X-shaped Radical Offshore Wind Turbine for Overall Cost of Energy Reduction

D7.2

Year 1 Report on workshops design recommendations

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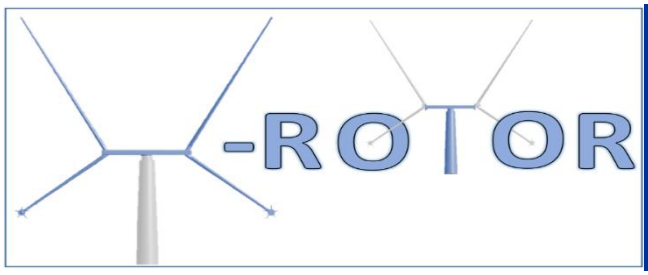
December 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007135



X-SHAPED RADICAL OFFSHORE WIND TURBINE FOR OVERALL COST OF ENERGY REDUCTION

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WP7 Environmental and Socio-Economic Impact
T7.1 – Complete Social Analysis
D7.2 Year 1 Report on Workshops Design Recommendations

Lead Beneficiary: University College Cork
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Executive Summary

Deliverable Description:

This deliverable details the workshop methodology used as part of the X-ROTOR project. It provides a summary of the feedback received from both Group 1 and Group 2, as well as recommendations for the development of the XROTOR concept.

Responsible:

University College Cork

Outcome Summary:

The pandemic has encouraged (or perhaps forced) everyone to become more familiar with online engagement methods, this has proven to be an advantage not only this year but also will benefit workshops in years 2 and 3. The principal finding of this year's workshops is that there are very different emphases from Group 1 (the host communities) and Group 2 (the wind energy community) regarding the features of a wind turbine which are considered important. Group 2 focuses on the energy output while Group 1 focuses on the local and environmental impact while supporting the idea of offshore energy.

List of acronyms and abbreviations

AHP	Analytic Hierarchy Process
ASD	Asynchronous Structured Dialogue
IET	Islay Energy Trust
LCOE	Levelised Cost of Energy
UCC	University College Cork
WP	Work Package

Contents

1 Introduction

This report outlines the approach taken and the methodology adopted for the stakeholder workshops and related engagements. The plan for the first year of engagement with both Group 1[1] and Group 2[2], (as described in D7.1), was to build relationships, gather the stakeholders' initial ideas and concerns, and explore how these may be incorporated into the X-ROTOR design. Due to many complex factors, principally the difficulties caused by the COVID-19 pandemic, a soft start to the stakeholder engagement has been employed, which will strengthen the project in the long term through fostering meaningful links and encouraging the development of a genuine relationship between the project officials and the stakeholders.

As detailed in D7.1 (Section 5), the approach adopted was to engage with Group 1 online in year 1, and to arrange for physical visits to Islay in years 2 and 3. This was designed to provide public health safety for islanders and researchers during the present pandemic. This also has the effect of gently introducing the research team to the islanders and to build a trusting relationship to the benefit of the research project.

Group 1 on the Isle of Islay, (Scotland) has been engaged; the plan is to build relationships with the gatekeepers on the island so that in year 2 of the project we may leverage their access to islanders to the benefit of the research project. In particular, useful contacts have been made with the Islay Energy Trust (IET) which has planned to conduct an island-wide survey of energy needs during 2022. By cooperating with IET we will have access to a larger number of community members that we could hope to contact on our own. IET currently has a membership of 10% of the island's population of just over 3,000.

The online response from the satellite Group 1 members has been positive. The approach chosen to carry out the engagement was to carry out asynchronous structured dialogues (ASDs) online, offering participants a high degree of flexibility. The plan as described in D7.1 (Section 5) was to engage with at least two other European countries (other than Scotland) during the course of year 2 of the research project. This has been done already in year 1 by engaging with communities in Ireland and Spain.

Given the recent publicity surrounding COP26, there has been a higher than usual level of media interest in environmental matters, which has been reflected in the responses to date. In this first year the objectives for the satellite community engagement are to explore the communities' interest in,

[1] Group 1 contains people who are from the host community such as: members of coastal communities, fisheries, environmental groups, shipping industry, oil and gas, tourism groups, policy makers, regulators etc.
[2] Group 2 contains people who are from the wider wind energy community such as: developers, academics, consultancies, standards bodies, operators, vessel companies, installation companies, O&M providers, OEMs

and concern about, climate change generally and about offshore wind farms specifically. This investigation will be further developed by examining stakeholders' opinions of the relative importance of three elements of environmental, social and economic sustainability. Through understanding the communities' preference for economic, social and environmental sustainability, we hope to establish a foundation upon which we may observe where the members of Group 1 place their priorities for the design of offshore turbines such as X-ROTOR. It was decided that a fundamental understanding of the communities' views and opinions was necessary before engaging the communities in any detailed design questions. In years 2 and 3 of the project, more detailed questions regarding the actual plans for X-ROTOR will be brought forward. At the current stage in year 1, this move would be too early and may indeed give the false impression that X-ROTOR installation was imminent.

The effect of the pandemic has been particularly abrupt for Group 2 engagement which would be expected to benefit from contacts made at conferences through personal invitations. However, D7.1 had planned for online engagement with Group 2, which is the best available choice given the situation.

Engagement with Group 2 has focused on the factors driving the decisions behind turbine choice. An initial list of factors has been compiled from an internal brainstorming exercise. Again, as with Group 1, the researchers have refrained from asking any detailed design questions at this early stage. Group 2 is the more difficult group to engage. Members tend to be busy people for whom there must be a gain associated with the effort of taking part in activities such as workshops. This was kept in mind when it was decided to realise the initial engagement workshops in the form of online asynchronous structured dialogues (ASDs). In this first year, the participants were invited to offer their opinions on the relative importance of the criteria they would apply to the choice of which wind turbine to use, and in what circumstances. This was kept as brief as possible with a detailed summary being returned so that participants are aware that their help is truly appreciated. In subsequent years, participants may be given some access to elements of the X-ROTOR design so that they are among the first people to be made aware of its operational characteristics. The details of X-ROTOR given to Group 2 will be those details deemed suitable for public dissemination. Having such information made readily available will be a valuable resource for participants and will act as a reward for their involvement with the project. It must be borne in mind that many of the members of Group 2 do not have the same freedom to pursue interesting ideas as is available to those in academia.

A detailed description of the methods used to conduct the ASD engagements and to summarise the feedback from the communities is to be found in Section 2. Summaries of the feedback and results of the workshops are found in Section 0, with some conclusions and suggestions for future research in Section 0.

2 Methodology

2.1 Workshops

Following the methodology of Revez *et al.* (2020) invitations were sent using social media, through contacts from within the research group, and via local gatekeepers for both Group 1 and Group 2. These offered participants the opportunity to take part in the design process and to express their opinions regarding offshore wind energy. Care was taken to explain the consent process and to explain the purpose of the research, including the fact that once results are published the participants can no longer withdraw their consent.

As this is the result of the first year of the engagement it is an opportunity to build a foundation for future engagements, as proposed in the previous deliverable, D7.1, which outlined the recruitment methods for the communities and the manners through which they may be called together to explore their attitudes, interests and requirements for offshore wind turbines. The engagement methods employed this year began online, this was partly as a result of the pandemic and partly as a means to engage stakeholders in a manner that was unobtrusive, flexible and convenient for them.

2.2 Community Perspectives - Engaging Group 1

It was a fortuitous time to ask members of Group 1 in Scotland to comment on their attitudes towards renewable energy because the COP26 meeting has recently taken place in Glasgow. This event helped to raise the profile and level of interest in renewable energy. The principal Group 1 community on Islay, off the west coast of Scotland, has already supported its own renewable energy project in the form of the UK's first wave energy project and has had a great deal of interest in a tidal project between it and the nearby island of Jura. These factors led to the selection of Islay as a community who would be aware of the issues involved in the production of renewable energy, as well as being a possible location for X-ROTOR deployment.

In order to make the best use of the expertise in the community, it was therefore decided to reach out to the community organisations on Islay, most notably the Islay Energy Trust (IET). The IET has spent several years working on renewable energy and energy efficiency projects on Islay and

currently has its own community owned wind turbine. A soft start to the engagement on the island was required so that both the X-ROTOR project and IET could benefit from each other's expertise and resources.

The Islay Energy Trust intends to carry out a wide-ranging survey of energy needs on the island during 2022. This will involve an energy audit for a large number of homes on the island and a survey of all its members. While this in itself is not entirely relevant to X-ROTOR, the access to the people living on the island which it involves, will be a huge advantage to the engagement of a large cohort of the population for X-ROTOR. It is therefore a great opportunity to synchronise efforts with the IET and not to launch our own large scale social media campaign this year. A more effective use of resources would be to leverage links with the IET, and arrange for a researcher visit to the island in years 2 and 3 of the project as planned for in D7.1. It can be hoped, given that the fact that X-ROTOR has been designed by engineers in the nearby University of Strathclyde, that this may help to encourage local people on Islay to take an interest in the X-ROTOR design.

North Inishowen, Ireland, was chosen as a suitable community for the X-ROTOR project for a number of reasons. The peninsula is quite close to Islay, Scotland, experiencing very similar metocean and meteorological conditions, meaning that both areas are possible sites for wind energy development due to relatively high wind energy potentials. In contrast to Islay, North Inishowen has a higher dependence on the fishing industry and a higher unemployment rate. It may therefore give a balance to the somewhat unusual level of industrial work available on Islay due to the presence of several whisky distilleries. In contrast with Islay, North Inishowen has a reasonable amount of onshore wind, while there is very little onshore wind on Islay due to the presence of an airport and much of the land being owned by the Royal Society for the Protection of Birds. Invitations to the workshops were hosted on the Facebook pages of the Malin Head, Glengad and Greencastle coastal communities. An invitation was also sent to a local newspaper, The Inish Times, participants were encouraged to invite others in the local community who would have an interest in offshore wind. This snowballing technique was also used for Group 2 recruitment, see below.

There is a potential weakness in selecting Ireland and Scotland as both are culturally quite similar and geographically quite close. They are both exposed to much of the same media in the English language and have a shared history to an extent. Selecting a community in Spain helps to balance these similarities by providing a community with a different language and history. Recruiting Group 1 members in Spain was more difficult due to linguistics and logistical challenges. However, by calling on existing interested groups in Spain, it was possible to begin the engagement process with Group 1 members living on Spain's Atlantic coast.

2.3 Industry Perspectives – Engaging Group 2

Individual members of Group 2 were contacted online through email, Linkedin and Twitter and through research groups such as IEA Wind and Wind Research Networks. Similar to the invitations for Group 1, participants were offered the chance to invite colleagues who would also be interested. This is known as "snowballing" and is a useful and effective technique to recruit people for research projects (Noy, 2008). Under normal circumstances personal invitations at conferences would have been used but were not possible due to the pandemic. It is hoped that invitations in person, will be possible in the next two years.

2.4 Quantitative Methods

The ASD workshops undertaken with both Group 1 and Group 2 resulted in the generation of both quantitative data – such as Likert scales and priority sequencing – and qualitative data, which included written opinions, ideas and expressions of interest. A Likert scale is used to record which of a series of possible phrases a respondent wishes to use regarding a particular topic (Likert, 1932). These have the advantage of being easy to understand and are easy to administer. They in some sense, bridge the gap between permitting participants to write freely as they describe their opinions, and measuring an opinion numerically. The scale typically uses graded responses such as, "Agree Strongly, Agree, No Opinion, Disagree and Disagree Strongly". From these, the participant selects one.

Analysis of the quantitative data is relatively straightforward and will be explained below. Analysis of the qualitative data was more nuanced and is explained in Section 2.5.

The Group 1 participants responded to several questions which were aimed at exploring their attitudes towards climate change and offshore wind energy. These involved a standard five-point Likert scale covering topics such as climate change and energy costs. The objective was to probe the participant's attitudes towards the reality of climate change and to consider their own energy usage and expenses. A numerical score was applied to the scale and the averages of these scores is reported below in Section 0. This was repeated with an emphasis on wind energy using a similar Likert scale probing the participants' attitudes towards various concerns associated with offshore wind energy, such as conflicts with fishing, tourism, and wildlife.

After sharing the feedback from surveys with the participants and giving them enough time to take in this information, the workshop continued to delve into the participants' understanding of the traditional three dimensions of sustainability: economic, environmental, and social.

Two complementary methods were employed at this stage of the research. Participants were first asked to simply rank economic, environmental, and social sustainability in order. This was analysed by allocating 2 points to top position, 1 to second and zero to third and calculating the average.

The second method asked participants to compare the three dimensions of sustainability in pairs, giving a judgement using the terms in Table 1 to describe how much more important one of the pair was relative to the other (Saaty, 2008). This is a standard AHP method and was chosen to contrast with the first method, as well as to encourage familiarity with this method amongst the participants for subsequent workshops in later years. These scores were processed into a pairwise comparison matrix (PCM) where the a_{ij} the entry in the i^{th} row and j^{th} column of the PCM is the factor by which the participant believes the subject of row *i* is more important than the subject of column *j*. In the PCM the main diagonal entries are all equal to 1, and $a_{ji} = 1/a_{ij}$. Following Saaty (2008) and our own work (Deeney *et al.*, 2021) the phrases and numerical values for the a_{ij} are presented in Table 1.

Table 1 Saaty (2008) Numerical Values for PCM

Numerical Value of the a_{ij}, entry in the PCM	Comparison
0	Don't know (This excludes the participant)
1	Equally important
3	Slightly more important
5	Strongly more important
7	Very strongly more important
9	More important by the highest degree possible

The eigenvector corresponding to the largest eigenvalue, λ, of the PCM was calculated, representing the weight of the three dimensions of sustainability relative to each other. The difficulty with using a PCM is that it is often the case that human beings do not give entirely rational responses to questions. When comparing three items pairwise, there are three pairings, leading to the possibility of inconsistency across the three comparisons. A participant could, for example, say that A is better than B, B is better than C and that C is better than A, which is inconsistent as it is not transitive. The consistency of the PCM can be measured by the consistency index, CI, of the PCM which is defined as, $CI = (\lambda - n)/(n-1)$, where in this case n = 3, the number of items compared (Saaty, 2008). In a perfectly consistent PCM, CI = 0; the test is for the ratio of the CI of the PCM in question, to the CI that of a randomly generated PCM, to be below 0.05.

2.5 Qualitative Methods

The focus of qualitative research is the generation of 'rich' data *i.e.,* data that is detailed enough to allow the performance of multi-layered thematic analyses. This kind of data may be generated through a number of appropriately designed research methods, including semi-structured interviews, focus groups and Delphi techniques. The original project plan consisting of a series of ASD workshops was revised to align with public health restrictions in place within the host countries. For this reason (ASDs) were implemented online as part of the research. The Delphi approach consists of a structured, iterative and anonymous survey of a panel of participants, who may be 'experts' or non-experts, but who collectively contribute towards the research within the same intellectual space (Crabbe *et al.* 2010; Swor & Canter 2011 as cited in Mukherjee *et al.,* 2015). The typical Delphi panel may comprise two or more rounds of structured questionnaires and subsequent aggregation of responses and anonymous feedback to the participants (Mukherjee *et al.,* 2015). This asynchronous, structured dialogue approach was aimed at exploring opinions towards offshore wind turbines amongst Group 1 and Group 2 and proved an effective means of gathering qualitative data and achieving the research goals despite the ongoing challenges brought about by the Covid-19 pandemic. Delphi techniques – both conventional and modified – offer many advantages to research projects, including cost-effectiveness, simplicity, and flexibility, as well as enabling opportunities for knowledge-sharing and smooth communication with the elimination of a geographical limitation (Avella, 2016).

The asynchronous structured dialogue approach employed in the research differed considerably from the conventional Delphi method (Avella, 2016). Firstly, conventional Delphi panels are typically anonymous, a fact which could not be ensured throughout the structured dialogue process due to unpredictable challenges brought about by the onset of the Covid-19 pandemic. Issues surrounding the recruitment of panel participants resulted in the application of a snowballing sampling technique in which individuals who were invited to participate in the structured dialogues recruited other willing participants. As such, participants were sometimes aware of the identity of other respondents, though all interactions between respondents and the facilitator took place on an individual *i.e.,* anonymous, basis. Furthermore, the asynchronous structured dialogues did not include a second round, as is typical of the Delphi method, and thus feedback on the process was not offered to participants. The approach was also modified from the conventional Delphi method in that many of the criteria for examination (various aspects of offshore wind turbines *e.g.,* O&M costs, effect on wildlife, etc.) had already been identified through a review of the relevant literature, and formed the basis of the structured dialogue (Avella, 2016; Revez *et al.*, 2020). The structured dialogue panel membership included members of Group 2 – professionals or "experts" – as well as non-expert members of coastal communities in Spain, Scotland and Ireland. The rationale behind inviting both wind energy

professionals and non-expert members of the coastal communities, rather than decision-makers or only one of these groups, was a desire to explore a wide range of opinions and concerns.

The asynchronous structured dialogue process involved the delivery of four structured questionnaires which were conducted online. Three of these structured dialogues – those distributed to coastal communities in Spain, Scotland and Ireland - were identical in content but differed in the language used (Spanish vs English). These consisted of a number of statements to which respondents were able to indicate the extent to which they agreed/disagreed with them, as well as some open-ended, non-specific questions aimed at gauging opinions of, and support for, offshore wind turbines and encouraging them to be expansive in their responses. Once these responses had been received, a word cloud was generated from these responses and is displayed in Figure 1, Figure 2, and **Error! Reference source not found.** These word clouds provided the researchers with a graphical representation of the frequency of certain words and terms used by the respondents. Word cloud visualisations can assist in exploratory textual analysis by identifying words that appear frequently in a set of text, whether that text be based on an interview or simply another document and can be useful for communicating the most significant points or themes interpreted from the text. These actions were augmented by the researchers reading and summarising the participant's responses, allowing for meaningful insight to be gathered into participant's opinions and attitudes towards offshore wind turbines.

The use of quantitative methods in the form of Likert Scales and priority sequencing allowed for a snapshot to be captured of attitudes towards specific aspects of offshore wind turbines, which complimented the rich descriptive data offered by the use of open-ended questions. A clear advantage to combining quantitative methods with qualitative research is that qualitative findings may support or further explain quantitative results, while discrete results may also demonstrate the robustness of the thematic analysis of data generated through qualitative engagements. Previous research (Rowe and Wright, 2011; Tapio *et al.*, 2011) has demonstrated the benefits of integrating quantitative and qualitative materials into the Delphi process, and the more holistic approach to addressing "real-world" problems that accompanies the application of mixed methodologies within the Delphi arena.

3 Results

Initial responses to the invitations to participate in the asynchronous workshops came from members of the fishing and coastal communities, environmental groups, shipping and tourism industries, as well as policy makers. Participants fell into a wide range of ages with a mean age of 53; females comprised 59.6% of the Group 1 and 38.5% of Group 2. Interestingly, in both Islay and North Inishowen there were a number of respondents who stated that they were not members of the coastal community, despite being able to see the sea from their house. This observation implies a sense of isolation which can be felt amongst some respondents living near the coast. The Group 1 participants included people living in the coastal community, those involved in tourism, fishing and the shipping industries, members of environmental groups and a policy maker. Participants in Group 2 included academics, researchers, consultants, and those involved in the management of wind farms and renewable energy projects. Neither age nor location data was collected from Group 2.

3.1 Initial Community Insights – Group 1

Table 1 presents the mean levels of agreement across Group 1 with the statements indicated. The levels were awarded for each participant from -2 for strong disagreement, -1 for disagreement, 0 for neither, 1 for agreement, and 2 for strong agreement. The statements on the left relate to the participant's opinions on climate change and the need for electricity generation. The statements on the right refer to offshore wind energy. For example, there is strong agreement that the country of the participant[3] needs more electricity. There is also an almost even balance for and against the proposal that offshore wind poses a problem for fishing, wildlife, and seabirds.

Word clouds from Group 1 are presented in Figure 1 and in Figure 2. The size of the word represents its frequency of use in the written responses from participants. Figure 1 is based on responses expressing concerns about offshore wind farms. It is notable that the environment is a major theme, with fewer mentions of fishing. Figure 2 represents the responses to a request to suggest ways to make offshore wind farms more acceptable. Note that in this case fishing is a major theme as well as the good of the local community.

There was strong support for increased action on climate change and electricity production amongst residents of Islay, Scotland, where participants felt positively about offshore wind energy and turbines, and their ability to produce electricity cheaply. Concerns were raised relating to any possible damage that offshore wind could do to the tourism and fishing industries, as well as the effects it may have on wildlife and marine seabirds. Similarly, participants voiced their worries about both the potential noise

[3] Ireland is shown in the table but the mean figures are across all three Group 1 locations, Scotland, Ireland and Spain when questioned about their own location.

pollution brought about by the wind turbines and visual pollution brought about by siting the turbines in "*a needlessly silly location*". There was variation in the support for the belief that offshore wind could generate jobs for people living along the coast; this may be a result of the very low unemployment rate on Islay compared with Ireland and Spain.

In order to increase the acceptability of offshore wind turbines, participants made clear the importance of engaging the local coastal community and ensuring that any offshore wind energy project provides the community with "*suitable local benefits, such as O&M jobs, local use of electricity generated, potential partial local ownership*". These comments relating to job creation are interesting given the mixed views on the ability of offshore wind energy to create jobs for those along the coast. Also suggested as a means of increasing acceptability of offshore turbines, was the idea of effectively advertising the potential for offshore wind to generate clean electricity. Despite clear support for offshore wind energy, a particular concern was raised as to whether it is appropriate for a national policy to be imposed on a small community, and the suggestion was made to harmonise consenting processes between the Britain and Ireland[4].

Satellite Group 1 communities in Ireland and Spain showed strong support for offshore wind energy, though participants in both satellite communities expressed a number of concerns about this form of energy (Table 1). In particular, concern was raised about the environmental impacts and effects of offshore wind energy on seabirds and other wildlife, though respondents expected that this aspect would be investigated rigorously before any development took place, see Figure 1. Noise and visual pollution also featured amongst the concerns voiced by participants, as did the longevity of the turbines and the process of their disposal once they are retired. Not surprisingly, one of the most common issues remains the potential effects of offshore wind on fishermen and local coastal communities, due to fears that these stakeholders would be the only groups to 'lose out' as a result of offshore wind development. Despite these concerns, offshore wind turbines were considered a necessary, or even good, way to generate electricity.

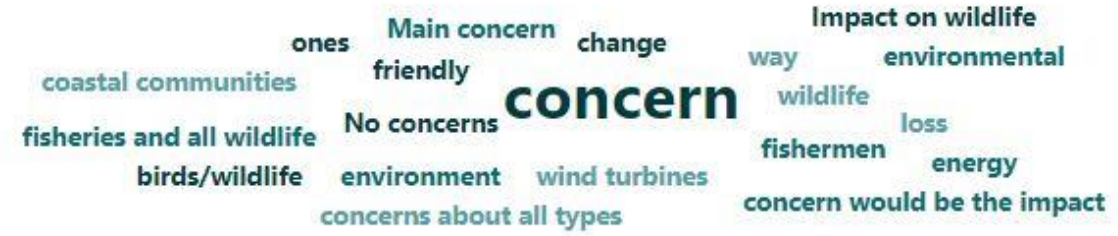
[4] The north coast of the island of Ireland is visible from Islay, and so there is a communal bond between the two coastal communities which transcends regulatory frameworks.

Table 2: Group 1 Agreement Scores for Topics

Climate Change Awareness	Agreement Level	Attitude Towards Offshore Wind	Agreement Level
Climate Change is a Serious Problem	1.18	Offshore Wind Farms are Good	0.91
Ireland needs more electricity	1.19	Serious problem for Fishing	-0.09
I use more energy now than 10 yrs ago	0.61	Damage to Leisure and Tourism	-0.68
Energy for heat is too expensive	1.16	Wildlife is Disturbed	-0.07
Fuel for transport is too expensive	1.46	Jobs for people on the coast	0.68
Electricity is too expensive	1.16	Kills Seabirds	-0.11
Global Warming is a hoax	-1.14	Produces Cheap Electricity	0.58
Wind energy is too unreliable	-0.65	Wind Turbines are Noisy	-0.39

Participants suggested increasing the acceptability of offshore wind turbines through rigorous planning, the engagement of local coastal communities in the planning and development process, as well as the inclusion of benefits for these communities, such as local jobs, cheaper electricity and investments in local infrastructure (Figure 2). Participants emphasised the importance of allocating enough space for the wind turbines in order to "*provide a happy co-existence of different uses at sea such as aquaculture, wind turbines, marine activities, tourism and nature conservation*". Specifically, fishermen should be consulted as to the most appropriate locations for siting in order to minimise losses to the fishing industry. Placing the turbines as far offshore as is needed for them not to be visible was another suggestion which featured frequently, along with an interesting recommendation to "*change the colour* [of the turbines] *to blend in with the environment*". Participants seemed to be of the opinion that the public is in need of more information on the benefits of offshore wind energy and that this would be a useful means of promoting this form of energy.

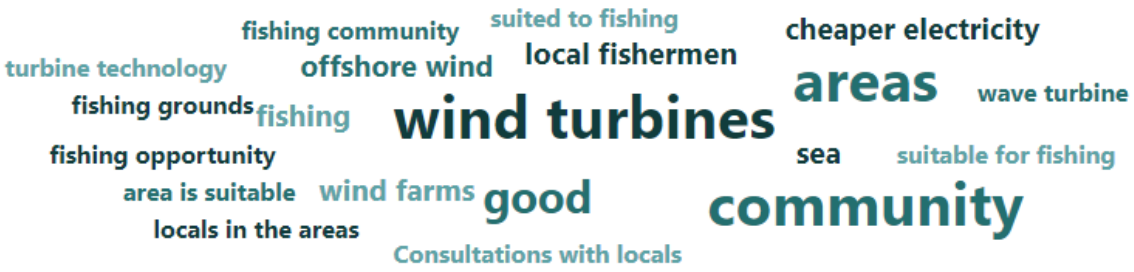
Figure 1: Word Cloud of Concerns (Group 1)



A sense of anger towards the government could be identified through comments made on the need to reassure community members that "*all associated jobs created won't just go to Dublin*". Similarly, respondents seemed angered at a lack of consultation with local communities, wondering whether locals will have a choice as to whether offshore wind turbines will appear in their area or whether they will simply appear overnight without any warning. Based on an analysis of the responses received

using the PCM and sequencing exercise, it became clear that environmental concerns were regarded as the most important dimension of sustainability, followed by social and, lastly, economic dimensions. However, it was seen that there was a high level of inconsistency in this comparison. This may be explained as the result of AHP being a new method for members of Group 1.

Figure 2: Word Cloud of Suggestions for Acceptability (Group 1)



3.2 Initial Industry Insights – Group 2

Table 3 presents the mean level of importance for 19 criteria for the selection of wind turbines. The levels were given as 3 for very important, 2 for important, 1 for not so important and zero for don't know. **Error! Reference source not found.** is a word cloud displaying responses from Group 2 describing desirable qualities in an offshore wind turbine.

The top priority expressed by Group 1 was the levelised cost of energy (LCOE) (see Table 3). This was closely followed by ability to survive extreme conditions, installation cost, maintenance cost, purchase costs, O&M costs and the choice of power capacity. These are largely technical issues relating to the business viability of an offshore wind farm. The next most important criteria consisted of the effect on local people, effect on wildlife, onshore requirements and choice of height. These may be characterised as the social and environmental aspects of running an offshore wind farm. These criteria were followed by likelihood of collision with birds, impact on fishing, choice of fixed or floating, effect on radio and radar, visibility and impact on shipping. These, and the least important criteria of noise output and impact on scenery, may be considered as having little effect on the economic aspects of the wind farm.

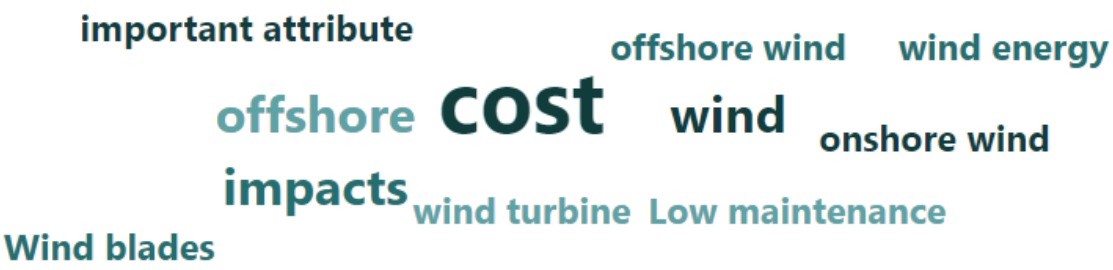
Table 3: Level of Importance of Different Criteria from Group 2.

Criteria	Level of Importance
Levelized cost of energy	2.58
Ability to survive extreme conditions	2.42
Installation cost	2.36
Maintenance costs	2.33
Purchase Cost	2.27
O&M cost	2.27
Choice of power capacity	2.25
Effect on local people	2.00
Effect on wildlife	1.92
Onshore requirements	1.83
Choice of height	1.83
Likelihood of collision with birds	1.69
Impact on fishing Industry	1.54
Choice of fixed or floating	1.45
Effect on radio and radar signals	1.42
Visibility	1.38
Impact on shipping	1.36
Noise output	1.23
Impact on scenery	1.08

The mean levels are shown in the table, where the highest level of importance scores 3.

When offered the chance to describe the most important attributes of a good offshore wind turbine, a number of key attributes were considered by wind energy professionals (**Error! Reference source not found.**). Reliability and maintenance were frequently voiced as concerns surrounding offshore wind, with one participant commenting that "*Wind blades get damaged far too often. This will be even more of an issue for far offshore (>15 km)*". Reliability will significantly affect operating and maintenance (O&M) costs, as well as the levelised cost of energy (LCOE).

Figure 3: Word Cloud of Important Attributes of a Turbine (Group 2)



It is therefore important to wind energy professionals that the system can be relied upon to carry out its intended task without requiring constant and high levels of (very expensive) maintenance. Other important attributes described by participants included efficiency and low overall cost, as well as the system's ability to contribute towards the national renewables target while co-existing with non-energy offshore industries and bringing minimal impacts for the marine environment. Wind energy professionals also cited their desire for wind energy projects to engage and involve local coastal communities, "*bringing benefit for the community as a whole*". A key concern of some professionals was the effect offshore wind energy may have on the development of onshore wind should it be "*promoted as the ONLY socially viable (due to visuals, noise, land use, birds, bats, etc, etc) type of wind energy*", despite the fact that, in many parts of the world, onshore wind energy makes far more sense. As illustrated by one participant:

> *"It would be a disaster if the public became much more resistant to onshore wind because of the perceived (and widely touted) benefits of offshore wind. This is one of the greatest concerns I have with offshore wind."*

This viewpoint was echoed by a resident of Inishowen:

"No concerns [about offshore wind turbines]. I would much prefer them to the ones on the hills and landscape."

4 Discussion and Conclusions

It is clear that the two groups, Group 1 who may be directly impacted from offshore wind turbines, and Group 2, have very different priorities regarding offshore wind farms. As might be expected, the top priority of Group 2 is the LCOE and the ability of a turbine to survive extreme conditions, with less importance being placed on the effect on wildlife and fishing, both of which were important concerns for Group 1. This is an interesting finding and points to the need for a mediator when these two groups are in dialogue, so that these divergent views may be introduced to each other carefully.

Despite fishing being a minor part of the EU and UK workforce, accounting for 0.05% and 0.03 % of jobs respectively[5], fishing draws considerable support from Group 1, and what must be regarded as almost disinterest from Group 2.

[5] 163,000 people in the EU 27 are employed in fishing industries, a third of whom were in aquaculture (Eurostat, 2011), there are about 11,000 fishers in the UK (House of Commons Library, 2021). There

There was a slight difference between the 60% positive or very positive agreement that offshore wind could create jobs from Islay, and that of Ireland (72%) and Spain (100%). This may well be explained by the varying unemployment rates in the three locations, Islay 2.9% (HIE, 2019), (Scotland 4.6%, (Holyrood, 2021), Ireland 4.5% and Spain 13.8% (Eurostat, 2021b). There are also reports that Islay effectively has full employment due to the number of whisky distilleries on the island. The possibility of offshore jobs may be particularly tempting to community interest in Spain due to the high unemployment rate there.

The first conclusion is that there are wide differences between Group 1 and Group 2 regarding their attitudes towards wind turbines, the environment and the protection of local society. This is reflected in the differing levels of importance they placed on the environment and the impact on the local community, especially fishing. This underlying difference of opinions may lead to different concepts from each regarding the maximisation of the advantages of X-ROTOR over standard wind turbine designs.

A second conclusion which may be drawn is the similarity across all of the communities in Scotland, Ireland and Spain. While there was a slight divergence over the ability of wind energy to provide local employment, this may have been the result of different levels of unemployment in the three countries.

A third conclusion is that while the beginning of this three-year engagement has been affected by the limitations imposed by the pandemic, these limitations have also been advantageous in terms of the ease with which participants in the workshops have used online communication technologies. It is perhaps arguable that the egalitarian nature and the structure of the workshops being conducted online has offered an advantage to this research which was not anticipated.

- *Wide differences between the priorities of Group 1 and Group 2. Group 1 is focused on environmental and local impact, Group 2 is focused on power production.*
- *Similarity across Scotland, Ireland and Spain regarding the attitudes towards the environment and support for local jobs, and protection of fishing.*
- *Online communication has been quite satisfactory. While it is clear that face-to-face offers a unique level of engagement, much good work has been done.*
- *Details about the design of X-ROTOR will add a new dimension to the engagement in years 2 and 3.*

were 209,395,220 people employed in the EU 27 in 2019 and 32,794,590 employed in the UK in 2019 (Eurostat, 2021a).

Finally, as the engagement develops in years 2 and 3, a greater degree of specificity will be given to the communities regarding details of X-ROTOR. This is aimed at bringing a greater degree of community involvement from both groups.

The next steps in the engagement with Group 1 will be to hold hybrid workshops on Islay in year 2 and year 3. A hybrid model is proposed in light of the success of the online engagement from Group 1, which avoids problems of distance and medical safety. This will leverage the intention of the IET on Islay to contact many of the island's population for their own survey. As planned in D7.1 more satellite locations for Group 1 will be developed so that a wide range of opinions and feelings regarding offshore wind turbines may be gathered.

Remote online working will continue for Group 2 with the hope that in year 2 and year 3 of the project, it may be possible (safe) to attend wind energy conferences and/or trade shows to personally invite more people to participate in the project. Much depends on the safety advice from governments and the medical situation.

In this deliverable an account of the initial engagement with Group 1 and Group 2 has been described. Group 1 comprises those people who may be directly affected by the introduction of the X-ROTOR technology. Group 2 comprises those people who may use, purchase, or offer advice on the use of the X-ROTOR technology. This first year of the research project has had to cope with unprecedented disruption to travel and face-to-face encounters between people. These disruptions have had a damaging effect on the practical ability of the researchers to meet members of both groups, however flexibility has been shown by many people and progress has been made.

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