Statoil

Decommissioning Programme

Sheringham Shoal

by Scira Offshore Energy

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1 Introduction

The Sheringham Shoal Offshore Wind Farm (SSOWF) comprises of 88 wind turbine generators (WTG) with a total capacity of 316,8MW. The wind farm is located approximately 17km to 23km offshore from the coastal town of Sheringham on the north Norfolk coast, and 5km north of the sand bank known as Sheringham Shoal. The SSOWF project covers 35km2. The associated landfall for the onshore works is located in Weybourne Hope, on the north Norfolk coast.

The owners of Scira Offshore Energy Limited (Scira), are the two Norwegian energy companies Statoil (50%) and Statkraft (50%). To follow-up the installation of the wind farm, Statoil has established an internal project organisation called "Sheringham Shoal Offshore Wind Farm Project".

The Environmental Statements (ES) for the offshore and onshore elements of the development were approved in August 2008 through the respective consents according to the Energy Act 2004 (Section 36), The Coast Protection Act 1949, the Food and Environmental Protection Act 1985, as well as the Town and Country Planning Act 1990. Elements related to decommissioning were briefly discussed in the Environmental Statements. Upon issue of the Section 36 consent for the SSOWF, a notice under Section 105(2) of the Energy Act 2004 was also issued, regarding the requirement to prepare and seek approval for a decommissioning programme for the project prior to commencement of construction.

This Decommissioning Programme is prepared as a response to Scira's consent condition relating to the preparation and submission of a Decommissioning Programme prior to the start of offshore installation work and to the corresponding Notice from DECC dated 7th of August 2008. The decommissioning program was submitted July 2009 to the consultees listed by DECC and was also made public available at our webpage.

This Decommissioning Programme has been produced in accordance with the Department of Trade and Industry (DTI) (now the Department for Energy and Climate Change (DECC)) guidance document "Decommissioning of Offshore Renewable Energy Installations under the Energy Act 2004 – Guidance Notes for Industry".

Installation of offshore foundations started mid June 2010, while the scour protection (rock installation) at the foundations started early March 2010.

1.1 The 2013 revision

Autumn 2012 Statoil received a request from Scira to refine the decommissioning cost estimate and methodology for the decommissioning of SSOWF according to experience from the installation. The subsequent work resulted in an increase in the cost as shown in Table 1-1 and the report was delivered to Scira in November 2012.

The increase in cost was primarily attributed to the cost estimate including the entire scope of preparation and conclusion and a more realistic decommissioning duration as a result of experience from the installation of SSOWF.

The updated decommissioning programme was requested by Scira in October 2013 to be submitted to DECC with the updated cost and method prepared by Statoil in autumn 2012. The update is limited to:

- Chapter 1.1
- Chapter 3
- Chapter 4
- Appendix 4
- Appendix 5

Because the update of this document is limited to the above some references to the installation of SSOWF are made in future tense. All updated refer to the installation in past tense.

Table 1-1 - Cost estimate in decommissioning programme updated in 2013 vs 2008

	Scira Decommissioning Cost Estimate	**2013 Estimate**	**2008 Estimate**	
NO	**DESCRIPTION**	**TOTAL in kNOK**	**TOTAL in kNOK**	**Comments**
1	Marine operations for decommissioning	880 527	0	
1.1	*Campaign 1 - Preparation for disassembly*	*94 551*	*0*	*Not included in the estimate before*
1.2	*Campaign 2 - WTG and foundation removal*	*728 396*	*275 984*	*Much smaller vessel was assumed previously with a dayrate (indexed 2008-2013) of 1 330 kNOK. Duration of operation was assumed to be 168 days for 90 monopiles and TPs', and 88 WTGs using 1 vessel. New estimate assumes 308 operation days with 2 vessels.*
1.3	*Campaign 3 - Rock dumping and inspection*	*57 580*	*0*	*Not included in the estimate before*
2	Port, transport and logistics	44 026	0	Not included in the estimate before
3	Engineering	88 053	0	Not included in the estimate before
4	Project management	61 637	0	Not included in the estimate before
5	Waste disposal	3 872	-191 058	Previous estimate does not include cost for reciveing and recycling of the structures at the scrap yard, only income after selling scrap (indexed 2008-2013). New estimate includes payments to a scrap yard and income after selling ther scrap.
6	Insurance	10 742	0	Not included in the estimate before
	SUM, base estimate	**1 088 858**	**84 926**	
7	Contingency	326 657	0	Not included in the estimate before
	SUM, expected cost	**1 415 515**	**84 926**	

2 Executive summary

The Sheringham Shoal Offshore Wind Farm (SSOWF) commenced operation and production of electricity in the second half of 2011. The SSOWF consists of 88 wind turbine generators (WTG), two offshore electrical substations, marine infield cables and marine export cables. The Crown Estate has given a lease of 50 years. The wind farm has a design life of 20 years, at the end of which the condition of the installation is evaluated with respect to the possibility for further production lifetime.

The Energy Act 2004 requires that Scira prepares and eventually carries out at the appropriate time a decommissioning programme for the Sheringham Shoal Offshore Wind Farm.

The Environmental Statement and Appropriate Assessment presented during the consenting process provide the current baseline of conditions in the physical, biological and human environment. The full Environmental Statement and Non-Technical Summary can both be found at the website www.statoil.com/en/TechnologyInnovation/NewEnergy/RenewablePowerProduction/Offshore

The scope of the decommissioning works described in this document is determined by the legislation in place at the time of writing and involves all accessible installed components of the wind farm. This includes all components of the WTGs (i.e. blades, nacelles, towers, transitions pieces and associated components), the WTG foundations and the inter-array cables. Cable sections planned to be removed, will be those from the J/I tubes on the WTG structures to the grade-in point of cable burial. The Table 2.1 below summarises the decommissioning proposals for the separate components of the SSOWF.

Table 2.1 Decommissioning proposal

Component	Decommissioning Proposal
Wind Turbine/generating equipment	Complete removal from site
Wind Turbine foundations	Cut off at or below seabed and removed
Inter-array Cables	Left in situ

Health, Safety and Environment (HSE) performance management will be central to the decommissioning process. HSE risks will be identified and mitigated during the whole process, embedded in the contract philosophy and carried out through evaluation of decommissioning contractors and the planning and execution of the work. Specific evaluation criteria for evaluation of future decommissioning contractors will be established in due course.
As per the DTI guidance notes (2006) the proposed method of removal for the separate components will have regard to:

- The Best Practicable Environmental Option, the option which provides the most benefit or least damage to the environment as a whole, at an acceptable cost, in both the long and short term;
- Safety of surface and subsurface navigation;
- Other uses of the sea; and
- Health and safety conditions

Decommissioned material, such as metal, will be recycled wherever possible. Hydraulic oil will be returned to the supplier for reuse. Unused and/or remaining chemicals will be returned to the supplier for reuse or satisfactory treatment. The need for emptying fluid systems prior to decommissioning will be assessed and planned prior to decommissioning. Equipment such as motors, cranes, transformers etc, may be returned to the supplier for possible re-use and/or recycling.

It will be both appropriate and necessary to review the decommissioning programme throughout the lifetime of the wind farm as legislation, regulatory requirements and current approaches change overtime. Such reviews will also need to reflect advances in knowledge and understanding of the marine environment, changes in working practices and technological advances.

Consultation throughout the decommissioning process will be similar to that undertaken during the Environmental Impact Assessment (EIA) process but will also incorporate changes and amendments made overtime to the requirements within the regulatory consultation process.

Costs and financial security provisions have also been provided within this document as per requirements set out in the DTI guidance notes (2006). These are provided within Appendix 4 and 5.

The following key documents have informed the provisions presented:

- Decommissioning of Offshore Renewable Energy Installations under the Energy Act 2004: Guidance notes for Industry, DTI, December 2006
- Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone, International Maritime Organisation (IMO), 19th October 1989
- Guidance Notes for Industry: Decommissioning of Offshore Installations and Pipelines under the Petroleum Act 1998, DTI, http://www.og.dti.gov.uk/regulation/guidance/decommission.htm
- Review of the Current State of Knowledge on the Environmental Impacts of the Location, Operation and Removal/Disposal of Offshore Wind-Farms, OSPAR, 2006, ISBN 978-1-905859-15-3, www.ospar.org
- Guidelines for Environmental Risk Assessment and Management, Defra, September 2002, http://www.defra.gov.uk/environment/risk/eramguide/08.htm

3 Background Information

3.1 Organisation

The owners of Scira Offshore Energy Limited (Scira), are the two Norwegian energy companies Statoil (50%) and Statkraft (50%). The windfarm is operated by Scira Offshore Energy Limited.

The electrical transmission system is a part of the new OFTO-system. The appointed OFTO for the Sheringham Shoal project will be responsible for decommissioning of the transmission system. Scira will be responsible for decommissioning of those parts of the Wind Farms that are not part of the transmission system.

3.2 Project status

The SSOWF is currently in operation and is operated by Scira Offshore Energy Limited.

3.3 Project overview

SSOWF covers 35km^2 and is sited approximately 17km to 23km offshore from the coastal town of Sheringham on the north Norfolk coast, and approximately 5km north of the sand bank known as Sheringham Shoal. The depth is 15 – 22 m. The associated landfall for the onshore works is located in Weybourne Hope, on the north Norfolk coast. The electrical connection is located at an existing electricity substation at Salle near Cawston, which is owned by EDF Energy (EDFE). The location of the wind farm site and the export cable route corridor is as shown in **Figure 3.1** and **Table 3.1**.

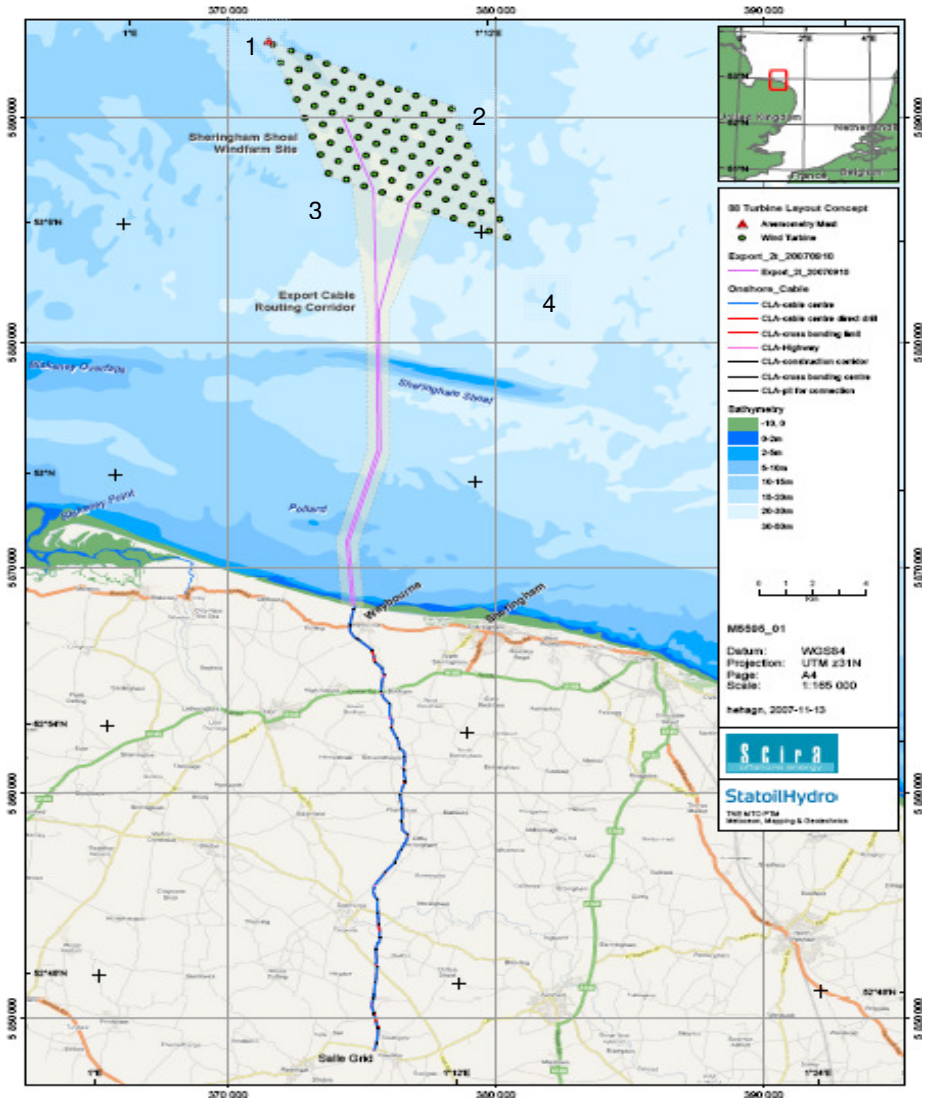

Figure 3.1 Sheringham Shoal Offshore Wind Farm site lay-out (A4 version of this figure in Appendix 1).

Table 3.1 Co-ordinates of Sheringham Shoal Offshore Wind Farm Site

Point	Latitude (N) degrees	Minutes	Longitude (E) degrees	Minutes
1	53	10.4788	01	4.6665
2	53	8.9810	01	10.9461
3	53	5.7867	01	13.0286
4	53	7.2916	01	6.7490

The wind farm consists of 88 wind turbine generators (WTG) 3.6MW each. The WTGs are connected via a network of inter-array cables to two offshore substations. Six strings, connecting 7-8 WTGs in series, are connected to each substation. The

infield cables have two different sizes, 36 kV 3x400 m2 and 36 kV 3x185 m2, where the largest cables are closest to the substations. One fibre optic element is included with each cable. Each offshore substation is connected to the onshore substation in Salle via a submarine export cable, coming onshore near Weybourne, with underground cables from Weybourne to Salle. The main section of the submarine export cable is a 145 kV 3x1x630 mm2 cable and the landfall section is a 145 kV 3x1x1000 mm2. Both sections include one fibre optic element. Cable burial depth is 1m. At the Salle substation the underground export cables connect the wind farm to the regional distribution network, and further via overhead power lines connected to the UK transmission network at Norwich.

The wind turbines themselves are constructed of steel monopiles with a diameter of 6m which are driven into the seabed by means of a hydraulic hammer on a jack-up barge. The scour protection has been made up of rock, gravel or frond mats.

3.4 Other human activities in the area

The area adjacent to the SSOWF site has a range of on-going activities and uses which may change over the lifetime of the wind farm. At present and in the near future they may include:

- Other wind farm operators;
- Oil and gas activities;
- Marine aggregate extraction;
- Disposal of dredged material;
- Outfalls and subsea cables;
- Navigation and shipping; and
- Commercial fisheries.

Due to changes in use over time it may be necessary to review these key activities prior to decommissioning taking place. Following confirmation of other activities and uses in the area at the time of decommissioning a programme of consultation and communication with the relevant stakeholders is developed. Predicted possible activities and uses are outlined below.

3.4.1 Other wind farm operators

It is likely that there will be other wind farm operators in the area adjacent to SSOWF over the project lifetime. Currently Scira is aware of a number of other existing and potential wind farms in the vicinity of the SSOWF and these are described in **Table 3.2** and their positions relative to the project are shown in **Figure 3.2**.

Table 3.2 Potential wind farms in the vicinity of SSOWF

Site	Developer	Location	Distance from SSOWF	Status	Capacity	Round of award
Docking Shoal	Centrica	40km off Cromer	32km	Submitted	500 MW	Two

	Renewable Energy Ltd.					
Dudgeon	Dudgeon Offshore Wind Ltd.	22km off Sheringham	3km	Submitted	300 MW	Two
Inner Dowsing	Centrica Renewable Energy Ltd.	5km off Ingoldmells	43km	Operational	97MW	One
Lincs	Centrica Renewable Energy Ltd.	8km of Skegness	39km	Approved	250MW	Two
Lynn	Centrica Renewable Energy Ltd.	5km off Skegness	42km	Operational	97MW	One
Race Bank	Centrica Renewable Energy Ltd.	30km off Ingoldmells	28km	Submitted	620 MW	Two
Triton Knoll	RWE Npower Renewables	38km off Mablethorpe	40km	Pre-submission	1200MW	Two

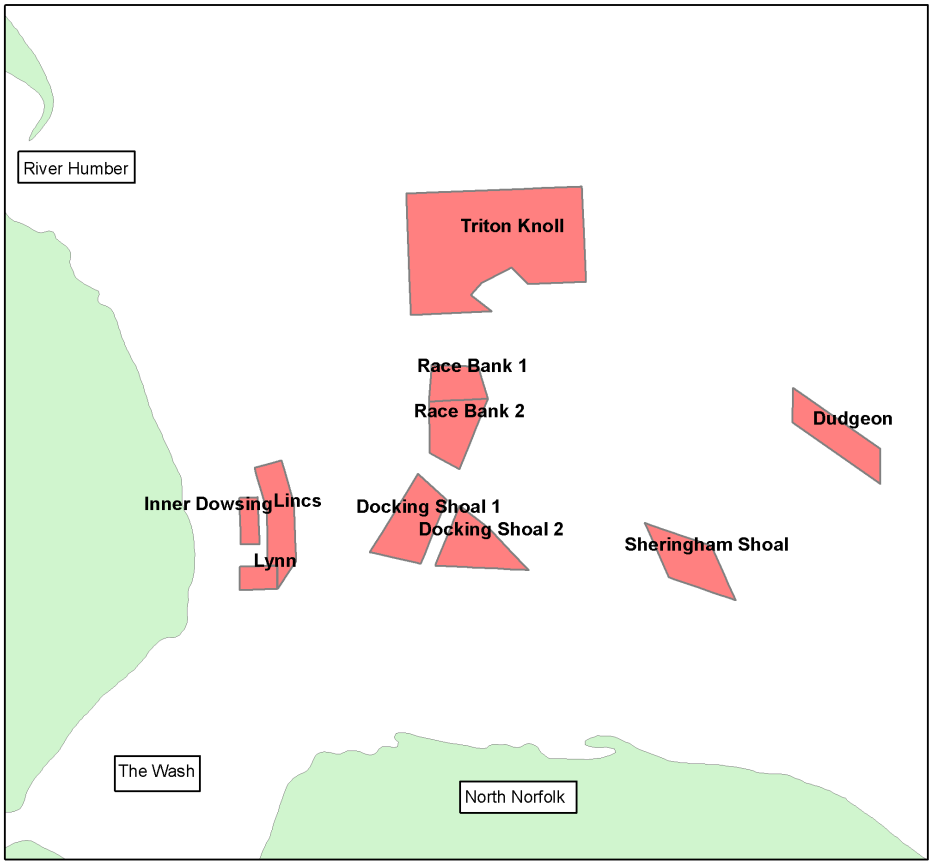

Figure 3.2 Potential and existing wind farms in the vicinity of Sheringham Shoal Offshore wind farm

3.4.2 Oil and gas operations

The southern North Sea is an important area for oil and gas extraction dominated by offshore gas fields. The sector is regulated by the DECC though its licensing process. The SSOWF site falls partially within block 21 and 27 of quadrant 48. Block 21 is currently under licence to Warwick Energy Exploration Ltd. It is unlikely that the area will be subject to future prospecting or drilling due to the limited prospects.

Block 27 of quadrant 48, located to the west of the proposed site, has been awarded to Bridge E&P at the 23rd licensing round, which closed on 9th June 2005. Other activity includes two wells drilled in 2005, due north of Cromer by Century Oil.

There are no oil or gas pipelines traversing the proposed site or cable routes, at present the nearest pipeline is over 15km away to the north and east, terminating respectively at the gas terminals at Theddlethorpe and Bacton.

3.4.3 Aggregate Extraction

Aggregate extraction activities are licensed by The Crown Estate following a positive Government View regulated by DEFRA. There are currently no licensed aggregate extraction areas close to the proposed wind farm site. A number of licensed areas exist to the north-west, the closest being South Inner Dowsing (Area 107) owned by British Dredging Limited (RMC Marine) and Area 440 owned by Westminster Gravels Ltd. Both areas are 25km from the site.

3.4.4 Marine disposal sites

There are no marine disposal sites located within the vicinity of the SSOWF or any areas nearby subject to capital or maintenance dredging activities.

3.4.5 Outfalls and sub-sea cables

There are two discharge consent sites within 250m of the landfall site at Weybourne Hope. These are presently operated by Anglian Water Services Ltd and are identified as Sewage Discharges - Final/Treated effluent.

Telecommunications cables have been laid in the southern North Sea at numerous locations. Concentration of cables run from the East Coast directly across to the Netherlands. The SSOWF lies within an area of low density cabling with no active cables passing directly through the site. A marine communications cable passes just to the east of the landfall site, which comes ashore at the Weybourne car park. This cable is not in service but should be treated as live (Openreach Sub-sea Operations Group).

3.4.6 Navigation and shipping

A survey of merchant vessel activity in the vicinity of the SSOWF identified six main routes. Three of the routes pass to the south of the SSOWF and three to the north-west. The routes were further examined for the Closest Points of Approach (CPA) which showed that the route closest to the SSOWF had the lowest number of vessels per day passing by compared to the other five routes.

The maritime traffic survey established that there were low levels of recreational activity during the period of the survey. To establish whether this was accurate, discussions were held with the Royal Yachting Association and the Cruising Association. These discussions confirmed that the SSOWF is outside the main sailing areas and cruising routes but is partially within a racing area.

The survey of dredging vessel activity observed that the vessels mainly passed to the south of the SSOWF, either side of Sheringham Shoal and in avoidance of other shallows in this area such as the Race Bank.

3.4.7 Commercial fisheries

The maritime traffic survey carried out indicated that there is presently limited fishing in the area mainly by small inshore vessels. More detailed studies of fishing activity levels in the area further indicated that the wind farm site does not encompass primary fishing grounds with the main fishing activity within the wind farm area being predominantly by local North Norfolk based boats with occasional activity from Lowestoft long-liners.

The study concluded that based on the available evidence there is little scope for any substantial increase in the numbers of locally based vessels or in their fishing effort or landings. Similarly there is sufficient stability and long term commitment amongst the local potting fleet to suggest that there is unlikely to be any dramatic decline in vessel numbers or effort levels within the foreseeable future.

3.4.8 Military exercise areas and unexploded ordnance

Currently there are no military practice and exercise areas (PEXA) within the vicinity of the SSOWF. The north Norfolk Coast and the adjacent sea area have, however, been subject to considerable military activity in the past, in particular from activities during World War II. Specific activities in the locality include.

- The local Anti Aircraft Gunnery School at Weybourne;
- The coastal defence battery at Sheringham;
- The coastal defence line along the beach minefields of Sheringham, Weybourne and Cromer;
- Naval actions off Sheringham and Cromer;
- Cargoes dispersed from sunken ships;
- British laid minefields to protect Convoy Routes; and
- German mines laid by aircraft, warships and submarines.

The hazardous items likely to be encountered as a result of these activities include:

- Sea mines;
- Naval gun ammunition, depth charges and torpedoes;
- Air delivered bombs;
- Aircraft machine gun ammunition and rockets;
- Land based defence gun ammunition;
- Land and ship based anti aircraft gun ammunition;
- Munitions on wrecks from attacking aircraft, ships and coastal artillery;
- Munitions in the holds of wrecks; and
- Munitions from the holds of wrecks broken up by the sea and weather.

Whilst many of the hazards will have been removed after WWII, ordnance has been washed ashore and dealt with in the past 60 years and unexploded ordnance may still remain buried in the seabed and the beaches.

Prior to the start of offshore installation work, an UXO-survey of the offshore wind farm area has been undertaken. This survey information will also be available to inform the future decommissioning.

3.5 Nature Conservation

International nature conservation designations relevant to the SSOWF site include: Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites.

The SSOWF site is not within any designated sites but there are designated sites close to the landfall area. The site is however, within an area used by populations for which the site has been designated.

3.5.1 Wash and North Norfolk Coast European marine site

The Wash and North Norfolk European marine site includes:

- The Wash and North Norfolk Coast SAC;
- The Wash SPA;
- The North Norfolk Coast SPA; and
- The Gibraltar Point SPA.

The Wash and North Norfolk Coast SAC and the North Norfolk Coast SPA are the sites of most relevance to the offshore components of the wind farm and are discussed further below (where the habitats and species are of relevance to the project). However, when referring to the European marine site, all the designations that form it are considered as integral.

3.5.2 The Wash and North Norfolk SAC

The Wash and North Norfolk Coast SAC qualifies as a SAC for the following Annex I habitats, as listed in the EU Habitats Directive:

- Large shallow inlets and bays;
- Sandbanks which are slightly covered by seawater all the time (referred to in this document as subtidal sandbanks);
- Mudflats and sandflats not covered by seawater at low tide (referred to in this document as intertidal mudflats and sandflats);
- Reefs (eg: Sabellaria spinulosa);
- Samphire (glasswort) *Salicornia* spp. and other annuals colonising mud and sand;
- Atlantic salt meadows (*Glauco-Puccinellietalia*); and
- Mediterranean and thermo-Atlantic halophilous scrubs (*Arthrocnemetalia fructicosae*).

The Wash and North Norfolk Coast also qualifies as a SAC for the following Annex II species, as listed in the EU Habitats Directive:

- Common seal (*Phoca vitulina*).

3.5.3 The North Norfolk Coast SPA

The North Norfolk Coast SPA qualifies under the EU Birds Directive for the following features:

- Internationally important populations of regularly occurring Annex I bird species;
- Internationally important populations of regularly occurring migratory bird species; and
- Internationally important assemblage of waterfowl, including the internationally important populations of regularly occurring migratory bird species.

Ramsar criteria 1,2,5,6 have been applied for the justification of the North Norfolk Coast Ramsar site:

- Relating to Ramsar Criterion 1: The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish water lagoons and extensive areas of freshwater grazing marsh and reed beds.
- Relating to Ramsar criterion 2: Supports at least three British Red Data Book and nine nationally scarce vascular plants, one British Red Data Book Lichen and 38 British Red Data Book invertebrates.
- Relating to Ramsar criterion 5: Assemblages of wildfowl of international importance. Over winter the area regularly supports 91,536 waterfowl (5 year peak mean 1991/92-1995/96).
- Relating to Ramsar criterion 6: Breeding and over wintering bird species of international importance, as identified at designation.

3.6 Site Characteristics

In order to inform the decommissioning programme summaries of the physical characteristics of the site are provided in the following sections and are mainly taken from the Project's Design Basis. As input for the offshore installation activities and design of the offshore parts of the windfarm, further geophysical survey work was carried out in 2008. This survey data will now also go towards informing the decommissioning process in the future.

3.6.1 Normal wind conditions

Wind data is provided in **Table 3.4**. The estimated mean wind speed in the centre of wind farm is 9.2 m/s at 80m.

In summary, the turbulence measurement from Docking Shoal can be used to describe the turbulence intensity at SSOWF. The average ambient turbulence intensity at a wind speed at 15m/s is estimated to 6.1%.

Table 3.3 Summary of measurement results used in the update of wind resource assessment

Station	Period	Mean wind speed [m/s]
Lynn & Inner Dowsing (43 m)	Sept 1999 - Nov 2007	8.2
Race Bank (80 m)	June 2006 - Nov 2007	9.5*
Docking Shoal (80m)	June 2006 - Nov 2007	9.3*
SSOWF (80 m)	Estimated long term	**9.3** (9.2)**

* Corrected values using linear regression with L&ID measurement mast as a reference station. Extrapolated values from 90 m to 80 m using wind shear coefficient α=0.1. These values are not corrected for over speeding effect (1.5% is anticipated here) due to the mounting arrangement of the 90 m top sensors.

** Mean wind speed value for the most exposed turbine is given in bold, while 9.2 refer to the centre of the park.

3.6.2 Extreme wind conditions

The extreme wind conditions given in Table 3.4 are applied as a basis for wind farm design conditions.

Table 3.4 Summary of extreme wind conditions for SSOW at 80 masl

Design parameters	[m/s]
50-years 10 min wind speed	43
50 years 2 sec gust speed	53

3.6.3 Tidal and extreme water levels

Table 3.5 Key values for tidal and extreme water levels

	West side of wind farm	East side of wind farm
Mean seawater Level (MSL) above LAT	3.1 m	2.9 m
Mean high water springs (MHWS) above LAT	5.2 m	4.9 m
Highest astronomical tide (HAT) above LAT	6.0 m	5.6 m
Mean spring tidal range	4.3 m	4.1 m
50-year atmospheric surge above LAT	2.9 m	2.9 m
50-year atmospheric surge below LAT	1.8 m	1.8 m
50-year SWL above LAT	7.3 m	7.1 m
50-year wave crest elevation above LAT(1)	17.2 m	16.9 m

(1) Coexist with 1-year extreme still water level

3.6.4 Waves and currents

The 50-year significant wave height is 7.4 m. The 50-year extreme surface current is 1.5m/s in the NW end of the wind farm area and 1.8m/s in the SE end of the wind farm area.

3.6.5 Seabed conditions and shallow geology

Seabed conditions and geological interpretation for the wind farm site is found in the Seismic Survey Report. **Table 3.6** presents a geological summary for information.

The model was correlated to the 2006 Borehole campaign and the Site survey from 2005. The model has been further refined following the 2008 borehole campaign leading to an updated distribution of soil units for the turbine and substation locations.

Table 3.6 Geological summary. All depths are approximate and refer to metres below seabed (BSB) /9/

Unit	Formation	Description	Distribution
1a	Holocene sands	Loose fine to medium sand with shell fragments	In the centre and to the southeast of the survey area
1b	Holocene sands and gravels	Slightly clayey, gravelly, shelly sand	Veneer on the seabed over remainder of survey area
2	Botney Cut	Laminated clays with silts, peats and fine sands infilling channels that cut into the underlying unit	Two north/south trending channels through the centre with a smaller northwest/southeast trending channel in the north of the survey area
3	Bolders Bank	Firm to stiff slightly gravelly sandy sand	Blanket deposit seen throughout the

Unit	Formation	Description	Distribution
		with pockets of sand and gravel. Occasional boulders may be expected.	survey area to a maximum depth of 14m BSB
4	Egmond Ground	Dense to very dense slightly gravelly silty fine to medium sand with occasional flint gravel with some stiff gravelly clay bands	Expected over the entire survey area to a maximum depth of 19m BSB
5	Swarte Bank	Hard sandy gravelly clay, with some layers of gravel and very dense sand.	Infills channels cut into the chalk running NNW/SSE and east/west, up to 1.2km wide and 150m deep.
6a	Weathered Chalk	Weak structureless chalk composed of sandy silty fine to coarse gravel with a clayey sandy silty matrix (Grade Dm/Cm Chalk)	Underlies the whole survey area
6b	Chalk	Weak, low to medium density (Grade B5 to B3 chalk)	Underlies the whole survey area

3.6.6 Geotechnical conditions

Geotechnical conditions are identified based on among other laboratory test based on performed borehole campaign and survey. Key strength and stiffness characteristics of the soil unit are identified.

Figure 3.3 presents the expected layer thicknesses at each individual turbine location. The locations are grouped into three characteristic profiles for illustration; (1) turbine locations at infill channels with thickness of soft clay larger than 1.5m, (2) turbine locations in areas with top of chalk above anticipated depth of pile penetration and/or influence depth for foundation resistance and (3) turbine locations where chalk material is not present within influence depth of the foundation.

The basis for Figure 3.3 is the interpretation of the geophysical survey at each turbine location and the 5 existing boreholes from 2006. When the 7 new boreholes from 2008 are tied in with the same model some adjustments should be expected, particularly with respect to the top of chalk interface. Field results suggest that this interface is deeper at the edge of the erosion channels cutting into the chalk plateau.

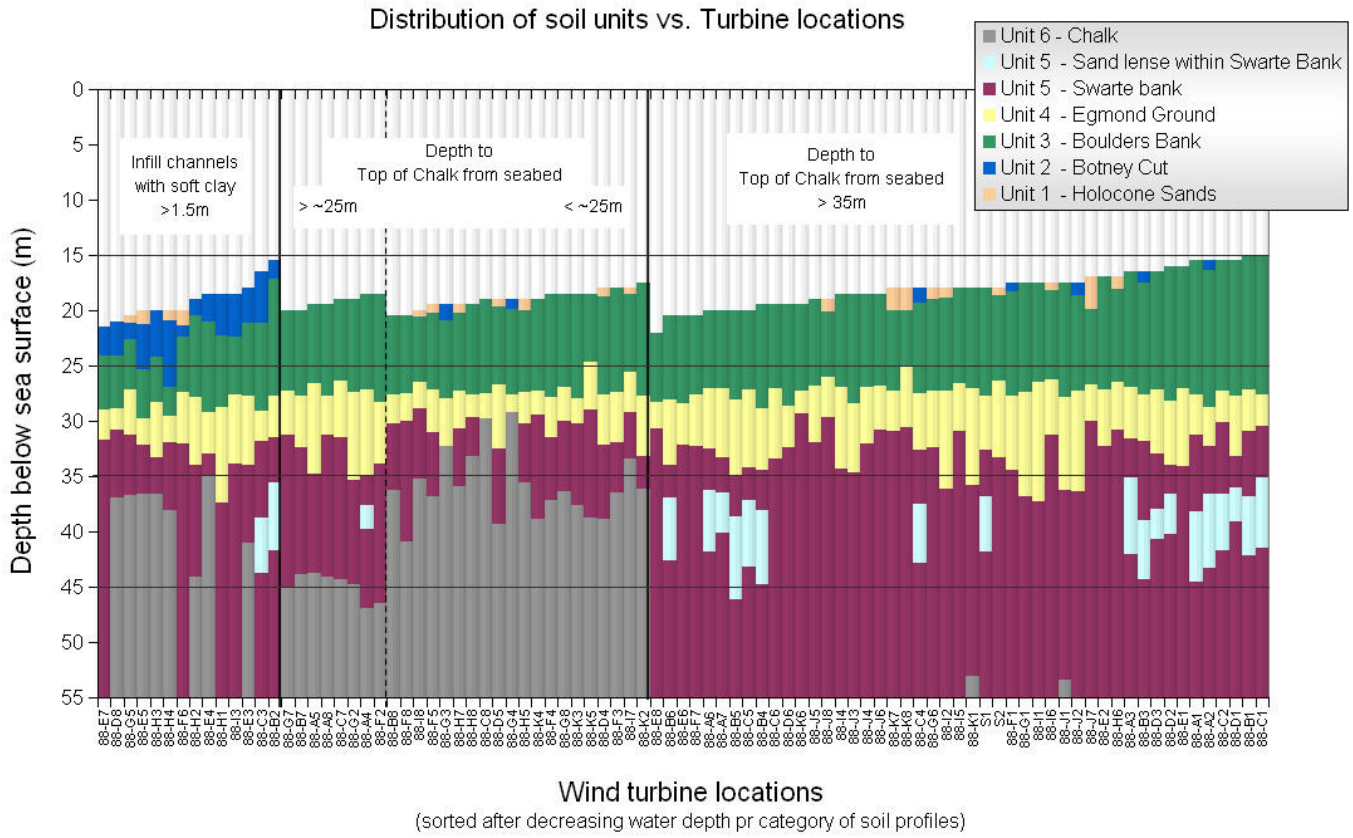

Figure 3.3 Sequence of soil Units for all wind turbine locations

Where the backshore is low, the shingle beach forms a barrier ridge and is the main defence against backshore flooding.

4 Description of items to be decommissioned

4.1 Towers and Wind Turbine Generators (WTG)

The wind farm consists of 88 Siemens SWT-3.6-107 WTGs including towers, which gives a hub height of 81.75m, each of the three rotor blades are 52 m long and weigh 20 tonnes

4.2 Offshore foundations

The offshore foundations consist of a Monopile and a Transition piece. The SSOWF contains 88 foundations for WTGs and 2 foundations for export power substations. The monopiles are of varying size with weights ranging from 370 tons to 500 tons and diameters from 4.7 meters to 5.2 meters. They are driven to approximately 30 meters below mud line.

4.3 Scour protection

To prevent erosion around the J-tubes at the foundations rock installation was performed at 77 of the foundations. The scour protection is in accordance with what is described in the Environmental Statement.

4.4 Marine infield cables

The infield cables consist of Type 1 (OD approx. 132mm), Type 2 (OD approx. 105mm), with a total length of 25km and 57km, respectively. The infield cables comprise unit lengths between 400m and 1400m and are laid and buried between the WTGs, see **Figure 4.8**.

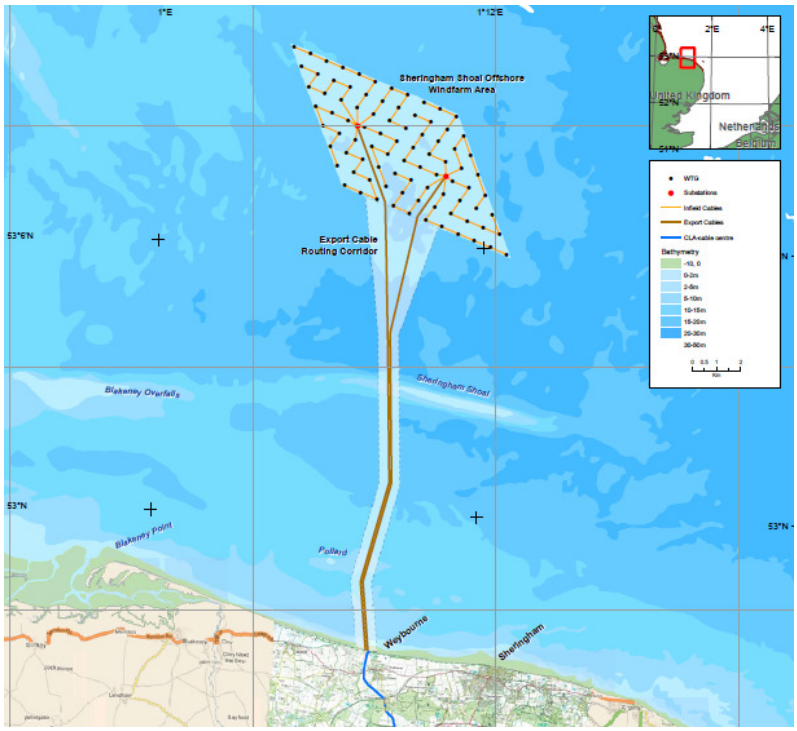

Figure 4.7 Route of the marine export with corresponding landfall drill and junction pit

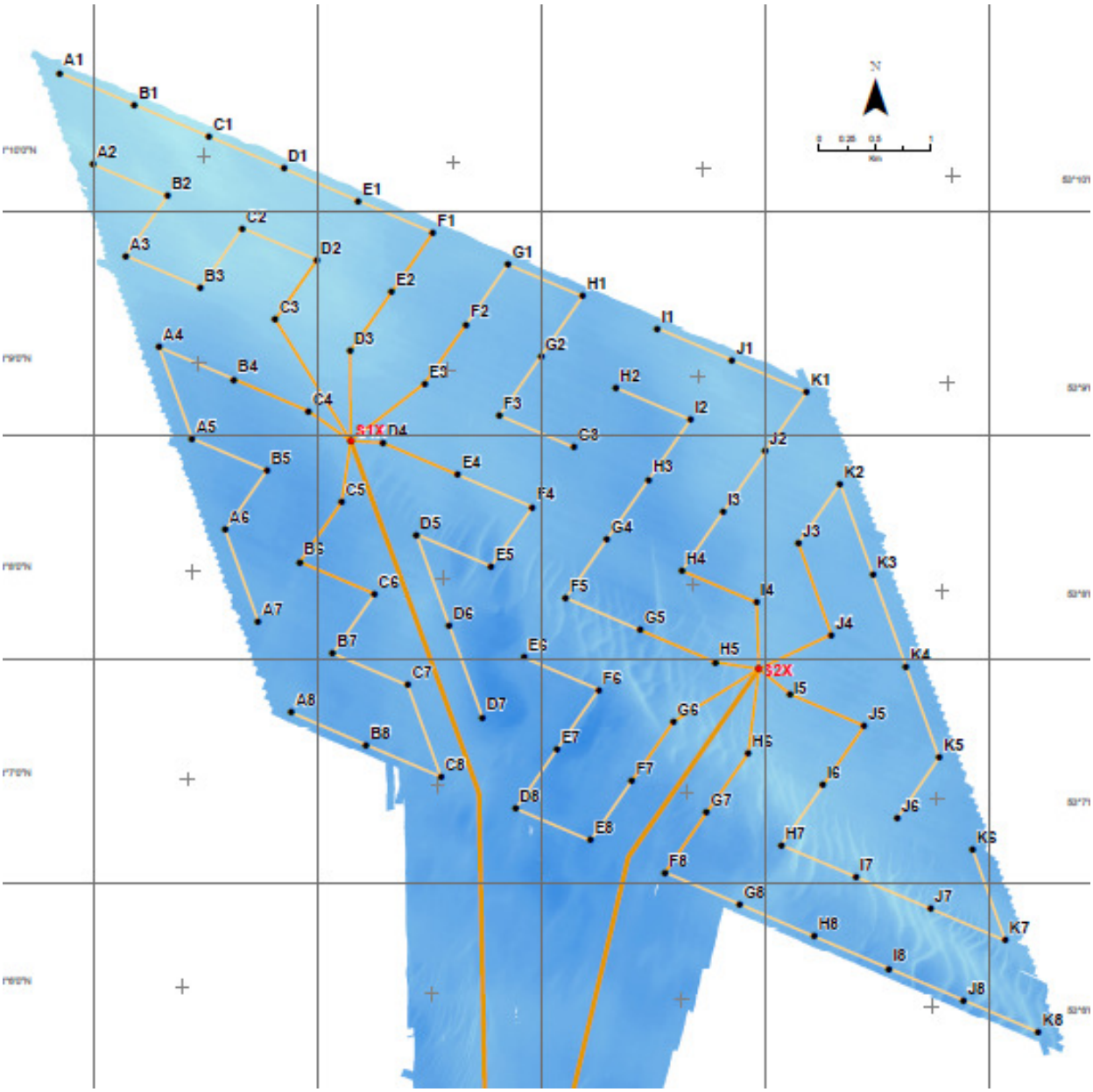

Figure 4.8 Layout of the infield marine cables

5 Proposed decommissioning method

5.1 Proposed decommissioning programme

At the end of the SSOWF's economic lifetime, decommissioning will take place. Towards the end of the initial lifetime, of 20 years, an assessment of the technical conditions of the installation and its continuing economic potential will be made. The lease period from The Crown Estate is 50 years and within this time, it is possible that the project could be re-powered.

When planning the decommissioning of the wind farm, the possibility of recycling material and/or reuse of plant elements will be considered. Prior to decommissioning a contract strategy will be established, defining number of contracts and scope of work for each contract. Through the contractual process, reuse and or recycle of plant items, handling of Health, Safety and Environment (HSE) during working operations, principles described in the decommissioning program and applicable laws and regulations at the time of decommissioning will be assessed.

Decommissioning will need to be performed in accordance with applicable laws and regulations current at that time. In the following the expected decommissioning is described based on requirements, guidelines and practices at the time of writing.

Effective management of HSE issues is central to the owners of Scira and, as such, prior to the start of decommissioning, detailed plans including HSE risk assessments and mitigation will be developed.

The onshore and offshore Environmental Statements described the environmental impacts related to construction, operation and eventual decommissioning of the SSOWF. The environmental impacts of the decommissioning are considered to be temporary and either within or of lower magnitude and significance than those described for the construction and operation of the SSOWF.

5.2 Decommissioning method

Decommissioning will generally be a reverse of the order of installation and is described in more detail in chapters 2, 3 and 4 of appendix 4. Prior to decommissioning, the power will be cut off and disconnection from the grid system will occur. The electrical transmission system is part of the OFTO-system. The appointed OFTO for Scira project will be responsible for decommissioning of the transmission system including substations and export cable. In addition, appendix 3, contain a rough preliminary evaluation (pros and cons) of decommissioning activities made for some criteria.

5.3 Lighting and Marking

In accordance with Clauses 4f and 5a of the Sheringham Shoal consent under Section 36 of the Electricity Act 1989, Scira will ensure that the appropriate marks and lighting are displayed during the decommissioning of the wind farm. Navigational

marking in the construction phase has been discussed and agreed with the authorities. In the decommissioning phase, a similar navigational marking and lighting as for the construction phase is expected.

With regards to aviation safety, the shape, colour and character of the lighting will be compliant with the Air Navigation Order 2005 (or as otherwise directed by the Civil Aviation Authority).

For navigational safety, lights and marks will be agreed with Trinity House, in consultation with the Maritime and Coastguard Agency. Trinity House will be consulted prior to decommissioning to specify any obstruction marking that may be required during the removal operations. Should any obstruction be left on site that could be considered to present a hazard to navigation, Scira will provide the necessary markings specified.

5.4 Authority handling

Prior to start planning for decommissioning an authority plan will need to be prepared addressing the applications and notifications needed to be performed prior to the stopping of electricity production and during the decommissioning. Reference is made to the authority plan prepared for the installation project. Consultation will be carried out with the relevant regulatory authorities at the time of decommissioning. Some of the notifications will include notification to Mariners and fishermen. Further to ensure safety for third parties at sea, temporary safety zones around the installations during decommissioning will be applied for.

5.4.1 Marine archaeology

A Written Scheme of Investigation (WSI) has been prepared and discussed with English Heritage. For the construction phase, some archaeological construction exclusion zones have been identified. It is expected that these also may be relevant for the decommissioning, and information about these will then be communicated to a future decommissioning contractor and followed-up by Company

5.5 Construction safety

Decommissioning involves heavy lifting activities, electrical work, offshore working, entering of the WTGs and offshore substations from the sea, offshore transportation etc. As already pointed out thoroughly planning will be carried out prior to the commencement of decommissioning. Risk activities will be identified and mitigating measures will be addressed and followed-up. This relates to the Contract requirements, mechanical and electrical checking prior to lifting and decommissioning activities offshore and at possible yard.

Prior to decommissioning and during decommissioning several safety mitigating measures will need to be addressed. Such safety mitigating measures may include the following:

- Evaluation of decommissioning procedures;
- Establishing contract philosophy and nominating well experienced and suited Contractors;
- Safety assessments of the plans and activities;
- HSE-follow up of the activities;
- Perform safety risk assessments and compare the risk with the project's safety acceptance criteria;
- Notifying 3rd parties;
- Notifying relevant authorities and fishery; and
- Temporary safety zone around the WTGs and the offshore electrical substations during decommissioning.

6 Environmental Impact assessment

The intention of the decommissioning process will be to remove the wind turbines and the monopile foundations to either sea bed level or 1m below sea bed level. Scour protection is planned to be left in-situ.. It is intended that the cabling will remain buried in-situ. It is currently estimated that the decommissioning process will take approximately six months.

The SSOWF ES and subsequent studies undertaken to inform pre-construction baseline represents Scira's current understanding of the site and impacts. Both the ES and the further studies undertaken would be used in the preparation of applications to decommission the SSOWF. It is further anticipated that a full EIA will be required prior to the decommissioning of the wind farm and this will focus on the same list of key criteria as the original EIA together with any issues that may have arisen in the interim. Those key criteria are expected to be:

- Identification and assessment of potential impacts on the environment;
- Identification of surveys to inform the assessment process;
- A review of nature conservation designations
- The potential interference with other legitimate users of the sea
- Identification and assessment of potential impacts on amenities, communities and future uses of the environment; and
- Identification and assessment of potential impacts on the historic environment.

Some of these key criteria may change in emphasis over time and the EIA will need to recognise and examine such changes.

7 Consultations with interested parties

During the EIA and consenting process consultation took place with statutory and non-statutory bodies representing key interests and user groups in the north Norfolk area and the wider area during the Scoping Study. Initial consultation included a description of the project proposals and invited comments and requested relevant data or information. Detailed formal and informal consultation has continued throughout the EIA via correspondence and meetings. All comments received were taken into consideration during the EIA.

The statutory consultees and non-statutory organisations involved in the EIA and consenting process will also be involved in the decommissioning process. The list of consultees may develop and change overtime, but at present the key consultees are anticipated to be *inter alia*:

- The National Federation of Fishermen's Organisations;
- The local Sea Fisheries Committee;
- Chamber of Shipping;
- Royal Yachting Association;
- Joint Nature Conservation Committee;
- Natural England;
- The Environment Agency;
- English Heritage;
- Maritime and Coastguard Agency;
- Trinity House Lighthouse Service;
- The relevant harbour authority; and
- British Marine Aggregate Producers Association (BMAPA).

These consultees were consulted July 2009 prior to submitting this document to DECC February 2010. The comments and answers to comments from the different consultees are listed in the table below.

Table 6.1 Summary of comments from the consultees and Scira's answer

Consultee	Comment	Scira's answer
The National Federation of Fishermen's Organisations	No comments received	-
The local Sea Fisheries Committee	No comments received	-
Chamber of Shipping	Foundation removal – cutting below the seabed is acceptable only if the foundation is cut as follows – adequate depth of water from the mean sea level surface in order for vessels to navigate and or transit safely in close proximity. Cutting at the sea-level is acceptable only if there is a pre-existent sandbank or perhaps inadequate depth where commercial vessels would not and cannot safely navigate.	Foundations are planned cut below
	Cable removal – we recommend complete removal of the cables from the seabed once they are not to being used. However, in case where this is not practically feasible, we recommend as a secondary option which is to leave them in situ subject to them being buried at safe and adequate depth.	The cables are at present planned left in-situ. Refer OSPAR guidelines for cables and pipelines.
Royal Yachting Association	The RYA notes that the turbine structures and foundations will be removed to seabed level or below and would therefore pose no future risk to surface navigation.	OK

Consultee	Comment	Scira's answer
	The RYA notes that cables will be left in situ. This could pose a potential risk to craft who may anchor along the cable route, but as the cables will be buried to a depth of at least 1.0 m, this risk would be negligible and the RYA would therefore have no objection	Noted. The cables planned burial depth is 1 m.
	It is proposed that any scour protection will be left in-situ. The RYA would like assurances that any such scour protection would be at such a depth that it would not pose a navigational risk to recreational craft. Given that the depths at the site are between 15 and 22m above LAT, it seems unlikely that the scour protection would be a hazard however.	OK
Joint Nature Conservation Committee	No comments received	-
Natural England	Thank you for your reply and I confirm that Natural England are satisfied with the decommissioning plan	OK
The Environment Agency	Thank you for consulting us on the proposed decommissioning program for the Sheringham Shoal offshore windfarm. We have reviewed the proposals and can confirm we have no objection to the plans.	OK
English Heritage	We note the detail in Section 4.9.1 (Marine Archaeology) and it is our advice that any Archaeological Exclusion Zones declared at the time of project construction will remain valid at the time of project decommissioning, subject to any prior survey, analysis and reporting to indicate otherwise.	OK

Consultee	Comment	Scira's answer
Maritime and Coastguard Agency	We note that temporary safety zones around the WTGs and other offshore electrical substations during decommissioning may be included as a safety mitigation measure.	OK
	The final EIA should also describe the measures envisaged to avoid, reduce and if possible, remedy any significant adverse effects indicated.	OK
	12. Sea bed clearance No reference to over trawling of the site or the presence of an independent observer during site clearance operations. Survey should be at least to UKHO Order 1 standard as required for consent.	The results of the seabed clearance, can be made available to the authorities, refer chapter 11. Comment regarding survey noted.
	14. Post Decommissioning Possible monitoring survey strategy will need to be confirmed at that time noted	Noted
Trinity House Lighthouse Service	I can advise that Trinity House concurs with the general approach taken by Scira Offshore Energy and the proposals summarized in the Executive Summary at section 3 of the Report. It is however our view that if the foundations of the structures in the wind farm are not completely removed they should be cleared to at least 1 metre below seabed level.	Noted. Refer chapter 4.4 and table 4.1.

Consultee	Comment	Scira's answer
	The commitment to provide any marking that is considered necessary during decommissioning and thereafter of any obstruction remaining which is considered the commitment also needs to extend to include the continued maintenance thereafter of that navigational marking until such time as the danger no longer exists.	Noted. It is expected that details regarding temporary marking during decommissioning will be discussed with Trinity House, i.e. similar as Company have for done the construction phase.
	It is noted that the plan as currently drafted does not contain detailed proposals for post decommissioning monitoring of the site, and whilst the reasoning for this is appreciated, it is our view that there should be some specific proposals put forward at this stage. Such proposals can, of course be refined when the proposed 10 year review of the decommissioning programme is undertaken, when there will be actual experience of ground conditions at the site after the structures have been built. Trinity House considers that the proposals should now include provision for at least one further site survey, say 12 months after the initial post decommissioning site survey.	See chapter 11.
The relevant harbour authority	No comments received	-
British Marine Aggregate Producers Association (BMAPA)	No comments received	-

The consultation process for the decommissioning phase will be scheduled to begin early enough so that initial responses can be adequately assessed and any concerns or queries addressed and/or mitigated in advance of the proposed timing of the decommissioning.

Once decommissioning is due to begin a Notice to Mariners will be issued as well as other navigational warnings as per Clauses 5c and 5d of the Sheringham Shoal consent under Section 36 of the Electricity Act 1989. Appropriate notification on the progress and completion of the works will be supplied to the UK Hydrographic Office.

8 Costs

Only an estimate of the decommissioning costs can be made at this stage. This cost estimate is given in Appendix 4. The estimate is of course provided at a very early stage. Prior to decommissioning, the estimate will be updated to reflect the decommissioning contract strategy.

9 Financial Security

See appendix 5.

10 Schedule

In approximately 20 years time the wind farm will be approaching the end of its designed lifetime. However, the actual technical status will be regularly assessed and an operation and maintenance program is expected to be in place, in order to prolong the lifetime of the plant. Further since the lease period with the Crown Estate at time being is 50 years, there is also the possibility for re-powering of the wind farm. The possibility to extend the lifetime of the wind farm is in a lifetime perspective positive with respect to the environment.

Scira plan to undertake internal reviews of the decommissioning programme. It is proposed that DECC is consulted at the following times:

- After 2 years of operation
- After 15 years of operation
- 2- 5 years prior to decommissioning

A final decommissioning programme will be prepared prior to decommissioning, 2 - 5 years prior to closing down the wind farm. The final decommissioning programme is expected to include references to relevant surveys performed during the construction phase and during the operational phase.

Prior to decommissioning, Scira will establish a project that will execute and follow-up the following main activities with the following roughly anticipated duration:

- Decommissioning EIA and consultation phase: 12 months
- Project management, planning, procurement and contract follow-up: 36 months

- Offshore decommissioning: 6 – 12 months

11 Project management and verification

It is understood that information pertaining to project management and verification will only be required to be included when the final review of the programme takes place towards the end of the installation's life.

Guidance provided by DECC suggests that at that time the programme should provide information on how the Operator will manage the implementation of the decommissioning programme and provide verification to Government concerning progress and compliance. This should include a commitment to submit a report, detailing how the programme was carried out. The guidance suggests that this report should generally be submitted within four months of completion of the decommissioning work.

12 Sea-bed Clearance

Following the completion of the decommissioning of the wind farm, surveys are expected to be carried out to check that the site has been cleared. The purpose of the surveys will be to identify any debris located on the sea-bed which may be associated with the wind farm's construction, operation, maintenance or decommissioning and that may pose a risk to navigation, other users of the sea or the marine environment. The type of surveys to be carried out (side scan etc.) and the technical requirements will be specified in due course prior to decommissioning.

The area to be covered by the survey will be determined prior to decommissioning taking into account the results of the "as-laid" surveys and other surveys performed in the operation phase.

The decommissioning surveys may be part of the scope of work for the future decommissioning contractor(s) or as separate contracts. Scira also understands that DECC will expect to see an element of independent third party involvement in providing evidence that the site has been cleared and therefore propose that the survey reports can be made available to the authorities as necessary.

13 Restoration of the site

The key areas of work related to restoration of the site will be in relation to:

- Cutting the foundations to below the seabed and ensuring that they are made safe and adequately covered; and
- Ensuring that cables and cable ends are adequately buried

No active restoration which would rely on intervention with equipment is proposed as it is considered that this present unnecessary and unacceptable risks to personnel. Rather, it is considered that allowing the seabed to "self-settle" is sufficient and is contributing to the limited environmental impact of the proposed decommissioning.

14 Post decommissioning monitoring, maintenance and management of the site

As cables and foundations are proposed to remain at the site post-decommissioning, there will be a need for some further work so that any possible unexpected risks to navigation or to other users of the sea can be identified and mitigated to an appropriate level. The assessment of the level of risk and appropriate mitigation will be dependent on the nature and scale of those items remaining, the likelihood of the remaining items becoming exposed and the degree of risk to other users of the sea.

Based on present day conditions and knowledge the following assessments have been made:

- The risk of exposure of the foundations (the part of foundation located below seabed) or cabling is assessed to be low due to the depth to which the foundations will be cut and also the burial depth of the cable coupled with the relative stability of the sea bed in the area;
- The risk of debris falling overboard at any time is relatively low as offshore work associated with operations and maintenance is low and contained within the turbine structure;
- The risk to legitimate users of the sea is considered to be low as the area is not heavily fished and recreational use of the area is low.

The parameters used in the above assessment may change overtime and so will need to be re-visited closer to decommissioning and therefore any possible monitoring survey strategy will need to be confirmed at that time.

15 Supporting studies

At present the supporting studies used for this decommissioning plan are the studies already carried out in connection with the Sheringham Shoal Offshore Wind Farm Environmental Statement (May 2006). In addition to these studies there are geological surveys performed by the Project (2007/2008), pre-construction, during construction and post-construction monitoring programmes either already underway or scheduled to be undertaken at the appropriate time according to the FEPA licence. These monitoring studies will also feed into the assessment and final form of the decommissioning plan.

16 References

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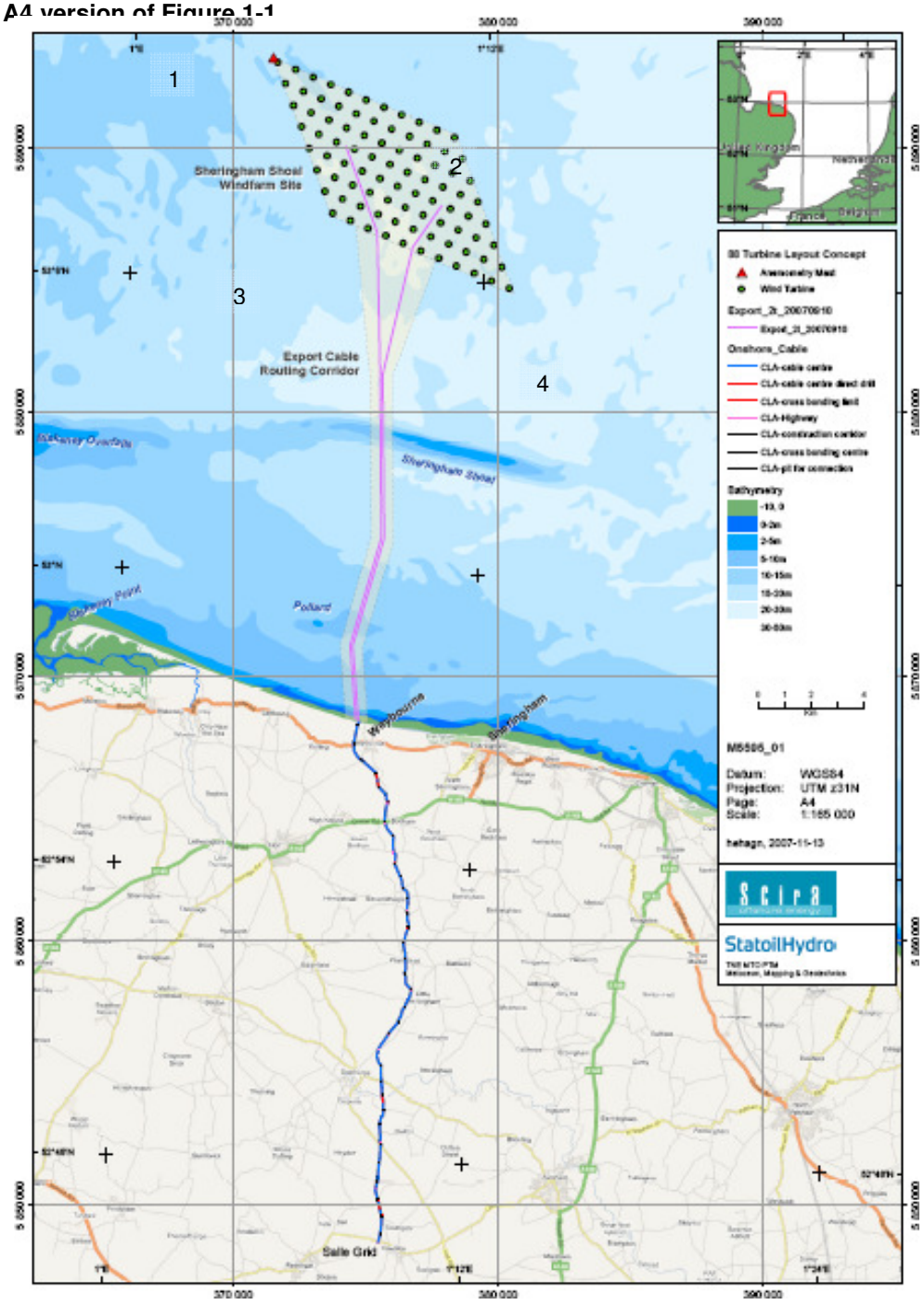
2. Burd, F. (1989) The Salt Marsh Survey of Great Britain. An Inventory of British Salt Marshes. Research and Survey in Nature Conservation No. 17, Nature Conservancy Council, Peterborough.
3. Coast Protection Act,1949 - consent number 33369/08/0/CON (issued by Defra August 2008)
4. Dixon, MJ. and Tawn, JA (1994). Estimates of extreme sea conditions: extreme sea levels at the UK A-class sites: site by site analyses. Internal Document 65, Proudman Oceanographic Laboratory, Bidston.
5. Envision (2005). Accoustic, video and grab sample survey of Sheringham Shoal Offshore Wind Farm. Envision Mapping Ltd report prepared for Scira.
6. Food and Environmental Protection Act 1985 - licence 33369/08/0 (issued by Defra August 2008)
7. Section 36 consent under the Electricity Act 1989 (issued by DTI, August 2008)
8. Sheringham Shoal Offshore Windfarm Environmental Statement (Scira, May 2006)

17 Appendices

1. Map of the location of the Sheringham Shoal Offshore Wind Farm development
2. List of abbreviations
3. Preliminary evaluation (pros and cons) of decommissioning activities made for some criteria
4. Decommissioning costs
5. Financial security

Appendix 1 A4 version of Figure 1-1



Appendix 2 List of abbreviations

AONB	Area of Outstanding Natural Beauty
BPEO	Best Practicable Environmental Option
CD	Chart Datum
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Fisheries and Rural Affairs
DTI	Department for Transport and Industry
EDFE	EDF Energy
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Statement
FEPA	Food and Environmental Protection Act
HDD	Horizontal Directional Drilling
HSE	Health, Safety and Environment
kV	kiloVolt
LME	London Metal Exchange
MHWN	Mean High Water Neaps
MHWN	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
mODN	Mean Ordnance Datum Newlyn
MSL	Mean Sea Level
MW	Mega Watts
NNR	National Nature Reserve
OD	Ordnance Datum
OFTO	Offshore Transmission Owner
OSPAR	Oslo Paris Agreement
PEXA	military Practice and Exercise Areas
Project	The Sheringham (Shoal Offshore Wind Farm) Project
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
SSOWF	Sheringham Shoal Offshore Wind Farm
TP	Transition Piece
UXO	Unexploded Ordnance
WSI	Written Scheme of Investigation
WTG	Wind Turbine Generator

Appendix 3 Preliminary table listing of pros and cons of possible decommissioning activities

The following appendices list a rough preliminary evaluation (pros and cons) of decommissioning activities made for some criteria.

Appendix 3.1 Wind Turbine Generators

For the Wind Turbine Generators, complete removal is the planned decommissioning activity.

Wind Turbine Generators	
Criterion	Complete removal
No harm to people	Prior to decommissioning a risk assessment has to be performed addressing the mitigating measures that need to be in place prior to start this decommissioning activity.
Consideration of the rights and needs of legitimate users of the sea	Complete removal of structures best long term solution. Appropriate notification and consultation will be carried out during the decommissioning work. Further to ensure safety for third parties at sea, safety zones around the installations during decommissioning will be applied for.
Minimise environmental impact	Materials will be completely removed from site. Materials are expected to be reused as much as possible.
Commercial viability	Most commercial viable solution. Optimization of the method and the associated costs, will be further assessed in due time prior to decommissioning.
Practical integrity	The decommissioning is expected to re reverse of the construction.

Appendix 3.2 Foundations

For the foundations, cutting below seabed is the planned decommissioning activity.

Foundations		
Criterion	Complete removal	Cutting below seabed
No harm to people	This alternative is assessed to represent a much higher risk towards personnel.	Fewer activities to be undertaken over a shorter time period offshore, minimising the risk to personnel.
Consideration of the rights and needs of legitimate users of the sea	Disadvantages to other users of the marine environment include disruption over a longer time period whilst the works are undertaken and remaining scour holes associated with excavation.	No risk presented providing cutting is at sufficient depth and site is monitoring post decommissioning.
Minimise environmental impact	Excavation pits over a wide area causing significant impact to marine environment. Associated dumping of excessive volume of waste material also required. Disturbance would take place over long time period. Some artificial reef habitat may be lost, but long term risk of decay and pollution will be eliminated.	Considerable reduced works footprint relative to complete removal. Works would take place over reduced time period and involve less equipment. Seabed recovery time shorter than complete removal scenario. Some artificial reef habitat may be lost, but long term risk of decay and pollution will be eliminated.
Commercial viability	Not commercial viable. Excavation and extreme lifting involves major equipment requirements over longer periods of time.	Less expensive alternative to complete removal, involving minimal excavation.
Practical integrity	Not a practical solution as the following are expected: High risk associated with heavy lift, considerable excavation needed with possible associated storage of disposal of large volumes of waste	Expected to be more standard procedures and equipment. The decommissioning is expected to re reverse of the construction.

Appendix 3.3 Marine cables

For the marine cables, leave in-situ is the planned decommissioning activity.

Marine cables		
Criterion	Complete removal	Leave in-situ
No harm to people	Some risk to personnel as all possible decommissioning activities represent a HSE risk	No decommissioning activity, hence no risk to personnel
Consideration of the rights and needs of legitimate users of the sea	No risk assumed, except temporarily during possible removal operation	No risk assumed from leaving buried cables in-situ. The situation is expected to be unchanged from what will be experienced in the future operational phase.
Minimise environmental impact	Given the considerable length of cable and the need for jetting techniques, removal would cause considerable damage and disruption to the seabed and established communities. These impacts could be considered large relative to the environmental gains from removal.	Benign – no environmental impact associated with long term disintegration of buried cables
Commercial viability	Extensive operation, offset to some extent by copper re-sale value	Costs limited
Practical integrity	Possible to undertake. Likely to cause disturbance to the marine environment.	N/A

Appendix 3.4 Scour material

For scour material, leave in-situ is the planned decommissioning activity.

Scour material		
Criterion	Complete removal	Leave in-situ
No harm to people	Removal is labour intensive and involves a risk to personnel involved in operation	Reduced risk for contractor personnel
Consideration of the rights and needs of legitimate users of the sea		
Minimise environmental impact	Removal will cause considerable damage and disruption to the seabed and established communities. Associated equipment and vessels will generate disturbance and additional noise. Materials gathered would need to be dumped elsewhere.	Habitat for established communities retained, no short or long term detrimental effects on marine environment anticipated.
Commercial viability	Expensive, labour intensive, high volume of operation	Costs limited
Practical integrity	High reliance on manual work, labour intensive. Possible, but not practical	N/A

For scour material, leave in-situ is the planned decommissioning activity.

Appendix 4 Decommissioning cost estimate with method statement

Decommissioning Cost Estimate
Sheringham Shoal Offshore Wind Farm

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	DOCUMENT NO:	REV:1A

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DOCUMENT TITLE:

Decommissioning Cost Estimate
Sheringham Shoal Offshore Wind Farm

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		Approved by	Rune Rønvik			
REV	**DATE**	**ISSUE OR REVISION DESCRIPTION**	**ORIG. BY**	**CHKD. BY**	**COMP. COORD**	**PRJ. MGR.**

Executive Summary

The decommissioning of the Sheringham Shoal Offshore Wind Farm is suggested removed in three campaigns. The first campaign prepares the Wind Turbine Generators for removal, the second removes the structures and the third completes the operation with rock-dumping and documents the completed decommissioning operation.

The removal of the structures is suggested performed with two large jack-up vessels working in parallel with various cutting tools to remove the structures. The removal of the rotor, nacelle and tower is performed as reverse installation where the individual components are unbolted and loaded back to the deck of the jack-up vessel. The removal of the foundation is performed by cutting the foundation into two pieces. The first cut just above the grouted connection and the second at two meters below the mud-line. It has been estimated that the duration of the second campaign will be 154 days when using the TERRC[1] facility in Harlepool.

The total cost of the decommissioning operation has been calculated to be 1 415 515 kNOK, including 30% for contingency.

[1] Teesside Environmental Reclamation and Recycling Centre, Able UK

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List of abbreviations

- AWJ cutter – Abrasive Water Jet cutter
- ECM – External Cutting Manipulator
- ICM – Internal Cutting Manipulator
- MP – Monopile
- PSV – Platform Supply Vessel
- PTV – Personnel Transfer Vessel
- SSOWF – Sheringham Shoal Offshore Wind Farm
- TERRC – Teesside Environmental Reclamation and Recycling Centre
- TP – Transition piece
- TPCT – Transition Piece Cutting Tool
- WTG – Wind Turbine Generator

1 Introduction

The Section 36 Consent for Sheringham Shoal given 7 August 2008 contained a requirement for Scira to present for DECC (Department of Energy and Climate Change) a Decommissioning Programme. Such programme was submitted 22 April 2010 and was approved by DECC in letter to Scira dated 24 January 2011.

Sheringham Shoal Offshore Wind Farm has a technical design lifetime of 20 years. The economic lifetime is expected to be longer than the technical lifetime and the Board of Directors has approved for accounting purpose to apply 24 years. The Lease period for the wind farm is 50 years, and at the time for investment decision the assumption was that a repowering of the wind farm would be considered allowing for a 2 x 25 years offshore wind production from the site - ideally using the existing foundations and electrical infrastructure subject to the technical integrity at the time.

Because the removal of the Offshore Wind Farm will be performed in more than 20 years the available tools for removal are uncertain and assumptions on available tools for the removal have been made. The removal of the rotor, nacelle and tower has been assumed to be performed as a reversal of the installation procedure. The removal of the foundation has been assumed to be performed by cutting and removing the foundation in two pieces.

The scope of this decommissioning operation is to remove the WTGs with foundations. The export cables and sub-stations are the property of OFTO and Scira Offshore Energy is therefore not obliged to decommission these. The inter-array cables and scour-protection rock-dumps are assumed left in-situ, equivalent to the Decommissioning programme approved 24. January 2011.

This document has 5 primary chapters. In addition this introduction and the list of references are chapters 1 and 7.

- Chapter 2 describes the chosen procedure with a rational for this choice of method.
- Chapter 3 documents the vessel time necessary to remove all 88 units according to the procedure.
- Chapter 4 provides a rational for the assumptions that are made in the development of the procedure.
- Chapter 5 covers the capital expenditure analysis

2 Method Statement

The removal of the WTGs (Wind Turbine Generators) with foundations installed on the SSOWF (Sheringham Shoal Offshore Wind Farm) is planned to be performed in three campaigns.

- 1st Campaign – Preparation of WTG + Foundation
- 2nd Campaign – WTG + Foundation Removal
- 3rd Campaign – Rock-dumping and completion

Because the decommissioning of monopile based WTGs will become an industry as SSOWF nears decommissioning assumptions have been made on the availability of specialist tools and the capacity of the vessels used for decommissioning.

2.1 1st Campaign - Preparation of WTG + Foundation

To achieve optimal use of the Jack-up vessel preparation of WTG and foundation is performed prior to the removal. The preparation is performed using PTVs (Personnel Transfer Vessels).

Preparation of the WTGs will result in debris, items and fluids that will need to be cleared away from the unit before removal can commence in the 2nd campaign. This debris is planned stored in the WTG in containers until the 2nd campaign. They will then be moved to the Jack-up before the lifting operations begin. This is to remove the HSE risk a transfer of containers from WTG to PTV would involve.

As the removal will be done in approximately 20 years the following is assumed on the capability of the PTVs. These assumptions are valid for technology that is presently being developed as part of Carbon Trust, MAROFF and several other projects.

- PTVs with crew transfer system are able to do crew transfer at 2.0 meter Hs
- PTVs are able to load 200 kg of tools onto WTG at 2.0 meter Hs
- PTVs with a capacity of 20 pax are able to use Wells Next to the Sea as a harbour

It is estimated that a five man crew will need 6 x 12 hours to finish the work tasks presented in **Table 2-1**. When working only during daytime they will need 6 days to finish the work. With two 20pax PTVs it will be possible to prepare 8 units simultaneously and finish the 1st campaign in 66 working days when not including waiting on weather.

Task #	Task
1	Clearing of loose items in nacelle and tower.
2	Installation of temporary lighting in tower and nacelle
3	Cutting of wiring at separation points between nacelle and tower, tower sections and at cutting points in TP
4	Preparation of bolts on rotor blades and tower flanges. Cleaning and application of penetrating oil to help the disassembly.
5	Preparation of temporary power supply for high speed motor to turn rotor. Cabling from nacelle to the base of the tower, the motor will be powered from the jack-up for the removal operation.
6	Installation of ventilation system below airtight platform. The void space below the airtight platform is designed to be oxygen free to prevent corrosion inside the MP (Monopile). Because work will be performed below this platform during the removal this space must be ventilated before the removal.
7	Removal of elevator from tower. The elevator in the tower will be parked at the base of the tower and the steel wires, power cables and additional systems are dismantled and stored at the base of the tower

Table 2-1 - Work tasks to be performed during the 1st campaign

2.2 2nd Campaign - WTG + Foundation removal

The removal of the WTG structures is the most comprehensive task of the decommissioning. Two vessels with capacities equivalent to the Pacific Orca of Swire Blue Ocean is assumed as a base case for the removal of the WTG and its foundation. A vessel this size has deck space to load approximately five complete WTGs with foundations to its deck, this is assumed in the following.

For recycling of the WTGs and foundations the TERRC facility in Hartlepool is used as a base case. The transit distance from SSOWF to Hartlepool is 135 Nm and the harbour has the necessary facilities to accommodate for the jack-up vessels while un-loading.

Removal of the WTG is done using a reversed installation method where tools such as angle grinders and plasma cutters are used to remove bolts that are not possible to remove using normal methods. Plasma cutters are used in place of acetylene torches to remove the need for combustible gasses with their accompanying HSE risk.

While the tower is removed the foundation is prepared for removal. A cutting tool is fitted below the airtight platform in the TP, just above the lower platform at z=7400 mm. While this is installed the J-tubes are cut where they exit the MP and at z=7400 mm. The vibration dampers installed on the J-Tubes are cut to release the J-Tubes.

After removal of the WTG, rigging is prepared to lift the top of the TP. Cutting is started while the crane supports the load above the cut. With the top piece of the TP removed the internal J-tubes can be lifted out of the MP.

After the j-tubes have been removed internal access to the lower end of the MP is possible. An ICM (Internal Cutting Manipulator) is used to release the external j-tubes and cut the MP at 2 meters below the mud-line.

ICMs use AWJ (abrasive water jet) cutting to cut piles for O&G platform removal. Today these tools are limited to approximately 2.3 meters diameter piles, while the MP has a diameter up to 5.7 meter. It is assumed that a cutting tool based on AWJ technology capable of cutting the MP will be available on the market by the time Sheringham Shoal is decommissioned. The validity of this assumption has been confirmed by a contractor with experience from works with decommissioning of O&G platforms and who frequently use ICMs for cutting of piles, well casings and caissons for the O&G industry.

2.3 3rd Campaign – Rock-dumping, completion and third party inspection

It will be necessary to perform rock-dumping to even out the hole-which the MP leaves after removal. This must be performed after removal of the structures, but can likely be performed within the same season. For the capex estimation it is assumed that one rock-dump vessel can dump rocks at 8 locations / day, thus needing 11 days to finish the rock-dumping, not including waiting on weather.

Third party inspection at each site will be required to provide documentation that the removal has been done satisfactorily. For the inspection a PSV with an observation ROV will be necessary.

3 Time estimation – 2nd Campaign

To calculate the time necessary to perform the tasks presented in chapter 2.2 a simulation tool developed by the DNV for Statoil has been used. The tool uses approximately 50 years of Hindcast weather data to calculate the amount of structures that can be removed for a given operation.

To finish the marine operations for the 2nd campaign 154 days is necessary when working with two vessels in parallel. This is for an operation starting the first of April and ending on the first of September. This is based on calculations done with input parameters as stated in **Table 3-1** and **Table 3-2**.

Variable	Value	Comment
One-way transit distance	135 Nm	Sheringham Shoal - TERRC
Vessel Transit Speed	13 Knots	Equivalent to Pacific Orca
Vessel deck-space capacity	5 units	Equivalent to Pacific Orca
Unloading time	4 hour / unit	Assumption

Table 3-1 - Input data to DNV model

	Duration [H]			Hs limit	Max WindSpeed	Comments
	P10	P50	P90			
Tower	[h]	[h]	[h]	[m]	[m/s]	
Positioning	3	6	8	1.8	14	
Jack-up and pre-loading	6	8	10	1.8	14	
Removal of Blades	6	8	10	4	10	Reverse of Installation
Removal of Nacelle	2.5	4	6	4	14	Reverse of Installation
Removal of upper tower section	2.5	4	6	4	14	Reverse of Installation
Removal of lower tower section	2.5	4	6	4	14	Reverse of Installation
Removal of TP above grouted connection	4	5	7	4	14	
Removal of MP and grouted connection	8	11	15	1.8	14	
Jack-down	1	2	4	1.8	14	
Total	35.5	52	72			

Table 3-2 - Operational sequence for removal of WTGs and Foundations

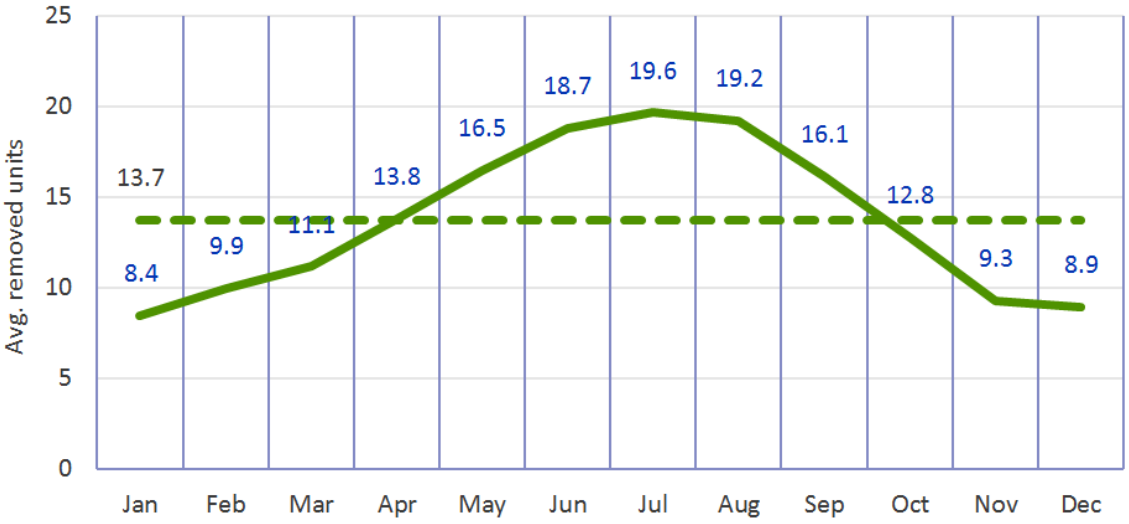

Figure 3-1– Average amount of removed units / month for two vessels working in parallel

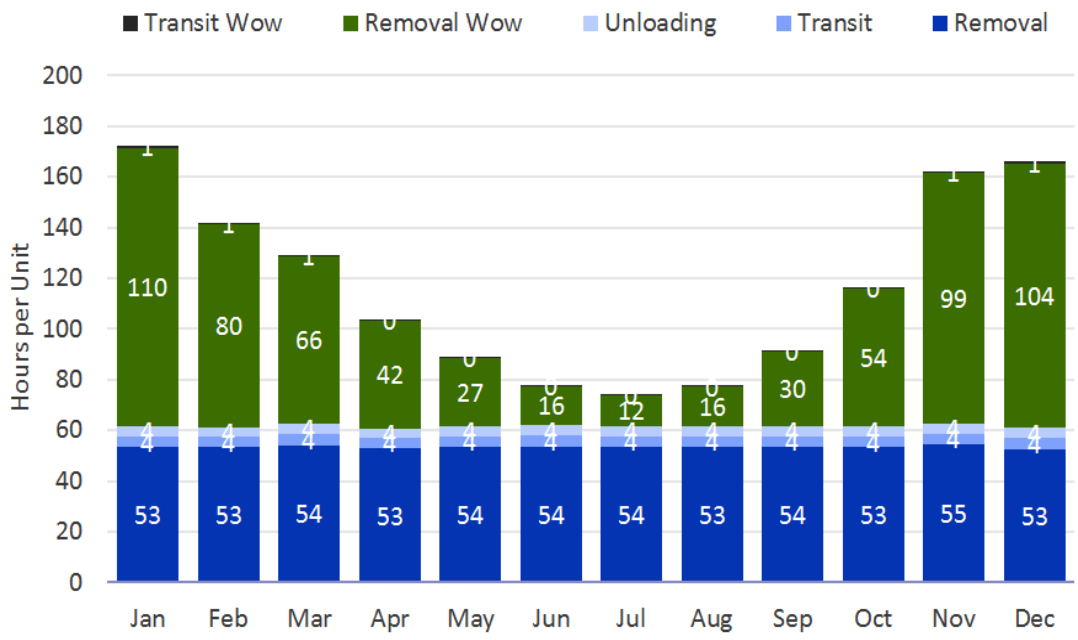

Figure 3-2 – Distribution of the time used for the removal operations

4 Rationale for assumptions

4.1 Plasma based TPCT

A rail mounted plasma cutter is suggested for cutting of the TP at elevation z=7400 mm. Using rails for automated cutting and welding is routinely used for metalwork for industrial applications and is considered well within limits of what can be assumed available as tools for the removal of WTG structures.

The choice of plasma cutters is based on HSE consideration. Plasma cutters are only dependent on a supply of inert gas and electricity. Electricity can be delivered from the jack-up vessel and inert gas is shipped in pressurized containers and is not combustible.

4.2 AWJ based cutting

AWJ cutting uses high pressure water jets with scour material added to the water to scour away material to cut steel. It can cut most materials, layered materials and is safe for the environment.

AWJ cutters are today routinely used for the cutting of piles and tubular legs on O&G jackets during removal operations. They are used to cut flexible risers, cut grouted casings in O&G wells during removal, cut inspection holes in jacket legs, cut mooring chain etc.

Figure 4-1 - Subsea well casings cut using AWJ based cutting tools, [1]

Figure 4-2 - External cutting, [1]

Today's largest ICMs are used to cut piles with a diameter of up to 3 meters. To cut a MP with diameter of 5.7 meters new tools will need to be developed. These can be designed and built with present technology and are considered to be within reasonable assumptions for this study.

An MP will likely not remain stable once cut and must therefore be lifted immediately after cutting. It is therefore proposed the ICM be designed into the lifting frame used to lift the MP. The ICM will be suspended from its umbilical and lowered using an umbilical winch also designed into the lifting frame.

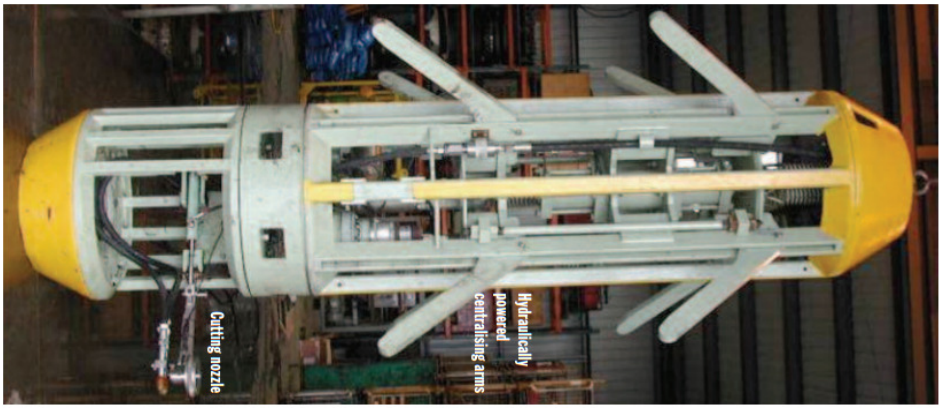

Figure 4-3 - 42" → 72" ICM, [1]

5 Capex estimate

Cost estimation for the Sheringham Shoal decommissioning program is carried out based on the technical decommissioning plan described in the chapters above. For estimation of capital expenditures the internal estimation model for offshore wind park decommissioning was used with norms and rates from EST manual for offshore wind updated in Q3 2012 and EST manual for subsea projects. Where rates were not specified in the EST manuals, offers from suppliers were obtained for necessary types of equipment. Contingency is set as 30% of base estimate due to uncertainties in the technical procedures for decommissioning at the time of estimation, and taking into consideration the time when decommissioning will take place (20 years from now). Due to the same reason market effect is not added to expected cost for removal of the wind park.

EST internal colleague check has been carried out to verify that the estimate is correct and is done according to EST best practice. Cost estimate is presented in the table below.

NO	DESCRIPTION	TOTAL in kNOK	% of base estimate
1	Marine operations for decommissioning	880 527	80,9 %
1.1	*Campaign 1 - Preparation for disassembly*	*94 551*	8,7 %
1.2	*Campaign 2 - WTG and foundation removal*	*728 396*	66,9 %
1.3	*Campaign 3 - Rock dumping and inspection*	*57 580*	5,3 %
2	Port, transport and logistics	44 026	4,0 %
3	Engineering	88 053	8,1 %
4	Project management	61 637	5,7 %
5	Waste disposal	3 872	0,4 %
6	Insurance	10 742	1,0 %
	SUM, base estimate	**1 088 858**	100 %
7	Contingency	326 657	30,0 %
	SUM, expected cost	**1 415 515**	

For the estimate the following assumptions were taken:

1. Marine operations:

1.1. Campaign 1 - Preparation for disassembly of turbines and foundations:

- Upfront preparation work; seabed and substructures survey should be performed with special ROV. It is assumed 11 days for survey work plus 2 days sail to/from site. Cost for survey vessel with ROV based on Subsea experience.
- Preparation for disassembly offshore will be carried out by 8 decommissioning crews of 5 men each, working in 12 hours shifts 6 days at each turbine location. Crews going to be delivered to turbines by 2 large PTVs' (each of capacity for 20 people plus equipment), 4 crews at each PTV. In addition 4 sets of equipment will be placed on each vessel. Total work duration estimated to 66 days, 132 total vessel days. 20% WOW is included to the given duration.

1.2. Campaign 2 – Substructures and wind turbines disassembly:

- Considered 2 jack-up vessels similar to Pacific Osprey working in parallel. A day rate from EST manual for wind is applied, based on the incoming offers in 2012.

- Operation start-up is in April. Duration of work is 154 days per vessel based on P50 duration from the DNV model. Hence no extra WOW is applied.
- For transition piece and monopile cutting, an abrasive water jet cutting tool is going to be used. Cost per day and mob/demob cost is based on input from contractor with relevant equipment. This rate includes cost for renting out the equipment and personnel. No extra cost is added to this rate.
- For j-tubes cutting a diamante wire cutting tool is assumed. Cost of renting out this equipment is obtained from contractor with relevant experience and excludes a crew of divers for performing the work. In addition cost for a crew of divers (4 divers plus 1 supervisor) and equipment is added which is based on Statoil subsea experience.
- In addition mob/demob cost for 2 vessels, 4 cutting tools and 2 diver crews is added to the estimate,

1.3. Campaign 3 – Rock dumping and inspection:

- Rock dumping is going to be carried out from the specialized vessel with the relevant day rate from the Subsea Estimating Model. Duration is assumed to be 4 WTG locations per day, 22 days total.
- Final inspection is assumed to be carried out by the same vessel with ROV as for the upfront survey. For this operation 11 days are also assumed, plus 2 days sail to/from site and mob/demob cost.

2. Port, transport and logistics:
   - Is assumed to be 5% of marine operations cost.
   - Includes decommissioning facilities, guard vessel and port fees.
3. Engineering:
   - Is assumed to be 10% of marine operations cost.
   - Includes engineering work for decommissioning, planning of decommissioning program, surveys and studies related to marine operations, etc.
4. Project management::
   - Is assumed to be 7% of marine operations cost based on Sheringham Shoal experience from installation phase.
   - Includes management personnel for following-up of decommissioning program (~3 persons), engineering follow up (~ca. 7 persons), studies and 3rd part services not related to marine operations.
5. WTG and Foundation disposal:
   - Cost for disposal of substructures and wind turbines is based on the difference between cost for delivering of scrap at a demolition company's pier and sum we are receiving back after scrap sale
   - Parts of substructures and wind turbines are assumed to be delivered to the scrap yard at Teeside operated by Able UK Ltd.
6. Insurance:
   - Is taken as 1 % of the cost items above which is typical for offshore wind projects.

6 References

[1]: *"Abrasive water jet cutting systems for jacket & subsea structure removals.pdf",* Brochure downloaded from http://www.oilstates.com/fw/main/Abrasive-Cutting-511.html, on 24.09.2012

Appendix 5 Financial Security

Scira Offshore Energy Limited has a prudent approach with regard to the decommissioning of Sheringham Shoal. The estimated decommissioning cost of the generation asset (excluding the transmission asset) is GBP 25.4 million (2010 GBP). The estimated decommissioning cost of the transmission asset to be transferred to the OFTO is GBP 4.5 million.

The Sheringham Shoal wind farm has a design life of 20 years with a corresponding expected technical and economic lifetime of up to 25 years. As the lease with The Crown Estate is 50 years, the owners of Scira will take a decision on whether or not to repower Sheringham Shoal before the end of design life.

If a repowering is chosen we anticipate existing infrastructure to be used to the extent possible. Where existing infrastructure is not used the decommissioning and removal of this will be described in the consent application for the repowered wind farm. There will also be a new decommissioning programme established including a new scheme for financial security

If it is decided not to repower Sheringham Shoal, the generation period will be extended to the full length of the technical and economic lifetime, which is likely to exceed the design life.

During first half of 2027 (year 15 of production from Sheringham Shoal), Scira will present for DECC the Sheringham Shoal repower decision plan together with an update of the decommissioning programme and cost estimate, and invite DECC to a discussion on the financial security.

Scira acknowledge the fact that a parent company guarantee normally would be an unacceptable form of security. However, Scira's point of origin is that investment grade companies (rated minimum BBB- by Standard & Poor's or Baa3 by Moody's or equivalent in 2027) should be considered qualified as guarantors for the partial or full performance of decommissioning should such security be required, considering the scope of the decommissioning programme.

Should a parent company guarantee (PCG) not be accepted, Letter of Credit (LC) could be an alternative financial security. A qualified issuing bank should have a minimum credit rating of A- by Standard & Poor's or A3 by Moody's or equivalent.

The PCG/LC should be renewed on a yearly basis, starting at 10% of the net decommissioning liability and be increased by a flat rate each year in order to reach, but never exceed, the full net decommissioning liability at the end of the technical lifetime.

If a repowering is decided after any guarantees have been issued, such guarantees will become null and void. Following the end of the generation period, the value of the guarantee will be reduced annually in line with remaining net decommissioning liabilities.