LT2.2 Social Acceptance study

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Document History

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Executive Summary

The purpose of activity 2 of the Long-Term work package is to evaluate the EU (more precisely, the NWE territories) social acceptance level of the project technologies, identifying potential barriers and proposing solutions. Consequently, the evolution of the project social acceptability is tracked, establishing its level before and during the project duration and finally making considerations on project impact and new trends. Identifying the potential stakeholders and the main key factors is then the first item. Subsequently datasets are collected and analysed. The implementation of this study is realized in collaboration of the academical partners, Universities of: Caen Normandie, Le Havre Normandie, and Ghent, and supervised by ESCAT.

Introduction

One of the main challenges in establishing a project achievement is its social acceptability. Particularly, the project must be respectful of the practices and aspirations of the local individuals and groups. To assess the social acceptability of the project, many factors, such as economic, political and social, must be evaluated to identify the possible source of non-acceptance. Before exploring the social acceptability of the ITEG project in detail, an overview of the considered "social acceptability" definition and the related conceptual frameworks are introduced.

Social acceptability definition can change from one scientific field to another, assuming different perceptions and analysis. In the renewable energy domain, the social acceptability definition proposed by Rolf Wüstenhagen et al. [1] is assumed as reference. According to the authors, a project is successful if the following categories of acceptance are reached:

1. <u>Socio-political acceptance</u> (<u>SPA</u>) is the largest one, involving energy technologies and policy acceptance of the major societal actors and stakeholders. Particularly, the project must be environmentally acceptable.

2. <u>Community acceptance</u> (<u>CA</u>) is mainly focusing on project location, investigating local stakeholders' perception and feeling about their local environment and personal well-being. Concluding, the project must be welcomed by the local communities.

3. <u>Market acceptance</u> (<u>MA</u>) is mainly focusing on energy market supply and demand. It includes consumers and investors. The project must be profitable in view of the market conditions.

According these definitions, renewable energy projects are often subject to environmental concerns, needing trust in and information about the technology. The involved stakeholders include general public, experts in the domain, possible actors and end-users. The technology's perception will depend on different opinions, attitudes and fears, knowledge levels and expected benefits.

In this scenario, several factors must be considered. Some of them are purely geo-political and demographics, including country-wide, i.e. both rural and urban points of view. Stakeholders appear particularly receptive to the government policies and public engagement. Consequently, public funding, tax/incentives, regulations and standards are usually assumed as driving factors for social acceptance. Additionally, the prior knowledge considering both initial understanding and available information remains one of the highest aspects. This point is strictly related to the need for trusting in new technologies and to the main actors' communications (government, research and industry agents). The level of knowledge is followed by the environmental awareness usually affected by considerations related to landscape, flora and fauna, noise and safety conditions. Particularly for these aspects, the stakeholders' point of view can change depending on the applications' location and proximity. In fact, community acceptance is strongly affected by the NIMBY (Not In My Backyard) phenomenon [2] because local residents' perception is dependent on their local environment. Consequently, community acceptance is mainly related to the residents' personal well-being, instead of looking for technical or collective interests. Finally, the public is interested in evaluating economic benefits, risks and costs, including considerations of technology maturity level, safety and reliability, infrastructure construction for local energy availability and distribution, and new job opportunities.

All these factors are correlated and can affect all the three categories of acceptance introduced by [1]. The most determining factors are defined and classed below, matching project topics and literature survey results [1,3]. The resulting factors will be used throughout this document.

1. **Prior Knowledge (PKn)**: represents public knowledge, usually, indicating the level of understanding going from the initial information available to expert knowledge level. It is particularly influenced by geo-political and demographic factors and can be improved through public awareness campaigns via media and communication actions, dissemination, demonstrators, etc. Communication affects the public perception of the technology, usually increasing the acceptance level, and reducing stakeholders' doubts.
2. **Public Opinion and Perceptions (POP):** represents the public opinion and perceptions. Usually, this indicates if people trust the technology or not, and if the public will support the technology or not. It is a mandatory index for acceptance level estimation and can be influenced by all the other factors.
3. **Technology level (Tec):** represents the technology maturity level and perception, focusing on different aspects such as efficiency and reliability, costs, risk perception and safety. This factor is a particular important point for all the acceptance categories (SPA, CA, MA). The perception of the maturity level can affect public opinion, influence policies and investors, and answer pending questions and/or doubts of the local residents about the technology.
4. **Environment impact (Env):** represents the public perception of the technology impact in their environment, focusing on CO_2 reduction in energetic transition scenarios, flora and fauna, noise and landscape aspects. Its influence affects both the social acceptance and the community acceptance levels.
5. **Policy Makers (PM):** represents the public perception of the regulatory framework, government and public funding, taxes and collaborations between public and private research. These factors are related to the socio-political acceptance, and have an important influence in stakeholders' decisions and perceptions in market acceptance.
6. **Resident Doubts and Perceptions (RDP):** represents the local residents' perception of the installation and their major doubts. It mainly concerns the NIMBY phenomenon in CA. It is related to the residents' personal well-being, instead of collective interests.
7. **Driving factors (Driv):** includes the major factors aimed to enhance public awareness (and then both public knowledge, technology perception and acceptance). Among the different options, dissemination, media and demonstrators are largely considered as the best way to improve public awareness. Additionally, public funding, energy availability / distribution and collaborative projects between public and private research are also considered as possible leverage for acceptance. Particularly, this sub-category is introduced to evaluate the perception of the possible actions proposed by investors and public authorities to the stakeholders.
8. **Direct Benefits (DB):** represents a particular category of factors, mainly aimed to consider the potential benefits for stakeholders; in some cases, also used as driving factors. Among these, are CO_2 reduction, energy price reduction, enhancement of local economy and job creations.
9. **Costs (Cost):** represent all the factors related to the plant installation costs, such as the technology cost, the infrastructure construction and services. Plant cost perception influences both social and market acceptance.
10. **Market actions and support (Mark):** includes the main factors affecting market building for industrialization. It includes market analysis to test both public and market receptivity to the new technology, and it is based on market building and scaling-up strategies for market penetration. Market penetration is an important point both for customers and investors, and is usually supported by policy makers.

The proposed study, evaluates the different factor correlations and their impact on acceptance indicators by analysing both the social acceptance questionnaire and the literature survey results. Results are indicated in table 1 and graphed in figure 1, where the percentages of the factor influence are reported with respect to the different acceptance indicators. The socio-political acceptance (SPA) is evaluated giving priority to policy makers at 21%, followed by the prior knowledge and awareness (PKn), to the public perception on the technology (POP), to the technology level (Tec), and to the environmental impacts (Env) with a weight of 16%. Resident doubts and perceptions (RDP) do not impact this index, while the influence of driving factors (Driv), direct benefits (DB), costs (cost) and marketing (mark) have a weight of only 3% on socio-political acceptance. On the contrary, community acceptance (CA) indicator, is mainly influenced by the resident personal well-being instead of looking for collective interests. Therefore, the resident perception and doubts (RDP) factor is considered 76% of the indicator. While the market factor is neglected and all the other factors are only 3%, to account for potential minor impacts. Finally, for the market acceptance (MA) indicator, the resident personal well-being is not accounted for. However, market strategies are considered to account for 26% of the indicator, followed by government funding, benefits, and costs, which are rated at 15%. The technology maturity and the driving factors in communication are accounting for 10% of the indicator, while the remaining factors are rated at 3%, to account for potential customers and investors points of view. Finally, a new indicator, named social acceptance level (SAL) is introduced to state the average acceptance considering all the determining factors rated with the same weight of 10%.

Table 1: Most determining factor impact in social acceptance indicators; obtained by matching project topics and survey results with available literature reviews [1,3,5-11].

	SPA	CA	MA	SAL
PKn	16%	3%	3%	10%
POP	16%	3%	3%	10%
Tec	16%	3%	10%	10%
Env	16%	3%	3%	10%
PM	21%	3%	15%	10%
RPD	0%	76%	0%	10%
Driv	6%	3%	10%	10%
DB	3%	3%	15%	10%
Cost	3%	3%	15%	10%
Mark	3%	0%	26%	10%

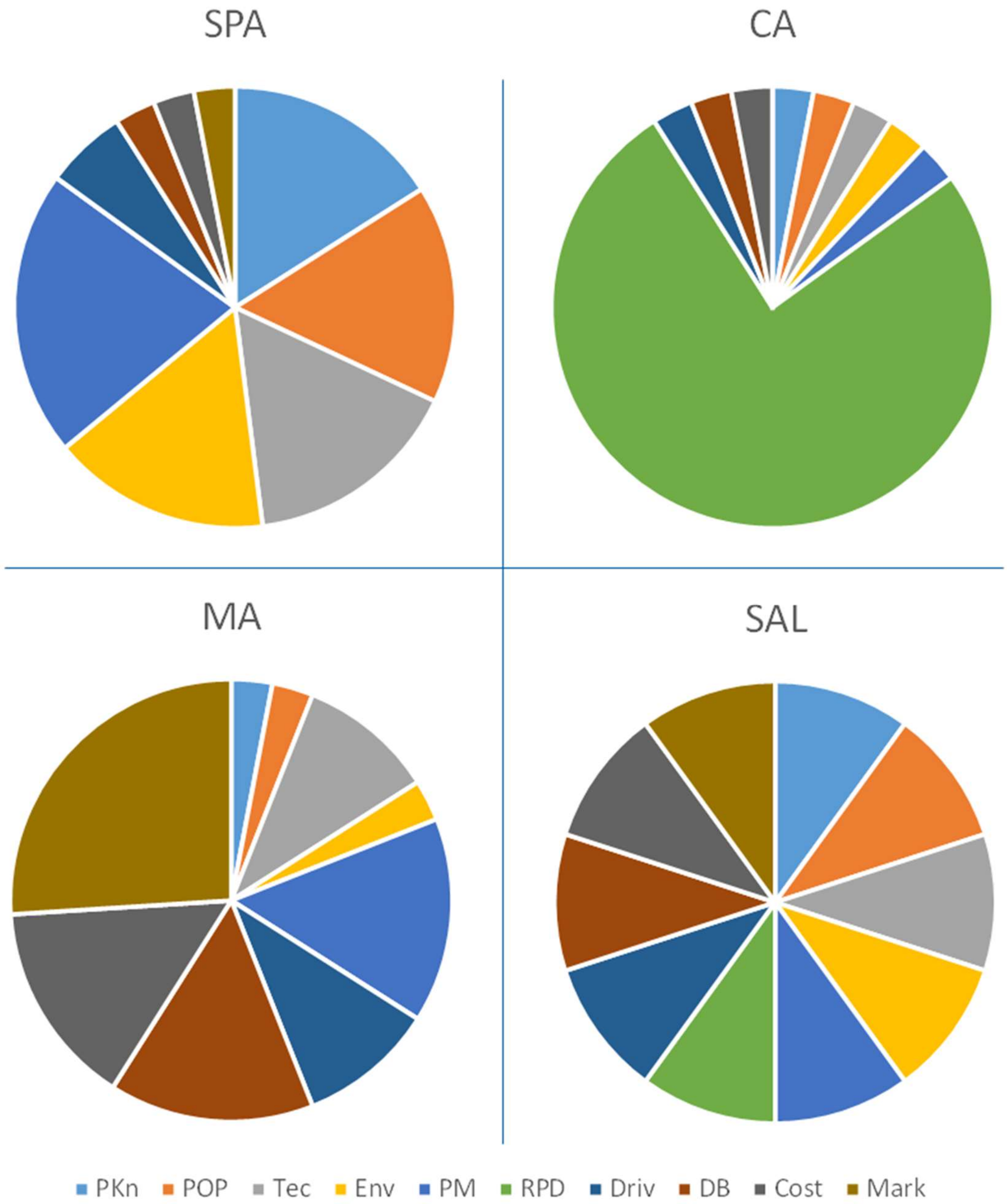


Figure 1: Determining Factors in Social Acceptance Indicators.

It is worth noting that the perception of all these factors can change with time. This is particularly notable in the socio-political acceptance social awareness indicator, where variation is driven by communication and demonstrator actions, or influenced by policy changes, system efficiency improvement and cost reductions. In fact, new technology acceptance occurs in several steps [3], following a "U" shaped curve over time [4]. At the beginning, the stakeholder community is generally receptive of new technologies. However, when it comes to location selection, the community often questions its location, revealing the need of communication, demonstrations and learning to trust a new technology. This kind of behaviour is typically observed with an initial drop in acceptability. With the increasing of the level of knowledge and the incoming support of the policy makers the negative inclination is commonly reduced, stopped and finally inverted. Particularly, driving factors and possible benefits, such as exhaustive communication, projects demonstrators, public engagements and possibility of job creation, are the main factors to change the community inclination. Maximal acceptance is attained with the establishment of regulations and standards, scaling-up processes and market building for industrialization.

Social acceptance plays a pivotal role in a project's success. In this document, care will be given to identify the stakeholder's perception by analysing and classifying their feedback. The major potential barriers will be underlined and investigated to propose useful driving factors to increase the project acceptance. Finally, social acceptance is a large domain involving social, technical and economical sciences. In this context, both qualitative and quantitative analysis are required. Some parameters, such as performance, efficiency and cost are easy to quantify (when available). Community perception coupled to the factors of table 1 are more qualitative and subject to different interpretations. In order to solve this, a hybrid approach of data and information analysis is adopted in this study. The developed strategy for the LT2.2 task implementation is presented in the following section. The methodology to identify and quantify the stakeholder feelings is then introduced. Subsequently, qualitative information and data are gathered and treated (quantified) through descriptors. A quantitative analysis is then performed and results presented. Finally, the potential benefits and main barriers are underlined, proposing solutions and possible future scenarios to enhance social acceptance.

Case Study & Methodology

This section deals with discussing the methodology used to analyse the social acceptance of the project.

Project overview

The ITEG project integrates two types of new technologies, namely the marine current renewable energy and the hydrogen production systems. Together, they form an all-in-one solution to be demonstrated in EMEC at the Fall of Warness (FoW) site, situated off the island of Eday in the Orkney Islands, Scotland. The project focuses on clean energy production and carbon emission reduction in North-West Europe and tackling grid export limitations faced in remote communities. The integrated solution combines Orbital's next generation 2 MW floating tidal energy converter, with a custom built Elogen PEM electrolyser. An energy management system (EMS) will support the production of hydrogen by routing the energy generated by the Orbital O2 turbine for powering the Elogen electrolyser. For additional information the reader can refer to the project website: https://www.nweurope.eu/projects/project-search/iteg-integrating-tidal-energy-into-the-european-grid/

The project has several objectives. The first objective is the integrated tidal energy and hydrogen production system development and validation of clean energy generation in remote areas. The demonstrator is then expected to improve the stakeholders' prior knowledge and perception of the technologies, by proving the technology maturity and concept reliability and feasibility, and braking barriers related to the environmental impact and risks. This objective will mainly deal with socio-political and community acceptance. Another objective is to open and demonstrate new market opportunities for the ocean energy sector using hydrogen production and storage as an energy carrier solution, to support market acceptance. Investors must be reassured in technology cost reductions of the pre-commercial demonstration. ITEG sets out to identify and drive down these costs by analysing the impact of scaling-up. In parallel, to improve system performance and thus revenues, the energy management system is optimized. Finally, as one of the project results, a roadmap will support the replication of the integrated solution in other remote, grid restricted, areas. The attainment of these objectives is expected to improve the technologies' social acceptance status. All the different stages of the U-shaped curve will be of importance to reach commercialisation.

Activity Plan

The purpose of activity 2 of the Long-Term work package in the ITEG project is to evaluate the current social acceptance level for the project technologies in the EU, more precisely in the NWE territories, and to identify the potential barriers and proposed solutions. Consequently, the project social acceptance is tracked, establishing its level before and during the project and concluding with establishing project impact and new trends. The first action is identifying the potential stakeholders and the most important factors. Subsequently, datasets are collected and analysed to draw conclusions and propose solutions. The approach adopted for study is organized in six main activities, as represented in the LT2.2 activity plan proposed in figure 2.

Activity 1 focusses on literature research to state the social acceptance level from the past. This step deals with a first state-of-art aimed to identify the different stakeholders and their feelings in several topics, such as social awareness, environment, technology efficiency and costs, security and safety. Additional factors, such as government, policies and technology infrastructures are also investigated. Once the main actors and indicators are established, activity 2 aims to find the impact of the potential social benefits derived from the project solution. For this purpose, a first study is performed on the technology' costs definition and possible reductions, evaluating revenues and possible improvements. In parallel, the reduced carbon emissions and the creation of new jobs are investigated. Activity 3 is focused on tracking stakeholder perception of the key factors and benefits throughout the project. This is done by analysing input from meetings and conferences through open discussions with different layers of society. Then, a questionnaire is used in this task to track social acceptance perceptions in each territory and environment of the NWE area targeting specific audiences. Data collection and analysis is the purpose of activity 4. In this task, qualitative information is treated with quantitative data (outcomes of activities 1-3) to evaluate the social acceptance indicators. Activity 5 aims to identify the possible barriers. Finally, activity 6 proposes future scenarios and solutions concerning the prioritized social acceptance key factors and barriers.

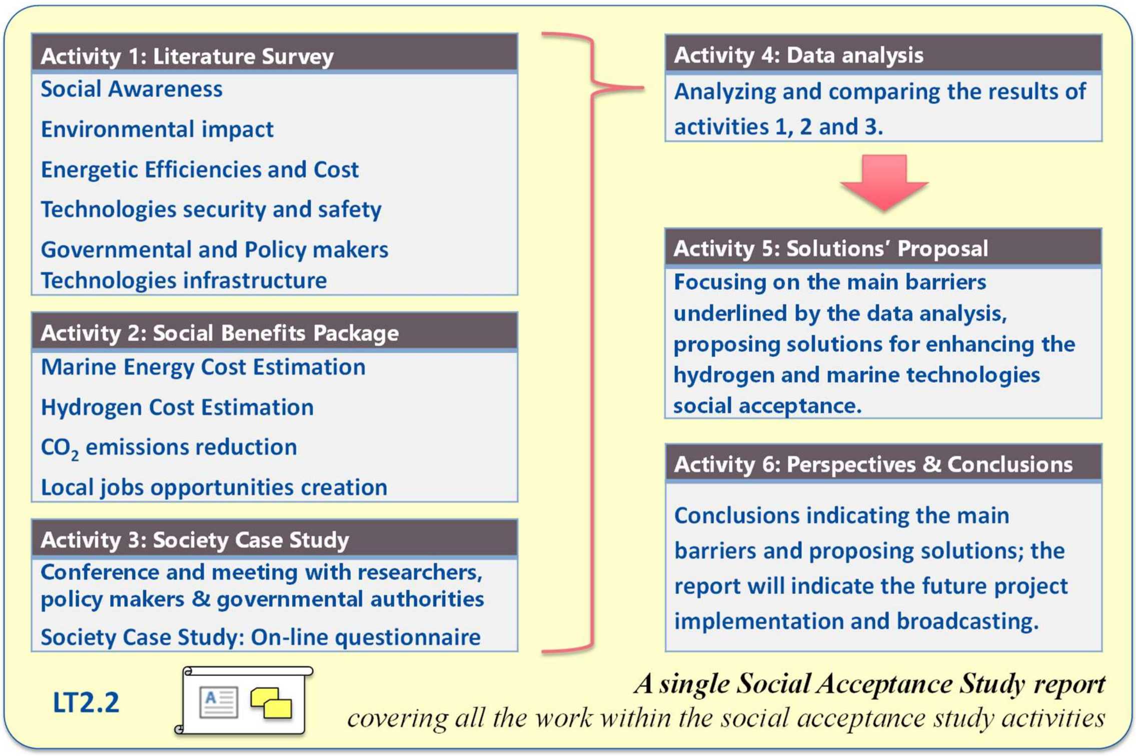


Figure 2: LT2.2 Social Acceptance Study approach.

For a better understanding of LT2.2, the work listed in activity 4 is described in the following sub-paragraph. The methodology is presented by introducing the adopted criteria for data treatment, features identification and classification. This approach is applied to all the LT2.2 activities., Outcomes of activity 4 will be presented throughout this document.

Data Analysis Methodology

Social acceptance is commonly built on information resulting from a literature survey, i.e., a systematic review on technology perceptions and acceptance and benefit evaluations, project data, webinars and questionnaire feedback. Due to the qualitative nature of the descriptors and their diverse origins, the following research questions were raised in the preparation of activity 4. The first question was directly related to data classification, and particularly to identify, among different items, common indexes for qualitative information quantification. Once the indexes were defined, they need to be treated in a robust way. Three important points must be considered. The first point deals with the number of inputs and their different origins, making sure that redundancies and uncertainties are avoided. The second point refers to a possible lack of information. The third one is focused on result extrapolation. To address these points, a well-structured approach is required, as described in the next paragraph and show in the flowchart of figure 3.

The first step in the methodology is the *topics' identification*. This part was fixed based on project expectations and an initial literature review focused on social acceptance studies [1,3,5-11]. The research topics identified for the social acceptance assessment in this study are reported as follows.

1. ***Technology selection***
   Based on ITEG project goals, **hydrogen** and **marine current** technologies are selected.

2. ***Geographical area to investigate***
   For the ITEG project, the **North-West Europe (NWE)** countries are considered.

3. ***Relevant actors in the study***
   This topic aims to consider the largest as possible range of actors involved in technology social acceptance. For this purpose, not only directly interested actors to the business, such as investors and users, but also the perception of indirect actors, such as government, policy makers, researchers, and the general public is investigated. Based on this, the following target groups (TG) are identified.

   TG1. *Enterprise & SME*, including different business sectors.

   TG2. *Infrastructure service provider & business support organization*.

   TG3. *Public Authority*, including governmental and public structure.

   TG4. *Higher education & Research*, including academical and private.

   TG5. *General public / Other*.

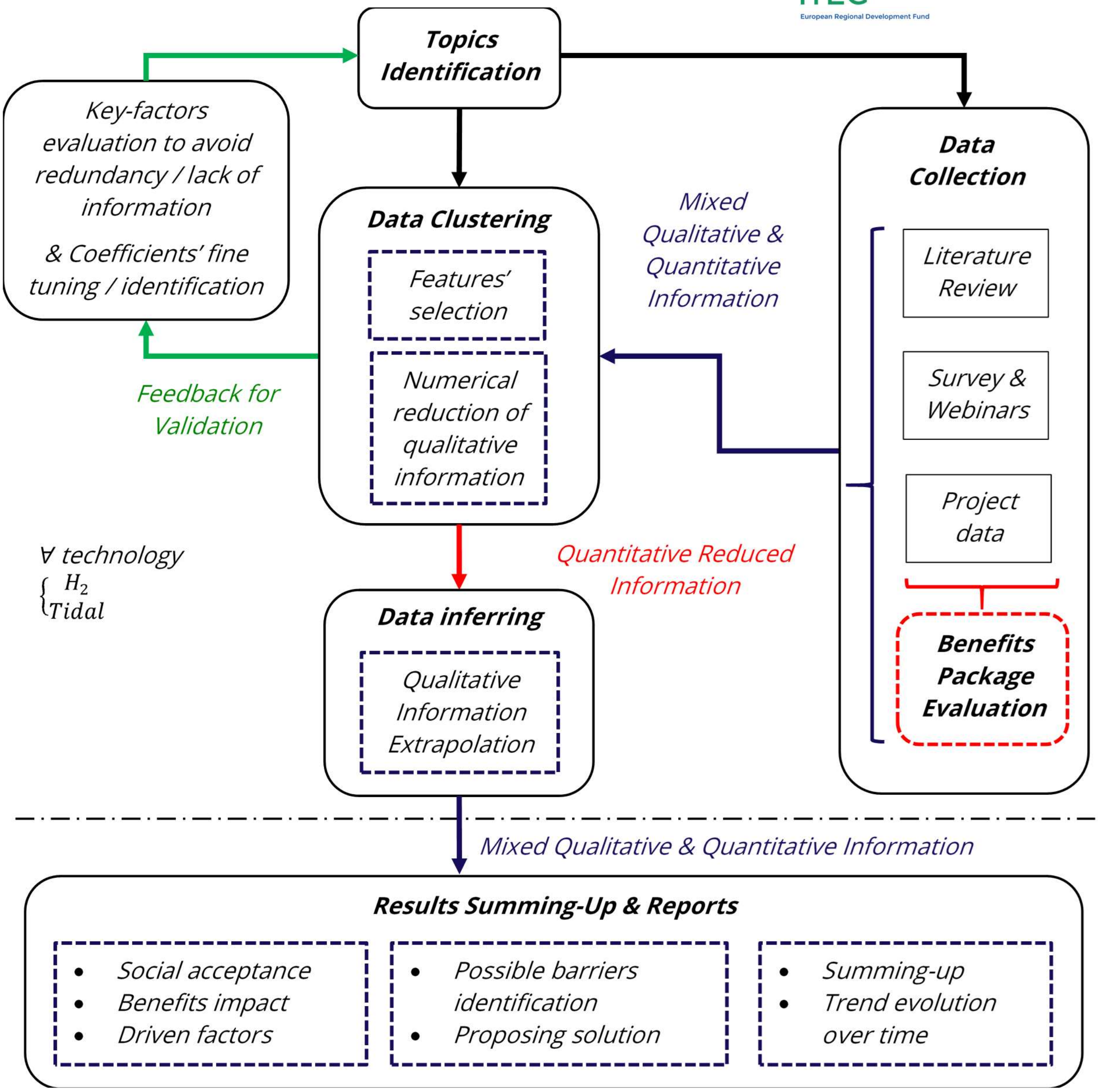


Figure 3: Methodology flowchart.

4. *Key factors*

This topic deals with establishing different factors playing a key role in project social acceptance. It was stated by [3], that these factors influence the main social acceptance categories. As presented in the introduction, the selected key factors are:

- Prior Knowledge (PKn)
- Public Opinion and Perceptions (POP)
- Technology level (Tec)
- Environment impact (Env)
- Policy Makers (PM)
- Residents' Doubts and Perceptions (RDP)

- Driving factors (Driv)
- Direct Benefits (DB)
- Costs (Cost)
- Market actions and support (Mark)

The changes in these factors are observed and analysed throughout this document. The global *social acceptance level* (**SAL**) is then evaluated by the combination of all their stakeholder perceptions. While, according to [1], specific combinations of these factors (see table 1) are used to identify: *the socio-political acceptance* (**SPA**), *the community acceptance* (**CA**), and *the market acceptance* (**MA**).

5. ***TG perception and expected results***
This topic aims to establish the objectives of the social acceptance study. With the previous topics, the perception levels of the different stakeholders (target groups, TG) of the most determining factors are tracked. The expected results are listed as follows.

R1. Evaluate the social acceptance indicators *(SPA, CA, MA, SAL);*

R2. Identify useful driving factors to enhance social acceptability;

R3. Identify pending gaps & possible barriers and propose solutions to solve them. Particular attention is spent to find the gaps between the technology and its perception, the existing policies, and the market;

R4. Key factors possible impact in future trends.

Once the topics were known, the next step was defining both the procedure and the techniques for methodology implementation. During this phase, the qualitative information related to the different factors is classed and then treated to extrapolate numerical information. Independently from their origins (*data collection* from literature review, project, webinars and questionnaires outcomes), data and information are classed and rated in specific clusters (*data clustering*) depending on the key factors proposed in topic 4. At the end of this task, first results are analysed for topic 4 validation (*re-evaluation of the key-factors*). Redundancies and/or possible lack of information are then investigated to identify if table 1 must be adjusted. If a new cluster is identified, it will be added to the list in table 1. The following criteria are introduced for the numerical reduction (quantification) of the information.

- ***Feature definition:*** a feature (or descriptor) is assumed as an attribute representing a physical behaviour or a qualitative behaviour (considering the social acceptance case study), to be observed and treated for data analysis. In this work, the key factor perceptions are assumed as features to study.
- ***Feature evaluation / quantification:*** introduced for evaluating the **perception levels** (**PL**) of the different features. Particularly, an *evaluation grid* is developed to rate the TG perceptions in a numerical range between 0 and 3, as proposed in table 2. Perceptions are structured from negative to positive. The limit condition for acceptability requires a value higher than 1,5. Below this threshold, the public is expressing uncertainty of opinion or no opinion with the perception values between 1,1 and 1.5. A perception value of 1 or below, is classed as 'not acceptable', and 'not acceptable at all' if values are 0.5 or below. Above the threshold of acceptability, values between 1,6 and 2 indicate a favourable trend.

In this case, the technology is perceived as acceptable; people are favourable, but some actions are required for complete trust. Values higher than 2,1 are indicating a perception of technology maturity and complete trust in the technology. Generally, this outcome coincides with proven scaling-up strategies, market penetration and system commercialization. In the renewable energy domain, proven solutions, such as solar and wind energies, are classed around 2,4. Ideally, values between 2,6 and 3 are indicating an excellent perception.

Table 2: Perception levels evaluation grid.

Limit for Acceptability				Maturity	
Not Acceptable				*Scaling-up*	
0 - 0,5	**0,6 - 1**	**1,1 - 1,5**	**1,6 - 2**	**2,1 - 2,5**	**2,6 - 3**
(red)	(orange)	(yellow)	(light green)	(green)	(dark green)
Absolutely NO / Don't Trust	Not Acceptable	Doubtful / Reserved	Acceptable	Very Acceptable / Full Trusting	Excellence

- ***Feature occurrence:*** to give the appropriate weight to the different PL, the frequency of their occurrence is counted.

- ***Feature evolution:*** aimed to state the features variations in trends. Data collected at the beginning of the project, mainly through a literature survey, are compared with project questionnaire outcomes to state possible variations. Expected benefits, driving factors and possible barriers are then considered to forecast future trends.

Once the information is ranked and translated in numerical values, the steps *data inferring* and *results' extrapolation* are done. During these phases, the numerical outcomes are combined in data clustering to deduce the social acceptance indicators. The data clusters are used to extrapolate qualitative information from numerical values. According to topic 6, the social acceptance indicators (SPA, CA, MA, SAL), the potential driving factors and the possible barriers and solutions are evaluated. Finally, results are summed in tables indicating possible solutions for the social acceptance improvement of future projects. This approach is used for both technologies considered within ITEG. Moreover, the feature variations are studied to state the expected benefits, driving factors and possible barriers to forecast future trends.

Literature Survey

This paragraph deals with analysing data and information collected at the beginning of the project, in activity 1 of LT2.2. Results presented in the Marine Current and Hydrogen Technologies Social Acceptance Literature Survey Report (WP LT, Deliverable 2.2-Interim Report 1) [5] are then validated, summed-up and assumed as reference for initial conditions to state the social acceptance indicators evolution throughout the document. More details on the establishment of the initial conditions can be found in Deliverable 2.2-Interim Report 1 [5]. Activity 1 was implemented at the beginning of the project, so new results of current available literature works are also integrated in this current study to cover potential lack of information or improve the statistical inference. Report 1 covers 109 studies available in literature, including literature papers and reviews, project deliverables and National and European studies. Among these, 80 studies are related to hydrogen, 18 to marine energy, and 11 generally related to renewables project acceptance, risks and policy makers. It is worth noting that, a factor 4 difference can be stated for documents available about hydrogen technologies with respect to tidal technologies, this is mainly due to the fact that hydrogen solution studies cover different aspects, such as power-to-gas, gas-to-power, mobility, μ-CHP, storage and distribution, refuelling stations, etc. Additionally, tidal technologies can be seen as a more recent development than hydrogen technologies, this is considered as a main factor explaining some lack of initial information. For these reasons, concerning hydrogen technologies only reference [3] is added to Report 1 [5] outcomes to enhance statistical inference in category ranking. This reference, [3] from 2021, presents an exhaustive literature review in world hydrogen technology social acceptance. While for tidal technologies, references [6-11] are added to Report 1 [5] outcomes to cover the possible lack of information and enhance statistical inference in categories ranking.

The literature Survey focused on hydrogen and marine current technologies social awareness, environment, energetic efficiency and costs, policy makers initiatives and service infrastructures. According to the indicators presented in the previous section, information is treated to obtain quantitative scores and categories are ranked. Finally, based on indicators' ranking the determining factors are classed and assumed as reference to state the social acceptability level of the integrated solution as presented in the ITEG project. It is worth noting that, based on the obtained reference values, the process is inverted to extrapolate qualitative information, giving priority to making synthesis and highlighting important points. For better understanding of categories ranking, the extrapolated qualitative information is also reported. The scores of the key factors and related social acceptance indicators are presented in the following section for both technologies. Subsequently, the project case study is evaluated.

Before analysing results, it is worth underlining that the different scores are evaluated based on the correlations presented in table 1 and matched with the evaluation grid criteria of table 2. The procedure was validated by matching project topics and literature survey results. According to the methodology presented in figure 3, the evaluation grid was set via an iterative procedure aimed to find the best fit between qualitative available information and obtained quantitative results. To avoid overestimation or underestimation, induced by positive or negative attitude bias, the evaluation grid was calibrated with respect to the "no opinion attitude", corresponding to a central value ranked at 1,5; refer to table 2. Care must be taken in considering the perception level values. In fact, they are only used for classification purposes, and they are not indicating an evaluation note. To give an example, a value of 1,4, referring to the doubtful class is mainly to alert stakeholders' possible doubts (to be investigated and answered), and not that the category has a negative grade.

Hydrogen technologies perception

The following results involves public perception of different hydrogen technologies. In particular, hydrogen production (electrolysis), applications (fuel cell for stationary electricity production, mobility, boiler and μ-CHP), storage and delivery solutions are investigated. Different aspects, such as knowledge and awareness levels, technology maturity, market penetration, environment, safety, risks, costs, possible benefits, comfort and policy makers are considered.

The Prior Knowledge (PKn)

Cathegory:				PKn		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																	Score: 1,8													

Prior knowledge represents the public information on hydrogen technologies and their applications. The different comments observed in literature [3,5], showed that, even with an increase in communication and demonstrators in recent years, many questions are still pending or need to be clarified. The global opinion is rated as positive; people have heard about hydrogen and hydrogen technologies, and have a quite good perception, but require more information for complete trust. The general public particularly agrees with technology applications to reduce CO_2 emissions and fight climate change. However, some people (a minority) require clarification of possible risks and ask for a suitable regulatory framework. While others are more interested in technology maturity and would like to have more accessible and simple information. In fact, even with several awareness campaigns identified, the common feeling is that technology operation and application is still considered at research stage. The increasing in scientific literature publications and projects [3,5] is showing the growing interest in the technology, usually followed by seminars and public dissemination campaigns. Concluding, this category is in a positive trend expected to grow with future progress in dissemination.

The Public Opinion and Perceptions (POP)

Cathegory:				POP		Perception level:					Very Acceptable / Initial Maturity Conditions for Trusting																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																				Score: 2,1										

Public opinion and perceptions usually indicate if people trust the technology, or if they have doubts. Results of current analysis [3,5] are showing a positive trend, with an increasing interest in hydrogen technologies applications and a high awareness in environmental benefits for energy transition to reduce CO_2 emissions. The concept of hydrogen used as energy vector sees one of the most diverse opinions in community. However, it is worth underlining that the public mainly agrees with this concept if hydrogen is produced by renewable sources [3,5]. In fact, the public majority supports hydrogen production projects related with renewable sources to solve grid integration issues related to power fluctuations. Hydrogen production from fossil combustion processes and nuclear plants appear a less attractive for public, even considering their minor production costs [3,5]. Finally, a good perception in possible benefits, such as local economy growth, new jobs and mixed energy production plans are observed.

The Technology level (Tec)

Cathegory:				Tec		Perception level:					Very Acceptable / Initial Maturity Conditions for Trusting																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
Score: 2,1																														

The technology maturity factor focuses on different aspects, such as efficiency, reliability and costs. Particularly, this factor is an important point for all the stakeholders. The current technology perception is positive and growing. This is mainly related to the increasing of project demonstrators, incoming feedback from hydrogen technology users, etc. This phenomenon can be stated both in gas-to-power, power-to-gas and mobility applications. The public agrees with technology reliability and efficiency. However, some questions related to system lifetime and costs are still pending [3,5]. Concluding, although the technology is perceived positively, some efforts are still required to completely reach the full maturity level. In this context, enhancing system lifetime and develop scaling-up strategies for cost reduction appear as mandatory points, which are fundamentals for market penetration.

The Environment impact (Env)

Cathegory:				Env		Perception level:					Very Acceptable / Initial Maturity Conditions for Trusting																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
Score: 2,1																														

The public perception of the technology in their environment is an important point. As underlined by awareness, the public is particularly favourable and attracted to a technology's capability in CO_2 reduction and useful solutions for the energy transition. However, other parameters must be taken into account, especially if referred to community acceptance. In this context, possible impacts in local flora and fauna and landscape are usually investigated. Concerning hydrogen, public seems to be less concerned by these aspects, and when expressed, doubts are mainly related to a low level of knowledge. Considering noise, hydrogen technologies seem to be particularly appreciated. Some minor exceptions can be stated for FCEV where the lack of noise can be perceived as a danger for pedestrians [3,5]. In any case, the public seems more interested in possible environmental benefits, thus resulting in a positive evaluation. Concerning hydrogen, no strong doubts about negative environmental impact are noted, while local inhabitants are mainly looking for safety criteria.

Policy Makers (PM)

Cathegory:				PM		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
Score: 1,7																														

The public perception of regulatory framework, government and public funding, is still an important point. The scenario of the NWE area's government strategies and incentives until 2019 is given in WP LT, Deliverable 2.2-Interim Report 1 [5], while additions in current initiatives are available in WP LT, Deliverables LT1.1- Roadmap Study for Tidal Generation with Electrolysis [12], and LT2.3 - Opportunities for Roll-Out of Tidal Generation with Electrolysis Across North-West Europe [13]. Finally, legislations and regulations are referred in WP LT Deliverable LT4.3 - Hydrogen Handling and Logistics [14]. Considering the last years, it is possible to state a continuous growth in European funding and government initiatives for hydrogen technologies. Particularly, followed by the technology maturity perception, funding strategies resulted in a progressive increase in new projects and demonstrator creations. The actual framework shows that, driven by project demonstrators and market needs, the task to improve / create legislation in the hydrogen domain has started and is currently on-going. However, public perception on policy makers' initiatives is still quite reserved [3,5]. Several comments can be observed on this topic and can be summed-up as follows: asking for more funding and support for commercial partners and R&D collaborative projects, more regulations and streamlined procedures, more visibility in political knowledge and particularly, in long-term strategies [3]. For these reasons, the policy maker trend can be considered as positive (quite good) because it is effectively in a constructive approach, but it requires suitable actions to answer any public doubts.

Residents' Doubts and Perceptions (RDP)

Cathegory:				RDP		Perception level:					Acceptable / Sufficient																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																Score: 1,6														

Local resident perception of the technology characterizes the major doubts concerning personal well-being. Affected by the NIMBY phenomenon, usually results in a reserved opinion. Although residents agree with benefits to the environment (if hydrogen is produced by renewables energy), they are more concerned about personal impact. The community seems attracted by the potential benefits, such as new local job creation and hydrogen facility availability in their neighbourhood, but simultaneously is concerned around safety standards [3,5]. It is worth underlining that, according to [3] and [5], concerns are mainly found about risks of leakage and flammability of hydrogen. However, the public opinion on the topic resulted in trust in the application of the suitable safety measures. To give an example, [15] cites: "*I do not feel more endangered by a hydrogen fuelling station than by a conventional gas station*." Concluding, although public attitudes towards hydrogen were positive and safety concerns were the minority, efforts in standards and certifications are required to change the residents quite reserved opinion. The perception is rated as sufficiently acceptable.

The Driving factors (Driv)

Cathegory:				Driv		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																			Score: 1,9											

Factors aimed to enhance public awareness are considered here. Among the different options, dissemination campaigns, media and demonstrators are largely considered as the best way to improve public awareness. Additionally, public funding and collaborative projects between higher education and private research facilities are also considered as possible leverage for acceptance. Based on these considerations, knowledge dissemination efforts in the last years led to a relatively good perception level for hydrogen technologies. However, public is always asking for better communication and more accessible information and demonstrators [3,5].

The Direct Benefits (DB)

Cathegory:				DB		Perception level:					Acceptable / Good - Closed to Initial Conditions for Trusting																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																				Score: 2,0										

Direct benefits for stakeholders are mainly related to energy cost reduction, the local economy growth and the creation of new jobs. In general, hydrogen technology supporters and potential investors are looking with interest at this factor. The public was more attracted by the possibility of local economy development and new job creation. The mayor doubts are mainly concerning local long-term policy strategies to support investors to assure durability of the new activities [3,5]. The direct benefits coupled with environmental awareness and driving factors are globally showing a positive perception.

The Costs (Cost)

Cathegory:				Cost		Perception level:					Acceptable / Sufficient																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
Score: 1,6																														

Plant installation costs, such as CAPEX, infrastructure construction and services, maintenance and operational costs are considered here. Even though hydrogen technologies are perceived as relatively mature for market penetration, costs are still the main weakness [3,5]. This perception is stated by both users, investors and general public and usually resulted in a reserved perception and doubts. This is mainly due to the fact that hydrogen production costs are higher when produced by electrolysis instead of fossil sources, and that the CAPEX of fuel cells and electrolysers technologies is still relatively high. Finally, some concerns are also found about the compression, storage and delivery supply costs. It is worth noting that this low perception is usually changed by the trust in scaling-up strategies for costs reduction, standardization and industrialization strategies. Public opinion is quite reserved and perception in cost resulted just sufficient.

Market actions and support (Mark)

Cathegory:				Mark		Perception level:					Very Acceptable / Initial Maturity Conditions for Trusting																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
Score: 2,1																														

This includes a market survey to understand both public and market receptivity to the new technology, and it is based on market building and scaling-up strategies for market penetration. Opinions of customers, investors and policy makers are of main interest. A very positive trend for technology maturity is observed for hydrogen marketing penetration. This feeling is supported by potential customers perception, initial user feedback, policy makers funding and scaling-up strategies development (mainly studied by investors) [3,5]. Moreover, the initial commercialization of FC vehicles, power-to-gas and gas-to-power plant creation proved the first items moving to technology industrialization. Consequently, both standards and automated productions are observed. These points are expected to play an important role in cost reduction. In fact, the perception of this category is still concerned by the need in cost reduction and suitable long-term strategies and regulations [3]. As a consequence, one of the priorities for actors involved in hydrogen domain is the conception of suitable road-map and long-terms strategies, to be coupled to future scaling-up scenarios analysis. The contributions of the ITEG project in these topics can be found in deliverables [12-14,16].

Hydrogen social acceptance indicators

Finally, according to table 1 criteria, the social acceptance indicators for hydrogen technologies are evaluated based on the perception levels of the observed categories. In figure 4, it is possible to state an acceptable perception of socio-political acceptance (SPA) and market acceptance (MA) estimated at 1,9, respectively. While the community acceptance (CA) is found at 1,6, indicating the residents' position as sufficient. Residents are not in opposition to the technology, even though they are quite reserved and need to be assured with more information on regulations. Concluding, hydrogen technologies are in a positive trend to reach public acceptance and market maturity. Nevertheless, some efforts are still required. It is worth noting that, the evaluated information resulted in a balanced range of public responses, including confident user, investor and researcher opinions, with less confident opinions from the general public.

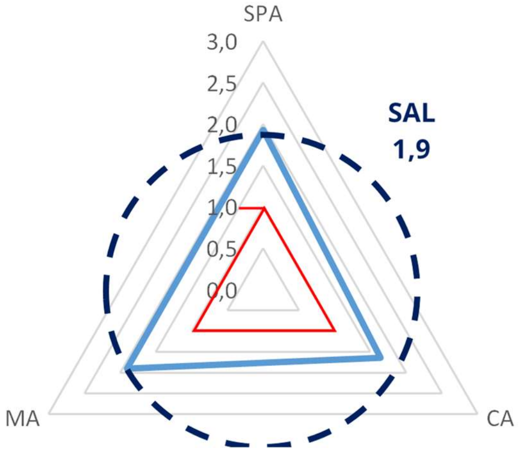


Figure 4: Hydrogen technologies' first acceptance indicators.

Marine current technologies perception

The following results involve public perception on marine current technologies. Similar to the hydrogen technologies, the prior knowledge and awareness levels, the technology maturity, the market penetration, the environment, the risks, the costs and the possible benefits are considered. It is worth noting that, compared to hydrogen solutions, tidal technologies resulted in more recent studies. Consequently, less information was available for tidal technologies than for hydrogen solutions. Although the number of inputs for classification resulted limited, all the key factors are completed. First results showed the typical outcomes for novel technology development, characterized by an initial (low) prior knowledge level. Several doubts related to the low level of awareness are countered by a favour of new technologies resulting in a sufficient, relatively good attitude and perception. Because of the novelty, the need for analysing the different aspects and underlining the possible driving factors are the main concerns. Finally, a faster improvement in acceptance indicators is expected in coming years, and confirmed by the project questionnaire results (refer to the next sections). An overview of the perception of the categories and the related concerns is reported as follows.

The Prior Knowledge (PKn)

Cathegory:				PKn		Perception level:					Doubtful / Reserved																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
Score: 1,4																														

In accordance with novel technology development, prior knowledge perception is still poor (reserved). Care must be taken in analysing this score. In fact, according to the different works available in literature [5-11], public knowledge and awareness are improving through the years and public opinion becomes more friendly, as can be stated with the score of the next categories. Efforts in the technology maturity show that tidal conversion energy systems are finally completing the development position for entering in market push strategy area [11]. This means the development of new demonstrator project, such as the ITEG project, and then more visibility and communication in tidal opportunities and results. Concluding, initial knowledge is still low, but there is a big opportunity to improve this, for example through presentations to a technology-interested public [5,6]. Several actions such as information strategies, based on journal articles (scientific and not) publications, participation acts to account residents' recommendation and financial participation [11] are currently under examination for covering this gap.

The Public Opinion and Perceptions (POP)

Cathegory:				POP		Perception level:					Very Acceptable / Initial Maturity Conditions for trusting																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																					Score: 2,1									

Concerning public opinion and perception, although the awareness level is still low, the attitude of the general public is very positive [7]. Local residents interviewed in [7] are most favourable to tidal technologies, and only the 10% of the participant opposed the technology. The main reason is that the public is particularly sensible to renewable energy production and local resources to attain energy independence. This is mainly observed for remote areas, such as in some groups of islands. Although some doubts are presented in landscape, flora and fauna possible impacts [5-11], direct benefits were more appreciated. The outstanding questions related to the need for information, the technology costs, and policy maker strategies and regulations [7-11].

The Technology level (Tec)

Cathegory:				Tec		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																			Score: 1,9											

Concerning the technology level, tidal energy conversion systems are finally completing the initial development phase (proof of concept), for entering the market push strategy area for industrialization [11]. In this scenario, public perception and trust in technology advancement is evaluated as acceptable. Projects related to tidal energy development and demonstration are growing [5,7,11], and studies related to the identification of suitable areas for tidal energy conversion has started and need to be improved [11]. In order to improve system efficiency and reliability, system design and optimization actions are considered, and finally new studies in scaling-up configuration are analysed for energy production and profit improvement. More efforts are needed, because of the limited experience in array deployment [5-11]; current demonstrators are mainly composed of individual converters. Important points are the actual lack of standards, infrastructures and service providers for grid connection, device installation, operation and maintenance [11]. The related costs, which are coupled to the capital cost of the device, result in a possible barrier for market penetration.

The Environment impact (Env)

Cathegory:				Env		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																		Score: 1,8												

Environment represents an important point for the general public. Considering energy transition and CO_2 emission reduction, a very positive opinion can be stated for tidal converters [5-11]. But environment is also composed of different aspects involving landscape, flora and fauna. Consequently, tourism, fish and marine transports sectors are also concerned. Studies [5-11] indicate potential environmental impact from tidal energy. Floating devices can have a visual impact on the landscape. However, boats (for floating systems) and buoys (for fixed systems) can be considered to have a similar impact. Thus, impact is estimated as low. Other aspects could have a more concerning effect such as noise, possible stream modifications and cable magnetic field generation impacts on flora and fauna. Several studies are on-going on these topics. Due to a lack of large-scale installations (tidal farms), studies are often performed with simulation models, laboratory scale-tests and in-situ installations based on one generator demonstrator. First results show a minor impact on possible fish migration and very low chance of lesions and mortality [5,11]. It was observed that, marine species are usually interacting with structures when the system is off and are not in direct contact with the turbine blades when the system is operating, due to their natural auto-conservation behaviour [5]. Similarly, the impact of installation, maintenance and dismantling are considered, accounting for possible contaminant leakages (mainly of lubricants). Also in these cases, the environment impact is expected to be minor [11]. The water quality variation and possible seabed and transportation phenomena are also considered [5,11]. Finally, some considerations are made about restricted area creation. If areas can be considered as a potential reservoir for marine species reproduction, other sensible questions related to navigation and fishing activities limitations are underlined [5-11]. Concluding, the public perception resulted as acceptable. The continuity of the specific and scientific studies is one of the possible keys to prove the minor environment impact. Consequently, results dissemination and direct communications with local residents are mandatory actions to improve public perception in this topic.

Policy Makers (PM)

Cathegory:				PM		Perception level:					Reserved																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
															Score: 1,5															

Nowadays, a sensible growth of funding strategies and a major awareness in regulatory framework is observed in the EU. In the last decade, 18 tidal energy related projects received EU Horizon 2020 funding and FP7 awards, and among these, 11 are developed from 2017 [11]. However, current situation in public funding, private agency support and legislation is still fragmented, due to the fact that these actions are related to national authority strategies and then it is complicated to assess a common plan [5-11]. Consequently, the public opinion is still reserved, resulting in a possible and not negligeable barrier in enhancing tidal generators penetration in the market. In fact, if appropriate funding support is expected to push the market, unsuitable local procedures will delay in projects development and investments [5-11]. Consequently, although policy makers have developed important actions in the last years, the resulting difficulty in obtaining suitable information and visibility in long-term strategies is still the major cause of doubts in public and stakeholder opinions.

Residents' Doubts and Perceptions (RDP)

Cathegory:				RDP		Perception level:					Reserved																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
															Score: 1,5															

Although public is highly interested in the potential benefits of tidal generators, several doubts, mainly related to the lack of information for novel technologies, are observed [5]. This perception resulted in a 'reserved' attitude. The possible impact on local environment is an important point for residents, joined with possible impacts on both commercial activities and personal well-being. Tidal converter installation area can influence several local activities, such as tourism and fishing. Consequently, local residents are particularly asking for more visibility and discussion on evaluating possible interactions [5-11]. Finally, some concerns related to local policy makers decisions and long-term strategies are found [5-11]. Concluding, although public opinion is still reserved, suitable information/communication strategies and resident participation in local planning development are expected to address any concerns [11].

The Driving factors (Driv)

Cathegory:				Driv		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																		Score: 1,8												

As mentioned in the previous descriptions, among the different factors aimed to enhance the public awareness, dissemination campaigns and demonstrators are considered as the best way to improve public awareness. Additionally, relevant public funding, regulatory strategies and collaborative projects between higher education and private research facilities are also required. Public opinion increases when benefits in clean energy production, energy independency / sustainability for remote areas and job creation factors are considered [5-11]. Current perception on this topic is estimated as acceptable.

The Direct Benefits (DB)

Cathegory:				DB		Perception level:					Acceptable																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																		Score: 1,8												

Direct benefits perception is acceptable and public is influenced by the energy cost reduction, the local economy growth and the related creation of new jobs. While major doubts are mainly related to local long-term policy strategies to assure investors of durability and integration of existing business activities [5-11]. Coupled with environmental awareness and driving factors, direct benefits are an important leverage to enhance the social acceptance of tidal generators. To give an example, tidal energy conversion offers large opportunities in several domains involving research and technologies, energy and business activities. Both private and public academic research are widely solicited for technology development. Companies involved in electrical device manufacturing and naval constructions, automation and services, such as management, logistics and maintenance are expected to support converters installation, operation and dismantling [11]. All these opportunities will create direct and indirect jobs to be exploited in-situ, underlining the need of long-term strategies deployment.

The Costs (Cost)

Cathegory:				Cost		Perception level:					Doubtful																			
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
													Score: 1,3																	

The public perception of factors affecting company and investor decisions in terms of costs are analysed. Economic analysis is representing the main barrier, while cost reduction will be considered as one of the best leverages for tidal energy deployment. As expected with novel technology development processes, current cost perception is poor, showing a lot of pending questions. Actual costs are mainly based on demonstrator development, without considering industrialization or without automation in manufacturing. Studies concerning scaling-up scenarios for industrialization are required and under development [5-11]. Capital expenditures (CAPEX), including system and ancillary services installation costs, and operational expenditures (OPEX), including administrative, management, operation and maintenance costs, are still relatively high [5,11]. Considering the life-cycle cost assessment with respect to the produced energy, the levelized cost of energy (LCOE) is still too high for market penetration, if not funded by public sector support [11]. Due to the development phase, it is difficult to predict cost reductions. However, considering analogies with wind technologies, this score is projected to change quickly once the proof of concept and development steps are completed and scaling-up scenarios are proposed [5].

Market actions and support (Mark)

Cathegory:				Mark		Perception level:				Acceptable																				
0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3
																		Score: 1,8												

Factors involving market penetration, such as financial analysis, technology development level, market receptivity, and actions for market creation and consolidation are analysed. A relatively good perception level was found. It is worth underlining that this is mainly related to positive public perception of the technology and trust in scaling-up phenomena and analogies with wind turbine case studies. As reported in [11], tidal converters are finally completing the development phase to enter market push strategies. However, this step will be determined by funding availability from public sectors, while investment risks can represent a possible barrier for private financing [11]. Concluding, the perception of this category is mainly based on the need for cost reduction and policy makers funding, long-term strategies and regulations assessment. As a consequence, one of the priorities for actors involved in tidal energy conversion is the development of suitable road-map and long-terms strategies, to be coupled to future scaling-up scenarios analysis. The contributions of the ITEG project in these topics can be found in deliverables [12-14,16].

Marine current social acceptance indicators

Finally, as with hydrogen technologies' case study, the social acceptance indicators for marine current technologies are evaluated. It is worth noting that because of a lower availability in information, care must be taken in considering social acceptance indicators for tidal converters. In figure 5, it is possible to state an acceptable perception in socio-political acceptance (SPA) and market acceptance (MA) estimated at 1.7, respectively. While the community acceptance (CA) is found at 1.6, indicating that local residents are not opposed to the technology, but relatively reserved. Results of the ITEG project questionnaire (performed during the period: 2021-22) confirmed this trend and showed a clear improvement of the indicators; more details are presented in the next section.

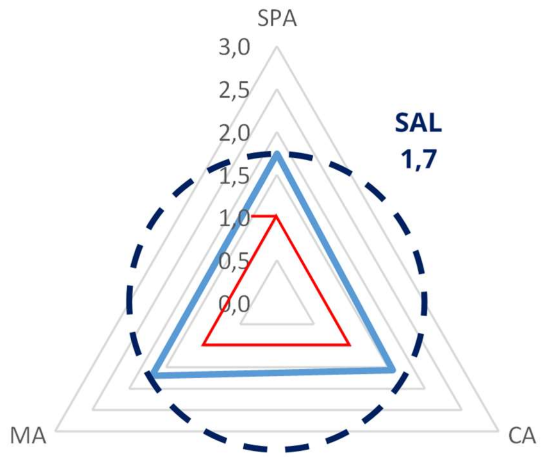


Figure 5: Tidal technologies' first acceptance indicators

Concluding, the obtained results provide the before 2020's scenario indicators. Subsequently, the 2021-22's scenario is stated by analysing the project questionnaire results. By comparing and coupling the different information (before and after 2020's scenarios), possible variation in social acceptance indicators, possible barriers and related key factors for proposing solutions are studied.

The integrated solution

Finally, the different technology perceptions are coupled to evaluate the project social acceptance level. Particularly, the ITEG project aims to support remote area energy production and sustainability by coupling tidal generator advantages and hydrogen capabilities in energy storage and grid fluctuation reduction.

Outcomes of the ITEG project are expected to support the social acceptance enhancement. Particularly, results obtained during the demonstrator development and manufacturing, installation and operation will be analysed and disseminated. Consequently, the prior knowledge and public awareness are expected to improve. Simultaneously, public questions concerning the lack of long term-strategies, cost reduction, environmental impact and the benefits will be answered by direct experience.

In order to evaluate the possible variations in social acceptance indicators for the integrated solution, both hydrogen and marine current energy converters perceptions are merged, as proposed in figure 6. It is worth noting that the obtained results are purely qualitative and are just used to set the literature survey reference level before the 2020's years. An acceptable perception is identified for socio-political acceptance (SPA at 1,8) and market penetration (MA at 1,8), while sufficient conditions for acceptability are considered for community acceptance (CA at 1.6). In the following section, information related to the 2021-22 project questionnaire results is treated based on the same criteria. The possible variations observed in the presented trends will be identified and discussed. Data variation depending on stakeholders' different points of view is also considered. Consequently, the qualitative information is merged to underline the advantages and possible benefits, the still pending questions, the possible barriers, and potential solutions. Finally, the impact of relevant benefits and driving factors are considered for social acceptance improvement.

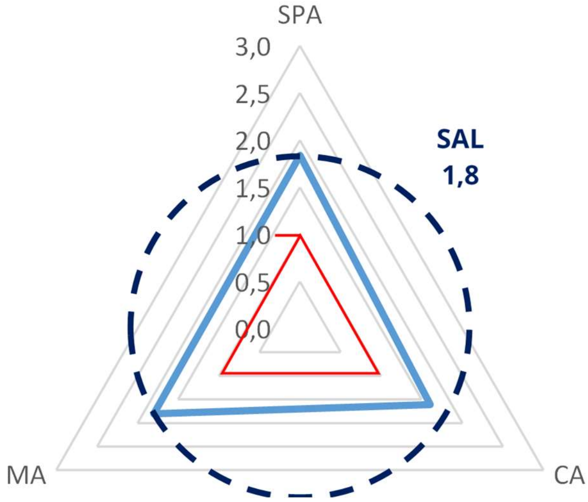


Figure 6: Integrated solution first acceptance indicators estimated matching hydrogen and tidal technologies perceptions.

Society Case Study

The stakeholder perception of the different categories is tracked throughout the ITEG project. Activity 3 was focused on this task, by analysing input from social meetings and conferences for open discussions with all the layers of society.

A questionnaire strategy is developed to track social acceptance perceptions in the North-West Europe (NWE) area based on specific target audience. The questionnaire represented a 10-minute survey for North-West Europe society case study and is aimed to investigate the acceptance levels of the technologies involved in ITEG project with respect to renewable energy solutions in general. Particularly, results of activity 1 are considered to define the different topics and target stakeholders. Among others, social awareness, environmental impact, technology maturity, energy efficiency and costs, job opportunities, market and policy makers have been selected as the major indicators to study the stakeholder feedback. The questionnaire template is attached to this document in Annex A. For sharing purposes, the questionnaire was developed on-line via the SurveyMonkey® platform (https://surveymonkey.com/), and was available on-line during one year (from the end of April 2021 to the end of April 2022). The questionnaire targets are summed in Figure 7. It is possible to differentiate the main concerns in technologies and social impact factors, the targeted countries (UK, FR, B, NL) and the targeted stakeholder groups.

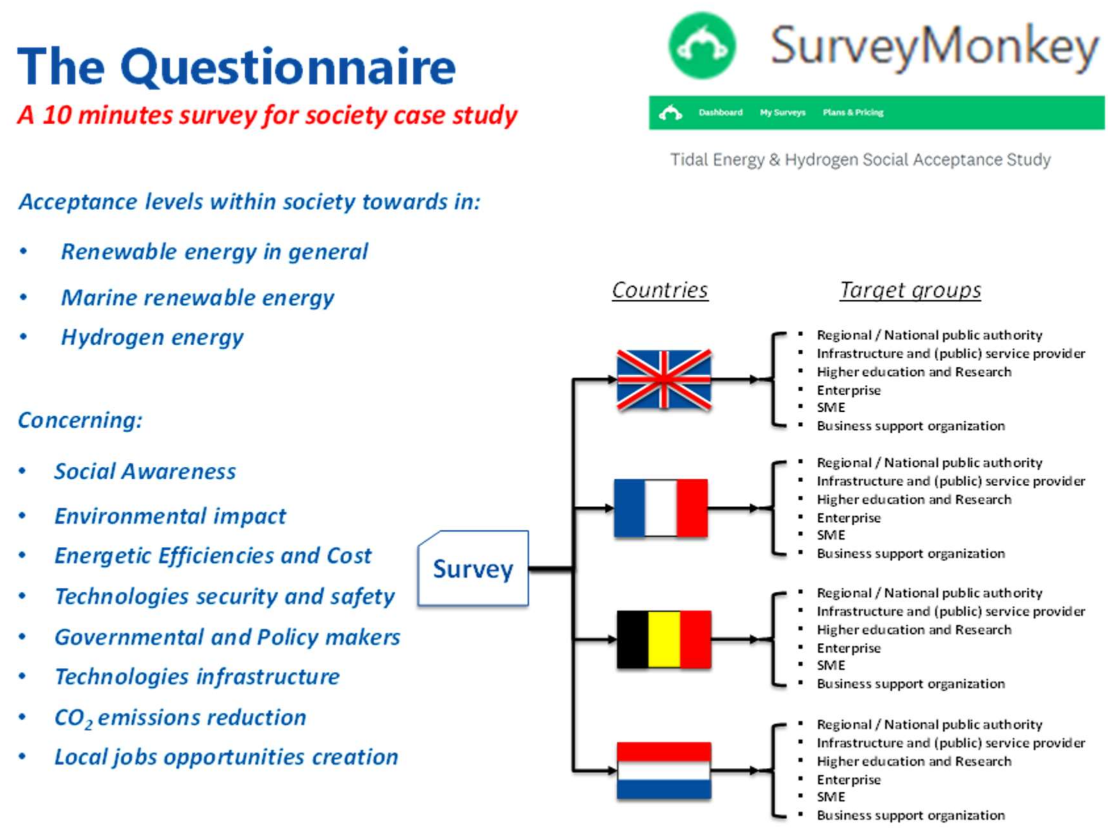
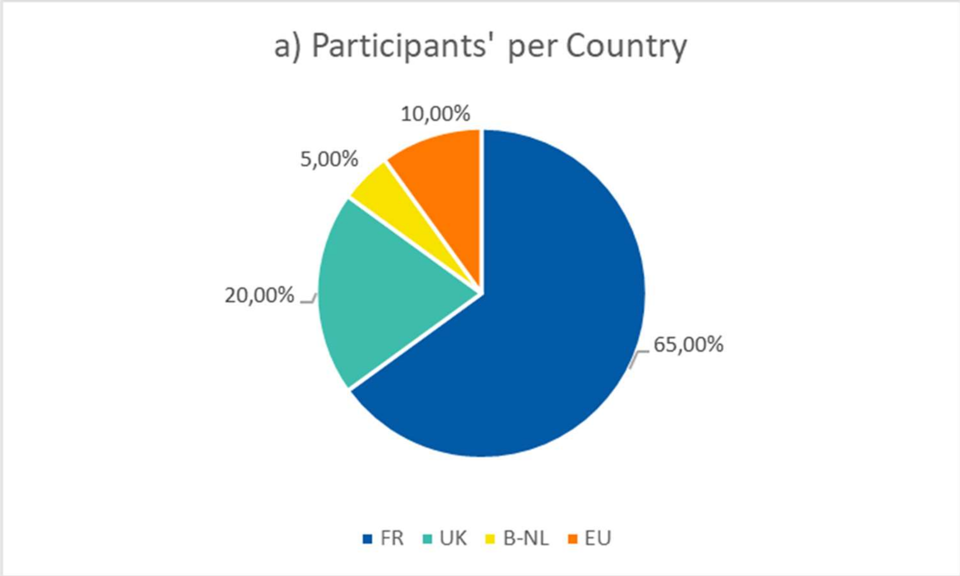


Figure 7: The questionnaire targets.

A large panel was targeted for stakeholders, including higher education and research, local and National public authorities, infrastructures and services providers, business support organization, small and medium enterprises (SME) and companies involved in different sectors (energy, manufacturing, etc.) and other (including everyday man/women, students, householders, etc.). Nevertheless, activity 3 is mainly concerned by real-life meeting input, so results have been particularly affected by the COVID-19 restrictions. In fact, although the questionnaire was available on-line, public need to be met and informed about the project for a better sharing to reach the highest number of participants. Project webinars and international conference participation represented suitable opportunities for exchange. As reported in the project communication work package, relevant efforts are observed in project activities in dissemination, public press and webinar organization. Although a high number of participants / followers was observed also in remote meeting and videoconference, the number of questionnaire participants was low. To enhance the number of participants, several options were tested. After the on-line questionnaire closure, in April 2022, the questionnaire was printed and shared during direct interviews in an additional period of 6 months. Particularly, students showed to be more receptive in participating and allowed to increase the number of answers, with a final number of 91 fulfilled questionnaires. 90% of the participants are living in the NWE area, of which 51% of people were aged between 18 and 25 years old. Particularly, observing the target groups, it was stated that 27% of the participants is working in industry. Small-medium enterprises (SME) and larger industrial groups (companies) are grouped for obtaining highest statistical inference in industrial point of view. Local and National authorities are represented by 4% of the participants, while infrastructures and service providers are representing 7% of all participants. 18% of the participants are working in higher education and research facilities, while 37% are students and the remaining 7% are householders. The resulting data-set configuration with respect to the considered countries and target groups are proposed in figure 8 (a) and (b), respectively. In order to ensure a minimum number of answers for statistical inference the questionnaire results are analysed as follows. The perceptions of the different categories are evaluated for the entire NWE area, the UK area, the FR country (only areas concerned by NWE) and NL and B zone. It is worth noting that the Netherlands and Belgium were grouped to obtain a minimum query of 5% of participants, and consequently represent the smallest dataset of the panel. The obtained perceptions are then compared with the ones estimated in the other EU countries' dataset (corresponding to 10% of all the participants). Finally, the NWE area perceptions are analysed and compared with respect to the reference estimation obtained through the literature survey activity. Concerning targeted groups, a specific analysis in stakeholder perceptions is proposed. It is worth underlining that, due to the limited number of participants, the stakeholder perceptions are used for all the NWE area (and not for single country as initially scheduled). In this case, the lower dataset is composed by local/National public authorities, infrastructures and service providers and householders, corresponding to 4%, 7%, and 7% of the panel, respectively.

Before starting to analyse the questionnaire results in depth, a first overview is given. Initial feedback showed that social acceptance is gradually growing in the last years, mainly due to public interest in energy transition, governments efforts in funding and the development of first demonstrators. Nevertheless, in accordance with the literature survey conclusions, some points are still pending. Doubts are still observed in local environment, safety, capital costs and policy (funding and regulatory) frameworks. To fully trust in the new technology and then to overcome these possible barriers, an increase in research communication and project demonstrators coupled to long-term strategies are requested by the different stakeholders.



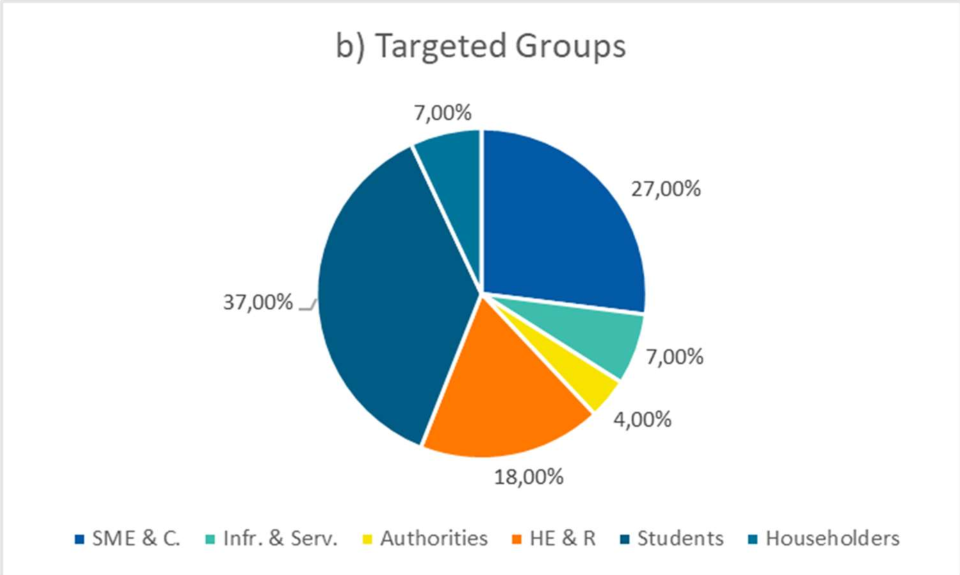


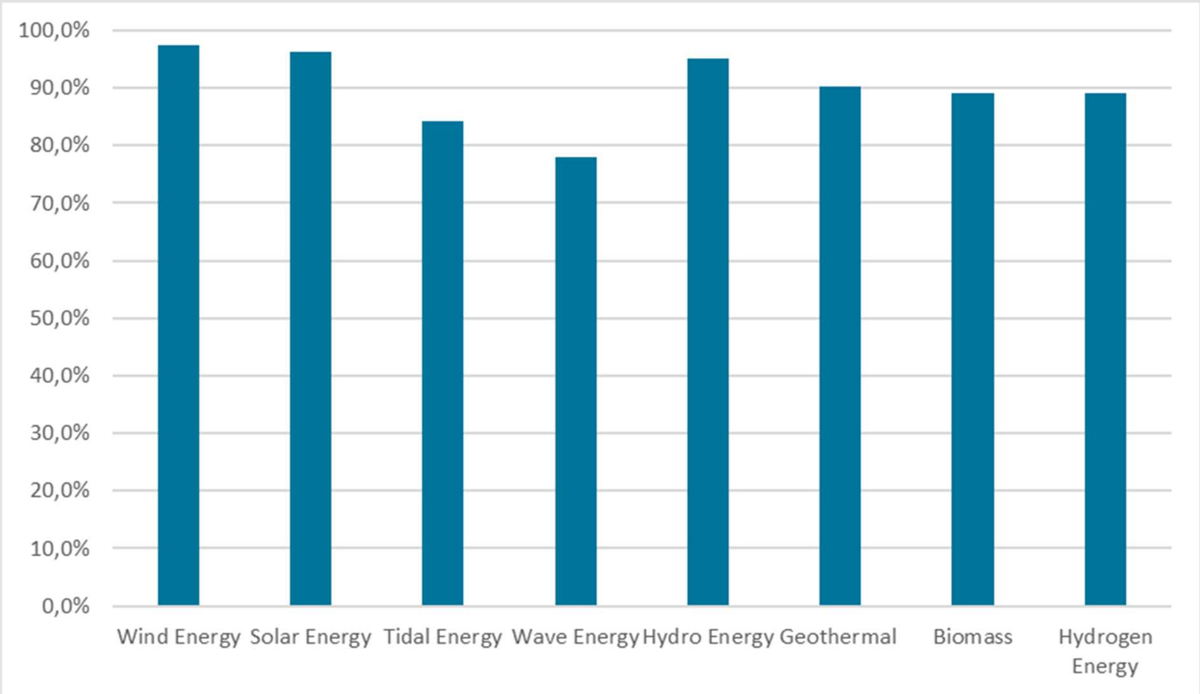
Figure 8: Questionnaire data-set origins and composition.

NWE area questionnaire results

The questionnaire is aimed to state the participants' knowledge, awareness and perceptions of the technology, environment, market and public authority strategies with respect to renewables energy technologies in general, hydrogen solutions, and marine current generators. Answers are analysed separately and then coupled to highlight the key factors perceptions.

Initially, the general level of knowledge is tested. For this purpose, participants are invited to indicate the technologies that they have heard of (question 1), rate their own level of knowledge (question 2) and specify if they heard about installations and demonstrators in their area (question 3). Question 4 deals with personal and local awareness perception, while question 5 focusses on the level of acceptability perception. The perception of the technology maturity level for market penetration and energy efficiency are evaluated in question 6. Question 7 is aimed to state participant feedback on the technologies' possible impacts on the environment and local economy. Additional aspects, such as technology safety, reliability and costs are treated in question 8, in which participants are also questioned on the perceived level of the regulatory framework, the governmental funding and the public / private partnership in research. Finally, question 9 aims to rate the participants willingness to support technology installation in their neighbourhood. Questions from 10 to 12 concern the participants' organization, nationality and age to allow data treatment (clustering) and consequently are not presented. The questionnaire was completely anonymous. Results concerning the NWE area are reported in the next section.

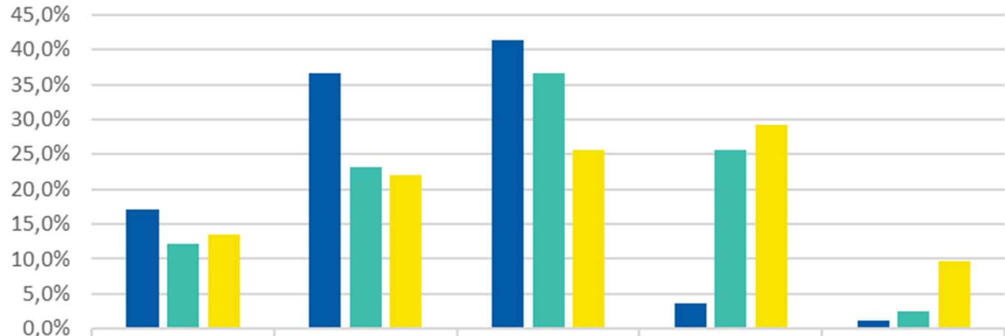
1. **Which of the following technologies have you heard of?**



Answers obtained for question 1 are positive, particularly considering the most common and accepted renewable technologies, such as wind, solar and hydro energies evaluated at 98%, 96% and 95%, respectively. Public has heard about hydrogen at 89% of the cases (the same level as biomass and geothermal solutions), while tidal resulted at about 84%, that is a very good result for a novel technology.

Although this result does not guaranty a precise prior knowledge indicator, it highlights a first awareness level, showing the impact of the previous communication and development activities performed in the NWE area on the referred technologies. Information related to the prior knowledge is then completed with the next questions.

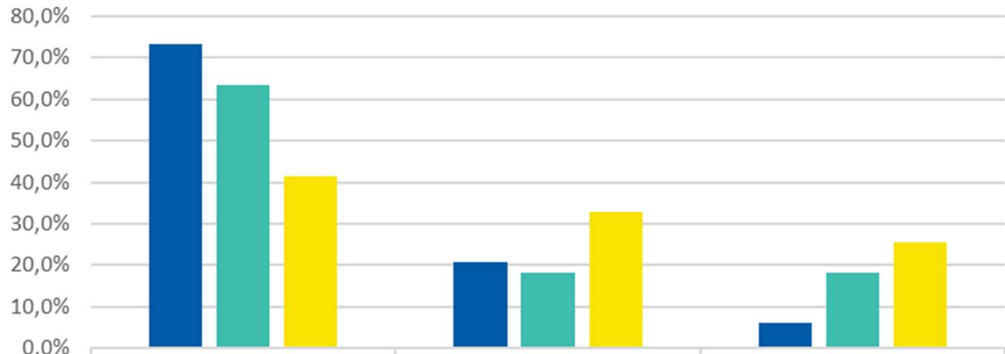
2. How would you rate your knowledge?



	Very-high	High	Average	Low	Very-low
Renewable Energy	17,1%	36,6%	41,5%	3,7%	1,2%
Marine Energy	12,2%	23,2%	36,6%	25,6%	2,4%
Hydrogen Energy	13,4%	22,0%	25,6%	29,3%	9,8%

Answers related to question 2 showed more detailed results. About 35% of the participants declared a high / very high level of knowledge for both the technologies, while around 37% and 26% have an average knowledge in marine and hydrogen technologies, respectively. A good point can be underlined in the fact that more than half of the participants have an average / high level of knowledge. Nevertheless, lower levels (low and very-low) of knowledge are observed at 28% and 39% for marine and hydrogen technologies, respectively. This last result indicates a residual gap with respect to the consolidated renewables technologies, which showed a lower level only limited at the 5% of the participants. This is mainly indicating that, although question 1 underlined that at least 84% and 89% of the participants (for marine and hydrogen energies, respectively) have heard about the technologies, this does not directly prove that the suitable knowledge level is completely attained. Consequently, actions in dissemination are still required to improve public perception in this topic.

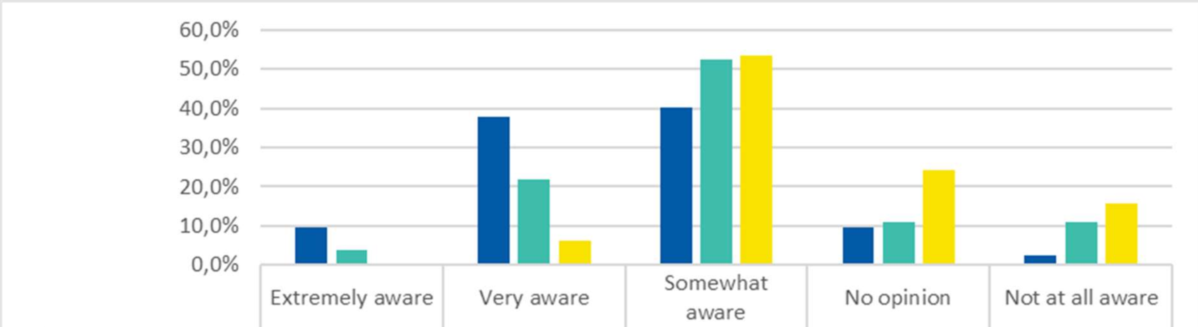
3. In your region, are you aware of any specific installation?



	Yes	Don't know	No
Renewable Energy	73,2%	20,7%	6,1%
Marine Energy	63,4%	18,3%	18,3%
Hydrogen Energy	41,5%	32,9%	25,6%

To complete the previous analysis, question 3 also confirmed the need of specific actions in dissemination. Particularly, more simple and direct communication strategies are asked to reach a larger public. In fact, although demonstrators are the best way to communicate results, a higher visibility is demanded. It is possible to state that, when an installation is realized, in their neighbourhood only 63% and 41% of the participants are informed for marine and hydrogen technologies, respectively. Consequently, the number of the not informed participants is still high (about the double with respect to the consolidated renewables technologies). This represents one of the most important points to address for social awareness improvement.

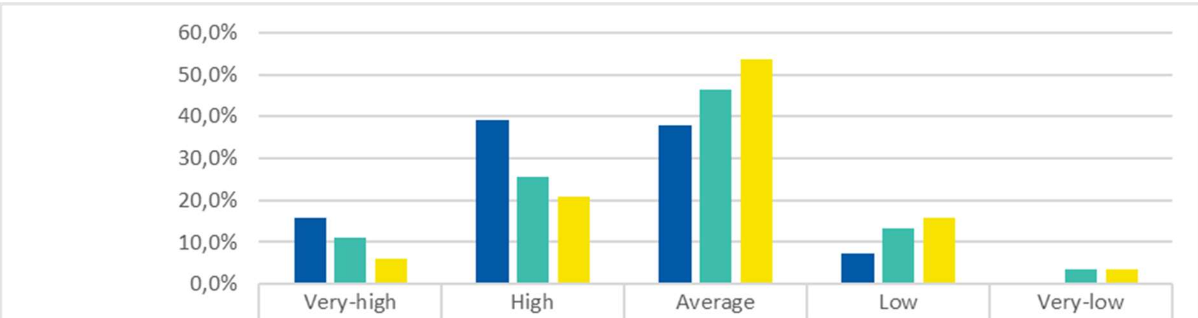
4. How would you rate public awareness in your region?



	Extremely aware	Very aware	Somewhat aware	No opinion	Not at all aware
Renewable Energy	9,8%	37,8%	40,2%	9,8%	2,4%
Marine Energy	3,7%	22,0%	52,4%	11,0%	11,0%
Hydrogen Energy	0,0%	6,1%	53,7%	24,4%	15,9%

Results of question 4 confirmed the need in communication. The lack of awareness in marine and hydrogen technologies is estimated at 11% and 16%, respectively. While consolidated renewable energy solutions showed a lack of awareness around the 2%. Additionally, no opinions about marine and hydrogen technologies are estimated at 11% and 24%, respectively.

5. How would you rate public acceptance in your region?

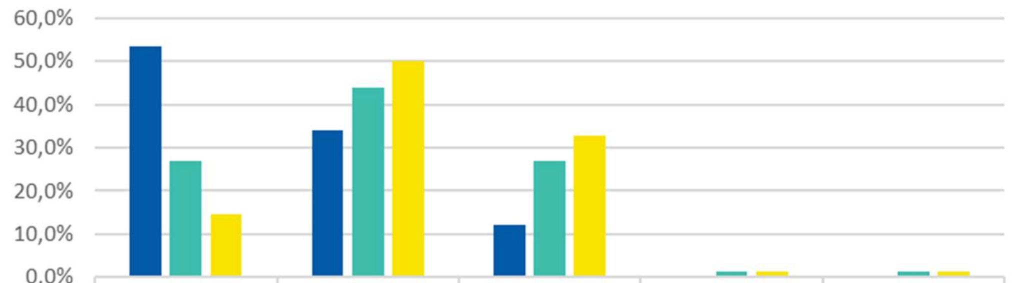


	Very-high	High	Average	Low	Very-low
Renewable Energy	15,9%	39,0%	37,8%	7,3%	0,0%
Marine Energy	11,0%	25,6%	46,3%	13,4%	3,7%
Hydrogen Energy	6,1%	20,7%	53,7%	15,9%	3,7%

Question 5 is aimed to track feedback on the perceived local acceptance. Results are quite positive, indicating that only 17% and 19% of the participants think that local acceptance is negative for marine and hydrogen energy applications. Concerning highest opinions, about 37% and 27% are counted, respectively. While 46% and 54% of the participants perceived local acceptance of the technologies in average/reserved conditions. Concluding, even if the trend in local acceptance is perceived as positive, efforts should be made to recover the lower opinions. In fact, a simple comparison with the consolidated technology perceptions highlights that lower acceptability could be as low as 7% of the participants.

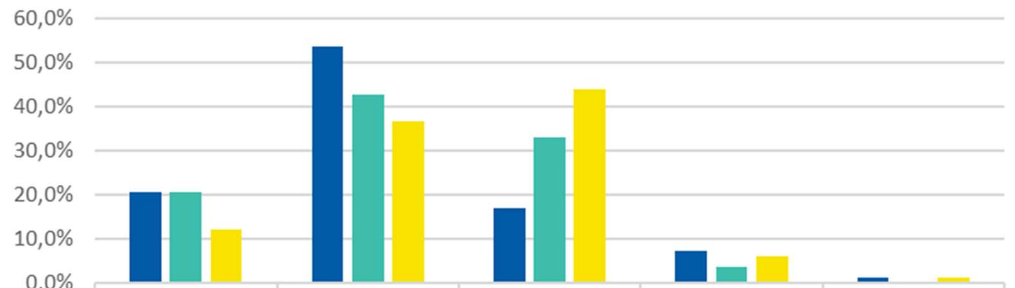
6. In your opinion, the technologies associated with the following energy sectors are:

- **<u>Ready to enter the market</u>?**



	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
Renewable Energy	53,7%	34,1%	12,2%	0,0%	0,0%
Marine Energy	26,8%	43,9%	26,8%	1,2%	1,2%
Hydrogen Energy	14,6%	50,0%	32,9%	1,2%	1,2%

- **<u>Energy efficient</u> (in generating electricity)?**



	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
Renewable Energy	20,7%	53,7%	17,1%	7,3%	1,2%
Marine Energy	20,7%	42,7%	32,9%	3,7%	0,0%
Hydrogen Energy	12,2%	36,6%	43,9%	6,1%	1,2%

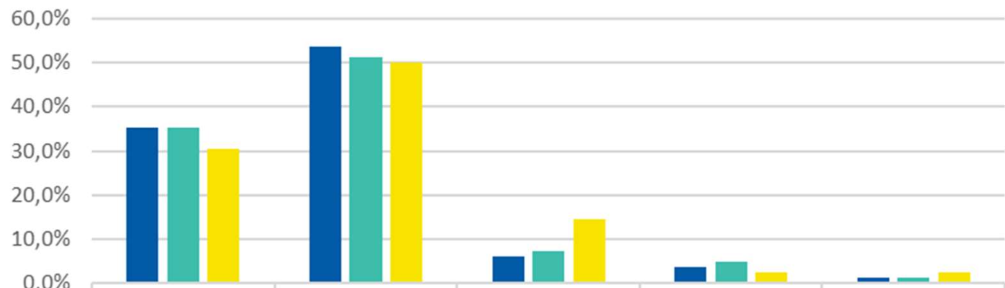
Although the prior knowledge and the public awareness level results are impacted by the need of communications, positive feedbacks are noted in evaluating technology concerns. Question 6 mainly analyses public perceptions in technology maturity for market penetration and efficiency in energy conversion and electrical power generation. In both cases, the trends are good and consistent when comparing with consolidated renewable technologies.

For technology maturity for market penetration, participants are confident that if developed by suitable research activities the technologies are ready. Particularly, consolidated technologies show about 88% of agreements and only 12% of participants are reserved. In case of marine and hydrogen technologies, agreements are rated at 71% and at 65% of the participants, respectively. Only a negligible 2% of disagreement is stated for both the solutions. While reserved opinions involve 27% and 33% of the participants, respectively. This difference with consolidated technologies can be explained with the pending questions related to the need of more visibility in technologies development and their current higher capital costs.

A similar behaviour can be found in energy efficiency perception, where the values of 75%, 17% and 8% are stated for consolidated technology agreements, reserved opinions and disagreements, respectively. In this case, marine technologies are perceived at 63%, 33% and 4%, respectively. While hydrogen technologies are rated at 49%, 44% and 7%, respectively. Concluding, the perception trend is positive, but a relevant number of participants is still reserved. Efforts in technology development and a better communication on the achieved results could improve this point.

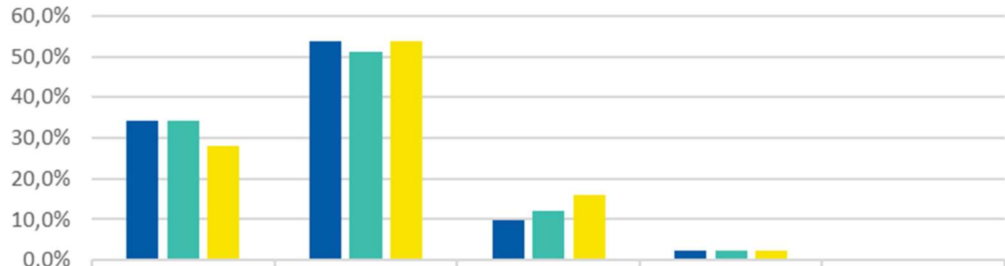
7. How would you assess the impact of the technologies on the following issues?

- **Reducing carbon emissions**



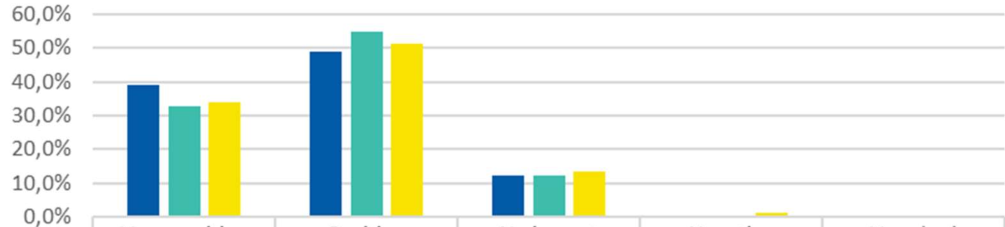
	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	35,4%	53,7%	6,1%	3,7%	1,2%
Marine Energy	35,4%	51,2%	7,3%	4,9%	1,2%
Hydrogen Energy	30,5%	50,0%	14,6%	2,4%	2,4%

- **Fighting climate change**



	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	34,1%	53,7%	9,8%	2,4%	0,0%
Marine Energy	34,1%	51,2%	12,2%	2,4%	0,0%
Hydrogen Energy	28,0%	53,7%	15,9%	2,4%	0,0%

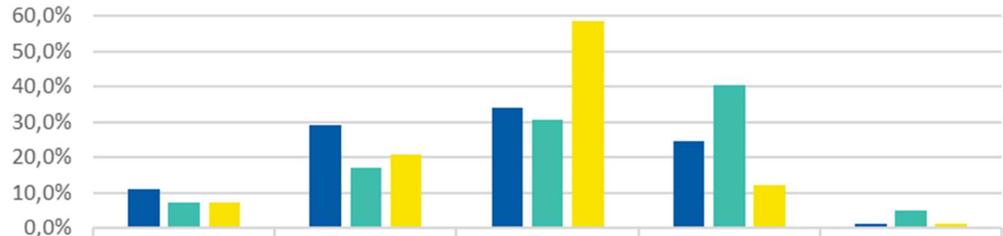
- **<u>Supporting transition</u> towards low carbon energy systems**



	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	39,0%	48,8%	12,2%	0,0%	0,0%
Marine Energy	32,9%	54,9%	12,2%	0,0%	0,0%
Hydrogen Energy	34,1%	51,2%	13,4%	1,2%	0,0%

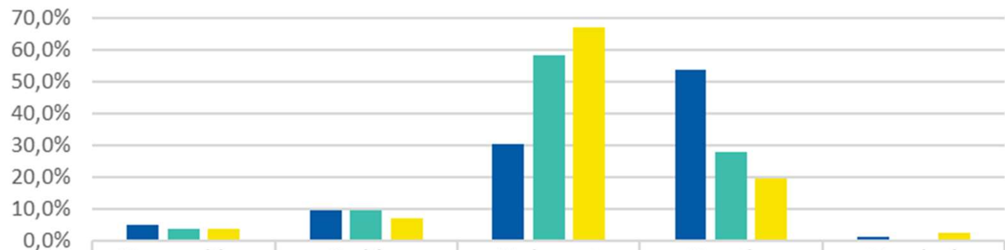
Question 7.1-5 mainly deal with stating participant perception on potential environmental impacts. Particularly, from 7.1 to 7.3, possible benefits are treated. As expected, a very good perception is stated, and similarities can be found with consolidated technologies. Participants trust both marine and hydrogen energy solutions to fight climate change, reduce CO_2 emissions and support the energy transition.

- **<u>Local ecosystems and wildlife</u>**



	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	11,0%	29,3%	34,1%	24,4%	1,2%
Marine Energy	7,3%	17,1%	30,5%	40,2%	4,9%
Hydrogen Energy	7,3%	20,7%	58,5%	12,2%	1,2%

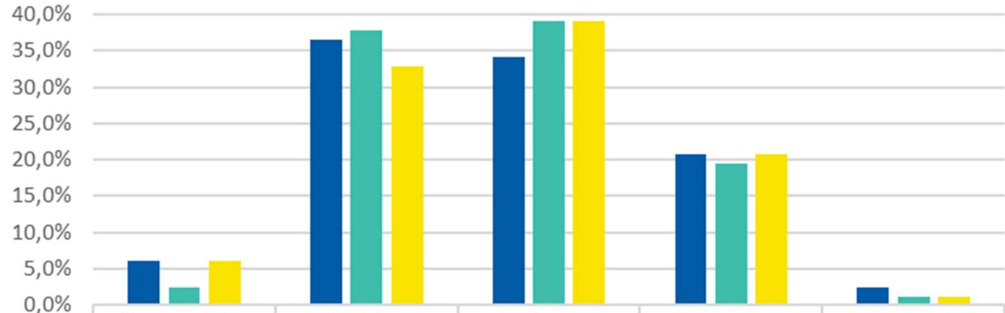
- **<u>Visual landscape</u>**



	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	4,9%	9,8%	30,5%	53,7%	1,2%
Marine Energy	3,7%	9,8%	58,5%	28,0%	0,0%
Hydrogen Energy	3,7%	7,3%	67,1%	19,5%	2,4%

Questions 7.4 and 7.5 deal with defining participant perception in possible interactions with local ecosystems and wildlife, and in the landscape. Also in this case, a very good trend is found, and in some cases better than for consolidated technologies.

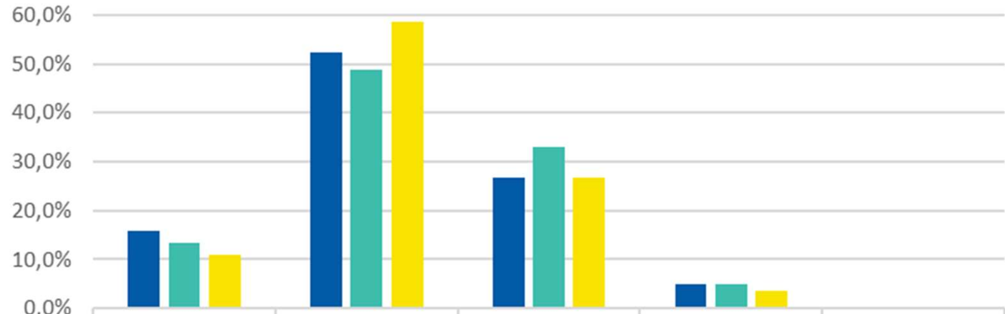
- **Energy price reduction**



	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	6,1%	36,6%	34,1%	20,7%	2,4%
Marine Energy	2,4%	37,8%	39,0%	19,5%	1,2%
Hydrogen Energy	6,1%	32,9%	39,0%	20,7%	1,2%

Question 7.6 is aimed to state public perceptions and attitudes in potential benefits in energy price reduction. Results are quite positive and in accordance with consolidated technologies. However, with about 40% confident (positive and very positive) in the renewable energies positive impact on price reduction, about 40% is reserved and the remaining 20% (negative and very negative) is pessimistic. It is worth underlining that, results are the same for both technologies. This presumes a generalized condition, maybe influenced by actual instabilities in the worldwide energy scenario, that might trouble participants.

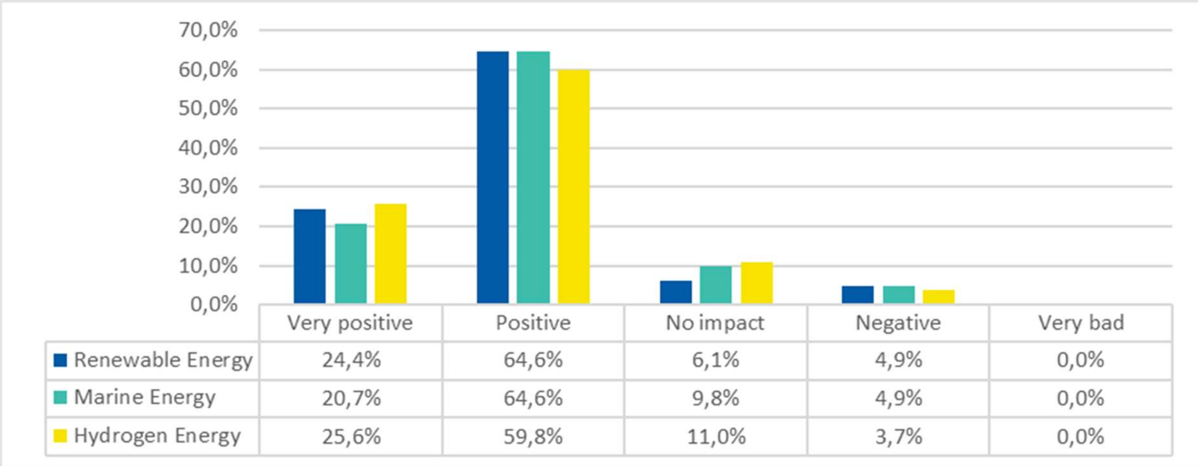
- **Local economy growth**



	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	15,9%	52,4%	26,8%	4,9%	0,0%
Marine Energy	13,4%	48,8%	32,9%	4,9%	0,0%
Hydrogen Energy	11,0%	58,5%	26,8%	3,7%	0,0%

Subsequently, public perception of potential benefits related to local economy growth are investigated in question 7.7. Results are positives, showing a common behaviour, independently of the questioned technology. In general, more than 60% is optimistic, while less than 5% is pessimistic. The remaining participants (about 30%) are reserved.

- **<u>Job creation</u>**

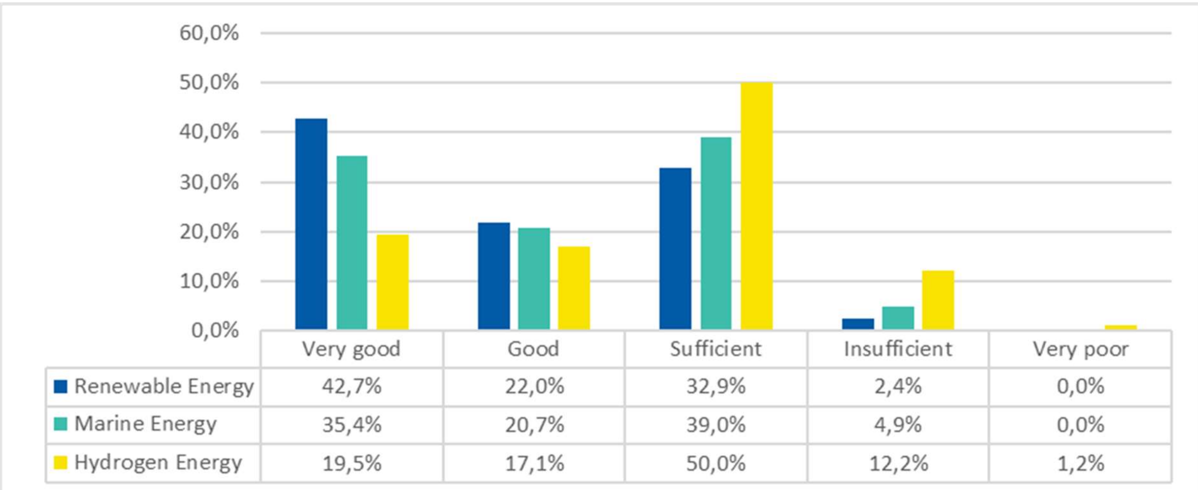


	Very positive	Positive	No impact	Negative	Very bad
Renewable Energy	24,4%	64,6%	6,1%	4,9%	0,0%
Marine Energy	20,7%	64,6%	9,8%	4,9%	0,0%
Hydrogen Energy	25,6%	59,8%	11,0%	3,7%	0,0%

One of the direct possible benefits of plant installations is the creation of new jobs. Results of question 7.8 underline a positive / very positive perception (more than 80%) in job opportunities, confirming this feature as one of the strongest driving factors for social acceptance.

8. How would you consider each of the following aspects?

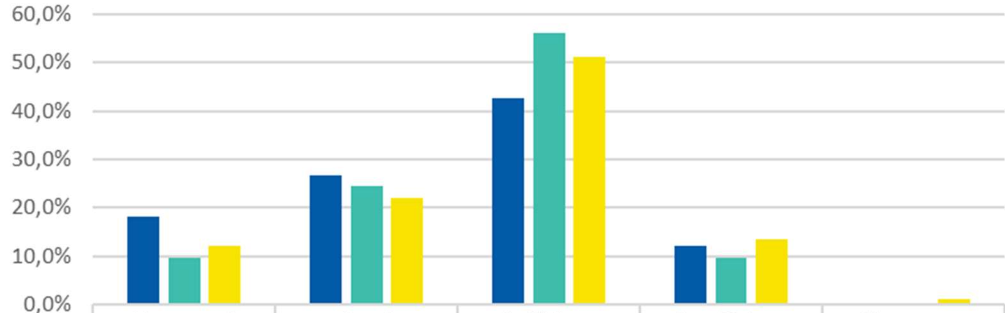
- **<u>Safety</u>**



	Very good	Good	Sufficient	Insufficient	Very poor
Renewable Energy	42,7%	22,0%	32,9%	2,4%	0,0%
Marine Energy	35,4%	20,7%	39,0%	4,9%	0,0%
Hydrogen Energy	19,5%	17,1%	50,0%	12,2%	1,2%

Question 8.1 deals with safety concerns. Results are globally positive. As expected, similar trends are observed for marine energy converters and consolidated renewable energy technology, while some differences are stated for hydrogen solutions. Considering hydrogen, only 13% of the participants have a negative perception, while the other 50% estimate the safety level as sufficient and the remaining 37% are confident. This feedback joins the results of the literature survey highlighting that, in general, public is not scared by hydrogen, but more visibility in regulatory framework, standards and certification is required.

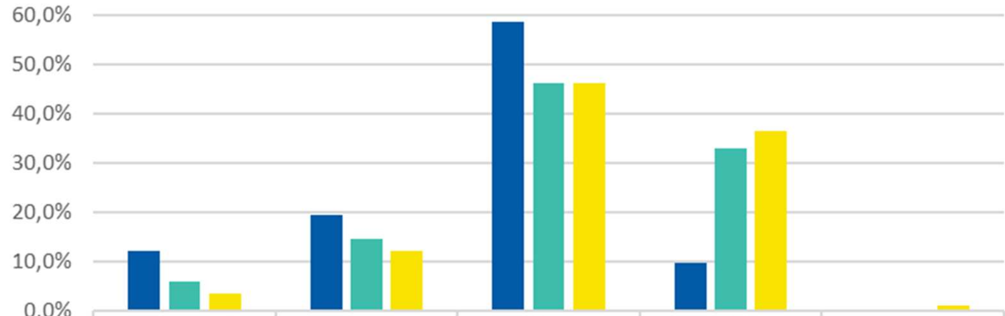
- **<u>Reliability</u>**



	Very good	Good	Sufficient	Insufficient	Very poor
Renewable Energy	18,3%	26,8%	42,7%	12,2%	0,0%
Marine Energy	9,8%	24,4%	56,1%	9,8%	0,0%
Hydrogen Energy	12,2%	22,0%	51,2%	13,4%	1,2%

The positive perceptions of trust in both technologies that were observed in question 6 are confirmed in question 8.2. Particularly, concerning reliability, it is stated that about 34% of participants have a positive perception in both marine and hydrogen technologies, with respect to the 45% attained in case of consolidated technologies. A sufficient perception is stated at 56%, 51% and 43% of the participants, in case of marine, hydrogen and consolidated renewables, respectively. Finally, negative perceptions are observed only at 10%, 15% and 12%, in case of marine, hydrogen and consolidated renewables, respectively.

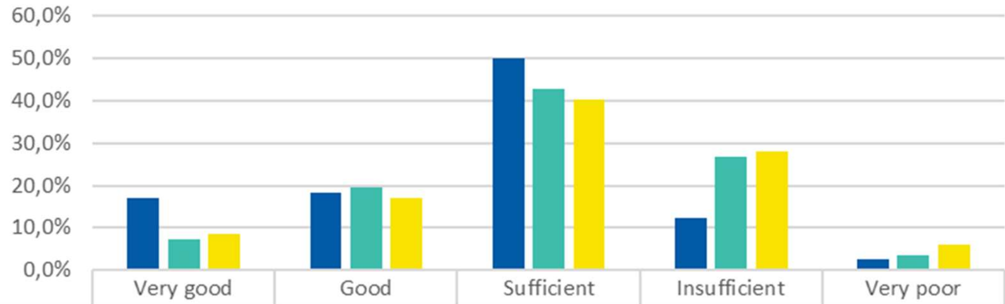
- **<u>Capital costs trajectory</u> over the coming years**



	Very good	Good	Sufficient	Insufficient	Very poor
Renewable Energy	12,2%	19,5%	58,5%	9,8%	0,0%
Marine Energy	6,1%	14,6%	46,3%	32,9%	0,0%
Hydrogen Energy	3,7%	12,2%	46,3%	36,6%	1,2%

Question 8.3 deals with economic analysis. Particularly, the participants perceptions about capital cost and possible reduction are analysed. According to literature survey, the capital costs resulted as one of the highest barriers in social acceptance and market penetration for both marine and hydrogen technologies. In this case, a clear difference can be stated with the consolidated technologies with results rated at 32%, 58% and 10% for positive (good and very good), sufficient and insufficient (insufficient and very poor) evaluations, respectively. While for marine and hydrogen solutions, only 21% and 16% of the participants are confident, respectively. Sufficient perceptions are stated around 46% of the participants for both the technologies, while a larger part (between 33% and 38%) of the participants are estimating actual reductions in capital cost as not sufficient, indicating an important barrier to overcome.

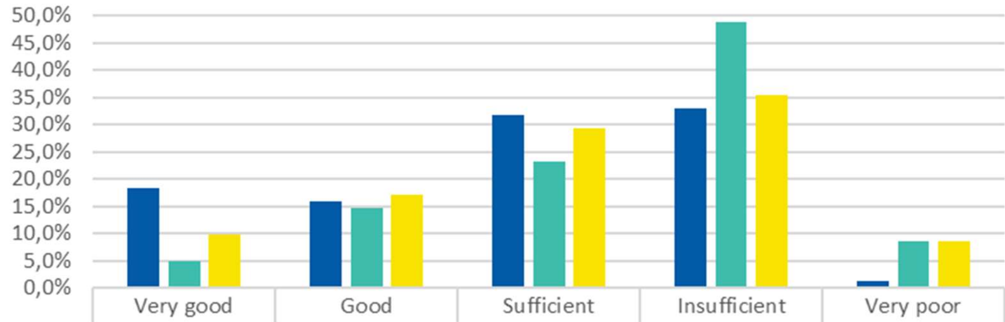
- **<u>The regulatory framework</u> with respect to the technology up-take**



	Very good	Good	Sufficient	Insufficient	Very poor
Renewable Energy	17,1%	18,3%	50,0%	12,2%	2,4%
Marine Energy	7,3%	19,5%	42,7%	26,8%	3,7%
Hydrogen Energy	8,5%	17,1%	40,2%	28,0%	6,1%

Question 8.4 aims to state public perception on current regulatory framework, standards and long-term strategies. Generally, relatively good feedback is obtained for consolidated technologies: about 35% of the participants are confident, the other 50% estimate the regulatory framework as sufficient and only the remaining 15% is unsatisfied. On the contrary, concerning marine and hydrogen technologies, the public is more demanding for developing / enhancing actual regulatory framework. For both the technologies, only 26% of participants are confident, while about 40% is reserved and about 34% is unsatisfied. Concluding, actual standards and/or a lack in regulatory framework are currently an important barrier to overcome both the technologies deployment; efforts to develop frameworks are required.

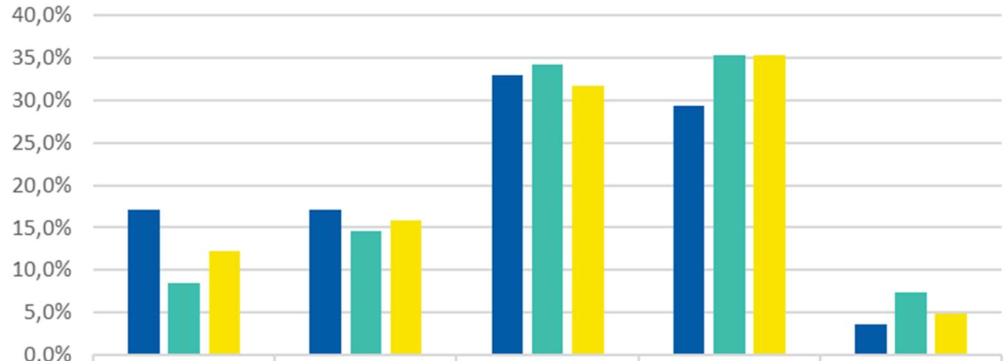
- **<u>Level of government funding</u>**



	Very good	Good	Sufficient	Insufficient	Very poor
Renewable Energy	18,3%	15,9%	31,7%	32,9%	1,2%
Marine Energy	4,9%	14,6%	23,2%	48,8%	8,5%
Hydrogen Energy	9,8%	17,1%	29,3%	35,4%	8,5%

Similarly to the previous query, question 8.5 aims to state public perception in government actions and funding. In general, the public is asking for funding, as can be seen for the consolidated technologies. Results concerning marine and hydrogen technologies are quite negative, about 57% and 44% of participants are unsatisfied, respectively. It is worth highlighting that hydrogen funding perception is quite close to the public opinion in case of consolidated technologies, due to the effects of longer EU funding and actions. While as expected in case of novel technology development, the perception in funding for marine technology appears as the critical one. Care must be taken in results interpretation. In fact, the questionnaire is evaluating only the public perception on this topic, that does not mean the actual absence of funding. On the contrary, several EU programs and government funding are created in the last decade to support renewables energy deployment. Consequently, a possible interpretation of the stakeholders' opinion should be that, due to the technology high costs, funding is a mandatory condition for rentability and market penetration.

- **<u>Partnership between public or private research institutions</u>**

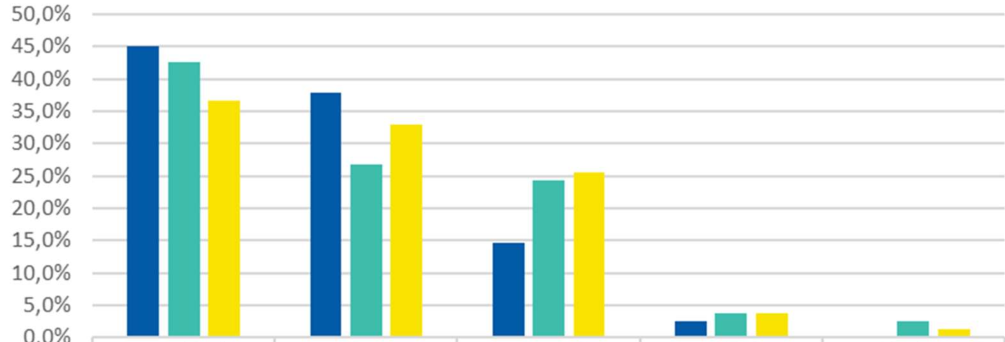


	Very good	Good	Sufficient	Insufficient	Very poor
Renewable Energy	17,1%	17,1%	32,9%	29,3%	3,7%
Marine Energy	8,5%	14,6%	34,1%	35,4%	7,3%
Hydrogen Energy	12,2%	15,9%	31,7%	35,4%	4,9%

Question 8.6 deals with analysing the community perception in public and private research partnership and collaborations. In this case, the common perception is rated as insufficient. Again, care must be taken in result interpretation. Several collaborative national and international projects are funded by the EU and the Local/National authorities for developing renewable technologies. This can be explained with research and development activities being subjected to confidentiality. When results are presented (not subjected to confidentiality), researchers prefer to publish in scientific journals. Consequently, a possible interpretation should be that, although research and development activities are on-going, the information is not accessible for the public (everyday man). To solve this point, simple communication acts aimed to generalize the high-level knowledge should be included and must be planned in parallel to the higher education dissemination activities.

The different perceptions are evaluated throughout the questionnaire, underlining positive and negative points. Among the positive perceptions it is possible to retain: the possibility of new local economies, job creation, and a common trust in the technology. While among the negative aspects, the need to raise the prior knowledge and the public awareness, to reduce the high capital costs and to enhance the still lower perception and visibility of the policy makers' strategies and funding must be underlined. In this context, question 9 aims to investigate how likely participants would like to support the different technology installations in their neighbourhood. Results are most positives for both the technologies: about 70% of the participants are favourable (likely and very likely), 25% is neutral and only 5% shows an unfavourable (unlikely and not likely at all) opinion.

9. In your region, how likely would you support?



	Very likely	Likely	Neutral	Unlikely	Not likely at all
Renewable Energy	45,1%	37,8%	14,6%	2,4%	0,0%
Marine Energy	42,7%	26,8%	24,4%	3,7%	2,4%
Hydrogen Energy	36,6%	32,9%	25,6%	3,7%	1,2%

NWE area questionnaire data treatment & extrapolation

Once the questionnaire answers were presented, results are rated based on the criteria introduced in section 1 (table 2), as follows:

- Not likely at all / Very poor / Very Negative (0,5);
- Unlikely / Not sufficient / Negative / Disagree (1);
- Reserved / No opinion / Sufficient / Average (1,5);
- Positive / Agree / Good (2);
- Very Positive / Very Good / Strongly Agree (3)

The different occurrences are then taken into account considering the individual percentages in the answer. To give an example, for question 9 it is obtained a value of 2,4 for renewable energy in general, and a value of 2,2 for both marine and hydrogen technologies. These values are included in the very acceptable / full trusting class [2,1:2,5], confirming question 9 results. Consequently, a specific score is given per each question and sub-question. Finally, questions are grouped to satisfy the key factor presented in section 1. Results obtained for hydrogen and marine technologies are reported in the following sections and compared with the literature survey reference values for additional information. Some variations can be stated with respect to the reference values deduced through the literature survey.

Before analysing results, it is worth highlighting that the different scores are used only for classification purposes, and are not indicating an evaluation.

Discussion in Hydrogen Energy perception

Table 3 refers to hydrogen technologies. It is possible to observe that, for the same prior knowledge level (PKn at 1,8), the public in the NWE area is a little more critical in determining factors' perception if compared to the reference scores. In fact, the general level of perception is acceptable, but several factors are more minor than the reference values evaluated with the literature survey. This is mainly related to the fact that the higher the level of interest and curiosity, the higher the need for information. Consequently, even if the public has heard about the technology and several disseminations activities are on-going, more effort in communication is still needed. In this scenario, information that is not easily available is directly perceived as a possible lack, potentially affecting all the determining factors. The need for clear communication is also confirmed with the sensible reduction in driving factors perception (Driv from 1,9 to 1,6). The public is open to the technology as shown by POP indicator evaluated at 2. Therefore, proposing solutions for knowledge vulgarization and giving more visibility to project demonstrators are expected to easily address this topic. The main concerns are reported for policy makers actions, concerning both regulatory framework and standards, long-term strategies and funding (PM at 1,5). Similar considerations can be stated for technology cost concerns (Cost at 1,4). The perception of both PM and Cost categories are consequently classed as reserved instead of quite acceptable, identifying them as the most sensible factors and possible barriers. However, reserved opinions are countered by the increasing in local residents' attitude (RDP is rated at 1,7 instead of 1,6). The public is not scared by hydrogen and on the contrary, is very interested in possible benefits, such as the creation of new job positions (DB is rated in trusting at 2,1 instead of 2).

Table 3: Hydrogen energy most determining factors and social acceptance evaluation in NWE area: a comparison between questionnaire results and literature survey.

H_2 Energy	Absolutely NO / Don't Trust	Not Acceptable	Doubtful / Reserved	Acceptable	Very Acceptable / Full Trusting	Excellence	*From Literature Survey*	Social Acceptance Indicators	
Class	**0 - 0,5**	**0,6 - 1**	**1,1 - 1,5**	**1,6 - 2**	**2,1 - 2,5**	**2,6 - 3**	**Ref. Class**	**Survey Ref. Ind.**	
PKn				**1,8**			**1,8**	**SPA**	**1,9**
POP				**2,0**			**2,1**	**CA**	**1,6**
Tec				**1,8**			**2,1**	**MA**	**1,9**
Env				**1,9**			**2,1**	**SAL**	**1,9**
PM			**1,5**				**1,7**	**Questionnaire Ind.**	
RPD				**1,7**			**1,6**		
Driv				**1,6**			**1,9**	**SPA**	**1,8**
DB					**2,1**		**2,0**	**CA**	**1,7**
Cost			**1,4**				**1,6**	**MA**	**1,8**
Mark				**2,0**			**2,1**	**SAL**	**1,8**

Subsequently, the acceptance indicators are evaluated based on table 1 criteria. With respect to the survey reference values presented in section 2, a slight reduction can be stated for socio-political and market acceptance indicators, while a slight improvement is observed for the community acceptance. However, it is possible to state that, in analogy with the literature survey analysis, all the indicators are classed as acceptable, resulting in a positive trend.

The slight variations are mainly related to the public perceptions' sensibility to possible geo-political, and prior knowledge factors, as can be observed in table 4, where the different scores are reported for the different countries' areas. It is possible to state that the UK area is more confident in technology, showing a high prior knowledge level. However, public from UK is reserved in technology costs and show major doubts in governmental funding and regulatory framework. The French NWE area resulted more reserved, showing the lowest (but still acceptable, PKn at 1,7) level of prior knowledge. French public (in NWE area) seem more reserved concerning the technology costs. The highest level of prior knowledge and awareness is found in Belgium and Netherland areas. However, if B-NL public opinion and interest in possible benefits are high, local residents are still reserved and stakeholders are questioning on policy makers initiatives and issues related to the high costs of the technology. Finally, a comparison with other countries of the EU is given, showing the same acceptable prior knowledge level (PKn at 1,8). Particularly, public of the EU area has a generally good opinion (POP at 1,9), trusting in possible benefits for energy transition (Env at 2,1) and local economy enhancement (DB at 2,1). However, as for the NWE area, public results are still reserved in policies and costs. The ask for better communication is also underlined and driven factors are classed as reserved (Driv at 1,5).

Table 4: Hydrogen energy determining factors perception in the different countries.

H_2 Energy	*Countries*				
	NWE	UK	FR	B-NL*	OC-EU
PKn	1,8	2,1	1,7	2,4	1,8
POP	2,0	2,2	2,0	2,2	1,9
Tec	1,8	1,9	1,8	1,8	1,7
Env	1,9	2,2	1,9	1,9	2,1
PM	1,5	1,2	1,6	1,5	1,2
RDP	1,7	1,7	1,7	1,5	1,7
Driv	1,6	1,6	1,6	1,8	1,5
DB	2,1	2,3	2,0	2,1	2,1
Cost	1,4	1,4	1,5	1,1	1,5
Mark	2,0	2,0	1,9	1,9	1,6
* Care in incertitude: corresponding only to the 5% of the panel					
Not at All	Not Acc.	Reserved	Accept.	Very Acc.	Excellent

Subsequently, the stakeholders' different perceptions are stated and compared with the global indicators obtained for the NWE area. Results are proposed in table 5. In accordance with previous results, a general acceptable perception can be stated. However, depending on the targeted group expectations and needs, some variations can be noted. Highest prior knowledge and awareness levels (PKn at 2) are found for industry (SME & C.), high education and research (HE & R) and householders (Household.), followed by public authorities (PKn at 1,9). Minor but still acceptable prior knowledge is stated for infrastructures and service providers (Infr. & Serv.) and students (PKn at 1,7 and 1,6, respectively). At difference with the householders, students appear as the less informed. The minor level of prior knowledge resulted in a critical attitude for students. However, students' perception was acceptable in general. Concluding, not reserved class (in yellow) are stated for students, confirming that the young population is commonly more confident and open to new technologies use. Concerning public opinion, all the stakeholders underlined a very good perception of the technology and of the environment impact. Particularly, SME &C, public authorities and HE & R are trusting (POP major than 2, Tec closed to 2 and Env major than 2). On the contrary, regarding policy makers attitudes, public authorities are trusting (PM at 2,1), HE & R and students are sufficiently confident with minor doubts (PM at 1,6), while SME & C, infrastructures and service providers and householders are more reserved (PM from 1,3 to 1,5). Particular doubts are concern regulatory framework, long-term strategies and funding. The perception in local residents' interactions is in general mitigated, but acceptable (RDP at 1,6 and 1,7), and only householders declared a reserved opinion (RDP at 1,5). All the targeted groups are confident in positive impact of demonstrator creation and dissemination actions, if any. In particular, the perception in driving actions is acceptable (Driv from 1,6 to 1,9), but need to be boosted. Except students (DB at 1,9, and then acceptable), all the targeted groups are trusting (DB at 2,1) in possible benefits in new economy and job creation derived from hydrogen applications.

Table 5: Hydrogen energy determining factors perception from the different stakeholders.

H_2 Energy	*Targeted Groups*						
	NWE	SME & C.	Infr. & Serv.[1]	Authorities[2]	HE & R	Students	Household.[3]
PKn	1,8	2,0	1,7	1,9	2,0	1,6	2,0
POP	2,0	2,2	2,0	2,1	2,2	1,8	2,0
Tec	1,8	1,9	1,8	2,0	1,9	1,8	1,7
Env	1,9	2,1	1,7	2,1	2,1	1,8	2,0
PM	1,5	1,3	1,5	2,1	1,6	1,6	1,3
RDP	1,7	1,7	1,6	1,7	1,6	1,7	1,5
Driv	1,6	1,6	1,7	1,9	1,7	1,6	1,7
DB	2,1	2,2	2,1	2,1	2,1	1,9	2,1
Cost	1,4	1,4	1,4	1,3	1,2	1,6	1,1
Mark	2,0	2,1	1,8	2,0	2,1	1,9	2,1
SAL	1,8	1,8	1,7	1,9	1,8	1,7	1,7
SPA	1,8	1,8	1,7	2,0	1,9	1,7	1,7
CA	1,7	1,8	1,6	1,8	1,7	1,7	1,6
MA	1,8	1,8	1,7	1,9	1,8	1,7	1,6
[1,2,3] Care in incertitude: corresponding only to the 7%, 4% and 7% of the panel, respectively							
	Not at All	Not Acc.	Reserved	Accept.	Very Acc.	Excellent	

Technology maturity for market penetration is evaluated in a positive way by all stakeholders. Particularly, SME & C, HE & R and householders are trusting in initial scaling-up strategies for market penetration and industrialization (Mark at 2,1). This can be also observed if considering current industrial efforts in fuel cell and electrolysers assembly automation. However, in alignment with the policy makers' perception, costs are still the highest barriers and, except students (costs at 1,6) all the stakeholders reported a doubtful opinion (Costs from 1,1 to 1,4).

Based on previous considerations, the different perceptions stated in hydrogen acceptance are summed-up in table 6 to underline pending questions and possible solutions.

Table 6: Hydrogen energy acceptance summed perceptions and possible actions, matching questionnaire and literature survey [3,5] information.

Positive Perception / Potential Benefits	Negative Perception / Potential Barriers	Driving Actions & Possible Solutions
Positive acceptance trend expected to growth with progress in dissemination. Good perception in technology efficiency and reliability. Public agree with environmentally friendly definition (no doubts for environment). EU and NWE area government funding are boosted. The process is on-going, and perception is quite good, but still requiring actions. Residents are attracted by possible direct benefits. Hydrogen technologies are perceived as quite mature for market penetration.	Public is asking for more communication and experience for trusting. Public opinion is reserved concerning costs and lifetime. Public is asking for more: funding and support for commercial partners and R&D collaborative projects, regulations and simplest procedures, more visibility in political long-term strategies. Public concerns are minor in safety questions, more in infrastructures' creation and support.	Efforts in **communications**: enhancing discussions with local residents and increasing dissemination actions to offer more accessible and easily friendly information. Give more visibility in policy makers funding and regulatory framework. **Developing demonstrators** in energy transition scenario, coupling several technologies for energy mix. Support R&D **collaborative projects**: enhancing collaboration between high education & private research. Improves the **regulatory framework**. Improve efforts in **standards and safety certifications**. Possibility in using direct benefits as leverage: **new jobs' creation, boost local economy durability and energy well-being enhancement.** **Support investors, services' providers and infrastructures**. **Reduce hydrogen production costs.** **Reduce hydrogen technologies' costs.** **Reduce hydrogen storage and distribution costs.** **Enhance systems' lifetime and reduce maintenance costs**. Support **scaling-up strategies** for **standardization and industrialization**. Create **road-map, business plan and long-term strategies**.

Concluding, the public is interested in hydrogen technology development, perceiving it as mature for market penetration, if efforts in cost reduction and long-term strategies deployment are improved.

Discussion in Marine Energy perception

Table 7 refers to marine current technologies. It shows a general better perception than the reference values extrapolated from the literature survey. This positive outcome can be explained as follows. Firstly, because of the novel technology the literature survey mainly referred to information available in the initial development of marine converters. Consequently, with more recent studies and related dissemination activities, familiarity is improved, enhancing the perception of all the key factors. It is worth noting that, if this logical variation is observed, it is mainly due to the public curiosity and trusting in technology (POP stated at 2,1 already in literature survey analysis). Moreover, and not negligible, participants are mainly living in areas close to the sea coasts, showing higher familiarity with marine technologies.

Table 7: Marine energy most determining factors and social acceptance evaluation in NWE area: a comparison between questionnaire results and literature survey.

Marine Energy	Absolutely NO / Don't Trust	Not Acceptable	Doubtful / Reserved	Acceptable	Very Acceptable / Full Trusting	Excellence	*From Literature Survey*	Social Acceptance Indicators	
Class	0 - 0,5	0,6 - 1	1,1 - 1,5	1,6 - 2	2,1 - 2,5	2,6 - 3	Ref. Class	Survey Ref. Ind.	
PKn				2,0			1,4	SPA	1,7
POP					2,1		2,1	CA	1,6
Tec				2,0			1,9	MA	1,7
Env				1,9			1,8	SAL	1,7
PM			1,4				1,5	Questionnaire Ind.	
RPD				1,7			1,5		
Driv				1,7			1,8	SPA	1,8
DB					2,1		1,8	CA	1,7
Cost			1,5				1,3	MA	1,8
Mark					2,1		1,8	SAL	1,8

Consequently, prior knowledge and awareness was raised from reserved to acceptable attitudes (PKn at 2). Care must be taken in analysing this outcome. In fact, it doesn't indicate that no actions are required in communication, but instead that efforts in driving actions for communications were appreciated, but still needed (driv at 1,7). In analogy with the hydrogen perception scenario, this is mainly related to the fact that, the higher the level of interest and curiosity, the higher the need for information. The technology level and possible impacts in marine environments are also perceived as acceptable (Tec at 2 and Env at 1,9), showing a slight increase in public approval. In particular, it is interesting to observe how the public is less scared than expected of impacts in marine flora, fauna and landscape, although this topic was initially anticipated as a possible barrier. Local residents' opinion raises from reserved to acceptable (RDP at 1,7 instead of 1,5), mainly due to the high interest in possible direct benefits (DB at 2,1 instead of 1,8), such as local economic growth and new job positions. When located in remote areas, the public is particularly aware of the need to produce energy by renewables and local resources to attain energy independency. Also in this case, care must be taken in results analysis. In fact, a positive outcome doesn't indicate that studies in environmental impact are not necessary or that residents' full participation is achieved, but more that, driven actions initiated in these topics are receiving public approval. In fact, to involve residents' opinions in local planning development, supported by scientific work to prove the ecosystem feasibility, and minimizing restriction for fishing and other marine activities, are still sensible points for community acceptance enhancement. Finally, in analogy with hydrogen energy perception, the real concerns are stated in policy makers actions, concerning both regulatory framework and standard, long-term strategies and funding (PM at 1,4), and for the technology costs (Cost at 1,5). The perception of both PM and Cost categories are consequently classed as reserved, identifying them as the most important factors and possible barriers.

In this new scenario, the acceptance indicators are increased with respect to the survey reference values presented in section 2. This behaviour can be stated for the totality of the indicators: the socio-political acceptance (SPA at 1,8 instead of 1,7), the community acceptance (CA at 1,7 instead of 1,6) and the market acceptance (MA at 1,8 instead of 1,7). It is possible to observe that, in analogy with the literature survey analysis, all the indicators are classed as acceptable, resulting in a positive trend.

Public perceptions on possible geo-political, and prior knowledge factors are proposed in table 8, where the different scores are reported for the different countries' areas.

Table 8: Marine energy determining factors perception in the different countries.

Marine Energy	Countries				
	NWE	UK	FR	B-NL*	OC-EU
PKn	2,0	2,2	1,9	1,7	1,8
POP	2,1	2,3	2,0	2,1	2,0
Tec	2,0	2,1	2,0	1,8	1,9
Env	1,9	2,2	1,9	1,9	2,0
PM	1,4	1,2	1,5	1,2	1,0
RDP	1,7	1,8	1,7	1,7	1,8
Driv	1,7	1,7	1,7	1,4	1,5
DB	2,1	2,3	2,0	2,0	2,2
Cost	1,5	1,7	1,5	1,4	1,8
Mark	2,1	2,1	2,1	1,8	1,8
* Care in incertitude: corresponding only to the 5% of the panel					
Not at All	Not Acc.	Reserved	Accept.	Very Acc.	Excellent

It shows that UK area is more confident in technology (in trusting), showing the highest perceptions in prior knowledge, public opinion, technology, environment impacts, direct benefits and market possible penetration. However, public from UK is still reserved in governmental funding and regulatory framework (as well as all the participants of the different countries). The French NWE area participants confirmed a general acceptable perception level, although are asking for more information to increase this level to trust. French public (in NWE area) seems more reserved concerning the governmental funding, the regulatory framework and technology costs. Similar considerations are stated for Belgium and Netherland areas, underlining a real need for communication actions. Concluding, stakeholders are mainly questioning policy makers initiatives and issues related to the high costs of the technology. Finally, a comparison with other countries of the EU area is given, showing a quite acceptable perception. Some relevant differences are stated. In particular, for this group of participants, costs are acceptable, while governmental funding and regulations are clearly not acceptable. Moreover, a reserved attitude is stated for driving actions, indicating the need for more communication and information, probably due to less familiarity with tidal phenomena and related technologies in general.

Subsequently, the stakeholders' different perceptions are stated and compared with the global indicators obtained for the NWE area. Results are shown in table 9. In accordance with previous outcomes, a general acceptable perception is observed. However, depending on the targeted group expectations and needs, some variations can be noted.

Table 9: Marine energy determining factors' perception from the different stakeholders.

Marine Energy	Targeted Groups						
	NWE	SME & C.	Infr. & Serv.[1]	Authorities[2]	HE & R	Students	Household.[3]
PKn	2,0	1,9	1,3	2,2	2,0	2,1	1,8
POP	2,1	2,2	1,9	2,2	2,2	2,0	2,0
Tec	2,0	2,0	1,9	2,1	2,0	1,9	2,0
Env	1,9	2,1	1,8	2,1	2,0	1,8	1,8
PM	1,4	1,2	1,3	1,9	1,4	1,6	1,3
RDP	1,7	1,8	1,6	1,7	1,7	1,7	1,6
Driv	1,7	1,6	1,4	1,9	1,6	1,8	1,7
DB	2,1	2,2	2,0	2,1	2,1	2,0	2,1
Cost	1,5	1,6	1,3	1,3	1,5	1,5	1,0
Mark	2,1	2,2	1,9	2,2	2,1	2,1	1,8
SAL	1,8	1,9	1,7	2,0	1,9	1,9	1,7
SPA	1,8	1,9	1,6	2,0	1,9	1,9	1,7
CA	1,7	1,8	1,6	1,8	1,7	1,8	1,6
MA	1,8	1,9	1,7	2,0	1,9	1,9	1,7
[1,2,3] Care in incertitude: corresponding only to the 7%, 4% and 7% of the panel, respectively							
	Not at All	Not Acc.	Reserved	Accept.	Very Acc.	Excellent	

Highest prior knowledge and awareness level (PKn at 2,2) is found for public authorities, followed by students (PKn at 2,1), high education and research (PKn at 2,0), industries (PKn at 1,9), and householders (PKn at 1,8). On the contrary, infrastructures and service providers appear as less informed (PKn at 1,3, in reserved conditions), resulting in a more reserved attitude for several key factors. Concerning public opinion, all the stakeholders underlined a very good perception of the technology level and of the environmental impact. Particularly, SME & C, public authorities and HE & R are in trusting (POP at 2,2, while Tec and Env vary from 2 to 2,1). The perception in local residents' interactions is acceptable for all the stakeholders (RDP from 1,6 to 1,8), being in trusting for possible benefits (DB between 2 and 2,1). Concerning the driving actions' perception, the feedback is acceptable (Driv from 1,6 to 1,9), but needs to be boosted. Only infrastructures and service providers are still reserved (Driv at 1,4). On the contrary, for policy makers attitudes, only public authorities and students are sufficiently confident with minor doubts (PM at 1,9 and 1,6, respectively), while industries, infrastructures and service providers and research are more reserved (PM from 1,2 to 1,4). In particular, doubts are more concerning around funding, regulatory framework and standards, with more visibility needed in relevant actors / agencies and their respective roles. Technology maturity for market penetration is evaluated in a positive way by all the stakeholders. Particularly, SME & C, HE & R, public authorities and students trust in possible analogies between wind and tidal turbines' technologies and consequently are confident in scaling-up strategies for market building. Nevertheless, joined to the need of policy makers' actions, marine technologies' costs are the highest barriers and, except SME and C (Costs at 1,6), the stakeholders show a reserved attitude (Costs from 1,3 to 1,4); not acceptable (cost at 1) for the householders.

Based on the previous considerations, the different perceptions stated in marine technologies' acceptance are summed-up in table 10 to underline pending questions and possible solutions.

Table 10: Marine energy acceptance summed perceptions and possible actions, matching questionnaire and literature survey [5-11] information.

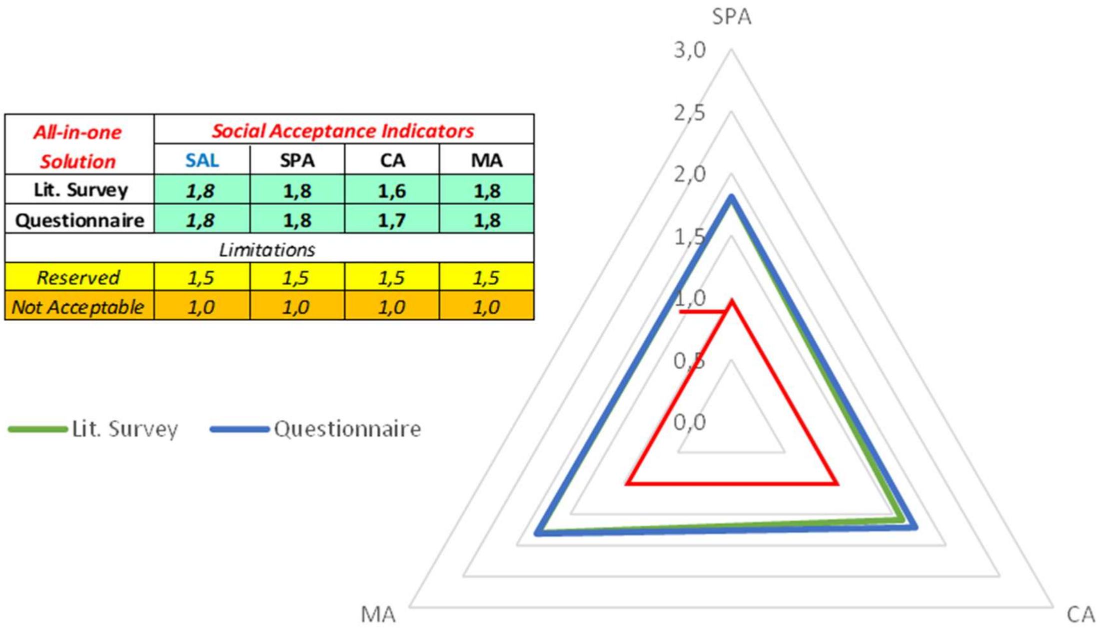
Positive Perception / Potential Benefits	Negative Perception / Potential Barriers	Driving Actions & Possible Solutions
Public opinion is positive. Local residents are favourable to tidal technologies. Public favours to produce energy by renewables and local resources to attain the energy independency. Public agree with environmentally friendly definition (for energy transition and CO_2 reduction). Tidal conversion energy systems are completed the proof-of-concept step for entering the market push strategy phase. Residents are attracted by possible direct benefits, such as new jobs and cheaper energy scenarios.	Communication must be improved to raise the awareness level and increase local residents' perceptions. Some doubts are still present on possible impacts in landscape, flora and fauna. Questioning in installation and dismantling. Questioning in creation of specific areas with restrictions for navigation and fishing activities. Current situation of public funding, private agencies support and legislation is fragmented. Difficulty in obtain suitable information and visibility in long-term strategies. Actual lack in standards, infrastructures and services providers for grid connection, device installation, functioning and maintenance.	Efforts in **communications**: enhancing discussions with local residents to acknowledge their recommendations and increase dissemination actions to offer more easily accessible and user-friendly information. Involve **residents' opinions in local planning development**. **Involve residents in financial participation.** Possibility in using direct benefits as leverage: **new job creations**, **local economy** and **energy well-being enhancement**. Improve tidal energy resource mapping by **maximizing resource availability** and **minimizing restriction for fishing and other marine activities**. **Support R&D collaborative projects**: enhancing collaboration between higher education & private research, going from simulation and small-scale prototypes to large-scale demonstrators. Develop suitable energy management system for **system control optimization**. Support **systems' components standardization and maintenance plan**. Improve / Give more visibility in **policy makers funding and strategies.** Identify the relevant actors / agencies and the respective roles. Provide **premium price per generated MWh /** introduce (or support) **strike price strategies**.

	High technology cost. High cost of installation. High costs of maintenance.	Create a common and dedicated **regulatory framework**. Create/Support **infrastructures and services' providers**. Reduce: **tidal converts and ancillaries' costs;** **installation and maintenance costs;** **administrative, management and logistic costs.** Support **scaling-up strategies**, **production standardization** and **industrialization**. Create **road-map, business plan, and long-term strategies for market development**.

Concluding, public opinion is positive. Local residents are favourable to tidal technologies and attracted by possible benefits, minor doubts are found for local fauna, flora and landscape. Studies aimed to prove the minor impact on the environment are on-going, and seems to assure local residents, who are more interested in maximizing resource availability and minimizing restriction for fishing and other marine activities. Finally, the global perception is that the technology is becoming quite mature for market, but cost reduction and funding are still mandatory for systems' deployment. Moreover, a lack of suitable procedures and standards is observed. These are the main points to resolve.

Project Configuration: The All-in-One Solution

Finally, the different technologies' outcomes are coupled to evaluate the project social acceptance level. Based on the presented results, the initial social acceptance level is estimated as proposed in figure 9. Outcomes from the literature survey and questionnaire are compared. It is possible to state that all the indicators are rated as acceptable. The same perception level of 1,8 resulted from both literature survey and questionnaire outcomes for Socio-Political (SPA) and Market Acceptance (MA) indicators. A slight improvement in Community Acceptance (CA) is observed (CA from 1,7 to 1,8) from questionnaire results, underlining the continuous growth of the community interest.



All-in-one Solution	Social Acceptance Indicators			
	SAL	SPA	CA	MA
Lit. Survey	1,8	1,8	1,6	1,8
Questionnaire	1,8	1,8	1,7	1,8
Limitations				
Reserved	1,5	1,5	1,5	1,5
Not Acceptable	1,0	1,0	1,0	1,0

Figure 9: Social acceptance initial estimation of the ITEG All-in-One configuration.

For a better interpretation of the obtained results, it is worth reminding that, values included between 1,6 and 2 indicate a favourable trend, while values above 2 indicate the technology maturity perception and full trust conditions achievement. A value closer to 1,8 is then representative of an acceptable good level for demonstration aimed at market building and industrialization. The current status of both technologies is matching this condition. Concerning hydrogen technologies, a high number of project demonstrators is available and hydrogen technologies have started to be commercialized [17]. Marine current technologies are more recent, and the number of project demonstrators is in growth. The concept proof phase has been completed successfully and demonstrators are now moving to the development phase prior to industrialisation [11]. Consequently, the technology maturity level can be considered appropriate for both hydrogen and marine energy converters applications. Questionnaires' results show that public acceptance is now positive. People are more receptive and are trusting, but communication activities are required to boost the community acceptance level. However, some issues must be highlighted for market penetration. If the public is confident, questions related to the higher costs and governmental long term-strategies and regulations must be addressed to assure investors. Outcomes of project demonstrators, such as the ITEG project, are expected to prove and communicate the technologies efficiency and reliability to support social acceptance enhancement. Public questions concerning the lack of long term-strategies, the cost reduction, the environment impact and the real benefits will be answered by direct experience.

Based on outcomes of tables 9 and 10, the relevant advantages for both the technologies are summed-up in table 11 to identify possible synergies and solutions to the potential barriers. Finally in the next section, the impact of relevant benefits and driving actions are considered for social acceptance enhancement. For this purpose, a future scenario is simulated to study the impact of both benefits and driving actions in fighting potential barriers.

Table 11: Possible synergies and advantages coupling marine energy converters and hydrogen's technologies versus possible barriers: the ITEG project possible impacts.

	H_2 Technologies Status	**Tidal converters Status**	**All-in-one solution (Possible impacts / Points of Strength)**
PKn	Level of knowledge: positive / sufficient	Level of knowledge: positive / sufficient	ITEG dissemination activities are aimed to **enhance communication** and then the public level of knowledge of both technologies.
POP	Public opinion: very positive	Public opinion: very positive	Is one of the strength points of the project (particularly coupling hydrogen production with renewables insuring clean energy sustainability)
Tec	Technology maturity: positive (first system are commercialized)	Technology maturity: good (demonstrators level activities)	ITEG project demonstrator is aimed to **prove both system operations and production efficiency**.
Env	Public opinion on environment is positive (particularly if H_2 is produced by renewables' sources)	Public opinion is positive: trust in CO_2 reduction; studies concerning possible environment impacts are on-going.	ITEG aims to enhance public acceptability offering a **clean hydrogen and electrical energy production demonstrator**. The environment friendly operations will be observed.
PM	Perception of policy makers is quite good: several funding and initial directions can be stated, but public need more visibility in long-term strategies	Is a possible barrier: If funding actions are on-going, the regulatory and standard situation is still fragmented	Expensive technologies employment is still mainly dependent on public authorities funding. ITEG project aims to **prove the technologies sustainability for investors and lenders.** Moreover, the all-in-one solution installation and operation processes will require to **analyse and clarify the current situation in permissions, standards and certifications, contributing to regulatory framework visibility enhancement**.
RDP	Public attitudes towards hydrogen were positive and safety concerns were in the minority. Efforts in standards and certifications for safety are on-going.	Public opinion is reserved, suited communication strategies and residents' participation in local planning development are demanded to solve pending questions in possible environment impact and main actors' definitions.	In analogy with PKn, ENV and PM points, ITEG project aims to clarify local residents doubts via **suited communication and dissemination** of project results. Questioning related to safety's standards and certifications, permission and regulatory frameworks will be clarified during the demonstrator installation phase. While the negligible effects in local environment will be proved with system operations.

Driv	Public perception in driving actions for H_2 awareness raising is quite good, but still demanding for communication and demonstrators	Public perception in driving actions for awareness raising in tidal energy converters is depending on communication, long-term strategies and demonstrators	ITEG contribution in driving actions for supporting public awareness growth can be directly found in answers to the PKn, ENV, PM and RDP categories' pending questions. Project **communication / disseminations activities joined to demonstrator operations** will be a fundamental asset.
DB	Public is attracted by local economy development and new job creations	Public is attracted by the local economy development, new job creations and energy sustainability	With POP and Env, DB is one of the strength points of the project. **New economies' possibilities and jobs positions** are proposed increasing local economy and energy sustainability actions.
Cost	Costs are still an important point.	LCOE is too high for market penetration if not supported by public sector and policy makers funding	Costs representing one of the major barriers, ITEG project aims to **prove the technologies sustainability for investors and lenders**. Particularly, during the system components production phase, installation and operations, costs will be monitored and optimized. The main objective is **underlining current and future possible progresses in costs' reduction.**
Mark	H_2 technologies are perceived as mature for market penetration. Some doubts in costs and logistics / distribution.	In market building. Costs' reduction and policy makers funding, strategies and regulations assessment are the main barriers.	ITEG project will contribute to a proposed **suitable road-map** and **long-term strategies**, to be coupled to future **scaling-up scenarios** analysis. ITEG demonstrator will prove the **project profitability for investors and lenders**.

Social Benefits & Driving Actions vs Barriers

This section deals with matching the expected benefits from the project and driving actions in social acceptance evolutions. Among the different key factors, the technologies' cost reduction (Capex and Opex for both PEM electrolysers and tidal turbines), the CO_2 emission reduction, and the new job creations matched best with ITEG outcomes. The perception of these factors was estimated in activity 2 of the LT2.2 work-package, where benefits are stated comparing the project system information with literature data and trends to analyse their impact on social acceptance. Particular attention will be also given to analyse communication results as a main driving factor. To improve the prior knowledge level and public awareness, suitable communication actions (public relations, press release, webinars, conference and journal scientific publications) are scheduled all along the project, involving activities going from the demonstrator manufacturing, installation and operation.

The benefits of deploying the all-in-one solution into the Orkney Archipelago energy scenario are deeply analysed in Deliverable LT.4.2 "Whole Energy System Analysis: Long Term Impacts on the Orkney Energy System" [16], where the potential larger scale deployment of the technologies is considered. In particular, the influence of introducing the ITEG solution in Orkney's local energy system is analysed, by exploring the effects of the price and performance of the proposed solution on deployment options. For grid operators, the combined technologies will provide a source of flexibility to help in matching local supply and demand, and reducing problems related to network constraints. Moreover, combining local tidal generators with hydrogen electrolysis will provide a local supply of low carbon hydrogen that could be mixed with hydrogen imported/exported to the local area for use in sectors such as industrial processes, heavy duty transport and space heating of buildings. The opportunity for revenue generation is then analysed. For ITEG contributions to the roadmap case study, and possibilities in roll-out and logistics' strategies, the reader can refer to the related project deliverables LT.1.1, LT.2.3 and LT.4.3 [12-14], respectively. In parallel with LT.4.2 actions, the LT2.2 activity 2 is charged to estimate the possible benefits' trend variations and the related impact of social acceptance on the ITEG solution.

In the current scenario, the European Green Deal aims to deploy offshore renewable energy plant to reach Europe's carbon neutral objective by 2050. Concerning hydrogen, the EU strategies in funding and support are aimed to power 40GW of renewable linked electrolysis technologies by 2030 [5,17]. While considering ocean energy, the target is 1GW of installed capacity for 2030 and 40GW in 2050. The difference in objectives timelines is mainly related to the novel technology, with tidal energy converters largely under the demonstration phase with few devices in pre-commercialization phase [18]. In this context, France has adopted three pilot farms to accommodate tidal, off-shore wind and wave technologies (Raz Blanchard, Raz Barfleur and Fromveur). The UK has fixed a legal target of 40-70 GW of new low carbon electricity capacity by 2030 and 100 GW by 2050 for reducing the LCOE [5].

These targets are expected to align with the public approval of producing hydrogen from renewable energy sources, as previously underlined by this study. In fact, current hydrogen production from electrolysis only corresponds to the 4% of the global production, instead of the more diffused steam methane reforming (SMR) processes [5,18]. This situation is mainly due to the cheaper production cost of the SMR, from 1.4 to 1.8 €/kg [17]. While, based on 2014 estimations, electrolysers' technologies show a hydrogen production cost in the range of 3.2 – 5.2 €/kg in the case of alkaline (AEL) technologies and 4.1 – 6 €/kg in the case of polymer electrolyte membrane (PEMEL) technologies [17,19]. These values are obtained considering a range in system costs varying from 1000 – 1500 €/kW and 2000-3000 €/kW for AEL and PEMEL, respectively. It should be noted that AEL technology is cheaper than PEMEL, but its electrical efficiency is around 60% instead of the 75% of PEMEL technology. Moreover, the difference in price is mainly related to the fact that PEMEL are novel technologies with respect to AEL [5]. A recent estimation [18], based in 2020 data presented in [20], proposed a lower value of about 1830 €/kW for PEMEL costs. With this reference, the levelized cost of hydrogen resulted of about 3.8 €/kg for PEMEL, including ancillaries and short-term storage at 200 bar. Nevertheless, it is worth noting that the hydrogen price can vary depending on the electricity cost. In the current energy scenario, the average price for hydrogen production from the grid is estimated at 11.34 €/kg [20]. Lower prices (around 3-6 €/kg) can be observed if hydrogen is produced from different production pathways, including renewable energy and/or special electricity prices [21-23]. According to literature [20,23], efforts are on-going in technology costs' reduction, and when hydrogen is produced by renewable energy, competitive prices can be obtained. IRENA perspectives [23] reports an important hydrogen cost reduction by 2050 considering PV and wind technologies implementation, showing comparable prices with SMR. In this scenario, public acceptance will rise and possible barriers of higher costs will be removed.

The ITEG project is in line with this concept, considering tidal energy as a renewable source for powering an electrolyser. In particular, the optimized energy management system (EMS) that, joined to tidal and electrolyser technologies' deployment is one of the mayor targets of the project, will match the tidal energy generation with grid energy demand and electrolyser needs. The highly predictable nature of tidal will be the main advantage to solve the intermittent characteristics of renewable energy, assuring the plant optimal operations and hydrogen production price reduction.

Consequently, tidal technologies' cost reduction is another important point to investigate. To be competitive with other renewable energy sources (RES), the UK strategic energy technology implementation plans (SET-Plans) targeted the tidal levelized cost of energy (LCOE) reduction at 0.15 €/kWh and 0.1 €/kWh for the years 2025 and 2030, respectively. For better understanding, the LCOE value is estimated at 0.082 €/kWh for offshore wind plants in comparison to the 0,13 €/kWh estimated for tidal, by the same authors [24]. It is possible to note that, LCOE literature estimates for tidal, are currently in a wide range from 0.115 €/kWh to 0.476 €/kWh [25]. Alex et al. [18], considered the current market scenario referred to system standalone costs, as the high-cost scenario, while system costs under scaling-up (i.e. 500MW) scenarios are assumed for low-cost estimates. Technologies capital costs are found at about 4.9 M€/MW and 1.8 M€/MW in worst and best scenarios, respectively. While the LCOE values are estimated at 0.22 €/kWh and 0.09 €/kWh, respectively. Concluding, the expected trends related to scaling-up strategies and target levelized costs fixed at 0.1 €/kWh are indicating that tidal technologies will be competitive with other RES by 2030. Moreover, to support new investment in low-carbon generation, other governmental strategies can be found to support technology during the cost reduction transition. The Contract for Difference (CFD) of the Electricity Market Reform (EMR) programme, by the UK Department for Business, Energy and Industrial Strategy is an example. A CFD is a private law contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), an independent government-owned company [26]. For this purpose, the CFD contract is based on a fixed strike price, currently assumed at about 0.25 €/kWh for tidal stream energy systems [18,27].

The ITEG project, funded by the Interreg North-West Europe programme, is operating in this framework and is in line with efforts in technologies' costs reduction. Other interesting outcomes are observed in project progress. In 2009 the target of 20% of CO_2 emission reduction was fixed by the EU by assuring the 20% of the consumed energy by RES. According with [11], tidal has a great potential. In no more than one year, the 2 MW Orbital floating turbines installed in the ITEG project has saved about 3500 $tCO_{2,e}$ (more than the fixed target of 3000 $tCO_{2,e}$), with a maximum electricity monthly production of 490 MWh stated in August 2022. This value is expected to grow with the incoming installation of the electrolyser. In fact, an additional carbon emission saving of 5.5 kgCO2/kg of produced hydrogen is expected in accordance with [18]. Finally, but not least, the opportunities in new economies and job creations are evaluated. Segura et al. [11] reported that, if suitable actions are applied, tidal converters could generate about 680,000 direct job positions by 2050. In this framework, the ITEG project progress is accounting today for 77 new direct jobs and new ones can be expected if considering plant full operations, management and maintenance.

Concluding, the capability of the all-in-one solution in generating direct benefits is stated. A large contribution in carbon emission reduction is proved, with the creation of new opportunities in local job positions. Concerning the technology costs and suited policies, an interesting scenario is emerging for costs' reduction and market development. For this purpose, the project long-term work package also developed a suitable road-map coupled to long-term strategies and possible scaling-up scenarios, as proposed in deliverables [12-14,16]. In parallel, a continuous increase in public interest is stated. During project webinars, a large number of attendants and viewers were registered, accounting for about 320 SME and enterprises, 450 high education and research, 59 public authorities and more than 1million general public.

Future trends in social acceptance

Based on project outcomes, this sub-paragraph mainly focuses on future trends predictions for social acceptance indicators. According to literature, the number of project demonstrators is increasing both for hydrogen [17] and marine current technologies [11]. As in the ITEG solution, all these projects have common objectives to develop the proposed technologies, reduce costs, support the low-carbon energy transition and enhance public awareness through targeted dissemination activities.

In this framework, the different benefits and actions previously described are considered, to evaluate the possible impact in future public acceptance perception. For this purpose, project outcomes are grouped accounting for their possible influence in key factors. The direct impacts are qualitatively estimated supposing the generalized outcomes repeatability due to the increasing number of project demonstrators expected in the following years. Subsequently, correlations are evaluated matching the information stated in collected data analysis to estimate their indirect impacts. Finally, the new social acceptance indicators are predicted. It is worth underlining that project outcomes are used to state the generic benefits and useful actions / solutions that can be obtained with a project demonstrator. In fact, demonstrators are considered as one of the best actions to prove the technology maturity for market penetration and improve social awareness and familiarity with the technology. At the same time, the pending questions related to the regulatory framework and costs are treated during the progression of the project.

In order to analyse the future possible impact in social acceptance, the relevant actions are generalized and listed in table 12. For each action, the related (direct) class is given, indicating the public possible perception and the corresponding percentage. Depending on public attitude and receptivity, the percentage values are given in a range from +1% to +5%. Subsequently, results are iterated in time domain from actual conditions (year 2022), which corresponds to the questionnaire outputs, to the future scenario in year 2050. Outcomes for the targeted periods of 2030 and 2050 are underlined. Possible saturation phenomena are accounted for, limiting each category at a maximum value of acceptance of 2,6. This value is chosen considering the maximum level stated in the case of consolidated renewables' technologies, such as solar and wind energies.

Table 12: Relevant actions to assess project demonstrators' impact in social acceptance.

Generalized outcomes and relevant actions	Class	Perception	[%]
Systems' efficiency Efficiencies of the developed technologies and of the EMS are stated and proved by demonstrator operations.	**Tec**	Public is generally receptive	3%
CO_2 emission Saved emissions will be evaluated.	**Env**	Public is generally receptive	3%
Regulatory framework The demonstrator will give visibility of public funding utilization and regulatory framework (policies, standards, certifications, etc.) application.	**PM**	Public is less receptive	1%
Communication / disseminations More familiarity with the technologies. Project dissemination activities will contribute to enhance awareness in the different factors categories.	**Driv**	Public is generally receptive and asking for	5%
Local Benefits Demonstrator installation, operations, management and maintenance will create new job positions.	**DB**	Public is generally receptive	3%
Costs Demonstrator operations will prove the technologies sustainability for investors and lenders.	**Cost**	Public is receptive but doubtful before trusting	2%
Market actions Propose suitable road-map and long-terms strategies, to be coupled to future scaling-up scenarios analysis.	**Mark**	Stakeholders are receptive	3%

In figure 10 it is possible to observe the obtained variations in social acceptance indicators. It is possible to notice that, during the first period (until 2035) all the indicators show a linear trend. This is mainly due to the gradual increasing of both the number of project demonstrators and growth in public interest. Subsequently, the different perceptions start to be saturated. The public perception is now very acceptable, people are trusting and the impact on communication is reduced. In this case, the only possible variations are due to the cost reductions and policy actions. As expected, local residents need more time to trust and consequently the saturation in community acceptance is observed 5 – 10 years later than for socio-political and market acceptance. It is interesting to state that the common perception of maturity for market penetration is finally achieved in 2030, when all the indicators raise the value to 2,1. Finally in 2050, the highest final and stable condition for acceptance is obtained.

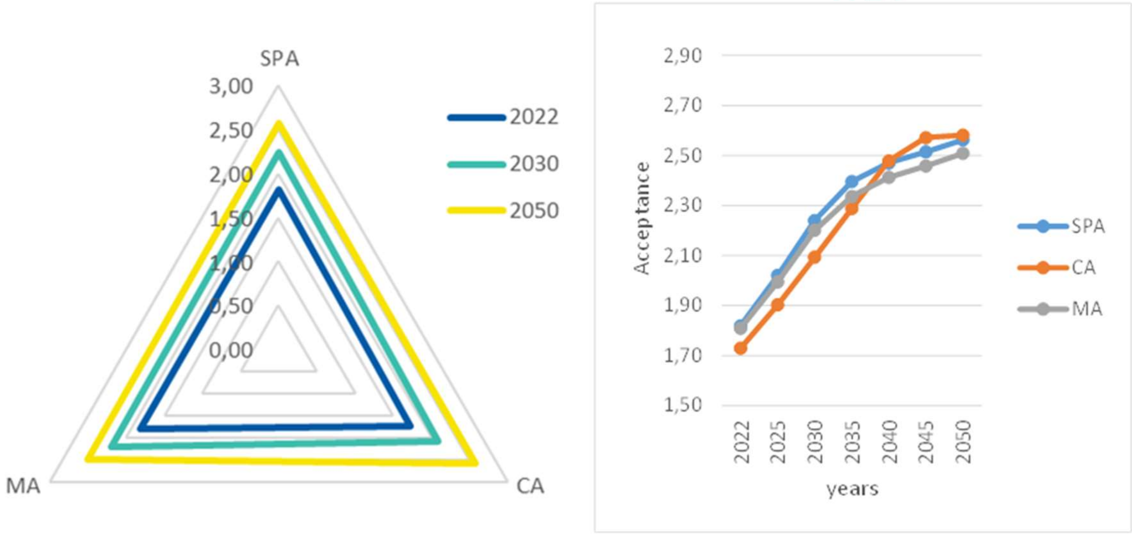


Figure 10: Project demonstrator perception and possible impact in social acceptance indicators: a) radar graph; b) indicators' expected trends in the next years.

Concluding, the main outcomes of project demonstrators are considered. In particular, the highest capacity in communication, showing both the technology maturity, the possible benefits in CO_2 reduction and the new job positions' creation, are highlighted. All these points, joined to efforts in project realization, are expected to enhance public familiarity and acceptance with the technology. A qualitative prediction of the future trends for socio-political, market and community acceptances are obtained, considering the different factors' correlations. Depending on potential public perceptions, a slight enhancement involved between 1% and 5% is supposed per each action. Results are indicating that the public is now receptive to the new technologies. The development of new demonstrators will prove the technology maturity and play a relevant role in social acceptance enhancement. If project demonstrators are developed and supported by targeted scaling-up strategies, a linear improvement is expected in the next ten years, attending the suitable conditions for market penetration.

Conclusions

This deliverable deals in evaluating the EU (more precisely, the NWE territories) social acceptance level of the ITEG project technologies, identifying potential barriers and possible solutions. The evolution of the project's social acceptability is tracked, establishing its level before and during the project duration and finally making considerations on project impact and new trends. The potential stakeholders and the most determining factors are identified firstly. Subsequently data are collected and analysed.

A short introduction of social acceptance definition is given. Social acceptance topics are defined matching with project outcomes. In particular, acceptability of hydrogen and marine current technologies are analysed in the North-West-Europe (NWE) countries. Enterprises & SMEs (including different business sectors), infrastructure service providers & business support organizations, public authorities (including governmental and public structure), higher education & research (including academical and private) and other possible inhabitant (students & householders) are considered as targeted stakeholders. Subsequently, the methodology adopted to treat and classify qualitative information is presented. For this purpose, an evaluation grid is defined to assess the different perception levels: not acceptable at all, not acceptable, doubtful, acceptable, very acceptable and excellent. The perception levels of the most determining factors are then selected as relevant features for clustering.

Results concerning the literature survey presented in the previous Deliverable 2.2-Interim Report 1 [5] are analysed and summarised. Report 1 covers 109 studies available in literature until 2019, composed of literature papers and reviews, projects' deliverables and National and European studies. Among these, 80 studies are related to the hydrogen domain, 18 to marine energy and 11 generally related to renewables' project acceptance, risks and policy makers. Moreover, more recent articles are added to the study. The social acceptance indicators are evaluated based on the perception levels of the observed categories per each technology. Concerning hydrogen, an acceptable perception of the socio-political acceptance (SPA), market acceptance (MA) and community acceptance is observed. However, the local residents' position is rated as sufficient. In particular, residents are not opposite to the technology, even if they are quite reserved and need to be assured with more information through regulations. Concluding, hydrogen technologies are in a positive trend to confirm public awareness and market maturity. Nevertheless, some efforts are still required; particularly considering policies and costs' reduction. For marine current technology, the social acceptance perception result was also acceptable, although still a low level of knowledge, and several pending questions regarding policies and costs are found. This result was mainly influenced by the lower availability of information because of novel technology. The initial gap underlined in literature survey was removed by questionnaire results. Finally, outcomes are coupled to evaluate the level of acceptance of the project's all-in-one solution.

A questionnaire strategy is developed to track social acceptance perceptions in the North-West-Europe (NWE) area based on specific targeted audience. The questionnaire aimed to investigate the acceptance levels of the technologies involved in ITEG project with respect to renewable energy solutions in general. Concerning the targeted groups, it was stated that 27% of the participants are working in industry. Local and National authorities are represented by 4% of the participants, while infrastructures and services' providers represent 7%. 18% of the participants are working in high education and research, while 37% are students and the remaining 7% are householders. Questionnaire answers are initially commented separately, underlining potential analogies and main differences with consolidated renewable energies. Subsequently, the evaluation criteria are applied for data treatment. Outcomes cover the initial gap in information availability observed in literature survey. Social acceptance indicators resulted in positive trends, although some actions are requested by participants. Combining both literature survey and questionnaire results, the main pending questions, perceived barriers and required actions are identified and summarised as following.

Concerning hydrogen technologies:

- *Pending questions:*
  - Public is asking for more communication and experience to improve trust.

- *Perceived as possible barriers:*
  - Public opinion is reserved concerning high costs and lifetime.
  - Public is reserved regarding policy makers long-term strategies and is asking for:
    - More funding and support for commercial activities,
    - Simplest procedures: regulations, standards and certifications are still confused.
  - Logistic: public concerns are regarding infrastructure creation.

- *Required actions and possible solutions:*
  - Enhance discussions with public and increase dissemination actions to offer more accessible and user-friendly information.
  - Develop demonstrators in energy transition scenario, coupling several technologies for energy mix.
  - Support R&D collaborative projects between higher education & private research.
  - Give more visibility of policy makers funding and regulatory framework.
  - Improve efforts in standards and safety certifications.
  - Possibility in using direct benefits as leverage: create new job positions, enhance local economy durability and energy well-being.
  - Support investors, service providers and infrastructures.
  - Reduce hydrogen production, technologies and distribution costs.
  - Enhance systems' lifetime.
  - Support scaling-up strategies for standardization and industrialization.
  - Create road-map, business plan and long-term strategies.

Concerning marine current technologies:

- *Pending questions:*
  - Public is asking for more communication.
  - Some doubts are still present in possible impacts on landscape, flora and fauna:
    - Questioning in installation and dismantling;
    - Questioning in creation of specific areas with restrictions for navigation and fishing activities.

- *Perceived as possible barriers:*
    - Current situation of public funding, private agencies support and legislation is fragmented.
    - Difficulty in obtain suitable information and visibility in long-term strategies.
    - Important points are the actual lack of standards, infrastructure and service providers for grid connection, device installation, functioning and maintenance.
    - The technology costs

- *Required actions and possible solutions:*
    - Enhance discussions with local residents to acknowledge their recommendations and improve dissemination actions to offer more accessible and user-friendly information.
    - Involve residents in financial participation.
    - Involve residents' opinions in local planning development.
    - Resource mapping: identify the suitable area, maximizing resource availability and minimizing restriction for fishing and other marine activities.
    - Possibility in using direct benefits as leverage: new jobs creation, local economy and energy well-being enhancement.
    - Give more visibility in policy makers funding and strategies, identifying the relevant actors and the respective roles.
    - Support investors and service providers.
    - Support R&D collaborative projects between higher education & private research.
    - Provide premium price per generated MWh / introduce (or support) strike price strategies.
    - Reduce tidal turbines and ancillaries' costs, installation and maintenance costs, administrative, management and logistic costs.
    - Support systems' components standardization and maintenance plan.
    - Support scaling-up strategies, production standardization and industrialization.
    - Create road-map, business plan, and long-term strategies for market development.

Finally, the social benefits related to the all-in-one solution proposed in the ITEG project are analysed. An overview in current technologies costs and expected reductions is given. Moreover, initial project outcomes are presented to underline the positive impact in carbon emission saving, job position opportunities and dissemination activities. All these points, joined to efforts in project realization, are expected to enhance the social acceptability. A qualitative prediction of the future trends for socio-political, market and community acceptances is presented. Results confirmed that the public is now receptive to the new technologies. With the increasing of project demonstrators, a linear improvement is expected in the next ten years, enabling suitable conditions for market penetration.

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Annex A: The Questionnaire Template

Tidal Energy & Hydrogen Social Acceptance Study

This survey should take you no more than 10 minutes to complete.

The social acceptance study of tidal energy and hydrogen technologies is developed for the ITEG (Integrating Tidal Energy into the Grid) project funded by Interreg North-West Europe.

ITEG will develop and validate an integrated tidal energy and hydrogen production solution for clean energy generation to be demonstrated in Orkney. The project addresses energy related carbon emissions in North West Europe and will tackle grid export limitations faced in remote communities.

The survey aims to measure the acceptance level within society towards the following low carbon energy sectors:

- **Renewable energy in general;**
- **Renewable marine energies;**
- **Hydrogen energy.**

Thanks for your participation.

1. Which of the following technologies have you heard of?

- ☐ Wind Energy
- ☐ Solar Energy
- ☐ Tidal Energy (offshore)
- ☐ Wave Energy
- ☐ Hydro Energy (river or estuary dam/barrage)
- ☐ Geothermal Energy
- ☐ Biomass
- ☐ Hydrogen technologies (e.g. hydrogen production by electrolysis, hydrogen-fuelled vehicles, fuel cells)

2. This survey focuses on three specific types of low-carbon energy technologies:

Renewable energy in general (e.g. power from wind turbines and solar panels);

Marine renewable energy (e.g. power from tidal stream turbines and wave energy converters);

Hydrogen energy (hydrogen production from water by electrolysis, using electricity from renewable sources, and various uses of hydrogen such as hydrogen-fuelled cars, hydrogen-fuelled domestic boilers, fuel cells, etc)

Considering these technologies, how would you rate **your knowledge** of each type?

	Very high	High	Average	Low	Very Low
Renewable energy in general and its applications	○	○	○	○	○
Marine renewable energy and its applications	○	○	○	○	○
Hydrogen energy and its applications	○	○	○	○	○

3. In your region, are you aware of any specific installation of:

	Yes	No	Don't know
Renewable energy in general	○	○	○
Marine renewable energy	○	○	○
Hydrogen energy	○	○	○

Other (please specify)

4. How would you rate **public awareness** of each of the following technologies in your region?

	Extremely aware	Very aware	Somewhat aware	Not at all aware	No opinion
Renewable energy in general and its applications	○	○	○	○	○
Marine renewable energy and its applications	○	○	○	○	○
Hydrogen energy and its applications	○	○	○	○	○

5. How would you rate **public acceptance** of each of the following technologies in your region?

	Very high	High	Neither high or low	Low	Very low
Renewable energy in general and its applications	○	○	○	○	○
Marine renewable energy and its applications	○	○	○	○	○
Hydrogen energy and its applications	○	○	○	○	○

* 6. In your opinion, the technologies associated with the following energy sectors are...

	Ready to enter the market	Energy efficient (e.g. harnessing energy, generating electricity)
Renewable energy in general		
Marine renewable energy		
Hydrogen energy		

* 7. In your opinion, how would you assess the impact of the technologies within each energy sector on the following issues?

	Renewable energy in general	Marine renewable energy and its applications	Hydrogen energy and its applications
Reducing carbon emissions			
Fighting climate change			
Supporting transition towards low carbon energy systems			
Local ecosystems and wildlife			
Visual landscape			
Energy price reduction			
Local economic growth			
Job creation			

* 8. How would you consider each of the following aspects in relation to technologies in the three energy sectors:

	Renewable Energy	Marine renewable energy	Hydrogen energy
Safety			
Reliability			
Expected capital cost (CAPEX) trajectory over the coming years			
The regulatory framework with respect to the technology uptake			
Level of government funding support			
Partnership between government and public or private research institutions			

9. In your region, how likely would you support:

	Very likely	Likely	Neutral	Unlikely	Not likely at all
Renewable energy in general and its applications	○	○	○	○	○
Marine renewable energy and its application	○	○	○	○	○
Hydrogen energy and its applications	○	○	○	○	○

Other (please specify)

10. *Finally, we'd like ask you very quickly about yourself and your organisation.*
What type of organisation do you represent ?

- ○ Small or Medium sized Enterprise (SME)
- ○ Commercial business (excluding SME)
- ○ Higher education and/or research
- ○ Local/Regional Public authority
- ○ National authority
- ○ Infrastructure and public service provider
- ○ I do not represent any organisation, I am a householder

Other (please specify)

11. In which country are you living?

- UK
- France
- Belgium
- Netherland
- Other country in North West Europe
- Elsewhere in Europe, outside the North West Europe region
- Other

12. What is your age ?

- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+
- Prefer not to say