# 2 Project Details

## 2.1 Assessment of Alternatives

### *2.1.1 Introduction*

2.1.1.1 In 2013 MORL was offered an updated grid connection point in to the existing 275 kV overhead line south of New Deer to replace the previous connection point at Peterhead Power Station. This was driven through the Connections Infrastructure Options Note (CION) process, which determined that consumers would benefit from a more economic and efficient connection if MORL was connected to the grid where it passes New Deer. This was on the basis that this connection involved a shorter length of export cable route (85 km from the southern boundary of the three consented wind farm sites (Telford, Stevenson and MacColl) area to New Deer compared to 135 km to Peterhead). This shorter length means that an AC connection is technically feasible (which was not to Peterhead due to the greater length of the route). AC Transmission Infrastructure (TI) is both less expensive and more readily available (with the lead in timescales for DC equipment being two years longer than AC) meaning that the interface with the national grid at New Deer was judged to be both more economic and efficient. Thus MORL's connection agreement at Peterhead has been replaced with one at New Deer (see Figure 1.1-3, Volume 3). The amended grid connection was initially for up to 1,500 MW to the existing overhead transmission line running to the south of New Deer, owned and operated by SHE-Transmission PLC (SHE-T). MORL received a revised offer on the basis of a modification application in June 2014 altering the grid connection to 1,000 MW. This capacity has been assessed through a technical investigation driven by MORL and supported by SHE-T as the maximum MW which can be connected using AC TI at the present time. The change in grid connection requires alternative offshore and onshore works proposals to be developed.

2.1.1.2 MORL commissioned an Export Cable Feasibility Study (Metoc-Hyder, 2011) (see Technical Appendix 2.1 A of the MORL ES). This study was primarily desk-based (with site visits to the identified landfall points) which sought to identify options and assess feasibility for 2 km route corridors for export cable (onshore and offshore) and landfall points along the northern Aberdeenshire and Moray coastlines taking into account the likely environmental issues and engineering and health and safety constraints. The onshore export cable route also incorporated the Holford Rules (guidelines on overhead line routeing) for overhead lines, with adaptations for underground lines. The study identified 13 offshore cable routes, 11 potential landfall points, and three primary onshore route corridors which diverged to connect with eight of the potential landfall points (the onshore corridor width for the study was 2 km, which meant all 11 landfall points were covered in the onshore corridor study) (see Figure 2.1-1, Volume 3).

2.1.1.3 Based on environmental, technical and economic criteria, the initial 13 offshore routes identified were narrowed down to eight landfall points (Portgordon, Sandend, Inverboyndie, Fraserburgh Beach, Fraserburgh Golf Car Park, Philorth, Inverallochy and Rattray). These eight landfall points and associated onshore and offshore routes were then taken forward into a stage 1 concept engineering study by JP Kenny (JP Kenny, 2011; Appendix 2.1 B, Volume 8 of the MORL ES). As part of the preparation of the JP Kenny report, there was consultation on the routes identified by Metoc-Hyder with local fisheries groups and the Scottish Fishermen's Federation (SFF).

2.1.1.4 The abovementioned studies assumed an onshore grid connection point at Peterhead. Following the determination in 2013 from the CION process to alter the connection point to New Deer, MORL commissioned a consultant engineer, PCS to undertake an assessment of potential grid connection points in the New Deer area

(PCS, 2013) (see Technical Appendix 2.1 A (Technical Grid Connection Study) of this ES). This study identified seven general substation locations in close vicinity to the existing overhead line that were suitable for MORL's requirements. MORL then commissioned a feasibility study to assess these locations, and the proposed cable routes, from an environmental and planning perspective (RPS, 2013) (see Technical Appendix 2.1 B (Environmental and Planning Study) of this ES).

### *2.1.2 Offshore Export Cable Route Selection*

Criteria based on SHE-T guidelines, United Kingdom Cable Protection Committee (UKCPC) recommendations and other best practice were used to define potential marine export cable routes (see tables 2.1-1 and 2.1-2 below). These criteria were used in the concept engineering study (Metoc-Hyder, 2011), to identify onshore and offshore cable route options and landfall points.

**Table 2.1-1 Concept Engineering Weighted Risk Matrix**

| Key Driver | Classification of Contribution | | |
|---|---|---|---|
| | -3 | 0 | +3 |
| **Safety Relative to ALARP** | Elements of increased personnel risk and complex technical safety would be difficult to achieve ALARP. | Tolerable level of personnel and technical risk requires some mitigation to achieve ALARP. | Especially safe in operation, personnel exposure. |
| **Consenting** | Risk of a severe / significant effect - potential show stopper. | Risk of moderate / minor effect which could result in acceptable permit conditions. | Opportunity for environmental enhancement. |
| **Cost** | Significant risk of exceeding target costs requiring significant project management resource. | Tolerable risk of effect on target costs requiring some project management resource. | Potential opportunity to reduce costs. |
| **Execution Schedule** | Significant effect on First Generation date. | Ability to meet First Generation date. | Accelerate First Generation date. |
| **Wind Farm Performance** | Risk of serious adverse effect on performance, availability and energy losses. | Potential minor effect on performance, availability and energy losses. | Negligible effect on performance, availability and energy losses. |
| **Technical Risk** | Unproven technology with very little track record. | Technology with only / short track record. | Proven technology with track record. |

**Table 2.1-2 Criteria Used to Define the Potential Marine Export Cable Routes**

| Criteria | Factors to be Considered |
|---|---|
| **Cable Route Length** | Minimising cable length should minimise environmental impacts, cable manufacturing and installation costs. The carbon footprint associated with cable manufacture and installation is also directly dependent on the cable route length. The optimal route will ultimately be the shortest feasible route which takes into account the environmental and technical constraints listed below. |
| **Minimise Complexity of Installation Works Through Choosing Optimum Water Depths**<br><br>**Minimise Length of the Intertidal Area**<br><br>**Maximise Extent of Cable Route in Water Depths Between 10-200 m** | Landing a cable through intertidal areas is typically the most challenging aspect of a cable installation as it represents the inter-face between land and vessel based operations. Both land and marine operations need to be coordinated and the handling of the cable, from the vessel on which it is being held to shore, managed. The tidal regime of the area may also severely constrain the time available for installation operations.<br><br>A water depth of 10 m is used as an average cut-off for a typical large cable handling vessel. If a route contains sections in shallow water then the larger main installation spread may be unable to operate, requiring an additional cable handling vessel. Sections of cable may also need to be cut and rejoined.<br><br>Cables need to be designed to resist installation forces, including tensile strains produced during installation and any subsequent recovery for repair. For power cables, the tensile strength is distributed through the cable structure with much of it being provided by the external ‘armour’ wires. In water depths of 200 m or less only one layer of armour wires will generally be needed. In water depths greater than 200 m, it is possible that two layers of armour wires may be needed increasing the capital cost of the cable. Waters deeper than 200 m are, therefore, avoided where possible. |
| **Maximise Potential for Cable Burial** | In order to ensure optimal burial depths can be achieved and maintained for as much of the route as possible, known areas of exposed bedrock, or bedrock with thin covering of sediment, should be avoided during cable routeing. Should bedrock be present the choice of routeing must be justifiable through other factors.<br><br>Similarly possible areas of glacial till or boulder clay, which could make installation more challenging, should be avoided. |
| **Minimise Potential for Cable Re-Exposure During Operation** | Avoid areas of high sediment mobility, such as mobile estuaries, mobile sandbanks and sandwaves, which could result in subsequent exposure and / or spanning of the cable. In certain cases deeper burial beneath the mobile layer can be achieved by dredging through sandwaves or using specialist tools such as the “vertical injector”. Deeper burial increases insulation of the cable and can reduce efficiency of electricity transmission due to thermal heating effects, depending on seabed characteristics and cable capacity. Some cables can be “over-engineered” to resolve this issue, although this may not be possible depending on the cable capacity.<br><br>Furthermore, whilst routine maintenance work can be undertaken to re-bury exposed cables, cables in highly mobile environments are at risk of damage and or failure which is not an ideal long term scenario, both in terms of cable protection and the environmental impacts associated with ongoing maintenance works. In protected and / or sensitive seabed areas environmental and consenting issues could complicate the feasibility of regular maintenance works, causing delays or restrictions to maintenance work. |

| Criteria | Factors to be Considered |
|---|---|
| **Avoidance of Sensitive Environmental Areas. Where It Has Not Been Possible to Avoid Conservation Areas, Route Length Within These Areas to be Minimised** | Avoid existing Natura 2000 sites (SACs and SPAs), national protected sites (SSSIs, Marine nature reserves), possible future SACs and SPAs (Annex I habitat, areas of search for offshore SACs). Where routes within protected sites are unavoidable, the interest features of the site should be considered to determine whether the cable can be installed and operated without causing significant environmental effects.<br>The following general principles can be followed in discussion with the relevant conservation bodies:<br>• Seasonal sensitivities: For example if a site is designated for wintering birds, the Project's installation programme can be scheduled to avoid impacts during the sensitive period. With such mitigation measures implemented routeing within the area may be acceptable. If the site is designated for both wintering and breeding birds the seasonal restrictions that are likely to be applied to the Project may be too onerous for the installation to be feasible.<br>• Mobile species: From the point of view of cable installation and operation, the key impact on mobile species (seabirds at sea, fish, mammals) is disturbance during installation activities, which is generally a minor impact that can be managed. However, if the species is breeding, impacts can be more significant.<br>• Benthic species: For benthic species or habitats, significant impacts may be harder to avoid and therefore the cable should be routed away from sites designated for such features if possible. This is particularly true for habitats which do not recover well from disturbance, such as rocky or biogenic reef (mussel beds, *Sabellaria* etc), piddocks in clay, or saltmarshes. Lower significance impacts are likely for mobile sands and muds supporting invertebrates, which do have higher recovery rates, and therefore routeing in such areas may be more feasible.<br>• Spawning and nursery areas: Areas where fish spawn on the seabed (such as herring) should be avoided if possible. Pelagic (in the water column) spawning areas are widespread and cable routing can be undertaken in these areas without significant environmental effects.<br>• EMF and Heating: Possible issues associated with EMF and heating impacts on sensitive species should also be considered. The significance of this potential impact cannot be determined at this stage, but EMF impacts are likely to be more of a concern in rivers / estuaries where salmon and trout migrate. |
| **Avoidance of Areas Where There Is an Increased Risk of Damage to the Installed Cable** | The following areas should be avoided due to the increased risk of damage to the buried cable:<br>• Known dredging areas should be avoided by a minimum of 500 m where possible; and<br>• Known anchorage areas should be avoided by a minimum of 500 m where possible.<br>Areas containing high levels of munitions contamination should be avoided by cable routeing. Munitions are known to migrate along the seabed depending on hydrodynamic conditions and sediment transport pathways operating in the area of concern. Therefore the presence of munitions on the seabed, outside of such areas, cannot be discounted and a survey should be targeted towards establishing the presence and location of munitions on the seabed where the cable passes in the vicinity of disused munitions disposal sites. |
| **Minimise Crossings With Cables and Pipelines** | The number of crossings with existing and proposed cables and pipelines should be minimised. Undertaking crossings with existing cables necessitates placement of rock berms or mattresses to ensure the cable is protected at the crossing, where burial is not possible.<br>Installation of a crossing increases the environmental impacts of the Project. It results in a permanent structure on the seabed, which will smother the marine life beneath it, and introduces a different type of sediment which may locally alter the marine ecosystem. The rock berms on the seabed can also represent an obstruction to fishermen, who may risk snagging their gear.<br>Crossings are also financially costly, and may involve lengthy legal discussions with the cable or pipeline owner. A Crossing Agreement (CA) is a voluntary agreement with the crossed party, although it is generally required under the Crown Estate lease, and proceeding with crossings without having obtained the necessary agreements is not recommended.<br>If any pipelines or cables are to be crossed that the crossing angle should be as close to 90º as possible. Any cables and pipelines not crossed should be avoided by a 500 m exclusion zone.<br>Cable routing parallel with existing cables and pipelines should be avoided if possible. Cables and pipelines will have a seabed lease which gives a 250 m no-works zone and a further 250 m notification zone either side of the cable. This is necessary to allow access for repairs, and also should a repair be undertaken, the cable will be re-laid on the seabed in a loop, potentially increasing its proximity to the other cables than previously. Specific measures for individual pipelines and cables will need to be confirmed with the owner / operator. |

| Criteria | Factors to be Considered |
|---|---|
| **Avoid Existing and Proposed Seabed Developments.** | Areas which are currently licensed for other uses or involve physical infrastructure on the seabed need to be avoided. This includes:<br>• *Licensed dredging areas:* The licence holder has exclusive rights to the seabed in the licence area.<br>• *Oil and gas infrastructure*: Operational wells platforms operate a 500 m exclusion zone which should be avoided by cable routing. Cable routing is not excluded through oil and gas fields, or licence blocks, as oil and gas developers do not have exclusive seabed rights to the entire block. Plugged and abandoned wells should be avoided as they represent seabed structures over which the cable cannot be buried, but the 500 m exclusion zone is not required.<br>• *Existing and proposed sites for offshore renewables* (e.g. wind farms, or wave or tidal arrays) should be avoided by a 500 m exclusion zone. Cable routing through the R3 development zones should be avoided if possible, due to the current uncertainty as to where specific wind arrays will be placed and the possible need for additional crossings. However, the Crown Estate has confirmed that the offshore wind developers do not have exclusive rights to the seabed in the R3 zones and cable routing through the zones is permitted. The cable route should seek to develop a route which minimises interactions with the future development of the zone, such as routing adjacent to an existing cable, or through the area of highest shipping activity within the zone. Whilst shipping activity precludes turbine placement, installation of a cable in this area is likely to be acceptable as the buried cables are not an obstruction to shipping. Routing adjacent to an existing cable is converse to the point above regarding avoidance of running adjacent to existing cables, however it may be an acceptable compromise for routing through R3 zones. |
| **Minimise Interference With Shipping and Navigation** | Cable installation in certain areas may be unacceptable to the relevant port authorities due to conflicts with their normal operations. This should be determined through discussion with the relevant port authorities. However, should cable installation works restrict key approach channels to major ports, even for a short period of time, this may be considered unacceptable. Port authorities issue licences to undertake marine works in their area of jurisdiction and they can reasonably refuse.<br>Cable installation may also not be permitted across areas where regular channel maintenance dredging is undertaken by a port authority. This would also be undesirable from the perspective of maintaining cable burial depths and should also be avoided for this reason. |
| **Marine Archaeology** | The cable route centre-line should avoid wrecks by a 100 m exclusion zone. Positions of known wrecks, and previously unrecorded wrecks will need to be confirmed during cable route survey, and micro routing may be required as a result. Certain wrecks are given additional protection under the Protection of Wrecks Act or the Protection of Military Remains Act, and such wrecks may have a specific exclusion zone designated around them, which would need to be avoided for any seabed disturbing works being undertaken as part of the cable installation. |
| **Military Practice Areas** | The existence of military practice and exercise areas does not generally preclude the installation or operation of marine cables. However, consultation with the MOD has been undertaken to confirm this, where relevant. |

2.1.2.1 Phase 1 of the Metoc-Hyder concept engineering study utilised GIS data and constraint mapping was generated to conduct a detailed desktop route selection process. From this study it was concluded that four landfall points be taken forward to the next stage of Concept Engineering (JP Kenny, 2011) - Sandend, Inverboyndie, Fraserburgh Beach and Rattray North and South.

2.1.2.2 Concept engineering stage 2 looked at the remaining four routes developing indicative cost estimates and comparing each option against relative complexity, risk and cost. Following confirmation of the grid connection point at New Deer, the two preferred landfall points were selected, as noted below. These were selected following the results from the Metoc-Hyder, JP Kenny, PCS and RPS reports and using the criteria described above:

- Inverboyndie; and
- Sandend.

2.1.2.3 The sites further to the east of these landfall points were discounted for constructability issues, primarily in relation to the offshore export cable route, which would have been required to extend around to the east of the Southern Trench, a deep area of the Moray Firth and would therefore be in excess of 100 km.

2.1.2.4 Inverboyndie and Sandend are considered the preferred options with minimal impact on the environment and the shortest overall cable route.

2.1.2.5 EIA studies commenced along onshore routes for both the Inverboyndie and Sandend landfall points. Balfour Beatty were also commissioned to provide technical advice on the onshore cable routes and substation locations. Following the EIA studies, landowner negotiations, technical advice and offshore geophysical and geotechnical studies, Inverboyndie was selected as the optimum landfall point. As well as offering the shortest possible export cable route both offshore and onshore, the geophysical and geotechnical surveys undertaken in 2014 suggest that this landfall point is adequate from a technical standpoint and offers sufficient space at Inverboyndie Beach for the cables to come ashore. The benefit of the shorter export cable route means that the footprint of the TI is smaller and therefore minimises potential likely environmental effects.

### *2.1.3 Onshore Export Cable Route Selection*

2.1.3.1 The key considerations that were followed where possible to identify potential onshore underground export cable routes include:

- Consider avoiding areas of environmental designation in which underground cable construction, operation or decommissioning might affect the purpose of designation;
- Consider the ground and slope conditions along the route into which the cable system must be installed. Consider whether the ground is stable and whether it can reasonably be expected to remain stable and suitable for the service life of the cable system. Consider if the ground is suitable for use in reinstatement to avoid the need for imported backfill;
- Consider the practicality of moving any obstructions which would constrain the cable route;
- Consider whether the cable route will have an adverse effect on the local and surrounding environment. Consider whether this effect can be mitigated by route selection;
- Consider whether the cable route can be viewed from above, and if so, what length will be seen, at what distance, over what type of ground cover, with what probability of successful long term reinstatement;
- Consider whether the cable route is one within which it is safe to construct a cable system. Consider, if constructed, will the cable system provide the required service life? Will the system be economic and maintainable? Will the installation be safe and have an acceptable level of reliability when in operation for owners, operators and third parties?;
- Consider the disruption the construction, operation and decommissioning of a cable route would cause to third parties, is it possible to mitigate and is it possible to do this by route selection?;
- Consider avoiding wet areas and habitats that are sensitive to the construction, operation and decommissioning of underground cables, particularly habitats that are difficult to reinstate successfully;
- Consider avoiding areas known to be occupied by protected species and / or their habitats;

- Consider following existing linear features particularly those that have already created habitat disturbance such as existing overhead lines or habitat and hydrological disturbance such as roads or railways;
- Consider access for construction and operation. Consider use of existing roads and tracks and consider the existing road network in terms of the effects of road closure and disruption. Consider the use of existing crossings / structures at roads and railways. For river crossings consider height and steepness of banks, substrate and width of river and use of existing structures;
- Detailed Routing Considerations;
    - Preferable to avoid areas of flooding for joint bays;
    - Preferable to avoid steep side slopes (cross slopes) and gradients;
    - Preferable to follow existing linear features particularly those that have already created disturbance, such as roads or existing overhead line wayleaves;
    - Preferable to make as much use of existing access as possible but preferable to avoid reliance on rural roads that would require alteration;
    - Preferable to avoid loss of landscape features such as individual trees, hedges, semi-natural and other woodlands and commercial forestry, preferable to utilise existing gaps;
    - Preferable to cross water courses and other infra-structure at the most accessible points;
    - Preferable to avoid known archaeology;
    - Preferable to avoid water supplies;
    - Preferable to avoid areas where excavation or ground levels may change in the future;
    - Preferable to avoid areas with unstable, contaminated or high thermal resistivity ground; and
    - Preferable to avoid settlements, particularly those with a concentrated pattern of development.
- Deviation Considerations:
    - Avoid if possible unknown archaeology when it is identified;
    - Avoid if possible the root zones of semi-mature and mature trees;
    - Avoid if possible cable route obstructions such as large boulders;
    - Avoid if possible ground with high thermal resistivity;
    - Avoid if possible unsafe, unstable or contaminated ground;
    - Avoid if possible protected species and / or their habitats particularly during the breeding season;
    - Avoid if possible close proximity to existing overhead lines, cables and other system equipment which may require system outages; and
    - Avoid if possible close proximity to other utilities and services.

## 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 |
| | Scour protection around each leg plus suction caisson diameter | 40 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 m² |
| | 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.

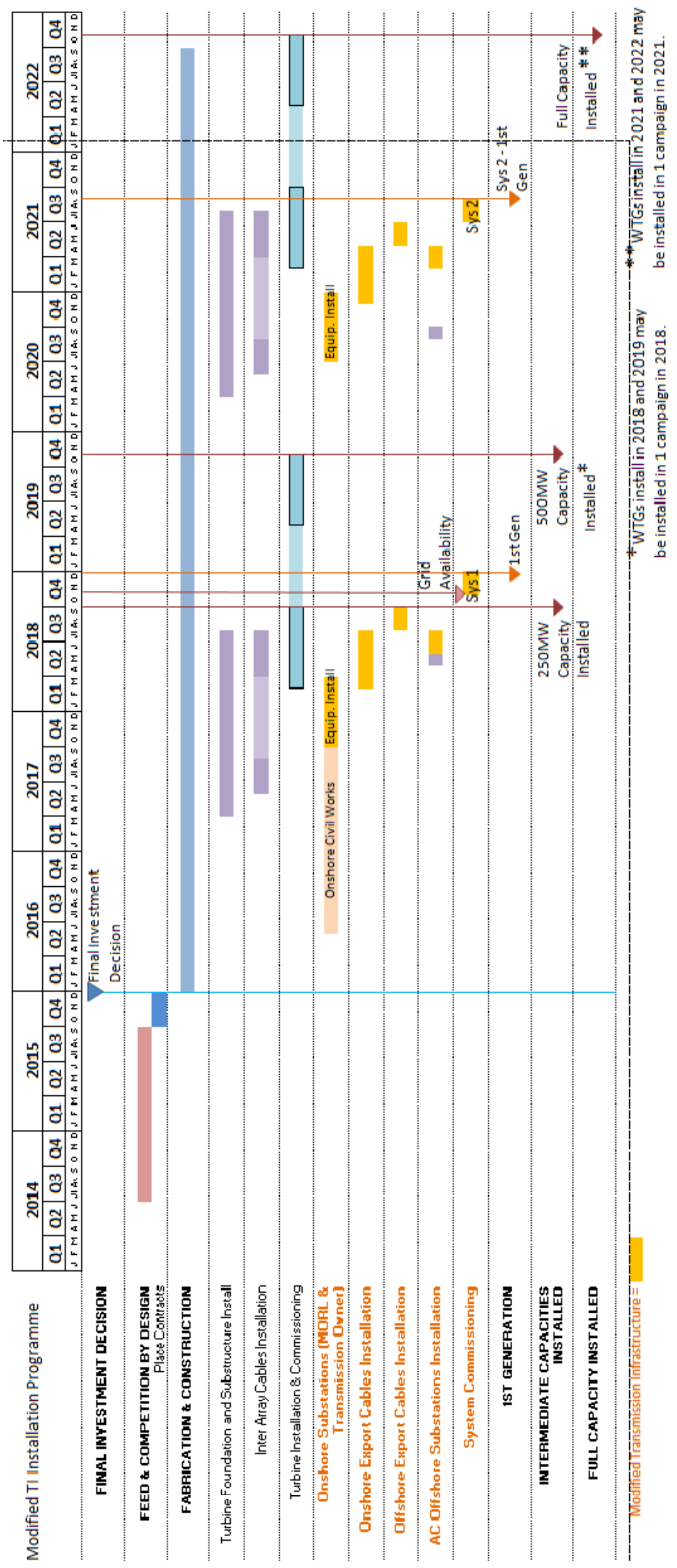


**Plate 2.2-1 Indicative Installation Programme (includes indicative modified Project timescales for reference)**

### *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 modifed 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 though 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 $m^2$) 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.

2.1.3.2 The onshore route from Inverboyndie identified during the Export Cable Feasibility Study (Metoc-Hyder, 2011) and modified to connect to the proposed substation locations near New Deer were also deemed to satisfy all routing constraints and to meet engineering and health and safety operational and construction requirements during the concept engineering study (JP Kenny, 2011). The Technical Grid Connection Study (PCS, 2013) and Environmental and Planning Study (RPS, 2013) and early EIA studies (particularly LVIA, ecology and archaeology) further informed route selection (where possible). In addition to the abovementioned technical and environmental considerations, selection of the final onshore export cable route corridor (see Figure 1.1-5, Volume 3) was influenced by discussions with landowners along the route.

### *2.1.4 Onshore Substation Site Selection*

2.1.4.1 MORL will require one AC substation, covering an area of up to 270 x 135 m at the connection point to the south of New Deer (Figure 1.1-5). This substation will ultimately be transferred to the ownership of an OFTO entity along with the offshore substations, and the offshore and onshore export cables. In order to allow the connection of the modified Project to the national grid, an additional substation must also be installed which will ultimately be owned by the regional TO and will feed into the existing 275 kV overhead line. This additional substation will be up to 270 x 170 m. Both substations will be a maximum of 13 m in height. The onshore substation site identified by MORL allows for the co-location of the MORL substation and the additional substation within a compound, which together will occupy an area no more than 10 hectares in size (the substation compound). The substation compound will be located adjacent to the existing 275 kV overhead line.

2.1.4.2 The site for the substations was selected following technical and environmental studies (PCS, 2013; RPS, 2013), advice (technical advice from Balfour Beatty, LVIA advice from OPEN and general environmental advice from EIA consultants) and landowner discussions. At an early stage, following environmental and technical assessments, MORL took the decision to embed mitigation into the design of the substation by electing to install Gas Insulated Switchgear (GIS) as opposed to Air Insulated Switchgear (AIS) at the substations. As well as reducing the footprint significantly (approximately 25%), GIS has more equipment housed within a building than AIS therefore having a reduced visual impact. AIS is a more commonly used type of substation, and can be seen nearby at locations such as Kintore and has recently been consented at Rothienorman. GIS, on the other hand, has a smaller footprint, is more contained and allows for greater levels of visual and noise screening. The substation area will be used to provide landscaping to further screen the substations.

2.1.4.3 Of the shortlisted substation locations, the proposed substation area (Figure 1.1-6, Volume 3) was selected for the following reasons:

- Distance from residential properties;
- Proximity to existing overhead 275 kV line;
- Existing screening;
- Space for additional screening works;
- Ground, slope and gradient conditions;
- Accessibility;
- Technical principles associated with the Holford Rules for Substation Locations;
- Landowner discussions.