Pentland Firth and Orkney Waters Enabling Actions Report

Pentland Firth and Orkney Waters Onshore Infrastructure Information Note

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PENTLAND FIRTH AND ORKNEY WATERS
ONSHORE INFRASTRUCTURE INFORMATION NOTE

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EXECUTIVE SUMMARY

Wave and tidal stream energy has the potential to meet up to 20%[1] of the UK's current electricity demand and it, along with a number of energy sources, will be utilised in the coming decades to help reduce the UK's reliance on fossil fuels. Scottish waters have a particular abundance of wave and tidal stream energy resource and are currently the focus of the majority of the UK's emerging wave and tidal industry activity. In 2010 the Pentland Firth and Orkney waters (PFOW) became the first area ('Round 1') in the UK to be made available for commercial scale development of wave and tidal energy.

The development of commercial wave and tidal projects in the PFOW represents a major step for the emerging marine energy industry and the Orkney, Caithness and Sutherland communities. Within the PFOW Strategic Area there are eleven development sites; six where wave energy technologies will be deployed and five where tidal stream energy technologies will be deployed.

In addition to the deployment of offshore wave and tidal energy devices a number of land-based developments such as substations and power cables will also be necessary in order to service the projects. These onshore developments, some of which will be owned by developers and some of which will be owned by the electricity network operator SHETL and SHEPD (which are owned by SSE) are the focus of this Information Note. The Crown Estate has commissioned Parsons Brinckerhoff to develop the Note as part of their Enabling Actions work to accelerate and de-risk the development, construction and operation of the PFOW projects.

Feedback from a previous consultation on new grid infrastructure on Orkney conducted by SSE has indicated the need for more clarity on the overall scope of land-based development that is likely to be needed as part of the PFOW projects. This Onshore Infrastructure Information Note attempts to address that need by providing high level information on the potential nature/type, scale and broad location of the onshore development likely to be associated with the Round 1 wave and tidal projects in the PFOW. The aim of the Note is to remove some of the uncertainties and therefore risks associated with the consents process for PFOW projects. For example, the planning authorities have advised that their ability to provide early guidance and advice is influenced by the availability of information.

Onshore infrastructure developments will be progressed by the relevant party (SSE and/or PFOW developers). During that process it is likely that iterative changes will be made to project plans as additional information on technologies and project sites comes forward. The eventual development of onshore infrastructure in Orkney, Caithness and Sutherland directly related to the PFOW projects may therefore vary from that presented in this Note, which is based on current understanding and some necessary assumptions of the PFOW projects and examples drawn from renewables projects elsewhere to provide an informed understanding and context.

The Note shows that to connect initial arrays generating at each of the PFOW sites, new network connections would be required on Orkney as well as a new sub-sea cable landing point in Caithness. In addition, new developer-owned onshore facilities and infrastructure such as cables, wires, plant compounds and substations will be required at or near to each project site. SSE will also be required to provide additional infrastructure such as new substations and connections to accommodate the additional development.

A further, but less certain, assessment of infrastructure requirements under a full deployment generation scenario has also been made. This shows that in addition to the development put in place for initial arrays, new HDVC connections would be required between Orkney and the mainland as well

[1] As estimated by The Carbon Trust in their report 'Future Marine Energy', 2006.

as new transmission connections in Sutherland. It is likely that the developer owned facilities located onshore would also need to be expanded to accommodate this larger generation scenario.

The Note highlights the generally early stage of development that many of the PFOW projects are at, and consequently the lack of available detail on the exact configuration of infrastructure required at developer sites for both generation scenarios. This has a number of knock-on consequences, most notably, the ability of SSE to make the most efficient network investment plans and the ability of Planning Authorities to issue guidance and advice to assist developers.

The early stage of development of the PFOW projects has also had implications on this Note, as it has affected our ability to gauge what onshore infrastructure owned by developers and SSE may be built. To counteract this, a number of assumptions have been made to accommodate the limitations and associated information gaps. These assumptions include:

- All the Round 1 PFOW project sites will eventually be developed to their full capacity (i.e. to the maximum capacity of the Agreement for Lease with The Crown Estate).
- The PFOW generating capacities will be developed over time, in phases, with a smaller number of devices deployed initially.
- We have assumed 10 MW as the initial array capacity where information is not available.
- Developers will make appropriate connection applications.
- The relevant and necessary generation connection consents are granted.
- Wave and tidal generator power would be delivered by the generators to the connection points at a voltage of up to 132 kV.
- A single connection would be provided between each generating array and SSE's network.

The Note does not include detailed information on the type, location and scale of developer and SSE onshore infrastructure which is at this time (with the exception of some SSE development) uncertain, and is the remit of individual developers to define as necessary for their projects. The findings should therefore not be read as a definitive design for the development of onshore infrastructure in the north of Scotland. Any development of infrastructure associated with the PFOW wave and tidal projects will be contingent on satisfying a range of criteria, including economic, technical, environmental and social considerations; as well as the technical requirements of the connection applications that have already been made. When specific proposals do come forward, full stakeholder consultation will be carried out.

It should also be noted that the images used in the Note should not be looked at in isolation without reading the text, as they are provided as examples to support the text rather than providing an explanation in isolation.

The lack of available information also presents a risk in the consents process for the future development of onshore infrastructure to support the PFOW projects due to the uncertainty that this lack of information creates. A number of actions are identified throughout the Note under the general theme of 'information sharing and guidance' that could help to reduce those risks. These can be summarised as the strategic use of existing stakeholder groups; the preparation of high-level assessments, guidance and the use of relevant expertise to inform future infrastructure development; and continued information sharing/joint working.

In developing this Information Note, stakeholder workshops were held in Edinburgh and Stromness. The Crown Estate and Parsons Brinckerhoff are grateful to all those who have contributed.

1 INTRODUCTION

This Information Note has been published by The Crown Estate as part of its Enabling Actions work to support development of the Pentland Firth and Orkney waters wave and tidal projects. The Crown Estate commissioned Parsons Brinckerhoff to complete the work which aims to accelerate and de-risk the development process, looking at a range of key issues. Under the Enabling Actions Programme, work is selected, commissioned and steered by The Crown Estate in close discussion with the PFOW project developers.

For more information on The Crown Estate's work in wave and tidal energy, see www.thecrownestate.co.uk/energy/wave-and-tidal/ or contact waveandtidal@thecrownestate.co.uk.

1.1 Aims and Objectives

The Crown Estate has identified uncertainty amongst stakeholders regarding the overall scope of land-based development that is likely to be needed as part of the wave and tidal projects currently being developed in the Pentland Firth and Orkney waters (PFOW).

This Information Note addresses information gaps concerning the type, scale and broad location of onshore infrastructure such as power lines, substations and other buildings likely to be required to support their phased development and in doing so aims to help de-risk the consenting of onshore infrastructure directly associated with the PFOW projects. The Note considers infrastructure owned by PFOW developers as well as infrastructure owned by SSE (the north of Scotland transmission and distribution system owner).

SSE has already published comprehensive information on its plans for developing infrastructure to support the expected growth of renewable energy generation in the Orkney, Caithness and Sutherland area. However those plans do not take into account the total potential capacity of wave and tidal generation from the PFOW projects, as only a limited number of developers have applied for grid connections (a key criterion for being considered in SSE's plans to accommodate new generation). Similarly only some PFOW developers are sufficiently advanced in their project planning to have published details of the onshore infrastructure they expect to develop.

The information currently available therefore provides only a partial picture of the total possible type, scale and broad location of onshore infrastructure that is likely to be developed to support Round 1 PFOW wave and tidal Projects[2]. This Note aims to fill in more of that picture, using scenarios and assumptions where information is not available and drawing from real examples where possible. In doing so the Note provides a high level view of the total volume of onshore infrastructure that might be developed during the phased development of the combined PFOW projects. Provision of such a strategic overview will be of use to developers seeking to gain consent to develop onshore infrastructure (for example, the Note may aid developers' assessments of potential cumulative and in combination effects). It will also be of use to Statutory Agencies, planning authorities, members of the public and others seeking to understand and plan for the combined development of the PFOW projects.

[2] The Crown Estate announced the successful bidders for its first wave and tidal leasing round in the PFOW – providing up to 1.6GW installed capacity - in March 2010. The possibility of future leasing (and associated infrastructure requirements) is not considered in this Note.

1.2 Onshore Infrastructure Considered in this Information Note

This Note considers the onshore infrastructure likely to be developed, owned and operated by PFOW developers as part of their electricity production and transfer to the transmission and/or distribution systems owned and operated by SSE. Throughout the Note a distinction is therefore made between 'developers' infrastructure' and 'SSE's infrastructure'. Plans for infrastructure upgrades published by SSE are included as context in addition to a consideration of what additional SSE infrastructure might be required if all of the PFOW developers apply for grid connections under two generation scenarios;

- Scenario 1 - Initial arrays – initial wave/tidal energy generating device deployments at all PFOW project sites (up to approximately 305 MW).
- Scenario 2 - Full deployment – wave/tidal energy generating device deployments utilising the total PFOW Round 1 development site capacities (up to 1,600 MW).

The Note primarily focuses on the initial array scenario. This is because these are currently the critical phases of development and more information is therefore available as to the developers' plans for initial arrays at this time. So whilst even the initial array scenario is uncertain, there is more information available than for the full array scenario.

1.3 Onshore Infrastructure Not Considered in this Information Note

This Note is restricted to onshore infrastructure directly associated with PFOW wave and tidal project development. It does not consider ancillary development such as ports and harbours. Offshore infrastructure including sub-sea cables and offshore substations are not considered in detail in this Note.

Highland and Islands Enterprise and Scottish Enterprise are currently working on Stage 3 of their National Renewables Infrastructure Plan (N-RIP) which will focus on the broader infrastructure needs of the wave and tidal sector, outside of that covered in this Note. Interim findings were discussed at the Scottish Renewables Marine Conference in September 2012 and a report will be published in Spring 2013.

Also, The Crown Estate has recently commissioned a piece of work to consider the potential requirement for the marine energy supply chain in the north of Scotland with respect to the PFOW developments, including a consideration of ports and harbours, which is also outside the remit of this Note. That work will complement a report by BVG Associates on how the PFOW wave and tidal projects could be built[3].

1.4 Context

1.4.1 Policy Context

UK energy policy is to transition to a low carbon economy while maintaining energy security and minimising costs to consumers. Decarbonising the electricity sector through the increased deployment of renewable energy is central to that transition and is also critical if the UK is to meet its obligations under the Renewable Energy Directive[4] and those established by the Climate Change

[3] Wave and tidal energy in the Pentland Firth and Orkney waters: How the projects could be built; BVG Associates, May 2011. Available at http://www.thecrownestate.co.uk/media/71431/pentland_firth_how_the_projects_could_be_built.pdf.

[4] The UK has a target under the Renewable Energy Directive to deliver 15% of the UK's energy consumption from renewable sources by 2020.

Act[5]. Even more stretching is the Scottish Government objective to generate the equivalent of 100% of Scotland's gross annual electricity consumption from renewable sources by 2020.

The UK has an abundant wave and tidal energy resource, estimated by The Carbon Trust[6] to have the potential to provide 20% of current UK electricity demand. The emerging wave and tidal energy sector has been recognised by the UK Government and the Devolved Administrations as having an important role to play in the future renewable energy mix, and they have put in place policies to support its growth. A recent report by the House of Commons Energy and Climate Change Select Committee[7] has highlighted the numerous benefits that the establishment of a commercial wave and tidal energy sector could deliver for the UK.

1.4.2 Wave and Tidal Energy in Scotland

In 2011, the Scottish Government published a 2020 Routemap for Renewable Energy in Scotland[8] as an update to their earlier Scottish Renewables Action Plan 2009[9]. The Routemap underlines the drive to significantly increase the renewable energy generating capacity in Scotland, including in Scottish waters. With a quarter of Europe's tidal stream resource and 10% of its wave energy potential, the wave and tidal energy resource in Scotland has the potential to make a significant contribution to Scotland's longer term energy and carbon reduction targets. The Scottish Government have put in place a number of measures to support the growth of the wave and tidal energy sector in Scotland to harness that potential[10].

Established in 2003, The Orkney-based European Marine Energy Centre (EMEC) Ltd. provides internationally recognised and independently accredited purpose-built, open sea test facilities for wave and tidal energy converters. EMEC has 14 grid-connected full-scale test berths as well as a number of smaller 'nursery' sites offering facilities for testing smaller scale wave and tidal devices. The Centre was established with around £30 million of funding from the Scottish Government, Highlands and Islands Enterprise, the Carbon Trust, the UK Government, Scottish Enterprise, the European Union and Orkney Islands Council. More details can be found on their website at www.emec.org.uk.

In addition to activity at EMEC there are a number of other wave and tidal energy projects currently in development in Scotland. The focus of this Note is the Pentland Firth and Orkney waters Strategic Area which in 2008 became the first area in the UK to be made available by The Crown Estate for commercial scale development of wave and tidal energy via a competitive leasing round. In July 2012, the PFOW region was also designated as a Marine Energy Park by the Department of Energy and Climate Change.

1.5 The Crown Estate

The Crown Estate is a commercial property business tasked by Parliament with managing and enhancing the value of the hereditary estates of the Crown on behalf of the nation. The Crown Estate is a key player in supporting the delivery of a diverse and secure energy supply for the UK and,

[5] The Climate Change Act established a legally binding target to reduce the UK's greenhouse gas emissions by at least 80% below base year levels by 2050.

[6] Future Marine Energy, Carbon Trust, 2006

[7] The Future of Marine Renewables in the UK, House of Commons Energy and Climate Change Select Committee, February 2012

[8] http://www.scotland.gov.uk/Publications/2011/08/04110353/0

[9] http://www.scotland.gov.uk/Publications/2009/07/06095830/0

[10] http://www.scotland.gov.uk/Topics/marine/marineenergy/wave

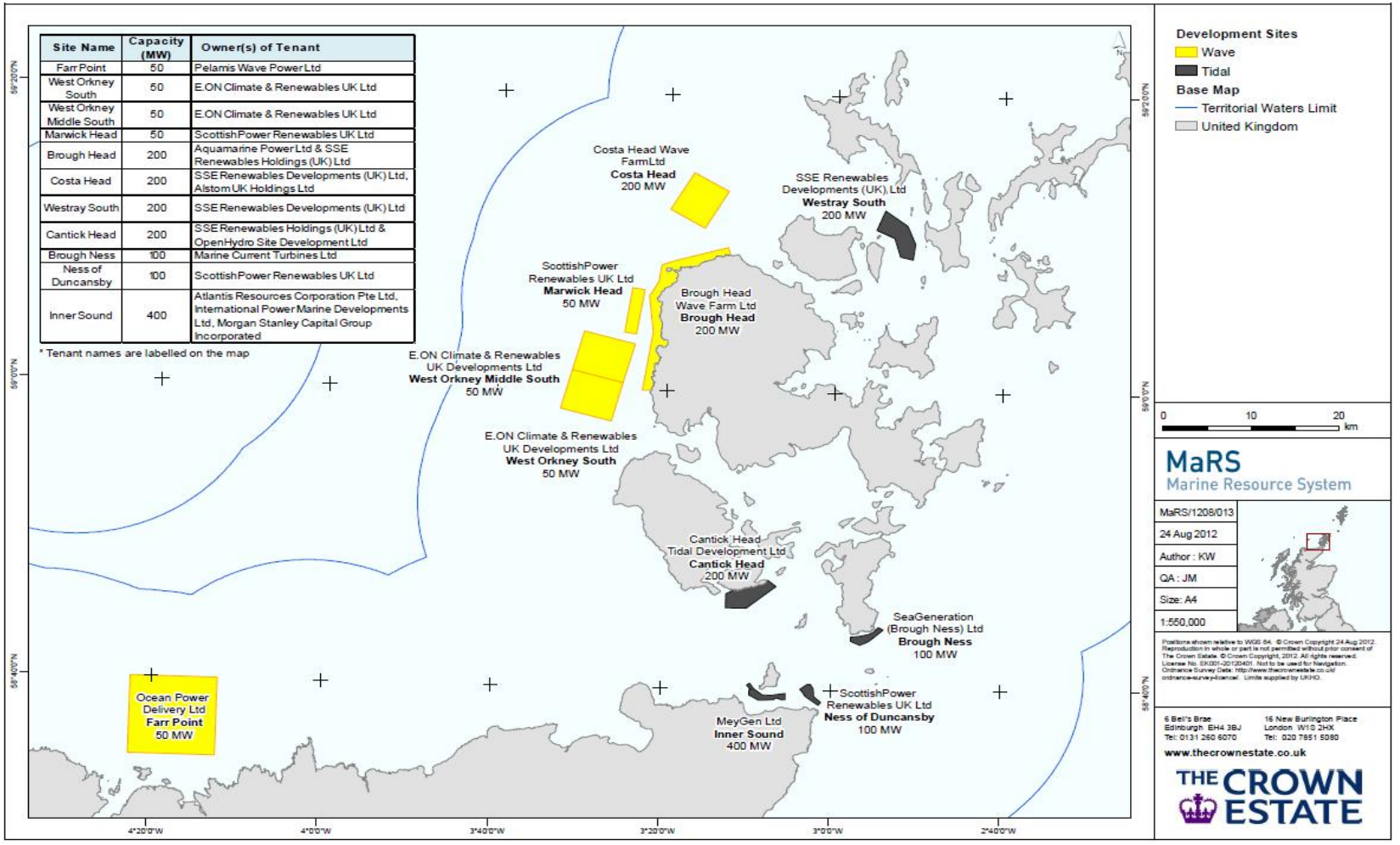
as managers of the seabed out to the 12 nautical mile limit and with rights to explore and exploit the natural resources (such as renewable energy and gas storage) of the Continental Shelf (less than 200 nautical miles), play a major role in the development of the UK offshore energy industry. To date (November 2012) The Crown Estate has awarded agreements for lease for 41 wave and tidal sites around the UK, including those in the PFOW Strategic Area.

With respect to the UK wave and tidal industry The Crown Estate's objectives are to:

- Support the growth of the emerging industry;
- Attract significant investment to the sector;
- Encourage major players to commit to development; and
- Support Government in defining policies that support the development of the industry.

The Crown Estate has entered into agreements for lease with developers for 11 projects in the PFOW with a potential capacity of up to 1,600 MW (see Figure 1). To facilitate successful and timely construction and operation of those projects The Crown Estate is investing £5.7 million in work that accelerates and de-risks their development. More detail on this enabling actions work can be found on The Crown Estate's website www.thecrownestate.co.uk. This report forms part of that Enabling Actions programme.

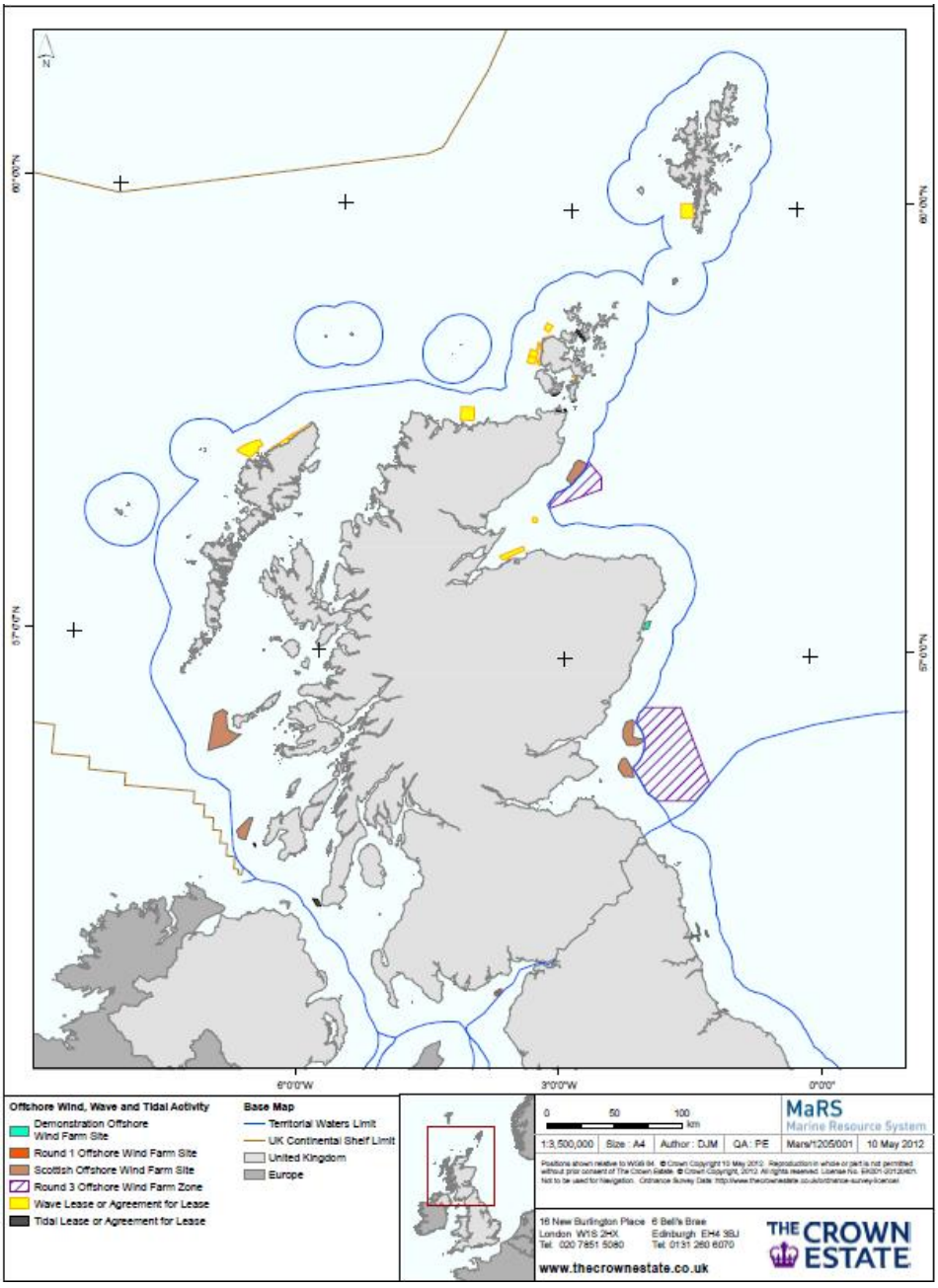
Figure 1: Pentland Firth and Orkney waters Round 1 Development Sites (see http://www.thecrownestate.co.uk/energy/wave-and-tidal/ for more details)



1.6 Other Offshore Renewable Energy Activity in Scotland

Development of wave and tidal projects in the PFOW is just one of a growing number of offshore renewable energy projects in Scotland. Figure 2 shows the areas outside the PFOW Strategic Area where wave and tidal projects are being developed as well as a number of offshore wind projects. This wider activity will have an impact on the requirement for onshore infrastructure and is an important context for this Note.

Figure 2: Offshore Renewable Energy Activity in Scotland (see http://www.thecrownestate.co.uk/energy/ for more details)



1.7 Grid

A recently published report by the Electricity Networks Strategy Group 'Our Electricity Transmission Network: A Vision for 2020'[11] highlights the challenges that the decarbonisation of electricity generation present to the ongoing and future maintenance and investment in the national electricity system. This includes the impact of increasing levels of generation from renewable energy technologies such as wave and tidal energy.

Grid access is clearly a critical component in the growth of the offshore renewables sector in Scotland and is the focus of a number of studies and discussions involving industry and Government[12]. Although this Note does not consider grid access and charging issues they are recognised as an important context to the information provided. Applications to connect to the electricity network at 132kV and above are made to the National Grid who deals with the applications in conjunction with Scottish Hydro-Electric Transmission Limited (SHETL). Applications to connect to the electricity network at below 132kV are made to Scottish Hydro-Electric Power Distribution Ltd (SHEPD).

1.8 SSE

Scottish Hydro-Electric Transmission Limited (SHETL) and Scottish Hydro-Electric Power Distribution Ltd (SHEPD) are both part of SSE plc (formerly Scottish and Southern Energy plc). Both SHETL and SHEPD own and operate electrical infrastructure in the North of Scotland. Infrastructure owned by SSE is therefore considered in this Note.

1.8.1 Scottish Hydro-Electric Transmission Limited (SHETL)

Scottish Hydro-Electric Transmission Ltd (SHETL) are the Transmission Owner (TO) in the North of Scotland and are responsible for the 5,000 km high voltage electricity transmission network (at or above 132 kV) that serves the northern part of Scotland, and connects to central and southern Scotland and the rest of Great Britain. SHETL's three main activities are to;

- Invest in new assets to accommodate growth in demand and generation;
- Invest in replacements for existing assets to maintain network performance; and
- Day-to-day running and maintenance of network assets.

SHETL are contractually obliged to provide new connections to the existing grid. This includes making the necessary upgrades to the network to accommodate new generation capacity such as that from the PFOW wave and tidal projects. In response to applications for grid connections made by energy generators, including PFOW developers, SHETL have published their plans for upgrades to the transmission network in the north of Scotland. Those plans provide important context for this Information Note and are described in more detail in Section 5. SHETL is regulated by the Office of Gas and Electricity Markets (Ofgem). More information in SHETL's activities can be found at http://www.ssepd.co.uk/Transmission/.

1.8.2 Scottish Hydro-Electric Power Distribution (SHEPD)

Scottish Hydro-Electric Power Distribution (SHEPD) operates the electricity distribution network (less than 132 kV) in the north of Scotland. The distribution network carries electricity from the transmission system (and from some generators that are connected to the distribution networks) to electricity users.

[11] http://www.decc.gov.uk/en/content/cms/meeting_energy/network/ensg/ensg.aspx

[12] For example see Project TransmiT
http://www.ofgem.gov.uk/Networks/Trans/PT/Pages/ProjectTransmiT.aspx

SHEPD are responsible for maintaining, repairing and improving the electricity distribution network in the north of Scotland, including investing in distribution infrastructure. Their objective is to match the network infrastructure development to the growth in demand for electricity. SHEPD is also regulated by Ofgem. More information on SHEPD's activities can be found at http://www.ssepd.co.uk/WhatWeDo/.

2 APPROACH

2.1 Limitations

At the time of writing the PFOW projects are at varying but generally early stages of development - the majority of PFOW developers are scoping their projects[13] and developing their respective technologies. Our ability to assess exactly what developer and SSE onshore infrastructure will actually be built is therefore limited by a number of key factors;

- Many of the wave and tidal technologies under consideration for deployment at PFOW sites are currently in the early phases of development and the detail of what is required for commercial scale projects is largely undefined. Project plans may necessarily change as those technologies develop and more information on project sites become available through the scoping process.

- Some developers have not yet published scoping reports, meaning that little or no public domain information is available for either offshore or onshore plans for some projects.

- SSE plans for infrastructure to accommodate new generation only take into account the actual applications received from developers for network connections. To date, only a few PFOW developers have applied for connections, so current SSE plans do not account for the predicted generation volumes (for initial arrays and full deployment) that this Note is seeking to consider.

It should be noted that the assessments made in this Note are based on the Round 1 development sites in the PFOW Strategic Area. Any future leasing in the Pentland Firth and Orkney waters could result in the requirement for onshore infrastructure in addition to that considered in this Note.

2.2 Accounting for Uncertainty

Assumptions and scenarios have been used in this Note to accommodate the limitations – and resulting information gaps - described above whilst allowing the aims and objectives of the Note to be met. They have also been used to address the more general uncertainties inherent in a strategic-level study of this type. When reading this Note it is therefore important to remember that the information provided does not represent a definitive design and scale of onshore infrastructure that is likely to be required to meet the two (initial arrays and full deployment) generation scenarios.

Onshore infrastructure developments will be progressed by the relevant party (SSE and/or PFOW developers). During that process it is likely that iterative changes will be made to project plans as additional information on technologies and project sites comes forward. The eventual development of onshore infrastructure in Orkney, Caithness and Sutherland directly related to the PFOW projects may therefore vary from that presented in this Note, which is based on current understanding and some necessary assumptions of the PFOW projects and examples drawn from renewables projects elsewhere to provide an informed understanding and context.

2.2.1 Key Assumptions

Our key assumptions in producing this Note are that;

- All the Round 1 PFOW project sites will eventually be developed to their full capacity (i.e. to the maximum capacity of the lease agreement with The Crown Estate).

This is to enable us to identify an upper bound on the onshore infrastructure which could be associated with the Round 1 PFOW projects.

[13] Scoping is one of the initial stages of the environmental impact process (EIA). A Scoping Report is produced to facilitate the identification and assessment of the potential environmental impacts associated with a proposed development.

- The PFOW generating capacities will be developed over time, in phases, with a smaller number of devices deployed initially.

All of the PFOW developers are planning to develop their sites in a phased way with an initial deployment of wave/tidal energy generating devices in the short term followed by either further stepped deployment or a single second full deployment to make up the lease capacity. Where PFOW developers have published their plans for an initial deployment we have used the published initial array capacity as the starting point for our assessment. Where information is not available we have assumed 10 MW as the initial array capacity.

- Developers will make appropriate connection applications. This includes the assumption that the relevant and necessary generation connection consents are granted. We have not attempted to ascribe timescales to developments or their related connections, other than to recognise that the generation capacities are time-phased.

In order to obtain a connection to SSE's infrastructure, developers must make an application to National Grid and/or SSE[14]. Although SSE will do some forward network planning based on their assessment of energy generation sector growth, in the absence of a connection application they cannot make firm plans for network reinforcements[15] to be made. At present only some of the developers have applied for grid connections (see Tables 4 and 5).

- Wave and tidal generator power would be delivered by the generators to the substation collector points at a voltage of up to 132 kV.

The actual voltage of power delivery could range from 3.3 kV to 132 kV and will depend on a number of factors including the individual technologies developers choose to utilise. More information will become available as technologies (and projects) develop.

- A single connection would be provided between each generating array and the national network.

Some developers may ultimately require more than one connection for future arrays; however, for the purposes of this Note an assumption of one connection per project has been used for the initial arrays.

2.2.2 Scenarios

To accommodate the uncertainty of both the ultimate generation capacity to be installed in the area and the timescales over which this capacity will be commissioned, this Note makes use of two illustrative generation scenarios;

- Initial arrays – initial device deployments at all the PFOW project sites; and subsequently

- Full deployment – utilising the total PFOW Round 1 development site capacities (1.6 GW) by deploying maximum arrays at each PFOW project site.

For each scenario we estimate the type and broad location of SSE's infrastructure likely to be required to extract the power generated. This high level assessment is presented in the form of a network concept for each scenario.

[14] For more information see http://www.nationalgrid.com/uk/Electricity/GettingConnected/

[15] Network reinforcement is work carried out to upgrade the existing network where needed to provide security of supply, new connection or load increase.

The Note focuses on the initial array scenario as more information is available on the developers' plans for initial arrays at this time as these are currently the critical projects which the developers' are focussed on. The full deployment scenario is included to represent an upper bound for possible onshore infrastructure development. The scenarios have been developed for illustrative purposes only to allow a measure of planning to be progressed in this very uncertain environment. The actual eventual development of generation and onshore infrastructure is inherently uncertain and is likely to be bracketed by these two scenarios.

2.3 Caveats

While The Crown Estate and other organisations contributing to this Note have taken reasonable steps to ensure that the information is correct, they give no warranty and make no representations as to its accuracy and accept no liability for any errors or omissions.

The Note does not include detailed information on the type, location and scale of developer and SSE onshore infrastructure which is at this time (with the exception of some SSE development) largely unknown, and is the remit of individual developers to define as necessary for their projects. The findings should therefore not be read as a definitive design for the development of onshore infrastructure in the north of Scotland. Any development of infrastructure associated with the PFOW wave and tidal projects will be contingent on satisfying a range of criteria, including economic, technical, environmental and social considerations; as well as the technical requirements of the connection applications that have already been made. When specific proposals do come forward, full stakeholder consultation will be carried out (see Section 8 for more details).

2.4 Definitions

A full glossary of the terms used in this Note is provided at Annex B. For additional clarity a description of the key terms used are given in Table 1 below;

Table 1: Definitions for the Key Terms Used in this Document. (A full glossary is available at Annex B)

Term	Definition
Developers' infrastructure	Any onshore cables, buildings etc. required by a developer to connect wave/tidal generation equipment to the distribution and/or transmission systems owned and operated by SSE.
Developer(s)	Individual or consortium company in possession of a PFOW Round 1 development site agreement for lease with The Crown Estate
Distribution network	The electricity network (below 132 kV) owned and operated by SHEPD, an SSE company.
Full deployment	Full take-up, by all developers, of their Round 1 lease generation capacities, totalling 1,600 MW
Generator(s)	As Developer.
Initial arrays	Initial take-up by each of the developers of their Round 1 lease generation capacities (i.e. first project phases), anticipated to total approximately 305 MW

Term	Definition
Onshore infrastructure	All developers' and SSE's infrastructure landward of the mean low water mark of ordinary spring tides level owned and operated by the developers and SSE. It excludes offshore infrastructure such as sub-sea cables and connectors owned by any of developers and other ancillary facilities such as ports, harbours and transport routes.
Scenario(s)	The two scenarios considered in this document refer to two stages of development of the PFOW projects (see Section 2).
SSE's infrastructure	Underground cables, overhead lines, substations and other buildings which comprise the distribution and transmission networks owned and operated by SSE.
Transmission network	The electricity network (132 kV and above) owned and operated by SHETL, an SSE company.
Wave/tidal energy	Electricity generated from wave and tidal flows. More detail on wave and tidal energy technologies can be found in The Renewable UK Wave and Tidal Energy in the UK State of the Industry Report 2012.

3 WAVE AND TIDAL PROJECTS IN THE PENTLAND FIRTH AND ORKNEY WATERS STRATEGIC AREA

Within the PFOW strategic area there are eleven Round 1 development sites; 6 where wave energy technologies will be deployed and 5 where tidal stream energy technologies will be deployed. The developers that hold agreements for lease with The Crown Estate for these sites are shown in Table 2 below. Also shown is the upper bound of the installed capacity at each site in line with the agreement for lease (the site capacity). This figure is used for our 'full deployment' scenario. The generating capacity of the initial arrays that developers have indicated will be deployed at each site – and that used in our 'initial array' scenario – is also shown. Where developers have not published plans for an initial array we have assumed it to be 10 MW.

Table 2: The Pentland Firth and Orkney waters Round 1 Development Sites (The values in the table are correct as of October 2012)

Developer/owner	Technology/energy source	Site	Site capacity (full deployment)	Initial array capacity
Brough Head Wave Farm Ltd (Aquamarine Power Ltd & SSE Renewables Holdings (UK) Ltd joint venture)	Aquamarine Power Oyster (wave)	Brough Head	200 MW	Up to 50 MW
SeaGeneration (Brough Ness) Ltd (Marine Current Turbines Ltd)	Marine Current Turbines Ltd SeaGen S (tidal)	Brough Ness	100 MW	Unknown – assume 10 MW
Cantick Head Tidal Development Ltd (SSE Renewables Holdings (UK) Ltd & OpenHydro Site Developments Ltd joint venture)	OpenHydro Open Centre Turbine (tidal)	Cantick Head	200 MW	~30 MW
Costa Head Wave Farm Ltd (SSE Renewables Holdings (UK) Ltd & Alstom UK Holdings Ltd joint venture)	AWS-III (wave)	Costa Head	200 MW	10 MW
Ocean Power Delivery Ltd (Pelamis Wave Power Ltd)	Pelamis P2 (wave)	Farr Point	50 MW	7.5 - 15 MW
MeyGen Ltd (Morgan Stanley Capital Group Inc., International Power Marine Developments Ltd & Atlantis Resources Corporation	Tidal Generation Limited & Atlantis Resources Corporation (tidal)	Inner Sound	400 MW	20 MW rising to 86 MW within 3 years

Developer/owner	Technology/energy source	Site	Site capacity (full deployment)	Initial array capacity
Pte Ltd joint venture)				
Scottish Power Renewables UK Ltd	Pelamis P2 (wave)	Marwick Head	50 MW	9 MW
Scottish Power Renewables UK Ltd	Hammerfest Strom HS 1000 (tidal)	Ness of Dunscansby	100 MW	30 MW
E.ON Climate and Renewables UK Developments Ltd (E.ON Climate and Renewables UK Ltd)	tbc (wave)	West Orkney Middle South	50 MW	10 MW
E.ON Climate and Renewables UK Developments Ltd (E.ON Climate and Renewables UK Ltd)	Pelamis P2 (wave)	West Orkney South	50 MW	10 MW
SSE Renewables Developments UK Ltd	tbc (tidal)	Westray South	200 MW	30-45 MW
TOTAL			**1,600 MW**	**Up to 305 MW**

More detail on the individual PFOW projects listed above can be found on The Crown Estate website at http://www.thecrownestate.co.uk/energy/wave-and-tidal/pentland-firth-and-orkney-waters/ and at the individual project websites (see table 3 for details).

4 DEVELOPERS' INFRASTRUCTURE (ONSHORE)

This section describes and illustrates the broad type and scale of developers' infrastructure (cables, wires, buildings etc.) that could be required to service the PFOW projects, including connecting the PFOW generators to the SSE network. It should be noted that the exact onshore infrastructure requirements for each PFOW project will be influenced by a number of factors including:

- the wave/tidal technology being deployed, for example, where the Aquamarine Power Ltd Oyster device is used, high and low pressure pipelines rather than electrical connections would be brought to the coast and an onshore hydro-electric generating station would be required; and

- the grid connection strategy being employed, including the location of existing/planned SSE infrastructure. For example, some cases may require overland connections, whilst others may best be served with a combination of an under/over ground and undersea connection to the SSE network.

4.1 Project Information Sources

Further (and regularly updated) information on developers' plans for onshore infrastructure development can be found on the PFOW project websites listed in Table 3 below.

Table 3: Pentland Firth and Orkney waters Project Website Details

Project site	Website for up to date information
Brough Head	http://www.aquamarinepower.com/projects/west-coast-orkney/
Brough Ness	http://www.marineturbines.com/Projects
Cantick Head	http://www.sse.com/CantickHead/
Costa Head	http://www.sse.com/CostaHead/
Farr Point	http://www.pelamiswave.com/our-projects/project/5/Farr-Point-Wave-Farm
Inner Sound	http://www.meygen.com/the-project/
Marwick Head	http://www.scottishpowerrenewables.com/pages/marwick_head.asp
Ness of Duncansby	http://www.scottishpowerrenewables.com/pages/ness_of_duncansby.asp
West Orkney Middle South and West Orkney South	http://www.eon-uk.com/generation/OrkneyWaters.aspx
Westray South	http://www.sse.com/WestraySouth/

4.2 Infrastructure Included in a Typical Wave/Tidal Project

A PFOW wave or tidal project will typically include offshore and onshore infrastructure components as illustrated in Figure 3 and 4. There will be variations between projects although broadly speaking offshore components could include;

- an array of wave or tidal energy capture devices; and
- cabling or pipe-work running between devices and/or from the devices to the shoreline possibly via an offshore hub. Figure 3 shows a schematic diagram for wave hub in Cornwall where a number of different wave energy devices are connected into an offshore hub[16].

Onshore infrastructure could typically include;

- cabling or pipe-work brought onshore at a suitable landing point via appropriate offshore-to-onshore transition arrangements;
- equipment and facilities typically located close to the cable landing point on a plant compound, which may include (some or all of) a generator house, control building, substation with switching and transformation equipment, staff facilities and parking space/hard standing; and
- a cable or overhead line to connect the developer-owned electricity infrastructure to the distribution or transmission network owned and operated by SSE.

[16] The schematic shows more than one type of generating technology. In the case of most PFOW projects it is expected that only one type of wave/tidal technology would be deployed per project.

Figure 3: Schematic of Wave Hub Showing Several Types of Device Connected to an Offshore Hub (see www.wavehub.co.uk for more details)

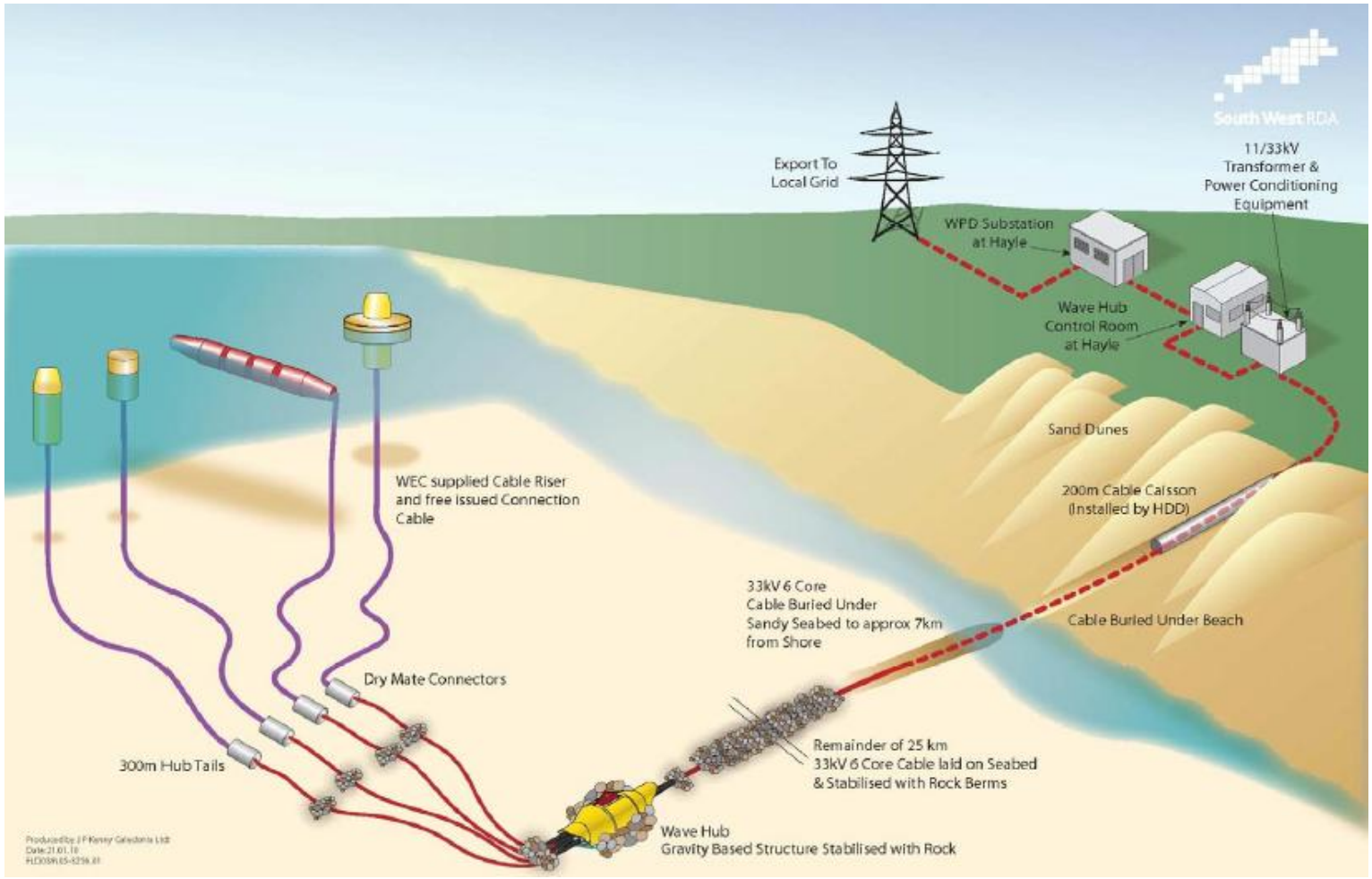
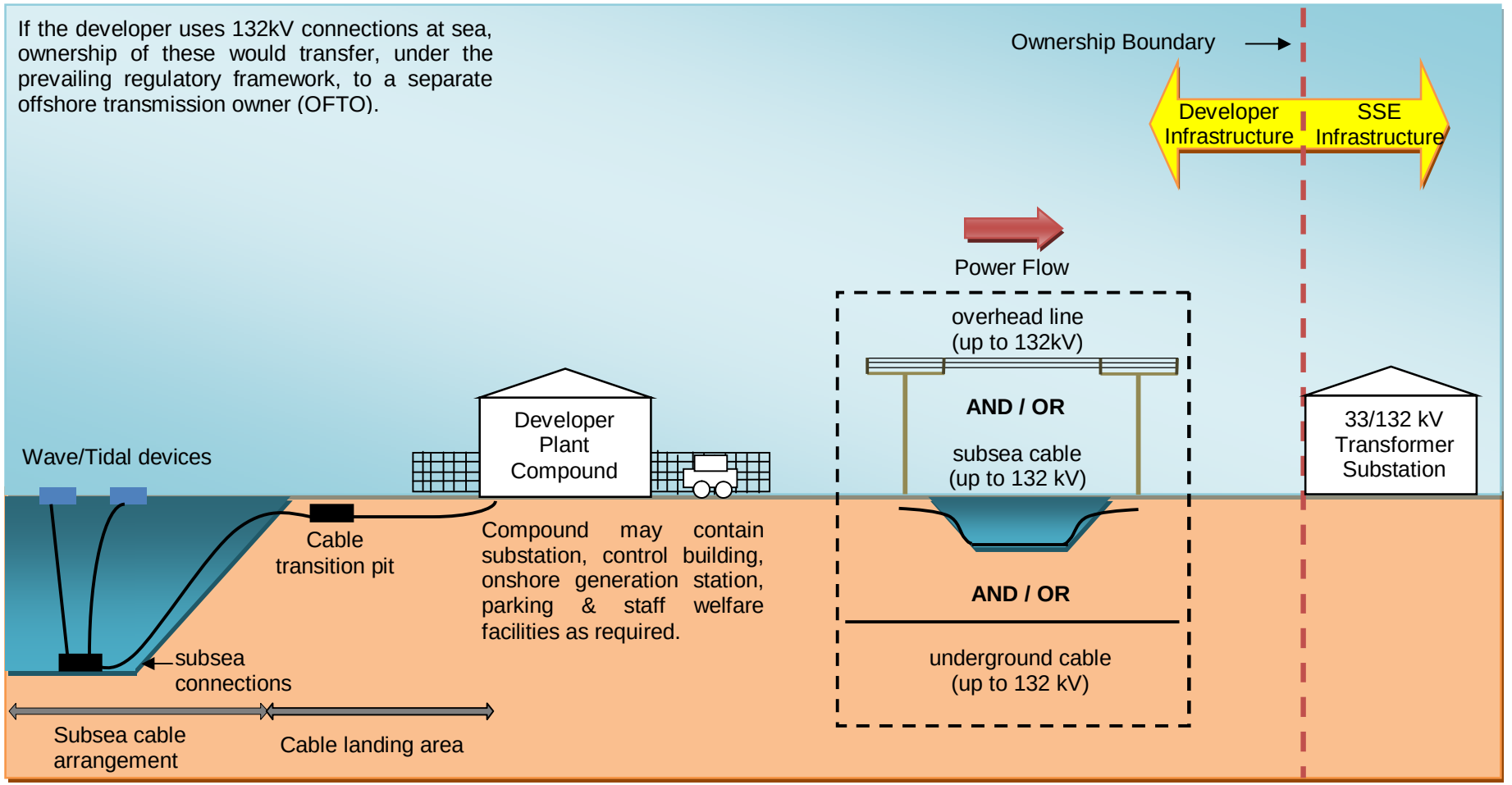


Figure 4: Linear Sketch to Illustrate a Typical Wave/Tidal Project and Associated Infrastructure (the actual arrangement for individual PFOW projects will be site specific)



4.3 Examples of Developers' Infrastructure

4.3.1 Cable and Hydraulic Pipe Landing Works

Most developers are planning to run submarine or subsea electric cables or hydraulic pipes from their offshore sites to shore for onward connection to their own and/or SSE's infrastructure. To avoid imposing any permanent visual mark at the landfall, and to protect the cables or pipes themselves from tidal or other damage, they are likely to be buried. This burial will likely extend from below the low-water mark to a transition joint bay, or even direct to a local substation or power station, well above the high-water mark. This buried section is sometimes termed the 'landing works'.

For both cables and pipes there are broadly two ways of bringing them to a suitable connection point on land – either laid in a trench, or drawn into a duct. These two options are briefly described below. The choice of which technique is used will depend on a number of factors including the required capacity of the connection, the number of cables or pipes being installed, shoreline topography, ground conditions, and the environmental sensitivity of the site.

Trenching

This technique is sometimes referred to as 'open cut'. Excavation equipment would be used to dig a trench, typically 1 m deep, from below the low-water mark right across the beach to a transition pit well above the high-water mark. Cables or pipes would be laid in the bottom of the trench and covered over with a protective layer of sand or cement-bound sand, before the trench is re-filled with the remainder of the excavated material. Figures 5 & 6 show cable landing works for the two 33 kV power cables at Wave Hub in Cornwall.

Figure 5: Cable landing works at Wave Hub in Cornwall (high tide) (Photograph courtesy of Wave Hub)

Figure 6: Cable landing works at Wave Hub in Cornwall (low tide) (Photograph courtesy of Wave Hub)

At some point above high water the ends of submarine cables would either be laid in a transition pit and connected to an underground cable or connected directly to an overhead line – see, for example, Figure 7. Transition pits would typically include a manhole cover for maintenance access during the life of the cable installation.

The number of cables or hydraulic pipes being brought ashore, and thus the number of trenches, would depend upon the particular generation technology and capacity being installed. However, whichever of the landing methods described above is used in a particular location, the geotechnical survey and coastal topography would largely determine the distance over which the cables or pipes need to be buried. Where the slope of the coast is shallow, the visible length of a trench – whose minimum depth is usually around 1 m – can run to several hundred metres across the tidal area of the coast/beach/cliffs. However, trenches are most visible during the construction phase, and become less visible as remediation measures (such as re-vegetation) mature.

The greatest environmental impact of a trenched cable or pipe landing would occur during the construction phase. During this period the excavators, the excavations themselves, and the access routes for excavation equipment, cables and/or pipes may cause environmental impacts such as noise, visual amenity impact or soil disturbance and compaction. However, this impact would be temporary, since the final phase of the construction process would be to reinstate the ground to agreed standards. Agreed signage would mark the presence of any underground installation.

Ducting

This technique is normally referred to as either ‘horizontal directional drilling (HDD)’ or ‘trenchless’. A pit would be dug well above the high-water mark, and a specialised drilling rig would be installed in the pit to drill at an oblique angle under the beach/cliff. The drilling head would be controlled during drilling so that it emerges below the low-water mark, whereupon polyethylene (high density plastic)

ducting would then be pulled back through the hole ready to accept cables or pipes. This duct allows the submarine cables to be simply drawn beneath the beach and up on to dry land, and protects them during their operational life. As with trenching, at some point above high water the ends of the cables would be laid in a transition pit and connected to underground cable or overhead line.

Steep beaches, and cliffs, would necessitate the use of HDD rather than trenching to bring the connections ashore. In this case, only the areas around the two ends of the ducting would be disturbed, and of course, one of these would be below the low-water mark. The dry-land area occupied by the HDD works (the place where the horizontal drilling would take place), and the number of ducts installed from this temporary construction location, would vary from project to project, but the drilling works area might typically measure around 40 m x 40 m.

Environmental impact of an HDD cable or pipe landing would only occur during the construction phase. During this period the HDD drilling rig and associated equipment, the construction work, and the access routes and storage for equipment and supplies, including ducts, cables and/or pipes may cause environmental impacts such as noise, visual amenity impact or soil disturbance and compaction. Any drilling mud and drilled aggregate from the drill-bore would be removed from the site as part of the construction process. After the duct(s) had been installed the ground would be reinstated to agreed standards. Again, agreed signage would mark the presence of any underground installation.

4.3.2 Connecting to the Electricity Network

Once onshore, connections may be taken from the cable landing to the nearest power network connection point either above or below ground, and sometimes a mixture of the two. Figure 7 shows a 33 kV cable on Orkney at the point at which it comes above ground (having been run sub-sea and underground to that point).

The lengths of the new overland connections required by the developers will be dependent upon the locations of the cable landing sites with any developers' infrastructure and the SSE network. Some developers have indicated that, rather than landing their cables at the nearest practicable shoreline and then triggering SSE to build a new connection, they may run submarine cables over longer distances, to connect to a more accessible point on the SSE network.

Figure 7: 33 kV Line on Orkney at the Point at Which it Transfers from Underground Cable to Overhead Line

4.3.3 Developer Plant Compound(s)

These compounds, most likely to be located within the vicinity of the offshore site although this will depend on the characteristics of each site and location of SSE infrastructure, are where developers are likely to situate the onshore equipment and facilities, owned and operated by them, necessary to support their respective projects. This could include a substation, onshore generating equipment, control equipment, maintenance facilities, office space, staff welfare facilities and car parking as necessary. In some cases the developer plant compound may be located adjacent to SSE's infrastructure.

The estimated land-take for plant compounds will vary between projects. Initial scoping[17] for the Westray South site estimates an area of 90 m x 50 m to be required to locate a 132/33 kV substation, control building and welfare/operational buildings and space (to support the full 200 MW deployment). However, there is not a standard size that can be applied across projects.

It is possible that more than one plant compound will be required per PFOW project. Factors influencing this will include the configuration of wave and tidal energy generating arrays within the offshore site and the technology choice and associated onshore equipment necessary for individual projects (and the best way of housing that). For example, Brough Head Wave Farm Ltd has estimated that to support an initial array of up to 50 MW, two plant compounds could be required, each containing car parking plus one building that will house generating equipment (see 4.3.5), offices and welfare facilities.

[17] http://www.sse.com/WestraySouth/

The arrangement of facilities on the compounds will vary between projects given the different technologies being deployed and the different site geographies. Drawing from some of the plans published by developers and from similar existing projects elsewhere, some examples of the types of facilities that may be included on a site compound are given below. These further illustrate the different approaches being taken by developers and therefore the different requirements at onshore sites. However, despite those differences it is likely that developers will require an onshore plant compound of some sort. The design and siting of buildings on compounds will be key factors in determining their impact on the landscape. What is appropriate in one location may not be suitable elsewhere and what may be suitable/necessary for one project may not be suitable for another[18]. Both the Highland Council and Orkney Islands Council have indicated that they would welcome continued/further discussions with developers on this issue.

Substation

The offshore electrical design that developers use will determine the need for and type of electrical equipment required onshore before a connection can be made to SSE's infrastructure. In most cases a switching station or substation containing switching and possibly transformer equipment will be necessary. Switching equipment is used to control voltage and control the flow of electricity (e.g. switching from developer circuits to SSE circuits). Transformer equipment is used to either increase or decrease voltages (e.g. changing the voltage of electricity from developers' infrastructure so it is compliant with SSE requirements for entry on to their networks).

Substations vary in size and shape depending upon many factors, the principal ones being the highest voltage they are required to handle, and the number of distribution and transmission connections made to the substation. Lower voltage equipment is often housed indoors, the benefits of which can include protection from the weather, or mitigation of its visual impact, etc.

The type, size and scale of developer-owned substations will vary between projects and as technology advances the requirement for space may decrease as electrical equipment and associated components reduce in size. The scoping report for the Farr Point[19] site estimates that a substation compound with a footprint of approximately 30 m x 20 m will be required to support the development of its first phase. The substation for the EMEC wave test site at Billia Croo on Orkney is shown in Figure 8 and the substation for the 4.5 MW Hammars Hill onshore wind farm on Orkney is shown in Figure 9. These provide examples of the type of developer substation that could be built to accommodate initial arrays.

Some developers have indicated that they do not anticipate developing a substation as they plan to transport grid-compliant power directly from their offshore site to the appropriate SSE infrastructure. In these cases it is possible that the developer will still require some sort of electrical transformer equipment (e.g. Figure 8 shows the three transformers at the EMEC site at Billia Croo) which could be located on a plant compound.

[18] A report by The Prince's Foundation for Building Community has looked at this issue and can be found at http://www.princes-foundation.org/what-we-do/projects/uk/north-highland-initiative-onshore-visioning

[19] http://www.pelamiswave.com/our-projects/project/5/Farr-Point-Wave-Farm

Figure 8: European Marine Energy Test Centre Substation and Transformers at Billia Croo, Orkney

Figure 9: Hammars Hill 33 kV Substation on Orkney West Mainland Serving the Hammars Hill 4.5 MW Onshore Wind Farm (Cables Run Underground from the Turbines to the Substation Building)

Control Room

A control room containing equipment necessary to remotely control and monitor the operation of offshore energy capture devices will be necessary for most PFOW projects. Some developers have

indicated they plan to house a control room in a building on the plant compound which also contains other facilities such as meeting space and staff amenities.

Control equipment could be located within a building on the plant compound or it is possible that the control building could be located some distance from the offshore site. For example, the control room for both EMEC test sites is located at their offices in Stromness. Some developers have indicated that they plan to site their control equipment in existing offices and therefore remotely from their PFOW sites.

Power Conversion Building

This type of building has been included within the development being progressed by MeyGen Limited at the Inner Sound site and who have published plans for up to three onshore Power Conversion Unit Buildings (PCUB) for their initial array. Other developers/projects may refer to this type of building as a substation. One PCUB is anticipated in the first instance and the remaining two will be required and constructed in subsequent years. The buildings are to be used to securely terminate each subsea turbine power cable and to provide protection and security to the associated electrical equipment housed inside. Each PCUB is expected to be up to 30 m wide, 45 m long and a maximum of 13 m high and have been designed (see Figure 10) following consultation with The Highland Council (THC) Planning and Development and Historic Environments Team and Scottish Natural Heritage (SNH). To provide an additional sense of scale, Figure 11 shows an industrial building in the Caithness landscape which is approximately 12 m in height.

Figure 10: Artists Impression of the Proposed Power Conversion Unit Buildings at the Inner Sound Site (For more information see www.meygen.com)

Figure 11: Halkirk Industrial Building in Caithness Landscape est. 12 m Height. (Photograph courtesy of SSE)

Onshore Generating Station

For some projects an onshore generating station may be required. For example, Brough Head Wave Farm Ltd intends to deploy Aquamarine Power's Oyster wave device at the Brough Head site. The device uses an alternative power take-off system which includes an onshore hydroelectric power conversion plant. The developer expects that one or two generating station buildings may be required to accommodate the first 50 MW (if two building are necessary these are expected to be sited within a few kilometres of each other (on separate compounds)). Figure 12 shows the Oyster 800 building (approximately 12 m x 30 m) for the 2.4 MW development at the EMEC test site at Billia Croo. The building(s) necessary to support an initial array of up to 50 MW at the Brough Head site are anticipated to be in the region of 2-3 times larger than the building at EMEC. They will contain generating equipment, office space and staff welfare facilities.

Figure 12: Aquamarine Power's Oyster 800 Building and Compound for their 2.4 MW Deployment at the EMEC Billia Croo Site (Photograph courtesy of Aquamarine Power Ltd)

4.3.4 Underground, Subsea or Overhead Lines

Depending on the grid connection strategy being used by developers, it is likely that they will need to run power cables from their own onshore infrastructure (if required) in order to connect to SSE's infrastructure at the correct voltage. The connection could be made via an underground cable or may require the construction of an overhead line and could be 11 kV, 33 kV or 132 kV depending on to which system (distribution or transmission) the connection is made. Options for cable laying have already been described in Section 4.3.1. Many of the developers have indicated in their scoping reports that they intend to make these connections via underground cables where conditions permit, including the location of existing or future SSE infrastructure.

Examples of the existing 11kV cables in Caithness and 33 kV cables on Orkney are shown in Figures 13 and 14 below. There are currently no 132 kV lines on Orkney. An example of a 132 kV cable is shown in Figure 23, which indicates that 132kv lines will not necessarily be much larger or visually different to overhead lines already present in Orkney and Caithness.

Figure 13: 11 kV Line in Caithness

Figure 14: 33 kV Overhead Lines on Orkney

For an image of a 132kV overhead line see Figure 23.

5 SSE'S INFRASTRUCTURE (ONSHORE)

Onshore infrastructure owned and operated by developers must link with transmission and/or distribution infrastructure owned and operated by SSE in order to transport the power generated at developer-operated sites to centres of demand (see Figures 20 and 21). This section describes and illustrates the broad type of SSE infrastructure that could be expected to be developed to support the PFOW projects[20]. Section 7 considers the broad scale and location of that infrastructure.

Two of the projects (Farr Point and Inner Sound) have contracted connections to the distribution system (less than 132 kV) that can accommodate at least some of their initial array deployment capacity. It is assumed in this Note that the remaining projects will connect to the transmission system (132 kV and above), although the requirement for new connections (and related SSE infrastructure development) will be driven by the applications SSE receives for new generator connections (see Section 4).

5.1 Substations

Substations owned and operated by SSE contain the electrical equipment required to switch and/or transform electrical power in order to ensure the efficient operation of the grid. Substations can be indoor or outdoor facilities, whose size will depend on the volume of electrical equipment they are designed to contain (for example, the number of switching bays and/or transformers). Some examples are given in Figures 15 - 19. Dimensions of substations will vary from site to site depending on local ground conditions. SSE estimates that a typical grid supply point substation (including 2 x 132 kV transformers and switch room) would be approximately 80 m x 80 m x 12 m high, whilst a typical primary substation (including 1 x 33/11kV transformer and switch room) would be 40 m x 40 m x 7 m high. SSE have recently consulted on a new 132 kV enclosed substation on the West coast of Orkney Mainland to provide a connection point for PFOW developments on that side of the Island (see Table 5 for a list of known existing connections). They have estimated the size of the building required to be approximately 50 m x 14 m x 10 m high. The overall compound size of approximately 350 m x 350 m would also accommodate a possible future High Voltage Direct Current (HVDC) converter station.

Recent advances in technology offer much more compact substation equipment than that of the 1950s and 1960s, which was when many of the existing substations were built. Technological advances will doubtless continue as the PFOW projects develop, so it is difficult to accurately predict the size of buildings and sites that will be necessary to house onshore infrastructure associated with the PFOW projects – especially the later cases. The examples of existing designs of substations given in Figures 15 - 19 should thus be viewed with that in mind. Figures 20 and 21 illustrate how Developers' infrastructure might interface with the distribution and transmission systems. These figures illustrate the differences between the two types of connections.

Section 7 provides an estimate of the likely volume and broad location of new substations that may be required under two PFOW generation scenarios – initial arrays and full deployment.

[20] It is possible that, at the time a generation developer makes a connection application, an Offshore Transmission Owner (OFTO) rather than SSE might take eventual ownership of any transmission voltage subsea connection whose construction is triggered by the application. The UK OFTO regime is still fluid, and further developments are likely during the development of the PFOW generation areas. This Note does not consider OFTOs. More information on OFTOs can be found at http://www.decc.gov.uk/en/content/cms/meeting_energy/network/offshore_dev/offshore_dev.aspx

Figure 15: SSE 33/132 kV Stromness Substation

Figure 16: SSE 33/132 kV Stromness Substation

Figure 17: Example of a 132 kV Indoor Substation. (Photograph courtesy of SSE)

Figure 18: Example of a 132 kV Indoor Substation with Woodpole 'Trident' Overhead Line. (Photograph courtesy of SSE)

Figure 19: Example of a 132-33 kV Transformer. (Photograph courtesy of SSE)

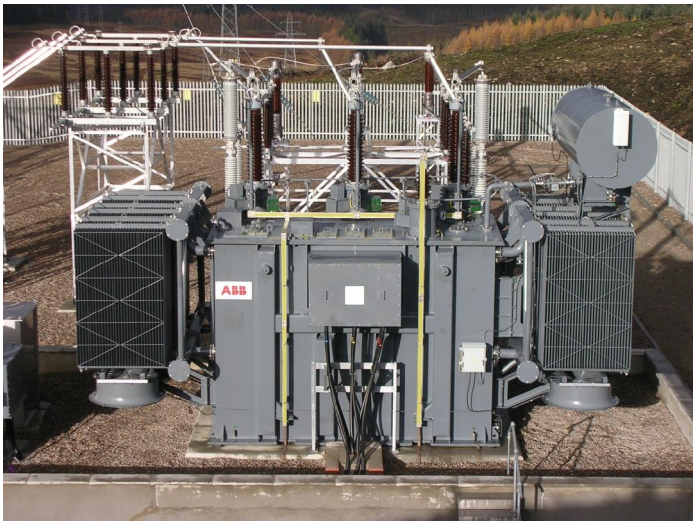


Figure 20: Linear Sketch Showing How Developers' Infrastructure Might Interface with the Distribution System (This is for illustrative purposes only and does not cover all the possible connection and ownership arrangements)

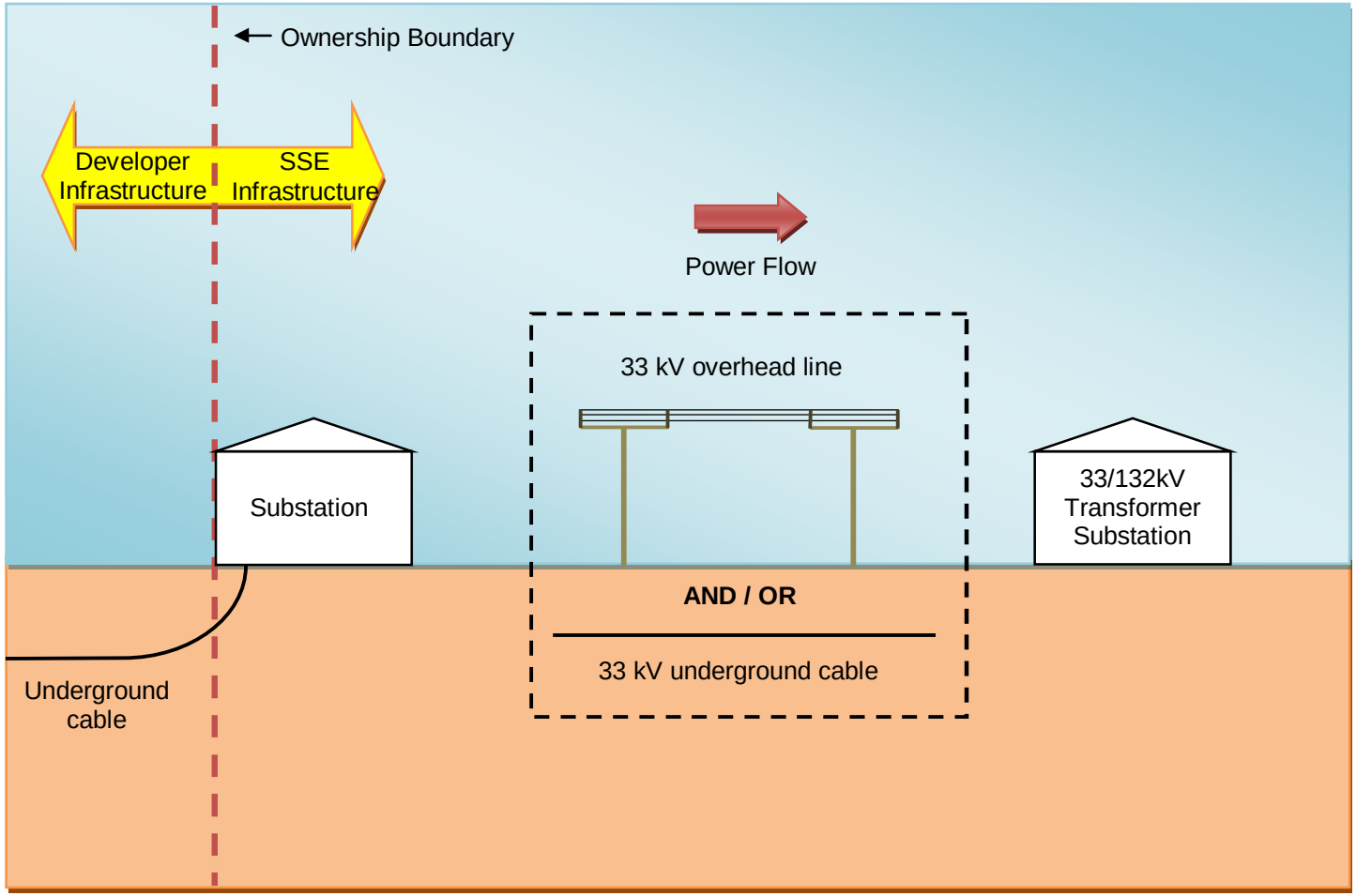
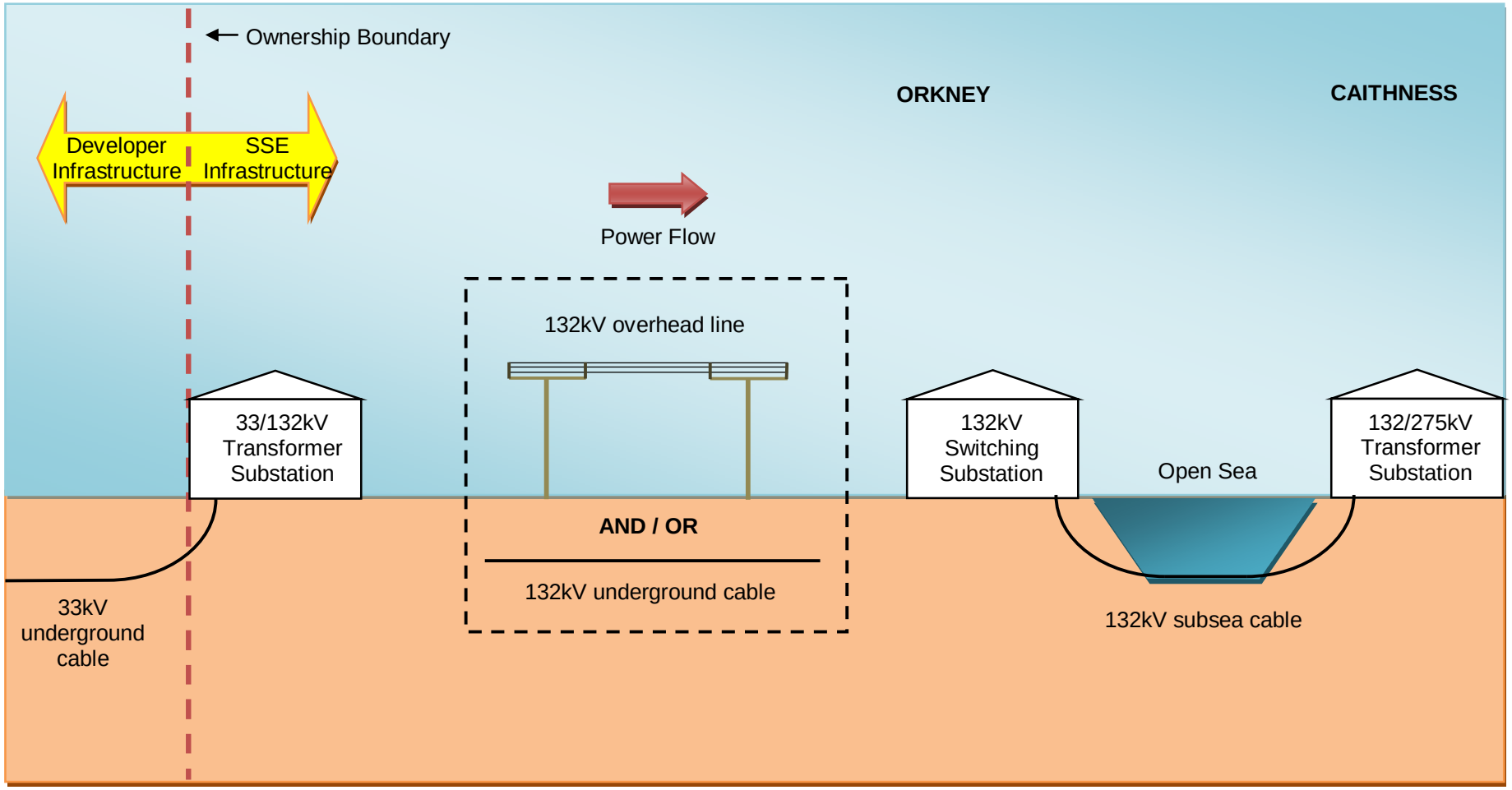


Figure 21: Linear Sketch Showing How Developers' Infrastructure Might Interface with the Transmission System (This is for illustrative purposes only and does not cover all the possible connection and ownership arrangements)



5.2 Overhead Lines

As for substations, the requirement for new and/or upgrades to existing overhead transmission/distribution lines (i.e. owned and operated by SSE) to support PFOW projects will be dependent on the applications SSE receives from developers. An estimate of the likely volume of new lines that would be required under two hypothetical generation scenarios (initial arrays and full deployment) is given in Section 7. Examples of overhead lines are given below.

Figure 22: 33 kV Lines on Orkney

Figure 23: 33 kV and 132 kV Overhead Lines on the Scottish Mainland (Photograph courtesy of SSE)

Where new overhead transmission/distribution lines are required SSE would typically seek to utilise existing corridors and infrastructure. Further information on SSE's approach to building new connections can be found on the SSE website at http://www.sse.com along with their plans for new overhead lines on Orkney (see also Section 6).

5.3 HVDC Converter Stations

Where High Voltage Direct Current (HVDC) technology is to be used by SSE, for example, to transmit high voltage power over large distances under the sea, converter stations will be necessary to convert from the power between the conventional alternating current (AC) system and the HVDC system. Converter stations require a significant amount of land for their construction. A typical converter station will take up an area of land 200 m x 120 m, including indoor and outdoor equipment, although the exact size, shape and layout of converter stations will be site-specific. Technological improvements may result in reductions in the size required for future converter stations.

As part of their proposals to upgrade and reinforce the existing electricity transmission network, SSE are planning to construct a new 800 MW converter station and associated substation at a site near Spittal in Caithness. Each HVDC Converter Station will have its own specific connection arrangement on the AC side, an example from the Spittal project can be found on the SSE website at: http://www.sse.com/Spittal/ProjectInformation/

6 INFRASTRUCTURE DEPLOYMENT – ESTABLISHING A BASELINE

The SSE networks to which PFOW projects will connect is continually changing as the number of generators seeking connections grows and demand from consumers changes. In order to make an assessment of the overall scope of land-based development that is likely to be needed to service the PFOW wave and tidal projects it is necessary to attribute changes in the network to the PFOW projects. To do that we have taken a snapshot of what we expect the SSE network to look like at the point at which the PFOW projects are ready to connect their initial arrays. Using that snapshot as our network starting point we have then estimated what additional SSE infrastructure would be required to service the PFOW projects under two generation scenarios – initial arrays and full deployment.

This section describes the 'starting point' and context for the two generation scenarios and their associated onshore infrastructure described in Section 7. It provides an overview of;

- network infrastructure owned and operated by developers and by SSE that is already physically present in the vicinity of the PFOW project sites;
- the drivers for making network reinforcements; and
- SSE's plans for future network reinforcements already committed or in detailed planning.

6.1 Existing Developers' Infrastructure

Given the early stage of PFOW projects there is very little developers' infrastructure already in place either on Orkney or in Caithness and Sutherland. A number of the PFOW developers are testing their devices at EMEC and have some infrastructure in place to support that activity (e.g. see Figure 12). The EMEC substation for the wave test site at Billia Croo is shown in Figure 8 and the EMEC substation for the tidal test site off Eday is shown in Figure 24. More information on the infrastructure available at EMEC can be found at http://www.emec.org.uk/.

Figure 24: EMEC Substation for the Tidal Test site on Eday, Orkney (Photograph courtesy of Orkney Islands Council)

6.2 Existing SSE's Infrastructure

The existing SSE infrastructure that comprises the distribution and transmission networks in the locality of the PFOW projects are shown in Figures 25 and 26. The figures are included to provide context by illustrating the volume of infrastructure currently in place. However, it should be noted that those existing networks are restricted in their capacity to accommodate new generation, including that from the PFOW Strategic Area. For example, the existing connections between Orkney and the mainland comprise two 33 kV circuits whose capacity is already fully allocated to existing generation.

Figure 25: The Existing Distribution Network in Orkney, Caithness and Sutherland

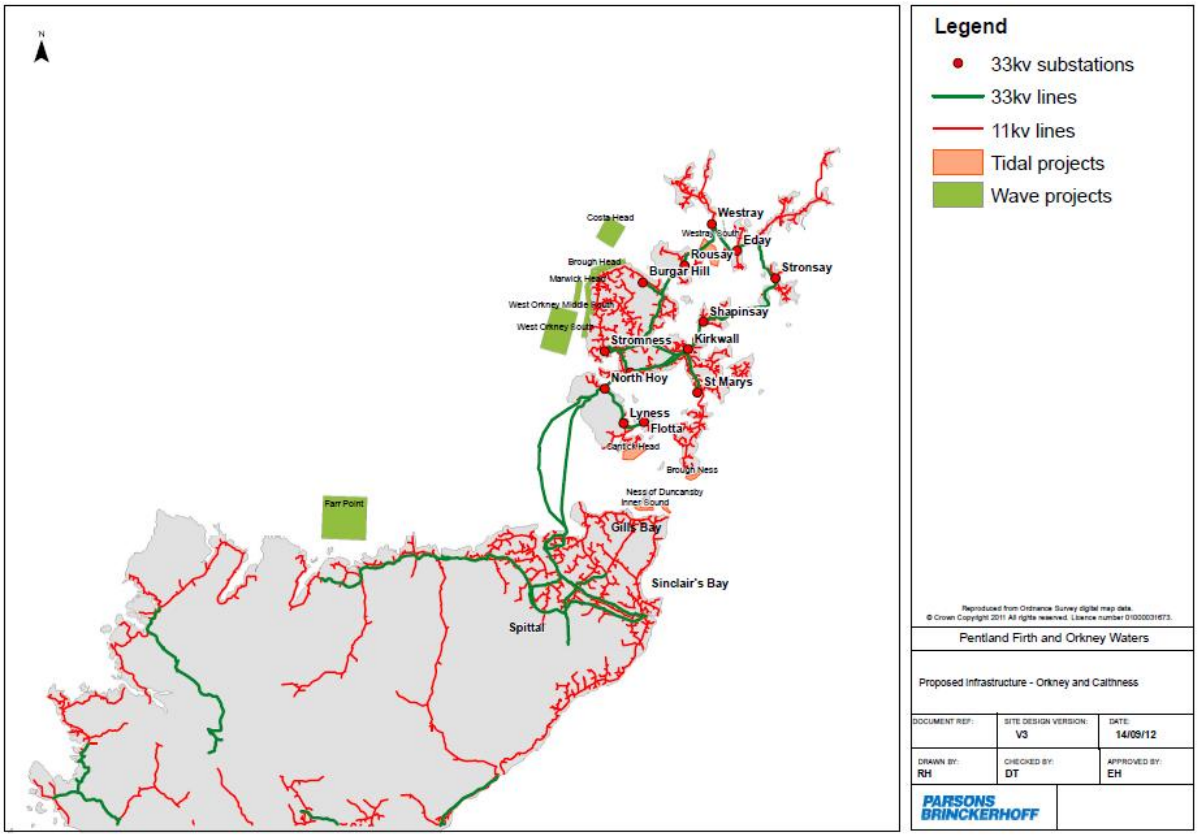
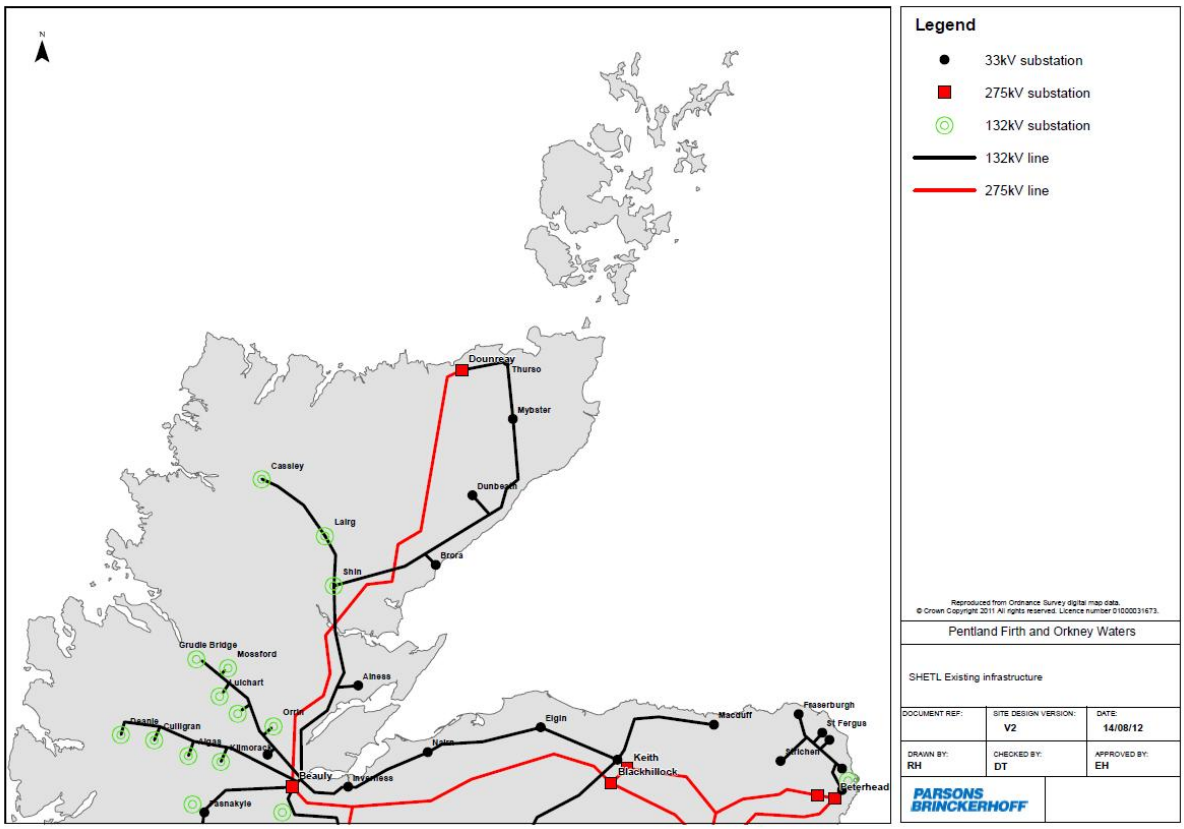


Figure 26: The Existing Transmission Network in the North of Scotland



6.3 Drivers for Future Network Reinforcement

Developers must apply for a connection agreement in order to link to SSE's infrastructure. This will typically require SSE to plan for and make upgrades to their infrastructure as necessary. As the number and size of schemes (and associated applications) increases, wider reinforcement to the electricity network may also be required.

Two of the PFOW projects have contracted connections to the SSE distribution network, as shown in Table 4 below.

Table 4: Current Status of Distribution Connection Agreements

Developer (site)	Distribution connection agreement (with SHEPD)	Connection date
Pelamis (Farr Point)	7.5 MW	Autumn 2014
Meygen (Inner Sound)	15 MW	Spring 2014

As of November 2012, three of the PFOW developers (representing six of the eleven projects) have their connection agreements in place to connect to the transmission system. An extract from the National Grid's Transmission Entry Capacity (TEC) Register in Table 5 below shows those connections

cover a proportion of the total potential capacity of six of the PFOW project sites. The TEC Register is available on the National Grid website at: http://www.nationalgrid.com/uk/Electricity/GettingConnected/ContractedGenerationInformation/TransmissionEntryCapacityRegister/

Table 5: Current Status of Transmission Connection Agreements for PFOW Developments (as on 1 October 2012)

Developer	MW base	MW increase	MW total	Connection date	Site capacities initial/full
MeyGen Ltd (Inner Sound)	0	66	66	2016	86/400 MW (MeyGen anticipate installing 86 MW over a 3 year period from 2014).
	66	78	144	2017	
	144	78	222	2018	
	222	15	**237**	2019	
Scottish Power Renewables UK Ltd (Ness of Duncansby, Marwick Head)	0	30	30	2016	Ness of Dunscansby – 30/100 MW
	30	30	60	2017	
	60	35	**95**	2018	
	0	9	9	2015	Marwick Head – 9/50 MW
	9	13.5	22.5	2016	
	22.5	26.5	**49**	2017	
SSE Renewables Developments (Costa Head, Westray South and Brough Head)	0	29	29	2016	Costa Head – 10/200 MW Westray South – 30-45/200 MW Brough Head – up to 50/200 MW
	29	38	67	2017	
	67	63	130	2018	
	130	320	**450**	2020	

The capacity of the contracted connections shown in Tables 4 and 5 is less than the total capacity of the sites on which those developers hold agreements for lease (see Table 2). There are a variety of factors relevant to when developers may be in a position to request a connection agreement. The key issue is the requirement to pay substantial securities for the grid connection, and a developer must be comfortable that it is an appropriate time in the project development process to take on that level of financial liability. Factors will differ on a site-by-site and project-by-project basis and may include, for example, project financing, the evolvement of the development process, the development stage of the technology to be used etc. As well as further illustrating the intention of PFOW developers to develop their projects in a phased way this mismatch highlights the difficulty SSE have in planning for deployment at all the PFOW sites. The uncertainty concerning the timing and capacity of generation

connection applications causes knock-on uncertainties in the transmission planning process. SSE can only provide transmission connections for applications it receives, and if applications are each for a relatively small capacity, and arrive at separate/different times, the connection costs are likely to be significantly higher than if several developers apply in a coordinated manner for connections in a particular area.

6.4 SSE Plans for Network Reinforcement

In the context of current network restrictions, and in response to initial applications received from some of the PFOW developers for connections to the electricity network, SSE have published their plans for making the necessary network reinforcements to accommodate new generation[21]. Those plans are accounted for in the starting point described below. Any further connection of PFOW projects (beyond those in Tables 4 and 5) would require additions to the network. The legend for the network maps given in this section and in Section 5 is shown in Figure 27.

6.5 Infrastructure Starting Point

In considering what further transmission capacity is required for the new PFOW projects, our starting point has been to establish what transmission capacity already exists and is likely to exist by the time the initial arrays are beginning to connect to the grid[22].

At the time of writing (Autumn 2012), our estimate of what the transmission network might look like when initial arrays are being connected is depicted in Figure 28. In addition to the eleven project areas and the 275 kV and 132 kV connections to Dounreay and Mybster, which are already in service, this figure anticipates the following further developments, all of which would be owned and operated by SSE:

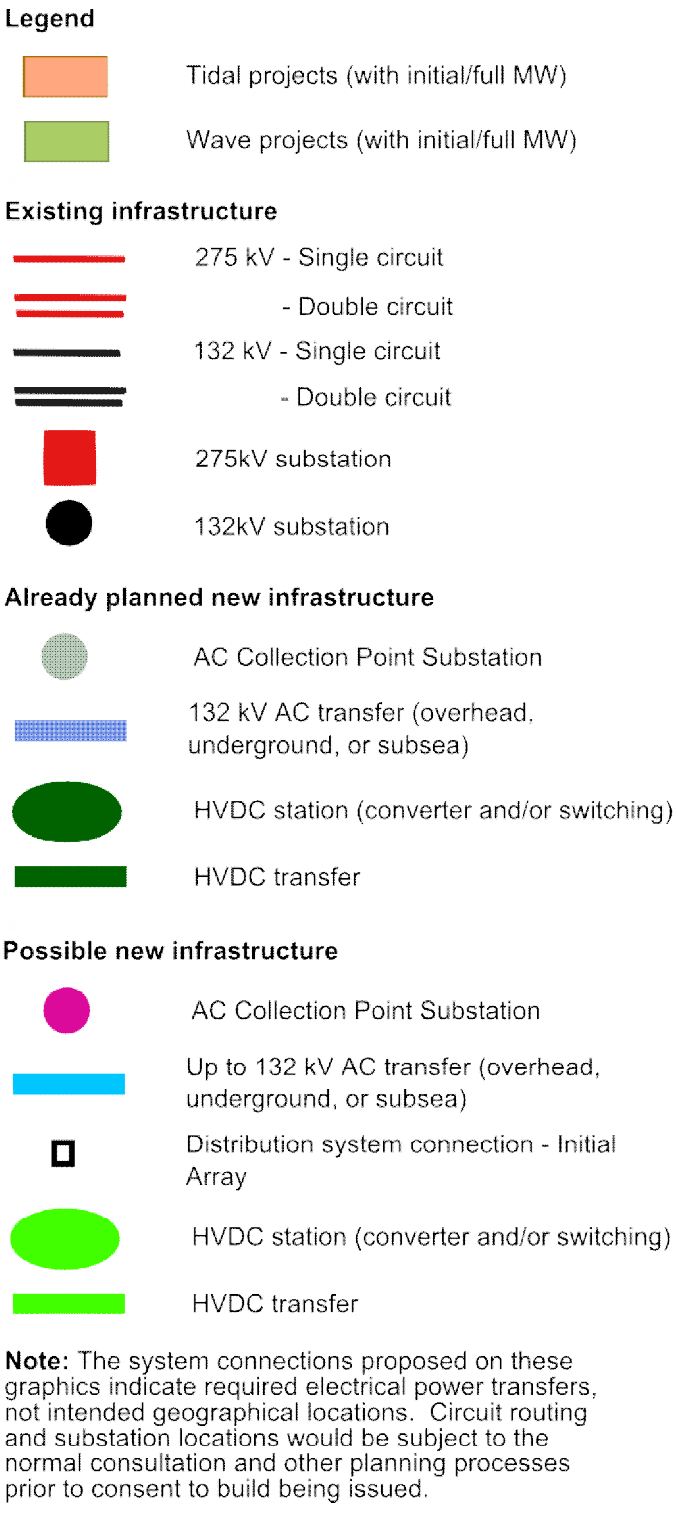
- 275 kV transmission circuits between Dounreay and Mybster, via a new 275 kV substation at Thurso, which is currently under consultation;
- A 132 kV subsea cable from Dounreay to North West Orkney Mainland;
- Two 132 kV substations, on the west and east coasts of Orkney mainland, with a 132 kV connection between them;
- A 132 kV substation in east Caithness, near Gill's Bay;
- A 132 kV connection from Dounreay to the Gill's Bay substation;
- A high voltage direct current (HVDC) converter station at Spittal in the Mybster area;
- An HVDC station in eastern Caithness, near Sinclair's Bay, and an HVDC connection to the Spittal HVDC station; and
- An HVDC connection from Sinclair's Bay under the sea southwards towards Blackhillock.

[21] http://www.sse.com/OrkneyCaithness/

[22] This task is, in itself, full of uncertainty since, in addition to the existing network, there are generator connections under construction, connections which are proposed but not yet approved, and other connection applications being discussed and which may, or may not, eventually materialise.

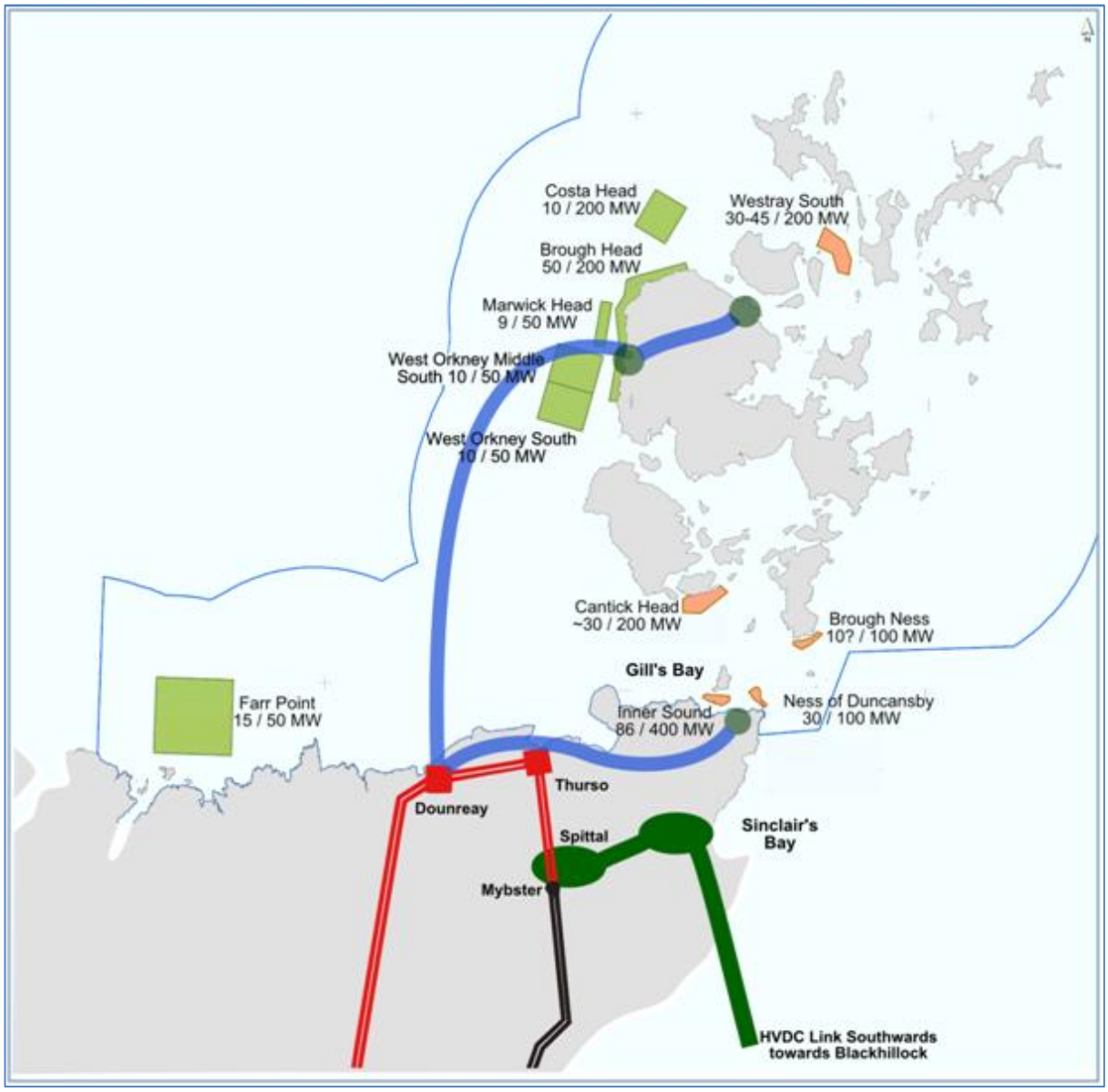
To depict this starting point and the subsequent network developments to meet the transmission demands of the PFOW scenarios, a number of maps are used on the following pages. The legend, which applies to them all is shown in Figure 27.

Figure 27: Legend for Figures 28 – 30



Note: The system connections proposed on these graphics indicate required electrical power transfers, not intended geographical locations. Circuit routing and substation locations would be subject to the normal consultation and other planning processes prior to consent to build being issued.

Figure 28: Transmission Network Starting Point for PFOW Projects (Existing and Planned SSE Infrastructure) (see Figure 27 for Key)



In order to estimate the type, scale and broad location of transmission infrastructure likely to be directly associated with the phased development of PFOW wave and tidal projects we have applied two generation scenarios to the starting point described above. The scenarios are described in Section 7.

7 INFRASTRUCTURE DEPLOYMENT – TWO GENERATION SCENARIOS

This section considers the likely scale, type and broad location of onshore infrastructure that might be developed to support the PFOW projects. In order to estimate what SSE infrastructure might be developed we have used two generation scenarios – initial arrays and full deployment. The type of developers' infrastructure that might be developed in addition to that given in the scenarios is described in Section 4. For a full estimate of the broad type, scale and location of all project-related onshore infrastructure likely to be developed to support the PFOW projects, the infrastructure described in the scenarios should be considered alongside the infrastructure described in Sections 4 and 5.

7.1 Limitations and Caveats

In considering these two scenarios it is important for the reader to appreciate that the actual transmission network outcome will depend entirely upon the timing, the capacity, and the location of actual connection applications received by SSE, and may therefore differ considerably from the concepts discussed in this Information Note.

For example, the transmission maps in this document indicating future electrical requirements do not imply any specific geographic route or transmission technology; rather, they indicate the need for a new power transmission corridor, or the enhancement of an existing corridor, to accommodate the proposed power exports. Specific routes and transmission technologies are for individual developers to determine and will be subject to detailed planning, design and consenting processes in the normal way. Similarly, information from developers suggests that most will target an initial installation of around 10 – 30 MW, although one has indicated 86 MW. The sum of the eventual generation capacities for all the PFOW areas is likely to lie somewhere between the two scenario extremes.

7.2 The Scenarios

We have considered two generation scenarios and for each scenario have focussed on what extra transmission capacity could be needed beyond that described in Section 4, and how that need might translate into (SSE) connection infrastructure in each case. We have developed these two scenarios in full consultation with SSE, and a brief description of each follows next:

- Scenario 1 - Initial arrays - An initial network of connections to serve the initial deployment of arrays at each of the PFOW sites shown in Figure 1. See Figure 29.

- Scenario 2 - Full Deployment - A network of connections to serve the deployment of generation at each of the eleven PFOW sites totalling 1,600 MW. It is implicit that this scenario would be preceded by Scenario 1 developments. See Figure 30.

Figure 28 provides a legend for the network concepts shown in Figures 29 and 30.

For both scenarios we have assumed that wave and tidal power would be delivered by the generators to the substation collector points at a voltage of up to 132 kV. In addition, we have assumed that to save on transmission costs there would only be one (unsecured) connection to the national network for each generating array.

7.3 Scenario 1 – Initial Arrays

This scenario assumes that all the PFOW wave and tidal sites will deploy an initial commercial-scale array in line with the generating capacities up to 305 MW as described in Table 2 in Section 3.

7.3.1 Developers' Infrastructure

The type (and where possible scale) of developers' infrastructure likely to be required to service individual PFOW projects when initial arrays are deployed are estimated in Section 4. These include;

- Cable and hydraulic pipe landing – a single or multiple landings may be required for first arrays.
- Plant compounds on which one or a combination of the following could be located[23];
    - Substation(s) – likely to be a single switching station or substation for initial arrays (for each project site), possibly on a site that could be extended as the project size increases;
    - Control room and staff facilities – some developers anticipate including these facilities on their compounds whereas others anticipate monitoring and staffing their projects from offices elsewhere (e.g. Stromness). These facilities are likely to be small in scale for initial arrays; and
    - Onshore generating station – this is specific to sites where the wave or tidal technology deployed utilises onshore power conversion equipment. For example, Brough Head Wave Farm Ltd intends to deploy Aquamarine Power's Oyster wave device and may require one or two onshore generating stations to support an initial array of up to 50 MW (see Section 4.3.6).
- Overhead lines and/or underground or subsea cables – these could be up to 132 kV.

Some developers have indicated that they would plan infrastructure to support initial arrays in a way that would allow for extensions and/or expansions to support future larger deployments and seek to potentially locate any new infrastructure close to SSE's infrastructure where appropriate. Some developers have also indicated that they do not however anticipate developing a substation as they plan to transport grid-compliant power directly from their offshore site to the appropriate SSE infrastructure.

Impacts

Section 4.3.1 describes the types of temporary impacts that could be expected during cable and/or hydraulic pipe landing. The impact of plant compounds will be more long lasting (up to the point of decommissioning[24]) and will vary depending on what building types etc. are sited there. The impact of overhead lines and/or underground cables will also vary depending on, for example, cable capacity.

Detailed plans are not yet available from developers[25] on the exact configuration of onshore infrastructure at each PFOW project site as the majority of projects are still at a very early stage of development. However, the high level assessment above does illustrate that some degree of new development will take place at onshore sites for each of the PFOW projects. When plans do come forward they will be subject to the planning and consents procedures described in more detail in Section 8.

In the interests of planning for those future applications and mitigating their possible impacts, the provision of early advice and guidance from Planning Authorities could assist developers in making their applications. Recognising that the ability of Authorities to provide advice is limited by the availability of information from developers that they may not yet be in a position to provide, strategic level studies may

[23] A Power Conversion Unit Building (PCUB) has been specified for the Inner Sound project to contain electrical equipment. Other projects may refer to this type of building as a substation. A number of developers anticipate that over time technology advances will result in a reduction in the space required to house electrical equipment.

[24] Decommissioning is discussed in more detail in Section 8.

[25] With the exception of MeyGen who have published detailed plans for their first phase development at Inner Sound.

be most appropriate at this stage. For example, developer-led identification of preferred locations and corridors for future infrastructure development and the provision of siting and design principles may reduce future consenting risks. Assisting developer teams to involve personnel with relevant professional skills such as landscape and buildings architects may also help ensure acceptable applications are made first time.

It should be noted that developments will be subject to technological and economic as well as environmental constraints and so the provision of advice and guidance of the type suggested should be developed in partnership with developers, Planning Authorities and other key stakeholders. Existing relevant stakeholder groups[26] could be utilised in this regard.

7.3.2 SSE's Infrastructure

It is not easy or cost effective to increase the capacity of a transmission circuit frequency by small amounts to accommodate the extra power from small additions to a generating array. Our estimate of SSE infrastructure necessary to service PFOW wave and tidal projects under this scenario thus uses the premise that at least a standard capacity connection is established for each of the generation development sites, whilst recognising that further transmission capacity may be required if all the leased capacity generation is eventually installed.

As illustrated in the initial arrays network scenario, Figure 29 (see Figure 27 for the map key), to connect the 'initial array' generating capacity we would expect that in addition to the infrastructure SSE have already published plans for, new SSE substations and connections (which could be overhead lines or underground cables) would be necessary on Orkney. Some subsea infrastructure beyond that already planned by SSE would also need to be landed in Caithness and Sutherland. Therefore, in addition to that infrastructure shown in Figure 28, the following SSE infrastructure would be necessary to accommodate our 'initial arrays' generating scenario (as shown in Figure 29);

- New substations (perhaps three), on the west and north coasts of Orkney mainland, through which the new generating arrays in those areas may be connected and controlled;
- New connections (up to 132kV) between the new Orkney substations and the existing transmission and/or distribution networks;
- A substation in the Cantick Head area of South Walls (near Hoy), and another on South Ronaldsay near the Brough Ness development, with a connection (up to 132kV) running between them (as above, a mixture of transmission and distribution voltages is likely to be used);
- A subsea 132 kV connection from the Brough Ness substation running south to the mainland. This connection is presently shown as running as far as Sinclair's Bay since, under current connection contracts, the generation connection capacity at Gill's Bay Substation is fully allocated. An actual physical connection configuration would be subject to the administration of system access arrangements[27] and could therefore be different to that shown in figures 29 and/or 30; and
- For the Farr Point development, a small extension to the existing SSE distribution substation would be required.

The new substations shown would act as collection points for the power from the generating arrays. They would contain switches and/or transformers, as appropriate for their location on the network and for the type of generation being connected. Generation equipment and associated wires connecting to

[26] There are three main stakeholder groups currently involved in the PFOW projects - The Orkney Islands Grid Group, PFOW Leadership Forum and the PFOW Developers Forum.

[27] The administration of system access arrangements govern the priority allocated to each connection application. For more information contact SSE.

these collection point substations would be owned by the generation developers (see Figure 4 and Section 4), whilst the substations themselves, and all distribution and transmission networks beyond (and linking) the substations would be owned and operated by SSE (see Figures 20 and 21 and Section 5).

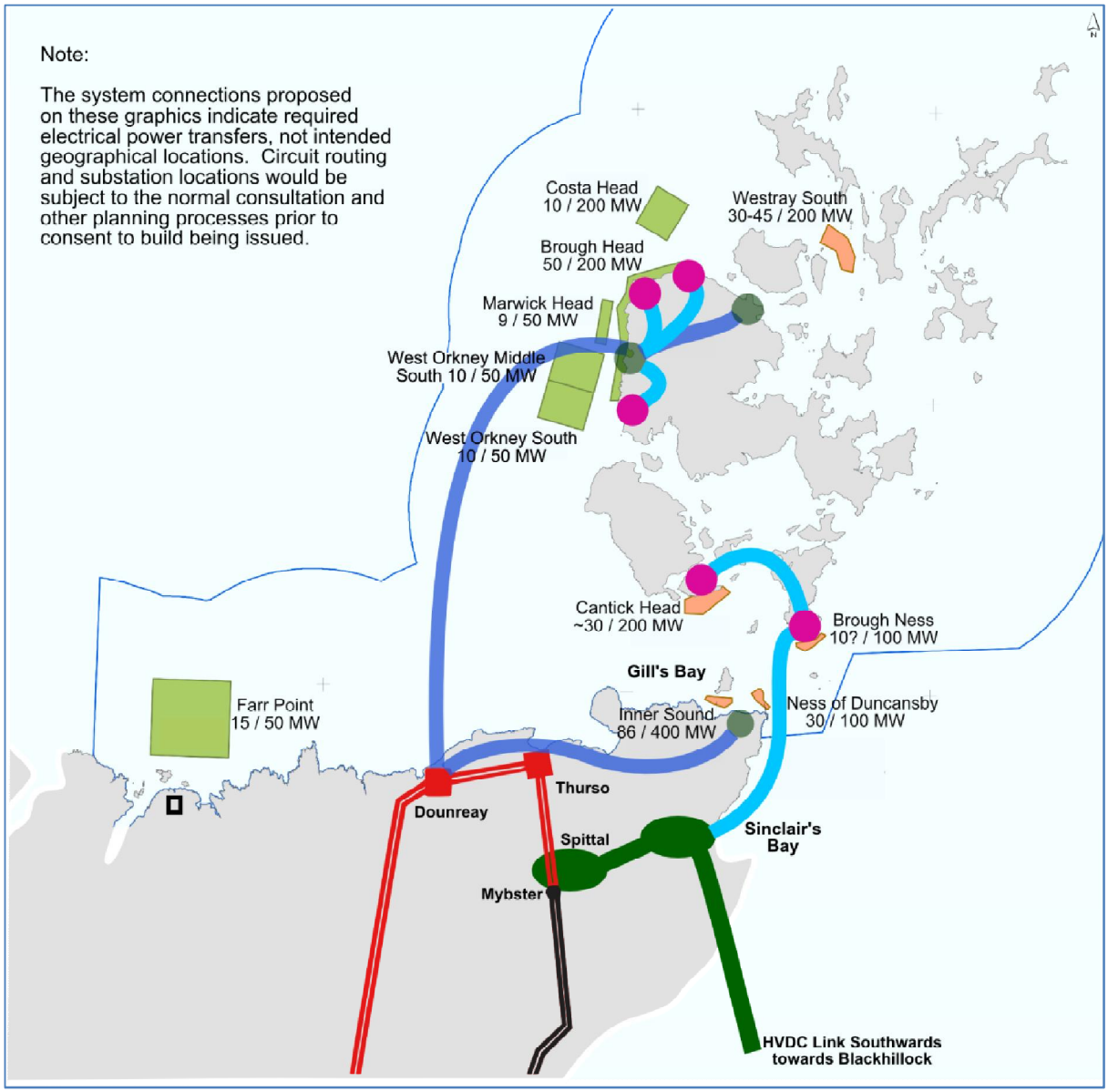
Impacts

At this time SSE have only received applications for some PFOW projects and made plans accordingly – including a consideration of the likely impacts (see Section 6). Our initial array scenario shows that to accommodate generation from initial arrays at all PFOW sites additional onshore development would be required and that the connection 'solution' would be a mixture of distribution and transmission connections.

SSE will always plan for the most efficient and least impact network solution based on the applications they receive. For example, they will try to pool schemes together in order to rationalise and reduce the need for new development where possible. Mechanisms to further facilitate efficient network planning could therefore help to reduce the impact of new infrastructure developments. This could include developers making joint applications to SSE and developers working together to explore the scope for sharing infrastructure.

As with developers' infrastructure, SSE developments would be subject to the planning and consents procedures described in Section 8.

Figure 29: Initial Arrays Network Scenario (see Figure 27 for key)



NB: For a full estimate of the broad type, scale and location of all project-related onshore infrastructure likely to be developed to support the PFOW projects, the infrastructure described in the scenarios should be considered alongside the infrastructure described in Sections 4 and 5.

7.4 Scenario 2 – Full Deployment

This scenario (shown in Figure 30) assumes that all the eleven PFOW generation sites would be developed to their full potential capacity, a total of 1,600 MW (see Table 2).

7.4.1 Developers' Infrastructure

In order to support this much larger generation scenario it is expected that developers would need to significantly upgrade their infrastructure described for scenario 1 in 7.3.1 above. Developer plans for the infrastructure likely to be required under this scenario are however at very early stages and several developers have not attempted to estimate their requirements yet.

The degree of uncertainty with respect to the size, scale and location of developers' full deployment onshore infrastructure is therefore high. In addition, expected advances in technology may result in more compact electrical equipment designs, or in the ability to locate more infrastructure offshore in the future (e.g. offshore substations), so a simple scaling up from the initial array scenario is unlikely to accurately reflect reality.

- Cable landings – given that the full deployment scenario would see a five or six-fold increase in installed wave/tidal generation capacity, we would expect this scenario to trigger a significant increase in cable landings. However, we would expect to see high connection voltages too, which would mitigate the overall cable landing count.

- Plant compounds[28]

    - Substations – where possible facilities put in place to service initial arrays are likely to be upgraded to accommodate larger generating capacities without significant further land-take.

    - Control building – controls for further arrays are likely to be established on the same site as those for the initial arrays.

    - Onshore generating station – the requirement for this type of facility is dependent on the wave/tidal technology utilised (see 4.3.6). It is anticipated that, compared to initial arrays, more and/or larger onshore generating stations will be required to support full deployment.

- Overhead lines and/or underground or subsea cables – it is likely that more connections will be required but the numbers and location of these are very uncertain at this stage.

Impacts

The scale of developers' infrastructure required to service full generation capacities at each PFOW site would be more extensive than for the deployment of initial arrays. However, as discussed in 7.3, developers' plans for what will eventually be built to service initial arrays is uncertain and therefore anticipating the size and scale of infrastructure for full scale arrays is even more so. As for initial arrays, the early provision of advice and guidance would help to mitigate future impacts.

7.4.2 SSE's Infrastructure

We have assumed that the SSE infrastructure estimated for the initial array scenario would remain in place, and would continue to collect the increased output from the expanding generator arrays. Developers' applications for higher capacity connections to the SSE network would trigger upgrades to the SSE collection point substations, and some of these upgrades may themselves prompt upgrades to the circuits connecting these substations to the transmission network.

In addition to these upgrades on Orkney, the SSE undersea connections onwards from Orkney southwards would need significant expansion to export the bulk power supplies available in this scenario. For the Orkney mainland, the most likely solution to this would be a new HVDC converter station on the north west of the Orkney mainland, with an HVDC sub-sea connection from there to the Sinclair's Bay HVDC station. For the undersea connection from Brough Ness to Sinclair's Bay, further AC connections are likely, accompanied by an upgrade of the HVDC converter capacity at Sinclair's Bay.

[28] In some instances, plant compounds might be contained in a building, such as MeyGen's Power Conversion Unit Building (PCUB) proposed in the Inner Sound project (see Section 4). There, the developer anticipates that the buildings will have an upper limit for the generating capacity they can accommodate, meaning that as the array size increases so will the need for more buildings. However, this may be partially offset by future technology advances, reducing the need for space to accommodate electrical equipment. For example, the developers aim to increase the power density in each building, meaning that they could cater for greater generating capacities.

The following list summarises the likely additions to the SSE network for the full deployment scenario, as shown in Figure 30.

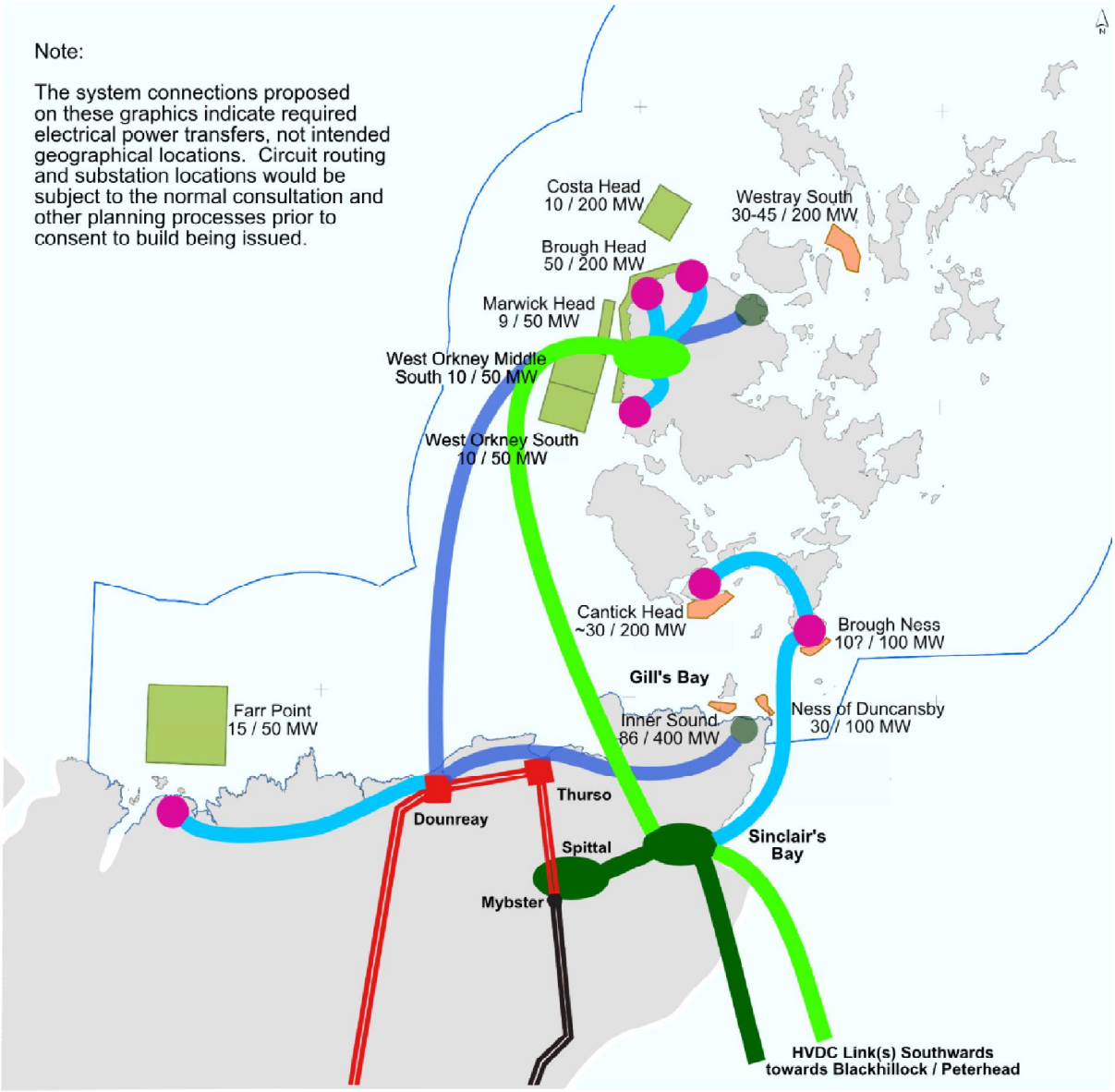
- A new 132 kV substation in the Bettyhill area of Sutherland (near the Farr Point development site), with the earlier Farr Point distribution connection transferred to the 132 kV transmission network;
- As the capacity of the Farr Point generating array develops, we anticipate that a new transmission connection would be required to replace the distribution connection (see Figure 30). The new 132 kV connection would be from the Farr Point substation to Dounreay;
- A new HVDC converter station in the west of Orkney Mainland; and
- A new HVDC connection from the west of Orkney Mainland to the Sinclair's Bay HVDC station. It is also probable that this HVDC link from Orkney to the mainland would trigger reinforcement of the link from Sinclair's Bay south, possibly with a subsea connection to Peterhead.

In this scenario new infrastructure would be required on Orkney and in Caithness and Sutherland.

Impacts

The impact of infrastructure to accommodate a full deployment generation scenario would undoubtedly be greater than for smaller generating capacities. This is illustrated in the difference between our estimate of infrastructure requirements in Figures 29 and 30. However, it should be noted that the deployment levels anticipated under this scenario are highly uncertain and the developments shown in Figure 30 may not materialise in the manner and/or to the level anticipated here – a network to accommodate full deployment would only come forward if SSE receives the appropriate connection application from developers. As discussed under the initial arrays scenario, continued information sharing as technologies and projects develop will help to mitigate any future impacts.

Figure 30: Full Deployment Network Scenario (see Figure 27 for key)



NB: For a full estimate of the broad type, scale and location of all project-related onshore infrastructure likely to be developed to support the PFOW projects, the infrastructure described in the scenarios should be considered alongside the infrastructure described in Sections 4 and 5.

8 PLANNING AND CONSENTS

The Agreements for Lease issued by The Crown Estate to developers provide the security to carry out site investigations and environmental surveys on the site, but do not provide planning permission/consent for the installation of generation devices or associated infrastructure. For the onshore infrastructure dealt with in this Note, both SSE and the developers will engage in the relevant planning and consents processes in order to progress their respective developments. It is important to recognise that proposals should seek to develop the best scheme in the best location. Applications for development will therefore include careful and detailed consideration of the potential impacts and opportunities arising during the construction, operation and decommissioning stages.

This section considers the legislation and guidance of direct relevance to the type of infrastructure considered in this Note and the issues that may arise during the consents process.

It should be noted that the information in this section is correct as of Autumn 2012. Readers should refer to the following websites for updated guidance and advice;

- Highland Council - http://www.highland.gov.uk/
- Orkney Islands Council – http://www.orkney.gov.uk/
- Marine Scotland – http://www.scotland.gov.uk/About/People/Directorates/marinescotland
- Scottish Natural Heritage – http://www.snh.gov.uk/
- Scottish Government - http://www.scotland.gov.uk/Topics/Built-Environment/planning

8.1 Relevant Consenting Related Legislation

Decisions on development proposals are made within the context of a number of pieces of legislation summarised below. The ways in which they might be applicable to different types of infrastructure are given in Table 6. The process for gaining consent varies depending upon the nature of the development proposed; however the responsibility remains the same – it is always the developer's role to obtain consent.

8.1.1 The Marine (Scotland) Act 2010

The Marine (Scotland) Act 2010 requires licences to be obtained from the Scottish Ministers for activities undertaken in the Scottish inshore region of UK waters (0-12 nautical miles); including wind farms, wave and tidal power. These are processed on behalf of the Scottish Ministers by the Marine Scotland Licence Operations Team (MS-LOT). The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) relate to development requiring a licence under the Marine (Scotland) Act 2010.

8.1.2 The Marine and Coastal Access Act 2009

The Marine and Coastal Access Act 2009 requires licences to be obtained from the Scottish Ministers for activities undertaken in the Scottish offshore region of UK waters (12-200 nautical miles); including wind farms, wave and tidal power. These are also processed by MS-LOT on behalf of the Scottish Ministers. The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) relate to development requiring a licence under the Marine and Coastal Access Act 2009.

In addition to these requirements for Marine Licences, development located within Harbour and Port Limits may also require a "Works Licence" in respect of the relevant local Harbour Order. In all cases where development is proposed within Harbour and Port Limits, the developer should consult with the relevant Harbour or Port Authority to determine whether a Works Licence would be required. This consultation should occur prior to submitting an application to MS-LOT to minimise the potential for duplication of effort.

8.1.3 The Electricity Act 1989 (as amended)

The Electricity Act 1989 is applicable onshore and offshore within Scotland. Under the Act Section 36 consent gives permission for the construction and operation of a generating station over 1 MW. Section 37 consent gives permission for the construction of overhead lines. The Scottish Government are the decision making body for such consent applications. The Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2008 and The Electricity (Applications for Consent) Amendment (Scotland) Regulations 2006 apply to applications made under Section 37 and 36 of the Electricity Act. Section 6 lists the licences that can be granted authorising the supply, generation, transmission and distribution of electricity. Such licence holders are considered to be "Statutory Undertakers", and it has been assumed that all developers of infrastructure discussed in this Note will be licence holders under Section 6 of the Electricity Act 1989; however, this will require confirmation on a case-by-case basis.

8.1.4 Town and Country Planning (Scotland) Act 1997 (as amended)

This Act makes provisions for the need for Planning Permission to be sought for onshore construction down to the Mean Low Water Spring tide level (including cable laying)[29]. Although it is not currently possible for "deemed consent" to be granted to the onshore infrastructure related to any development consented through S36 of the Electricity Act 1989 in Scotland, it is anticipated that this will become a possibility through legislative amendments via the Scottish Parliament in early 2013. Until then, separate Planning Permission will be required for infrastructure not consented via Section 36/37 of the Electricity Act 1989. Onshore elements requiring Planning Permission include onshore cable connection, underground cabling, onshore converter stations or substations, temporary or permanent compounds associated with wave and tidal developments or transmission infrastructure, and upgrades to onshore transmission infrastructure.

All such development may require an EIA; subject to discussion with the relevant determining authority. Substations that are to be developed in isolation will proceed through the Town and Country Planning process, and depending on their size and location may also require an EIA (see below) under the Environmental Impact Assessment (Scotland) Regulations 2011.

[29] A Marine Licence is required for development up to the Mean High Water Spring tide level.

Table 6: Relevant Consenting Regime and Determining Authority for Onshore Development

Component	Scale of Development	Type of Development	Consenting Regime	Determining Authority
Cable landings, substation, converter station, underground cable	• The gross floor space is less than 5,000 m^2; or • The area of the site is less than 2 hectares.	"Local" development	Town and Country Planning (Scotland) Act 1997 (as amended)	Local Planning Authority
	• The gross floor space exceeds 5,000 m^2; or • The area of the site is, or exceeds, 2 hectares.	"Major" development	Town and Country Planning (Scotland) Act 1997 (as amended)	Local Planning Authority
Overhead Line (OHL)	• Nominal voltage not exceeding 20 kV, which is for supplying a single consumer; • Any part of the electric line that will be within the premises of the person responsible for its installation; or • In such other cases as may be prescribed.	"Local" development	Town and Country Planning (Scotland) Act 1997 (as amended)	Local Planning Authority
	• over 20 kV; • any length	Electricity Act development	s.37 of the Electricity Act 1989	Scottish Ministers
OHL plus additional works	As per regime of OHL alone since any required substation does not trigger a more onerous requirement as it is classified as 'ancillary development' to the OHL.			

8.1.5 The Conservation (Natural Habitats &c.) Regulations 1994 (as amended) and the Offshore Marine Regulations 2007

These regulations implement the EU Habitats and Birds Directives[30] and require licences to be obtained from the Secretary of State for activities which would otherwise be considered illegal. Prior to granting a licence, the Secretary of State must seek advice from the Joint Nature Conservation Committee (JNCC) who may consult with Scottish Natural Heritage, particularly if the licence application affects

[30] The Habitats and Birds Directives is the short collective name for the *"Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora"* and *"Council Directive 2009/147/EC on the conservation of wild birds"*

species using inshore and offshore waters. Licences are required for a variety of activities that would affect protected species or habitats including causing disturbance, injury or death and damaging or destroying habitat.

Where development sites are within a European or international designation (Special Areas of Conservation, Special Protection Area, Ramsar sites); and there is potential for significant effects to occur on the site and the species it supports; the development proposals must be subject to an 'Appropriate Assessment' under the provisions of the Conservation (Natural Habitats &c) Regulations 1994, as amended.

The Habitats Regulations Appraisal (HRA) process shares many requirements of the EIA process, except in two key differences: the precautionary principle must be applied to HRA (there must not be an adverse effect upon the integrity of the site) and projects that would result in a negative impact upon the European site must not proceed unless there are no alternatives to the project, there are imperative reasons of overriding public interest and compensation measures are provided.

8.1.6 Environmental Impact Assessment (EIA) Directive

The EIA Directive, transposed into a variety of UK legislation, is applicable to qualifying (Schedule 1 or 2) onshore and offshore development activities. Its purpose is to ensure environmental effects of development are recognised in the planning and consenting process. It is likely that an EIA will be required to support any application made under Section 37 of the Electricity Act (1989). An EIA is mandatory for any proposals for transmission lines over 220 kV and of a length of greater than 15 km and may be required for any other onshore infrastructure. EIA may also be required for applications submitted to the Local Planning Authority and applications for Marine Licences. EIA is required for offshore generating stations with a capacity greater than 1 MW, and may be necessary for any project-specific onshore works required to support the generating station.

8.2 The Overlap between Marine and Terrestrial Consents

In Scotland, there is an overlap between the marine and terrestrial planning regimes. The UK-wide Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 together introduce a marine planning system which extends 200 nautical miles out to sea. The area covered by the Acts extends to "any area submerged at mean high water spring tide".

The terrestrial planning system, as regulated under the Town & Country Planning (Scotland) Act 1997 (as amended), extends to the mean low water mark of the ordinary spring tides. Dependent upon the specifics of the proposal therefore, consent under both the terrestrial and marine planning systems may be needed. An obvious example would be a proposal for a transmission cable from offshore to onshore. In this circumstance it would be expected that both marine and terrestrial regimes would need to be considered.

Pilot Pentland Firth and Orkney waters Marine Spatial Plan

Marine Scotland (MS), the Highland Council and Orkney Islands Council have established a working group to develop a pilot non-statutory Pentland Firth and Orkney waters Marine Spatial Plan (the pilot plan). This plan covers from mean High Water Springs to a seaward boundary of 12 nautical miles. The pilot plan will promote the sustainable management and development of the marine environment and will incorporate economic, environmental and social considerations into a strategic decision making framework for licensing and other consent applications in the marine area.

The process for developing a pilot marine spatial plan for Pentland Firth and Orkney waters started in 2009. The marine spatial plan will consist of three stages, one of which has been completed, one is ongoing and the third will be the plan itself. Marine Scotland has led on the first two stages, which has

involved information gathering and setting out a high level framework as a baseline from which to work. The working group will continue the work and develop the pilot plan itself; and will produce:

- A Plan Scheme (October 2012) which will set out step by step how the pilot plan will be prepared and outlines the opportunities for stakeholders to get involved.

- A Planning Issues and Options consultation paper (April 2013) which will set out the options and policy areas that the plan could address. It seeks views through stakeholder engagement and consultation and will enable stakeholders to inform the content of the pilot plan and consider alternative approaches to policies and proposals.

- The draft Marine Spatial Plan (November 2013) which will set out policies and proposals for the management, development and use of the marine area. It will address the key planning issues identified in the Planning Issues and Options Consultation Paper and contain detailed policies and spatial proposals maps.

- The final Pilot Plan (Spring 2014) which will take into consideration the comments received from the consultation process.

All these documents will be added to Marine Scotland's website as they are completed:

http://www.scotland.gov.uk/Topics/marine/marineenergy/wave/rlg/pentlandorkney

8.3 Planning Policy

8.3.1 National Planning Policy

The Scottish planning system is two-tier, with national planning policy delivered by the Scottish Ministers and planning policy at the local level by Scottish Councils.

At a national level, planning policy within Scotland is guided by the National Planning Framework 2 (NPF2) (Scottish Government, 2009) which contains the spatial vision for Scotland's development over the period 2009 to 2030. Scottish Planning Policy (SPP) (Scottish Government, 2010) outlines the Scottish Government's policy on land use planning and is supported in turn by a set of Planning Advice Notes (PAN). A number of PANs have been revoked, some of which previously applied to renewable energy development.

NPF2 was published in 2009, and Scottish planning legislation requires that it be revised within five years of publication. Scottish Ministers have begun this process and have confirmed that NPF3 will focus strongly on economic recovery and the transition to a low carbon economy. NPF3 will set out the Government's development priorities over the next 20-30 years and is anticipated to be published in June 2014. Further information on NPF2 and NPF3 is available here: http://www.scotland.gov.uk/Topics/Built-Environment/planning/National-Planning-Policy/npf

The UK Marine Policy Statement and National Marine Plan provide the national policy context for development within the marine area; and will require consideration where onshore infrastructure crosses the marine area (i.e. cables across the intertidal).

8.3.2 Local Planning Policy

The PFOW Strategic Area falls within the territorial responsibilities of Highland Council and Orkney Islands Council. Highland Council adopted its local development plan in April 2012. Orkney Islands Council is still in the preparation stages and therefore the adopted Structure Plan (2001) and the Local Plan (2004) form the statutory development plan and are statutory considerations in determining planning applications. As of July 2012, the Modified Proposed Orkney Local Development Plan had

just completed a formal public consultation. It is envisaged that this plan will be adopted in mid-2013, replacing the existing Structure and Local Plans as the statutory development plan for Orkney. Until such time, the existing Structure and Local Plans will form the Development Plan, and the draft LDP will be considered a 'material consideration' with more weight being applied to that document as it progresses through the adoption process.

Any applications for development will be considered against the requirements of the local Development Plan, therefore local planning documents should be referred to from the initial stages of feasibility through to detailed design.

In addition there are still some retained policies within the superseded Caithness Local Plan (2002) and Sutherland Local Plan (2010).

Further information about local planning policy is available on the following websites:

http://www.highland.gov.uk/yourenvironment/planning/developmentplans/

http://www.orkney.gov.uk/Service-Directory/D/Development-Planning.htm

8.3.3 Material Considerations

Section 25 of the Town and Country Planning (Scotland) Act 1997 (as amended) states that a Planning Authority's decision on a planning application must be made in accordance with the policies of the Development Plan "unless material considerations indicate otherwise".

Although material considerations are not defined, there are two main tests that are accepted for determining whether a consideration is (a) material and (b) relevant: it should serve or be related to the purpose of planning and it should fairly and reasonably relate to the particular application. Supplementary Planning Guidance is generally considered to be a material consideration.

The Highland Council Supplementary Planning Guidance

The Highland Coastal Development Strategy (HCDS) approved May 2010 sets out the vision for the sustainable use and development of the coastal zone. For the purposes of the Highland Coastal Development Strategy, the coastal zone is taken to mean the land area within 1 km of the coast and the inshore marine area out to 3 nautical miles.

The strategy states that the Council will support the sustainable development of the marine renewable industry through various policies and projects and the HCDS will support this by providing information on coastal classification and helping to identify the most appropriate sites. The HCDS recognises that the north coast has the greatest potential for marine renewable energy generation and outlines renewable energy as one of the key development opportunities for the Highland North Coast. It identifies that the Dounreay site has potential to be redeveloped for renewable energy generation.

Orkney Islands Supplementary Planning Guidance

Relevant Orkney Supplementary Guidance includes:

Supplementary Guidance	Current Status
Onshore infrastructure requirements related to marine renewable energy developments	No document
Flooding and Coastal Erosion	Draft (material consideration)
Heart of Neolithic Orkney World Heritage Site	Approved (material consideration)
Natural Heritage	Draft (material consideration)

8.4 Constraints and Issues

A number of environmental issues are likely to arise during planning and consenting for onshore infrastructure development. These issues can manifest themselves in the form of constraints to development which will be considered during the design process. An initial consideration of such issues and constraints is provided in this section; however as the infrastructure required is not yet defined, this section is generic in nature. Table 7 identifies the issues that are most likely to emerge during the consenting process. Issues identified with an asterisk (*) are likely to be pivotal to the permitting of onshore infrastructure considered in this Note.

It is emphasised that in most cases an EIA will be required at the permitting stage. The EIA will provide a comprehensive review of the potential effects of the development (including cumulative effects) and mitigation proposed for consideration by the decision makers and stakeholders.

Table 7: Potential Environmental Impacts from Transmission Infrastructure. (Issues identified with an asterisk (*) are likely to be pivotal to the permitting of onshore infrastructure considered in this Note)

Type of Effect	Typical issues for consenting
Land use	• Land take for towers, access roads, buildings (which may be larger during construction) • Disruption to agricultural activity and field boundaries • Methods for discharging waste
Geology and soils	• Temporary changes to soil cover from construction • Changes to drainage patterns due to new structures • Ground stability and soil erosion

Type of Effect	Typical issues for consenting
Water	• Disruption to groundwater by sub-surface structures • Surface water and groundwater pollution risks • Flood risk changes due to structures in flood plain • Impacts on coastal defences and geomorphology systems
Ecology*	• Loss of habitat due to new structures and opportunities for enhancement through mitigation • Risk to mammals, other protected species and designated sites • Potential for power line bird/bat strike • Water pollution risk to aquatic ecosystems • Impact on habitat from introduction of non-native species
Landscape and visual*	• Effects on landscape character and features • Visual impact to communities • Effect on recreational enjoyment • Consequential impacts on tourism • Visual impact of construction activities (such as trenching, cable laying and directional drilling) and equipment such as large cranes • Visual impact arising from lighting • Opportunities for integration with the vernacular of existing buildings
Cultural heritage*	• Loss and effect on setting of archaeological and cultural heritage resources
Traffic	• Effect of construction traffic on existing networks • Transport of large electrical components • Construction of temporary roadways • Short term increase in localised road haulage
Noise and vibration*	• Noise from construction and facility operation • Construction vibration
Air quality	• Air quality effects (dust) during construction
Communities*	• Concern over Electrical and Magnetic Fields (EMF)
Socio-Economics	• Impacts upon residential amenity as a result of the construction and operation of infrastructure • Potential for enhancing positive impacts such as employment generation

Issues identified with an asterisk (*) are likely to be pivotal to the permitting of onshore infrastructure considered in this Note.

Each application will be considered in relation to the potential impacts of the development, and whether these impacts are considered acceptable and consistent with the requirements of the relevant planning policies. It is therefore in the best interests of the developer to choose a site and design a scheme that minimises adverse impacts and to submit a planning application that illustrates this well. A Planning Statement can be submitted with the application to explain the design process followed, the benefits likely to arise from the development and how the far proposals are consistent with relevant planning policies. A "Design and Access Statement" (which documents the process taken in the design of the development) is a formal requirement for some Local and all Major developments. Where EIA is required, an Environmental Statement must be submitted with the application detailing the assessment undertaken and the associated results.

8.5 Consultation with Statutory Consultees

Statutory Consultees are organisations are defined by under article 15 of the Town and Country Planning (General Development Procedure) (Scotland) Order 1992, and are tasked with having responsibility for a particular subject area, such as Scottish National Heritage, Historic Scotland, etc. Their comments are sought at the initial scoping stages of an EIA, and in relation to planning applications in order to ensure that the interests of the organisation are considered. In some instances, Statutory Consultees represent the Secretary of State (for instance Historic Scotland and Transport Scotland).

8.6 Consultation with the Community

Consultation with the community is voluntary for "Local" development and applications made under the Electricity Act 1989, but is mandatory (i.e. a statutory requirement) for "Major" and "National" development. However, whether consultation with the community is mandatory or not, it is a useful process that can result in improved development proposals. Consulting with the community is considered best practice and the PFOW developers are committed to doing this. Figures 31 and 32 detail the requirements for community consultation with each type of development.

Figure 31: Pre-Submission Consultation Requirements

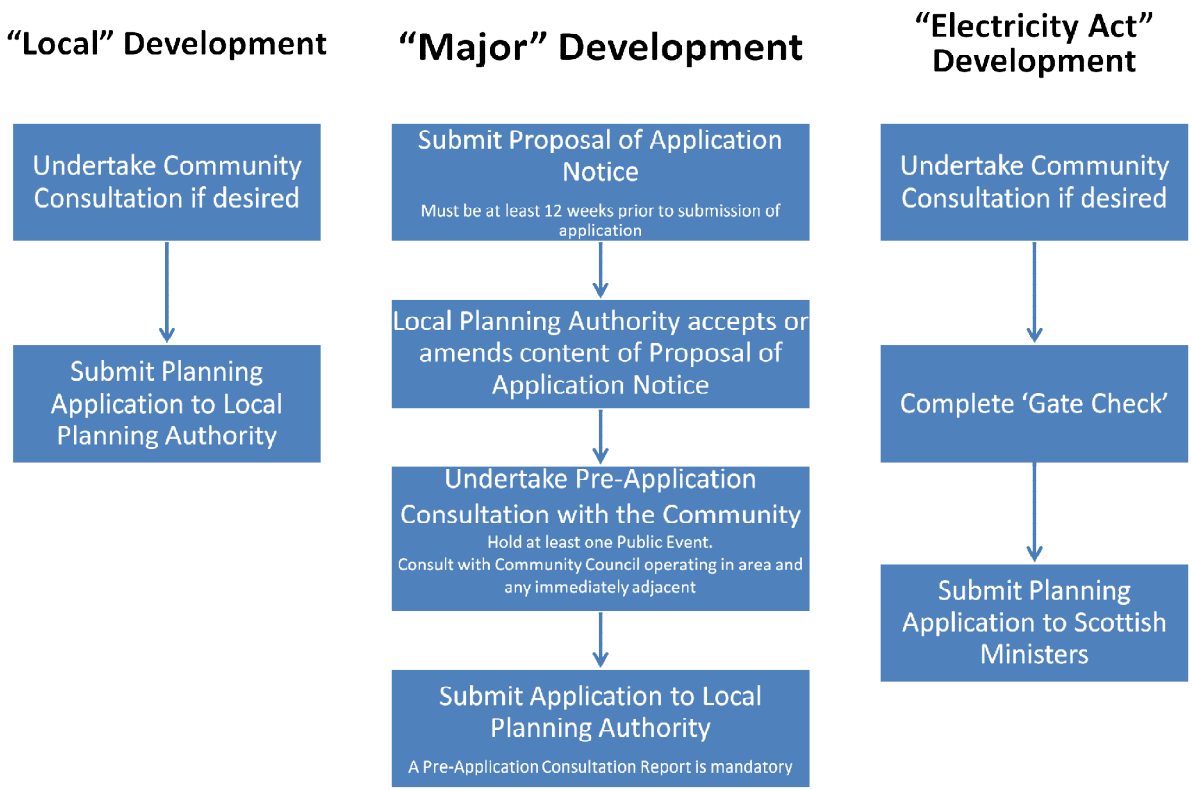


Figure 32: Community Consultation Requirements

Type of Development	Submission of Proposal of Application Notice	Consultation Period	Consultation with Community Councils	Provision of Public Event (advertised)	Submission of Pre-Application Consultation Report with application
Local	N/A	Voluntary	Voluntary	Voluntary	N/A
Major/National	Statutory Requirement	12 week minimum	Statutory Requirement	A minimum of 1 event	Statutory Requirement
Electricity Act	N/A	Voluntary	Voluntary	Voluntary	N/A

9 SUMMARY OF KEY INFORMATION

This Information Note provides a high level assessment of the type and scale of the new land-based development that would be required to service the Round 1 PFOW wave and tidal projects.

Two future development scenarios have been considered: initial arrays and full deployment.

It shows that to connect initial arrays generating at each of the PFOW sites, new network connections would be required on Orkney as well as new sub-sea cable landing points in the mainland. In addition, new developer-owned onshore facilities will be required at or near to each project site.

A further, but less certain, assessment of infrastructure requirements under a full deployment generation scenario has also been made. This shows that in addition to the development put in place for initial arrays, new HDVC connections would be required between Orkney and the mainland as well as new transmission connections in Sutherland. It is likely that the developer owned facilities located onshore would also need to be expanded to accommodate this larger generation scenario.

The onshore infrastructure requirements for developers are likely to be of the same type in both scenarios; and include the construction of:

- Cable landings
- Plant compounds (potentially accommodating substations, control building and/or an onshore generating station)
- Overhead lines and/or underground or subsea cables.

The requirements for SSE will vary depending upon the capacity of generation installed, as their infrastructure requirements are largely led by generation development. The requirements for the initial arrays (with a total generation capacity of up to 305 MW) could include:

- New substations (perhaps three), on the west and north coasts of Orkney mainland;
- New connections (up to 132kV) between the new Orkney substations and the existing transmission and/or distribution network;
- A substation in the Cantick Head area of South Walls (near Hoy), and another on South Ronaldsay near the Brough Ness development;
- A subsea (up to132 kV) connection from the Brough Ness substation running south to the mainland.

The requirements for the full deployment scenario (with a total generation capacity of up to 1,600 MW) could include:

- A new 132 kV substation in the Bettyhill area of Sutherland;
- A new 132 kV connection from the Farr Point substation to Dounreay;
- A new HVDC converter station in the west of Orkney Mainland; and
- A new HVDC connection from the west of Orkney Mainland to the Sinclair's Bay HVDC converter station.

The Note highlights the early stage of development that many of the PFOW projects are at, and consequently the lack of available detail on the exact configuration of infrastructure required at developer sites for both generation scenarios. As the development progresses, further information will be available; considering the current early stages of most of the projects, it is not unexpected that there is only limited information at the present time. This has a number of knock-on consequences, most notably, the ability of SSE to make the most efficient network investment plans and the ability of Planning Authorities to issue guidance and advice to assist developers. The lack of available information does however present a risk in the consents process for the future development of onshore infrastructure to support the PFOW projects.

Throughout the Note we have identified a number of actions under the general theme of 'information sharing and guidance' that could help to reduce those risks. These can be summarised as;

- **Use of existing stakeholder groups**

There are a number of relevant groups currently involved with delivery of the PFOW projects. These include;

- the Orkney Island Grid Group;
- the PFOW Leadership Forum, and
- the PFOW Developers Forum.

Focussing one of these groups on the specific task of future onshore infrastructure delivery could result in more information coming forward. For example the group could commission (or advise on the commissioning of) and steer future studies such as those suggested below.

- **Strategic planning, development of guidance and use of technical specialists when considering future infrastructure development**

When planning for future connections SSE routinely undertake strategic studies to identify preferred landscape corridors for new circuit routes and buildings. Developers too will need to site buildings, and run power cables, to connect their projects to the SSE infrastructure. In parallel to SSE's future planning work, the following actions could assist in identifying appropriate designs of, and locations for, new installations and, by engaging with the Planning Authorities with this information, reduce the risks associated with future consenting of those developments;

- In conjunction with Planning Authorities and/or others (including other developers) as necessary, developers to consider undertaking/continuing to undertake strategic level studies considering preferred locations and corridors for possible future developers' infrastructure.
- The development of siting and design principles for onshore infrastructure that are linked to supplementary planning guidance and/or development plan policies (which could themselves be updated).
- Ensuring that developer teams involve personnel with relevant professional skill sets, e.g. landscape architects and buildings architects to assist in the siting and design of onshore infrastructure, in particular substations and other buildings.
- Developers siting and designing initial-phase infrastructure in such a way that it could be added it in a modular way as necessary as projects increase in size.

- Timely (and, if necessary, commercially confidential) consultations between developers and Planning Authorities resulting in timely and consistent advice and planning decisions and conditions.

Recognising that technological constraints will also have an influence on siting and design decisions it is recommended that stakeholders work together wherever possible.

- **Continued information sharing and joint working**

Some developers, SSE and Planning Authorities are already working together to progress plans for land-based development to support PFOW projects. Continuing this open dialogue is critical in mitigating unnecessary delays in bringing forward the necessary development. We recommend that the following actions are considered in order to continue to facilitate efficient development planning:

- Developers and SSE explore, as early as possible, the scope for sharing infrastructure. This could be progressed via one of the stakeholder groups listed above, or via a commonly agreed 'honest broker' who would be able to promote developments to the greater good without compromising the commercial positions of individual players.

- Accepting commercial sensitivities, consider the development of a mechanism through which developers can share their expected requirements for future grid connections with SSE ahead of making formal applications.

- Ofgem, SSE and the developers develop a mechanism to facilitate joint applications from developers for SSE network connections to enable SSE to be more efficient in their strategic network planning activities.

ANNEX A – ASSUMPTIONS

As set out in Section 2, a number of assumptions have been used in the production of this Note to allow for the limitations resulting from the early stage of a large proportion of development in the PFOW area. A full list of the assumptions used is given in the table below.

Table A1: The Assumptions Used to Underpin the Onshore Infrastructure Assessments Made in this Information Note.

Assumption	Comments
All the round 1 PFOW sites will eventually be developed to their full capacity (i.e. to the maximum volume of the Agreement for Lease with The Crown Estate).	This is to enable us to identify an upper bound on the onshore infrastructure which could be associated with the Round 1 PFOW projects.
The PFOW generating capacities will be developed over time, in phases, with a smaller number of devices deployed initially.	Most of the PFOW developers have indicated that they plan to develop their sites in a phased way with an initial deployment of wave/tidal energy generating devices in the short term followed by either further stepped deployment or a single second full deployment to make up the lease capacity. Where PFOW developers have published their plans for an initial deployment we have used the published initial array capacity as the starting point for our assessment. Where information is not available we have assumed 10 MW as the initial array capacity.
Developers will make appropriate connection applications. This includes the assumption that the relevant and necessary generation connection consents are granted. We have not attempted to ascribe timescales to developments or their related connections, other than to recognise that the generation capacities are time-phased.	In order to obtain a connection to SSE's infrastructure, developers must make an application to National Grid and/or SSE[31]. Although SSE will do some forward network planning based on their assessment of energy generation sector growth, in the absence of a connection application they cannot make firm plans for network reinforcements[32] to be made. At present only some of the developers have applied for grid connections (see Tables 4 and 5).
Unless otherwise stated by developers we have assumed the capacity of initial arrays to be 10 MW.	Where PFOW developers have published their plans for an initial deployment we have used the published initial array capacity. Where information is not available from developers on initial array capacities we have assumed 10 MW as the initial array capacity.
Wave and tidal generator power would be delivered by the generators to the substation	The actual voltage of power delivery could range from 3.3 kV to 132 kV and will depend on a number of factors including the individual technologies developers choose to utilise. More

[31] For more information see http://www.nationalgrid.com/uk/Electricity/GettingConnected/

[32] Network reinforcement is work carried out to upgrade the existing network where needed to provide security of supply, new connection or load increase.

Assumption	Comments
collector points at a voltage of up to 132 kV.	information will become available as technologies (and projects) develop.
A single unsecured connection would be provided between each generating array and the national network.	Some developers may ultimately require more than one connection; however, for the purposes of this Note we have assumed one connection per PFOW project.
The network concept for Scenario 2 (full deployment) will be preceded by the network concept for Scenario 1.	The actual network outcome will depend upon the timing, capacity and location of actual connection applications received by SSE and may therefore differ considerably from the concepts discussed in this Information Note.

ANNEX B – GLOSSARY

Agreement for Lease	The Agreement for Lease is granted by The Crown Estate for a limited time period and grants a developer exclusive rights to investigate the possibility of a development (with respect to wave and tidal energy projects) within a defined area.
Cable	An insulated conductor designed for underground electricity transmission or distribution.
Circuit	The term used to describe specific electrical paths on the transmission system, e.g. overhead line or underground/subsea cable.
Cumulative effects	The overall effects of a number of different proposals of the same type of development.
Developers' infrastructure	Any onshore cables, buildings etc. required by a developer to connect wave/tidal generation equipment to the distribution and/or transmission systems owned and operated by SSE.
Developer(s)	Individual or consortium company in possession of a PFOW Round 1 development site lease agreement with The Crown Estate (see http://www.thecrownestate.co.uk/energy/wave-and-tidal/ for details on lease terms).
Development Plan	The collective term given to local planning policy documents – Structure Plan, Local Plan, Local Development Plan.
Distribution network	The electricity network (below 132 kV) owned and operated by SHEPD, an SSE company.
Duct	A form of black polypipe/rigiduct which electricity cables are fed through for protection.
Environmental Statement	A statutory document (containing the findings of the Environmental Impact Assessment) which is required for certain specified developments as part of the consent and licence application processes.
Export cables	Cables used to export power generated by the wave or tidal devices to onshore infrastructure
Full deployment	Full take-up, by all developers, of their Round 1 lease generation capacities, totalling 1,600 MW
Generator(s)	As Developer.
Horizontal Directional Drilling (HDD)	The process of drilling a bore(s) through a target geological formation. Directional drilling allows the drill bit to be steered in a pre-planned direction and hence the bore can be designed to exit the seabed in a pre-determined location.
HVDC	High voltage direct current
In Combination effects	The effects of an activity or development in combination with other different projects and activities.
Initial arrays	Initial take-up by each of the developers of their Round 1 lease generation capacities, anticipated to total approximately

	305 MW
kV	kiloVolt (1000 volts)
Landfall site	Location at which subsea cables come ashore
Local Development	Defined under the Planning etc (Scotland) Act 2006 as development where the gross floor space is less than 5,000 m2 or the area of the site is less than 2 hectares.
Local Planning Authority (LPA)	The decision making body for applications made under the Town and Country Planning (Scotland) Act 1997 (as amended), and refers to the Council operating in the area (e.g. the Highland Council or Orkney Islands Council).
Major Development	Defined under the Planning etc Scotland Act 2006; as development where the gross floor space exceeds 5,000 m^2 or the area of the site is equal to or exceeds 2 hectares.
Material Considerations	Referred to when a decision is being made on a planning application and must be both material and relevant. The 'test' for confirming this is that it serves the purpose of planning and it relates to the particular application. Material Considerations can be both in support and in opposition of an application.
MW	MegaWatts (1,000,000 watts)
National Development	As defined in the National Planning Framework for Scotland 2 - http://www.scotland.gov.uk/Publications/2009/07/02105627/10
Onshore infrastructure	All developers' and SSE's infrastructure landward of the mean low water spring tide level owned and operated by the developers and SSE. It excludes offshore infrastructure such as sub-sea cables and connectors owned by any of these parties and other ancillary facilities such as ports, harbours and transport routes.
Overhead line	Conductors (cables) that run overhead, suspended from poles or pylons
Permitted Development	Permitted Development is deemed to have prior planning permission under the Town and Country Planning (General Permitted Development) (Scotland) Order 1992 (i.e. the submission of a planning permission is not required).
Pre-Application Consultation	The statutory consultation activity required for Major and National Development under the Planning etc (Scotland) Act 2006.
Reinforcement	Work carried out to upgrade the existing network where needed to provide security of supply, new connection or load increase.
Round 1 Pentland Firth and Orkney waters development sites	The Crown Estate announced the successful bidders for its first wave and tidal leasing round in the PFOW – providing to 1.6 GW installed capacity - in March 2010. The possibility of future leasing (and associated infrastructure requirements) is not considered in this Note.
Scenario(s)	The two scenarios considered in this document refer to two stages of development of the PFOW projects (see Section 2).
Section 36 Development	Development which is applied for under Section 36 of the Electricity Act 1989, and is determined by the Scottish Ministers. Applications for generating stations over 50 MW in

	capacity fall under this classification.
Section 37 Development	Development which is applied for under Section 37 of the Electricity Act 1989, and is determined by the Scottish Ministers. Applications for overhead lines over 20 kV fall under this classification.
SSE's infrastructure	Underground cables, overhead lines, substations and other buildings which comprise the distribution and transmission networks owned and operated by SSE.
Substation	The general term for electrical plant which connects two or more circuits to form the power network. A substation generally comprises one or more switches (circuit breakers or fuses), and frequently also accommodates transformers and control and communication equipment.
Switching substation	Switching substations control the circuits that, together, form the network. The switches (circuit breakers) are for control, safety, and maintenance purposes. In the event of equipment fault, one or more switches will open automatically, to isolate the faulted equipment from the network, thus minimising damage and danger.
Transformer	A transformer 'transforms' electrical power between high voltage and low voltage. Power transmission is more efficient at higher voltages, hence the tendency to use transformers where the electric power is to be transmitted over long distances.
Transformer substation	A switching substation that also includes one or more transformers.
Transmission network	The electricity network (132 kV and above) owned and operated by SHETL, an SSE company.
Unsecured connection	A single circuit connection which, if it malfunctioned for any reason, be it internal equipment fault or third party interference, would cause total loss of connection of the generator to the transmission network. There is no bypass, or alternative connection route for an unsecured connection.
Wave or tidal energy	Wave and tidal stream energy is electricity generated from the movement of wave and tidal flows. Details of some of the leading wave and tidal technologies are summarised in the Renewable UK State of the Industry Report 2012 for Marine Energy in the UK which can be found at http://www.bwea.com/ref/reports-and-studies.html
Wave/tidal array	A group of wave or tidal energy converter devices that are positioned within close proximity of each other.

ANNEX C – STAKEHOLDER CONSULTATION

In producing this Note, we and The Crown Estate have consulted with a number of stakeholders, including at workshops held in Edinburgh and Stromness. We are grateful to all stakeholders for their input to the project. A full list of those consulted is provided below;

Aquamarine Power

Brough Head Wave Farm Ltd

Cantick Head Wave Farm Ltd

Costa Head Wave Farm Ltd

E.ON Climate and Renewables Developments Ltd

Highland Council

Marine Current Turbines

Marine Scotland

MeyGen Ltd

OpenHydro Ltd

Orkney Islands Council

Pelamis Wave Power

Scottish Government

Scottish Natural Heritage

ScottishPower Renewables

SHETL and SHEPD (SSE Plc)

SSE Renewables

ANNEX D – INFORMATION SOURCES

In addition to those information sources already referenced within the Information Note we have also drawn information from the following sources;

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Brough Head Wave Farm Limited (2011) *Brough Head Wave Farm: Scoping Report*. Available from http://www.aquamarinepower.com/projects/west-coast-orkney/

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