Summary Report

SUBSEA ENGINEERING OPPORTUNITY

International Market Insights Report Series

August 2018

Scottish Enterprise

Contents

1. Introduction

Scottish Enterprise (SE) has undertaken a review of non-oil and gas subsea sectors that have the potential to provide diversification and internationalisation opportunities for the Scottish oil and gas subsea engineering supply chain.

The following is a summary of the results of the sectors investigated and highlights where SE sees the most immediate opportunities as well as longer term interests. It considers both the synergies between the investigated sectors and the subsea engineering oil and gas supply chain and the interest and/or resource in the international geographies that present potential markets.

The work is part of the wider SE subsea engineering opportunity programme and further information on the benchmarking of Scotland against other international subsea hubs and Scottish supply chain capabilities can be found in 'Scotland's International Competitiveness and Benchmarking in Subsea Engineering' report available from Jamie MacDonald (jamie.macdonald@xodusgroup.com).

The non-oil and gas sectors considered include:

- Offshore wind
- Marine renewable energy
- Aquaculture
- Carbon capture, utilisation and storage
- O&G decommissioning
- Nuclear decommissioning
- Water and wastewater
- Ocean science
- Seabed mining

The reports have been conducted based on their synergies with the subsea oil and gas supply chain: they do not look at additional interactions between the non-oil and gas sectors. These undoubtedly exist and can be considered for any company looking to access additional markets. The summary below gives a brief overview of each of the sectors. If you would like to find out more please access the full reports, through Scottish Enterprise.

2. Immediate Opportunities

The most immediate markets of interest presented are offshore wind, nuclear decommissioning, O&G decommissioning and water and wastewater.

- *Offshore Wind*

Offshore wind (OW) is already an international market with over 14 GW of capacity installed at the end of 2016, across 45 countries[1], 88 percent of the capacity is installed in Europe with the greatest concentration in UK waters, with 5.2 GW (40 % of the European total). It is estimated that the industry will be worth £30bn by 2030 [RenewableUK].

The main synergies between OW and the O&G subsea supply chain are in the installation phase, including surveys and seabed preparation; the operational phase, in particular inspection, repair and maintenance (IRM), sensors and monitoring; and for decommissioning. There are additional synergies where the OW industry moves to floating substructures rather than fixed in deep-water scenarios as the main technologies used, spar buoys, semi-submersibles and tension leg platforms are all synonymous with floating O&G structures.

Globally there is 14.4 GW capacity (at end 2016), the current activity is taking place in Europe, predominately the UK, Germany, China, where 1.6 GW is already installed and there is a target for 30 GW to be installed, and Taiwan. Medium term markets include the US and Japan, where there have been some small projects, but no large scale build out yet, and both have deeper water sites for floating technologies, Japan, almost exclusively. In the long-term South America (including Brazil) and Australia have a huge resource, but are only just starting to build an industry around it.

- *Nuclear decommissioning*

Nuclear decommissioning is not conventionally a subsea market, however, the need to perform operations in highly hazardous environments has led to an increased use of remotely operated and autonomous vehicles (ROVs and AUVs), thus providing a cross over with the subsea O&G supply chain. The nuclear decommissioning market is estimated to be worth £250 billion in the decade to 2025. It is a market that will span over decades to longer than a century, based on the longevity of the operating timeframes and the decommissioning schedules, but one that is active now.

The main O&G subsea supply chain synergies exist around accessing to hard to reach and hazardous environments, with the use of ROVs in particular. Additionally, sensors and remote sampling techniques, many crossing over with O&G IRM activities, will also be valid in this area.

Nuclear decommissioning is an immediate opportunity in the UK, where the nuclear decommissioning authority (NDA) is already engaging with the O&G supply chain. Markets also exist in Germany and Japan, where with nuclear power plants being shut early due to policy decisions, there are supply chain opportunities. With 77 countries using civil NPPS,

[1] This include countries that have offshore wind activities such as site investigations, rather than those who have operational turbines.

75% of which are at least 25 years old, there will be significant decommissioning opportunities. Medium term opportunities exist elsewhere in Europe, as well as South Korea and Pakistan. Newly built NPPs are designed for decommissioning and so may not present the same difficulties as older NPPs.

- *O&G Decommissioning*

Oil and gas (O&G) decommissioning has the strongest crossover with O&G subsea engineering, as they are working in the same discipline, with common technology, price point and language. In the UK alone, decommissioning spend is expected to be £17.1 billion in the years to 2025, and an overall target of £39 bn. Within decommissioning, and in particular in the North Sea, plugging and abandonment (P&A) is estimated to be almost half of the cost of decommissioning (49%).

Key synergies between O&G operations and decommissioning include the knowledge and operations of wells in order to make them safe for P&A activities; technical and geoscience surveys; heavy lift vessels for the removal of seabed infrastructure; as well as HSE and offshore operations.

O&G decommissioning is an international market, with current significant activity happening in the UK continental shelf, Norwegian continental shelf and in the US. Future opportunities include west Africa and Asia, with estimates suggesting a decommissioning spend of between £21 to £42.5 billion.

- *Water and wastewater*

Water and wastewater is not obviously a synergistic sector with the subsea oil and gas supply chain, but crossovers in pipelines; pumps; inspection, repair and maintenance, particularly around internal pipeline inspection techniques; automated chemical dosing, for water treatment; and membranes for water treatment and desalination, exist and provide an opportunity for the Scottish subsea supply chain.

Water is a global industry, with leakage from the water network being an issue in many countries. Major pipeline infrastructure is being constructed in Singapore and China. Desalination is heavily used in the Middle East with research ongoing into less energy intensive techniques.

The sector is of global importance as not all people have access to safe drinking water and adequate sanitation, there is therefore an opportunity to develop improve existing infrastructure as well as implement new solutions. The water and wastewater industry is estimated to be worth £1 trillion by 2020, with £500m being spent annually on maintenance in Scotland alone.

3. Medium-term Opportunities

Medium term opportunities exist in marine renewable energy and aquaculture

- *Marine renewable energy*

Marine renewable energy (MRE), also known as ocean energy, encompasses six individual technologies – wave, tidal stream, tidal range, ocean current, salinity gradient and ocean thermal energy conversion (OTEC). Across these varying technologies they are at different stages of development, with tidal range, tidal stream and wave energy being the most developed. The global MRE industry is expected to be worth £95 billion annually by 2050.

There are multiple areas of technology synergies between MRE and the subsea O&G supply chain, particularly where there are devices placed on the seabed, such as bottom mounted wave and tidal stream devices and floating tidal stream, wave, ocean current and OTEC devices. This can include installation techniques, moorings, anchors, asset management and maintenance. Tidal range and salinity gradient have the least synergies as they are either coastally based or within an estuary. Other key crossovers will include project management; inspection, repair and maintenance (IRM); geotechnical and geophysical surveys; metocean data and HSE.

The resource for MRE is spread globally, although not all areas have all resource, for example the greatest wave energy is found in the northern and southern hemispheres between 30° and 50°. The greatest surface water temperatures, required for OTEC, are found in the equatorial region and tidal streams are strongest around peninsulas and where tidal movement is constrained by land mass, e.g. through island archipelagos. There is an interest globally in MRE, with current activity largely taking place within Europe, where approximately 50 percent of wave and tidal stream technology is based. There is growing interest in South America, in particular Chile; in Asia, in particular the Philippines and Indonesia where there are government initiatives to support the development of the sector.

- *Aquaculture*

Aquaculture involves the farming of aquatic organisms and plants, and is practised around the world. The main focus for the subsea supply chain, is on aquaculture in the marine environment – *mariculture* – and in particular the high value species such as Salmon. Globally, aquaculture is worth £125 billion (2015). Mariculture is facing a number of challenges relating to available coastline and environmental sustainability. These issues could be mitigated by a move further offshore where there is more space available and a better flow of water to disperse fish waste and unassimilated food. Moving offshore is a challenge as it exposes the fish and the cages to higher energy environments and therefore appropriate engineering solutions need to be found to support this. A small number of offshore fish farms have been trialled, such as the £65 million, Ocean Farm 1, in Norway, which was deployed in 2017.

Offshore engineering solutions, including mooring and anchors can be adapted from the subsea oil and gas supply chain, as well as monitoring techniques, IRM and installation processes.

The main markets for salmon mariculture are Norway, Chile, Canada and the UK (Scotland), with other smaller markets and those for other marine fish such as sea bream and sea bass in Japan, Egypt and France.

4. Longer-term Opportunities

Longer term, or less relevant, opportunities exist in seabed mining; carbon capture, utilisation and storage and ocean science.

- *Seabed mining*

Deepsea mining (DSM) involves the exploration and exploitation of deep sea minerals, such as polymetallic nodules, super massive sulphides and cobalt-rich ferromanganese crusts. These mineral deposits are found at depths of 800 m – 6,000 m, meaning expertise of ultra deep-water oil and gas operations is particularly relevant. Seabed mining also includes the extraction of methane hydrates (methane clathrates) from below the sea floor. Both sectors are in early stage development with test projects being carried out in Papua New Guinea and Japan respectively.

For DSM, the technology synergies are in ultra-deepwater activities, and will include ROV and AUVs; surface support vessels; risers and umbilicals; asset management and offshore operations. For methane hydrates, there will be similar synergies, although in shallower water, and drilling and well design activities as well.

These deposits are found all over the globe, depending on the specific minerals, in international waters the International Seabed Authority provide licences for exploration and exploitation, although none have yet been granted for the latter, due to environmental concerns, the main areas of search are currently the Clarion-Clipperton Fracture Zone, the Pacific Rise and the Indian Ocean. For Methane Hydrates, these are found globally, the major interest has been from countries without another indigenous hydrocarbon reserve, such as Japan and China.

- *Carbon capture, utilisation and storage*

The main crossover area between the O&G subsea supply chain and carbon capture, utilisation and storage (CCUS) is in transportation and offshore storage. There is a global importance of CCUS in the fight for reducing CO_2 in the atmosphere to limit global warming to below 2°C, however there have been limited applications of this so far, and only two offshore projects.

Technology synergies exist across pipelines, valves and pumps; geotechnical and geophysical surveys; reservoir mapping; well design and construction; and monitoring.

Globally there is interest across the Americas, although in North America, the focus has been on onshore. Europe has interest from the UK, Norway and the Netherlands and interest also exists in South Africa and Australia, with 38 projects worldwide.

- *Ocean science*

Ocean science and oceanography encompass the biological, physical, chemical and geological observations of the ocean environment. Synergies exist in terms of vessels, oceanographic equipment and IRM.

5. Other potential opportunity areas

Other potential areas for subsea cross over include:

- *Defence*
  This was initially considered with the reports and is considered to be a significant opportunity for the subsea O&G supply chain. However, market information was difficult to obtain. Synergies are anticipated to be with ROVs and AUVs, IRM and monitoring and sensors.

- *Subsea tourism and subsea living*
  This is a fairly futuristic concept, but subsea tourism, linked to artificial islands has been a concept for a while, and more recently 'seascrapers' have been proposed. Synergies will come with subsea construction, installation, IRM and asset management.

- *Offshore nuclear*
  Offshore small modular reactors have been proposed, due to their flexibility to be taken to areas that need an emergency electricity supply. They are likely to be built on floating structures, resembling ships, and the Chinese are close to completing their first one. By nature of a floating structure there will be synergies with moorings, anchors, operations, IRM, asset management and installation.

- *Energy storage*
  With a rise in the use of intermittent energy sources, energy storage is a key consideration, a number of solutions have been proposed, from the well-known pump storage hydro to storage as gravitational potential energy in disused mine shafts. Among the potential solutions, compressed air storage is seen as a significant option, with subsea airbags being used as the storage medium.

- *Data storage*
  In 2018 Microsoft deployed a subsea data centre off the coast of Orkney, with the intention to leave it in the water for five years. The use of water for cooling rather than air conditioning is a means of reducing the energy demand and therefore cost of data storage.

- *Salvage*
  Subsea salvage of wrecks could cross over with the subsea O&G supply chain through diving, ROVs and AUVs.

Acronyms

AUV	Autonomous Underwater Vehicles
CCUS	Carbon Capture, Utilisation and Storage
CO_2	Carbon Dioxide
DSM	Deepsea Mining
GW	Gigawatt
HSE	Health, Safety and Environment
IRM	Inspection, Repair and Maintenance
MRE	Marine Renewable Energy
NDA	Nuclear Decommissioning Authority (UK)
NPP	Nuclear Power Plant
O&G	Oil and Gas
OTEC	Ocean Thermal Energy Conversion
OW	Offshore Wind
P&A	Plugging and Abandonment
ROV	Remotely Operated Vehicle
SE	Scottish Enterprise