Marine Renewables Industry Association

Marine Renewables Industry: Requirements for Oceanographic Measurements, Data Processing and Modelling

October 2009

Table of Contents

1. Introduction

The Marine Institute and INFOMAR (the joint venture between the Marine Institute and the Geological Survey of Ireland which succeeded the Irish National Seabed Survey) have in the past and continue today to perform an excellent job at providing the marine industry with data and measurements. This document is intended to interpret Marine Renewables Industry Requirements and then to decide best how these can be delivered. This may be done by one of the agencies such as the Marine Institute and INFOMAR or a new/existing commercial entity.

2. Measurements / Survey Requirements

The Marine Renewables industry requires knowledge of the coastal characteristics around Ireland in order to design products which can be deployed in the majority of the sites and to identify specific sites which are suited to development. The characteristics which are required include:

Sea bed bathymetry – This is required by all developers to determine which areas are within the depth range and seabed slope limitations of the system. This is particularly important in the areas identified on maps submitted to the Foreshore Licensing authorities by developers.

Seabed sediment – This is required to identify how much of the Irish market requires mooring & cabling or piping solutions for rock, gravel, sand etc. This is particularly important in the areas identified on maps submitted to the Foreshore Licensing authorities by developers.

Non- spectral wave characteristics – Are in deep water and there is a need to calibrate wave models with them. This is currently provided through the buoy network.

Full spectral wave characteristics – Are in the 200m to 10m water depth range and there is a need to develop a good understanding of the 'real' sea states in which wave energy devices will operate (and hopefully do so profitably). These are also important in order to calibrate wave models while the deployment of more fully spectral buoys and ADCPs (with the wave processor module) would help develop understanding and confidence in wave modelling. There is a good opportunity to have a concentration of them in and around the planned Ocean Energy test centre at Belmullet, Co Mayo.

Tidal current records – in areas (to be defined): at least 4 weeks of continuous tidal current records should be collected, to calibrate tidal models against and understand the local tidal resource.

Environmental data – including environmentally protected/ sensitive areas, other sea users and known hazards. This data is necessary when choosing a site for development.

Offshore weather – including all available forecast wind speed, maximum gust speed, wind direction. This is required both for wave modelling and for developers to understand what weather windows exist. This affects site selection and system design.

Data base of 3rd party data – including data which 3rd parties have collected and are willing to provide in the database.

3. Data Processing Requirements

Some companies have the capability to handle large amounts of data delivered in a variety of formats. However, the majority of the Marine Renewables companies do not have this capability. Therefore it is important to developer a number of key data sets in easy to use formats and manageable volumes. These key data sets include:

Sea bed bathymetry (MSL) – This should be delivered in an ASCII file as gridded data referenced to WGS84, interpolated from the best available data for the area, corrected to mean sea level. The gridded data should be prepared up to the high water line. The gridded data should be available in resolutions of 1 minute, down to 3 seconds -see NOAA's method of providing this data (http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html). In the short term, it would be useful to get an updated and quality checked gridded INFOMAR data set, and a separate 'vessel bottom' data set. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Sea bed bathymetry (LAT) – This should be delivered in an ASCII file as gridded data referenced to WGS84, interpolated from the best available data for the area, corrected to lowest astronomical tide. The gridded data should be prepared up to the high water line. The gridded data should be available in resolutions of 1 minute, down to 3 seconds (again see http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html). The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Sea bed data quality map – This should be delivered as an image, and a shape file outlining the quality, age and resolution of the underlying data behind the gridded bathymetry data. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Seabed sediment depth – This should be delivered in an ASCII file as gridded data referenced to WGS84, interpolated from the best available data for the area. The gridded data should be prepared up to the high water line. The gridded data should be available in resolutions of 1 minute, down to 3 seconds (see NOAA's method of providing gridded bathymetry data for the US http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html). The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Seabed sediment type - This should be delivered as a shape file using polygons to show the predominant type of sediment. This data should be referenced to WGS84, interpolated from the best available data for the area. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Sea bed sediment quality map – This should be delivered as an image, and a shape file outlining the quality, age and resolution of the underlying data behind the gridded seabed sediment data. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Sea bed sediment statistics – a graph and table for each sediment type describing the percentage at each depth range and wave power flux.

Seabed geology – This should be delivered as a shape file using polygons to show the predominant type of bedrock. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Non-spectral wave characteristics – This should be delivered as an ASCII file and should include the complete time series taken at each buoy location, and should include that data currently reported on the last 24 hours report for each data buoy. Real time access to data at test centres has also been requested, this could be provided as a dynamic ASCII file online so as to keep it in a form which is easy for most people to access.

Non-spectral wave statistics – tables and graphs presenting the historic probabilities of significant wave height, energy period and direction for each buoy location.

Full spectral wave characteristics – provide the complete time series with the full power spectral densities for each buoy in ASCII files e.g. a datawell *.SPT file. Real time access to data at test centres has also been requested, this could be provided as a dynamic ASCII file online so as to keep it in a form which is easy for most people to access. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Tidal current records – This should be provided where ADCPs have been deployed in ASCII format.

Offshore weather – This should be delivered in two formats:

1. An ASCII file for each time step as gridded data referenced to WGS84, interpolated from the best available data for the area. The gridded data should be prepared up to the high water line. The gridded data should be available in resolution of 1 minute.
2. An ASCII file for a specified point containing a complete historical record of weather hindcasts for that point.

Data base of 3rd party data – This should include a description of the data, contact details and, if known, the purchase costs and standard licence conditions for the data.

Wave Atlas – This should be delivered in an ASCII file as gridded data referenced to WGS84, taken from the original ESBI Wave Atlas or an equivalent model. The gridded data should be available at least for the area from 200m to 50m depth. Average annual theoretical power flux (kW/m) and seasonal average theoretical power flux should be provided. The gridded data should be available in resolutions of 15 seconds. Ideally, this would be based on at least 10 years of hindcast wave models (described in the modelling section below). However, in the short term, the need should be met from the best available data. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Sea Users – This should be delivered in either an ASCII file as gridded data referenced to WGS84, or a polygon shape file, referenced to WGS84. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

> **Vessel Activity** – This should be delivered in an ASCII file as gridded data referenced to WGS84, derived from designated traffic lanes, AIS and VMS data. The gridded data should ideally be presented on a seasonal basis, describing the frequency of vessel presence in an area. The gridded data should be available in resolutions of 15 seconds.
>
> **Fishing Sensitivity** – This should be delivered in a polygon shape file, referenced to WGS84, derived from inshore, aquaculture, exclusion zones and known hatcheries.
>
> **Electricty grid** – This should be delivered in a polygon shape file, referenced to the Irish National Grid.
>
> **Ports and Harbours** – This should be delivered in a polygon shape file, referenced to WGS84.
>
> **'No-go' areas** – This should be delivered in a polygon shape file, referenced to WGS84.
>
> **SEA data** – This should be delivered in a polygon shape file, referenced to WGS84.
>
> **Other Sea Users** – this should be delivered in a polygon shape file, referenced to WGS84, and should include all other known sea users.

Environmental data – This should be provided in a polygon shape file format referenced to WGS84. The additional option of a Google Earth kmz file for download would help those developers who do not have access to mapping software.

Designated areas – This should be delivered in a polygon shape file, referenced to WGS84, and should include all the areas which have been given a designation, such as a SPA (Special Protection Areas), SAC (Special Areas of Conservation) etc.

Known habitats – This should be delivered in a polygon shape file, referenced to WGS84, and should include all the known habitats, such as nesting seabirds, seal haul outs etc.

Archaeology – This should be delivered in a polygon shape file, referenced to WGS84, and should include all the known areas of archaeological interest, such as ship wrecks, etc.

4. Modelling Requirements

It is important to quantify on a national level the wave resource around Ireland, both to guide policy and to attract investment. To do this properly, it is necessary to run a verified wave model historically for a period of no less than 10 years, at 3 hour time steps. It is unlikely that this would be possible on such a scale for waters of less than 50m depth. Therefore, it would seem sensible to take this model to the 50m contour line and produce assessments of wave power flux for the 50m, 100m and 200m contour lines. However, it is very important – at frequent intervals along the 50m, 100m and 200m contour lines - that the full time series of spectral properties are made available to support the development of local area models around the coast – this will give developers a sound foundation for their site resource models. These local models are used by developers to identify the conditions for which they must design systems which are commercially viable in a large number of locations. The high level 'Wave Atlas' is used by developers, alongside other datasets, to evaluate the potential of numerous sites around Ireland. The development of a good foundation to these models should increase investor's confidence in business models both for technology development and for site development.

The wave model should be compared against all the available buoy data, the historical comparisons should be available in ASCII data files and the last 48 hours displayed on a website graph. It is essential that the model can be shown to produce good results for investors to have confidence to finance the construction of a wave farm.

5. Outputs From The Wave Model:

- **Wave Atlas** – indicative properties (Hs, Ts), as an interpolated gridded data sets at 15sec interval.
- **Full spectral wave characteristics** – At frequent intervals along the 50m and 100m contour lines, the full time series of spectral properties.
- **Non-spectral wave characteristics** – The full time series of the non-spectral wave characteristics including energy period should be available for each model grid square. This should include the wind conditions at each time step and grid square as well.

- **Weather window statistics** – graphs and tables at a few key points (to be specified) describing the frequency of weather windows of increasing length for a range of significant wave heights as determined from 10 years of historical model data. The data must, therefore, be able to be queried in respect of variables defining the weather window in terms of wind speed (limits), significant wave height versus energy period (limits) and length of time required.

Non-spectral wave statistics – tables and graphs presenting the historical probabilities of significant wave height, energy period and direction, for each buoy location.The operation of the above model in a forecasting mode will become useful to the industry for installation work, maintenance and electricity system operations. The benefit when trading in the current all-island SMP market will be limited to risk mitigation, because there is no price difference between the payment received for being 'long' and that made for being 'short' in the market. Also wave generators will almost certainly enter the market as variable price takers which means there is no real benefit in providing the market with an accurate generation forecast. This could change if trading in CFDs around the market were to become considerably more active.

When operating the model in a forecast model it would be useful to produce an online zoomable map of the wave and wind conditions for early stage developers.

The model run outputs should be stored in the formats described above in historical, real time and forecast. This can then be used by developers and 'farm' operators to understand the degree of error in the forecast for any location on the model. This is important when hiring installation and maintenance vessels. A tool which enables developers to query the forecast model for weather windows would make this accessible to all. Such a tool should define weather windows in terms of wind speed (limits), significant wave height versus energy period (limits) and length of time required.

6. Research Requirements

There are a number of general research areas which are required by the industry which do not fall within oceanographic measurements, data collection & processing or modelling.

It is understood that in the current All-Island Market there is no economic value in lower intermittency and higher predictability of wave power in the SEM from the point of view of the wave generator. Wave generators would bid as variable price takers. However, there may be some benefit to the consumer because, for comparison, wind destroys price by about 5% when present. A study should be undertaken which compares the cost of supporting wave generation through REFIT against the customer benefit caused from the net market price reduction in Ireland.

A study should also be undertaken to provide developers with up to date estimates of the value of wave power (€/MWh) on a yearly bases for the next 20 years for all the major wave power markets around the world, in conjunction with any value wave forecasting may bring in those markets.