

# **Pentland Firth and Orkney Waters Strategic Area Review Project**

**July 2013**

## Contents

1. Overview .....	3
2. Methodology .....	4
2.1 Hydrodynamic modelling of energy resources in region .....	4
2.2 Review of environmental and consenting risks for existing projects.....	5
3. Revised strategic area .....	6
4. Further information .....	8

## 1. Overview

Between October 2011 and March 2012, The Crown Estate undertook a review of the Pentland Firth and Orkney waters (PFOW) Strategic Area. This area had previously been defined during the 2008/09 PFOW wave and tidal stream leasing round as the boundary within which developers could propose project sites.

The purpose of the review was to evaluate whether additional wave and tidal projects, at test and/or demonstration scale, could be leased in a part(s) of the strategic area without:

1. Significantly risking development of the eleven commercial projects which resulted from the 2008/09 leasing round. This is complex to assess in an objective manner, due to limits in current scientific understanding about the potential effects of one project on the energy resources used by another, and in-combination/cumulative environmental impacts; and
2. Precluding development of additional commercial-scale projects in future, noting that the PFOW area offer further space and the wave and tidal stream energy resources are amongst the best around the UK.

The review involved:

- *Development of new hydrodynamic models of the PFOW area.* The Crown Estate commissioned several models from consultancy ABP Marine Environmental Research (ABPmer). The models were at a higher resolution than existing datasets, which enabled the review to be made more precisely than would otherwise have been possible;
- *An assessment of physical conditions.* Using the models and referring to other relevant datasets (e.g. describing bathymetry), we evaluated the distribution of energy resources across the PFOW area; and
- *A review of key risks to the existing projects,* including factors related to potential environmental and socio-economic impacts.

Stakeholder input was a key part of the work and the review incorporated inputs from local organisations including Orkney Islands Council. The Crown Estate also worked with Marine Scotland to ensure the work aligned with the statutory marine spatial planning process and sought the views of developers of the existing projects.

The main outcomes of the work were as follows:

- *Redefinition of the PFOW strategic area.* Following the review of risk factors, it was decided to 'carve out' part of the original strategic area, on the eastern side, on the basis that test and/or demonstration projects could be developed in this carved out area without presenting significant risks to the existing projects. See Figure 1 at the end of this report; and
- *Creation of improved hydrodynamic data,* which have informed development of the existing projects, including their resource and yield assessments. This is available for download in GIS format from our wave and tidal knowledge network [here](#).

Since the work was completed, The Crown Estate made the carved out area available for applications for test and demonstration projects. This was through an existing leasing process, which involved four, six-month application windows between September 2010 and October 2012. As a result of the fourth application window, one project was leased in the carved out area. This is

the Lashy Sound project, which has a total potential capacity of 30 MW and is being developed by Scotrenewables Ltd, and can be seen on our Pentland Firth map [here](#).

## 2. Methodology

### 2.1 Hydrodynamic modelling of energy resources in region

This part of the work involved the following steps:

- *Building hydrodynamic numerical models:* We commissioned three new models – two describing wave energy resources and the other, tidal stream energy – from ABPmer. The models were run individually to quantify each type of resource and also used in combination to investigate potential wave/tide interactions; and
- *Assessing physical conditions:* In order to develop a clear understanding of the distribution of energy resources in the region, we also assessed other key physical factors (e.g. bathymetry).

The new models had a significantly higher resolution than previous datasets, which allowed the assessment of resources to be carried out more precisely than would otherwise have been the case.

The new wave models had a maximum resolution of 200m model cells and the tidal model had a maximum resolution of 100m cells. The best data which was previously available was the BERR Marine Renewable Energy (MEA) Atlas, which has wave cells at 12 km and tidal cells at 1.8 km. As such, the new hydrodynamic models improved resolution of the wave resource by up to 60 times and the tidal resource, up to 18 times. This was particularly advantageous to evaluate energy levels in areas of complex bathymetry and intricate coastal topography.

The new models also enabled the creation of scenarios to predict how the eleven existing projects, once installed, may interact with the wave and tidal resources.

These model outputs were used to identify where the best locations exist for large commercial-scale wave and tidal projects. We defined areas of commercial-scale resource as having the physical conditions and seabed space to support upwards of 100MW of installed capacity. Existing literature, industry sources and technical expertise were used to research and develop thresholds that characterise the commercial-scale resource, as follows:

- *Wave:* Minimum power density of 20kW/m, minimum water depth of 10m (LAT). (The greatest depth was taken as 200m (LAT), which is approximately the same as the depth at the edge of the UK Continental Shelf.); and
- *Tidal stream:* Minimum peak current during mean spring tide of 1.5 m/s, minimum water depth of 5m (LAT).

The locations of the existing projects were considered with reference to the coordinates of the site boundaries in the project agreements for lease.

### **Distribution of wave and tidal stream energy resources**

The wave models gave outputs in terms of annual mean significant wave height (m) and annual mean power (kW/m). The models showed that:

- Overall, the wave energy resource is highest to the north and north-west of the Strategic Area, around the Orkney Islands, due to the long wind fetch across the Atlantic. The annual mean significant wave height in the north and north-west of the islands ranges from 1.8m up to 3m, and the annual mean wave power is over 60 kW/m in some places;
- To the east of the Orkney Islands, wave energy levels are lower because there is a limited fetch in the prevailing wind direction. The annual mean significant wave height is 2.2m and the annual mean power is up to 19 kW/m;
- Wave energy levels are slightly higher to the south of the Orkney islands and along the north coast of the Scottish mainland, at up to 2.4m, with power densities in the range 22-60 kW/m; and
- Inter-island heights are below 1m and the power levels are up to 19 kW/m.

The tidal stream models gave outputs in terms of maximum velocity of mean spring tide (m/s) and annual average power per vertical square metre of water column (kW/m<sup>2</sup>). Findings from the tidal models concluded that:

- High velocities and power densities occur in a number of distinct pockets within the region, in particular, the Pentland Firth (where velocities reach >5m/s during an average spring tide), the Stronsay Firth, Papa Westray, north of North Ronaldsay and Lashy Sound; and
- For the most part, the power density in the Pentland Firth is over 4.5kW/m<sup>2</sup> and in pockets it ranges up to and over 38kW/m<sup>2</sup>. Outside the Pentland Firth, densities generally range from 0.5kW/m<sup>2</sup> up to 4.5kW/m<sup>2</sup>, with resources up to 12kW/m<sup>2</sup> in a few isolated locations.

## **2.2 Review of environmental and consenting risks for existing projects**

This part of the work involved reviewing the potential environmental and socio-economic interactions (particularly considering potential cumulative interactions) between the Round 1 Afl sites and the development of any additional test and demonstration projects outwith any revised Strategic Area boundary.

This involved:

- Consideration of various scenarios of potential new projects outwith the revised Strategic Area. This ranged from no new projects to a scenario of a limited number of potential new projects, of smaller (test and demonstration) scale than the commercial scale Round 1 projects;
- A review of relevant existing information sources;
- Consideration of existing known baseline conditions;
- A review of potential impacts; and
- A cumulative effects review.

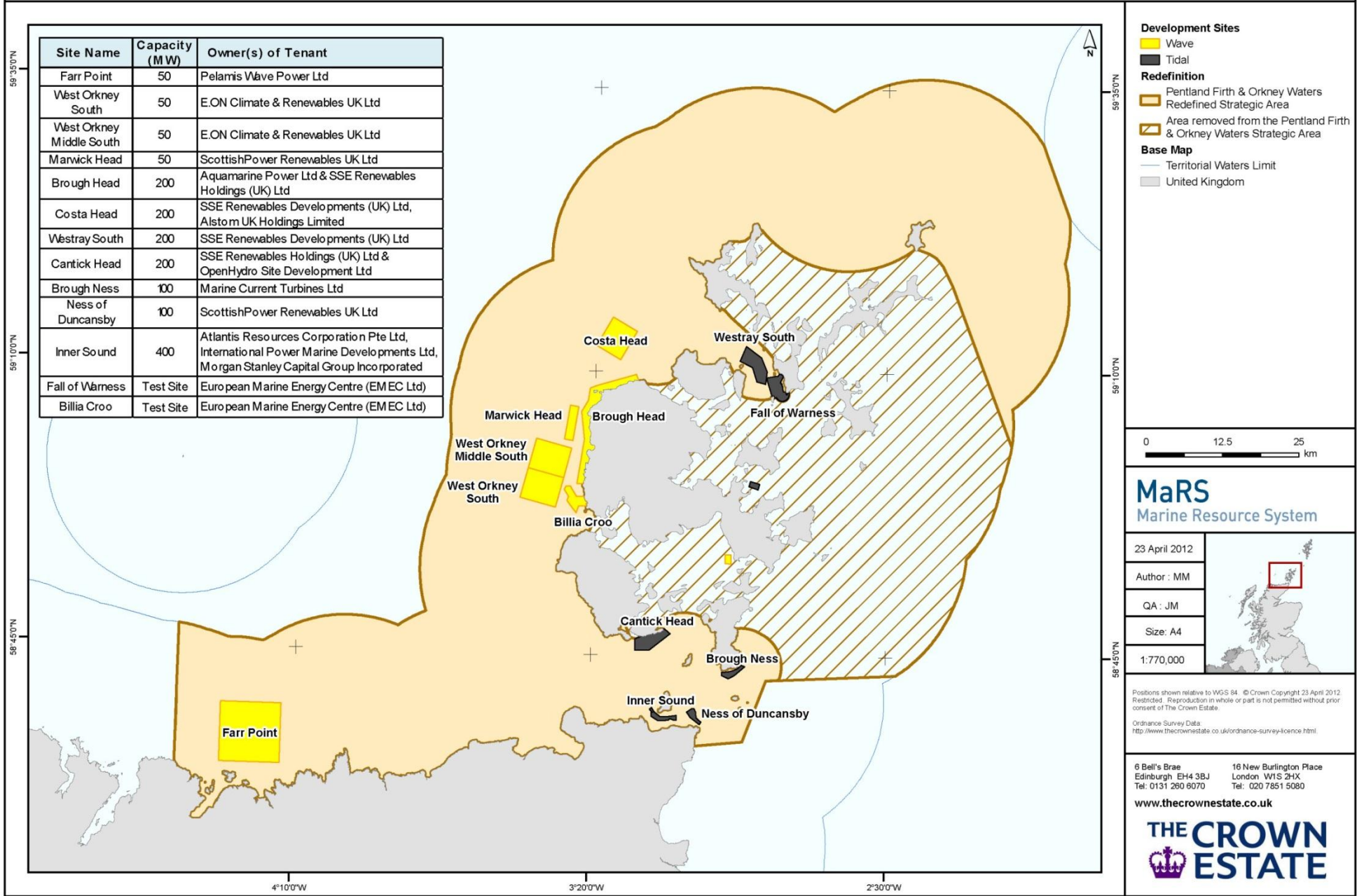
The work found that whilst there are clearly on-going uncertainties associated with the potential effects of wave and tidal stream devices, and many of these uncertainties are only likely to be reduced with the further research and monitoring of operating devices, the risk of additional cumulative effects from any additional projects in the PFOW area can be managed such that none of

the risks are considered significant. This position was reached given the limited number of any new wave and tidal stream projects anticipated, their relative small scale (particularly compared to the overall capacity of the Round 1 projects), through the implementation of mitigation measures, such as careful siting and project design, and the requirement for thorough impact assessment at the project-level.

### **3. Revised strategic area**

Following the review, the Pentland Firth and Orkney Waters Strategic Area was revised as shown in Figure 1, below. Areas of commercial level wave resource in the north and west remain within the Strategic Area. Pockets of commercial tidal resource also remain wholly within the revised area. Locations that have mean spring tidal currents less than 1.5 m/s and an average wave power less than 20 kW/m have been excluded from the revised Strategic Area, resulting in removal of the central and south eastern sections.

# Figure 1; Redefined Pentland Firth and Orkney Waters Strategic Area



S:\MARINE\Restricted\MaRS\GIS\TCE\_Work\W&T\_SAs\Pentland\_Firth\MXD\Redefined\_PFOW\_SA.mxd

## 4. Further information

A map of Pentland Firth Wave and Tidal leases can be found [here](#).

GIS dataset of the model outputs can be downloaded from the Wave and Tidal Knowledge Network, [here](#).

The model output GIS datasets can be viewed online in the ABPmer webGIS, [here](#).

For further information about the hydrodynamic modelling please contact Jamie Moore ([Jamie.moore@thecrownestate.co.uk](mailto:Jamie.moore@thecrownestate.co.uk)).