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ENFAIT
ENABLING FUTURE ARRAYS IN TIDAL

Bluemull Sound Site Resource Map

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 745862.

Document History

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0.2	Draft	21-Mar-2018	Draft for consortium review	A Macleod	EnFAIT consortium
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Contents

1 Introduction

A Funding Grant was awarded, from the European Union's Horizon 2020 research and innovation programme in January 2017 to demonstrate a grid-connected tidal energy array at a real-world tidal energy site, propelling tidal energy towards competing on a commercial basis with alternative renewable sources of energy generation – Enabling Future Arrays in Tidal (EnFAIT). This was in response to the call *LCE-15-2016: Scaling up in the ocean energy sector to arrays* to generate significant learning through demonstration of cost-effective tidal arrays.

This document is produced to summarise the key data about the characteristics of the deployment site in Bluemull Sound, including a summary of the numerical site modelling undertaken and the offshore measurement campaign to calibrate and validate this analysis. It is to be submitted to satisfy deliverable D10.2 of the EnFAIT project and to be also made available for public dissemination.

2 The Site

2.1 Location

Bluemull Sound is in the north of Scotland between the Islands of Yell and Unst. The sound is 6 kilometres in length and around 1 kilometre wide. The Sound runs from the north-east tip of Yell directly south to the south-west tip of Unst, Figure 1.

Figure 1 - Bluemull Sound Location

The movement of the Atlantic tide, to the north of the Shetland Isles, sets up a phase difference across Bluemull Sound. This phase difference drives the tidal flow through the sound.

The Nova Innovation tidal turbine deployment locations are around 1 kilometre to the east of the Cullivoe Pier, Figure 4.

2.2 Bathymetry

The site bathymetry data has been created through site survey and open source data sources, Figure 2.

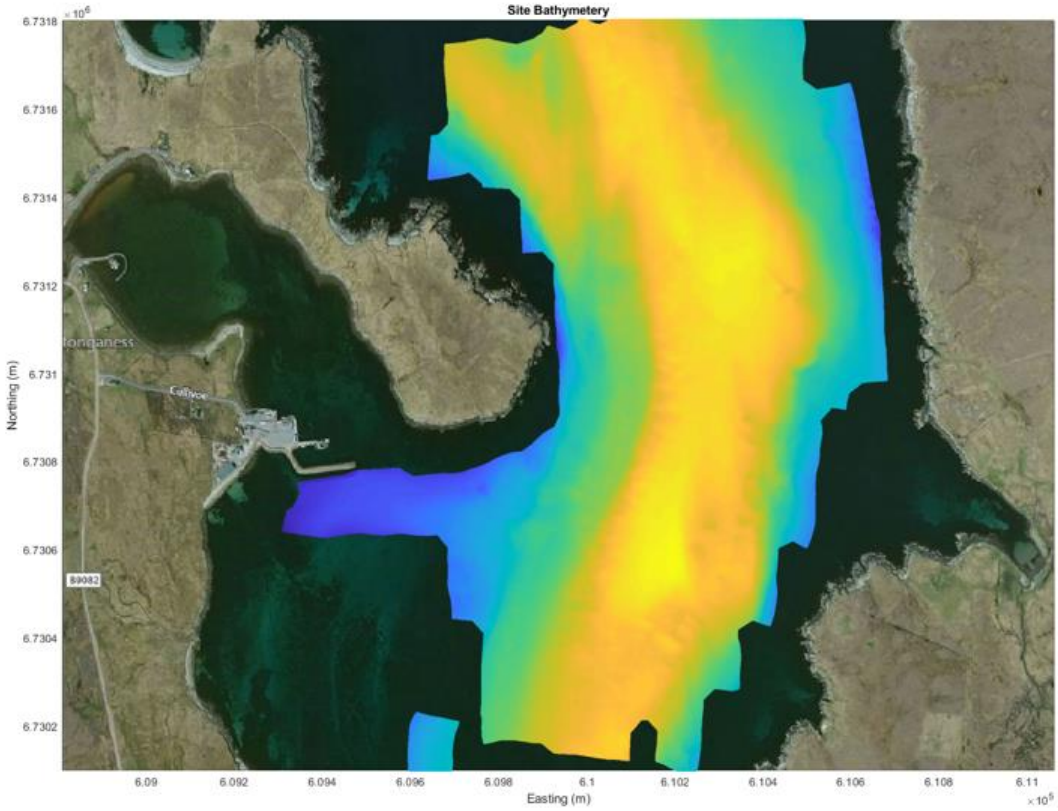

Figure 2 - Site Bathymetry

The depth at the site is up to a maximum of around 40 metres. Site surveys have confirmed that the seabed at the site consists of relatively flat shattered rock and small boulders that form a stable seabed.

2.3 General Site Conditions

The tide runs in ebb from South to North and in flood from North to South. A general flow direction and velocity asymmetry, at the turbine locations, has been recorded. Surface velocity peaks can reach 3 metres per second.

The site is relatively well sheltered from waves apart from those coming from due north.

3 Observed Site Data

3.1 Sensor Installations

To help understand the site tidal resource, sensors were installed to monitor flow conditions. Three Nortek Signature 500 series Acoustic Doppler Current Profilers (ADCPs) were installed, in seabed frames (Figure 3), around the tidal turbine installation locations, Figure 4.

Figure 3 - ADCP Set-Up

The ADCPs were housed in protective seabed frames, Figure 3. The frames were linked to a ground line and clump weight. The ground line was used for frame recovery. Spirit levels were mounted on the ADCP frames to confirm a level deployment.

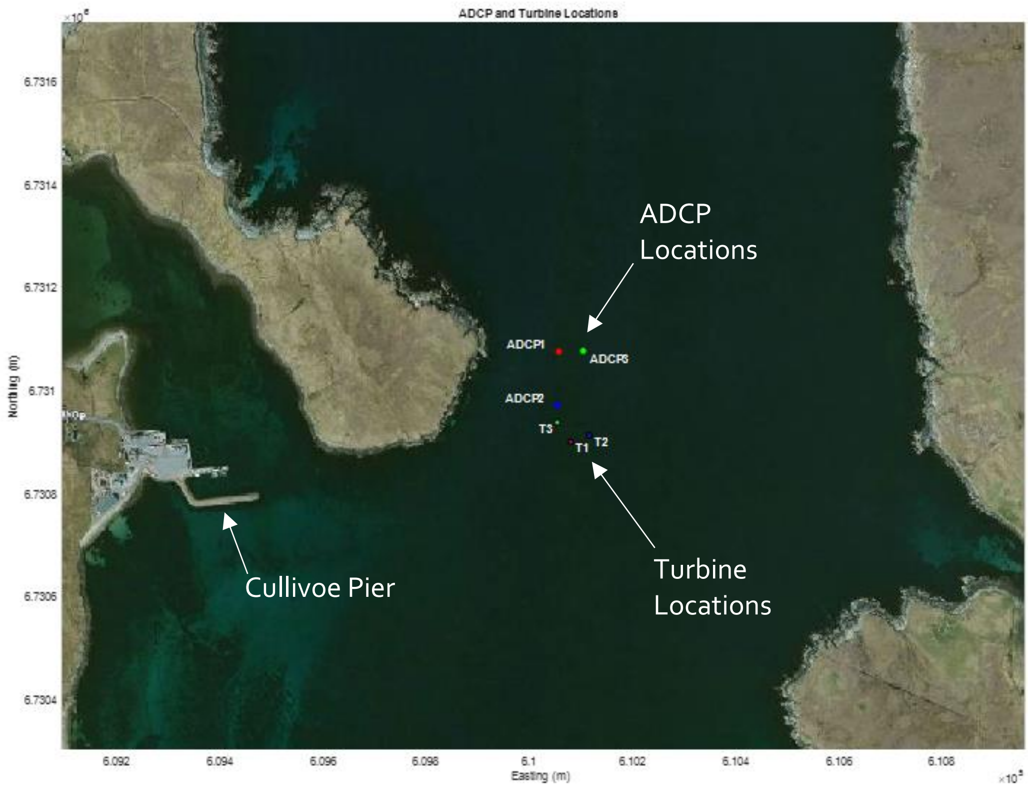

Figure 4 - ADCP and Turbine Locations

The sensors were positioned to best understand the flow through the site area. Further deployments are planned for later in the project to better understand the full scope of Bluemull Sound.

The sensors recorded data for September, October and November 2017. They output 10 minute flow speed and direction averages in 0.5m depth layers from 1m above the seabed to the sea surface. They also recorded pressure data, which will be used to plot tidal ranges, and temperature data.

3.2 Flow Velocity and Direction

A summary of the site data is provided in this report.

The site ebb and flood flow characteristics are different. This difference is due to several factors. The most powerful of these factors are the shape and bathymetry of Bluemull sound.

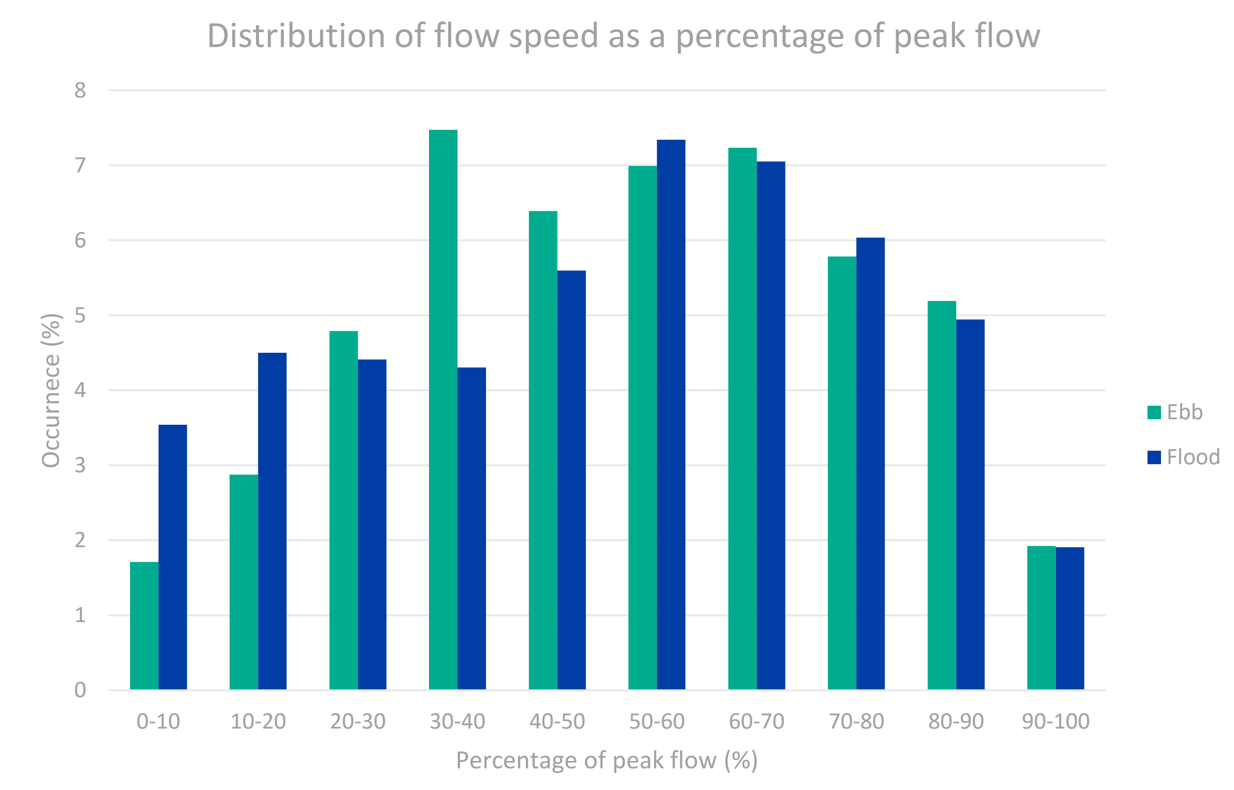

Figure 5 - Site flow distribution

Shown, in Figure 5, is the recorded distribution of ebb and flood flow speeds, at installed turbine hub height, from the ADCP closest to the turbines (ADCP2). At higher flow speeds (>50% of peak flow speed) the distribution of flow in ebb and flood conditions, at the ADCP location, is similar. However, as the tide builds and falls there is an obvious asymmetry.

The corresponding tidal flow direction rose is shown in Figure 6. The tidal rose indicates the direction the flow is going.

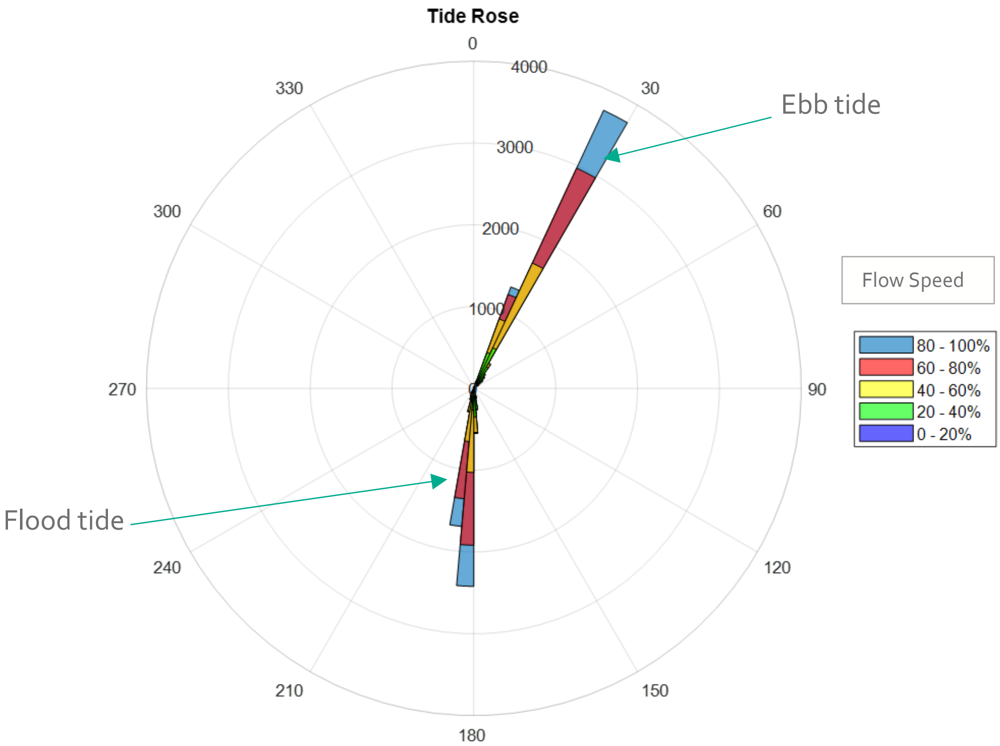

Figure 6 - Tide Rose

In ebb the tide runs at around 28 degrees from north and in flood at around 182 degrees from north. There is a swing of about 150 degrees in flow direction between ebb and flood at the turbines.

3.3 Tidal Height and Current Speed

3.3.1 Monthly Profile

Figure 7 presents a full month's tidal cycle for the site. There are 3 neap and 2 spring periods visible.

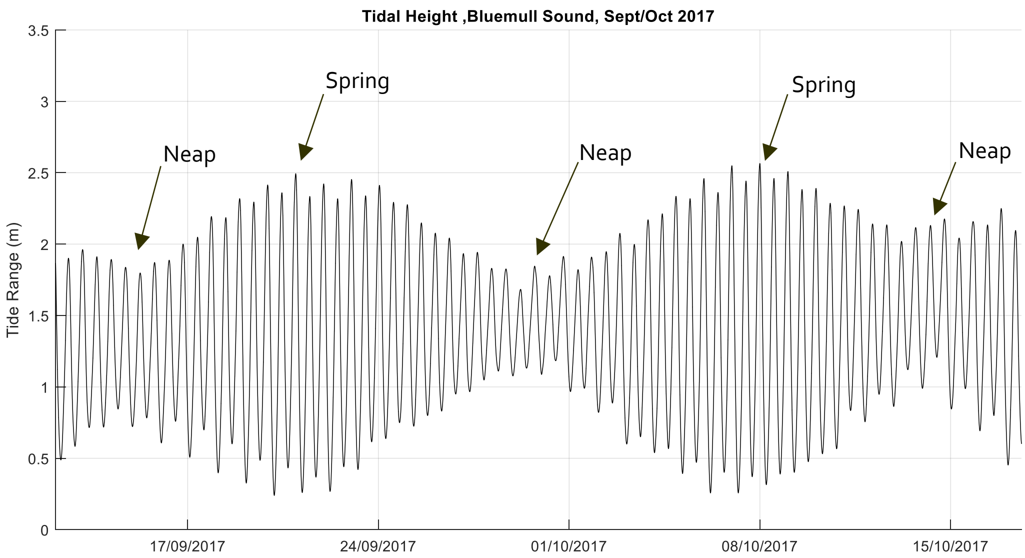

Figure 7 – 30 day tidal cycle

3.3.2 Daily Profile

Shown, in Figure 8, is the recorded tidal range and near surface flow speed for 30 hours in September 2017.

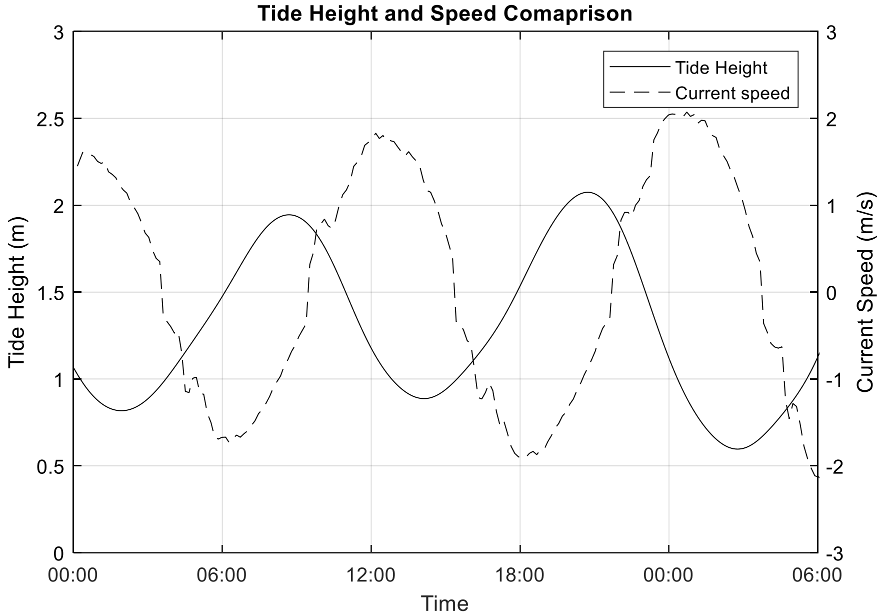

Figure 8 - Tide tidal cycle, Sept 2017

4 Tidal Flow Model

A tidal flow model has been built to provide flow information for the extent of Bluemull Sound. This model has been calibrated against the recorded site data.

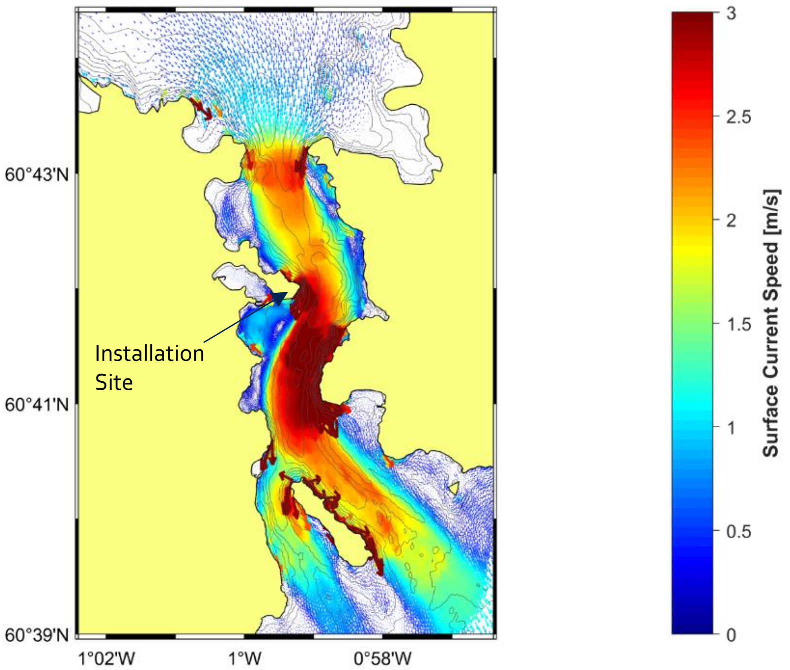

Figure 9 - Site Peak Spring Flood Flow

Figure 9 presents a vector plot of flood flow, on a spring tide, as predicted by the numerical model. Note the flow concentration on the headland east of the Cullivoe pier. This is the tidal site installation location. The bend in the sound helps to focus the flow here.

In the ebb flow of the spring tide, Figure 10, the flow is again focused in the location of the tidal turbine site. However, notice that the flow speed is more focused, and faster, to the north of the site than when the tide is in flood. This is due to the headland funnelling the flow through the sound.

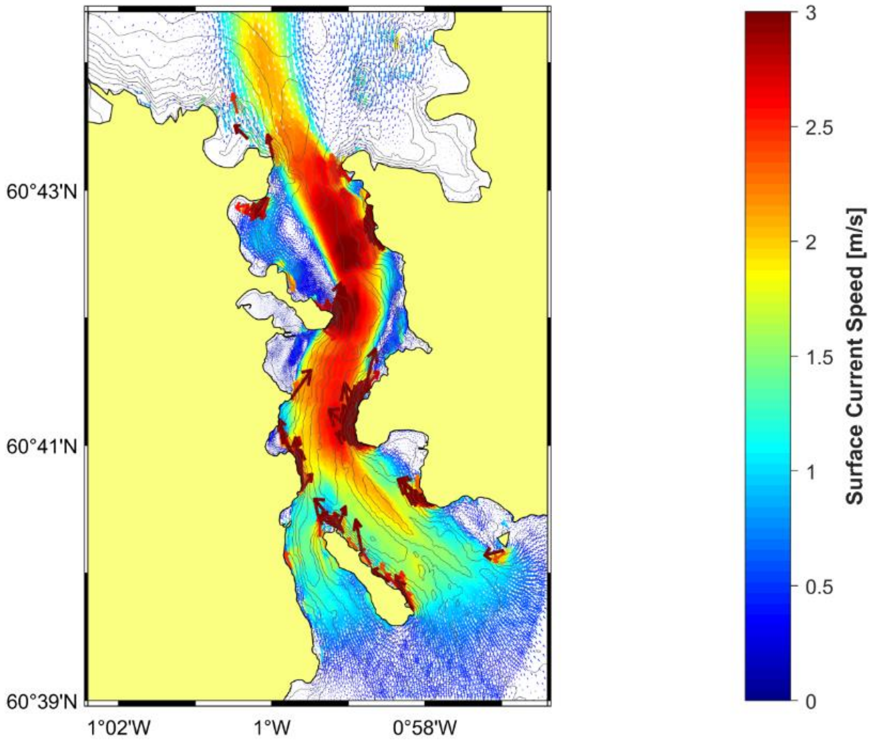

Figure 10 - Site Peak Spring Ebb Flow

5 Conclusions

An initial site conditions survey has been carried out. The data from this survey has been used to produce and calibrate a full site flow model.

This flow model will be used through the EnFAIT project for;

- Power analysis,
- Loads analysis,
- Turbine placement studies,
- Operations modelling,
- Turbulence modelling,
- Informing further sensor installation campaigns,
- and more.

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RSK mojomaritime WOOD GROUP SKF HMK