

2.2 Project Description

2.2.1 Introduction

2.2.1.1 This section provides a high level description of the proposals for the modified Transmission Infrastructure (TI) required to connect the wind farms to the pre-existing onshore National Electricity Transmission System (NETS). The information contained in this report reflects the Rochdale Envelope at the time of writing, which will narrow as the design is finalised prior to construction. There are three main elements to the modified TI: the offshore substation platforms (OSP) structures accommodating those assets necessary for the collection and conversion of power from the individual wind turbine generators (WTGs); the offshore to onshore export cables for the bulk transfer of power; and the onshore assets (i.e. onshore export cables and substations) necessary to facilitate the final connection to the pre-existing assets of the NETS.

2.2.2 Rochdale Envelope Approach

2.2.2.1 A Project Parameter Plan, which outlines the proposed infrastructure, and the construction, operation and decommissioning methods, has been used in all impact assessments. The reasoning behind the use of a Rochdale Envelope with a range of parameters in the case of large developments is that the developer must apply for consents several years in advance of commencing the construction process. At this stage in the MORL project much of the infrastructure is still at the pre-FEED (front end engineering design) stage and will not be designed in detail or selected until closer to construction.

2.2.2.2 The applications for consent will set out a scheme of parameters which is known as a Rochdale Envelope. The range of parameters sets out the realistic maximum (and where relevant minimum) physical parameters of the proposed development which result in realistic worst case effects. Therefore, in subsequent phases of the engineering design process, the development must be within the scope of the assessed effects.

2.2.2.3 The concept selection process for the modified TI has been completed and the range of concepts suitable for the infrastructure, and construction and operation methodologies identified. This range of concepts was critically assessed, refined and narrowed down to produce the Rochdale Envelope. The Rochdale Envelope for the modified TI is explained in full in this Project Description.

2.2.2.4 For the EIA, the realistic worst case scenario based on the options within the Rochdale Envelope has been assessed. The realistic worst case scenario can vary between receptors, therefore, a summary of the worst case scenario is provided at the start of each discipline impact assessment.

2.2.3 Rochdale Envelope – Project Parameter Plan

2.2.3.1 Table 2.2-1 below provides a summary of the modified TI parameters, which are fully discussed in Sections 2.2.3 to 2.2.12.

Table 2.2-1 Modified Transmission Infrastructure Parameters

Infrastructure Type	Parameter	Parameter Range
AC OSPs	Maximum number required	2
	Indicative topside width x length	100 x 100 m
	Indicative maximum height above LAT	70 m
Substructure & Foundation for OSPs: Steel Lattice Jackets with Pin Piles or Suction Caissons Or Steel Lattice Jack-up with Pin Piles or Suction Caissons	Jacket base width	Up to 100 m
	Number of legs (Jacket) and foundations: piles / suction caissons	Up to 6 legs with 6 piles / 6 suction caissons
	Number of legs (Jack up) and pile foundations	4 legs with 16 piles in total
	Maximum diameter of piles	3 m
	Length of piles	60 m
	Scour protection around each leg plus pile diameter	16 m
	Diameter of suction caissons	20 m
Cabling Within the Three Consented Wind Farm Areas	Voltage	220 kV
	Maximum length (including inter-platform cabling)	70 km
New Deer Onshore Grid Connection via Inverboyndie Landfall		
Export Cabling (Offshore)	Cable configuration	12 cables in four triplecore (offshore) arrangements
	Cable bundle separation distance	4 x water depth
	Voltage of cabling	220 kV (AC)
	Entry / exit method from OSPs	J-tube
	Target burial depth in seabed	1 m
	Protection where target burial not achieved	Concrete mattresses or rock placement
	Trench affected width	6 m per cable
	Cable corridor length (from three consented wind farm areas)	Approximately 52 km
	Cable corridor width	Up to 1200 m
Export Cabling (Onshore)	Location	Underground from Inverboyndie to southwest of New Deer
	Cable configuration	Trefoil (onshore)
	Route length	Approximately 33 km
	Number of trenches / conduits	Up to four trenches
	Width of trenches / conduits	4 m assuming individual trenches (60 m working width)
		If two trefoil cables co-located within a single trench, then 6 m each
	Voltage of cable	220 kV (AC)
Target burial depth	1 m	
MORL Onshore Substation	Length	270 m
	Width	135 m
	Area	36,450 m ²

Infrastructure Type	Parameter	Parameter Range
	Maximum height	13 m
	Type of switchgear	Gas Insulated
Additional Substation	Length	270 m
	Width	170 m
	Area	45,900 m ²
	Maximum height	13 m
	Type of switchgear	Gas Insulated

2.2.4 Modified Transmission Infrastructure

2.2.4.1 The modified TI will consist of both onshore and offshore cable systems. The constituent parts of this overall system can be summarised as follows:

- Up to two OSPs located within the three consented wind farms area. These will house substations which will form the interface between the inter-array cables and the offshore transmission system;
- Offshore transmission system: up to four triplecore submarine high voltage alternating current (HVAC) export cables in up to four separate trenches between the OSPs and the shore, which are used to transmit the energy generated by the WTGs to the shore. The cables may include embedded fibre optic data and communication cable cores;
- Subsea cabling specification (AC, voltage level 220kV);
- Cable landfall: the point at which the submarine cables are physically brought ashore;
- Onshore transition jointing pit: the interface between the offshore and onshore cables systems;
- Onshore transmission system: underground circuits, comprising up to 12 cables in trefoil arrangements in up to four separate trenches, which transmit the energy generated by the wind turbines from the landfall to the connection point;
- Onshore cabling specification (AC, voltage level 220kV); and
- Two onshore substations consisting of grid transformers and HVAC switchgear and associated electrical equipment.

2.2.5 Construction Schedule

2.2.5.1 An indicative construction schedule for the modified TI is shown in Plate 2.2-1 below.

2.2.5.2 There will be different organisations responsible for issuing the consents (see Section 1.2, Regulatory and Policy Context, for information on the correct applications to be submitted, and section 1.1.6 of this ES), however for the purposes of this document it is assumed that there will be similar consenting timescales for the onshore and the offshore aspects of the modified TI. The award of consents would be anticipated later in 2014. The installation process of modified TI assets may begin onshore in 2016 and the construction is anticipated for completion by 2022 (assuming a phased installation process along with the construction of the wind farms). Some systems will be fully operational in 2018 with the remaining infrastructure operational by 2022 (See Plate 2.2-1 below).

2.2.5.3 Key elements associated with the installation of the TI are listed below. The activities are not in order of occurrence:

- Pre-construction site investigation (i.e. cone penetrometer testing, CPT / boreholes) (which is currently subject to separate licensing process by Marine Scotland);
- Substructure and foundation installation and associated site preparation;
- Disposal, if necessary, of any spoil excavated during installation;
- Installation of OSPs;
- Installation of HVAC cable between OSPs;
- Installation of HVAC cables between OSPs and the shore landing area;
- Installation of transition jointing pit at shore landing;
- Installation of HVAC cables between onshore landing area and the onshore substation; and
- Construction of onshore substations to facilitate connection to the national grid.

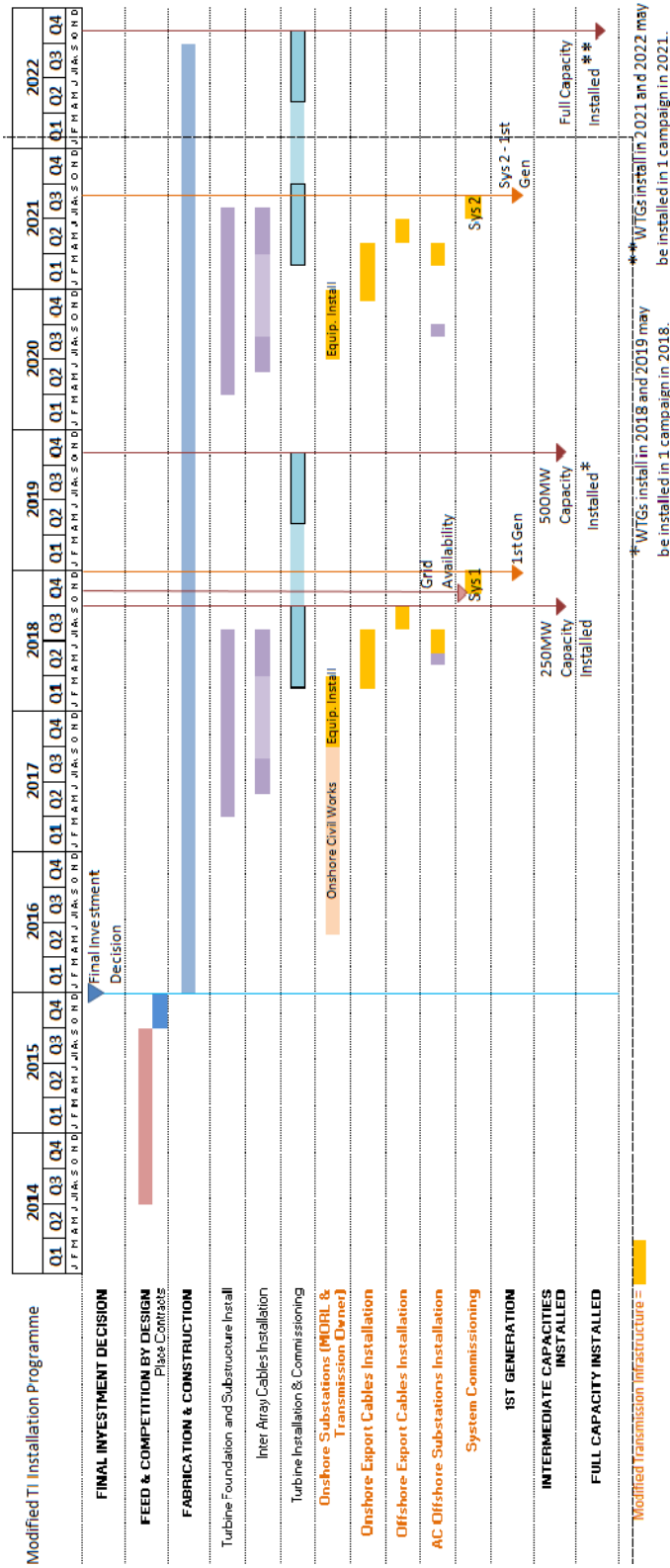


Plate 2.2-1 Indicative Installation Programme (includes indicative modified Project timescales for reference)

2.2.6 Modified Offshore Transmission Infrastructure (OfTI)

2.2.6.1 This section outlines the range of concepts for each category of infrastructure required for the modified OfTI. A geophysical and geotechnical survey campaign was carried out in the spring of 2014 to identify appropriate areas for installation of cables and platforms. The modified OfTI infrastructure will be located within the three consented wind farms (Telford, Stevenson and MacColl) area and within the modified offshore export route corridor (Figure 1.1-4, Volume 3).

AC Offshore Substation Platforms

2.2.6.2 Up to two (high voltage alternating current (HVAC)) offshore substation platforms (OSPs) will be required to collect the power generated by the three wind farms. The exact locations of the OSPs are not currently known, however they will be located within the three consented wind farms (Telford, Stevenson and MacColl) area (see Figure 1.1-2, Volume 3). The HVAC OSPs are enclosed structures housing heavy electrical equipment such as transformers, switchgear and control systems. The function of the HVAC OSPs is to transform the electricity generated by the turbines from voltages of 33–66 kV to 220 kV and transmit it to the export cables. Table 2.2-2 below provides the maximum dimensions of the AC OSPs. The original marine licence application submitted in August 2012 was for up to 6 AC OSPs and 2 DC convertor OSPs. The modified TI represents a significant reduction in the amount of the TI required in terms of OSPs.

Table 2.2-2 Dimensions of the HVAC OSPs

Platform Parameter	HVAC Platform
OSP 'topside' max width x length	100 m x 100 m
Topside max height above LAT	70 m

Foundations and Substructures for HVAC OSPs

2.2.6.3 The overriding factors influencing the choice of foundation and support structure for a specific project are the dimensions and weights of the electrical infrastructure to be used, nature of ground conditions in the area and water depth.

2.2.6.4 MORL is studying the possibility of using the same foundation and substructure type as contained in the consented Rochdale envelope for the three wind farms for the wind turbines (with the exception of gravity base structures which are not included within the Rochdale Envelope for the modified TI). These concepts can be tailored to suit the variable water depths and seabed gradients.

2.2.6.5 All OSPs will include access facilities, lifesaving appliances and appropriate lighting and marking for surface navigation. Options for the configuration of the foundations and substructures, and details of their potential environmental effects, are included in the assessments for the modified OfTI within this ES.

2.2.6.6 The HVAC OSPs will be supported by substructures and foundations, of which there are four concepts identified as suitable for the three sites:

- Jacket with pin piles;
- Jacket with suction caissons;
- Jack-up with pin piles; and
- Jack-up with suction caissons.

2.2.6.7 These concepts are further described below.

Jackets with pin piles or suction caissons

2.2.6.8 The jacket structure required to support an AC OSP will have a maximum of 6 legs. One (up to 3m) pin pile would be installed to fix each leg to the seabed. The alternative suction caisson foundation would be an open-ended steel cylinder up to 20 m diameter attached to each leg. The principle is that water is sucked out of the cylinder which then embeds itself in a sandy seabed to a depth of up to 20 m. This option cannot be used in many locations across the EDA because only 10 % of the seabed in this area is suitable for this concept.

Jack-ups with pin piles or suction caissons

2.2.6.9 The jack-up concept will have either pin pile or suction caisson foundations. The jack-up substructure consists of a topside box with 4 support legs that can be raised or lowered using a powerful jacking system operating between each leg and the hull. Water ballast is taken by the jacking system to ensure the legs are fully loaded and secure in the seabed. At the base of each leg a 'spud can', such as a steel cone which penetrates the seabed, may be fitted. For long-term stability it may be necessary to install a pin pile up to 3 m diameter at each leg. Alternatively a suction caisson of 20 m diameter can provide stability. The area around the legs will require scour protection. Corrosion protection is likely to take the form of cathodic protection, painting and mechanical removal of deposits, there is potential for use of corrosion inhibiting chemicals inside the J-tubes.

Scour and Impact Protection

2.2.6.10 The substructure and foundation concept as well as the current regime approaching seabed level defines the type and extent of scour protection required, and typically a 'scour allowance' is specified in the design of jackets. However, as foundation size increases the potential scour depth around the structure also increases and hence there is a greater need to protect the foundation, i.e. it becomes more efficient to protect the foundation rather than utilise an in-built design to allow for scour.

2.2.6.11 The suitability of installing rock or concrete mattresses for cable protection, especially around the structure bases, will be assessed based on the currently known seabed data across the proposed development area and the assessed risk of impact damage.

Offshore Export Cable

2.2.6.12 HVAC export cables will be required to connect the HVAC OSPs to the grid connection point at New Deer. There will be a maximum of four triplecore cables in four separate cable trenches. The total width of the cable corridor will be four times water depth. The trench affected width during installation will be a maximum of 6 m with a target depth for burial of 1 m. Should there be any area where the cable cannot be buried concrete mattresses or rock placement will be utilised to shield the cable. The approximate length of the offshore export cable route is 52 km from the southern boundary of MacColl Offshore Wind Farm to landfall at Inverboyndie, excluding micrositing allowances.

2.2.7 Modified Onshore Transmission Infrastructure (OnTI)

Onshore Export Cable

2.2.7.1 The HVAC cables will come ashore at Inverboyndie and will continue to the grid connection point southwest of New Deer. There will be a maximum number of twelve cables bundled into four trefoil arrangements and buried in a maximum of four trenches. The trench width will be 4 m per trench assuming individual trenches. It is also possible that two cables will be buried in one trench, in which case there will be a maximum of two trenches and the maximum width of each will be 6 m. The maximum working width required during installation will be 60 m. The approximate cable route length from Inverboyndie landfall to the connection point is 33 km.

Onshore Substation Location

2.2.7.2 MORL will require one AC substation, covering an area of up to approximately 270 x 135 m at the connection point near New Deer. MORL has undertaken land negotiations, environmental and technical surveys which have resulted in the selection of the location indicated in Figure 1.1-6, Volume 3. In order to allow the connection of MORL to the national grid, an additional substation must be consented which will ultimately be owned by the regional Transmission Operator (TO) and will feed into the existing overhead line. This substation will be up to 270 x 170 m. Both substations will be a maximum of 13 m in height. Both substations will use Gas Insulated Switchgear (GIS). The onshore substation site identified by MORL allows for the co-location of the MORL substation and the additional TO substation which together will occupy an area no more than 10 hectares in size.

2.2.8 Offshore Installation

2.2.8.1 The following section describes the installation procedures likely to be utilised for installation of the modified OfTI. Final installation methods are subject to detailed engineering design and may be adapted based on the technology selected and technical advances.

Foundations and Substructures

Jacket with Pin-Piles or Suction Caissons

2.2.8.2 A jack-up barge or other suitable lift vessel will be used to transport the jackets to site and a crane would be used to install the substructure. Where pin-piles are used as the foundation technique, the piles may be installed before (pre-piling) or after (post-piling) the jacket is installed. For pre-piled foundations, a template is placed on the seabed to ensure the piles are installed in the correct locations. The template is then removed and moved to the next location and the jacket is landed onto the piles. For post-piling, the piles are installed through pile sleeves located at each corner of the jacket.

2.2.8.3 Impact piling is the most common method of installing piles, using a piling hammer from a suitable vessel (e.g. jack-up). In some cases, it may be possible to drill the post-hole. However, this method is not currently commercially viable for large-scale use and is currently only expected to be used in exceptional circumstances. Another option will be to combine the two techniques in a drive-drill-drive pattern. This is usually used in areas with very hard geological strata and it is not currently expected to be used unless piling alone has been unsuccessful.

- 2.2.8.4 Suction caissons may also be used as the foundation of the jacket legs. These will be installed either by pushing the caisson into the seabed or by creating a negative pressure within the skirt by “sucking the water out” which secures the caisson to the seabed.
- 2.2.8.5 Where required, grout will be used to provide a strong connection between jacket and pile. The grout will be installed using the pile sleeve and ROV observation. After grouting, scour protection may need to be installed around each leg / pile depending on local conditions. This will be controlled rock placement, concrete mattresses or anti-scour matting.

Jack-up concept

- 2.2.8.6 The concept of using a jack-up to support an OSP offers the advantage that the entire jack-up including the topsides equipment box can be built in a shipyard. Once complete the hull of the jack-up, which is essentially a water tight steel box containing the equipment can be floated out of dry dock at the shipyard to the site with the four legs fully extended above the hull.
- 2.2.8.7 The principle of the jack up is that the support legs can be raised or lowered using a jacking system operating between each leg and the hull. On arrival at site the legs will be jacked down to contact the seabed, then the full weight of the hull plus water ballast will be taken by the jacking system to ensure the legs are fully loaded and secure in the seabed. After this the hydraulic jacking system will elevate the hull up the legs to its intended elevation. At the base of each leg a ‘spud can’ will be fitted, typically a steel cone.
- 2.2.8.8 To ensure stability over the operational life of the platform, it may be necessary to install a pin pile at the foot of each leg. This will be grouted to secure the connection to the leg structure. The J-tubes for the OSP cable entries / exits will be positioned after the jacking operation is complete. Alternatively a suction caisson will be utilised as an alternative seabed fixing method, installed using similar methodology as described above.
- 2.2.8.9 Dimensions of the jack up concept will be within the envelope described for the jacket substructures.

Offshore Substation Platforms

- 2.2.8.10 The HVAC OSPs jacket substructure will be installed independently of the OSPs themselves. The topsides will be transported to site and lifted into position using a crane from a heavy lift vessel. The topsides will be installed as a single unit or in separate modules.

Offshore Export Cabling

- 2.2.8.11 The following section describes cabling installation relevant to the modified TI where the cables are installed offshore, i.e. from the intertidal area to the OSPs. The modified offshore export cable corridor is up to 1.2 km wide (except in the vicinity of the Southern Trench), which allows MORL the opportunity to micro-site the cable around any identified sensitive features. The spacing of the cable will target four times the water depth.

Cable Burial

- 2.2.8.12 Cable lay vessels are used to lay and bury the offshore export cables. Further analysis will be carried out on the site seabed conditions as part of the cable protection and burial study. The study will consider the technically and economically achievable burial depths based on the export cable corridor site specific ground conditions. The target burial depth is 1 m. For most of the offshore export cable route

it is expected that the cables will be in trenches for protection. However, should the seabed contain areas of rock at, or close to the surface which is potentially unsuitable for trenching, cables may be laid on the seabed. Where this occurs the cable will be protected by graded rock placement, concrete mattresses or other suitable protective coverings.

- 2.2.8.13 The available techniques for creating the cable trenches are ploughing, jetting, jet-assisted plough, tracked devices or mechanical cutting. The technique used is chosen so it is suitable for the seabed conditions. A short technical description of these techniques is detailed below:
- 2.2.8.14 **Ploughing:** A cable plough is a device towed behind a vessel. The plough sits on the seabed and as it is pulled forward, curved steel plough blades are driven into the seabed creating a trench.
- 2.2.8.15 **Jetting:** Jetting is performed by a remotely operated vehicle which sits on the seabed on a tracked wheel system. The jetting vehicle receives power and control signals via an umbilical from a surface vessel. The jetting vehicle lowers jetting swords into the seabed, fluidising the substrate with high pressure water jets into the swords. The vehicle drives itself along the cable route using its tracked wheel system with the swords and the water jets creating a trench as it travels forward.
- 2.2.8.16 The operation itself may take one of two forms:
- Combined lay and bury: where the cable trench is created and immediately after, the cable is laid in the trench using the same tool and therefore in the same operation; and
 - Post-lay burial: where the cable is laid on the seabed in one continuous operation. Upon completion of this, a second operation is done to create the trench into which the cable will fall through gravity.
- 2.2.8.17 **Jet assisted plough:** This technique is basically a hybrid method incorporating ploughing and jetting. Cable ploughs are towed by a vessel and at the surface specialised nozzles introduce water at the soil interface, fluidising the substrate, reducing the stresses involved in this process.
- 2.2.8.18 **Tracked devices:** These have tracks (like bulldozers) and are deployed on the seabed and usually powered by an umbilical from a vessel. The tracked vehicle can carry a range of equipment for trenching such as mechanical rock cutters or jetting equipment.
- 2.2.8.19 **Mechanical cutting:** Is used to cut a trench through rock or very stiff clay. It would be deployed on a tracked device and consist of rotating cutting heads.
- 2.2.8.20 Each cable laying operation is expected to be done continuously without the requirement for splicing. The maximum speed of progress is in the range 300–500 m / hr. In difficult conditions, e.g. very stiff clay or rocky sea beds progress will be slower.
- 2.2.8.21 For either method used, the degree to which the trench naturally back-fills depends on the nature of the seabed and local metocean conditions or scour protection will be laid where cables cannot be buried to the target depth.
- 2.2.8.22 Where the cable has to cross existing infrastructure, such as other cables, special arrangements will be required. For example a layer of concrete mattresses or grout bags may be fitted over the top of the existing cable. The new cable will be run over this protective layer and then itself protected with a further layer of mattresses or grout bags. The methodology for crossing arrangements will be developed in agreement with third party cable owner / operators where relevant.

Cable Pull-in

2.2.8.23 At the OSPs it is necessary to pull in each cable. Typically a system using messenger wires and cable guides allows pull-in to proceed without diver intervention. Once the cable is pulled in and secured, any exposed areas may be protected, e.g. by mattresses or rock placement. At the OSP typically a row of J-tubes will be pre-installed along sides of the substructure to accept the cable from each of several array string.

Modified Export Cable Landfall

2.2.8.24 The key components at the landfall point will consist of but not necessarily be limited to:

- Four subsea triplecore cables, transitioning to four trefoil onshore cables;
- A temporary contractor's compound;
- A temporary horizontal directional drilling (HDD) site (if HDD being utilised);
- Cable winching equipment and platforms; and
- Transition bays and earth link boxes.

2.2.8.25 The contractor's compound (approximately 40 m by 60 m), within the landfall working area, will be a fenced off area used for the provision of welfare facilities, site offices and the storage of plant and machinery.

2.2.8.26 The techniques which could be used for the modified export cable landfall and intertidal area include open cut trenching, ploughing, dredging, mechanical cutters and HDD.

2.2.8.27 Open cut trenching consists of excavating a trench across the landfall location and down below low tide level to a point where marine vessels and equipment can operate and continue trenching. Construction of a temporary causeway across the beach and down through the low tide level may be required to provide a base for excavation equipment to dig a trench alongside the causeway. On the beach or in shallow water a back-hoe dredger may be used. In deeper water specialist dredging / trenching equipment could be used.

2.2.8.28 In the case of sandy beaches it may be possible to locate a marine trenching plough above high tide connected to the cable installation vessel lying near to shore. The vessel can then pull the trenching plough down the beach and out to sea installing the cable in the foot of the trench as it goes.

2.2.8.29 If rocky conditions are encountered it may be possible to use a mechanical cutter which uses a rotary cutting wheel to excavate a narrow trench. Such machines may operate above or below water.

2.2.8.30 HDD may be used to avoid cutting an open trench. This involves drilling a hole from the landward side of the landfall to a point below low tide where marine equipment can operate. The diameter of the hole is sized to take a conduit through which the cable(s) are pulled. The maximum distance of cable pull depends on the design strength of the cable. For standard cables the limit of pull and therefore of the HDD approach is 500 m. However, specially strengthened cable can be used to extend this distance to 1 km in exceptional circumstances.

Transition Bays

2.2.8.31 An onshore transition bay is required to joint each triplecore offshore export cable to the trefoil onshore cables. The modified TI comprises a maximum of four export cables, and therefore requires up to four onshore transition bays located adjacent to each other. All four transition bays will be located underground inland of mean high water springs (MHWS). The footprint of each transition bay will be approximately 20 m x 5 m. Spacing between each of the bays will depend on the cable arrangement

up to the limit of the transition bay area and the method of construction, but will be approximately 5 m. Each bay will be excavated to a depth of approximately 2.5 m. The transition bay walls will be constructed using reinforced concrete and the floor of each will be concrete lined.

- 2.2.8.32 Adjacent to each transition bay there will be a link box. Link boxes are used at cable joints and terminations to provide easy access for cable testing and fault location purposes. Link boxes will require a number of surface level access covers (dimensions approximately 1.5 m x 4 m) placed in the vicinity of its associated transition bay. The area around the transition bays will be backfilled upon completion of the jointing works, but permanent access will be required to the link boxes during the operational lifetime of the wind farms for maintenance purposes.

Construction Phase Safety Zones

- 2.2.8.33 In accordance with the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007, it is expected that a 500 m safety zone will be applied for under Section 95 of the Energy Act 2004 around the OSPs and an advisory safety zone will be communicated to relevant stakeholders along the offshore cable route during the period of construction works. In order to minimise disruption to navigation by users of the sea, safety zones are expected to be established around such areas of the total site that have activities actually taking place at a given time. As such the safety zones are expected to follow throughout the different areas of the site as construction work is undertaken. The exact locations are to be determined at a later stage and would be notified to mariners. Safety Zones in place on the OfTI will be implemented and communicated through standard protocol (i.e. Notice to Mariners).

2.2.9 Onshore Installation

Cabling

- 2.2.9.1 The modified onshore cable route corridor mainly passes through agricultural (primarily arable) land. For the purposes of the applications and Environmental Impact Assessment, a 500 m corridor has been assessed. The location of the onshore cable route within the corridor would be subject to approval by Aberdeenshire Council. The cable route working width will only be a 60 m wide route within this corridor and will route around any environmental or technical constraints wherever possible.
- 2.2.9.2 The maximum working width during installation is expected to be 60 m wide to allow access to the trenches by excavators and cable-drum trucks etc. There will be a maximum of four trenches at a width of 4 m (unless two cables are co-located in the same trench in which case the width would be up to 6m). The trench will be excavated using a digger (e.g. JCB) or possibly a cable plough. The cable plough method has an indicative rate of installation of 1 km / day, while the open trench method has an indicative rate of 300 m / day.
- 2.2.9.3 It is likely that the installation will be over two campaigns, with 2 cables being laid to support the first OSP, and the remaining cables laid at a later date. If cables are laid in two separate campaigns it will still be within the 60 m maximum working width.
- 2.2.9.4 Excavated material will be stored within the construction corridor temporarily and used later to fill in the trench and bury the cable. The trench will be lined with sand for the cable to rest on and depending on the properties of the excavated material, a thin layer of sand may also be used to cover the cable.
- 2.2.9.5 Where crossings of sensitive watercourses are required HDD will be used. The depth and length of the small sections of HDD would be agreed with Aberdeenshire Council in consultation with SEPA (Scottish Environment Protection Agency) prior to construction.

Road crossings will either be crossed utilising HDD or could involve excavation of the road surface, cable laying and reinstatement of pavement and road.

- 2.2.9.6 Periodically along the cable route there will be the requirement for jointing pits which will be wider than the cable trench, up to approximately 10 m wide. These are needed where two lengths of cable are joined together and require larger areas for workers and equipment to manoeuvre. The total number of and distance between jointing pits is determined by the size of the cable drums and the feasibility of transporting them to the construction site. Typically, lengths of hundreds of metres are manageable. The location of the jointing pits will be determined prior to construction, but joints will be positioned in locations that will minimise any impact associated with the construction activities.
- 2.2.9.7 The contractor responsible for the onshore cable installation works will establish a temporary construction compound (or compounds) for the location of site offices, welfare facilities, stores, laydown and parking areas. The exact location and number of these will be determined prior to construction. Due to the length of the route it is likely that a maximum of seven temporary compound areas will be required. One of these will require to cover an area of 75 m x 50 m (3,750 m²) and the remainder would be 20 m by 30 m. Locations of all compounds will be agreed with landowners and Aberdeenshire Council prior to construction as part of the detailed planning process.
- 2.2.9.8 There should not be any need to establish permanent access tracks, however depending on the route and specific equipment selected, there may be a need for some temporary access tracks for construction although the nature and location of these has not been determined. Construction access roads (where required) will be approximately 5 m to 6 m in width and will be constructed in parallel with cable trench excavation.
- 2.2.9.9 Shortly prior to installation, topsoil and vegetation will be stripped from the working area using tracked excavators and stored to one side of the allocated area. Topsoil will be stored away from watercourses or drains and in such a way that it will not be mixed with subsoil or subject to construction trafficking. Storage times for topsoil will be kept to a minimum to prevent deterioration in its quality. Topsoil from different fields will be stored separately as appropriate.

Horizontal Directional Drilling (HDD) (Onshore)

- 2.2.9.10 It is likely that HDD will be utilised along parts of the onshore cable route, at the landfall point, water crossings and/or road crossings. The construction of HDD ducts will be carried out before the cables are pulled ashore or installed along the onshore export cable route.
- 2.2.9.11 The HDD works will involve drilling an arc between two points (known as the launch site and receiving site), to pass underneath the feature to be avoided (e.g. a water crossing).
- 2.2.9.12 The first stage of HDD involves a small pilot hole being drilled with a cutting/ steering head to set the path of the arc from the launch site towards the receiving site. When the pilot bore is completed, the cutting/steering head is replaced with an appropriately sized back-reamer at the receiving site and pulled through the pilot hole from the drill rig towards the launch site to enlarge the diameter of the hole. Depending on the final borehole diameter required, it may be necessary to carry out the back-reaming in several stages, each time gradually increasing the borehole diameter. Once the required diameter has been drilled, the back-reamer is sent through the bore once or twice more to ensure that the hole is clear of any large obstructions.

- 2.2.9.13 On the final pass, the cable duct is connected onto the back-reamer and the drill string at the receiving site, using an extending sealed towing head. The drill string is then pulled from the drill rig and retracted to the drilling site, cutting a larger diameter (clearance) bore whilst also installing the new pipe (the cable ducts).
- 2.2.9.14 The temporary HDD drilling site will require launch pits for each of the drilling operations. An area of approximately 5 m by 2 m (and 1 m deep) will be excavated for each entry pit. As the drilling rig and ancillary equipment will need to be moved between three entry sites, a set up area, on firm level ground, of approximately 80 m by 60 m will be required.
- 2.2.9.15 A non-saline water supply at the HDD drilling site will be necessary within 100 m of the drilling rig to facilitate the installation of the water based drilling mud (bentonite, which acts as a lubricant during the process). If there is no suitable water supply on site this can be provided by tanker and stored on site.
- 2.2.9.16 A silt settlement pond will be required to capture and recycle the water based drilling mud during the drilling process and to ensure it does not exit the site. The plan area of the settlement pond may vary but will be a maximum of 7 m by 7 m. The depth of the settlement pond will generally be 0.8 m but this may vary according to local topography. Excavations will be plastic lined and protected with 'Heras' type fencing. Mud waste from this activity will be disposed of in accordance with a site Waste Management Plan (WMP). The WMP is one of a suite of documents which will form part of the Construction Environmental Management Plan (CEMP).
- 2.2.9.17 Following completion of the HDD exercise, the excavated materials will be replaced into the pits and the area will be reinstated. Where excess waste material is generated this will be re-used or disposed of in accordance with the site WMP.

Onshore Substations

- 2.2.9.18 The construction of the substations will take into consideration industry established methodologies and will incorporate embedded environmental management and risk mitigation measures as standard practice.
- 2.2.9.19 A full CEMP and traffic management plan will be prepared in advance of the commencement of construction for each of the substations. Following completion of construction activities, the land will be reinstated to its previous condition and the only above-ground structures onshore will be the substations southwest of New Deer.
- 2.2.9.20 Precise construction methods will differ according to the varying ground conditions of the substation site. Of particular importance are the underlying soils and strata, the terrain, the existence of physical constraints such as services and other infrastructure.
- 2.2.9.21 Particular care will be taken to ensure that there is no deterioration in the existing land drainage regime as a result of the construction activities or presence of the substations. Prior to construction and during the detailed design phase, the drainage characteristics of the site will be identified and recorded and an appropriate drainage design developed.
- 2.2.9.22 All aspects of the detailed engineering design and construction work will be in accordance with the Construction Design and Management (CDM) Regulations 2007. The CEMPs will also provide details of the construction processes to be adhered to.

2.2.10 Transport to Site

2.2.10.1 It is anticipated that most OfTI elements will be transported to site or the construction port by sea although some elements may be transported via road before transfer to a vessel. For the OnTI, it is likely that the largest pieces of infrastructure (i.e. the transformers for onshore substations) will be transported via vessel before being transported by road. The construction port has not yet been identified, although it is expected to be based on the eastern coast of Scotland or northern England.

2.2.11 Operation and Maintenance

OfTI Operations and Maintenance

2.2.11.1 Operational activities will either be carried out primarily from a shore base or from an offshore location.

2.2.11.2 Maintenance activities will include the following types of activities:

- Major interventions include overhauls of OSP equipment which may be required periodically in the 50 year life of the modified OfTI. Unplanned failures within OSP equipment or cables may also require major repairs which require the use of equipment and methods originally used to install the relevant infrastructure;
- Preventive maintenance comprising scheduled activities including plant and equipment scheduled maintenance, necessary safety inspections and testing of safety related equipment, inspections of primary and secondary structures, scheduled overhauls;
- Corrective maintenance to address equipment failures, primary alarms, or actions arising from results of inspections; and
- Opportunistic maintenance in cases where maintenance personnel and access vessels are available at site and some precautionary inspections or preventive maintenance can usefully be carried out.

2.2.11.3 The types of vessels that will be used during operation are yet to be decided but further details will be provided within the appropriate EIA chapters.

OnTI Operations and Maintenance

2.2.11.4 For the OnTI, the CEMP will outline best practice measures in developing an overall maintenance plan for the installed onshore export cables. This will involve routine cable testing during a circuit outage. Apart from routine testing, the onshore cable circuits should largely remain maintenance free.

2.2.11.5 The installation of the cables seeks to ensure that these are buried securely for a maintenance free operational life, protected from damage. In the event that damage or a fault occurs, testing will diagnose where the faulting section of the cable is so it can be replaced and reburied.

2.2.11.6 The cables will be marked on services maps which will be provided to other utility companies for their records. The cables will be installed with marker tape and protective tiles to warn of their presence below the ground in case of excavation taking place in close proximity.

Onshore Access to Site

2.2.11.7 Operation of all modified TI assets will continue 24 hours per day; 365 days per year, and therefore the final onshore substations site identified within the proposed development area will require to be accessible at any time. Operational activities will be predominantly onshore activities with automated systems utilised to the fullest extent to ensure minimal operational activities offshore.

2.2.11.8 Scheduled maintenance activities will be confined to planned interventions for limited periods on an annual basis. Both substations will be unmanned.

Lighting and Marking

2.2.11.9 The lighting and marking of the offshore OSPs will be agreed with Marine Scotland in consultation with the Northern Lighthouse Board, the Maritime and Coastguard Agency (MCA), the Civil Aviation Authority (CAA) and the Ministry of Defence (MOD).

2.2.11.10 The positions of the OSPs, subsea cables and ancillary structures will be conveyed to the UK Hydrographic Office (UKHO) so that they can be incorporated into Admiralty Charts and the Notice to Mariners procedures.

Modified TI Control and Supervision

2.2.11.11 Once commissioned, the modified TI assets will operate automatically to the extent practicable. The operation and control of the modified TI assets will be assessed by a Supervisory Control and Data Acquisition (SCADA) system, installed at each OSP, and at an onshore control base. The SCADA system will enable where practicable the remote control of all TI assets, as well as information transfer, storage and the shutdown of any individual asset in emergency circumstances.

Modified TI Inspection and Maintenance

2.2.11.12 The TI assets will be serviced and maintained throughout their life which shall be as a minimum equal to the duration of the lease to MORL from The Crown Estate (i.e. 50 years). Maintenance or replacement of the assets is normally separated in to three categories:

- Periodic overhauls;
- Scheduled maintenance; and
- Unscheduled maintenance.

Periodic Overhauls

2.2.11.13 These will be carried out in accordance with the Original Equipment Manufacturers (OEMs) warranty. They are typically planned for execution in periods of the year with the best conditions, preferably in the summer, they will be scheduled to coincide with planned maintenance outages.

2.2.11.14 They are carried out according to the supplier's specifications and typically include function and safety tests, visual inspections, analysis of oil samples etc.

Scheduled Maintenance

2.2.11.15 This applies primarily to inspections and testing of safety equipment, auxiliary power supplies, major balance of plant equipment and protection systems. A scheduled inspection of offshore substations is likely to occur every 12 months though specific activities may occur less frequently. Additional tasks will typically include inspection on faults and minor fault rectification.

2.2.11.16 The onshore substations will not be permanently staffed. Typically during operation, site visits will be limited to fortnightly routine inspection visits and annual routine operation and maintenance activities. Each visit will generally involve one or two service engineers visiting the site in a light goods vehicle. The frequency and duration of maintenance visits will be dependent on the manufacturer's recommendations related to the equipment installed on site and the final maintenance regime developed by the Offshore Transmission Owner (OFTO) and the regional TO.

Unscheduled Maintenance

- 2.2.11.17 This applies to any sudden defects. The scope of such maintenance would range from small defects to complete failure or breakdown of main components. Such maintenance would require the intervention of construction vessels similar to those involved with the construction of the modified TI.
- 2.2.11.18 Inspections of substructures, foundations, support structures and subsea cables will be performed on a risk assessment basis. As such, an initial base line inspection survey will be performed, thereafter the scope and period of inspections will be determined based on the findings of each previous inspection.

Electromagnetic Fields and Human Health

- 2.2.11.19 The modified OnTI will comprise up to four 220 kV export cable circuits and two onshore substations that generate electromagnetic fields (EMFs). EMFs are part of the natural world and are also produced wherever electricity is generated, transmitted or used. Public exposure to EMFs comes from a range of sources including household wiring and appliances, low-voltage distribution power lines or underground cables and high-voltage transmission power lines or underground cables. A report on EMFs from the modified OnTI is provided in Technical Appendix 2.2 A (Electromagnetic Field Report).
- 2.2.11.20 Strong EMFs are known to have a detectible physiological effect on the body. Very extensive scientific research has been undertaken to investigate whether there is potential for adverse health effects from EMFs exposure. International and national health protection bodies have reviewed this data using a weight of evidence approach and have recommended conservative guidelines for public EMFs exposure, set to protect health. These guidelines have been adopted in the UK and are applied using a Code of Practice for electricity transmission infrastructure (DECC, 2012).
- 2.2.11.21 Electric fields generated by the onshore underground cables will be fully screened by the cable sheath and their burial in the ground. No electric field will be experienced above ground level. The onshore substation building walls or perimeter fence will also offer screening of the electric field and the field strength from them will not be significant relative to the existing nearby 275 kV overhead line.
- 2.2.11.22 The maximum magnetic field that would be generated by the underground export cabling, using worst-case assumptions regarding design parameters, has been calculated in line with the Code of Practice approach. The calculation results show that this maximum magnetic field strength would be 8.6 μT , 2.4 % of the 360 μT guideline public exposure limit set to protect health.
- 2.2.11.23 Due to the distance between substation components and the closest publically-accessible point (the outer wall or perimeter fence), the greatest EMFs exposure in the vicinity of the substations is typically from the overhead lines or underground cables entering and exiting them. The magnetic field strength from the underground export cabling connecting with the onshore substations has been calculated and forms a conservative proxy for magnetic field exposure from the onshore substations. The onshore substations will be designed and operated in accordance with all relevant health and safety legislation and the occupational exposure guidelines for EMF, to protect the health of workers and maintenance staff accessing the modified OnTI.
- 2.2.11.24 In conclusion, EMFs from the modified OnTI will be well below the adopted guideline public exposure limits set to protect health and no measurable adverse health impacts as a result of public exposure to EMFs from the modified OnTI are anticipated. Further information can be found in Technical Appendix 2.2 A: Electromagnetic Field Report.

2.2.12 Decommissioning Plan

- 2.2.12.1 The lease term agreed with The Crown Estate for the three consented wind farms is 50 years. Decommissioning will be a key requirement by the Crown Estate lease agreement and of the Energy Act 2004 and will influence all stages of design of the OfTI, and will be addressed in the updated assessments.
- 2.2.12.2 Under the Energy Act 2004, a wind farm and associated transmission infrastructure must be decommissioned at the end of its lifetime. Guidance is currently available on decommissioning liabilities and standards (DECC, 2011) and a preliminary decommissioning programme was prepared to support the Section 36 consent application (See Technical Appendix 1.3 E of the MORL ES) and involves decommissioning of the OfTI. However, the decommissioning plan will be updated in accordance with relevant legislation and guidance available at the time of decommissioning.
- 2.2.12.3 Decommissioning will most likely include the removal of non buried-elements (e.g. OSPs and onshore substations) and associated substructures. Buried elements such as foundations and cables may be removed or left depending on regulatory and project aims at the time.
- 2.2.12.4 It is possible that one or both of the onshore substations may continue to be used as a substation site after the three consented wind farms have been decommissioned. It is also possible that the substations could be upgraded for use by future developments. Should this be the case, consent will be sought under the relevant planning and environmental legislation at that time.
- 2.2.12.5 Decommissioning of substation equipment and infrastructure is a key consideration that will be incorporated at an early stage into the design of the substation. The case for decommissioning the substation in the event of the three consented wind farms being decommissioned would be discussed with Aberdeenshire Council, the OFTO, the regional TO and the regulator of the NETS in light of any other existing or proposed future use of the substations or development of the grid infrastructure in the area.
- 2.2.12.6 In the event that the onshore substations are decommissioned, the effects of decommissioning would be generally similar to those of construction activities. The most appropriate method of decommissioning and the handling and disposal of materials will be undertaken in agreement with the relevant authorities and in line with environmental best practice and the relevant legislation and guidance prevailing at the time.

2.2.13 Ports and Harbours

- 2.2.13.1 Ports and/or harbours will be required during the construction and operation and maintenance phases of the modified OfTI infrastructure. During the construction phase, deepwater ports with facilities for pre-assembly (site office, laydown areas, warehouses etc) will be required. The ports or harbours used during the operation and maintenance phase are likely to be smaller than that used during construction. MORL is in the process of identifying and agreeing which ports and harbours will be used during the lifetime of the project.

2.2.14 References

DECC (2011). Decommissioning of offshore renewable energy installations under the Energy Act 2004: Guidance notes for industry. January 2011 – revised. Available from https://www.og.decc.gov.uk/EIP/pages/files/orei_guide.pdf.

DECC, "Power Lines: Demonstrating compliance with EMF public exposure guidelines. A voluntary Code of Practice," Department of Energy and Climate Change, 2012.