targets set and meet its climate goals by 2030 [10]. While the appointment of MARA is expected to play that role [79], they also emphasised the need for more adaptive policies and financial support, faster planning regimes, continued R&D and data acquisition, and stakeholder collaboration to effectively balance marine conservation with sustainable energy development in coastal waters [110].

The series of highlighted challenges in this paper could be summarized with the need for more clarity at all levels of ORE development in future years, particularly when it comes to pathways for future DMAPs [123]. When compared to the 2011 findings of O'Hagan and Lewis [42], we can also find many similarities and persisting challenges even more than a decade later, in particular the ones related to the lengthy and complex planning and permitting processes [118].

By the end of 2024, Ireland's share of renewable electricity has reached a record high of 41.3% [133], almost half of which (around 42%) came of wind energy supply. Yet, these numbers remain significantly below the 2030 target of 80% renewable electricity, and well below the overall RE share from all sources. Moreover, there is a public impression that onshore wind deployment is reaching a saturation point [79], due to the several community objections that have been raised and filed over the past years across the country [134–136].

In recent years, ORE has emerged as an alternative to onshore projects, knowing its ability to minimize community objections by moving further offshore, and this was supported by policy actions at the EU level to industrialize tidal energy. The European Commission has published its ORE strategy in 2023 [137], updating the 2020 numbers [138], with dedicated targets for 2030, 2040 and 2050. This included around 100 MW of ocean energy (wave and tidal) to be deployed by 2027, as well as 1 GW by the end of the decade or early 2030s [137]. Moreover, the RE Directive of 2023 [120] has set a 5% innovation target for new technologies, including tidal and wave.

Thus, ocean energy can contribute to achieving the EU's political priorities, strengthening energy security and unlocking net-zero opportunities. Some countries have already embarked in benefitting from that momentum and issuing the necessary incentives and strategies faster than others. Over the next five years, tidal energy project expansions will be concentrated in leading markets such as France and the UK, and to lesser extent Denmark, Netherlands, in addition to Canada and the US (outside of Europe). Around 32 MW have been deployed since 2010 across Europe (with around 13 MW still operational), and around 152 MW are planned to benefit from revenue support schemes [1,122,139]. Nevertheless, the technology still needs further public support and grant funding to reach commercial competitiveness, improve industrial capacity and reinforce market confidence [1], all of which will constitute the main issues to be addressed in the coming years. Comparing tidal energy to offshore wind makes it expensive in current markets conditions, but comparing it to other emerging technologies such as battery storage or Hydrogen allows tidal energy to become more cost-effective [113]. Filling the current knowledge gaps and increasing social and environmental acceptance will play a crucial role and ensure its sustainable development.

In France, the 2026 French Energy Strategy [140] included a breakthrough announcement to trigger the sector through commercial tenders for around 250 MW of tidal energy projects expected to be delivered by 2030 [22]. This complements a government financing scheme of €65 million grant plus FiT to support its first commercial tidal farm [1]. As for the UK, it currently plays a leading role globally in tidal energy deployment around the world, as a result of the continuous governmental Contracts for Difference allocations, which have reached seven rounds since 2016 totalling around 140 MW of awarded projects expected to come online between 2026 and 2030 [20,141,142]. Since 2022, tidal stream projects in the UK have been benefitting from a minimum budget specifically allocated for such technologies, along with wave and floating offshore wind. This was supported by specific policy targets, strong domestic supply chain and heavy investments in technological innovation [20]. The UK Marine Energy Council has put a 1 GW target for tidal stream and wave technologies by 2035, and 6 GW by 2050 [3,143,144], which could create jobs and contribute to green growth. Yet, projects still face lengthy consenting processes irrespective of project size, grid constraints and a high price differential between tidal stream and other technologies [3].

Being a smaller country, Ireland is well positioned to learn from the abovementioned experiences and lead as an example for other island nations to enhance tidal and ORE potential in the future and unlock existing opportunities. The technology could also serve as a potential independent energy source for island and coastal remote communities providing reliable and clean energy. A case in point is the example of the village of Igiugig in Alaska [65,66], which was able to reduce the reliance on diesel and the associated environmental risks and noise through tidal energy devices.

6.2. Dynamic nature of ORE policymaking

Despite the challenges raised, interviews collectively underscored the dynamic and interconnected nature of ORE policies, as it involves a wide range of stakeholders, and its management practices aim at fostering innovation while safeguarding marine ecosystems and pioneering environmental sustainability. With Ireland being a LION, and while most of its population lives around the coastline, every policy is somehow a marine policy even if not clearly stated [118]. This reflects the importance of having a central marine decision-making entity for all activities within the marine environment, rather than scattered processes within departments and institutions.

In fact, the continuous adjustments of ORE strategies are creating further ambiguity and uncertainties and are delaying projects' development, irrespective on the technology used [79,118,132]. It is also making the whole process volatile, unstable and unsatisfactory for everyone involved [125]. This has led government departments to recently move away from the target of 5 GW by 2030, and start using the 20 GW by 2040 target instead in official communications [145].

Since its adoption in 2021, the NMPF reflected a clear political decision to manage and govern the entirety of Ireland's maritime area. Nevertheless, it has been criticised for only providing a framework document for marine planning, without being a marine spatial plan and allocating where the several activities will take place [58]. Thus, it lacks the spatial dimension where all activities can coexist with clear directions, objectives and priorities [118,125], all of which will be determined by future DMAPs. The Government has initiated this process with the decision to develop a national ORE DMAP [80–82], but the latter is not expected to bring clarity before the end of 2027 or early 2028 (Fig. 2).

In addition, the NMPF and the Future Framework documents lack a specific timeline for implementing several of the set objectives, thus leaving the door open for further planning and bureaucratic delays. Contrarily to Ireland's Climate Action Plans [7–9] which provide detailed actions and timelines along with allocated responsibilities, the NMPF and the Future Framework do not follow the same approach.

Another related issue is linked to MSP [118,123]. Being a process for managing and allocating shared marine spaces for the different human activities, MSP gives the impression of being a siloed technical zoning process. To the contrary, along with the latter facet, MSP presents the case of a political and social process in which stakeholders negotiate and aim to agree on sharing marine spaces [146–150], to achieve economic, social and ecological objectives [150]. Yet, this approach usually faces several management challenges [151], and requires an effective and sustainable approach to consider social and ecological aspects. An ecosystem-based MSP offers a comprehensive framework that is not limited to a sector-by-sector management [152], and where spatial distribution is sought to be maintained.

Thus, the important role of community engagement in such processes in order to understand their concerns, as communities will require reassurances of what future ORE projects will mean to them [118]. This engagement process in MSP is not a one-time exercise [150], but rather a continuous and complex process, as any future project in the maritime area will need to engage with stakeholders in surrounding communities as part of the planning process. Communities will need to be empowered to take ownership of such projects, and developers must bake in local skills as part of their development approach, all of which will allow increasing their level of acceptance [109,111].

6.3. Future pathways

This paper has highlighted the critical role of informed policymaking and clear political direction when it comes to ORE planning in Ireland.

The latest policy changes since the approval of the MAP Act and the NMPF in 2021, in addition to the appointment of MARA in 2023, are all important steps in the right direction. Yet, according to the interviews carried out, the process still holds uncertain and unpredictable pathways for its implementation.

The Programme for Government of January 2025 has realized that gap and has pledged to provide more clarity around these issues, including the appointment of a dedicated junior marine minister. This was established by the appointment of a Minister of State for both DAFM with special responsibility for fisheries, and DECC with special responsibility for the marine [153,154]. It also initiated the nationwide DMAP process. Moving forward, an enormous level of effort and coordination between departments, sectors and stakeholders will be needed in the future, bringing them together towards a unified vision to reach ORE targets. Incentive policies and tidal-specific funding schemes will be crucial to industrialize tidal energy technologies in the coming years, particularly for smaller-scale, pilot community projects across the island.

As for the planning system, developers' and investors’ complaints converge around the high costs bared prior to putting devices in waters, pushing some to reconsider their investment decisions [125]. With the formation and operationalization of MARA, it is expected that the lead-in times for MACs and MULs will shorten, allowing more flexibility and clarity, and faster routes to market. To that end, MARA and other departments and institutional bodies will need to be strengthened with the needed qualified resources to efficiently complete the required tasks.

On the other hand, a well-promoted R&D regime will be needed to accompany the technological advances at all levels of ORE developments [116]. This include supporting national entities such as SEAI and the Marine Institute with the needed funding and resources to push ORE research to the next level, which will help in reducing costs, increasing competitiveness and validating turbines' designs. In this regard, questions were raised during the interviews around Ireland's testing facilities in terms of their future role and the challenges they currently face. For example, Galway Bay test site was closed in 2022 due to several community objections, while there are ongoing discussions regarding the Atlantic Marine Energy Test Site's (AMETS, in Co. Mayo) role and market requirements [111,116,129]. This is complemented by the need to upgrade existing ports and infrastructure facilities across the country to accommodate for the scale of ORE industry, reinforce forthcoming industrial capacity, and complement the DMAP plans within the marine space.

On the environmental side, and contrary to the misconception that RE projects do not have environmental effects, interviewees mentioned that there will always be both positive and negative impacts in the case of MRE technologies [118,125]. Yet negative impacts become less profound when compared to the potential massive climate change impacts when no actions are taken. Ireland has transposed EU's Habitats (92/43/EEC) and Birds (2007/147/EC) Directives and has designed its SACs and SPAs, but concerns were raised that the latter are not yet fully managed or informed [112,125], and thus do not deliver the biodiversity benefits they were created for. Knowing the location- and technology-specific aspect of ORE technologies, there is a need to design specific conservation management measures, and to conduct continuous EIAs before, during and after implementation. Moreover, a formalized monitoring system should be put in place to monitor the effects of ORE projects in an appropriate granular manner and inform future consenting and decision-making.

6.4. Study limitations

This study included a moderate number of interviewees (20), which yet reflected the landscape of stakeholders involved in ORE development in Ireland. This is the result of Ireland being a small state, with a relatively narrow tidal energy (and ORE) market. This number could be higher in other countries and contexts where the development and implementation of such technologies has moved much faster.

Although many challenges identified in the Irish case were common in other EU and international contexts, the analysis remains limited to this case study and cannot be generalized without understanding the country context, as the policy framework may differ is some relevant ways and aspects, being a continuously evolving and dynamic process.

7. Conclusion

Ireland stands today at a crossroads when it comes to implementing its ambitious ORE targets for 2030 and beyond. The results of our analysis have identified a set of drivers and persisting barriers for tidal (and ORE) energy development following the recent policy changes, and have shown that some of those challenges are typical in a wider group of country-cases. The pace and policy pathways at which each country tackles those barriers and moves towards the commercialization of such technologies are yet different.

Our interviews have shown appreciation for the latest regulatory developments in Ireland since the adoption of the MAP Act and the formation and operationalization of MARA. Nevertheless, they highlighted the need to tackle several pressing issues. These include providing clarity for ORE future pathways, dealing with lengthy and bureaucratic planning processes, creating faster pathways for projects implementation, and addressing the skills shortage in departments and institutions.

On one hand, there is an opportunity for Ireland to learn from the experience of leading countries within the EU (including France and the UK) or across the Atlantic (the US and Canada), and scale-up projects’ implementation. On the other, it could constitute an example, in particular for other island nations, in terms of ORE policy trajectory, knowing its dynamic and continuously evolving nature. The study has also highlighted the importance of clear political direction that removes uncertainties and volatilities. It called for a more structured approach to enable ORE scalability through a whole-of-a-system approach, lowering its LCOE, improving R&D, and reducing environmental impacts.

Author contribution

Marc Ayoub: Conceptualization, Methodology, Formal analysis, Visualization, Writing - Original Draft **Gesche Kindermann:** Conceptualization, Writing - Review & Editing, Supervision **Marie-Christin Lanser:** Writing- Reviewing and Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

References

[1] E.T.I.P. Ocean, Strategic Research and Innovation Agenda for Ocean Energy, 2024.

[2] IEA TCP, Tidal Current Energy Developments Highlights, 2023.
[3] EMEC, Alternative Offtake Routes for Tidal Stream Energy, 2024.
[4] T.R. Munaweera Thanthirige, J. Goggins, M. Flanagan, W. Finnegan, A state-of-the-art review of structural testing of tidal turbine blades, Energies 16 (10) (2023) 4061.
[5] T.R. Munaweera Thanthirige, M. Flanagan, C. Kennedy, Y. Jiang, M. O'Conghaile, C. Courade, P. Cronin, C. Dillon, V. Fakhari, C.Ó. Cadhain, M. Walls, C. Bachour, T. Flanagan, B. Cahill, J. McEntee, J. Goggins, W. Finnegan, Advanced structural testing and modelling of a novel full-scale helical shape tidal turbine foil, Eng. Struct. 330 (2025) 119864, https://doi.org/10.1016/j.engstruct.2025.119864.
[6] Government of Ireland, in: DRAFT Offshore Renewable Energy Development Plan II: a National Spatial Strategy for the Transition to the Enduring Regime, In: C.A.C. Department of the Environment, 2023.
[7] CAP, Climate Action Plan 2021, 2021.
[8] CAP, Climate Action Plan 2023, 2023.
[9] CAP, in: G.o. Ireland (Ed.), Climate Action Plan 2024, 2024.
[10] DECC, Energy Security in Ireland to 2030: Energy Security Package, 2023.
[11] Government of Ireland, in: Draft Offshore Renewable Energy Future Framework Policy Statement, In: C.A.C. Department of the Environment, 2024.
[12] Marine Institute, University of Galway, Ireland's Ocean Economy Update, 2025.
[13] Marine Institute, University of Galway. Ireland's Ocean Economy: Key Facts and Figures, 2024.
[14] Clearlead, Offshore Renewable Energy Development Plan II: Strategic Environmental Assessment - Scoping Report Government of Ireland, 2022.
[15] L. Carr, Marine spatial planning in a climate of uncertainty – an Irish perspective, Ir. Geogr. 52 (1) (2019) 1–20, https://doi.org/10.55650/igj.2019.1375.
[16] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual. Res. Psychol. 3 (2) (2006) 77–101, https://doi.org/10.1191/1478088706qp063oa.
[17] A. Boretti, S. Castelletto, Advancements and challenges in tidal stream and oceanic current turbines: an overview of current technologies and future prospects, Mar. Dev. 3 (1) (2025) 10, https://doi.org/10.1007/s44312-025-00054-5.
[18] European Commission, Study on Lessons for Ocean Energy Development – Final Report, Publications Office, Directorate-General for Research Innovation ECORYS Fraunhofer, 2017.
[19] A.S. Bahaj, Generating electricity from the oceans, Renew. Sustain. Energy Rev. 15 (7) (2011) 3399–3416, https://doi.org/10.1016/j.rser.2011.04.032.
[20] E. Serin, P. Andres, R. Martin, A. Shah, A. Valero, Seizing Sustainable Growth Opportunities from Tidal Stream Energy in the UK, 2023.
[21] D. Coles, A. Angeloudis, D. Greaves, G. Hastie, M. Lewis, L. Mackie, J. McNaughton, J. Miles, S. Neill, M. Piggott, D. Risch, B. Scott, C. Sparling, T. Stallard, P. Thies, S. Walker, D. White, R. Willden, B. Williamson, A review of the UK and British channel islands practical tidal stream energy resource, Proc. R. Soc. A 477 (2255) (2021), https://doi.org/10.1098/rspa.2021.0469.
[22] Ocean Energy Europe, French Government to Industrialise Tidal Energy with 250 MW Tender, 2026.
[23] D. Magagna, A. Uihlein, Ocean energy development in Europe: current status and future perspectives, Int. J. Mar.Energy 11 (2015) 84–104, https://doi.org/10.1016/j.ijome.2015.05.001.
[24] J. Andersson, E. Perez Vico, L. Hammar, B.A. Sandén, The critical role of informed political direction for advancing technology: the case of Swedish marine energy, Energy Policy 101 (2017) 52–64, https://doi.org/10.1016/j.enpol.2016.11.032.
[25] G. Wright, Regulating wave and tidal energy: an industry perspective on the Scottish marine governance framework, Mar. Pol. 65 (2016) 115–126, https://doi.org/10.1016/j.marpol.2015.12.014.
[26] S. Leete, J. Xu, D. Wheeler, Investment barriers and incentives for marine renewable energy in the UK: an analysis of investor preferences, Energy Policy 60 (2013) 866–875, https://doi.org/10.1016/j.enpol.2013.05.011.
[27] S. Waldman, S. Weir, R.B. O'Hara Murray, D.K. Woolf, S. Kerr, Future policy implications of tidal energy array interactions, Mar. Pol. 108 (2019) 103611, https://doi.org/10.1016/j.marpol.2019.103611.
[28] A. Vazquez, S. Astariz, G. Iglesias, A method for the spatial targeting of tidal stream energy policies, Int. Mar.Energy.j 1 (2018) 19–26, https://doi.org/10.36688/imej.1.19-26, 1 (Aug).
[29] K. Dong-Hui, J. Chung, K.-S. Lee, P. Jin-Soon, Y. Jin-Hak, Current policy and technology for tidal current energy in Korea, Energies 12 (9) (2019) 1807, https://doi.org/10.3390/en12091807.
[30] H.-w. Liu, S. Ma, W. Li, H.-g. Gu, Y.-g. Lin, X.-j. Sun, A review on the development of tidal current energy in China, Renew. Sustain. Energy Rev. 15 (2) (2011) 1141–1146, https://doi.org/10.1016/j.rser.2010.11.042.
[31] J.T. Carlson, M. Adams, Assessing the consistency of in-stream tidal energy development policy in Nova Scotia, Canada, Mar. Pol. 113 (2020) 103743, https://doi.org/10.1016/j.marpol.2019.103743.
[32] S. Nash, N. O'Brien, A. Olbert, M. Hartnett, Modelling the far field hydro-environmental impacts of tidal farms – a focus on tidal regime, inter-tidal zones and flushing, Comput. Geosci. 71 (2014) 20–27, https://doi.org/10.1016/j.cageo.2014.02.001.
[33] D. Fallon, M. Hartnett, A. Olbert, S. Nash, The effects of array configuration on the hydro-environmental impacts of tidal turbines, Renew. Energy 64 (2014) 10–25, https://doi.org/10.1016/j.renene.2013.10.035.
[34] A. Phoenix, S. Nash, Optimisation of tidal turbine array layouts whilst limiting their hydro-environmental impact, Journal of Ocean Engineering and J. Ocean Eng.Mar.Energy 5 (3) (2019) 251–266, https://doi.org/10.1007/s40722-019-00145-8.
[35] K. Reilly, A.M. O'Hagan, G. Dalton, Attitudes and perceptions of fishermen on the island of Ireland towards the development of marine renewable energy projects, Mar. Pol. 58 (2015) 88–97, https://doi.org/10.1016/j.marpol.2015.04.001.
[36] P. Devine-Wright, Enhancing local distinctiveness fosters public acceptance of tidal energy: a UK case study, Energy Policy 39 (1) (2011) 83–93, https://doi.org/10.1016/j.enpol.2010.09.012.
[37] P. Devine-Wright, Place attachment and public acceptance of renewable energy: a tidal energy case study, J. Environ. Psychol. 31 (4) (2011) 336–343, https://doi.org/10.1016/j.jenvp.2011.07.001.
[38] J.R. Haslett, M. Garcia-Llorente, P.A. Harrison, S. Li, P.M. Berry, Offshore renewable energy and nature conservation: the case of marine tidal turbines in northern Ireland, Biodivers. Conserv. 27 (7) (2018) 1619–1638, https://doi.org/10.1007/s10531-016-1268-6.
[39] E. McKinley, L. McElduff, H. Ritchie, Putting people at the centre of marine governance across the UK and Ireland: 20 years of society and the sea, Ocean Coast Manag. 255 (2024) 107235, https://doi.org/10.1016/j.ocecoaman.2024.107235.
[40] P. Quero García, J. García Sanabria, J.A. Chica Ruiz, The role of maritime spatial planning on the advance of blue energy in the european union, Mar. Pol. 99 (2019) 123–131, https://doi.org/10.1016/j.marpol.2018.10.015.
[41] M. Lange, A.M. O'Hagan, R.R.N. Devoy, M. Le Tissier, V. Cummins, Governance barriers to sustainable energy transitions – assessing Ireland's capacity towards marine energy futures, Energy Policy 113 (2018) 623–632, https://doi.org/10.1016/j.enpol.2017.11.020.
[42] A.M. O'Hagan, A.W. Lewis, The existing law and policy framework for ocean energy development in Ireland, Mar. Pol. 35 (6) (2011) 772–783, https://doi.org/10.1016/j.marpol.2011.01.004.
[43] Government of Ireland, Ministers O'Brien and Dooley Drive Forward Legislation to Safeguard Irish Seas and Streamline Maritime Planning, 2025.
[44] SEAI, Ocean Energy Technologies, 2005.
[45] F.O. Rourke, F. Boyle, A. Reynolds, Marine current energy devices: current status and possible future applications in Ireland, Renew. Sustain. Energy Rev. 14 (3) (2010) 1026–1036, https://doi.org/10.1016/j.rser.2009.11.012.
[46] D.M. Fouz, R. Carballo, I. López, G. Iglesias, A holistic methodology for hydrokinetic energy site selection, Appl. Energy 317 (2022) 119155, https://doi.org/10.1016/j.apenergy.2022.119155.
[47] D.M. Fouz, R. Carballo, I. López, G. Iglesias, Tidal stream energy potential in the shannon Estuary, Renew. Energy 185 (2022) 61–74, https://doi.org/10.1016/j.renene.2021.12.055.
[48] D.M. Fouz, R. Carballo, I. López, X.P. González, G. Iglesias, A methodology for cost-effective analysis of hydrokinetic energy projects, Energy 282 (2023) 128373, https://doi.org/10.1016/j.energy.2023.128373.
[49] F. O'Rourke, F. Boyle, A. Reynolds, Tidal current energy resource assessment in Ireland: current status and future update, Renew. Sustain. Energy Rev. 14 (9) (2010) 3206–3212, https://doi.org/10.1016/j.rser.2010.07.039.
[50] A.G. Bryans, B. Fox, P.A. Crossley, M.O. Malley, Impact of tidal generation on power system operation in Ireland, IEEE Trans. Power Syst. 20 (4) (2005) 2034–2040, https://doi.org/10.1109/TPWRS.2005.857282.
[51] M. Coughlan, M. Long, P. Doherty, Geological and geotechnical constraints in the Irish sea for offshore renewable energy, J. Maps 16 (2) (2020) 420–431, https://doi.org/10.1080/17445647.2020.1758811.
[52] N. Isaksson, E.A. Masden, B.J. Williamson, M.M. Costagliola-Ray, J. Slingsby, J.D. R. Houghton, J. Wilson, Assessing the effects of tidal stream marine renewable energy on seabirds: a conceptual framework, Mar. Pollut. Bull. 157 (2020) 111314, https://doi.org/10.1016/j.marpolbul.2020.111314.
[53] B. McAteer, W. Flannery, "How can you quality assure a citizen?" expert rationalities, self-governance, and power in marine community science in the UK and Ireland, Maritime Studies 24 (2) (2025) 23, https://doi.org/10.1007/s40152-025-00418-z.
[54] T. Simas, A.M. O'Hagan, J. O'Callaghan, S. Hamawi, D. Magagna, I. Bailey, D. Greaves, J.-B. Saulnier, D. Marina, J. Bald, C. Huertas, J. Sundberg, Review of consenting processes for ocean energy in selected european union member states, Int. J. Mar.Energy 9 (2015) 41–59, https://doi.org/10.1016/j.ijome.2014.12.001.
[55] M.D.C. Troya, J.O. Ansong, A.M. O'Hagan, Transitioning from blue growth to the sustainable blue economy: a review of Ireland's new marine governance in the aquaculture sector, Front. Mar. Sci. 10 (2023), https://doi.org/10.3389/fmars.2023.1075803, 2023.
[56] W. Flannery, E. Nixon, M.Ó. CinnÉIde, Preparing the ground for marine spatial planning in Ireland, Int. J. Sustain. Dev. Plann. 5 (1) (2010) 57–67, https://doi.org/10.2495/SDP-V5-N1-57-67.
[57] W. Flannery, Marine Spatial Planning from an Irish Perspective: towards Best Practice in Integrated Maritime Governance, University of Galway, Research Repository, 2011.
[58] C. Walsh, An Evaluation of Ireland's Marine Spatial Plan – the National Marine Planning Framework SWAN, 2022.
[59] V. Ramos, G. Giannini, T. Calheiros-Cabral, P. Rosa-Santos, F. Taveira-Pinto, Legal framework of marine renewable energy: a review for the Atlantic region of Europe, Renew. Sustain. Energy Rev. 137 (2021) 110608, https://doi.org/10.1016/j.rser.2020.110608.
[60] J.O. Ansong, R. Heather, L. McElduff, Institutional barriers to integrated marine spatial planning on the island of Ireland, Mar. Pol. 141 (2022) 105082, https://doi.org/10.1016/j.marpol.2022.105082.
[61] W. Flannery, A.M. O'Hagan, C. O'Mahony, H. Ritchie, S. Twomey, Evaluating conditions for transboundary marine spatial planning: challenges and

opportunities on the island of Ireland, Mar. Pol. 51 (2015) 86–95, https://doi.org/10.1016/j.marpol.2014.07.021.
[62] NPWS, River Shannon & River Fergus Estuaries Special Protection Area: Conservation Objectives Supporting Document, 2012.
[63] Marine Institute, Tidal Flows Around Ireland, n.d.
[64] Marine Institute, Tidal Predictions, n.d.
[65] ORPC, RivGen® Power System & Integrated Microgrid Solutions, n.d.
[66] K. Hill, A. Salmon, A RESILIENT AND AUTONOMOUS MICROGRID POWERED BY MARINE RENEWABLE ENERGY, Igiugig Village Council, 2024.
[67] Government of Ireland, Harnessing our Ocean Wealth: an Integrated Marine Plan for Ireland, 2012.
[68] IEA, White Paper, Delivering a Sustainable Energy Future for Ireland, Government of Ireland, 2012.
[69] DCENR, Offshore renewable energy development plan: a framework for the sustainable development of ireland's offshore renewable energy resource, in: E.A. N.R. Department of Communications, 2014.
[70] AECOM, Offshore Renewable Energy Development Plan (OREDP) for Ireland: Natura Impact Statement (NIS), DCENR, 2011.
[71] AECOM, Offshore Renewable Energy Development Plan (OREDP), Strategic Environmental Assessment - SEA Statement, 2010.
[72] Government of Ireland, Offshore Renewable Energy Development Plan (OREDP) Interim Review, RPS and Remtec Consulting, 2018.
[73] Oireachtas, Maritime Area Planning Bill 2021, Bill Digest, 2021.
[74] Maritime area planning act 2021. https://www.irishstatutebook.ie/eli/2021/act/50/enacted/en/html, 2021.
[75] Marine Institute, Ocean Knowledge 2030: Ireland's Strategy for Marine Research, Knowledge & Innovation, 2025-2030 (DRAFT), 2024.
[76] Government of Ireland, National Marine Planning Framework, 2018.
[77] DHLGH, National Marine Planning Framework, Project Ireland 2040, in: L.G.A.H. Department of Housing, 2021.
[78] Government of Ireland, The South Coast Designated Maritime Area Plan for Offshore Renewable Energy (SC-DMAP), 2024.
[79] State Agency 3, Environmental Officer at a County Council, 2023.
[80] Government of Ireland, Work to Begin on a National Offshore Renewable Energy Designated Maritime Area Plan, 2025.
[81] Government of Ireland, National Designated Maritime Area Plan (DMAP) for Offshore Renewable Energy - the Proposal, DECC, 2025.
[82] Government of Ireland, Public Participation Statement for the National Designated Maritime Area Plan for Offshore Renewable Energy, 2025.
[83] DECC, Project Marine Newsletters - Newsletter 7, DECC, 2024.
[84] Government of Ireland, Project Marine Newsletters, 2025.
[85] Government of Ireland, Offshore Renewable Energy Development Plan II (OREDP II), 2023.
[86] Government of Ireland, The Second Offshore Renewable Energy Development Plan (OREDP II): Public Consultation, 2023.
[87] Clearlead, Offshore Renewable Energy Development Plan II, Non-Technical Summary of the Strategic Environmental Assessment, 2023.
[88] Marine Institute, Ireland's Marine Atlas, Marine Institute, n.d.
[89] DHLGH, in: Marine Planning Policy Statement, In: C.A.C. Department of the Environment, 2024.
[90] Government of Ireland, Offshore Renewable Electricity Support Scheme (ORESS), 2023.
[91] Eirgrid, Renewable Electricity Support Scheme: ORESS 1 Final Auction Results, 2023.
[92] Government of Ireland, ORESS 2.1 Indicative Roadmap, 2024.
[93] NPWS, Special Areas of Conservation (SAC), n.d.
[94] NPWS, Special Protection Areas (SPA), n.d.
[95] NPWS, Natura 2000, n.d.
[96] SEA directive, directive 2001/42/EC. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0042, 2001.
[97] EIA Directive, Directive 2014/52/EU amending directive 2011/92/EU. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052, 2014.
[98] Fair Seas, S.P.A. Sac, MPA… so what Do They all Mean?, 2022.
[99] Government of Ireland, Public Consultation Demonstrates Strong Support for Expansion of Marine Protected Areas, 2022.
[100] Fair Seas, Ten Key Asks of Ireland's MPA Bill, 2023.
[101] Fair Seas, MPA legislation: what's happening? Fairseas, Fairseas Newsletter - August 2025 (2025). https://mailchi.mp/ien/irelands-ocean-movement-august-18094065?e=490c0ad710.
[102] H. Ting, M. Memon, T. Ramayah, J.-H. Cheah, Snowball sampling: a review and guidelines for survey research, Asian J. Bus. Res. 15 (2025) 1–15, https://doi.org/10.14707/ajbr.250186.
[103] G. Stevens, Braun and Clarke: an Approach to Thematic Analysis, n.d.
[104] A. Vossler, N. Moller, V. Braun, V. Clarke, How to Use Thematic Analysis with Interview Data, 2015.
[105] V. Clarke, V. Braun, Thematic analysis, J. Posit. Psychol. 12 (3) (2017) 297–298, https://doi.org/10.1080/17439760.2016.1262613.
[106] V. Braun, V. Clarke, Reflecting on reflexive thematic analysis, Qualitative Research in Sport, Exercise and Qual. Res. Sport Exerc.Health 11 (4) (2019) 589–597, https://doi.org/10.1080/2159676X.2019.1628806.
[107] V. Braun, V. Clarke, Thematic Analysis : a Practical Guide, SAGE Publications Ltd, London, 2021.
[108] D. Byrne, A worked example of braun and Clarke's approach to reflexive thematic analysis, Qual. Quantity 56 (3) (2022) 1391–1412, https://doi.org/10.1007/s11135-021-01182-y.
[109] Technology Developer/Manufacturer 1, Director of Development at an International Tidal Energy Developer, 2024.
[110] Government Department 1, Public Servant at a Governmental Department, 2023.
[111] State Agency 1, Policy Officer at a National Institute, 2023.
[112] Environmental Conservation 1, Policy Officer at NGO, 2023.
[113] Industry Association 2, Policy Director at a UK-based Industry Association, 2023.
[114] Technology Developer/Manufacturer 2, Senior Research Engineer at a Tidal Technology Supplier, 2025.
[115] Technology Developer/Manufacturer 4, CEO at a Composites Design Company, 2025.
[116] Industry Association 3, Chairman at an Industry Association, 2025.
[117] Industry Association 1, Senior Policy Officer at a European Trade Association, 2023.
[118] Technology Developer/Manufacturer 3, Development Manager at the Renewable Energy Developer, 2025.
[119] Government of Ireland, Ireland's Industry 4.0 Strategy 2020-2025, 2019.
[120] Renewable Energy Directive, 2023/2413, 2023.
[121] REnews, EU Countries 'Lag on Permitting Reforms, 2025.
[122] Ocean Energy Europe, Ocean Energy Stats & Trends, 2025, 2024.
[123] State Agency 4, Head of Policy at a National Regulator, 2025.
[124] Environmental Conservation 2, Marine Biologist at a National Agency, 2023.
[125] Environmental Conservation 3, Marine Biodiversity Officer at an Environmental Group, 2025.
[126] Government Department 2, in: Marine Biologist/Advisor at a Government Department, 2023.
[127] State Agency 2, Program Manager at a National Authority, 2023.
[128] MARA, Statement of Strategy 2024-2027, 2024.
[129] Marine Institute, Looking Forward: the Future for Open Water Testing, MRIA Forum, MRIA, Dublin, 2025.
[130] State Agency 6, Representative of sea-fisheries and Seafood Sector Regulator, 2025.
[131] State Agency 5, Representative of a Seafood Industry Organization, 2025.
[132] Community Engagement Expert 1, Community Engagement Expert with a Focus on Renewable Energy Projects, 2025.
[133] SEAI, Energy in Ireland Report 2025, 2025.
[134] The Irish Times, Complaint Sent to Regulator over an Bord Pleanála's Scrutiny of Wind Farm Cases, 2025.
[135] J. Wilson, 12 New Wind Farm Proposals Have Been Rejected by an Bord Pleanála, News Talk, 2025.
[136] Stephen Robb, Why Are Irish Wind Farms Struggling to Secure Planning, Irish Farmers Journal, 2024.
[137] European Commission, Delivering on the EU Offshore Renewable Energy Ambitions 52023DC0668, 2023.
[138] European Commission, Offshore Renewable Energy Strategy, 2020.
[139] Ocean Energy Europe, Ocean Energy Stats & Trends, 2024, 2023.
[140] Government of France, Programmation Pluriannuelle De L'Énergie (PPE), 2026.
[141] Supergen, ORE Outlook 2040 - UK Offshore Renewable Energy in 2040: Building a Sustainable and Competitive ORE Sector on a Pathway to Net Zero by 2050, 2024.
[142] UK Government, Contracts for Difference Allocation Round 7a Results, 2026.
[143] O.R.E. Catapult, Quantifying the Benefits of Tidal Stream Energy to the Wider UK Energy System, 2022.
[144] UK Parliament, Written Evidence Submitted by UK Marine Energy Council, 2022.
[145] DECC, National Designated Maritime Area for ORE, 15th Annual Marine Economics and Policy Research Symposium - November 2025, 2025.
[146] W. Flannery, J. Clarke, B. McAteer, Politics and power in marine spatial planning, in: J. Zaucha, K. Gee (Eds.), Maritime Spatial Planning: past, Present, Future, Springer International Publishing, Cham, 2019, pp. 201–217.
[147] W. Qiu, P.J.S. Jones, The emerging policy landscape for marine spatial planning in Europe, Mar. Pol. 39 (2013) 182–190, https://doi.org/10.1016/j.marpol.2012.10.010.
[148] M. Cote, A.J. Nightingale, Resilience thinking meets social theory:situating social change in socio-ecological systems (SES) research, Prog. Hum. Geogr. 36 (4) (2012) 475–489, https://doi.org/10.1177/0309132511425708.
[149] Z.W. Brent, M. Barbesgaard, C. Pedersen, The blue fix: what's driving blue growth? Sustain. Sci. 15 (1) (2020) 31–43, https://doi.org/10.1007/s11625-019-00777-7.
[150] C. Ehler, J. Zaucha, K. Gee, Maritime/marine spatial planning at the interface of research and practice, in: J. Zaucha, K. Gee (Eds.), Maritime Spatial Planning: past, Present, Future, Springer International Publishing, Cham, 2019, pp. 1–21.
[151] T. O'Higgins, L. O'Higgins, A.M. O'Hagan, J.O. Ansong, Challenges and opportunities for ecosystem-based management and marine spatial planning in the Irish sea, in: J. Zaucha, K. Gee (Eds.), Maritime Spatial Planning: past, Present, Future, Springer International Publishing, Cham, 2019, pp. 47–69.
[152] M.M. Foley, B.S. Halpern, F. Micheli, M.H. Armsby, M.R. Caldwell, C.M. Crain, E. Prahler, N. Rohr, D. Sivas, M.W. Beck, M.H. Carr, L.B. Crowder, J. Emmett Duffy, S.D. Hacker, K.L. McLeod, S.R. Palumbi, C.H. Peterson, H.M. Regan, M. H. Ruckelshaus, P.A. Sandifer, R.S. Steneck, Guiding ecological principles for marine spatial planning, Mar. Pol. 34 (5) (2010) 955–966, https://doi.org/10.1016/j.marpol.2010.02.001.
[153] government of Ireland, Timmy Dooley, 2025.
[154] Afloat, Timmy Dooley Appointed Minister of State for Marine, 2025.