SOWFIA: Learning from Impact Assessments of European wave energy developments

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Abstract
The lack of coordinated policy for environmental impact assessment (EIA) at offshore energy sites has been identified as a hindrance to the growth of the wave energy industry. It may simultaneously result in lack of effective and cohesive EIA monitoring. The SOWFIA Project brings together ten European partners who have an interest in planned wave farm test centres, incorporating 15 existing wave power sites. The project encourages the sharing and consolidation of wave energy development approval processes, EIA best practices for offshore wave energy conversion developments. Key objectives are: to identify barriers and accelerators in existing EIA processes in EU member states; to assess EIA focuses and methodologies at wave energy sites, and to make recommendations for the development of streamlined project approval processes. To date, the project has produced a catalogue of wave energy sites across Europe, which also summarises European targets for renewable energy and provides an overview of the member states' action plans for ocean energy. An inventory of EIA data sets being collected at European wave energy sites is currently in progress and will result in a data management platform facilitating an analysis of current impact detection capabilities. These outputs will be invaluable in streamlining the EIA process to ensure environmental protection and faster, more economically effective wave energy project development in the future. Future work will include workshops to examine barriers to the industry and a socio-economic study to examine public perceptions of offshore energy developments.

Introduction
The Streamlining of Ocean Wave Farms Impact Assessment (SOWFIA) Project is an EU Intelligent Energy Europe (IEE) funded project that brings together ten partners, across eight EU Member States, who are actively involved in planned wave farm test centres. The SOWFIA project aims to achieve the sharing and consolidation of pan-European experience of consenting processes and environmental and socio-economic impact assessment (IA) best practices for offshore wave energy conversion developments. While there are significant plans to develop wave energy farms over the coming decades, the environmental and socio-economic effects of wave energy remain relatively unknown, particularly for the larger scale wave energy developments. The regulatory tools and instruments currently in existence were not designed with wave energy in mind and may need to be adapted for this purpose. Across Europe, there is a lack of coordinated policy for both environmental and social Impact Assessment (IA).

The overall goal of the SOWFIA project, therefore, is to provide recommendations for the streamlining of approval and IA processes, thereby helping to remove legal, environmental and socio-economic barriers to the development of wave energy farms. In the SOWFIA project, fifteen of the existing and/or planned wave energy test centres in Europe have varying levels of involvement. Data, information and supporting studies from each of these sites will contribute to the findings and over-arching goals of the project. Currently, the test centres comprise a wide range of device technologies, environmental settings and stakeholder interests. Through project workshops, meetings, ongoing communication and networking amongst project partners, ideas and experiences relating to IA and policy will be shared, and co-ordinated studies addressing key questions for wave energy development carried out. By utilising the findings from technology-specific monitoring at multiple sites, SOWFIA will accelerate knowledge transfer and promote European-wide expertise on environmental and socio-economic impact assessments of wave energy projects. In this way, the development of the future, commercial phase of offshore wave energy installations will benefit from the lessons learned from existing smaller-scale developments.

This paper outlines the work that has been completed to date in the SOWFIA project. The project partnership has produced a catalogue of wave energy test centres and demonstration sites across Europe. This report summarises the European targets for renewable energy and provides an overview of the Member States' action plans for ocean energy. An inventory of environmental datasets being collected at European wave energy sites is currently underway and a data management platform has been developed with the information collected so far, which in the longer-term will facilitate analyses of impact assessment methods and current impact detection capabilities. These outputs will be invaluable in informing on how IA processes can be streamlined to ensure environmental protection and faster, more economically effective project development in the future. The paper concludes with a brief overview of the future work to be undertaken.

National targets for Ocean Energy

A review of national targets and catalogue of wave energy test centres and demonstration sites was one of the first deliverables of the SOWFIA project. The objective of this catalogue is to provide context for the future development of wave energy. This is achieved by identifying the level of ocean energy that could be introduced in order to achieve the targets set by Member States to comply with EU law, what progress has been made to date in this regard, what is needed by 2020, the timeframe associated with achieving this set of targets, and what this will look like in reality.

In 2009, the European Commission set ambitious targets for all Member States through a Directive on the promotion of the use of energy from renewable sources (2009/28/EC). This requires the EU to reach a 20% share of energy from renewable sources by 2020 and a 10% share of renewable energy specifically in the transport sector. The Directive requires Member States to submit National Renewable Energy Action Plans (NREAPs) that establish pathways for the development of renewable energy sources. These NREAPs follow a specified template and were to be submitted by each Member State to the European Commission by June 2010. Each NREAP contains a detailed roadmap of how each Member State expects to reach its legally binding 2020 target, sectoral targets, the technology mix they expect to use, the trajectory they will follow and the measures and reforms they will undertake to overcome the barriers to developing renewable energy. It should be noted that the 2020 targets are legally binding on Member States, however, the path or mix that a Member States selects to meet these targets is of their own choosing and not binding. The fact that some States have chosen to achieve their targets through the inclusion of ocean energy could however suggest a desire, and more importantly, act as a driver at the national level, to progress ocean energy development.

Within the NREAPs, the term 'ocean energy' is taken to include both wave and tidal resources. No NREAP specifies the contribution from either source. Estimation of total contribution (installed capacity, gross electricity generation) expected from ocean (wave and tidal) and offshore wind to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in electricity for the period between 2010-2014 is presented in Table 2.

Offshore wind is included for comparative purposes only. From this it is clear that there will be little or no contribution from wave and tidal energy between now and 2015.

Table 1: Estimation of total contribution (installed capacity, gross electricity generation) expected from ocean (wave and tidal) and offshore wind to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in electricity for 2010-2014 (Source: Member State NREAPs)

Member State	Source	2010 (MW)	2011 (MW)	2012 (MW)	2013 (MW)	2014 (MW)
Belgium	Tide, Wave, Ocean	n/a	n/a	n/a	n/a	n/a
	Offshore wind	n/a	n/a	n/a	n/a	n/a
Denmark	Tide, Wave, Ocean	0	0	0	0	0
	Offshore wind	661	756	856	1256	1256
France	Ocean current, wave, tidal	240	240	256	271	287
	Offshore wind	5542	6830	7598	8512	9572
Germany	Tide, Wave, Ocean	0	0	0	0	0
	Offshore wind	150	432	792	1302	2040
Greece	Tide, Wave, Ocean	0	0	0	0	0
	Offshore wind	0	0	0	0	0
Ireland[1]	Tide, Wave, Ocean (a)	0	0	0	0	0
	(b)	0	0	0	0	0
	Offshore wind (a)	36	36	36	252	252
	(b)	36	36	36	252	252
Italy	Tide, Wave, Ocean	0	0	0	0	0
	Offshore wind	0	0	0	100	129
Portugal	Tide, wave, ocean	5	5	5	10	35
	Offshore wind	0	0	0	0	0
Spain	Tide, wave, ocean	0	0	0	0	0
	Offshore wind	0	0	0	0	50
Sweden	Tide, wave and ocean energy	0	0	0	0	0
	Offshore wind	76	87	97	108	118
The Netherlands	Tide, Wave, Ocean	0	0	0	0	0
	Offshore wind	228	228	228	465	940
United Kingdom	Tide, wave, ocean	0	0	0	0	0
	Offshore wind	1390	1980	2650	3470	4450

The same information for the period between 2015-2020 is presented in Table 2, the figures again derived from individual Member State NREAPs. In contrast to the previous table, it is clear that many Member States predict a significant proportion of their renewable energy mix to come from wave and tidal energy by 2020. This commitment should act as a strong driver at national level to progress the sector.

[1] Both a modelled and a non-modelled scenario are presented in the NREAP for Ireland. Figures (a) relate to the modelled scenario and figures (b) are from the non-modelled scenario. The non-modelled scenario is an 'export' scenario illustrating Ireland's potential to become a net exporter if the appropriate conditions (economic, technical and environmental) existed. It could be considered as aspirational.

Table 2: Estimation of total contribution (installed capacity, gross electricity generation) expected from ocean (wave and tidal) and offshore wind to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in electricity for 2015-2020 (Source: Member State NREAPs)

Member State	Source	2015 (MW)	2016 (MW)	2017 (MW)	2018 (MW)	2019 (MW)	2020 (MW)
Belgium	Tide, Wave, Ocean	n/a	n/a	n/a	n/a	n/a	n/a
	Offshore wind	n/a	n/a	n/a	n/a	n/a	n/a
Denmark	Tide, Wave, Ocean	0	0	0	0	0	0
	Offshore wind	1251	1277	1302	1328	1353	1339
France	Ocean current, wave, tidal	302	318	333	349	364	380
	Offshore wind	2667	3333	4000	4667	5333	6000
Germany	Tide, Wave, Ocean	0	0	0	0	0	0
	Offshore wind	3000	4100	5340	6722	8272	10000
Greece	Tide, Wave, Ocean	0	0	0	0	0	0
	Offshore wind	0	50	100	150	200	300
Ireland[2]	Tide, Wave, Ocean (a)	0	0	13	25	38	75
	(b)	0	0	125	225	352	500
	Offshore wind (a)	252	252	416	529	533	555
	(b)	539	827	1352	1802	2096	2408
Italy	Tide, Wave, Ocean	0	1	1	1	2	3
	Offshore wind	168	220	290	385	512	680
Portugal	Tides, waves, oceans	60	75	100	125	175	250
	Offshore wind	25	25	25	25	25	75
Spain	Tide, wave, ocean	0	10	30	50	75	100
	Offshore wind	150	500	1000	1500	2250	3000
Sweden	Tide, wave and ocean	0	0	0	0	0	0
	Offshore wind	129	140	150	161	171	182
The Netherlands	Tide, Wave, Ocean	0	0	0	0	0	0
	Offshore wind	1178	1978	2778	3578	4378	5178
United Kingdom	Tide, wave and ocean	0	200	400	700	1000	1300
	Offshore wind	5500	6810	8310	9800	11300	12990

Numerous Member States are aware of the opportunities surrounding the ocean energy resource and consequently have established specific targets for wave and tidal energy, separate to the NREAPs presented above. The associated objectives, in terms of installed capacity, are commonly put forward in "roadmaps" and associated "action plans". The European Ocean Energy Association, for example, have done this in their 'Oceans of Energy' Roadmap (EU-OEA, 2010) which states that the industrial sector objective is to install 3.6 GW of generating capacity from ocean energy systems by 2020 and reach 188 GW by 2050. A composite of both NREAP targets and EU-OEA scenarios is presented in Table 3. Further information on individual Member State targets and work carried out on this to date can be found in the associated SOWFIA report.[3]

[2] Both a modelled and a non-modelled scenario are presented in the NREAP for Ireland. Figures (a) relate to the modelled scenario and figures (b) are from the non-modelled scenario. The non-modelled scenario is an 'export' scenario illustrating Ireland's potential to become a net exporter if the appropriate conditions (economic, technical and environmental) existed. It could be considered aspirational.

[3] This is available for download from the SOWFIA website: http://www.sowfia.eu/index.php?id=5

Table 3: Summary table of NREAP targets and other documented scenarios to be achieved by 2020

Country	NREAP target (wave, tidal) (MW)	Ocean energy scenarios (MW)
Europe (Total)	n/a	3600[4]
Denmark	0	500[3]
France	380	800[3]
Ireland	75 500	500[3]
Portugal	250	300[3] 0.4 – 300[5]
Spain	100	600[3]
Sweden	0	0
UK	1300	2000[3]
Scotland	n/a	1300[6]
Northern Ireland[7]	n/a	n/a[4]

While most countries recognise the potential for wave energy in their surrounding waters, relatively few of these have dedicated wave, or indeed ocean, energy strategies, plans or roadmaps. Those that do exist derive from western European countries, around the Atlantic arc. It is difficult to ascertain with any certainty how realistic the various targets and scenarios are for ocean energy. Part of this is due to the fact that in none of the documents reviewed is ocean energy expressly divided into wave and tidal components with corresponding targets for each. For countries with Atlantic Ocean coastlines, it is more than likely that the majority of their ocean energy will be provided by wave energy and not tidal. Another explanation is the fact that both wave and tidal technologies have not yet reached the commercial scale so their ability to reach the anticipated targets cannot yet be determined.

The next section of this paper endeavours to quantify the number of wave energy farms needed to reach the 2020 objectives outlined above. This will assist developers, planners and regulators, as well as the wider community, to appreciate the level of effort required to achieve these targets. It will also be of fundamental use in developing a Maritime Spatial Planning (MSP) system. MSP is a planning process that enables integrated, forward-looking, and consistent decision-making on the human uses of the sea, and in doing so facilitates sustainable development (Ehler and Douvere, 2009). The European Commission have advocated that Member States develop an MSP system for their maritime domain and many are already progressing with this, for example, Belgium, Germany and Portugal. It is important that, as a new and developing industry, the wave energy sector can move towards documenting its likely future spatial requirements.

Test Centres and Spatial Requirements

In an attempt to calculate the probable spatial requirements of wave farms needed in SOWFIA project partner countries to meet Member State ocean energy targets, the numbers put forward in both individual Member State NREAPs as well as the EU-OEA's Oceans of Energy Roadmap (2010) have been used. A number of presumptions, however, have also been made:

[4] EU-OEA, 2010
[5] WavEC Seminar. 2010
[6] Scottish Executive, 2004
[7] The Northern Ireland Strategic Action Plan (DETI, 2009) only considers tidal energy at this time.

1. Developers anticipate wave farms will comprise between 10 and 250 devices for a full-scale commercial generating station. In this example, an early stage wave energy farm composed of 20 devices of 1 MW capacity is used;
2. The NREAP targets, which use a combined figure for wave and tidal energy, have been included here with the presumption that 'ocean energy' will be derived from wave energy only;
3. To give a possible range, the figures from the EU-OEA's Oceans of Energy Roadmap (2010) have also been used here. Again it is presumed that *all* ocean energy will come from wave energy to provide the maximum amount of sea space that could be required;
4. The Pelamis device has been selected for this example. This is because it is one of the only device developers that has worked on wave farm layout and device spacing. It is 180m long and 4m diameter. Figure 1 illustrates a theoretical Pelamis wave energy farm comprised of 40 Pelamis devices with a total capacity of 30 MW. For the purposes of SOWFIA, a more conservative figure is adopted. This would equate to 20 devices of 1 MW capacity each but the proposed area is of the same proportion: 2.1km by 0.6km resulting in an area of 1.26km^2. 20 devices of 1 MW gives a power density of 16 MW/km^2 (i.e. 20 / 1.26 = *c*.16).

Figure 1 Example of Pelamis array and theoretical wave energy farm for 40 devices with a total capacity of 30 MW (www.pelamiswave.com)

5. As the technology is still developing, details of array configurations cannot be definitively determined. Current reports quote energy density extraction values between 10 – 28 MW/km^2 therefore in the following example this range is used, giving a minimum and maximum space requirement.
6. Taking all of the above into account, the estimated number of wave energy farms needed by 2020 to deliver the range of documented scenarios are summarised in Table 4.

Table 4: Wave energy farms needed if 2020 targets for wave energy are to be achieved

Country	NREAP targets (MW)	EU-OEA figures (MW)	Wave energy farms (20 MW) 10 MW/km^2 Min./Max.	Wave energy farms (20 MW) 28 MW/km^2 Min./Max.
Denmark	0	500	0/50	0/18
France	380	800[8]	38/80	14/29
Ireland	75	500	7.5/50	3/18
Portugal	250	300	25/30	9/11
Spain	100	600	10/60	4/22
UK	1300	2000	130/200	47/72
TOTAL			210.5/470	95/170

On the basis of the above hypotheses, to achieve the objectives described, it would be necessary to install and operate between 95 and 470 wave energy farms in Europe by 2020 depending on the installed capacity and wave energy density.

To calculate the spatial extent or footprint of a wave energy farm is difficult as it will depend on the technology being deployed. Similarly, different technologies will have different spacing and mooring requirements which will again have consequences for the sea area occupied. With the above caveats in mind, tentative spatial requirements for each SOWFIA partner country, are put forward in Table 5.

Table 5: Theoretical spatial extent of wave energy farms needed by 2020

Country	Wave energy farms (20MW) Min./max.	Spatial extent (km^2) Min./max.
Denmark	0/50	0/63
France	14/80	18/100
Ireland	3/50	4/63
Portugal	9/30	11/38
Spain	4/60	5/76
UK	47/200	59/252
TOTAL	95/470	120/592

Local, national and international regulations and legislation usually require a buffer zone to be created around any offshore installation in the interests of navigational safety. Equally international best practice on cable protection suggests that a buffer of 500m should be created around any cables or pipelines to prevent damage from navigational activities such as shipping and fishing practices. None of the aforementioned factors can yet be definitely expressed but will still need to be considered in planning the development and management of commercial scale wave farms.

Currently there are a number of test centres and demonstration sites operational across Europe. These are shown in Figure 2. Test centres generally host large scale and/or full scale devices for further testing. Some centres, for example, the European Marine Energy Centre (EMEC) in Orkney, has both nursery and full-scale device berthing facilities. Smaller scale demonstration sites are usually specific to one device type and not available to other device developers.

[8] This figure includes Le Rance tidal power station which has an installed capacity of 240MW.

Environmental effects and data from wave energy farms

A second key output of the SOWFIA project to date is an inventory of environmental impact monitoring activities at wave and tidal energy sites in Europe. This builds upon and complements the review of targets and catalogue of test centres referred to previously. In most EU Member States ocean energy developments require an Environmental Impact Assessment. The purpose of such an assessment is to ascertain the likely significant effects of the development on the natural environment, species, biological and physical processes. According to the EIA Directive (85/337/EEC as amended), an EIA must include 'a description of the aspects of the environment likely to be significantly affected by the proposed development, including:

- human beings, fauna and flora;
- soil, water, air, climate and the landscape;
- material assets and the cultural heritage;
- the interaction between the factors mentioned in the first, second and third indents.

In the context of wave and tidal energy development, at the EU level, no over-arching specific guidance has been formulated for developers or regulators. Some jurisdictions have produced specific guidance, e.g. Spain (Bald *et al.*, 2010) and likewise some test centres have also issued EIA guidance, for example, EMEC in Scotland (2008). Other European projects, such as EquiMar, have also been instructive in elucidating the EIA process (EquiMar, 2009). Despite these efforts, however, regulators continue to often place significant information demands on developers in order to address the substantial unknowns that relate to the marine environment generally and the impact of ocean energy devices more specifically.

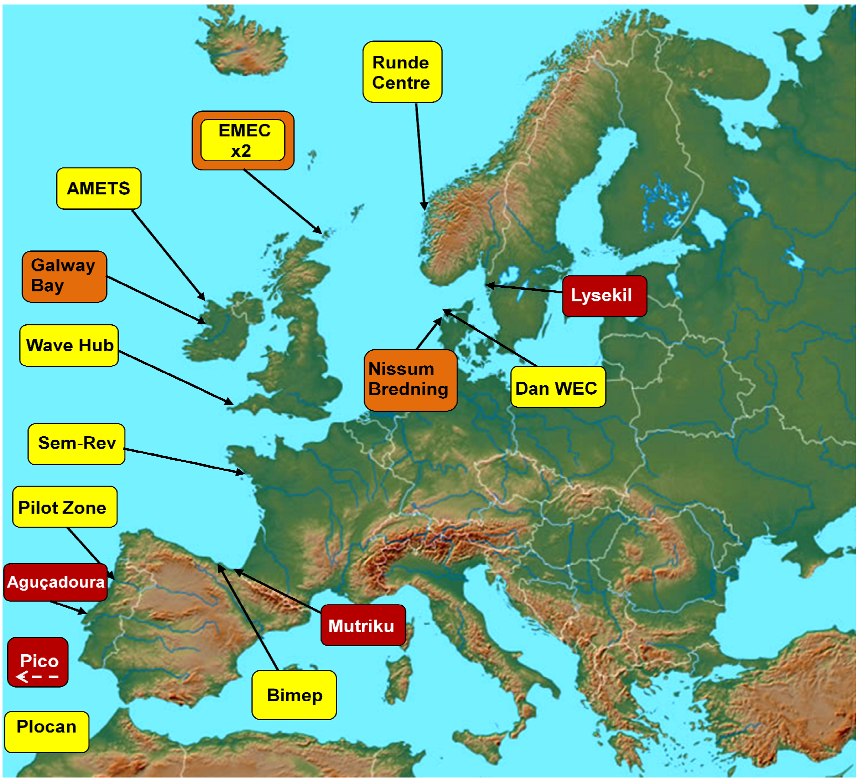


Figure 2: Location of the wave energy test centres and demonstration sites across Europe.

The Environmental Impact Assessment and associated documentation is heavily relied upon by regulatory agencies in the wider permitting process in order to determine whether consent to proceed should be granted or not. Given the number of 'unknowns' that surround the environmental effects of ocean energy devices, a precautionary approach has been adopted by many regulatory authorities resulting in regulatory enthusiasm for comprehensive monitoring programmes. A realistic and environmentally acceptable approach to both environmental and social impact assessment is a common goal of all actors in the wave energy sector. Nevertheless, the desire to cover all possible effects, regardless of their significance, may be viewed as an impediment by pioneering developers of wave energy projects. At this stage of the sector's development, completed EIAs for wave energy developments are rare. It is therefore essential to learn from the experiences of other industries and, where possible, build upon this and any associated studies which may be informative. It is also necessary to identify knowledge gaps specific to the effects of wave energy devices which can then lead to the development of targeted research programmes to answer specific questions. The associated findings can then be fed back to the industry and can inform more efficient, strategic impact assessment activities.

The anticipated environmental effects of ocean energy devices have been put forward in a range of publications (see, for example, Pelc and Fujita (2002); Gill (2005); Cada et al., (2007); Boehlert et al., (2008); Inger et al., (2009); Boehlert and Gill (2010)) and consequently will not be explored in any detail here. Suffice to say that while some of the effects of devices on the marine environment will be the same regardless of the installation involved, other effects will be device-specific. Effects will vary according to development stage, namely construction, operation and decommissioning as well as the scale of the project, and will depend on the site location and ecosystem in that area.

Some level of environmental monitoring is currently underway at most existing wave energy test centres. The focus of such monitoring and the methodologies employed are, however, varied and depend on a range of factors such as the perceived 'most threatening' environmental impacts, the level of involvement of stakeholders and the resources available. Given the partners involved in the SOWFIA project it is possible to bring together the environmental data and information associated with many of both the planned and operational wave energy test centres and demonstration sites. This will place the project consortium in a unique position to identify remaining knowledge gaps within the IA process. By categorising what is necessary in an EIA for wave energy and what need not be a concern, and by generating a better understanding of the site-specific and technology-specific factors underpinning IA design, the IA process can be streamlined, making it easier and less costly in the longer-term to effect new wave energy developments, whilst still ensuring appropriate consideration and protection of the marine environment.

In order to determine what monitoring activities are on-going at the various test centres, and what information will be made available to the project, a questionnaire was designed and distributed to any organisation collecting data at a wave and/or tidal energy development. The questionnaire was distributed to 74 different organisations with approximately 20% of recipients responding. The questionnaire aimed to determine:

- Basic information on the site (name, location, operation status, type of device, etc.)
- The organisation carrying out the monitoring
- What was being monitored
- How was it being monitored
- The underlying reasons why each monitoring activity was being carried out
- Whether the collected data would be available to the SOWFIA project, and if so, in what format and under what conditions

Thirteen of the fifteen previously identified wave energy test centres returned completed questionnaires on their environmental monitoring activities. Of the information provided, nine organisations have agreed to provide SOWFIA with data in a form which is more organic than printed reports. The type of information to be made available is presented in Table 6. Access to data in such a format will facilitate many of the future activities planned in the project. Some of these datasets will incur a cost but the majority will be available for use freely under an appropriate data sharing agreement.

Table 6: Catalogue of main data types available to the SOWFIA project.

Environmental data stream	Site (Organisation)
Point measurements of waves and currents surrounding wave energy test sites	AMETS, EMEC, Galway Bay, Pilot Zone, Reunion, SEM-REV, Wave Hub (UoE), Wave Hub (UoP)
Video monitoring of beach morphology in the shadow of wave energy test sites	Wave Hub (UoP)
Acoustic monitoring of ambient, biological and anthropogenic sound levels near test sites and at control locations	AMETS, EMEC, Pilot Zone, Wave Hub (UoE)
Water column properties at wave energy test sites	Wave Hub (UoE), Wave Hub (UoP)
Surveys of marine invertebrates around test sites	AMETS, Lysekil (UU), Reunion, Pilot Zone, SEM-REV, Wave Hub (UoE), Wave Hub (UoP)
Benthic sediment studies at test sites	AMETS, Pilot Zone, SEM-REV
Studies related to the utility of wave power devices as artificial reefs	Lysekil (UU)
Studies on fouling and colonisation of wave energy devices	Lysekil (UU)
Monitoring sites of national heritage	Sem-Rev
Seabird and marine mammal monitoring	AMETS, EMEC, Pilot Zone, Reunion, Wave Hub (UoE), Lysekil (UU) (pilot studies only)
Tidal flow data	EMEC

In order to facilitate flexible access to the information outlined above, as well as to demonstrate how such information and other environmental monitoring data can be arranged on the SOWFIA Data Management Platform (DMP), the information from the returned questionnaires has been input to the preliminary project-centred DMP[9]. The DMP interface is shown in Figure 3. Users can interrogate the dataset to acquire information on subsets of wave energy sites and marine energy research sites, based on features such as their distance from shore, the type of device(s) in place and whether they are in operation yet or not. As the DMP is developed, and information from more sites is added, it will also be possible to select sites based on the planned or ongoing impact assessment monitoring activities.

A larger goal of the SOWFIA project is to use the DMP to generate a better understanding of the links between site, technology and required EIA activities, and to use this understanding to streamline Impact Assessment requirements and methodologies. As information on monitoring activities from more projects is added to the DMP, this will facilitate the analysis of commonalities and differences in monitoring regimes at different wave energy sites. Furthermore, for sites with common focuses for monitoring, the various methodologies can be compared and contrasted. This will enable an assessment of the most efficient, user-friendly and cost-effective methods, those most likely to detect an impact, and a comparison of the data outputs of each. For example, acoustic monitoring of cetaceans is being carried out at a number of the wave energy sites for which the SOWFIA DMP holds data. However, the methods being used vary widely and include static acoustic monitoring using C-PODs, fixed hydrophones and towed hydrophone arrays; whilst the study designs and monitoring frequencies also differ among sites. At each site, the choice of monitoring tool and analyses of the resulting data will vary. It will thus be invaluable to compare the final datasets and

[9] Data management Platform: http://sowfia.hidromod.com/

ascertain whether specific monitoring methods and analytical tools can be considered most suitable for wave energy IA. Similar analyses will be possible for other monitoring focuses such as benthic fauna, background noise, wave energy and current features and avian fauna.

The ultimate goal of these activities is to facilitate faster, more effective, development of wave energy sites in the future by ensuring that data collected as part of EIA activities address the appropriate questions in the most efficient fashion possible. Using standardised or comparable methods for monitoring will also facilitate meta-analyses of datasets from multiple sites and will greatly increase our understanding of the factors affecting environmental impacts of wave energy developments on marine environments.

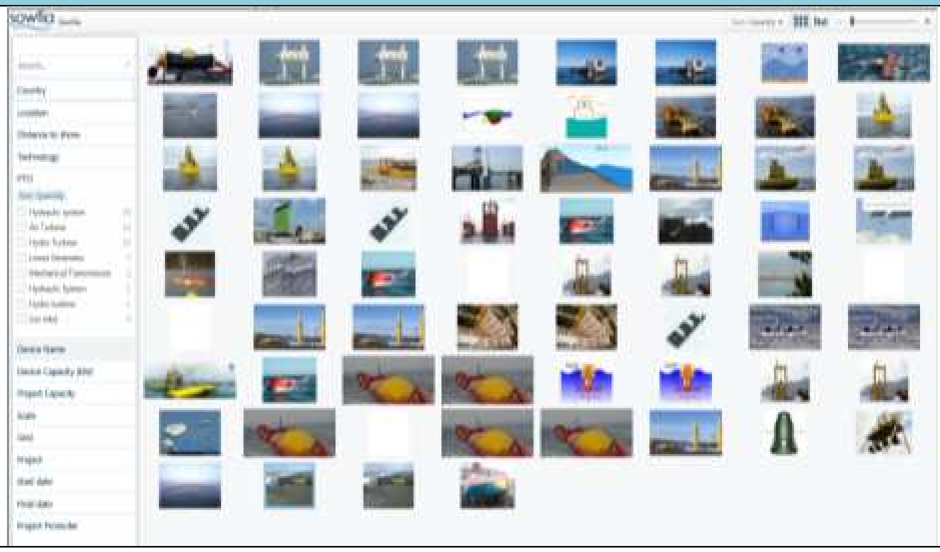
Search parameter	Screenshot from Data Management Platform
Country Location Distance to Shore Technology PTO Device Name Device Capacity Project Capacity Scale Grid Scale Start date End Date Project Promoter	

Figure 3: Provisional image from the SOWFIA Data Management Platform (http://sowfia.hidromod.com/)

Future SOWFIA work

Currently, the limited number of operational wave energy sites and the early stage of many planned sites means that wave energy impact assessment monitoring activities are relatively rare. Of the experiences that exist, SOWFIA has been able to obtain access to a relatively high number of the active projects which provide both a broad spectrum of individual activities and multiple instances of common activities. To date, the socio-economic aspects of wave energy development have been largely neglected, again to the fact that there limited wave energy sites operational. Of the studies on socio-economics carried out to date, these have focussed on the effects that the construction, operation and decommissioning of the existing or future wave farm will have on the society and the economy at a local, regional or upper level. The SOWFIA project will address the socio-economic element of wave energy development impact assessment in later tasks and deliverables, and will implement studies on developer perceptions of stakeholder concerns and stakeholder opinions of wave energy and local wave energy sites.

What is important for the future of the project is to maximise the amount of environmental data and information made available to the project so that recommendations can be based on the best science available. There are a number of ways in which other stakeholders can get involved in the project through a dedicated project network and also by participating in a series of workshops to be organised during the course of the project. Ultimately this will help to ensure that the SOWFIA project will benefit from a pool of data that extends across Europe and beyond and represents a large proportion of the existing or soon-to-be-collected global wave energy EIA data and experience. This resource will be sufficient to permit the SOWFIA partners to perform the proposed activities, in order to achieve the goals of project, namely to develop and recommend streamlining options for Impact Assessment processes which facilitate the sustainable development of the industry without compromising the integrity of the marine environment.

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