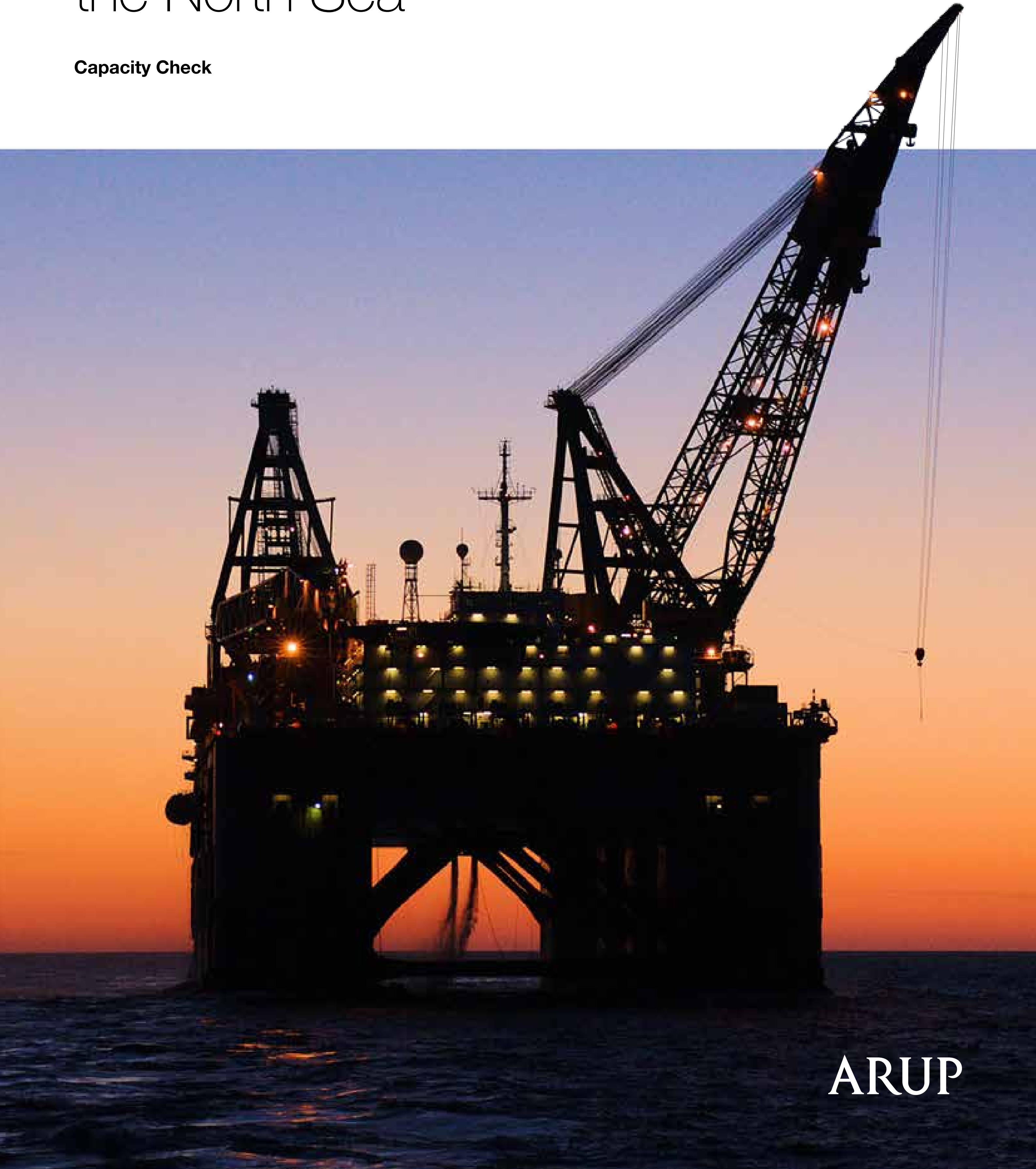
DECOM North Sea

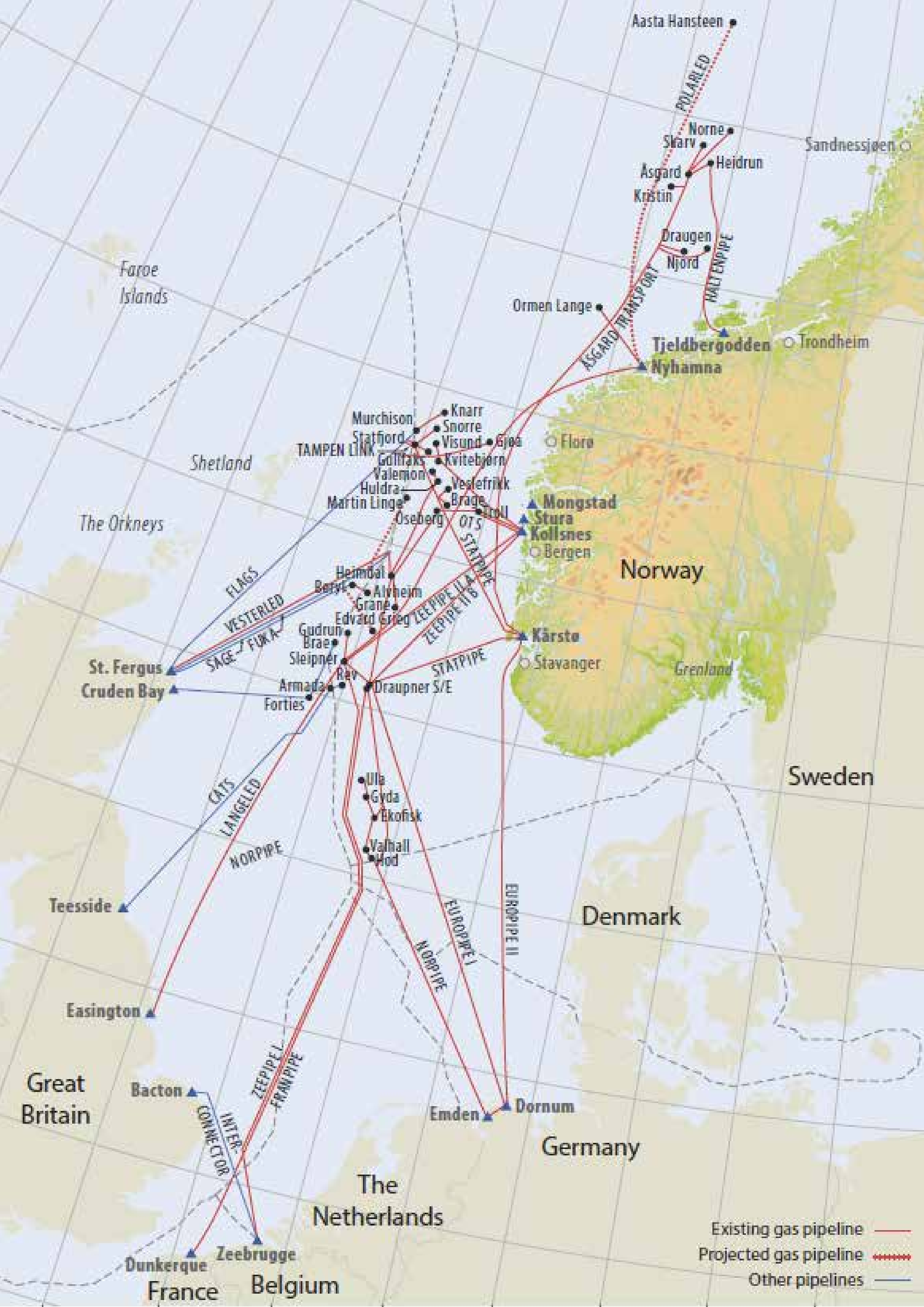
Scottish Enterprise

Decommissioning in the North Sea

Capacity Check



ARUP



Aasta Hansteen
POLARLED
Norne
Skarv
Heidrun
Åsgard
Kristin
Sandnessjøen
Draugen
Njord
HALTENPIPE
Ormen Lange
ÅSGARD TRANSPORT
Tjeldbergodden
Trondheim
Nyhamna
Faroe Islands
Murchison
Knarr
Snorre
Statfjord
Visund
Gjøa
TAMPEN LINK
Gullfaks
Kvitebjørn
Valemon
Huldra
Veslefrikk
Martin Linge
Brage
Troll
Oseberg
OTS
Florø
Mongstad
Sture
Kollsnes
Bergen
Shetland
The Orkneys
Norway
FLAGS
VESTERLED
Heimdal
Byrge
Alvheim
Grane
Edvard Grieg
ZEEPIPE II A
ZEEPIPE II B
STATPIPE
SAGE / FUKA
Gudrun
Brae
Sleipner
Rev
St. Fergus
Cruden Bay
Armada
Forties
Draupner S/E
Kårstø
Stavanger
Grenland
Sweden
CATS
LANGELED
Ula
Gyda
Ekofisk
Valhall
Hod
NORPIPE
Teesside
Denmark
EUROPIPE I
EUROPIPE II
Easington
ZEEPIPE I
FRANPIPE
Great Britain
Bacton
INTERCONNECTOR
Emden
Dornum
Germany
The Netherlands
Dunkerque
Zeebrugge
France
Belgium
Existing gas pipeline
Projected gas pipeline
Other pipelines

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Executive Summary

The Decommissioning sector offers a significant socio-economic opportunity in terms of job creation in the Scottish, UK and European supply chain, and an opportunity for North Sea based firms to export expertise to other parts of the world. This report, prepared by Arup and commissioned by Decom North Sea and Scottish Enterprise, seeks to provide an overview of the scale and nature of the decommissioning market in the next decade highlighting areas where there are potential bottlenecks in the supply chain.

There is need to develop an extensive supply chain of resources to deliver Decommissioning in the North Sea. This offers a significant opportunity to the supply chain in a growth market, and will require a range of highly skilled and high value capability. A range of activities will require innovation in terms of technical and management approaches to drive down the costs of decommissioning. There are other areas that will need significant growth in capacity to meet the demands of the market.

The analysis focuses on critical supply chain elements which are resources that are fundamental to delivering decommissioning projects, and which would have the most significant effect on the deliverability of the decommissioning market if there were capacity constraints. The critical supply chain elements that have been identified are:

- rigs/rigless abandonment infrastructure,
- removal vessels for topsides and substructure,
- ports/harbours/yards for recycling and
- skilled engineering and operational resources serving all aspects of the sector.

These are the areas were the supply chain, operators and government will need to work closely to ensure that the opportunities are realised. For other resources the supply chain is more likely to be able to naturally respond without major external intervention.

A capacity health check for the critical supply chain elements considers available capacity and investment lead time, investment commitment, pressures/ synergies from other industries and capability. The study drew from the experience and expertise of a number of significant firms currently operating within the North Sea decommissioning market. There was broad consensus amongst this group that the industry needed to evolve to efficiently deliver the activity needed over the next 40 years.

A Changing Mind Set

The approaches and philosophy of the Exploration & Production (E&P) market are currently largely implemented in the decision making processes of the decommissioning market. There is a need for the market to evolve an approach to decommissioning that is distinct from that of exploration and production activity. Recognition of the different drivers and success criteria of E&P versus decommissioning will allow the market to evolve an approach that is optimised for their respective projects.

Smoothing the Peaks

Creating accurate estimates of decommissioning expenditure across the North Sea is challenging. Estimates have been produced in isolation by a range of organisations from the bottom up. These show a broad range in variation on a year by year basis and over the next decade. Operators are likely to have significantly more flexibility to manage procurement and programme decisions for decommissioning activities than in E&P, where a race to production is imperative. Consequently, the market is unlikely to procure services in the peaks suggested by the predicted estimates as the cost to procure resources would increase i.e. the market will smooth out the peaks.

Contracting and Procurement Strategy

Rigidity in contracting and procurement structures developed to support the E&P market can inhibit operators and the supply chain from adapting to meet the demands of the decommissioning market. Adapting existing procurement strategies to reduce requirements for proof of previous experience will allow new entrants to the market who may introduce innovative methods.

Driving Innovation, Driving Down Costs and Regulation

Innovation can play a role in delivering decommissioning in a more cost effective manner. The nascent market has limited experience focusing on decommissioning activities and is at a stage where it can incorporate lessons learnt along with developing new approaches to reduce costs.
The uncertainty in the timescales of the market opportunity is limiting commitment to drive and invest in innovation. The supply chain cites the ‘stop/start’ nature of the industry as a barrier to investment.

1.0 Introduction

1.1 Background and Context

The Cost

Projected North Sea decommissioning activity estimates vary, with the most conservative estimates predicting the market will require over £30bn of expenditure before 2040 in the UK Continental Shelf (UKCS) alone[1]. As ageing assets reach the end of their economically useful life it is expected that the next 5 to 10 years will see a significant increase in activity, increasing up to an estimated annual spend in excess of £2.5bn per annum[1],[2],[3].

The Opportunity

The Decommissioning Sector offers a significant socio-economic opportunity in terms of job creation in the Scottish, UK and European supply chain, and a foundation from which North Sea based firms can export expertise to other parts of the world. To take full advantage of this opportunity, the industry must build on its existing capacity and capability to service the complex and demanding nature of decommissioning work in the North Sea.

The Objectives

This report, prepared by Arup and commissioned by Decom North Sea and Scottish Enterprise, seeks to provide an easily understandable and concise overview of the scale and nature of the decommissioning market. In particular, highlighting areas where there are potential bottlenecks in the supply chain which might impact decommissioning activity levels. These areas are likely to offer particular opportunity for new entrants to the Decommissioning Sector.

The Scope

North Sea oil and gas resources are extracted from the North Sea seabed and proximate areas including the Norwegian Sea and Atlantic Ocean. This area is collectively known as the North Sea within the oil and gas industry. Four countries have oil and gas resources rights which they exploit in the North Sea. These are the United Kingdom, Norway, Denmark, and the Netherlands, and it is this area that is the focus of this study.

The Contributors

This report uses a number of existing sources of information to assess the likely scale of demand for decommissioning services. It then draws on Arup's knowledge of the Sector, along with the expert views of a range of industry leaders in the field, to identify and assess critical areas of capability and capacity. Particular thanks go to the following for their invaluable insight and contributions:

Aker Solutions

CNR International

Halliburton

Marathon Oil

Royal Boskalis Westminster N.V.

Seaway Heavy-lifting

Weatherford International

Wood Group

1.2 Drivers and Influencers

The market drivers are complex and there are many technical, commercial and regulatory influences which will affect the manner in which the market for decommissioning activity is realised. Understanding the opportunities and challenges presented by North Sea oil and gas decommissioning is best informed by reviewing the market as part of a much more extensive whole, including E&P and other competing industries.

Regulation

A range of international and national legislations impact the North Sea Decommissioning Sector. Of these, OSPAR is particularly significant in terms of influencing decommissioning approach.

OSPAR Decision 98/3 prohibits leaving offshore installations wholly or partly in place unless further derogation are granted. However, it provides certain derogations to concrete structures and the footing of large steel jackets weighing more than 10,000 tonnes, from the fundamental principle that decommissioning should result in full removal of the installation. Derogation is not automatically available and is subject to a detailed assessment and consultation procedure to determine if there are significant reasons to allow the installation (or part thereof) to remain in situ. Furthermore, no derogation is available to steel installations constructed after 9 February 1999 (being the date that Decision 98/3 came into force).

As a result of the OSPAR ruling, the North Sea will lead global decommissioning practice from a total removal perspective.

The Other Industries

Decommissioning offshore installations is one component of offshore industrial activities occurring in the North Sea. These include E&P, offshore wind, marine renewables, power and communications networks, and port and harbour developments.

Understanding the opportunities and challenges presented by North Sea oil and gas decommissioning therefore needs to be considered in the context of these wider activities.

This broader appreciation of decommissioning activities will provide a greater understanding of where it competes for resources with other offshore activities, and where possible synergies exist, notably in the area of transferable skills.

The Global Industry

In terms of expenditure, the North Sea represents an important but modest part of an extensive global oil and gas industry, including onshore and offshore activity across upstream, midstream and downstream Sectors.

The resources supporting the North Sea market tend to be highly mobile and operate in a global, rather than local market. The cycles of the global activity will influence the availability of North Sea resources.

End of a Long Lifecycle

In a temporal sense, decommissioning is the final chapter of a whole asset lifecycle, which often stretches back many years to initial fabrication and installation, through maintenance, refurbishment and production, then into the late life asset management cycle, including cessation of production and ultimately decommissioning. The design and management of the asset through its long life cycle will influence the approach to decommissioning and provides important context for the market.

Interdependent Systems

Individual offshore oil and gas assets, be they platforms, pipelines, wells or utilities, all interact with and are interdependent upon one another to a greater or lesser degree. While these can introduce additional complexities to the decommissioning process, they can offer opportunities to increase the decommissioning process' efficiency through integrated management of systems and processes.

1.3 The North Sea in Numbers

One of the main challenges in determining the supply chain requirements stems from the heterogeneity of the types and designs of structures present in the North Sea. This renders a consolidated approach to removal difficult, if not impossible. Indeed, North Sea infrastructure varies across geographies due to a range of technical factors including the nature of the resources being exploited, the geological conditions, water depth, and the technology available and metocean conditions at the time of construction.

The Installations

More than 1500 registered installations in the North Sea include small fixed steel installations of less than 100 tonnes, large heavy concrete gravity base or fixed steel installations weighing up to 0.5 million tonnes, floating steel and concrete installations and Subsea steel infrastructure associated with wells[(4)].

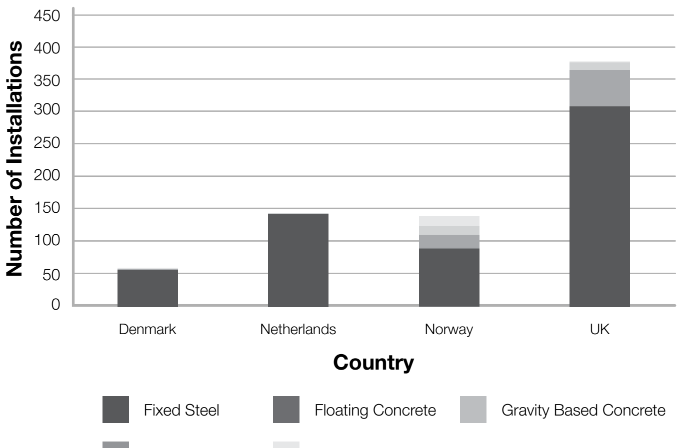
Excluding subsea steel, there are 715 installations in the North Sea: the vast majority of these installations are fixed steel (83%) and located in the UKCS (53%)[(4)].

The Age

The North Sea has an ageing asset base, with the first field having commenced production in 1967. The peak ten year period was from 1984 to 1993 when an average of 20 installations were commissioned each year. The yearly peak occurred in 1993, with 38 commissions[(4)]. The average over the last ten years has been just over 7.5 a year with a peak of 13 a year[(4)].

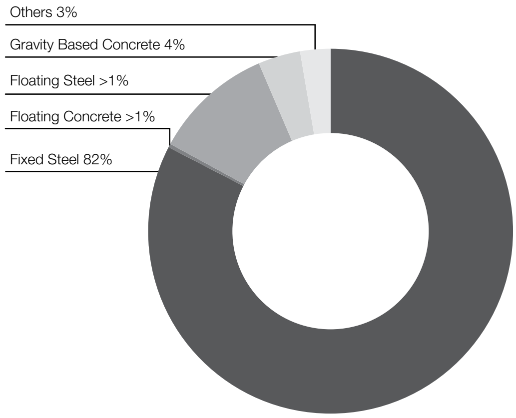
The average age of North Sea installation is 25 years. The UKCS has the oldest average asset base, whilst Denmark owns the youngest assets. There are currently 245 assets over 30 years old across the North Sea[(4)].

Installations in the North Sea



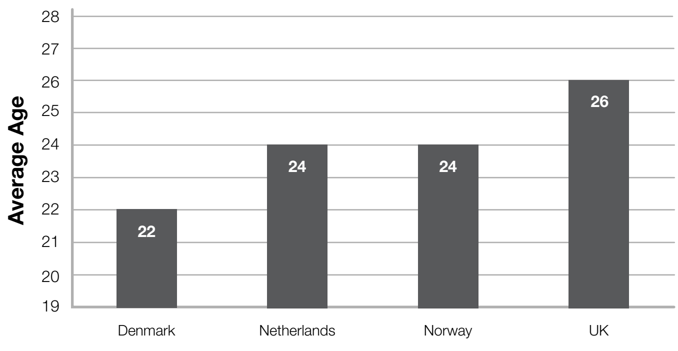
Source: OSPAR[(4)]

North Sea Installation Types



Source: OSPAR[(4)]

Average age of North Sea Installations

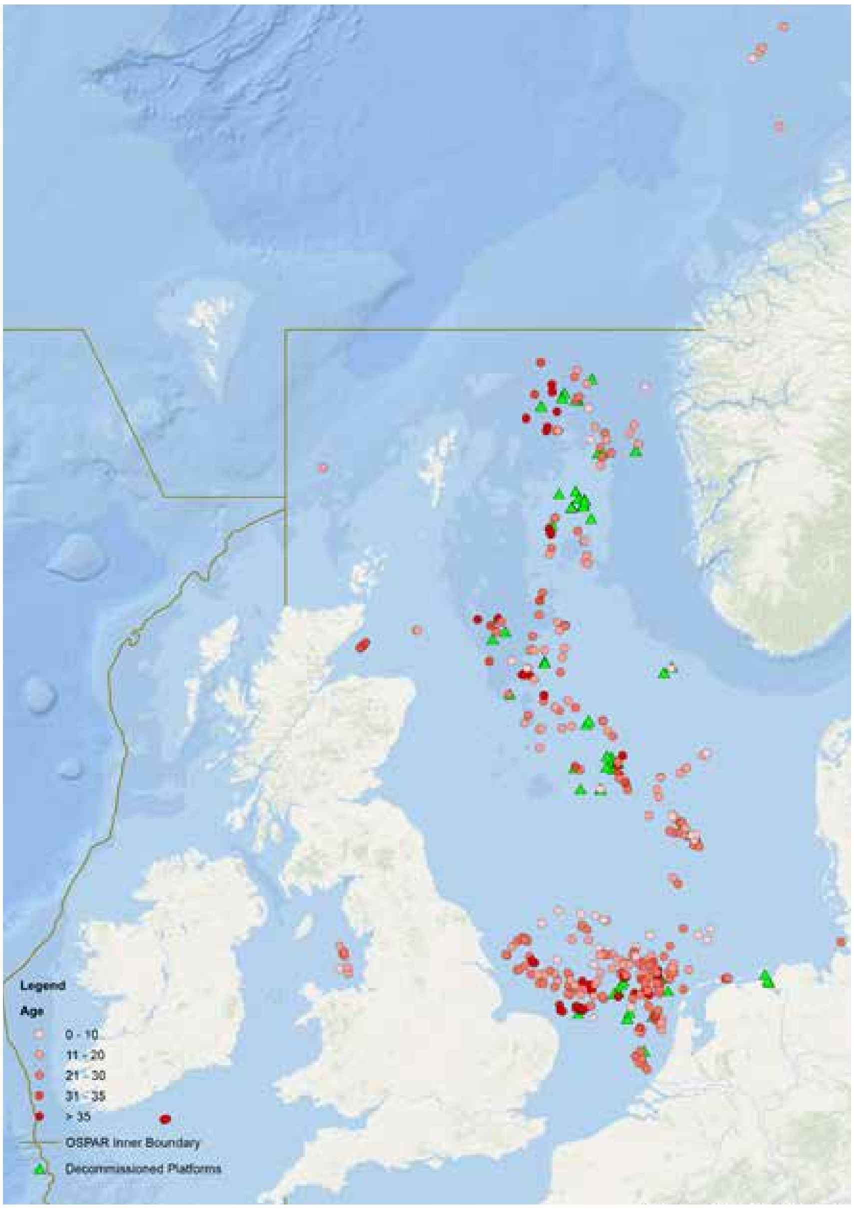


Source: OSPAR[(4)]

Decommissioning

Only 12% (88) of North Sea installations have been decommissioned to date, reflecting the nascent nature of the decommissioning market[4]. This includes 55 fixed steel installations, 22 floating steel, 3 concrete gravity base and 7 others.

Of the 88 installations that have been decommissioned, only seven have had derogations granted to allow infrastructure to remain in place. These have been associated with installations in NW Hutton, Frigg and Ekofisk. With the exception of Hutton, these were all concrete gravity base infrastructure with substructures over 200,000 tonnes. NW Hutton was a fixed steel installation where the jacket and topside were removed and the footings of the jacket were left in situ.



Installations by Age. Source: OPSAR[4]

The Geographies

UKCS Southern North Sea, Danish and Dutch Sectors are generally characterised by comparatively shallow water (less than 60 meters), relatively moderate metocean conditions, and exploit gas resources. They have comparatively light installations[4].

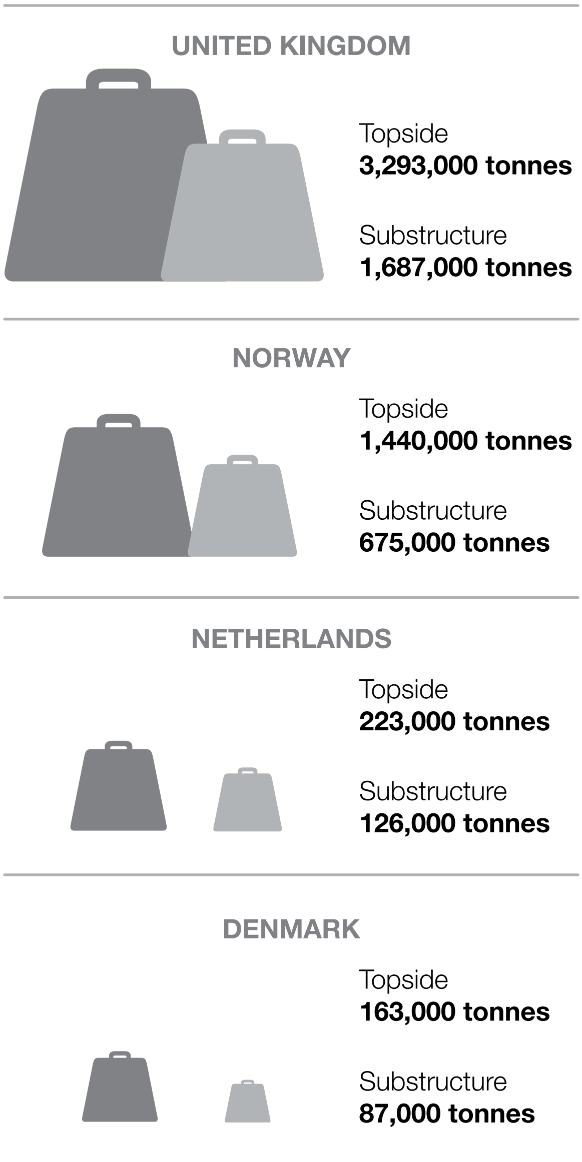
The Norwegian Sector and UKCS Central and Northern Sea have deeper water and more exposed metocean conditions. The platforms are larger and heavier[4].

The Norwegian Sector has proportionally larger installations in tonnage terms compared to other countries. This is because the majority are large deep water installations. Norway also has a proportionally higher number of concrete gravity base infrastructure, when compared to the UKCS.

The UKCS area contains a mix of platform sizes with lighter installations predominately in the southern area and heavier installations to the north.

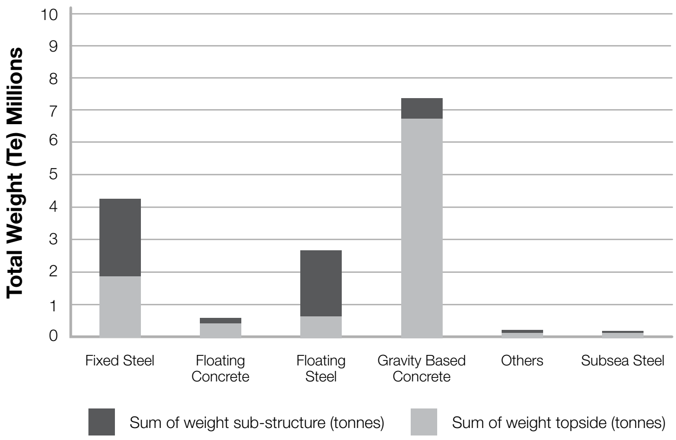
Despite having a similar number of installations to the Norwegian Sector, the Dutch Sector only has a small proportion of the total installation tonnage, as the majority are small installations.

Fixed Steel Infrastructure Weight in the North Sea

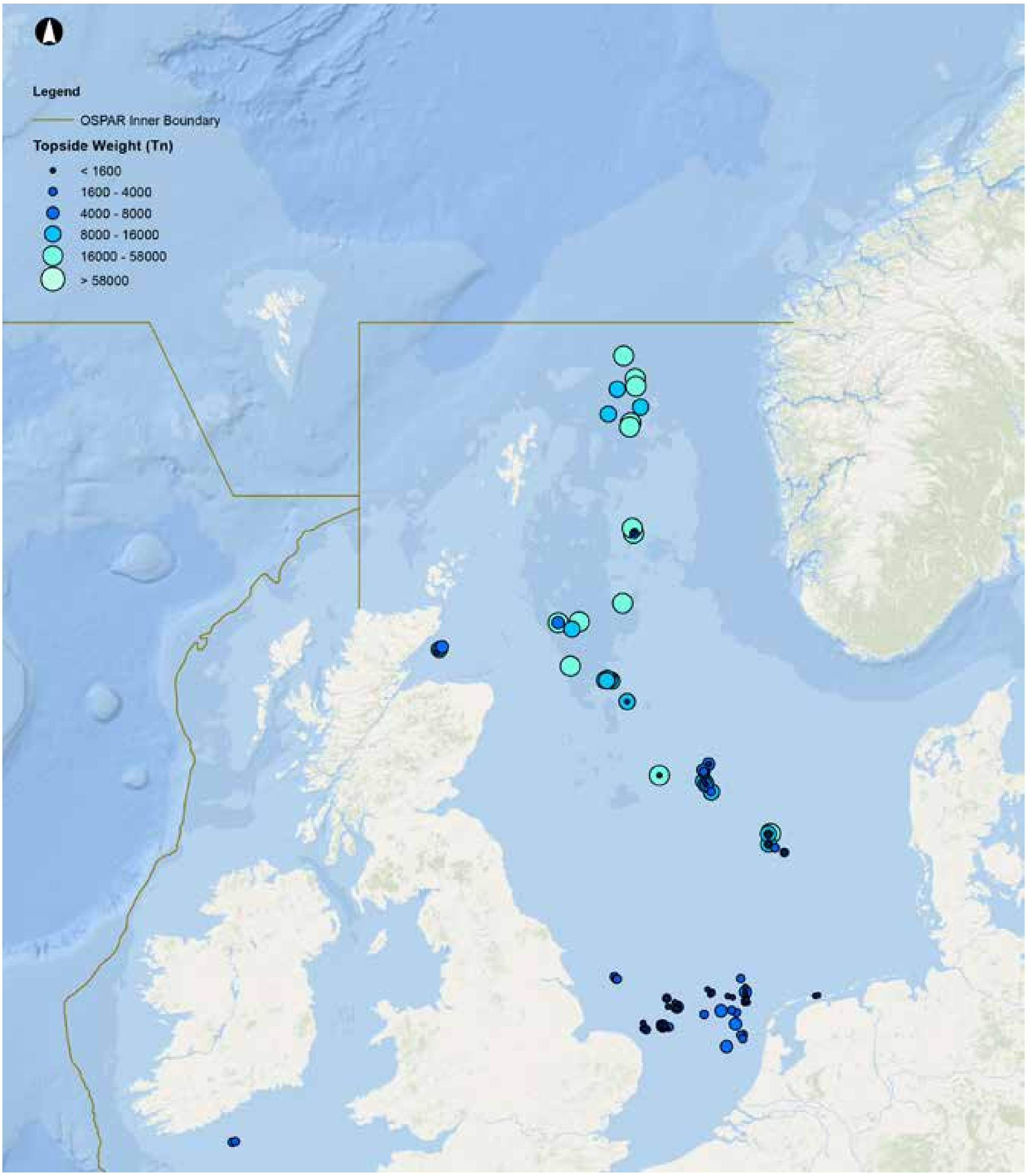


Installations by Age. Source: OPSAR[4]

Infrastructure Weight in the North Sea



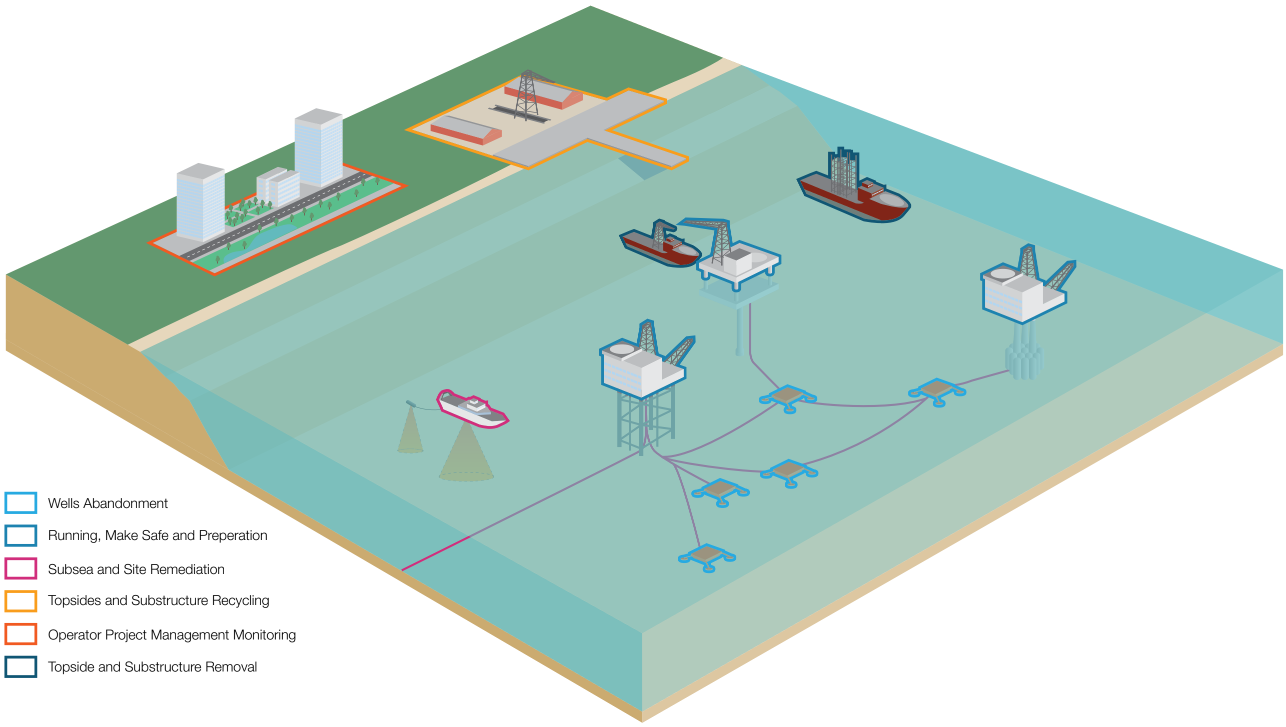
Source: OPSAR[4]



Topside Weight of Installations greater than 30 years old. Source: OSPAR[4]

1.4 Decommissioning Approaches

The manner in which these assets can be decommissioned is subject to a Comparative Assessment by the operators. This assessment is used to make recommendations to the regulatory authority. It considers the technical feasibility, environmental and social impact, economic and health & safety implications of all viable decommissioning approaches in determining the optimal approach. The decommissioning approaches associated with the main infrastructure elements are influenced by the original installation design, and the strategy implemented by the operator.



Topsides

Several methods are used for dismantling installations. The main classifications include:

- **Piece Small** - the installation is dismantled offshore by cutting or dismantling into small sections that are shipped onshore in containers.
- **Heavy-lift** - whole modules are removed in the reverse of the installation sequence and loaded on to flat-top barges or a crane vessel for transport to the decommissioning yard.
- **Reverse Float Over** - the topside is removed in an approach that is a reversal of a float over installation process. Here, the whole topside is cut from the jacket and taken ashore in one piece, with the installation partly floating during transport.
- **Single Lift** - the topsides and/or jacket are removed in one piece and transported to the decommissioning yard.

Substructures

The main classification of substructures includes:

- Steel Installations
- Floating Installations (concrete or steel)
- Concrete Gravity Bases

The majority of substructures will require total removal. For platforms with the option to apply for a derogation, they can be partially removed or left in place if approved.

The main classifications include:

- Heavy-lift [as explained in the section above]
- Reverse Installation [as explained in the section above]
- Single Lift [as explained in the section above]
- Buoyancy where buoyancy tanks are installed on the jacket legs to force the platform to the surface

Wells

Plugging & Abandonment (P&A) is the process by which a well is closed permanently, usually after either logs determine there is insufficient hydrocarbon potential to complete the well, or after production have ceased. Abandonment must be done in a way that protects the downhole and surface environment in perpetuity.

All wells must be P&A according to regulators once no longer in use and their connecting platform is being decommissioned. P&A involves plugging off the well with cement plugs and salvaging all recoverable equipment. The standards applied in terms of expected integrity vary between jurisdictions. The North Sea has some of the world's most onerous regulations. In this region, responsibilities for well integrity are enduring and any future failure must be remedied by the operators.

There is a diversity of well infrastructure in the North Sea which is determined by a variety of technical factors associated with the well including type, location, status and geology. Wells are associated with a range of E&P life cycle activities including exploration (identifying resource), appraisal (determining commercial viability) and development (extracting resource). Wells ready to be P&A may have been suspended through installation of a temporary cap. Alternatively, they may be associated with a depleted reservoir, depending on the installation production status.

In order to determine the manner by which the well can be abandoned, data is collected from the well to determine its current condition. Depending on the age and history of the well and the quality of records, it can be challenging to accurately determine the well state. This creates risk in selecting the appropriate abandonment approach. A low specification approach can reduce costs if well conditions are favourable, but may lead to significant additional costs if the infrastructure isn't capable of completing the abandonment operation.

Pipelines

OSPAR have not made any recommendation for pipelines, and therefore there is no obligation to remove them. Agreement must be obtained from the regulating authority on the appropriate approach through consideration in a comparative assessment. Key issues to be considered are pipeline cleanliness, stability, extent of burial and impact on other users of the sea.

There are diverging precedents in the North Sea. Indeed, some pipelines have been decommissioned in situ, while others have been removed to shore. Generally, the smaller pipelines which can be more easily removed without significantly disturbing the seabed are recovered.

2.0 Approach

2.1 Analysis of Supply Chain

The approach to the analysis of the decommissioning supply chain taken in this report is explained below.

Market Forecasts in Expenditure Trends

Review of existing industry estimates of overall anticipated decommissioning expenditure to understand the likely range of activity over the next 5 to 10 years in the North Sea. This information is found in Chapter 4.

Critical Supply Chain Elements

This involves identifying the critical supply chain elements on which the detailed assessment is undertaken. Critical supply chain elements are resources that are fundamental to delivering decommissioning projects, and which would have the most significant effect on the deliverability of the decommissioning market if there were capacity constraints. It is on these elements that a detailed activity analysis will be undertaken. This information is found in Chapter 3.

Market Forecasts in Activity Trends

These estimate the level of activity expected for each of the critical supply chain elements which is informed by the overall expenditure trends. This information is found in Chapter 4.

Supply Chain Capacity Review

This consists in a detailed review of the capacity of the existing supply chain for the critical supply chain activities. This information is found in Chapter 5 to 8.

Capacity Health Check

A capacity health check analysis is essential to determine the critical supply chain elements. The analysis considers the following parameters:

- Available Capacity & Investment Lead Time - considers the existing capacity of skills and resources against expected activity and the duration it takes to build any capacity shortfall.
- Investment Commitment – considers the progress and commitment made by the supply chain to build new capacity to meet any shortfalls.
- Pressures/Synergies from other industries - considers the opportunity or threat of analogous industries. This can result from completion from resources/skills, or supporting the investment case to build capacity.
- Capability - refers to the competence of the industry to support the decommissioning market. It is distinct from capacity as it doesn't relate to the volume of capable resources to meet the predicted demand. The classification of capability is derived from the assessment commissioned by DNS and Scottish Enterprise (5). In this report, the industry and supply chain was consulted on their perceived capability to provide decommissioning services as per the O&GUK Work Breakdown Structure (WBS).

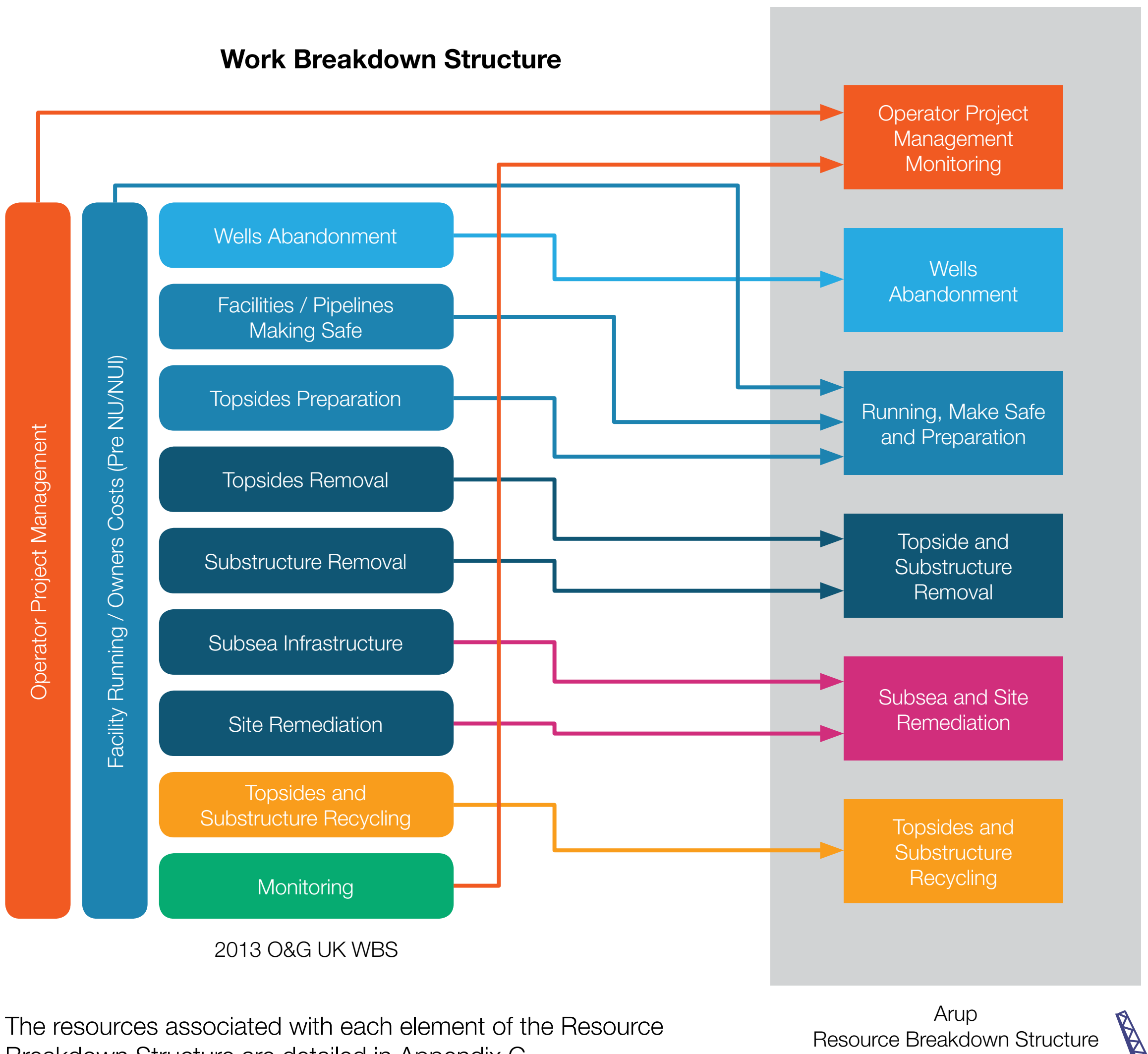
Each critical supply chain element is attributed a score of Low to High (Low, Low/Medium, Medium, Medium/High, High) for each parameter. The scoring is based on subjective criteria which are detailed in Appendix B. The capacity health check is found in Chapter 5 to 8.

2.2 Work Breakdown Structure

A common language in decommissioning has been developed by Oil and Gas UK (O&GUK) through the production of their Work Breakdown Structure (WBS). Activities associated with the decommissioning programme have been characterised in 11 categories which are defined.

This report uses an aggregated version of the O&GUK WBS which focuses on the resource requirements. Some O&GUK categories have been combined where there is commonality in the resources that support the activities. This categorisation has been termed in this report as the Resource Breakdown Structure (RBS) to differentiate it from the O&GUK WBS.

The relationship between the 2013 O&GUK WBS and the RBS can be seen in the figure below.



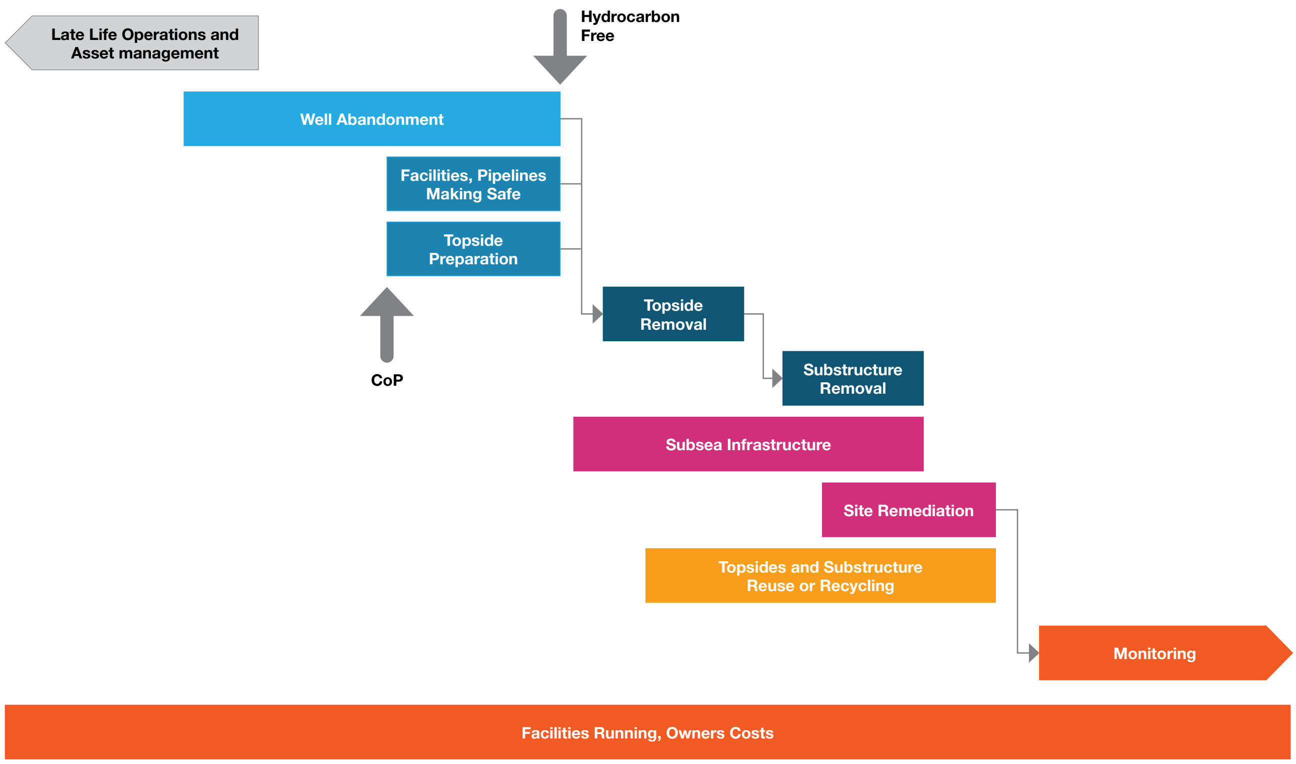
The resources associated with each element of the Resource Breakdown Structure are detailed in Appendix C.


NORTHERN DIVER
CYGNUS DIVE
Ti-4X
THERMACOTE

2.3 Programme

The decommissioning programme commences with the management of the asset during late life, and lasts all the way to the continuous monitoring of the seabed once the asset has been decommissioned. The diagram below shows the RBS activities in a programme format.

The programme duration depends on the technical complexity of the project as well as a range of commercial considerations. A typical project is often carried out in parts with several periods of inactivity, rather than a continuous activity flow and so individual project programmes can vary significantly.



3.0 Critical Supply Chain Elements

Identification of the critical supply chain elements has been based on our experience and view of the status of the industry and informed through consultation with the industry expert panel. The following critical supply chain elements have been established as those most likely to impact on the delivery of cost effective decommissioning programmes, with potential to require market intervention to ensure their capacity is secured.

They are parts of the supply chain which are known to have:

- demands from other maritime and other industries
- known shortages either in the past or expected or future, are specialised and not easily substituted by alternative, and
- challenges in growing capacity

The critical supply chain elements identified are show in the table referenced to the resource breakdown structure.

Resource Breakdown Elements	Critical Supply Chain Elements	Generic Critical Supply Chain Elements
Operator Project Management	None Considered Critical	Engineering Skills Operational Skills
Well Abandonment	Drilling Rigs or Rigless Alternatives	
Running Making Safe and Preparation	None Considered Critical	
Topside and Substructure	Removal Vessels	
Subsea and Site Remediation	None Considered Critical	
Topsides and Substructure Reuse	Ports, Harbours and Yards	

Rigs and Rigless Alternatives for Well Abandonment

Rigs or rigless alternatives have been identified as a fundamental aspect of the well abandonment process and cannot be replicated through another process. This infrastructure has significant pressures from E&P activities as the same infrastructure is utilised for drilling activities and is mobile across the global market. This market is volatile and the spot prices for this infrastructure is vulnerable to market demand. The capacity floats to meet an unpredictable demand and decommissioning activity will need to compete within this challenging market.

Removal Vessels for Topside and Substructure Removal

Removal vessels are a critical part of the decommissioning process and their cost and availability will have a substantial impact on the overall costs of the process. It is likely that vessels with lift capacities of 500 tonnes and significantly higher will be utilised by the market regardless of the approach to removal. They are not unique to the decommissioning market and new O&G infrastructure construction as well as offshore wind markets.

The capital costs of a new vessel are significant, and vessel operators will require a substantial commitment to invest in new capacity. The latest new specialist heavy lift vessel, the Pieter Schelte was over 10 years in development and was supported by an investment case from markets other than decommissioning. Although smaller vessels for piece small operations will be significantly cheaper and quicker through the planning process, they would need to be developed in greater volume to meet the capacity of the larger vessels.

Ports, Harbours and Yards from Topsides and Substructure Recycling

Although operators could potentially utilise ports, harbours and yards from the global market to carry out decommissioning activities, this would likely be at a significant cost penalty to decommissioning. This is not because it would impact recycling costs, which are only a small proportion of overall costs, but because it would impact on removal costs through increasing vessel costs. It would also reduce the potential for local socio-economic benefits through creation of jobs in the North Sea local markets.

The capital cost of upgrading major infrastructure can be substantial and generally requires high investment certainty to make commitment. In addition to this the timescales can be extremely protracted, with the duration to realise significant new infrastructure from design and development to construction potentially taking up to a decade for a contentious development.

Engineering and Operational Skills for all areas of Decommissioning

Skills capacity is an issue that cross all aspects of the decommissioning process, and was commonly cited as a potential concern and constraint. The challenges to grow skills capability are distinct to investment in a physical resource such as a vessel or port. They require a collaborative effort between schools, universities, operators, supply chain and government.

Other Resources

There are a significant number of other resources associated with the decommissioning processes which are detailed in Appendix C. These resources offer a significant opportunity to the supply chain in a growth market, and will require a range of highly skilled and high value capability.

A range of activities will require innovation in terms of technical and management approaches to drive down the costs of decommissioning. Examples include development in cutting tools, or improved logistics management of offshore operations. There are other areas that will need significant growth in capacity to meet the demands of the market, such as a growth in survey capability or support vessels.

There will undoubtedly be constraints in supply of many of these resources depending on the level of market demand. However these areas are lower capital investment and lead time when compared to the aspects considered as critical supply chain elements. The supply chain is more likely to be able to naturally respond to these opportunities without any market intervention. As such, although they are considered as significant opportunities, they are not assessed in detail as part of this exercise.

A health check of the four critical supply chain elements identified above is dealt with in Chapters 5 to 9 where each element is considered within the context of the expected activity and in light of current capacity. Engineering and operational skills are considered separately in Chapter 4, as these skills are somewhat transferrable across the RBS, but also because the capacity and demand is not so easily fragmented as in other areas.

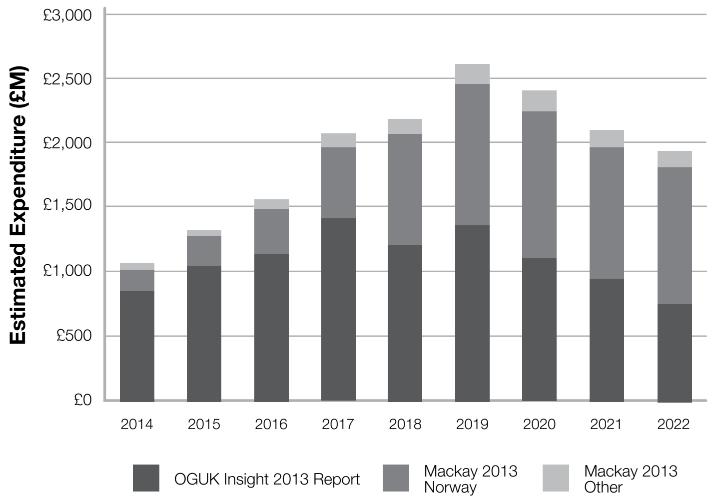
4.0 Market Forecasts in Expenditure and Activity

4.1 Market Forecasts of Expenditure

Available market forecasts indicate that the overall decommissioning expenditure in the North Sea could be between £1.1bn and £2.6bn per annum, and is estimated to reach over £17bn on the period between 2014 to 2022[3].

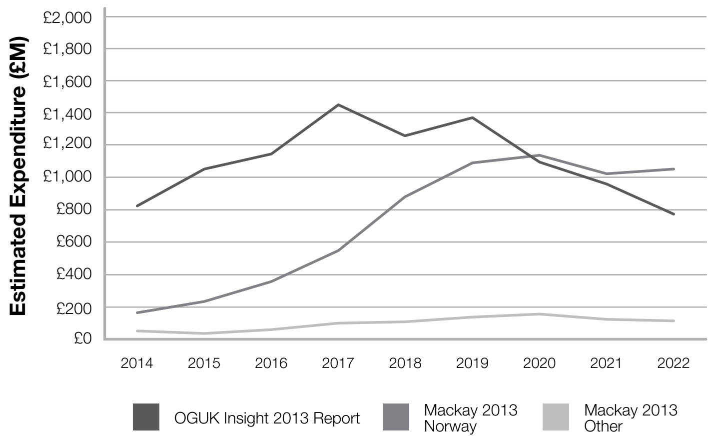
UKCS is likely to be the largest Sector of the North Sea decommissioning market, although Norway is expected to contribute a significant proportion of activity as the end of the decade approaches. Denmark and the Netherlands are likely to contribute a much smaller proportion of activity.

Annual Estimated North Sea Decommissioning Expenditure



Source: Oil & Gas UK[1], Mackay Consultants[3]

Estimated North Sea Decommissioning Expenditure



Source: Oil & Gas UK[1], Mackay Consultants[3]

Predicting Decommissioning Activity

Accurate estimation of decommissioning expenditure is challenging. Forecasts have been produced by a number of organisations to estimate the profile of decommissioning expenditure in the North Sea over the next decade. These estimates are substantially diverse both in the short and long term.

The estimates are underpinned by assumptions of the costs of decommissioning activities and the programme in which activities are delivered. There is inherent uncertainty in both areas:

- The timing of decommissioning activities is informed by an economic analysis which considers the revenue generated from the platform in terms of productivity and market value of the resource, the costs to operate and maintain the infrastructure and the capital costs of decommissioning. Current trends have seen the value of the oil and gas increase, while technology innovation has allowed for improved extraction, increasing the life span of ageing infrastructure
- The costs of decommissioning generally have not to date been reliably predicted, due to the nascent stage of the industry and lack of understanding of the technical complexity of projects. The evolving market has significant potential to reduce costs through technology innovation compared to these early projects.

Data from the Norwegian, Danish, and Dutch Sectors are significantly less detailed and less robust than data from the UKCS. Although these Sectors have fewer installations than the UKCS, they cumulatively represent almost half of the oil and gas infrastructure in the North Sea.

Profile of Market Activity

There are further limitations in decommissioning estimates which are built from a bottom-up analysis based on individual operators independently declaring their expected decommissioning schedule. These estimates suggest that activity will ramp up in the next decade with a number of peaks and troughs in activity.

However, the market is inherently different to that of E&P activities. In E&P programmes, delays directly impact the timing of subsequent revenue flows and programme drivers are highly significant in procurement decisions, resulting in an industry that has a peaking profile.

For decommissioning, programme delays defer capital expenditure and often have a relatively less significant detrimental impact on project economics. As a result, operators are likely to have higher flexibility to manage procurement and programme decisions, and are unlikely to procure in peak periods so there will be a flattening of the peaks and troughs with the decommissioning market flexing.

Interaction with the Wider Supply Chain

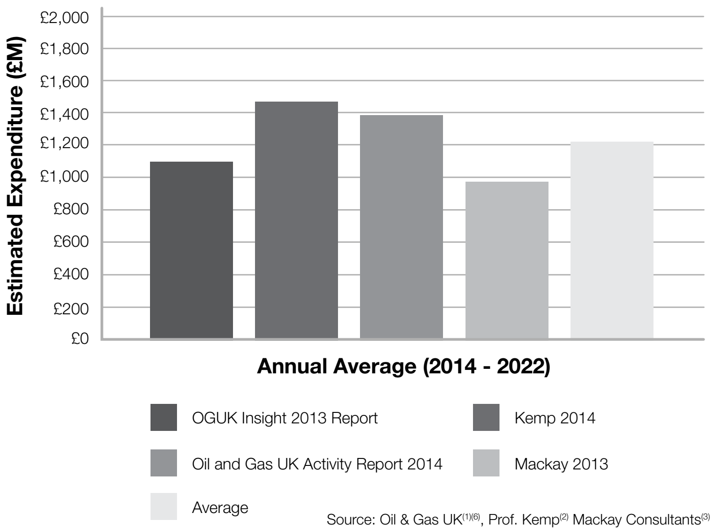
The vast majority of resources utilised by the decommissioning market are not wholly specialised to those activities. A number of critical supply chain elements support other offshore industries such as E&P, offshore wind, subsea cabling, and marine renewables. The mobility of resources means that the impact potential of local and global activities on decommissioning supply should be considered. Indeed, decommissioning spend over the next decade is expected to be a small proportion of overall oil and gas market, both in the North Sea and globally. Therefore expenditure in this area is likely to be a key influencing factor in the delivery of North Sea decommissioning.

Forecasts of Expenditure in the UKCS

O&GUK undertake a comprehensive survey of estimated spend and activity in the UKCS. Their members estimate that £10.4bn of expenditure will be incurred by 2022[1]. This is approximately 30% of the decommissioning costs in the UKCS estimated to 2040[1]. This spend is associated with the decommissioning of 2,300km of pipelines, over 130 installations and 800 wells[1].

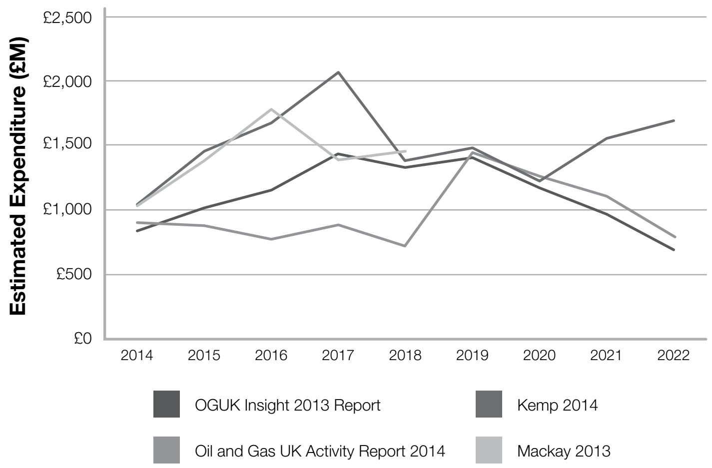
However, there is significant uncertainty with regards to the spend that will actually be incurred, due to confidence in the estimates of both costs and timing of individual programmes. Comparison of O&GUK analysis with other trend analysis shows a significant range in both the annual and average forecasts. The largest annual variance is over £1.2bn and average range is over £0.5bn[1],[2],[3],[6].

Forecast Annual Average Decommissioning Expenditure in the UKCS



Source: Oil & Gas UK[1][6], Prof. Kemp[2] Mackay Consultants[3]

Forecast Annual Decommissioning Expenditure in the UKCS

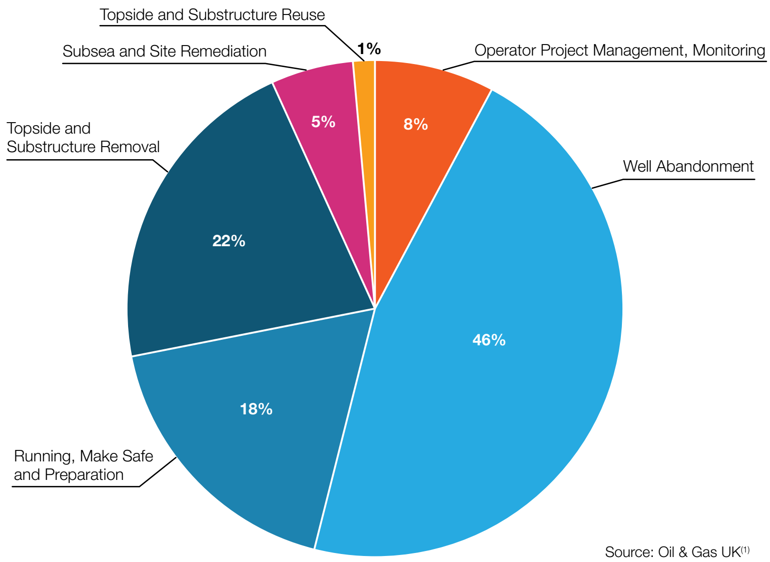


Source: Oil & Gas UK[1][6], Prof. Kemp[2] Mackay Consultants[3]

Expenditure in each of the six RBS categories is biased toward Well Abandonment which accounts for 46% of the average spend over the period. Two categories; Running, Making Safe and Preparation as well as Topside and Substructure Removal, account for a further 40% of spend, with the remaining categories accounting for only 14%[1].

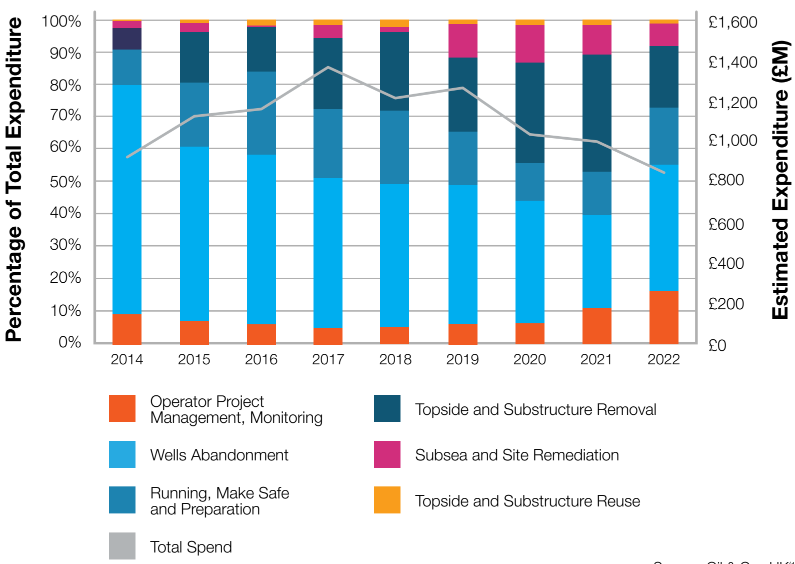
Within each of the RBS categories, trends of spend proportion vary over time as the overall projects profiles change from a bias to early stage activities (such as Well Abandonment), to later activities (such as monitoring)[1].

Resource Breakdown Structure Average UKCS Expenditure (2014 - 2022)



Source: Oil & Gas UK[1]

Estimated Annual Expenditure in the UKCS



Source: Oil & Gas UK[1]

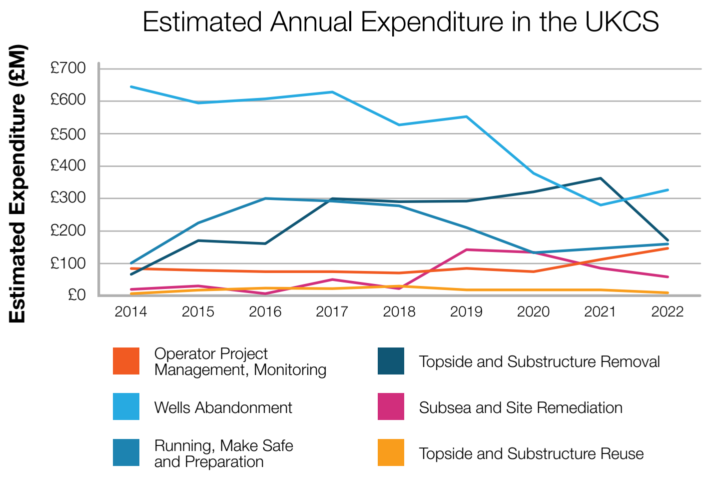
The data shows that the overall trends in peaks and troughs is not applicable to all RBS elements. Topside and Substructure Recycling and Operator Project Management are relatively consistent through the period. Whereas Well Abandonment shows a sharp decline to 50% of its peak to 2022. Topside and Substructure Removal grows to a peak near the latter end of the programme. This shows that the overall trends relating to growth and decline will not be consistent across all elements of the RBS[1].

Forecast of Expenditure in Norway

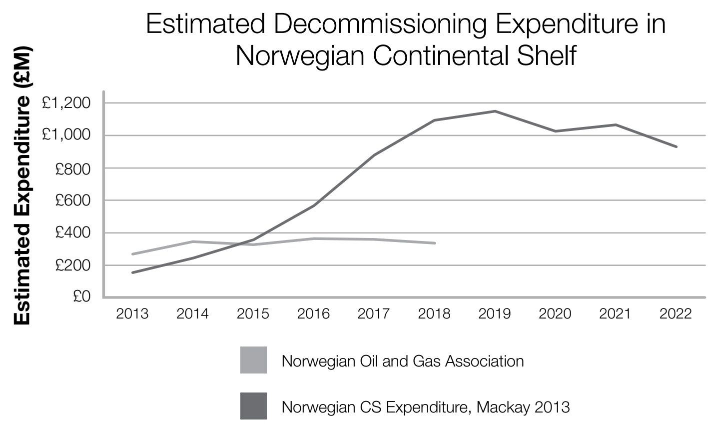
Norway has 19% of the North Sea installations, and approximately a third of the number in the UKCS[4]. There is a paucity of data regarding the likely decommissioning expenditure for the Norwegian Continental Shelf as compared to the UKCS.

The Norwegian Climate and Pollution Agency (NCPA) estimates the costs of decommissioning the entirety of the current infrastructure in the NCS to approximate 160bn NOK (£16bn)[7]. This represents about half of the UK's estimates to 2040. While the Norwegian Oil and Gas Association (NOGA) has predicted conservative estimates up to 2018, analysis undertaken by Mackay suggests a total spend of £7.3bn up to 2022, which represents over 55% of the total estimated spend[8],[3].

This is a more front loaded profile than for the UKCS, which expects only 30% of costs incurred to 2022. The assets based in the UK are on average older than in the Norwegian Sector, which suggest significantly different assumptions of asset life have been made in the two Sectors.



Source: Oil & Gas UK[1]



Source: Mackay Consultants[3], NCPA[8]

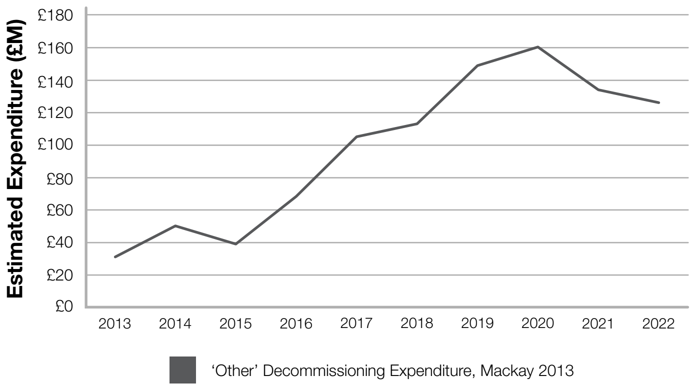
Forecasts of Expenditure Denmark and Netherlands

There is little information on decommissioning forecast in the Dutch and Danish Sectors.

- The Dutch Sector of the North Sea has a similar number of installations to that of Norway. However the depths are relatively shallow and generally platforms are much smaller than those in the Norwegian Sector.
- Denmark has only 8% of the total UKCS installations. Analysis by Mackay identified only five fields expected to be decommissioned in the period to 2022[(3)]. This means that overall expenditure is expected to be on a minor scale.

As such, the anticipated expenditure is expected to be significantly less than the UK and Norwegian Sectors.

Estimated Decommissioning Expenditure for Denmark and the Netherlands



Source: Mackay Consultants[(3)]

4.2 Market Forecasts of Activity

Market expenditure provides an understanding of the likely levels of overall activities predicted in the North Sea. However, to understand the requirements of the supply chain it is necessary to understand the characteristics of the infrastructure that is planned for removal in more detail.

There is limited publically available information on individual installation decommissioning programmes. It is therefore not possible to build up this understanding from the bottom-up. However, analysing the general characteristics of the North Sea Sectors provides insight into the infrastructure that could be removed in the coming decade.

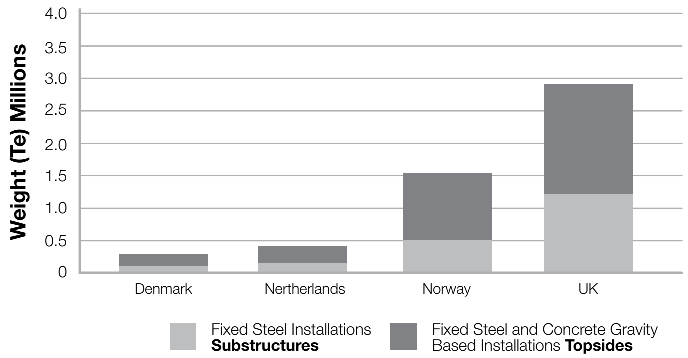
Steel Activity

Fixed steel installations and the topsides of concrete gravity base installations are most likely to require a removal vessel to decommission the topside and substructure either by lifting or reverse float over (a method where a vessel is semi-submerged and positioned under the platform, and the lift is achieved by de-ballasting the vessel). The remaining installations are either self-propelled or can be towed requiring less onerous intervention.

The UK and Norway have an estimated 4.5 million tonnes of steel associated with fixed steel or concrete gravity base topsides which will all eventually need to be decommissioned[4].
The other North Sea countries account for only 0.6 million tonnes or 12% of the total North Sea steel removal requirements[4].

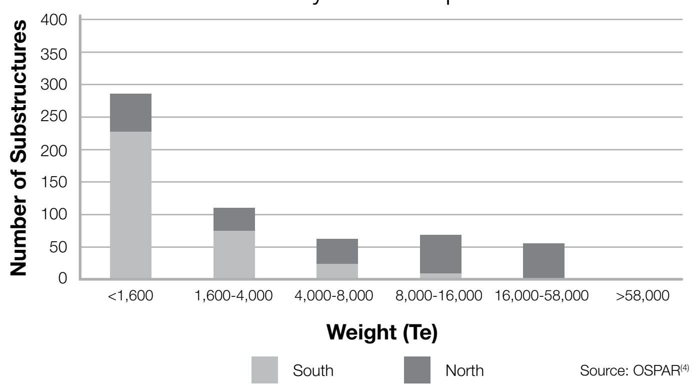
The largest steel substructure is the 45,300 tonne YME MOPUStor installation[4]. However, the majority of substructures are significantly lighter, with 64% under 2,000 tonnes. The largest topside for a fixed installation is the 53,000 tonnes Gullfacks C[4]. Again, the majority of substructures are significantly lighter with 62% under 3,000 tonnes.

Steel Removal Requirements of Fixed Steel and Concrete based Topside



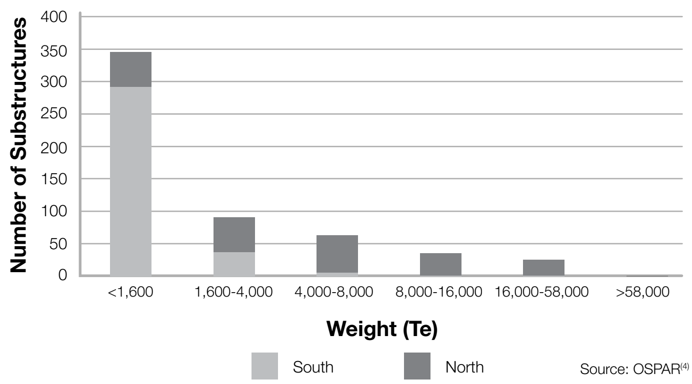
Source: OSPAR[4]

Weight of Fixed Steel and Concrete Gravity Based Topsides



Source: OSPAR[4]

Weight of Fixed Steel Substructures



Source: OSPAR[4]

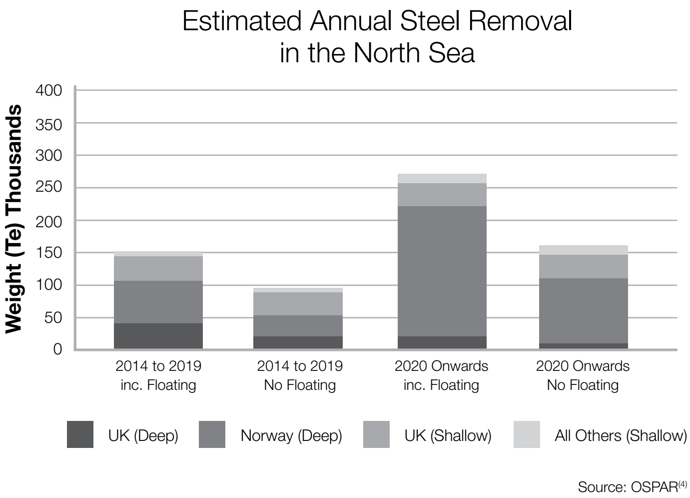
Across the North Sea, steel decommissioning is estimated to average around 150,000 tonnes per annum up to 2019 and over 270,000 tonnes per annum between 2020 and 2022 by O&GUK, the Norwegian Government and Arup[(1), (7)]. Excluding steel associated with floating installations, this figure could be around 100,000 tonnes per annum up to 2019 and over 150,000 beyond.

The decade from 1984 to 1993 was the period when the most infrastructure by weight was installed in the North Sea on an annual average basis with over 240,000 tonnes of the steel installed every year[(4)]. This volume of activity is commensurate with estimated activity over the next decade. This suggests decommissioning activity could be comparable to peak installation activity.

In the UKCS, it is estimated that nearly 440,000 tonnes of steel associated with topsides and substructures will be removed in the period between 2014 and 2022[(1)]. This equates to approximately 9% of the existing steel infrastructure in the UKCS.

The timing of decommissioning activities in the Norwegian Sector is considered more uncertain with limited published analysis available. The NCPA have estimated that between 50,000 to 80,000 tonnes of steel a year will be removed until around 2020[(7)]. The Agency then expects a steep increase to around 200,000 tonnes after 2020. This estimate seems surprisingly high as it equates to the removal of nearly 50% of the existing steel infrastructure in the Norwegian Sector by 2022.

The Dutch and Danish Sectors are even less quantified, but likely to only contribute a small proportion of total North Sea steel removal activity. Estimates made by Arup suggest a total removal of the order of 30,000 - 40,000 tonnes between 2014-2022, or 5-7% of their existing infrastructure.



Well Abandonment

Platforms vs Subsea

Wells are either co-located with a platform and have been drilled from a permanent installation to which the well is directly connected, or subsea and drilled from a mobile installation and tied back to a local platform. Platform wells may be abandoned using the platform as an operational base. If the original drilling rig is still present, it can be refurbished and reused to abandon the well. Alternatively, a rig can be retrofitted to the platform, or a rigless alternative can be used. Platform-based operations are significantly more flexible and lower cost than their mobile alternative. Encountering unexpected conditions is also generally less of a concern than for subsea wells, as operations are more easily suspended.

Subsea wells can also be abandoned using a mobile rig such as a drill ship, semi-submersible or jack-up vessels with associated abandonment rig. A light-weight intervention vessel can also be used if a rigless methodology is opted for. The water depth and metocean conditions of well location both influence the appropriate methodology and subsequent vessel requirements.

Rigs vs Rigless

Wells can be abandoned using either rig or rigless approaches. A rig based approach uses vessel or platform drilling rigs, adapted to recover downhole equipment and plug the wells. Rigless alternatives and can be utilised for some or all parts of the P&A operations to reduce the number of expensive rig days. However, the condition and type of well dictates the potential to use a rigless approach. Currently rigless operations have been limited mainly to platform based operations due to technology constraints and operators risk appetite. Due to the limitations of rigless methodologies, costs can dramatically increase if unexpected conditions are encountered and a rig needs to be deployed to complete the abandonment. Technology innovation and increased demonstration of rigless approaches is likely to reduce these risks and increase their use in the future with consequential cost reductions for web abandonment activities.

Activity

It is estimated that there are more than 8,200 wells in the North Sea that are active or suspended and awaiting P&A. The majority of these are located in the UKCS, accounting for 61% of wells [9] [10] [11] [12] [13].

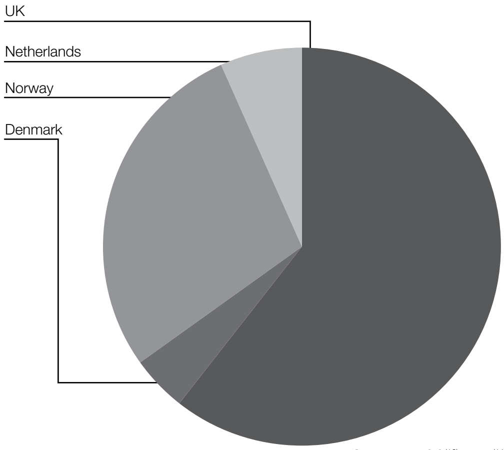
There is significant data available from the UKCS in terms of the nature of well infrastructure and planned decommissioning activity which can be used to inform the understanding of demands on the supply chain. The other Sectors have a paucity of data. It is therefore necessary to make assumptions in terms of the relative activity based on known data in terms of geographical characteristics, infrastructure volume, spend and activity profiles.

Activity in UKCS

It is estimated that there are close to 5,000 wells requiring abandonment in the UKCS of which around 18% (more than 800) will require removal in the next decade[9], [1]. Approximately 80% of all wells in the UKCS are associated with a platform, but the next decade will see a proportionately larger number of subsea wells to platform wells being removed, compared to the long term[9].

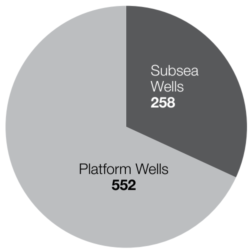
Of the wells expected to be decommissioned in the next decade, there is a relatively consistent and even split between wells in the south and central North Sea compared to the northern North Sea. This is the case for both subsea and platform wells. This will influence vessel selection as water depth and metocean conditions differ across these regions.

Wells in the North Sea



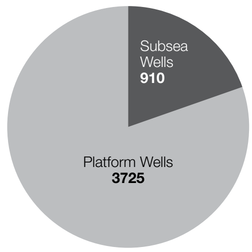
Source: DECC[10], NPD[11], DEA[12], NLOG[13]

Wells to be Decommissioned in the UKCS (2014 - 20122)



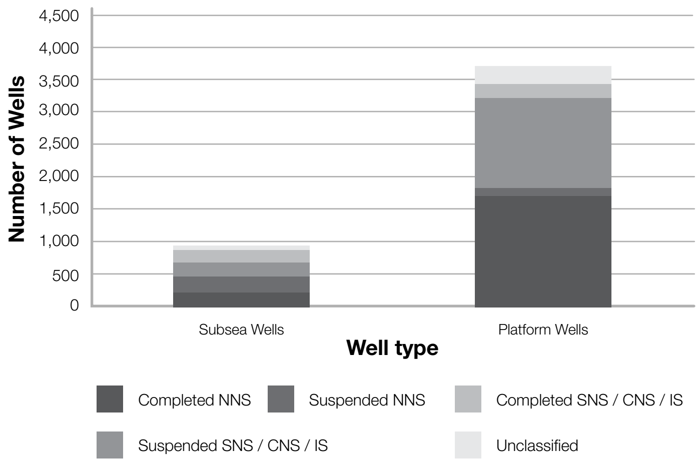
Source: Oil & Gas UK[1]

Total UKCS Wells to be Decommissioned



Source: Oil & Gas UK[9]

UKCS Wells to be Decommissioned (2014 - 2022)

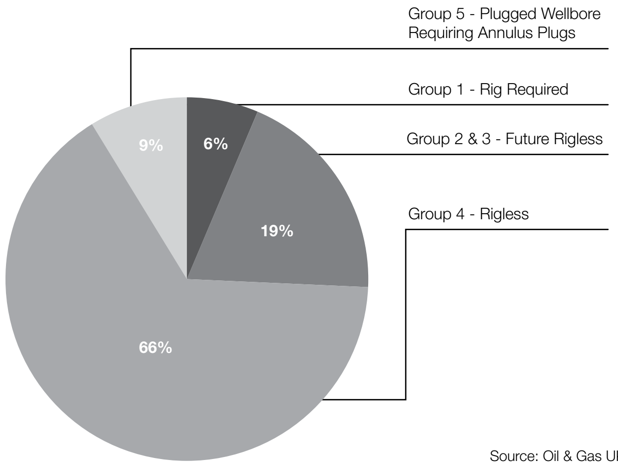


Source: Oil & Gas UK[9]

Analysis undertaken by O&GUK also estimates the number of wells that might be undertaken using rig-based and rigless approaches[9].
It considers that only 6% of wells will definitely require intervention with a rig. A further 19% could be abandoned using rigless methodologies if anticipated technological advancements are made; otherwise they would likely need a rig.
In total 66% of wells could be removed using current rigless technology, and the vast majority of these are platform wells which lend themselves more readily to this approach.

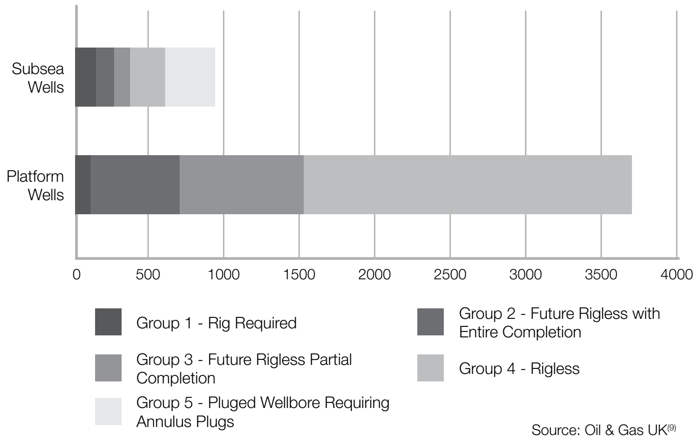
In the next decade, it is expected that approximately a third of wells removed from the UKCS will be subsea wells[9]. This is a higher ratio than for the total asset base where a fifth of wells are subsea[9]. Subsea wells are more likely to require a rig-based intervention than platform wells. Moreover, it is likely that the demand for rig equipment for well abandonment will be higher over the next decade than in the longer term.

Wells by Intervention Type



Source: Oil & Gas UK[9]

UKCS Wells to be Decommissioned



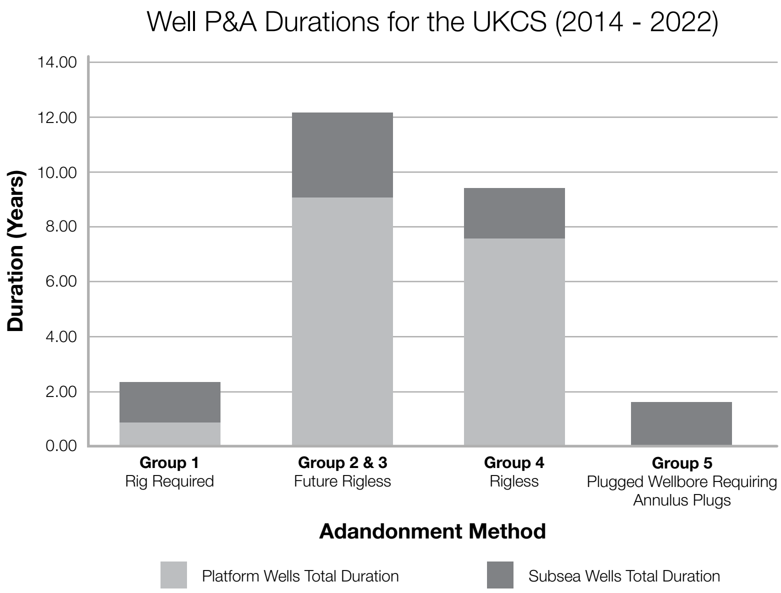
Source: Oil & Gas UK[9]

Activity in Norway

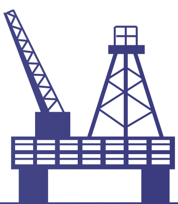
There are over 2,300 active wells in the Norwegian Sector of which only 140 have been suspended[11]. There is limited information regarding the planned decommissioning programmes for these wells, or if they are associated with platforms or subsea.

The nature of the Norwegian Sector water depths means that the wells are likely to all be in deeper waters, therefore requiring intervention by semi-submersible vessels or drill ships, rather than jack-up vessels.

The Norwegian volume of activity could be assumed as roughly half of the UK activity inferred from the knowledge that they have only 40% of the infrastructure, but that their spend and steel removal activity profile suggest a more aggressive spend profile than the UK. In the absence of published data, it could be assumed that Norway has similar characteristics to the UK in terms of demands for rigs versus rigless solutions. However, further analysis of the characteristics of the wells may affect those assumptions.



Source: Oil & Gas UK[9]



Activity in Denmark

There are nearly 380 active wells in Danish waters[12]. Denmark has been focusing on the P&A of suspended wells which has resulted in only a very small number remaining suspended, all of which have P&A plans approved by the Danish Energy Agency (DEA). Across the Danish North Sea, only 3 subsea wells exist with all remaining wells being platform based.

The nature of the Danish Sector water depths means that the wells are likely to be all in shallower waters requiring intervention by jack-up vessels rather than semi-submersible vessels or drill ships.

Activity in Denmark is likely to be more biased towards rigless approaches than the overall UK profile due to the low number of subsea wells. However, the spend profiles combined with the proportion of infrastructure suggests that activity will represent less than 10% of the level occurring in the UKCS.

Activity in Netherlands

There are nearly 500 active wells in Dutch waters of which approximately 10% are suspended[13]. There is limited information regarding the planned decommissioning programmes for these wells, or if they are associated with platforms or subsea.

The nature of the Dutch Sector water depths means that the wells are likely to be all in shallower waters requiring intervention by jack-up vessels rather than semi-submersible vessels or drill ships.

In the absence of published data, it could be assumed that the Dutch Sector would have similar characteristics to the UK in terms of demands for rigs versus rigless solutions. However, further analysis of the characteristics of the wells may impact those assumptions.

However, the spend profiles combined with the proportion of infrastructure suggests that activity will represent less than 10% of the level occurring in the UKCS.

Published Plans

There is a paucity of published data on decommissioning dates from operators. Data published by OSPAR and the North Sea regulators identifies a total of 32 installations likely to cease production and/or be removed in the coming decade [(4), (14), (15), (16)]. These include 29 fixed steel installations and 3 concrete gravity base. 67% of the platforms are located in the deeper and more exposed waters in the northern areas of the North Sea.

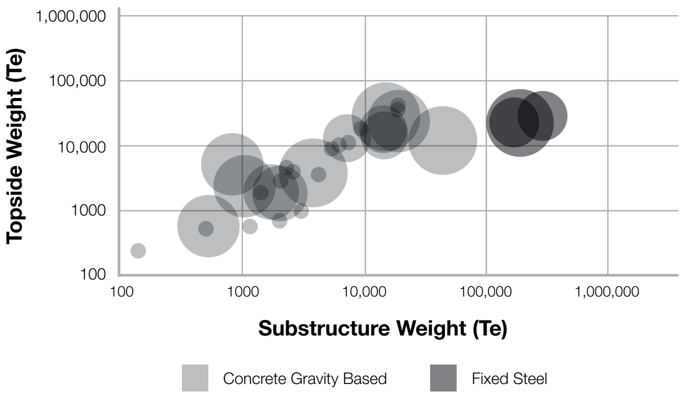
UK	Norway	Denmark	Netherlands
Miller	Albuskjell F	Cecilie	Q8-B
Brent A	Edda	Dagmar	K10-B
Brent B	Ekofisk A	Rolf	
Brent C	Ekofisk G	Svend	
Brent D	Ekofisk S		
Goldeneye	H-7		
Kittiwake A	Hod		
Thames AV	Huldra		
Thames AR	Valhall PCP		
Thames AP	Vest EkoFisk		
Brae A	YME MOPUStor		
Brae B			
Brae East			
Murchison			
Little Dotty			
Big Dotty			

The following plots show the relative topside and substructure weights for the 32 identified platforms. The larger the circle, the sooner the platform is planned for removal.

The identified platforms equate to approximately 1.2 million tonnes of infrastructure of which 540,000 tonnes is fixed steel or concrete gravity base topsides. This equates to an annual removal of approximately 54,000 tonnes of steel. These figures are about two thirds of the values identified by O&GUK and NCPA up to 2020. This suggests that there are plans for additional platforms to be decommissioned in the next decade, which aren't in the public domain and these estimates appear conservative.

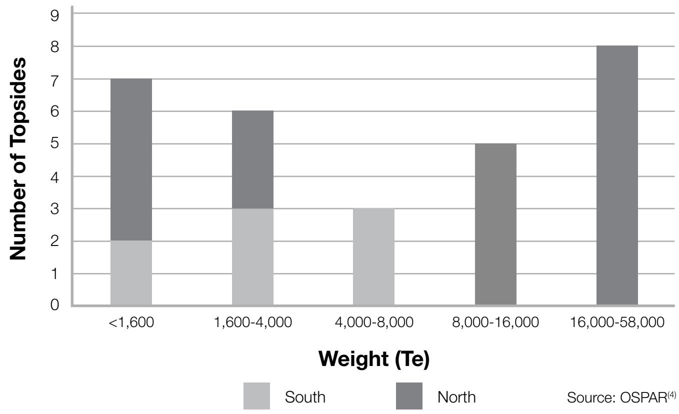
The weight distribution of these 32 installations, as shown in the graphs, show a broad spread of installation sizes. This is despite the fact that the overall North Sea asset stock includes a significantly higher proportion of smaller installations in the more sheltered areas of the southern North Sea. This suggests that the early demands for decommissioning are going to be more evenly spread across all the weight ranges, with a disproportionately higher demand for larger capacity vessels.

North Sea Platforms Expected to be Decommissioned (2014 - 2022)



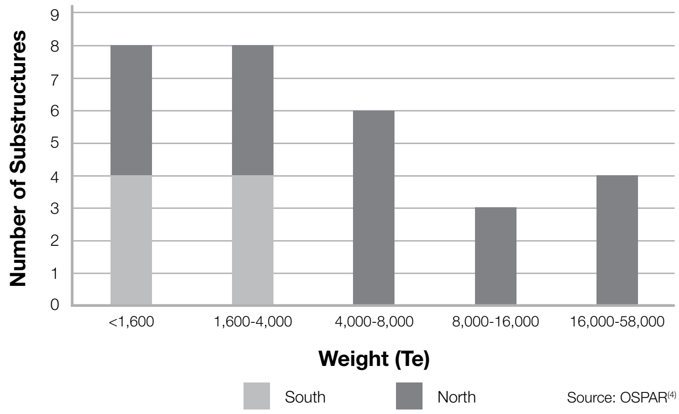
Source: OSPAR[4], NPD[14], DEA[15], DECC[16]

Weight of Topsides for Platforms Expected to be Decommissioned



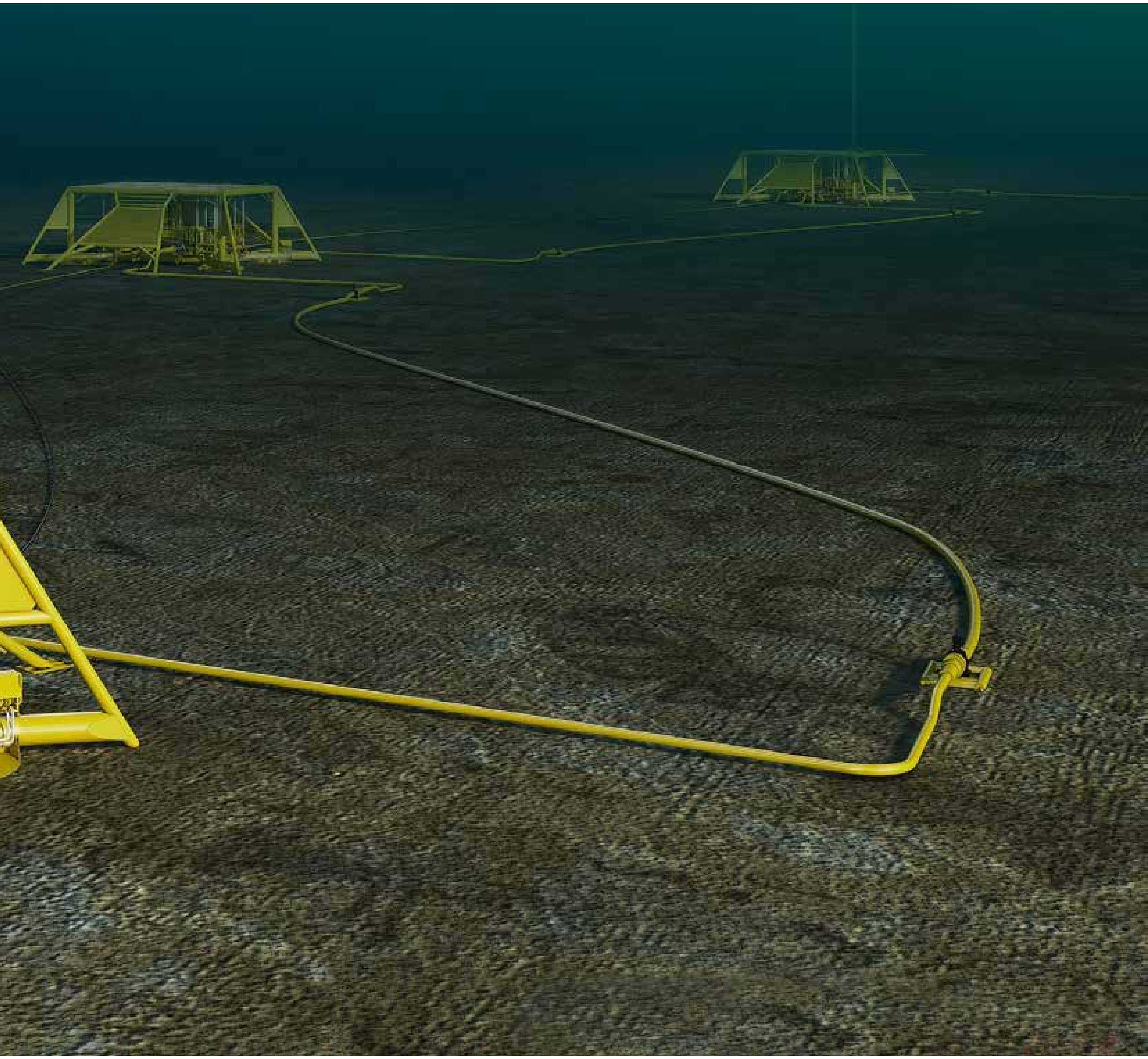
Source: OSPAR[4]

Weight of Fixed Steel Substructure for Platforms Expected to be Decommissioned



Source: OSPAR[4]

5.0 Well Abandonment



Well Abandonment

Skills

- Well Project Management
- Engineering (P&A)
- Operations Support
- Rig Upgrade Capabilities
- P&A Project Management
- Waste Management
- Rig and Rigless Design Services
- Supply and Abandonment Materials, expanding Cement, Resins, Silicone Rubber
- NORM Handling and Disposal Routes
- Specialist Well Inspection
- Specialist Services i.e. Wireline

Infrastructure and Equipment

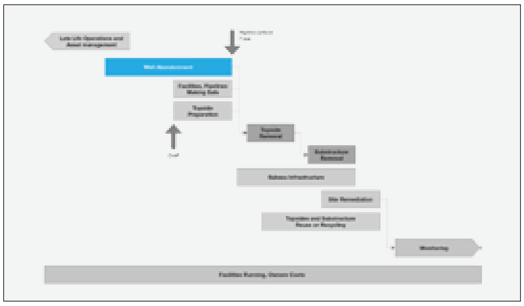
- Survey Vessels (pre and post removal)
- Mob-Demob Rigs
- Work over Rig
- Drilling Rig
- Light Weight Intervention Vessels
- Transport Vessels
- Waste Treatment and Storage
- Scale Treatment and Storage
- Logistics base (marine, aviation and onshore)

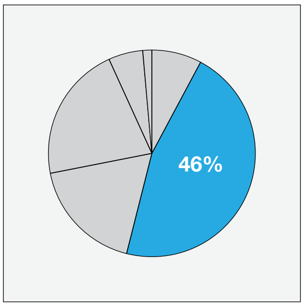
Supply Chain

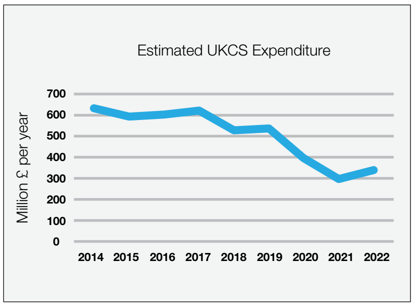
- Service Contractors
- Specialist Consultants and Contractors
- Vessel Operators
- Aviation Suppliers

5.1 Overview

- Well P&A can be done using mobile rigs mounted on a vessel, platform rigs or rigless solutions on a lightweight intervention vessel. These resources all considered critical supply chain elements. The selected appropriate approach is dictated by the type and condition of the well.
- There are over 8,200 active or suspended wells in the North Sea, all of which will eventually need to be plugged and abandoned[9] [10] [11] [12] [13]. In the UKCS it's estimated that over 800 wells will be abandoned in the next decade[9]. An extrapolation of data considering infrastructure and expected spend in Denmark, Norway and the Netherlands suggests that there could be up to a 70% increase in activity from the other Sectors. The majority of this additional activity will be in the deeper waters of the northern North Sea.
- The number of working years required to abandon wells in the UKCS in the next 10 years have been estimated. It is predicted there are 4.5 mobile drilling rig working years which require a jack-up vessel, semi-submersible or drill ship. There are nearly 10 platform rig years; less than 7.5 rigless platform solutions years, and less than 2 years of subsea rigless operations, which require intervention vessels but not mobile drilling rigs. These durations are exclusive of any weather related or other non-productive downtime.
- Considering P&A activity in isolation the market capacity for mobile drill rigs appears to be adequate for both jack-up vessels and semi-submersible vessels/drill ships. However, there is greater uncertainty when considering platform rigs and rigless solutions, where there is more potential for capacity constraints.
- Mobile drilling rigs, platform rigs and rigless intervention systems are all mobile resources. P&A contractors operate globally, following market opportunities in E&P and P&A in the world's producing regions. Although it is expected that there will be sufficient supply chain capability to meet the demands of abandonment activity in isolation, the competition for E&P resources has potential to cause a constraint in an already highly utilised supply chain.







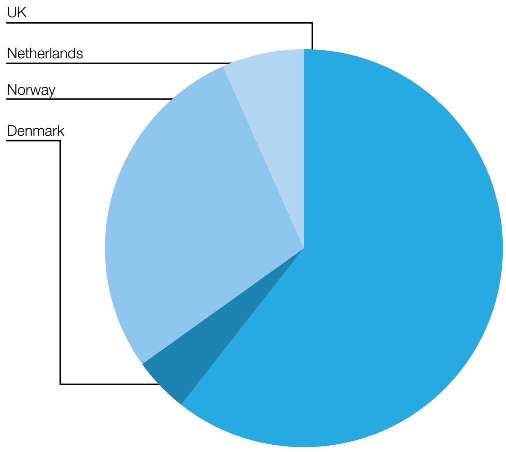
5.2 Activity

Well P&A can be done using mobile rigs mounted on a vessel, platform rigs or rigless solutions on a lightweight intervention vessel. These resources all consider critical supply chain elements.

Currently, there are more than 8,200 wells in the North Sea that are either in production, injection or that have been suspended and awaiting P&A. As with installation in general, the majority of these are located in the UKCS, and accounting for 61% of wells.

There is significant data available from the UKCS in terms of the nature of well infrastructure and planned decommissioning activity which can be used to inform the understanding of demands on the supply chain. The other Sectors have a paucity of data and it is necessary to make assumptions in terms of the relative activity based on known data in terms of geographical characteristics, infrastructure volume, spend and activity profiles.

Split of Wells in the North Sea



Source: DECC[10], NPD[11], DEA[12], NLOG[13]

UKCS and Other North Sea Regions

It is estimated that there are approximately 5,000 wells requiring abandonment in the UKCS of which around 18% (more than 800) will require removal in the next decade[1].

O&GUK estimates that it will require over 140 working years of activity to abandon all the wells currently in the UKCS, without any working downtime[9]. Of this, 80 years are expected to require rigs (based on current technology capability). The majority of this activity (55 years) is associated with platform wells which may be able to utilise existing or refurbished rig capability. However, a large proportion are likely to require a temporary rig. The remaining 25 years are associated with subsea wells, which are more likely to need a mobile drilling rig.

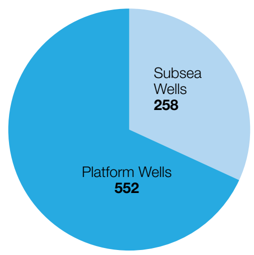
Using this as a basis to consider activities in the next decade (where 18% of wells will be removed) and assuming current technical capabilities, there are[9]:

- 4.5 years which require a mobile drilling rigs such as jack-up vessel, semi-submersible or drill ship.
- Approximately 10 years which require platform rigs.
- Approximately 7.5 years which require rigless platform solutions.
- Less than 2 years of subsea rigless operations which require intervention vessels but not mobile drilling rigs.

The next decade will see a larger proportion of subsea wells removed than platform wells. As such these statistics are likely to underestimate the number of mobile drilling rig years and overestimate the number of platform rig years.

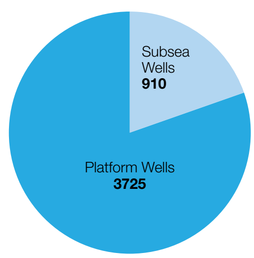
In the rest of the North Sea, contribution of activity from the Norwegian, Dutch and Danish Sectors will increase the demands on the supply chain. An extrapolation of data considering infrastructure and expected spend suggests that there could be up to a 70% increase in activity from the other Sectors. The majority of this additional activity will be in the deeper waters of the northern North Sea. Extrapolating between the balance of rig and rigless solutions is not possible due to a lack of available data.

Wells to be Decommissioned in the UKCS (2014 - 20122)



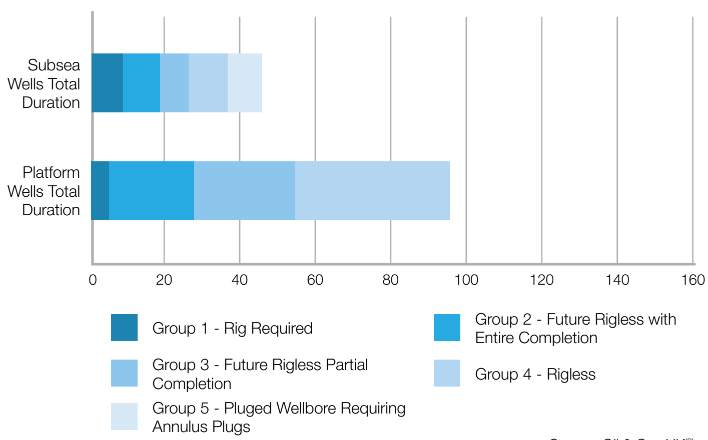
Source: Oil & Gas UK[1]

Total UKCS Wells to be Decommissioned



Source: Oil & Gas UK[9]

UKCS Well P&A Durations



Source: Oil & Gas UK[9]

5.3 Supply Chain

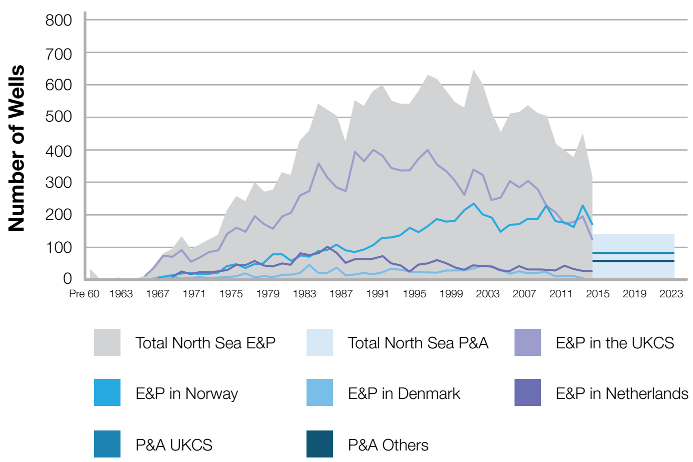
Drilling activity peaked in the decade following the mid-1980's with an annual of 540 wells drilled a year in that period. Currently drilling activity is lower than the peak activity, but still substantial with 470 wells a year or nearly 90% of peak activity[10], [11], [12], [13]. If drilling continued at the same rate over the next decade, estimated abandonment activities in the same period will represent an increase in activity of 30%. This will put increasing pressures on the supply chain for mobile and platform drilling rigs.

Mobile Drill Rigs

Drill ships and semi-submersible vessels are adapted to work in deep water and harsh exposed environments. Jack-up vessels are a lower cost option which are optimal for shallow water and are more weather sensitive in the period in which they are mobilised for operations. Jack-ups for abandonment have a broader water depth envelope than their heavy-lift counterparts, but are still limited to about 150 meters. Generally, jack-ups are suitable for the Southern, Central and Irish Sea in the UKCS as well as Dutch and Danish Sectors. Drill ships and semi-submersible vessels are usually deployed in the UKCS northern North Sea and Norwegian Sectors.

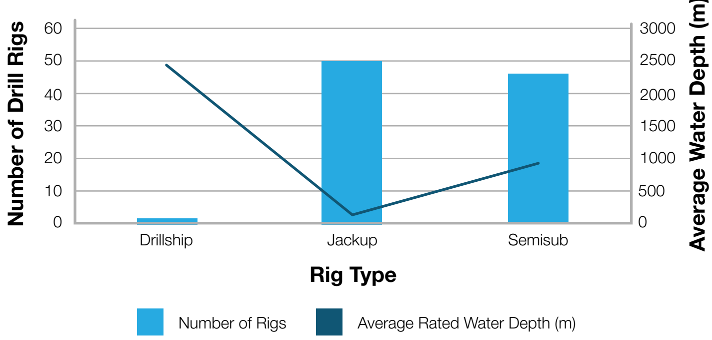
From the UKCS, approximately half of the working requirements are in the North North Sea, and as such there is likely to be an equal distribution between jack-up vessels versus semi-submersible vessels /drill ship requirements. An increase in activity in the Norwegian Sector will increase the requirements on drill ships and semi-submersible vessels. As this equates to approximately 50% of the UKCS activity, it is likely to affect the overall availability of these vessels. Although Dutch and Danish Sectors will be biased towards jack-up vessels, they have a significantly smaller proportion of vessel requirements. As such overall, it is assumed there is a bias towards the need for semi-submersible rather than jack-up vessels in terms of overall activity.

Historical E&P and Future P&A in the North Sea



Source: DECC[10], NPD[11], DEA[12], NLOG[13]

North Sea Mobile Drill Rigs



Source: Rigzone[17]

Rigzone catalogues that there are 97 mobile drill rigs currently operating in the North Sea, which represents around 12% of the global fleet[17]. These are relatively evenly split between semi-submersible vessels and jack-ups. Even when factoring in weather and other unproductive time, a fleet this size could easily support the 4.5 rig years of removal required in the next decade from the UKCS. The additional estimated 70% increase of activity from the other sectors is unlikely to cause a constraint.

However, utilisation of mobile rigs is currently high, with global utilisation of jack-ups and semi-submersible vessels averaging between 79 to 88% last year[18]. The incremental increase in abandonment activity when considered in the back drop of E&P activity, could potentially cause a constraint on mobile rigs, unless greater numbers of the global fleet are deployed in the North Sea.

Platform Rigs

The requirement of drill rigs for platforms is estimated to be more than double the requirement of mobile drilling rigs in terms of working days. The capability of the market to refurbish existing platform rigs will dictate the required capacity for additional rigs to be temporarily installed on the platform. Again, as platform rigs are in demand for drilling activity, there will be a competition for this resource and it has the potential to become a constraint.

Rigless Intervention Systems

Rigless interventions account for double the requirement of P&A resources in terms of working days assuming current technology capability. Rigless interventions are estimated to mainly be associated with platform wells, but also with a smaller number of subsea wells. For these operations, the availability of rigless systems must be considered.

There is also a significant number of additional wells that could be abandoned using a rigless solution if technology innovation was stimulated. Indeed, rigless solutions are significantly shorter and lower cost than rig-based alternatives and could offer a more cost effective alternative to operators.

The market is likely to want to move towards using rigless options where risk-based analysis concludes that it is the most cost effective approach. Availably of rigless solutions has the potential to become a constraint in the future, especially if the market confidence increases in its viability.

5.4 Health Check

Capability = Low / Medium

Accenture consider topside and substructure recycling aligned with the 2011 WBS which considers P&A of wells, rig upgrades and rigless options among others with an average capability for these three of 2.5.

Rig upgrades were rated the lowest capability with P&A and rigless options performing better.

Accenture conclude that the market for associated well services such as drilling, completions and interventions has extensive knowledge, tools, technology, experience and capability. Well Abandonment has been widely identified as a phase requiring focus and there are multiple organisations, events and publications that provide a forum for discussion, debate and knowledge sharing. The presence of global players in the UKCS provides a source of knowledge, technology and experience of complex well situations and well abandonments from other region

However, while the market for wells services is mature, the specific capability and experience for plugging & abandonment is not as strong. The entry costs for new wells companies in the UKCS are too high, in part due to the cost of compliance to local regulations

Estimated volume of supply against demand = Low / Medium

Considering P&A activity in isolation the market capacity for mobile drill rigs appears to be adequate for both jack-up vessels and semi-submersible vessels/drill ships.

There is more uncertainty when considering platform rigs and rigless solutions where there is more potential for capacity constraints.

Rigless solutions are significantly shorter and lower cost than rig-based alternatives and could offer a more cost effective alternative to operators. There are a significant number of additional wells that could be abandoned using a rigless solution if technology innovation is stimulated.

The market is likely to want to move towards using rigless options where risk-based analysis concludes that it is the most cost effective approach. Availably of rigless solutions has potential to become a constraints in the future if the market confidence increases in its viability.

The lead time to development of rig-based solutions is a number of years to commission and construct new capacity. For rigless solutions, where innovation and demonstration is required this lead time could potentially be even longer.

Pressures and/or synergies from other industries = Low / Medium

Mobile drilling rigs, platform rigs and rigless intervention systems are all mobile resources. P&A contractors operate as a global resource, following the market opportunities from E&P and P&A in the world's oil and gas producing regions. Anecdotally well contractors prefer to support new field development, as it is less cost and more programme focused than decommissioning.

Currently drilling activity is 470 wells a year or nearly 90% of peak activity which occurred in the 1980s. This bucks the trend compared to installation of platforms where current activity is only 6% of the peak.

Although there is expected to be sufficient supply chain capability to meet the demands of abandonment activity in isolation the competition for E&P resources has potential to cause a constraint in an already well utilised supply chain.

abandonment activity in isolation the competition for E&P resources has potential to cause a constraint in an already well utilised supply chain

Investment Status = Low / Medium

Contractors are reluctant to make commitments to new rigs and rigless systems without certainty in terms of timing of the North Sea decommissioning market. In the Gulf of Mexico an 'idle iron' policy had been implemented which places a deadline on abandonment activity. This policy decision has given market certainty and stimulated technology innovation in bringing forward more rigless solutions. In the North Sea further innovations are necessary to de-risk rigless solutions.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6.0 Substructure and Topside Removal

Substructure and Topside Removal

Skills

- Detailed Engineering (subsea and topsides)
- Naval Architecture
- Offshore Operations
- Transportation

Infrastructure and Equipment

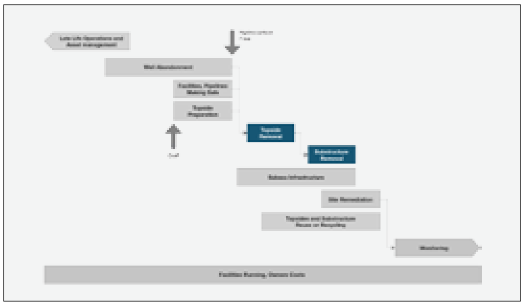
- Removal Vessel
- Transportation Barges
- Support Vessels
- Anchor Handling Tug Supply (AHTS) Vessels
- Construction Support Vessels (CSV)
- Safety Standby Vessels (SSBV's)
- Survey Vessels
- Rock Dumping/ Backfill Vessels

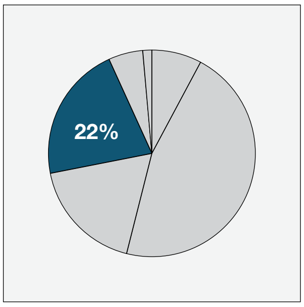
Supply Chain

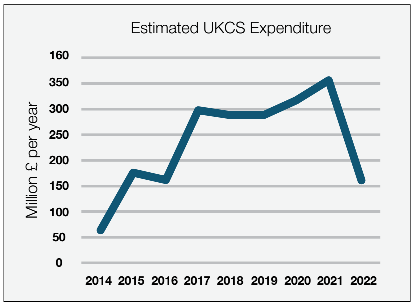
- Marine Vessel Contractors
- HLV Contractors

6.1 Overview

- 83% of installations in the North Sea are fixed steel and 4% concrete gravity base[4]. They will require a vessel to remove the topside and substructure, either by lifting or reverse float over. The remaining installations are either self-propelled or can be towed requiring less onerous interventions. The construction vessels utilised to remove topsides and substructures are considered to be the critical supply chain elements.
- The market is not consolidated on a single approach to decommissioning for topsides and substructures, and the methodology is influenced by a range of technical and commercial factors, such as the weight and design of the installation and the market availability of vessels. As a result, there is a diverse range of vessel types that can be utilised by the market. These include large heavy-lift vessels which operate in deep waters and exposed conditions in the northern North Sea, and to sheer leg, and jack-up vessels which are more suited to the shallow and benign waters of the southern North Sea.
- The market peak for installation in the North Sea occurred in the decade from 1984 to 1993[4]. In this period, an approximate average of 240,000 tonnes of steel was installed every year[4]. This activity level is equivalent to estimates of steel removal over the next decade, which are approximately 150,000 to 260,000 tonnes a year. This suggests that the demand for decommissioning resources in the next ten years will be comparable to the period of peak activity which occurred 30 years ago.
- The North Sea profile is biased toward multiple smaller platforms, and a few large platforms. However, published plans suggest the next phase of decommissioning will include a proportionately greater number of large installations and spread across all geographies of the North Sea.
- The availability of suitable heavy-lift vessels to decommission the larger platforms in the northern area is likely to create the biggest constraint. In southern areas, where platforms are generally smaller, there is a larger fleet of vessels that could remove topsides in a single lift, though this reduces for categories above >1,600 tonnes.







6.2 Activity

The vessels that are required to remove substructures and topsides are critical supply chain elements. The type and location of installation will impact on the vessels and approach to removal.

Fixed Steel

83% of installations in the North Sea are fixed steel with a combined weight of 4.4 million tonnes(4). There are 535 fixed steel installations with substructures which range from 100 tonnes to over 45,000 tonnes and topsides which range from 70 to 53,000 tonnes(4). The average substructure weights 3,500 tonnes and topside 4,300 tonnes.

All fixed steel installations with a substructure under 10,000 tonnes will require total removal under OSPAR regulations. This applies to 91 % of the installations. The remaining 9% may apply for a derogation to leave some or all of the structure in place.

Both substructures and topsides will need to be removed from site using construction vessels through either single lift, multiple lift, piece small or reverse float over methodologies.

Concrete Gravity Base

4% of installations in the North Sea are concrete gravity base substructures(4). Although there are significantly less of them, they are disproportionately heavier, with a total of 7.4 million tonnes, almost double the weight of all the fixed steel installations.

OSPAR regulations allow the possibility of a derogation to leave concrete gravity installations in situ at the end of their life. Technical and commercial constraints have meant that all concrete gravity base platforms decommissioned to date have obtained permission to leave their substructures in situ. It is likely that operators will continue to seek derogations for concrete gravity base installations in the absence of further regulator intervention or technical advancements.

However, it is also likely that the topsides will need to be removed from site and resort to a similar method as large fixed steel installations, although these can be technically more challenging than their fixed steel equivalents.

Other Installations

The remaining 13 % of installation types are predominantly floating technology. Although they can range in weight (up to 100,000's tonnes), they are more straight forward to decommission, either because they can self-propel, or because they can be towed from site(4). The requirements for vessels will be less onerous than for fixed steel and concrete gravity base.

Activity Focus

The critical supply chain is focused on the removal of fixed steel and the topsides from concrete gravity base installations with construction vessels carrying out either a single lift, multiple lift, piece small or reverse float over.

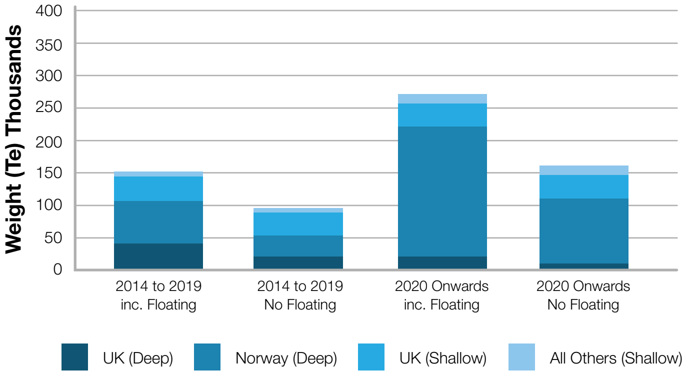
Volume of Activity

Overall estimates of activity and steel removal are discussed in detail in Chapter 4. In total, an average of 150,000 tonnes of steel (up to 2019) and over 270,000 tonnes (from 2020 onwards) is estimated to be removed annually from the North Sea[(1), (7)]. The decade from 1984 to 1993 was the period when the most infrastructure by weight was installed in the North Sea on an annual average basis (amounting to over 240,000 tonnes of steel installed per annum)[(4)]. This volume of activity is commensurate with estimated activity over the next decade suggesting decommissioning could be comparable to the peak installation activity.

However, this estimate includes removal of floating installations, which make up nearly 40% of the steel weight in the North Sea, which do not need heavy-lift construction vessel[(4)]. Pro-rata adjustment of these weight estimates to remove floating installations suggest annual requirements which require lift vessels might be on average a little less than 100,000 tonnes until 2020 and 160,000 tonnes beyond to 2022.

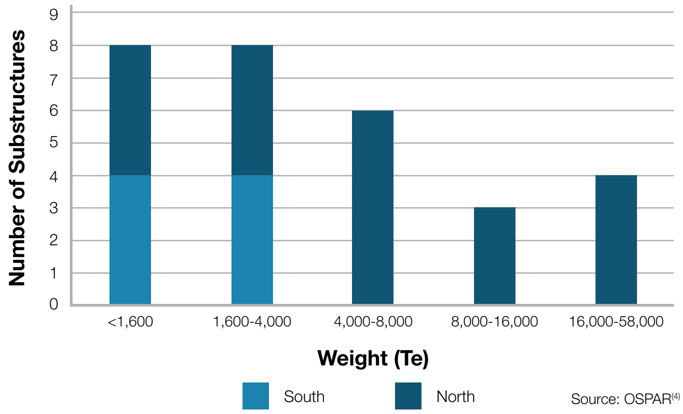
Published data from the North Sea operators and regulators suggests that the fixed steel and concrete gravity base topsides planned for removal are proportionately distributed to the heavier weight classes and biased toward northern North Sea platforms[(4), (14), (15), (16)].

Estimated Annual Steel Removal in the North Sea



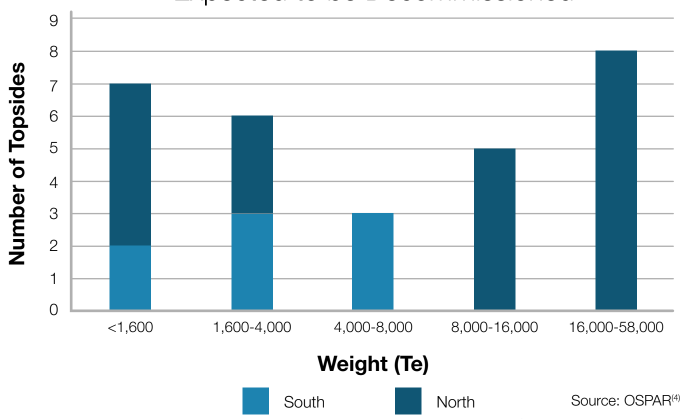
Source: OSPAR[(4)]

Weight of Topsides for Platforms Expected to be Decommissioned

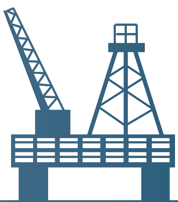


Source: OSPAR[(4)]

Weight of Fixed Steel Substructure for Platforms Expected to be Decommissioned



Source: OSPAR[(4)]



6.3 Supply Chain

Vessels with lifting capabilities can be used to decommission both topsides and substructures using single lift, multiple lift of piece small approaches. Semi-submersible vessels can also be used for removal of topsides for a reverse float over.

Each vessels has an operational envelope which is dictated by a range of criteria including crane capacity, deck area, draft, transit speeds, weather working windows and water depths. This envelope influences the projects in which they can feasibly be deployed, and the manner in which they are utilised.

Sheer leg and jack-up vessels are commonly deployed in the southern North Sea or Dutch Sectors where water depths, weather conditions and platform sizes are suited to their operational capability. Heavy-lift vessels have a broader operational envelope and are more frequently deployed in the central and northern North Sea and Norwegian Sectors. Although they could work in the southern North Sea, it is unlikely that they would be as commercially viable as the alternatives. On this basis, available vessels have been classified as either 'southern' or 'northern.'

The chosen approach of decommissioning a structure (single lift, multiple lift, piece small) is influenced by the market availability of vessels, and technical constraints associated with the structure's weight and configuration.

Topside Approach

Single lift requires a vessel with lift capacity to lift the entire topside structure. For the very large structures, the number of vessels capable of this approach are limited. A number of the smaller topsides deployed in recent years were installed as a single lift, and would potentially suit this method of decommissioning.

Multiple lifts and piece small give more flexibility in terms of vessel selection and vessel capability. However, there is a balance to be struck in terms of the economics and health and safety implications of multiple lifts and operations offshore. Historically, the larger platforms were constructed in a modular format and some of the older platforms may lend themselves better to a reverse installation in multiple lifts.

Substructure Approach

Fixed steel substructures do not lend themselves easily to removal in parts. Although it may be technically feasible to slice a substructure for removal in sections, the cost and health and safety implications often make this less viable than a single lift approach.

For the very large steel substructures, total removal becomes highly technically and commercially challenging. Consequently, OSPAR regulations allow a route for operators to seek a derogation to leave footings in place. As stated, concrete gravity base are significantly heavier and again, the approach to date has been to seek a derogation to leave the entire substructure in place.

Vessels

A range of construction vessels are used to decommission both topsides and substructures, particularly where large single or multiple lifts are undertaken. Vessels have a range of crane capacities, deck area, draught, transit speeds which influence the projects in which they can be deployed, and the manner in which they are utilised.

Matching vessel capacity to the North Sea installations has a number of challenges, in part due to the range of installations, technical characteristics and vessel types. Although vessels will have a stated maximum working capacity, the specific technical constraints of the lift and vessel characteristics can significantly reduce the practical capacity.

A review of vessels with lift capabilities of over 500 tonnes identified 80 vessels with a total combined nominal capacity of over 200,000 tonnes[19]. However, only 2 vessels, the Siapem 7000 and Thialf, have the capability to lift beyond 10,000 tonnes. The majority have significantly lower lift capacity[19].

These vessels operate in a global market, serving offshore wind, E&P as well as other marine sectors. In addition, a significant proportion are not working in Europe and are serving the global market. It is expected that only half of these vessels with a combined nominal capacity of less than 100,000 tonnes are likely to work in the North Sea and be pursuing decommissioning activity. Moreover, practical lift capacity is generally less than the nominal lift capacity (assumed to be 80% on average). As such, the total combined capacity of 80,000 tonnes is considered more realistic.

These vessels are shown in the figure below grouped by weight class. The majority of vessels are in the lower weight classes, and these are predominantly vessels suited to working in the more benign conditions in the southern North Sea. The larger lift capacity vessels are generally more suited to the exposed areas in the northern North Sea.

There are three new 'ultra large' vessels currently under development which have a significantly higher lifting capacity than the existing market range. The most advanced of these is Allsea's Pieter Schelte (48,000 tonne lift capability) which is due to be operational in 2015. Were this vessel to be deployed in a programme of activity, it could make sufficient inroads into meeting the next 10 years' worth of decommissioning requirements.

However, the Pieter Schelte is likely to only be commercially viable if it were deployed on a programme of work, rather than individual projects. Allseas has been contracted by Shell to remove the Brent Field topsides and substructures commencing in 2015/2016[20]. The vessel is also equipped with pipeline laying capabilities, as the vessel operator wants to spread risk by serving other markets.

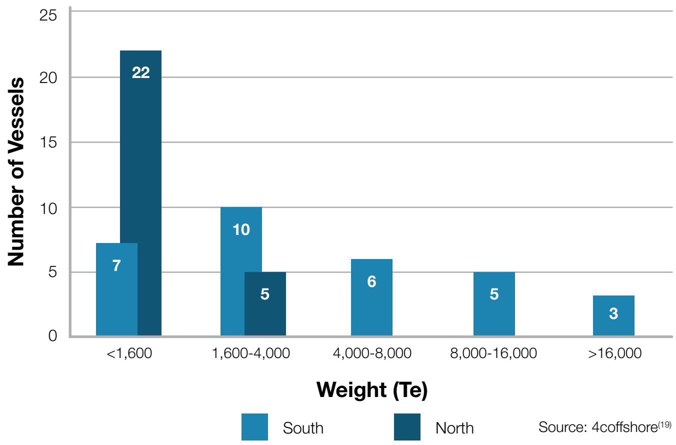
The graph shows the number of topsides and substructures by weight class plotted alongside the number of substructures and topsides which have been identified for decommissioning. This provides a picture of the match of vessel capacity against substructure demand. This is a simplified overview, as vessels in lower classes can decommission installations in higher weight classes if they proceed via piece small or multiple lifts methodologies. Moreover, vessels in higher weight classes can remove those in lower weight classes, although there may be commercial barriers.

The graph only shows decommissioning projects which are in the public domain (60% of steel removal requirements) identified by the O&GUK and the Norwegian Government. As such it will under estimate vessel requirements based on current estimated activity.

In the northern areas, to match the weight class and lift weight i.e. carrying out a single lift, there is limitation in the heavier weight classes. Indeed, as none of the >16,000t cranes are ready for market, the heavier topsides planned to be decommissioned in the next year will need to be removed by piece-small or multiple lift. For the lighter platforms, single lift will be more feasible.

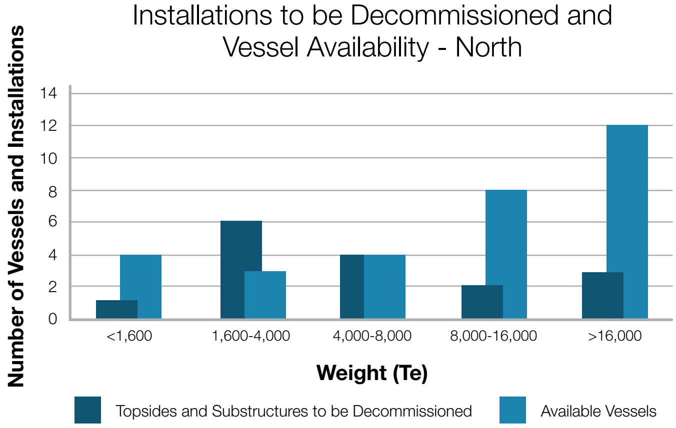
In southern areas, there are significantly more single lift opportunities, though there are some limitations in the above >1,600 categories.

Decommissioning Vessels By Weight Class and Working Class



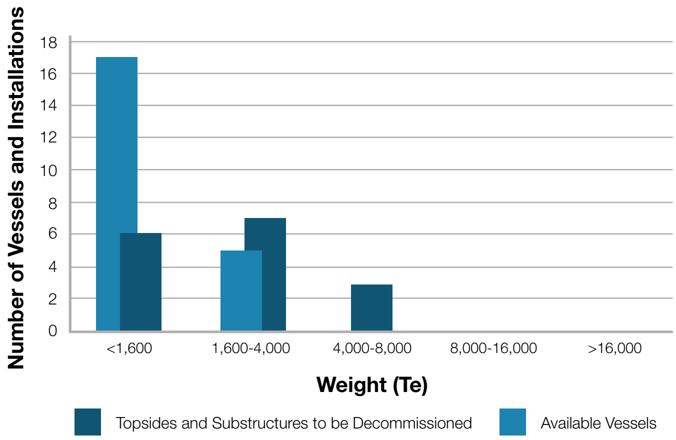
Source: 4coffshore[19]

Installations to be Decommissioned and Vessel Availability - North



Source: OSPAR[4], 4coffshore[19]

Installations to be Decommissioned and Vessel Availability - South



Source: OSPAR[4], 4coffshore[19]

6.4 Health Check

Capability = Low / Medium

Piece Small and Reverse engineering capability is higher than that of single lift removal. The market for heavy-lift, while relatively immature for decommissioning, has gained experience from decades of construction in the North Sea. There is more experience in lower weight categories. For lifts greater than 10,000 tonnes there is extremely limited capability, particularity in the North Sea.

Estimated volume of supply against demand = Low / Medium

There are challenges in determining the capability of the vessel market to respond to decommissioning opportunities.

The market peak for installation in the North Sea occurred in the ten years from 1984 to 1993. In this period an approximately average of 240,000 tonnes of steel were installed every year. This activity level is equivalent to estimates of steel removal over the next decade which are approximately 150,000 to 260,000 tonnes a year. This suggests activity next ten years will be comparable to the period of peak activity which occurred 30 years ago.

In the northern areas, to match the weight class and lift weight i.e. carrying out a single lift, there is limitation in the heavier weight classes. For the lighter platforms single lift will be more feasible.

In southern areas there are significantly more single lift opportunities, though there are some limitations in the above >1600 tonne categories.

If there are shortages in the market there is a long lead time to building new capacity, with vessel development and construction taking approximately 5 years or more. If there is an undersupply, the lead time to developing new capacity could cause constraints in the medium term.

Pressures and/or synergies from other industries = Medium

Vessels operate as a global resource, following the market opportunities from a range of marine industries such as offshore wind, and oil and gas construction.

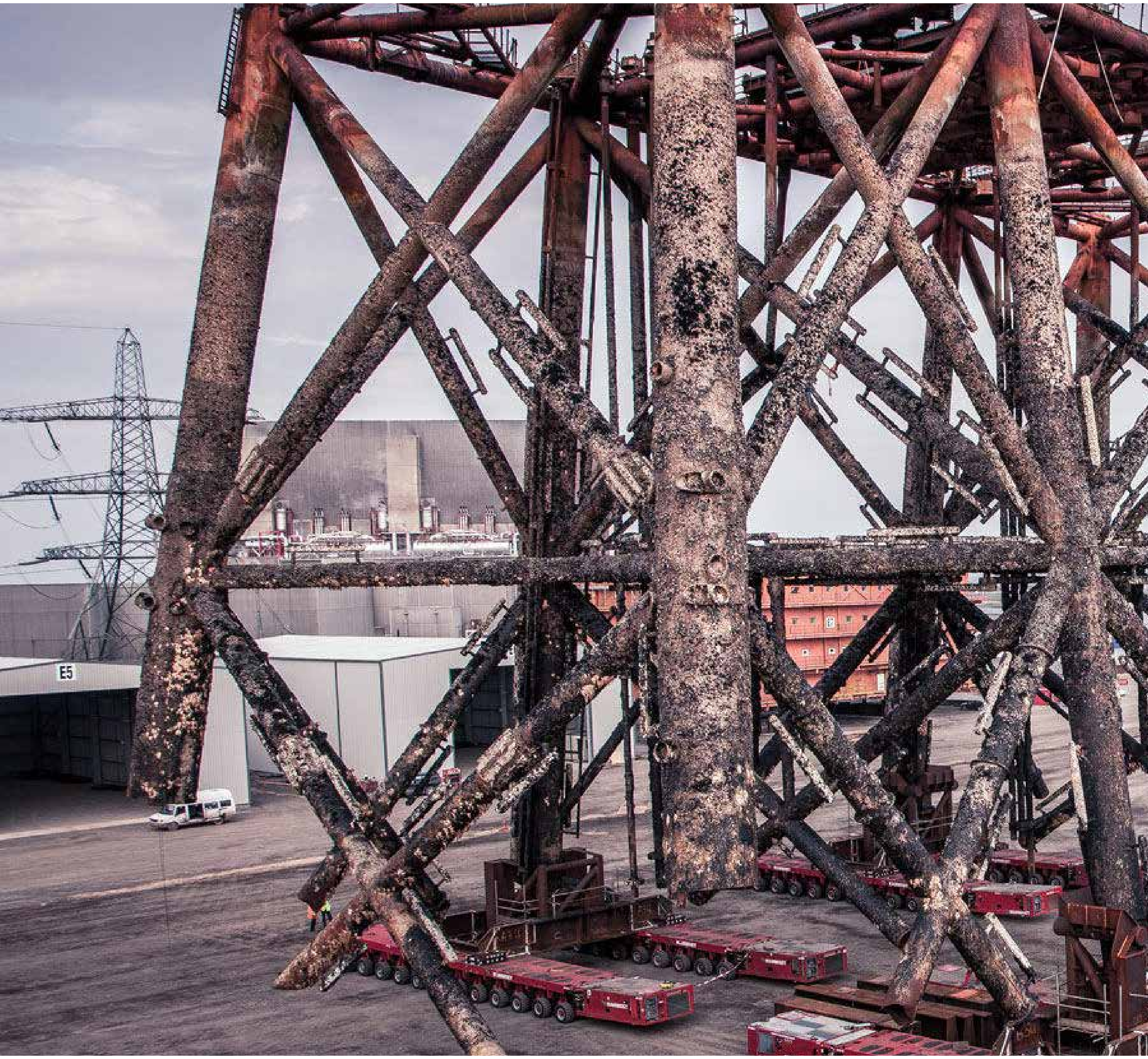
Jack-up, sheer leg and heavy-lift vessels are in demand from the offshore wind industry for substructure, turbines and substation platforms. There are significant developments planned in UK waters for projects with construction programmes that span over a number of years.

The majority of decommissioning vessels are also appropriate for new field development. Anecdotally vessel operators prefer to support new field development, as it is less cost and more programme focused than decommissioning.

Despite this, current North Sea new construction activity is significantly lower than during peak development. Over the ten year period from 1984 to 1993 there was an average of 20 fixed steel or concrete gravity base installations constructed a year, with a peak of 38. The average number of fixed steel or concrete gravity base installations constructed over the last ten years has been just over 7 a year only 35 % of the peak. As such there is less demand from E&P activities than historically occurred.

Investment Status = Low / Medium

Vessel operators are reluctant to make commitments to new vessels without certainty in terms of timing of the North Sea decommissioning market. There has been commitment to development and construction of new vessels, such as the Pieter Schelte, which can support the decommissioning market. However, these vessels have generally been justified on the basis of a business case covering a broader market Sector.


E5

7.0 Topsides and Substructure Reuse

Topsides and Substructure Recycling

Skills

- Material Characterisation
- Onshore Dismantling
- Onshore Environmental
- Metal Recycling Facilities and Logistics
- Hazardous Material Disposal, including NORM, LSA (Low Specific Activity Waste), Mercury

Infrastructure and Equipment

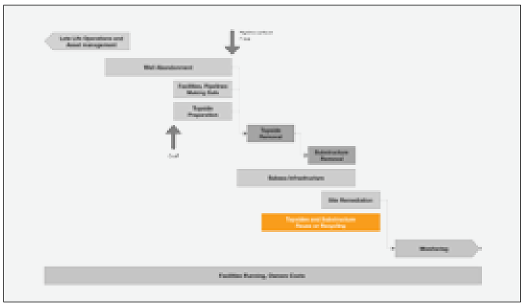
- Onshore Cranage
- Cutting Equipment
- Handling Equipment
- Onshore Yard Space
- Quayside Strength and Extent
- Deepwater Access Channel

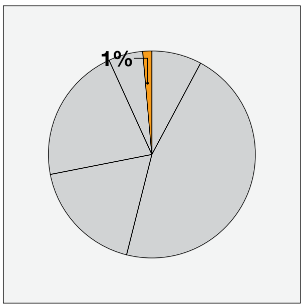
Supply Chain

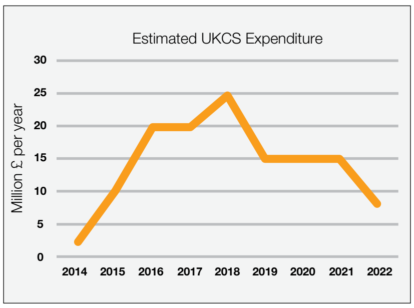
- Engineering Consultants
- Onshore Yard Operators
- Ports and Harbour Operators
- Civil Contractors
- Demolition Contractors
- Waste Recycling Contractors

7.1 Overview

- Determining capacity of a yard to service the O&G decommissioning market is a function of a number of parameters relating to processing capability such as; footprint, material handling capability, lift/skidding capability, quayside strength, drought, waste processing etc. It is also dependent on the weight of the total installation and the weight and dimension of any subsections delivered to the facility (which is dictated by the removal method).
- Currently there are 6 facilities with decommissioning experience in proximity to North Sea infrastructure with a total footprint of nearly 90 hectares[(3), (7), (19), (21), (22), (23)]. There are at least another 17 that have most of the required characteristics could support future decommissioning work[(3), (7), (19), (21), (22), (23)]. The total footprint available in these yards would increase the overall available footprint by ten times. There are also significantly more facilities that could support decommissioning with further investment. A number of these are making upgrades to support the offshore wind market, which would be suitable for the decommissioning market.
- Estimates by the NCPA suggest that Norway has a capacity to process 50,000-160,000 tonnes of decommissioning annually[(7)]. The UK is likely to have a similar scale of processing capability based on comparing facility footprints. The average demand of steel removal and recycling is estimated at 100,000 tonnes per year, ramping up to 160,000 tonnes a year[(1), (7)]. This suggests that, there could be capacity constraints over the period to 2022, particularly if the lower range of current Norwegian and UK port capacity is considered; if further ports are not developed; and if there is high competing demand for capacity.
- For smaller installations, there is less likely to be capacity constraints due to the range of viable options capable of lifting and processing installations of a few thousand tonnes. For heavier installations, depending on competing demands, there may be limitations on the available ports capable of receiving and processing large structures up to 10,000 which the current generation of large heavy-lift vessels can deliver. However, there are a range of opportunities to upgrade current ports to equip them with greater lifting and processing capability.







7.2 Activity

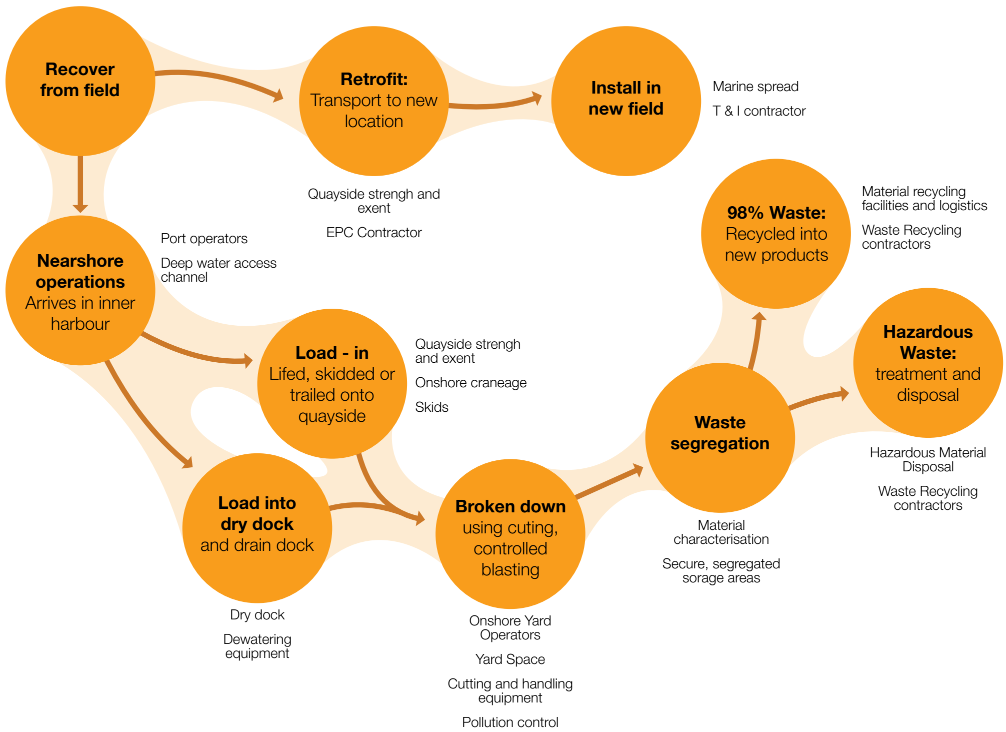
With pressure from OSPAR to reuse and recycle as much of the infrastructure as possible, capable facilities are required to respond to the challenge. However, there are a limited number of locations with experience and track record. The ports, harbours and yards infrastructure that are required to decommission steel installations have been identified as critical supply chain elements through the assessment and consultation process.

Approach

The activity for topside and substructure recycling consists of transferring the structure from a floating or towed condition to a reusable or recycled product. The following flow diagram shows the typical process during recycling.

Structures to be recycled are taken to a port/yard and either loaded in to a dry dock or lifted/skidded/trailed onto a quayside. The dry dock capacity, skids, craneage, marine crane access and quay side strength are all constraints which will affect the capacity of the facility to process the structures. As part of the breakdown and recycling process, the structure is cut into pieces and waste is segregated into hazardous and non-hazardous waste. For these activities, yard space, cutting and handling equipment, pollution control, and hazardous materials control dictate the volume of material that can be processed.

Rather than being recycled, many floating steel structures are reused at subsequent fields. This is often following a retrofit at a fabrication yard. The average age of North Sea floating structures is 17 years which is much less than the average life of North Sea fixed steel structure at 25 years[4]. As such, there will be significantly less demand for ports, harbours and yards associated with floating structures. The most demanding need for reuse and recycling of infrastructure will result from the steel associated with fixed steel installations and concrete gravity base topsides, and is the focus of this chapter.

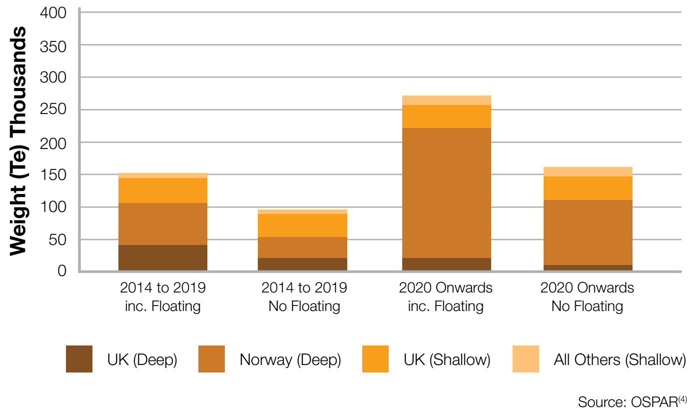


Volume of Activity

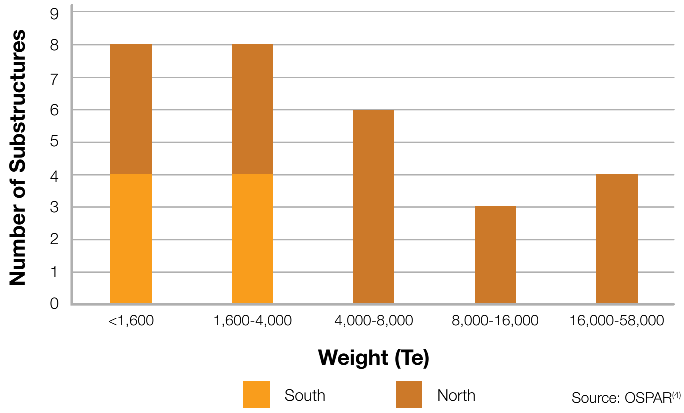
Full detail of the estimates of activity and steel removal requirements are detailed in Chapter 4. Total estimates of the North Sea decommissioning steel removal requirements equate to an average of 150,000 tonnes per year up to 2019 and over 270,000 tonnes from 2020 onwards[(1), (7)]. However, this includes floating installations which make up nearly 40% of the steel weight and could potentially be refurbished for reused at other fields[(1)]. If this is assumed to be the case, then demand for break-up of structures and steel recycling may be of the order of 100,000 tonnes per year until 2020 increasing to 150,000 tonnes beyond.

Published data from North Sea regulators suggests that the fixed steel and concrete gravity base topsides that will be removed are equally distributed across all the weight classes[(1), (7)]. This unlike the profile of the North Sea which is biased towards smaller platforms. This suggests that the short to medium term focus for the decommissioning market will be the larger heavier northern North Sea platforms, which are reaching end of the life.

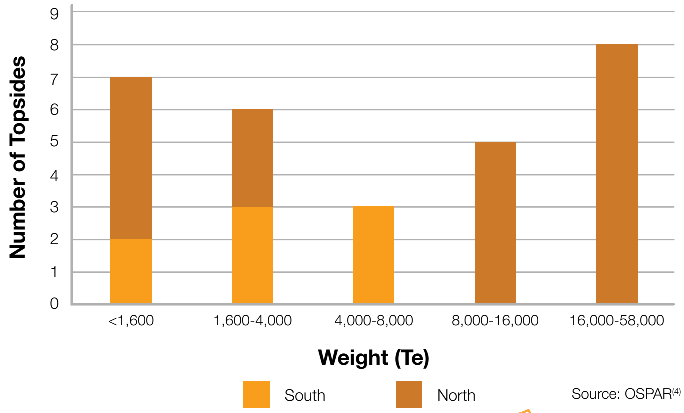
Estimated Annual Steel Removal in the North Sea

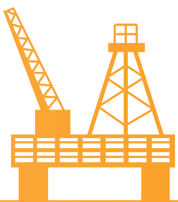


Weight of Topsides for Platforms Expected to be Decommissioned



Weight of Fixed Steel Substructure for Platforms Expected to be Decommissioned





7.3 Supply Chain

Determining the current and future supply chain capacity in the next 10 years is complex due to the technical, commercial and political factors influencing how the supply chain is utilised. The lead time to build new capacity and capability will result in limitations in terms of new facilities in the next few years.

Capability

The type of installations in terms of scale and weight and decommissioning approach (piece small, multiple lift, single lift) will dictate the required port, harbour and yard functional requirements. Smaller installations or piece small approaches will allow a much lower barrier to entry for the supply chain. For the very large installations, or multiple/single lift approaches the functional requirements are significantly more onerous, and there are less viable options in the current supply chain.

The average topside weight in the North Sea is just over 4,000 tonnes[(4)]. An ideal decommissioning yard to recycle a topside of this size would require the following characteristics:

- Draught sufficient to allow access for appropriate construction vessels.
- Depths in excess of 15 m provides flexibility for larger vessels, although this depth is not common. Alternative approaches such as use of barges can be utilised where there are draught limitations.
- Adequate working space to allow for the topside footprint and an appropriate working space estimated to be approximately 2 ha.
- Quayside with a capacity in excess of 40 tonnes per m2 and capability for lifting, skidding or trailing the topside; or
- A dry dock with footprint of approximately 2 ha with appropriate shape.

Depending on the volume of business and continuity of projects the following characteristics would also be attractive:

- Available and experienced workforce.
- Rail and other transport connections.
- Facilities for treatment and storage/transport of hazardous waste including Naturally Occurring Radioactive Material (NORMs).
- Areas for waste segregation.
- Located within reasonable proximity to the field that is being decommissioned; and
- A safety focussed and secure licensed worksite.

Smaller lighter substructure and topsides will be more flexible in terms of their functional demands, requiring a lesser footprint, draft and lifting capability. The largest installations will be significantly more limited in terms of the locations which they can utilise.

Waste Transfer

There are regulatory barriers in terms of capacity, as there are limitations in terms of waste that can be transferred across national boundaries. Waste requiring disposal cannot be shipped across international borders. However, waste can be moved across international borders if it is destined for recovery. Capacity must be considered in terms of constraints in North Sea operators considering facilities out with their continental shelf, especially where there are limitations in recovery of the waste products.

Naturally Occurring Radioactive Material (NORMS)

Oil and Gas operations can result in production of an insoluble NORM scale which can be entrained in plant such as pipework and valves. Additional regulations govern the management and disposal of NORMs, with the level of radiation dictating the manner in which material must be managed. In the UK, the O&G industry's current activities are estimated to produce approximately 800 tonnes of NORMs a year, of which less than 150 tonnes is disposed of, using specialist treatment and disposal.

Comparison of the information on estimated NORM waste arising and current landfill capacity suggests that there is no immediate disposal capacity problem for solid, non-hazardous NORM containing waste[24]. The same can be said for NORM waste that also has hazardous properties. However, there is only one landfill site in the UK that can take hazardous NORM waste, making this disposal route fragile. The growth of decommissioning activity has potential to impact on capacity, though there is considerable uncertainty in terms of the scale of impact due to the scarcity of experience in decommissioning activity.

Existing Capacity

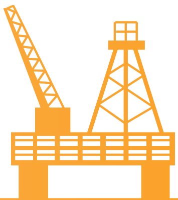
Determining capacity of a yard to service the O&G decommissioning market is a function of a number of parameters relating to processing capability, such as footprint, material handling capability, lift/skidding capability, quayside strength, drought, waste processing etc. It is also dependent on the weight of the total installation and the weight and dimension of any subsections delivered to the facility (which is dictated by the removal method).

At present, there are at least 6 yards available to service the North Sea that have decommissioning experience[3, 7, 19, 21, 22, 23]. These yards have a combined footprint of approximately 90 hectares[3, 7, 19, 21, 22, 23]. There are at least another 17 that have most of the above characteristics and are ready for future decommissioning work[3, 7, 19, 21, 22, 23]. The total yard space available in these yards suitable for decommissioning projects is estimated at over 950 hectares[3, 7, 19, 21, 22, 23]. This would increase the overall footprint by ten times, compared to current capacity.

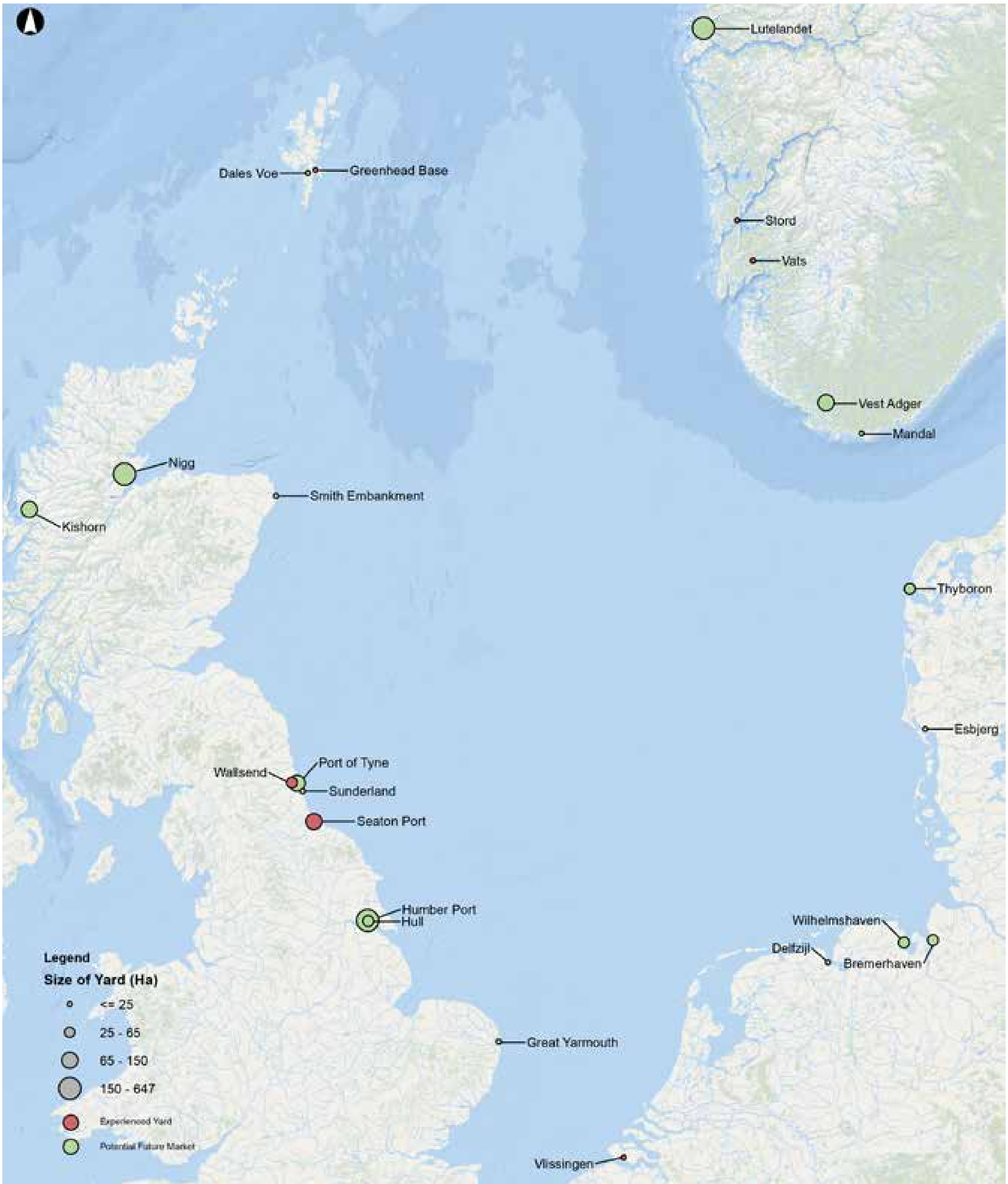
This includes the Lutelandet Offshore yard, under construction in Norway which is planned to service the Pieter Schelte vessel and encompasses another 140ha of potential development[25]. A number of other yards are currently planning on expanding, through construction of new quays or by developing additional land for storage for markets other than offshore decommissioning. For example, Nigg is planning a new deepwater harbour; while it is aimed towards the offshore wind market, the facilities would be suitable for decommissioning work.

The table under details yards in proximity to the North Sea which have present or future potential to support decommissioning.

Experienced Yards	Yards with Future Potential to Carry out Decommissioning
Vlissingen – Hoondert Services & Decommissioning	Bremerhaven
Wallsend – Peterson UK & Veolia Environmental Services	Dales Voe
Vats – AF Decom Offshore	Delfzijl
Stord – Kvaerner	Esbjerg
Seaton Port - Able UK	Great Yarmouth
Greenhead Base - Peterson UK & Veolia Environmental Services	Hull
	Humber Port
	Kishorn
	Lutelandet
	Mandal
	Nigg
	Port of Tyne
	Smith Embankment
	Sunderland
	Thyboron
	Vest Adger
	Wilhelmshaven



The graph shows some key yard characteristics and the capability of yards with existing and future decommissioning experience. The circles represent yard footprint.



Decommissioning Yards.

A comparison of the number of yards in each country also shows the capability available and the geographic spread. The UK is leading in terms of the current capacity, as well as in terms of locations with potential capacity to support the decommissioning market.

Estimates by the Norwegian Climate and Pollution Agency suggest that Norway has a capacity to process between 50,000 to 80,000 tonnes of steel annually at facilities in Vats, Stord/Scanmet, and Vest Adger which have permits to decommission offshore installations[7]. These facilities have a total footprint of nearly 70 hectares.

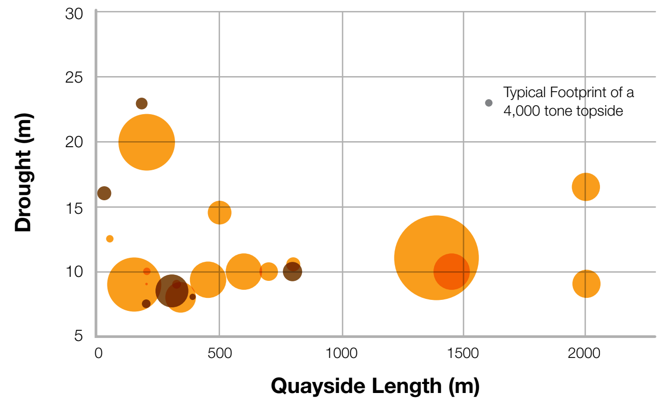
A 2002 study by DNV suggested that Norway had sufficient capacity to process up to 160,000 tonnes a year[26]. However, this included capacity of a number of facilities which are no longer operating. There is a lack of data on UK capacity, but it is likely that the UK will have the potential to match or exceed this processing capability based on comparing facility footprint.

The average demand of steel removal and recycling is estimated at 100,000 tonnes per year ramping up to 160,000 tonnes a year in the latter half of the next decade[1], [7]. This suggests that there could be capacity constraints over the period to 2022, particularly if the lower range of current Norwegian and UK port capacity is considered; if further ports are not developed, and if there is high competing demand for capacity.

For smaller installations, there is likely to be limited constraints due to the range of viable options capable of lifting and processing installations of a few thousand tonnes. For heavier installations, depending on competing demands, there may be limitations on the available ports capable of receiving and processing large structures up to 10,000 tonnes which the current generation of large heavy-lift vessels can deliver.

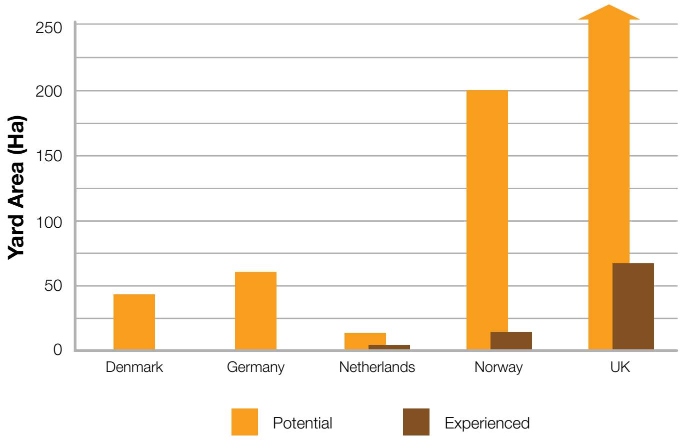
There are a range of opportunities to upgrade current ports to allow for greater lifting and processing capability. However, the lead time to develop upgrades may cause constraints in the short to medium term. Moreover, the high level of investment commitment may discourage investment, unless there is confidence that opportunities will materialise in a reasonable timeframe. The number of yards which can accommodate the 'ultra-large' vessels, such as the Pieter Schelte, will be very limited.

Decommissioning Yards in the North Sea

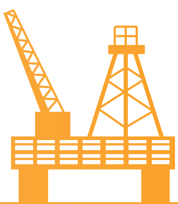


Source: Mackay Consultants[3], NCPA[7]

Footprint of Decommissioning Yards



Source: Mackay Consultants[3], NCPA[7]



7.4 Health Check

Capability = Medium

Accenture consider topside and substructure recycling including offloading, cleaning and handling, deconstruction, recycling and disposal and possible reduce with an overall capability for the phase of just over 3, making it the joint second strongest capability across the decommissioning supply chain. They assessed the activity with the strongest supply capability is Recycling & Disposal with 3.43 while, at 2.89, Offloading is the weakest.

There is good capability and track record in dealing with piece small decommissioning. However, deep water facilities capable of hosting large heavy-lift vessels are more limited with large vessels relying on transfer barges.

Steel processing plants are far from available yards, complicating logistics and increasing costs. There are also opportunities for improving the link between demolition contractors and yards.

Estimated volume of supply against demand = Medium

A review of capacity against demand suggests that, particularly if the lower range of current Norwegian and UK port capacity is considered, there could be capacity constraints over the period to 2022 if further ports are not developed and if there is high competing demand for capacity.

For smaller installations there are likely to be limited constraints due to the range of viable options capable of lifting and processing installations of a few thousand tonnes.

For heavier installations, there may be some limitations in terms of facilities capable of receiving and processing structures up to 10,000 tonnes which the current generation of large heavy-lift vessels can deliver.

There are a range of opportunities to upgrading current ports to allow for greater lifting and processing capability. However the lead time to develop upgrades may cause constraints in the short to medium term. And the high level of investment commitment, may discourage investment unless there is confidence that opportunities will materialise in a reasonable timeframe.

Pressures and/or synergies from other industries = High

Ports/Harbours/Yards have a variety of uses which may compete with the decommissioning market including oil and gas fabrication and refit, ship building and decommissioning, marine renewables and others.

There is potential competition from the offshore wind fabrication and assembly facilities could potentially reducing storage space and berths availability if a high deployment scenario is realised. Recent development activity in this market has been scaled back suggesting that the demands from the industry is likely to be more modest than initially anticipated.

Analysis undertaken on behalf of The Crown Estates indicated that there is sufficient European capacity for the offshore wind market (27). In the UK, there has been progress in developing installation capacity at Belfast, Great Yarmouth, Harwich, Hull, Merseyside, Mostyn and Teesside. There have also been developments in Belgium at Ostend, in Denmark at Esbjerg and in the Netherlands at Eemshaven and Vlissingen.

However, generally the locations currently being targeted by each industry do not overlap. It is considered that their development has potential to offer a synergistic benefit as the overall capability of infrastructure grows, rather than a risk of competition.

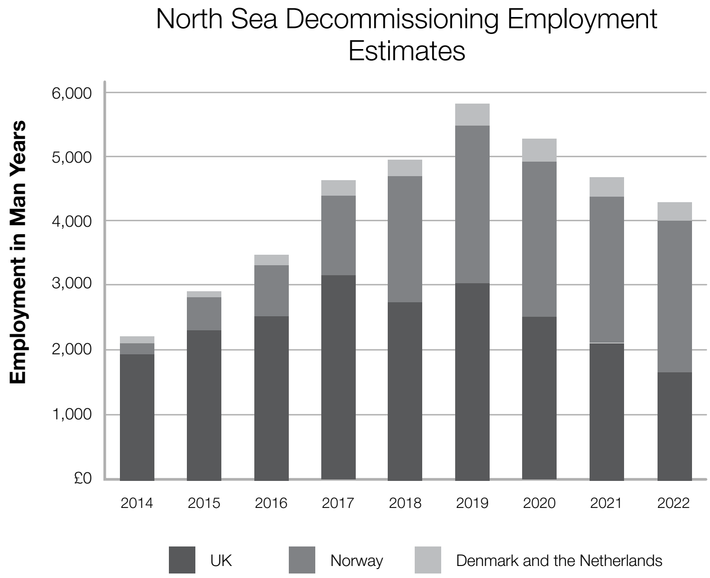
In some areas, ports face redevelopment pressures as they are sought after locations for residential or commercial enterprises. However, this pressure has reduced in recent years as the property market is less buoyant.

Investment Status = Medium / High

Investment has been made in a number of facilities in proximity to the North Sea on the basis of opportunities from decommissioning and other industries.

8.0 People

Common across all elements of the resource breakdown structure is the requirement to have skilled manpower to support decommissioning projects. People, and in particular those with engineering and offshore skills have been identified as a critical supply chain element through the consultation process. People are elements of the supply chain which are known to have demands from other maritime and other industries, have had known shortages, are specialised and not easily substituted by alternatives.



Source: Oil & Gas UK[1], Mackay Consultants[3]

As a nascent market, it is inevitable that there is currently a shortage in sufficiently experienced resources to meet future demand. Building capacity will involve attracting skilled resources from analogous industries and training new capability. Knowledge management is a core aspect to efficacious advancement of the decommissioning market. To drive down project costs, it is critical to ensure that lessons learned from early projects, both the successes and failures, are understood and integrated into future approaches. The oil and gas sector is generally characterised by a comparatively mobile workforce that follow opportunities across the sector and geographies. Capturing and disseminating experiences from a transient workforce will be a challenge.

Analysis undertaken on the Brent Decommissioning Programme concludes that there is approximately £450,000 of expenditure per man year of employment[3]. Using this figure for the predicted expenditure profile in the North Sea to 2022, results in an annual average employment of approximately 4,250 people.

Annual average decommissioning activity is predicted to double over the next decade, indicating a need to substantially grow the workforce capability. The most likely source of these resources is the North Sea E&P Sector. There are an estimated 271,000 employed within the oil and gas industry across the UK, Norway and Denmark[28], [29], [30]. These countries all estimate a workforce that will grow at a faster rate than the UK average[28], [29], [30]. A significant proportion of these individuals could have directly applicable or transferrable skills to support decommissioning. Decommissioning employment estimates represents less than 2% of the North Sea E&P resource. Considered in isolation it is unlikely that resources to support the decommissioning market will be a constraint.

However, the oil and gas market and engineering market as a whole are suffering from resource constraints. According to statistics from the Royal Academy for Engineering, the UK only produces enough science, engineering and technology graduates to meet two thirds of the required 110,000 new entrants required annually by UK businesses[31]. Analysis by OPTIO finds that 33% of businesses in the upstream oil and gas sector have hard-to-fill roles including design engineers, marine crew, and mechanical engineers[28]. Skills shortages also exist within the current workforce, with 24% of businesses with engineering and technical staff citing skills shortages as a particular issue[28].

Arup consultation suggested there is an anecdotal perceived image problem associated with the decommissioning market, which is not considered as interesting or as financially rewarding as the E&P market. As a result, the decommissioning market is likely to be vulnerable to competition from the North Sea and global E&P markets. Research highlights that the age profile of employees in the industry is a key issue[32]. An aging workforce creates a concern in terms of future reduction in available workforce as older staff retire without the pipeline of new staff filling their roles. This is particularly critical for the decommissioning market as the first tranche of projects will be older assets, many of which have suffered from poor record keeping. It is important that the expertise and knowledge held by older workers is retained within the industry and transferred to new recruits. Other markets such as the nuclear decommissioning and offshore wind sector may provide resources with transferrable skills that can support the market. However, these markets are already resource constrained and are unlikely to offer significant potential to alleviate resource constraints.

Health Check

Capability = Medium

As a nascent market it is inevitable that there is currently not be sufficient experienced resources to meet future demand. Building capacity will involve attracting skilled resources from analogous industries and training new capability.

Annual average decommissioning activity is predicted to double over the next decade, indicating a need to substantially grow the workforce capability. Capturing and disseminating experiences from a transient workforce will be a challenge[1].

Estimated volume of supply against demand = Medium

Annual average decommissioning activity is predicted to double over the next decade, indicating a need to substantially grow the workforce capability. The most likely source of these resources is the North Sea E&P Sector. There are an estimated 271,000 employed within the oil and gas industry across the UK, Norway and Denmark. These countries all estimate a workforce that will grow at a faster rate than the UK average based on the demand. A significant proportion of these individuals will have directly applicable or transferrable skills to support decommissioning. Decommissioning employments estimates represents less than 2% of this market. Considered in isolation it is unlikely that resources to support the decommissioning market would be a constraint.

Some capability can be quickly where there is the potential to build on existing capability. However, the lead time to build professional skills with experience can take up to a decade or more.

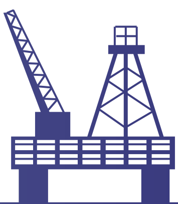
Pressures and /or synergies from other industries = Low / Medium

The O&G market and engineering markets as a whole are suffering from resource constraints. There is an anecdotal perceived image problem associated with the decommissioning market, which is not considered as interesting or financially rewarding as the E&P market. As a result the decommissioning market is likely to be vulnerable to competition from the North Sea and global E&P markets.

Other markets such as the nuclear decommissioning and offshore wind Sector may provide resources with transferrable skills that can support the market. However, these markets are already resource constrained and are unlikely to offer significant potential to alleviate resource constraints.

Investment Status = Medium / High

There is a recognised drive to increase resource capability and volume across the oil and gas Sector with significant growth in resources expected in the short term.

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9.0 Context and Considerations

A Changing Mind Set

The decommissioning market is largely served by consultants and marine contractors who also operate in the E&P Sector. The market is largely driven by operators who have taken assets through the E&P phases and whose business model focuses on E&P optimisation. As such, a number of the approaches and philosophy of E&P has been taken through to inform decision making in decommissioning.

Contributors to the consultation exercise informing this study commonly noted the need for the market to develop an approach to decommissioning distinct from that of exploration and production activity. Recognition of the different drivers and success criteria of E&P versus decommissioning will allow the market to develop an approach that is optimised for their respective projects.

Regardless, the existing operators of installations are critical to understanding the assets and their characteristics. To develop an effective decommissioning process, their experience should be integrated into the decommissioning plan.

The table gives examples of the differences in market drivers in E&P versus decommissioning.

Exploration & Production	Decommissioning
Economics driven by achieving first oil	Economics driven by reducing overall costs, with drivers bias towards defer spend
Projects may not proceed if they don't achieve investment hurdles	Project legally obligated to proceed
Future market scale uncertain	Future market scale relatively certain
Very mature market which has been evolved since first activity in the 1960s	Immature market with a small number of projects and operators having delivered a decommissioning project to date
Scope of project can vary based on technical and commercial drivers.	Scope of project is largely fixed and includes removal of all infrastructure (unless a derogation is granted). Although there is considerable uncertainty for older facilities were record keeping has been poor.
Safety and asset integrity driven, to ensure operation and production is sustained uninterrupted.	Safety driven. Asset integrity only relevant to maintain critical functions necessary for the removal process and limit environmental impact.
Perceived by the supply chain as having higher margins and offering more technical challenging	Perceived by the market as lower margins and less interesting.

Smoothing the Peaks

Creating accurate estimates of decommissioning expenditure across the North Sea is challenging. Estimates have been produced by a range of organisations which show a broad range in variation on a year by year basis and over the next decade. There is inherent uncertainty in terms of the costs of decommissioning and timing of activities which drive these variations.

Estimates of expenditure from all sources show large variations year on year. However there are inherent limitations in decommissioning estimates, which are built from a bottom-up analysis of individual operators independently declaring their expected decommissioning schedule. The rapid development of North Sea infrastructure means that a number of assets will come to the end of their life in similar timescales. This trend would suggest that there will also be peaks in the decommissioning activity, which is reflected in many of the forecasts.

However, the market is inherently different to that of E&P activities. In E&P programme delays directly impact the timing of subsequent revenue flows and so programme drivers are highly significant in procurement decisions. For decommissioning, programme delays defer capital expenditure and often have a less significant detrimental impact on project economics than in E&P projects.

As a result, operators are likely to have significantly more flexibility to manage procurement and programme decisions for decommissioning activities than in E&P. Consequently, the market is unlikely to procure services in the peaks suggested by the predicted estimates as the cost to procure resources would increase i.e. the market will smooth out the peaks.

Contracting and Procurement Strategy

Rigidity in contracting and procurement structures developed to support the E&P market can inhibit operators and the supply chain from adapting to meet the demands of the decommissioning market.

Current procurement procedures generally consider value, approach and experience. This creates a bias towards the limited parts of the supply chain that have existing experience. Adapting existing procurement strategy to reduce requirements for previous experience will allow new entrants to the market who may introduce innovative methods. This could allow learning from other markets, such as the nuclear or salvage industries to be integrated.

There are a range of contracting strategies pursued by operators which are generally an evolution of E&P activities. Innovative contracting strategies may allow contractors and operators to reduce costs through better allocation of risk and pain-gain mechanisms to better aligning objectives. Examples could include well P&A contracts being extended to cover a programme of wells which could be more efficient than contracting wells as individual projects. Provision of a more flexible window during which operations can be undertake could allow more efficient programming of resources.

There are also opportunities for the supply chain to collaborate more effectively to develop more comprehensive offerings which respond to emergining contracting strategies.

Driving Innovation, Driving Down Costs and Regulation

Innovation can play a role in delivering decommissioning in a more cost effective manner. The nascent market has limited experience focusing on decommissioning activities and is at a stage where it can incorporate lessons learnt along with developing new approaches to reduce costs. The uncertainty in the timescales of the market opportunity may limit commitment to drive and invest in innovation. The supply chain cites the 'stop/start' nature of the industry as a barrier to investment. Investment in the Pieter Schelte is a significant exception, however, opportunities from other markets provided investment confidence to Allseas.

An example of this is the development of a tested rigless approach for well P&A, which could significantly reduce costs. Currently there are limitations in North Sea operators that have accepted a rigless solution due to concerns associated with using novel untested technology. Also, well P&A contractors are not publically committing to develop and test infrastructure due to the lack of certainty over timing of decommissioning programmes. In the Gulf of Mexico regulatory intervention through the 'Idle Iron policy' gave greater certainty in pipeline of activity which provided the appropriate climate for the supply chain to invest in development of new tools[33].

In the UK the overhaul of the regulatory system offers opportunities for intervention that will motivate the market to reduce costs. Alternative approaches to encouraging the supply chain are increased collaboration between operators in terms of identifying clusters of projects which offer a more attractive contracting opportunity.

Appendix A: References

Sources of Information

The following sources of information were integrated into this analysis:

1. Oil and Gas UK (2013), Decommissioning Insight 2013, Available via; http://www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/OP082.pdf (Accessed 25th September 2014)
2. Prof. Kemp, A. (2014), Prospective Decommissioning Activity and Infrastructure Availability in the UKCS (updated figures), University of Aberdeen. Not publically available
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Appendix B: Criteria Scoring

Each critical supply chain element is attributed a score of Low to High (Low, Low/Medium, Medium, Medium/High, High) for each parameter. The scoring is based on subjective criteria which are detailed below.

Capability

Capability refers to the competence of the market to support the decommissioning market. It is distinct from capacity as it doesn't relate to the volume of capable resources to meet the predicted demand.

The classification of capability is derived from the assessment carried out by Accenture, 'Decommissioning in the UKCS, May 2013.' In this report the industry and supply chain was consulted on their perceived capability to provide decommissioning services as per the O&GUK WBS.

Score	Rational
Low	Very Limited
Low / Medium	Limited / Not Proven / Under Development
Medium	Established / Proven
Medium / High	Proven Track Record / Innovation / Industry Recognised
High	Best in Class

Available Capacity and Investment Lead Time

This criterion considers the existing capacity of skills and resources against expected activity and the duration it takes to build any capacity shortfall.

Score	Rational
Low	Existing Capacity has a high probability of being significantly limited and there is a long lead time from Final Investment Decision (FID) to establish new capacity. There are expected to be significant long term constraints.
Low / Medium	Existing Capacity has a high probability of being limited and there is a moderate lead time to establish new capacity. There are expected to be moderate medium term constraints.
Medium	Existing Capacity has a moderate probability of being limited and there are moderate lead times from FID to establish new capacity. There is expected to be moderate short to medium term constraints.
Medium / High	Existing capacity exists and there is limited need for further investment. There are at most limited short term constraints.
High	There is a high probability of there being an oversupply in the market. There are no expected capacity constraints likely.

Investment Commitment

This criterion considers the progress and commitment made by the supply chain to build new capacity to meet any shortfalls.

Score	Rational
Low	There are no publically available sources of the supply chain building investment commitment
Low / Medium	The market has indicated an interest in building capacity, but plans have not been made publically available.
Medium	There market has indicated an interest in building capacity and a number of plans are in development.
Medium / High	There are well advanced plans to building capacity, but uncertainty if the will deliver sufficient capability
High	The market is making strong commitment to building additional supply chain capacity and there is a high certainty that new capacity is due to come on line.

Pressures/Synergies from Other Industries

This criterion considers the opportunity or threat of analogous industries. This can result from completion from resources/skills, or supporting the investment case to build capacity.

Score	Rational
Low	The resource has an application in other industries which is likely to result in a pressure on the use of that resource in the decommissioning market. It is highly likely that the demands from the other industry will take precedence.
Low / Medium	The resource has an application in other industries which is likely to result in a pressure on the use of that resource. It is not clear which industry will take precedence.
Medium	The resource has potential for application in other industries which may result in a pressure on the use of that resource in the decommissioning market. However, it is highly likely that the demands from the decommissioning market will take precedence.
Medium / High	There are limited pressures on the resource from other industries. The resources is generally specialised for the decommissioning market.
High	The resource has an application in another industry which is likely to support capacity building and will be of an overall benefit to the decommissioning market.

Appendix C: Resources

Operator Project Management

Skills

- Project Management Core Team
- Corporate Services
- Commercial, Costing and Economic Support
- Decommissioning Programme Preparation, Reporting and Close Out
- Engineering Concept Appraisal (to support DP)
- Environmental Assessment (to support DP)
- Licencing and Consenting
- Stakeholder Engagement
- Commercial Fisheries Interface (Fish Safe, Admiralty Charts, Legacy Trust)
- Navigation Interface
- Legal Support
- Health and Safety

Infrastructure and Equipment

- Survey Vessels – Geotechnical data collection
- Survey Vessels – Geophysical data collection
- Survey Vessels – Environmental
- Navigational Aids

Supply Chain

- Engineering Consultancies
- Project Management Consultancies
- Integrated Professional Services
- Legal Advisors
- Accountants
- Survey Contractors
- Environmental Consultancies
- Tier 1 Contractors
- Navigation Consultants

Well Abandonment

Skills

- Well Project Management
- Engineering (P&A)
- Operations Support
- Rig Upgrade Capabilities
- P&A Project Management
- Waste Management
- Rig and Rigless Design Services
- Supply and Abandonment Materials, expanding Cement, Resins, Silicone Rubber
- NORM Handling and Disposal Routes
- Specialist Well Inspection
- Specialist Services i.e. Wireline

Infrastructure and Equipment

- Survey Vessels (pre and post removal)
- Rigs
- Rigless Solutions
- Light Weight Intervention Vessels
- Transport Vessels
- Waste Treatment and Storage
- Scale Treatment and Storage
- Logistics base (marine, aviation and onshore)

Supply Chain

- Service Contractors
- Specialist Consultants and Contractors
- Vessel Operators
- Aviation Suppliers

Running, Making Safe and Preparation

Skills

- Offshore Operations
- Deck Crew
- HV and LV Power Engineering
- Platform Services
- Integrity Management (structural)
- Engineering Down
- Engineering Up
- Detailed Engineering
- Health and Safety
- Waste Management Services
- NORM Disposal Routes
- Contaminant Disposal Routes
- Specialist Sampling Services

Infrastructure and Equipment

- Standby Vessels
- Support Vessels (anchor handlers, DSV, Tugs)
- Conventional Cutting Technologies
- Large Diameter Cutting Technologies
- Subsea Disconnection & Removal Tools
- Survey Vessels
- Logistics Base – Marine, Aviation and Onshore

Supply Chain

- Vessel Operators
- Engineering consultancies
- Specialist Contractors
- Survey Contractors
- Tier 1 Contractors

Substructure and Topside Removal

Skills

- Detailed Engineering (subsea and topsides)
- Naval Architecture
- Offshore Operations
- Transportation

Infrastructure and Equipment

- Removal Vessel
- Transportation Barges
- Support Vessels
- Anchor Handling Tug Supply (AHTS) Vessels
- Construction Support Vessels (CSV)
- Safety Standby Vessels (SSBV's)
- Survey Vessels
- Rock Dumping/ Backfill Vessels

Supply Chain

- Marine Vessel Contractors
- HLV Contractors
- Support Vessel Contractors
- Engineering Consultancies
- Specialist Consultancies

Subsea and Site Remediation

Skills

- Vessel Crew
- ROV Pilot & Support
- Offshore Operations
- Geotechnical engineering

Infrastructure and Equipment

- Suction Dredging
- ROV and Support Vessel
- Diver Support Vessels (DSV's)
- Stone Placement Vessels
- Anchor Handling Tug Supply Vessel (AHTS)

Supply Chain

- Engineering consultants
- Survey Contractors
- Vessel Contractors
- Environmental Consultants
- Specialist Contractors

Topsides and Substructure Recycling

Skills

- Material Characterisation
- Onshore Dismantling
- Onshore Environmental
- Metal Recycling Facilities and Logistics
- Hazardous Material Disposal, including NORM, LSA (Low Specific Activity Waste), Mercury
- Waste Management

Infrastructure and Equipment

- Onshore Cranage
- Cutting Equipment
- Handling Equipment
- Onshore Yard Space
- Quayside Strength and Extent
- Deepwater Access Channel
- Dry Dock

Supply Chain

- Engineering Consultants
- Onshore Yard Operators
- Ports and Harbour Operators
- Civil Contractors
- Demolition Contractors
- Waste Recycling Contractors