DECOMMISSIONING INSIGHT 2014

Oil & Gas UK
the voice of the offshore industry

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Contents

1. Foreword

Oil & Gas UK's *Decommissioning Insight* is the leading industry forecast for decommissioning activity and expenditure on the UK Continental Shelf (UKCS). Produced annually, the publication provides a ten-year forecast by region, enabling the industry to develop its capabilities accordingly. This year the report focuses on the activities of 28 operators on the UKCS.

The offshore oil and gas industry is the UK's largest industrial investor, and Oil & Gas UK's *Economic Report 2014*[1] indicates a potentially strong future for domestic oil and gas production. The Wood Review highlights the need for industry to focus on maximising economic recovery from the UKCS with a new spirit of cooperation to reduce costs and increase efficiency[2]. The review also recommends a dedicated decommissioning strategy, arguing that with sufficient early planning and coordination, the UK supply chain should be able to build a competitive advantage to meet the needs of maturing oil provinces at home and abroad. Oil & Gas UK's *2014 Decommissioning Insight* aims to facilitate this goal.

The report indicates that a handful of large decommissioning projects are well under way and will be delivered in the next five to seven years. Projects listed on the Department of Energy & Climate Change's pathfinder website include Brent, Miller, Murchison, and Thames[3]. These flagship projects will provide valuable insight for the industry as it learns how to decommission fields in a cost effective and efficient manner, thereby introducing new technologies and processes which, in turn, increase the UK's competitive capability.

Industry's shared aim is to undertake decommissioning in a cost effective, environmentally sound manner. However, success will also see decommissioning dates moved back if we can attract further investment into the many mature fields across the UKCS. Over the last three months, HM Treasury has led a consultation into the future of the fiscal regime for the UKCS. Industry has engaged constructively with the objective of delivering a simple, more competitive regime which encourages late-life investment and fosters new business models for decommissioning – innovation and investment will both be essential if we are to succeed in this task.

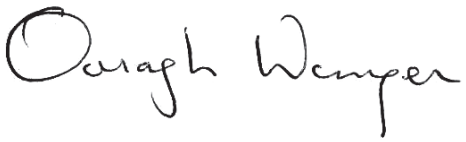
The Decommissioning Relief Deed (DRD), a contract between government and industry that guarantees certainty of future tax relief on decommissioning costs, has been such an innovation and has already extended the productive life of a number of fields. The DRD enables companies to move their decommissioning liabilities to a post-tax basis, releasing additional funds, which would otherwise be tied-up in securities for further investment in oil and gas production. To date, 61 DRDs have been executed, freeing up at least £2.2 billion for further investment in oil and gas production[4].

[1] Oil & Gas UK's *Economic Report 2014* is available to download at www.oilandgasuk.co.uk/economicreport
[2] The Wood Report – *UKCS Maximising Economic Recovery Review: Final Report* – is available to download at www.woodreview.co.uk
[3] The Department of Energy & Climate Change Pathfinder website can be viewed at www.og.decc.gov.uk/pathfinder/decommissioningindex.html
[4] As of 21 July 2014.

Total decommissioning expenditure on offshore assets over the next decade is forecast to be £14.6 billion, or just under £1.5 billion per annum. Whilst this is a significant sum, it should be put into context against total capital expenditure of £14.4 billion[5] last year. The challenge is to see a thriving decommissioning market emerge as part of a continued and sustained capital investment programme; both will rely on a relentless focus on cost efficiency and a desire to achieve yet more effective ways of working.

This document could only have been produced through support of the operators who provided data to the survey. We would like to thank these companies for their continued support.

We trust you find this document an informative and useful guide to decommissioning activity on the UKCS.



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[5] Oil & Gas UK's *Activity Survey 2014* is available to download at www.oilandgasuk.co.uk/forecasts.cfm

2. Key Findings

- In 2013, £470 million was spent on decommissioning.
- Total forecast expenditure on decommissioning from 2014 to 2023 is £14.6 billion[6].
- Total forecast expenditure has increased since 2013 due to the following factors; £3 billion is attributed to new respondents to the survey and £1.2 billion is attributed to higher forecasts from existing projects.
- Twenty-eight operators responded to the call for data, which is an increase on previous years.
- Forty-three per cent of total forecast expenditure will be concentrated in the central North Sea (£6.3 billion). Many of the projects included in the 2014 survey for the first time are in this region.
- Relative to the *2013 Decommissioning Insight* report, six projects have been deferred with their expenditure now occurring partially outside of the survey timeframe.
- Most of the decommissioning programmes captured in this survey are considered to be in the early scoping stages. Forecasts are therefore subject to change as projects become more defined.
- The largest category of expenditure is well plugging and abandonment (P&A) at 44 per cent of the total forecast (£6.4 billion).
- Operators forecast that decommissioning expenditure in 2014 will reach £1 billion for the first time in a single year and will average £1.5 billion each year over the ten years (2014 to 2023).

[6] This figure excludes £520 million of expenditure data provided as lump sums and for decommissioning onshore terminals.

Forecast Activity 2014 to 2023			
	Central and Northern North Sea	Southern North Sea and Irish Sea	Total UK Continental Shelf
Number of wells for P&A	510	417	927
Platform wells proportion of regional total	58%	80%	-
Topside modules to be removed	146	100	246
Topside weight to be removed	159,600 tonnes	122,000 tonnes	281,600 tonnes
Number of platforms	13	91	104
Substructure weight to be removed	65,000 tonnes	69,000 tonnes	134,000 tonnes
Number of mattresses to be removed	2,800	2,600	5,400
Subsea infrastructure to be removed	54,100 tonnes	1,500 tonnes	55,600 tonnes
Pipelines to be decommissioned	807 kilometres	2,470 kilometres	3,277 kilometres
Total tonnage coming onshore	288,800	192,600	481,400

Average Forecast Costs for 2014 to 2023 in the Central and Northern North Sea		
	2013 Survey	2014 Survey
Platform well P&A	£4.8 million	£4.8 million
Subsea exploration and appraisal well P&A	£8 million	£17.4 million
Subsea development well P&A	£10.1 million	£11.6 million
Topside removal cost per tonne	£4,100	£2,900
Substructure removal cost per tonne	£4,300	£4,300

Average Forecast Costs for 2014 to 2023 in the Southern North Sea and Irish Sea		
	2013 Survey	2014 Survey
Platform well P&A	£3.5 million	£2.7 million
Subsea exploration and appraisal well P&A	£4.8 million	£5 million
Subsea development well P&A	£6.9 million	£7.6 million
Topside removal cost per tonne	£3,600	£4,000
Substructure removal cost per tonne	£5,700	£4,500

3. Introduction

3.1 Survey Development and Methodology

The *Decommissioning Insight 2014* builds on the work of previous reports, incorporating requests from the supply chain and the Oil & Gas UK Decommissioning Market Insight Work Group. It is compiled from operators' responses to an Oil & Gas UK survey carried out between June and August 2014 on their decommissioning activity and expenditure in 2013 and respective forecasts for 2014 to 2023.

The survey is based on the components of the decommissioning Work Breakdown Structure (WBS) outlined in Oil & Gas UK's *Decommissioning Cost Estimating Guidelines*[7] (see Appendix). Operators were asked to quantify physical decommissioning activity for 20 different categories in the WBS, such as the tonnes of substructure (jacket) to be removed or the length of pipeline to be made safe.

Operators were also asked to provide expenditure forecasts for these categories of activity, broken down by year. The categories align with those used in the 2013 survey and allow easy mapping of the data to the WBS.

Although it is possible to compare data across the 2011 to 2014 *Decommissioning Insight* reports, it is important to note that the 2013 and 2014 surveys are modelled on the new WBS, while previous surveys were based on the former WBS. Any historical analysis that Oil & Gas UK has carried out for the purposes of this report has been conducted on comparable categories of the WBS.

The information presented in the following sections is solely based on the data as submitted at the time of the survey and is presented in a non-attributable, aggregate basis. Oil & Gas UK has not applied any additional treatment to the figures. Analysis has been carried out on a regional basis and split into two groups: the central and northern North Sea and the southern North Sea and Irish Sea.

The 2014 report has been expanded to include:

- An analysis of how well plugging and abandonment (P&A) cost forecasts have varied historically using data from the 2011 to 2014 reports
- A regional analysis of the rig type that will be used for well P&A
- An analysis of how the forecast cost per tonne for topside and substructure removal has varied historically using data from the 2011 to 2014 reports
- The number of topside modules to be made safe each year
- Analyses of the actual spend and activity carried out in 2013 compared with the forecast

[7] The *Decommissioning Cost Estimating Guidelines* are available to download at www.oilandgasuk.co.uk/publications/publications.cfm

Decommissioning Forecasts 2014 to 2023

Forecasting decommissioning expenditure at the outset of a project is challenging due to the many uncertainties and factors influencing expenditure, such as the duration of well P&A or the quantities of hazardous waste materials. As decommissioning projects are not subject to the same time pressures as development projects, there is more flexibility in the timing of execution, within integrity and safety constraints. Therefore, Oil & Gas UK expects forecasts presented in this report to be subject to change, particularly those post-2020.

Oil & Gas UK's *Activity Survey 2014*, which aggregates data over a longer timespan than this report, forecasts that £37 billion will be spent on decommissioning existing assets from 2014 through to 2040. New investment in probable developments would add £3.6 billion to this total, although much of this will be incurred after 2040[8].

3.2 Classification of Expenditure

The Association for the Advancement of Cost Engineering (AACE) has developed a set of guidelines[9] to apply an estimate classification to projected costs. Operators were asked to use these guidelines to provide an estimate class for all projects, determined by the level of 'project definition' with consideration to a set of secondary characteristics. The five estimate classes in the Cost Estimate Classification Matrix are shown in Appendix b.

Eighty-five per cent of the survey respondents classified their expenditure using the AACE Cost Estimation Classification Matrix. Forty-eight per cent of projects were reported as class 4, with a further 44 per cent reported as class 5. This shows that the majority (92 per cent) of projects are in the early planning stages of outlining the scope and carrying out feasibility studies. These will have a level of project definition from 0 to 15 per cent (where 100 per cent represents complete project definition).

Only five per cent of projects were reported as class 1 or 2, where the level of project definition is between 30 and 100 per cent and projects are either at the contracting stage or already in execution.

[8] All references in 2013 money, Oil & Gas UK's *Activity Survey 2014* is available to download at www.oilandgasuk.co.uk/forecasts.cfm

[9] Further information on the Association for the Advancement of Cost Engineering (AACE) classification scheme is available at www.costengineering.eu/Downloads/articles/AACE+CLASSIFICATION_SYSTEM.pdf

4. Results of the 2014 Decommissioning Survey

The following results represent operators' expenditure and activity forecasts for decommissioning UK Continental Shelf (UKCS) assets each year from 2014 to 2023. The analysis does not include the expenditure provided as lump sums or associated with decommissioning onshore terminals[10].

To put decommissioning activity into context with the overall industry, the total decommissioning expenditure forecast over the ten-year period 2014 to 2023 is £14.6 billion, whereas the total capital expenditure on development projects in 2013 alone was £14.4 billion[11].

The total expenditure forecast captured in the report has increased on last year. Three billion pounds of this increase is attributed to projects in the central North Sea (CNS) and southern North Sea (SNS) included for the first time from new survey respondants. A further £1.2 billion is attributed to higher expenditure estimates from the majority of projects included in the 2013 and 2014 surveys. This is a reflection of these projects becoming more defined.

Planning for decommissioning can be a long and challenging process which operators start far ahead of cessation of production (COP). The scope of each decommissioning project is refined over time and estimates are therefore subject to change during this process. As the field nears COP and the project scope becomes more fully defined, expenditure forecasts become more precise.

With the focus across industry on maximising economic recovery (MER UK[12]) and extending the life of fields in the basin, six projects have been deferred since the 2013 report was published, with a greater proportion of their decommissioning expenditure now falling outside the ten-year survey timeframe. An example of this is the Brae field – decommissioning was postponed to align the timing of Brae Alpha, Bravo and East Brae[13].

The forecast expenditure to decommission fields serviced by floating, production, storage and offloading (FPSO) vessels is £1.6 billion, all of which will be spent in the CNS and northern North Sea (NNS) areas. The majority of decommissioning activity for these fields is subsea, although some expenditure is associated with disconnecting the FPSO. FPSO weights have not been included in the removals section as these are typically relocated or sold for reuse.

[10] £500 million was provided as lump sums with no yearly breakdown of expenditure.
[11] Oil & Gas UK's *Activity Survey 2014* is available to download at www.oilandgasuk.co.uk/forecasts.cfm
[12] The Wood Report – *UKCS Maximising Economic Recovery Review: Final Report* – is available to download at www.woodreview.co.uk
[13] The presentation on 'Decommissioning Plan B: Thinking Differently' is available to download at www.bit.ly/decomplanb

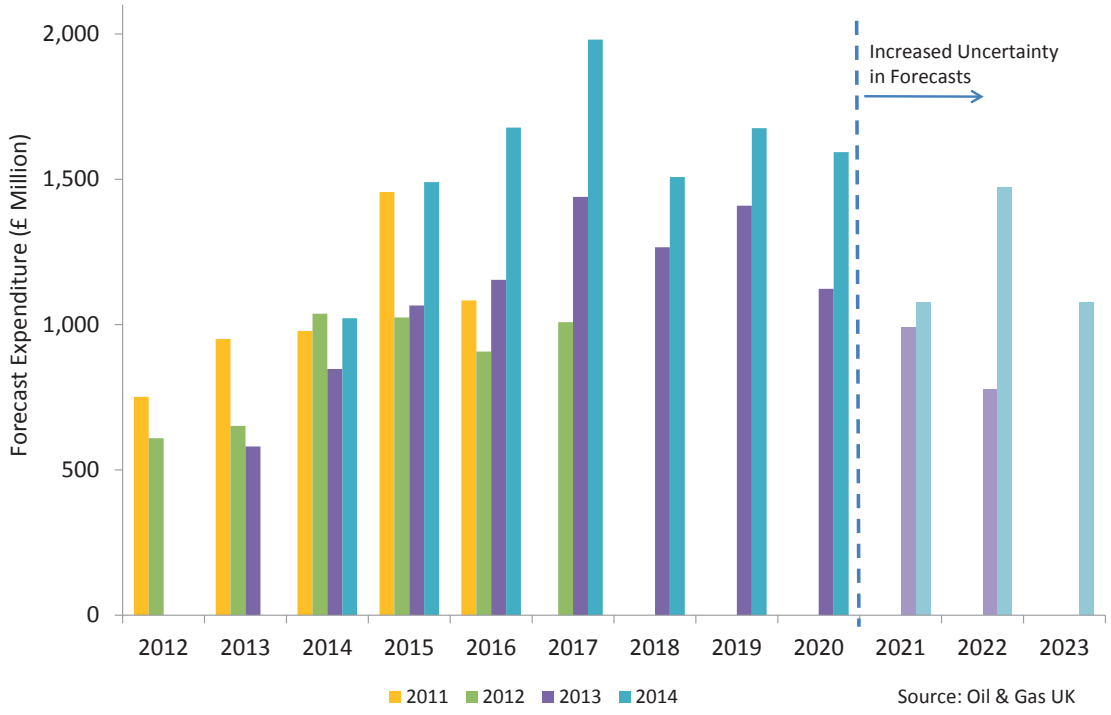
4.1 Historical Comparison of Forecast Expenditure

A comparison of forecast expenditure has been carried out using data from previous *Decommissioning Insight* reports (2011 to 2014)[14]. See Figure 1 below.

The pattern of forecast expenditure in this report is in line with last year; however, the average yearly forecast expenditure has increased to £1.5 billion, compared with £1 billion in the 2013 report, representing a clear market opportunity for the supply chain. For 2014 specifically, operators forecast that expenditure will reach £1 billion for the first time.

In 2013, £470 million was spent on decommissioning, representing 81 per cent of the £580 million forecasted. The difference between these figures is due to the timescales of some well P&As being extended. The associated expenditure has spread into 2014.

Figure 1: Comparison of the Annual Forecast Decommissioning Expenditure on the UK Continental Shelf (2011 to 2014 surveys)

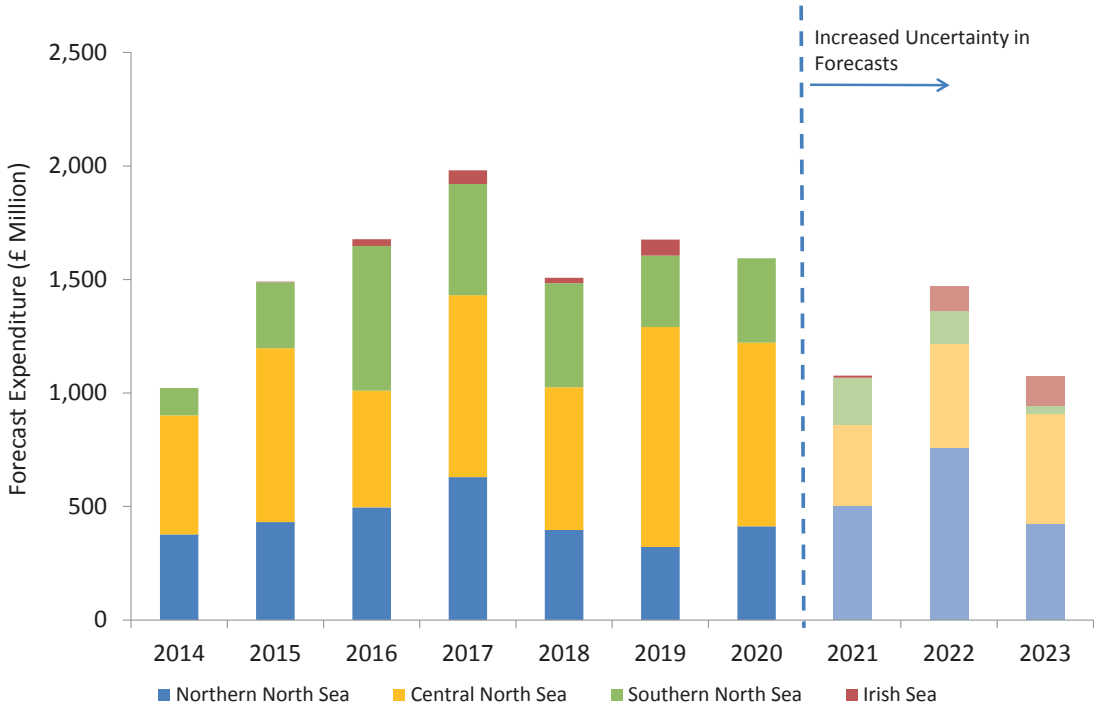


[14] All expenditure in 2014 money at 01.08.2014.

4.2 Regional Analysis

Figure 2 shows that of the £14.6 billion forecast decommissioning expenditure from 2014 to 2023, 43 per cent (£6.3 billion) will be concentrated in the CNS, 33 per cent (£4.8 billion) in the NNS, and 24 per cent (£3.5 billion) in the SNS and Irish Sea (IS). The higher proportion of expenditure in the CNS and NNS reflects the size and degree of complexity of projects in these regions.

Figure 2: Total Forecast Decommissioning Expenditure on the UK Continental Shelf by Year and Region from 2014 to 2023



Source: Oil & Gas UK

The majority of new projects captured in the survey are in the CNS area, where the expenditure has consequently almost doubled on last year's forecast (£3.3 billion in 2013). Most of these are subsea projects with a focus on well P&A, although several platform removals have also been included for the first time.

4.3 Forecast Expenditure by Decommissioning Component

The WBS components that incur expenditure during decommissioning are determined by the nature of the project. While a small subsea tie-back may only involve the P&A of a single well, decommissioning large complex projects can incur expenditure in all WBS components. These larger programmes require significant overheads for project management and operational costs, in addition to substantial engineering expertise, equipment and personnel.

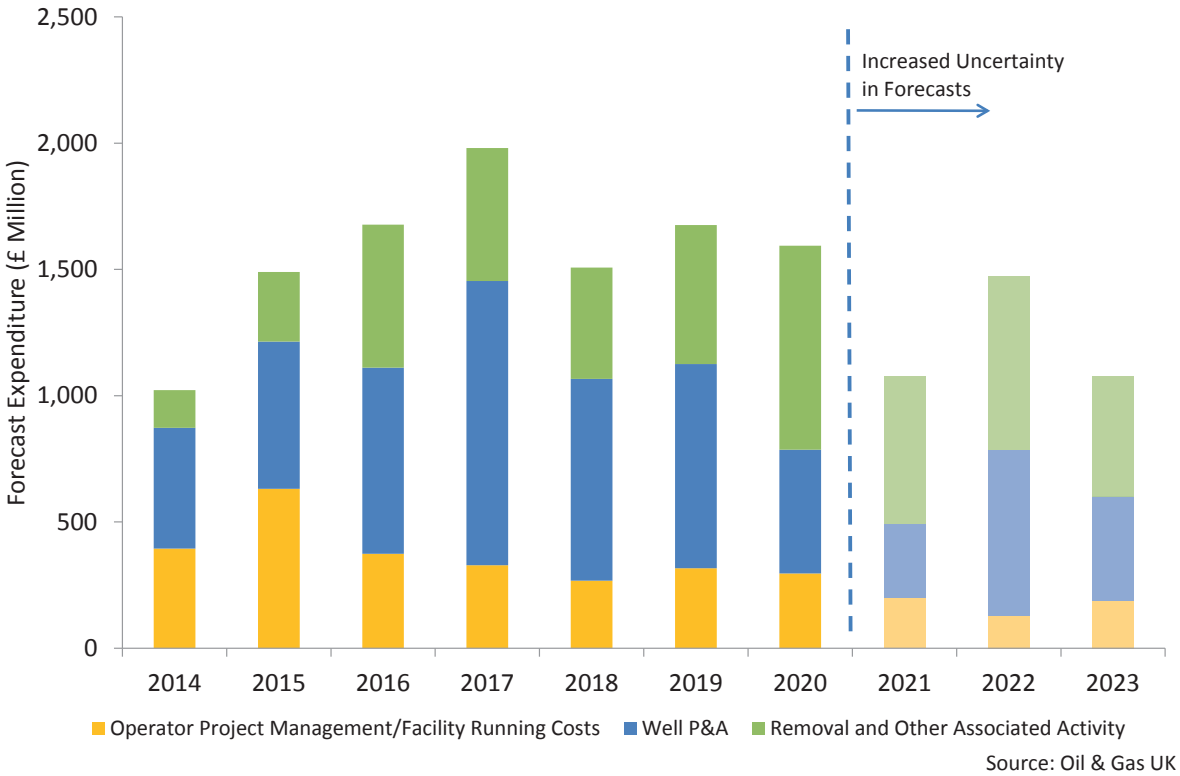
Operator project management costs span the entire decommissioning process and include: project management; preparation of decommissioning programmes, studies and reports; and all related consultation and stakeholder engagement.

Facility running and owners' costs are the expenses incurred to operate the decommissioning programme post-COP through to completion. This involves managing the facility, both as a pre-normally unmanned installation (Pre-NUI) and normally unmanned installation (NUI), with expenditure on logistics, a decommissioning team, the deck crew, power generation, platform services, integrity management (inspection and maintenance) and specialist services.

Figure 3 breaks down the total yearly expenditure into three categories: operator project management/facility running costs; well P&A; and removal and other associated activity. The latter includes expenditure on the following: making safe; topside preparation; removal of topsides, substructures and subsea infrastructure; pipeline decommissioning; and disposal, recycling, site remediation and monitoring.

Operator project management/facility running costs are forecast to remain relatively stable, peaking in 2015 as a number of projects gear up for decommissioning. Well P&A is highest in 2017, and removal expenditure is forecast to be low in the near term, but relatively stable across the rest of the decade. The activity related to each of these WBS components is discussed in section 6.

Figure 3: Total Forecast Decommissioning Expenditure on the UK Continental Shelf by Work Breakdown Structure Category from 2014 to 2023



Source: Oil & Gas UK

	Expenditure 2014 to 2023
Operator project management/facility running costs	£3.1 billion
Well P&A	£6.4 billion
Removal and other associated activity	£5.1 billion

Figure 4 overleaf breaks down the total forecast expenditure by proportion of WBS component for all UKCS projects, subsea projects (including FPSOs), facility removal projects in the CNS and NNS areas, and facility removal projects in the SNS and IS areas.

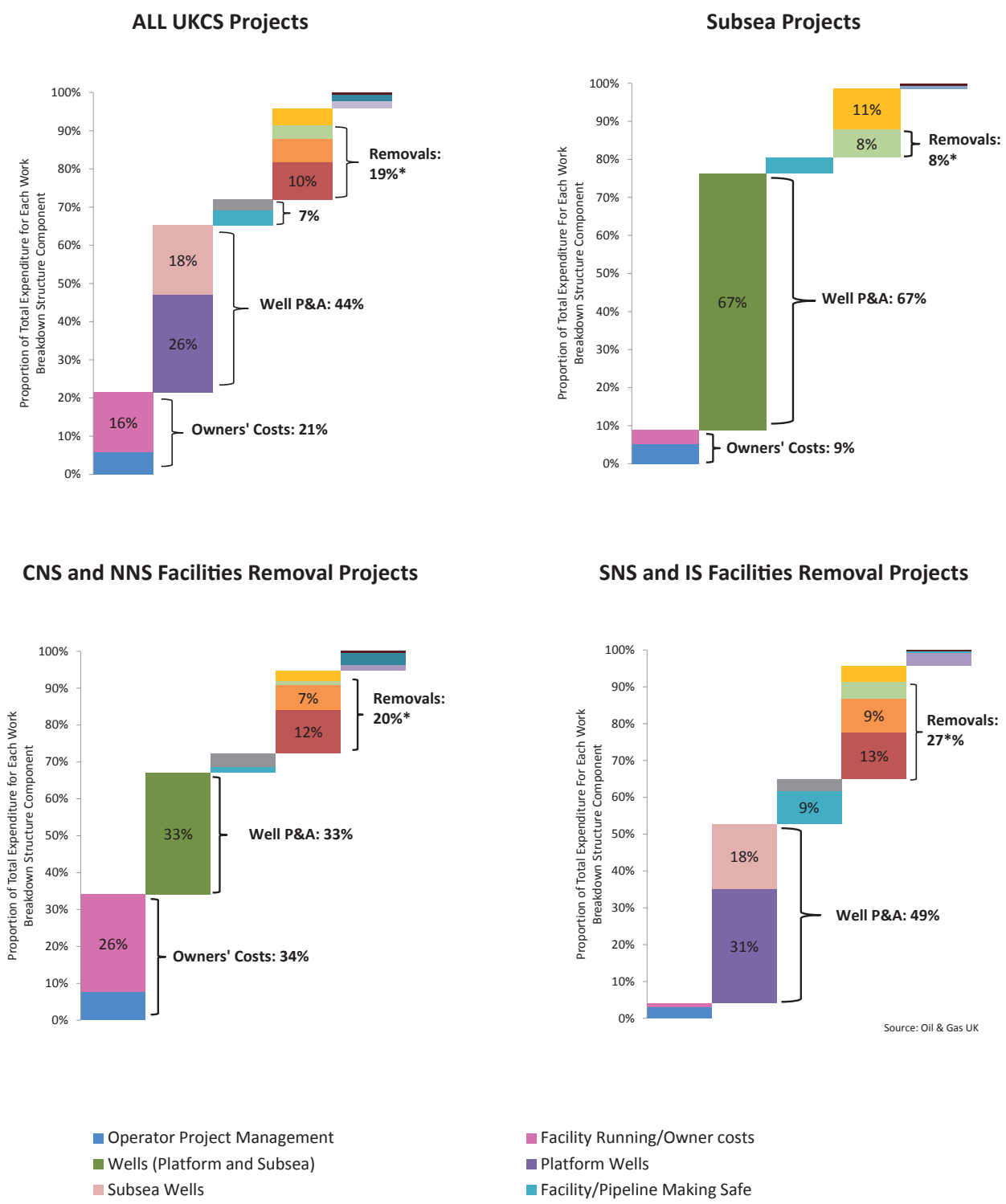
Well P&A is the largest category of expenditure, accounting for 44 per cent (£6.4 billion) of the total forecast on the UKCS, in line with previous reports. The proportion of expenditure on wells increases significantly for subsea projects to 67 per cent (£1.7 billion).

Across the UKCS, 94 per cent (£2.9 billion) of all owners' costs (including all facility running and operator project management costs) are in the CNS and NNS areas. This is due to the size and complexity of projects in these regions and the fact that platforms are typically manned installations. Owners' costs, in turn, represent 34 per cent (£2.7 billion) of facility removal projects in the CNS and NNS areas, compared with only four per cent (£145 million) in the SNS and IS areas.

As a proportion, expenditure on topside, substructure and subsea structure removals in the SNS and IS areas is higher than in the CNS and NNS, despite the greater complexity of projects in the latter regions. This is a consequence of the lower proportion of expenditure on owners' costs in the SNS and IS areas.

Oil & Gas UK and industry are currently working on developing a better understanding of the key decommissioning cost drivers and how these can be reduced. Well P&A duration, removal duration, and vessel rates have been identified as the key cost drivers and, as such, are the focus of this work.

Figure 4: Forecast of Total Decommissioning Expenditure on the UK Continental Shelf by Work Breakdown Structure Component and Project Type from 2014 to 2023



5. Decommissioning Activity in 2013

Analysis has been carried out to assess the level of activity forecasted for 2013 in comparison to what has actually been executed. Operators forecasted activity in well P&A, subsea infrastructure removal and pipeline decommissioning, the majority of which was accomplished as planned.

Decommissioning Activity	Forecast for Activity in 2013	2013 Actual Activity
Subsea exploration and appraisal well P&A	11	8
Platform well P&A	13	All activity carried out
Subsea development well P&A	2	All activity carried out
Mattresses	12	All activity carried out
Subsea infrastructure	1,600 tonnes	All activity carried out
Pipelines	22 kilometres	All activity carried out

All the platform wells were safely plugged and abandoned in 2013 using an integral rig. The subsea well P&As carried out in 2013 varied in degree of complexity. The subsea exploration and appraisal (E&A) well P&As that were not carried out in 2013 are scheduled to be finished in 2014 following longer P&A durations on some wells.

6. Forecast Decommissioning Activity from 2014 to 2023

The following sections of this report focus on the specific areas of forecast activity outlined in the WBS.

6.1 Well Plugging and Abandonment

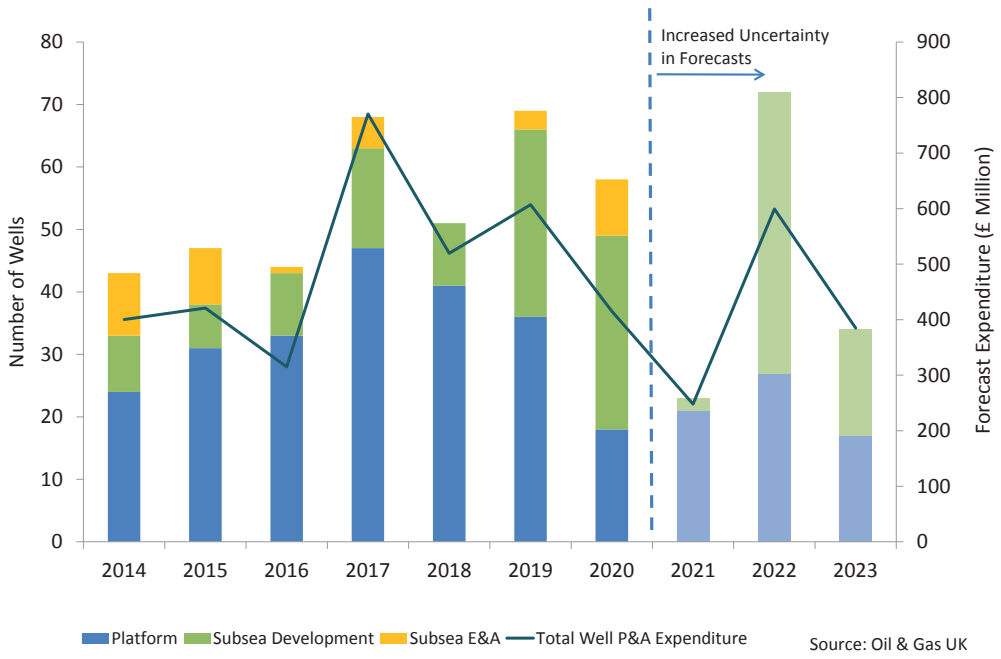
Well P&A on the UKCS is carried out in accordance with industry guidelines[15]. The process of well P&A can be challenging and may involve intervention, the removal of downhole equipment (such as production tubing and casing), and well-scale decontamination treatment. It also requires removing the wellhead and conductor to three metres below the seabed.

Of the current inventory of around 5,000 wells that will eventually require P&A on the UKCS[16], close to 930 are scheduled for decommissioning over the next decade at a cost of £6.4 billion. This represents nearly 19 per cent of the total well stock.

The Central and Northern North Sea

The number of wells forecast for P&A in the CNS and NNS is shown in Figure 5. Activity varies each year, with higher activity in 2017, 2019 and 2022. This variation is similar to that shown in the 2013 report, although the peaks have smoothed out and occur later.

Figure 5: Number of Wells Forecast to be Plugged and Abandoned by Type and Total Annual Expenditure in the Central and Northern North Sea from 2014 to 2023



Source: Oil & Gas UK

Number of Wells 2014 to 2023	Total Expenditure 2014 to 2023	Proportion of Platform Wells
510	£4.7 billion	58%

[15] The *Guidelines for the Suspension and Abandonment of Wells* are available to download at www.oilandgasuk.co.uk/publications/viewpub.cfm?frmPubID=447

[16] See Common Data Access Limited's data store at www.ukoilandgasdata.com

The years of high activity are due to a number of projects forecasting to carry out well P&A in the same year. In 2017, 2019, and 2022, well P&As are scheduled on ten, thirteen, and seven fields, respectively. Oil & Gas UK expects that as forecasts are revisited, activity will smooth out in line with the near-term forecasts of 2014 and 2015, which show a much smaller variation.

A number of operators plan to carry out well P&A in several phases, with each phase acting as a separate campaign. Phase one typically uses a lower cost method such as wireline, coil tubing and a hydraulic workover unit or light well intervention (LWI) vessel, while phases two and three use a rig. Where this is the case, Oil & Gas UK has counted wells at the start of the campaign to avoid duplication.

The total expenditure on well P&A in the CNS and NNS has increased by 52 per cent (£4.7 billion) compared to last year's forecast (£3.1 billion), while the total number of wells has only increased by six per cent (30 wells).

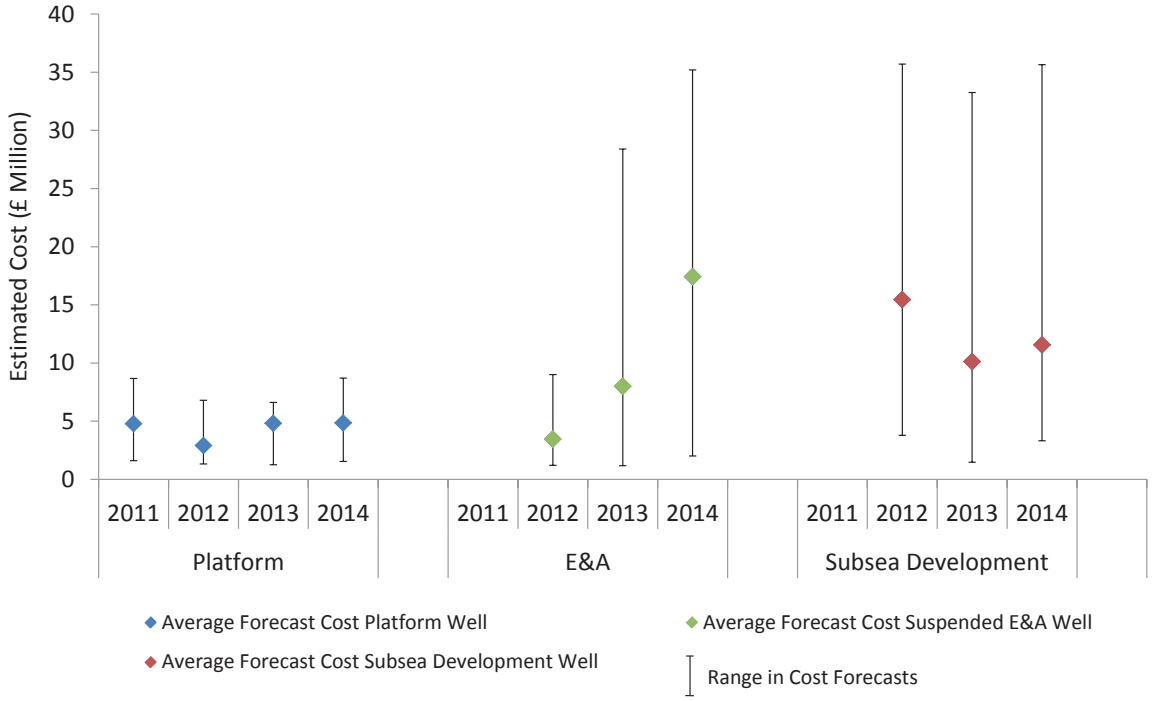
Historical variation in Well Plugging and Abandonment Cost Forecasts in the Central and Northern North Sea

The large range in forecasts for subsea wells, as shown in Figure 6 overleaf, reflects the wide variation in the type of well to be plugged and abandoned. Simple rig-less P&As using wireline, pumping or crane jacks account for the low end of the cost range, while wells at the top-of-the-range are typically complex, rig-based P&As with challenging access and cementing. They also require retrieval of tubing and casing, milling, and cement repairs. Older wells have the additional challenge of limited documentation of well design and material construction, particularly where well ownership has changed.

While the range in forecasts for subsea development wells has been consistently large, forecasts for subsea E&A wells have increased significantly since 2012. Several operators have reported that benchmarking exercises have influenced their cost estimates and that forecasts for complex wells have been revised up as they gain more experience.

Platform wells show the smallest variation in cost forecasts, as they typically have all of the necessary tools and materials to-hand and are not subject to the same weather constraints or rig requirements. These wells are also typically carried out in batches or campaigns, enabling mobilisation costs to be more easily shared across a number of wells.

Figure 6: Historical Variation in Well Plugging and Abandonment Cost Forecasts in the Central and Northern North Sea (2011 to 2014 Surveys)



Source: Oil & Gas UK

Well P&A	2013 Average	2014 Average
Platform wells	£4.8 million	£4.8 million
Subsea E&A wells	£8 million	£17.4 million
Subsea development wells	£10.1 million	£11.6 million

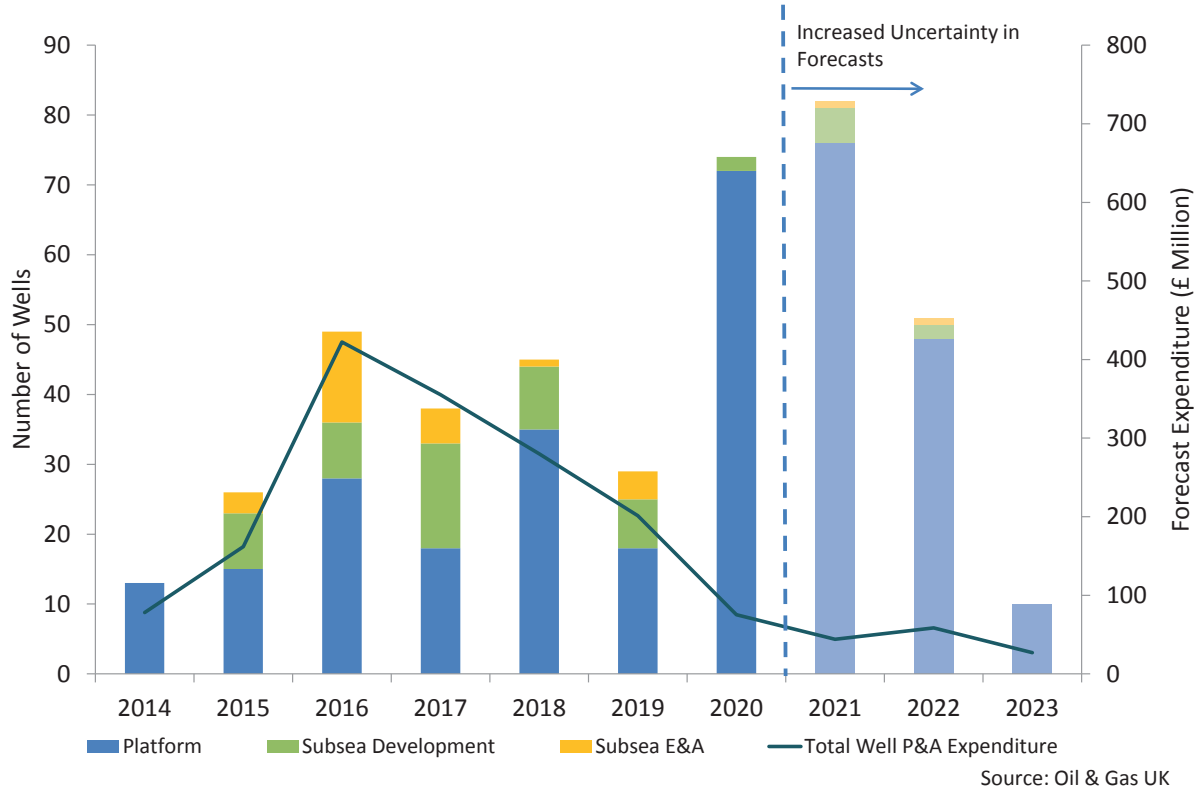
The Southern North Sea and Irish Sea

The number of wells scheduled for P&A in the SNS and IS areas has increased by almost 90 compared to the 2013 report. This increase is spread across the decade, although 60 more wells are forecast between 2015 and 2019. The rise is due to the inclusion of additional oil and gas projects and higher forecasts from existing projects.

The large number of wells forecast to undergo P&A in 2020 and 2021 is due to eight projects scheduling P&A at the same time, and it is expected that this activity will smooth out when forecasts are revisited. Activity in 2014 is lower than the forecast made for the year in the 2013 report as a number of projects have spread out their activity.

Well P&A expenditure increases in line with activity in the near term, tailing off towards the end of the decade. The higher expenditure between 2015 and 2018 is due to the greater number of subsea wells. The peak in wells seen in 2020 and 2021 is due to an increase in platform wells, which are less expensive.

Figure 7: Number of Wells Forecast to be Plugged and Abandoned by Type and Total Annual Expenditure in the Southern North Sea and Irish Sea from 2014 to 2023



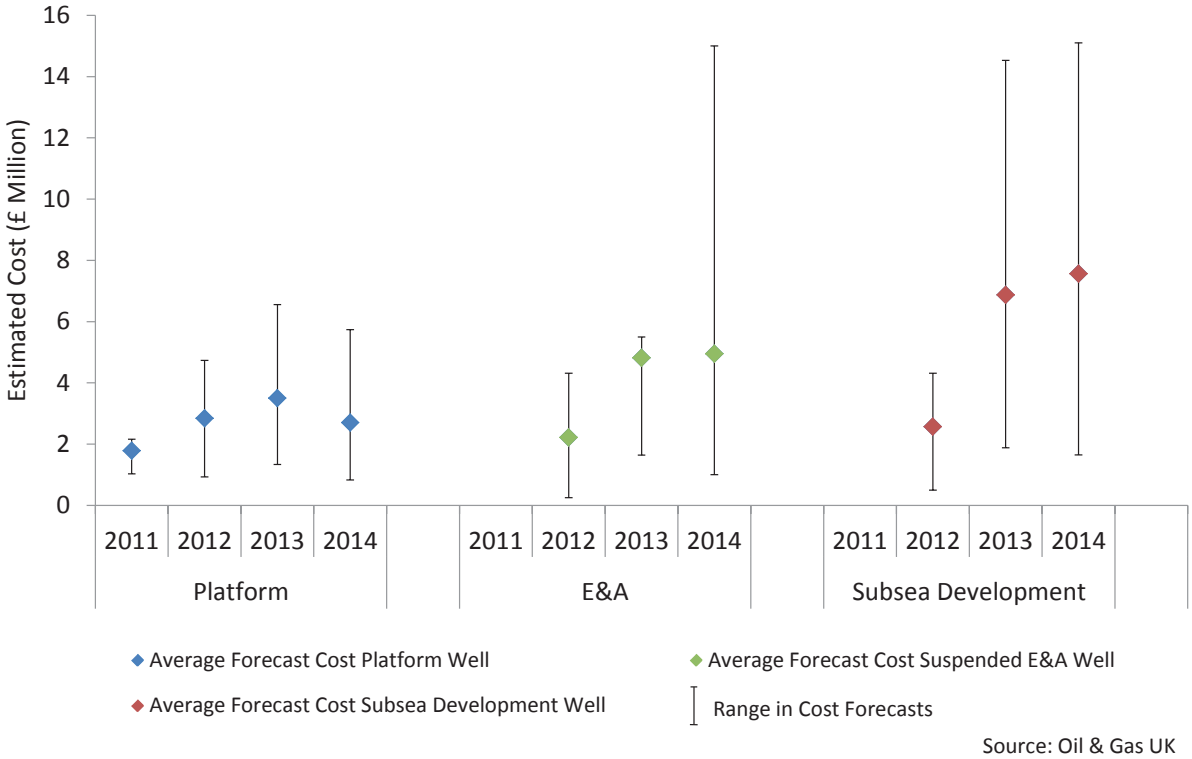
Source: Oil & Gas UK

Number of Wells 2014 to 2023	Total Expenditure 2014 to 2023	Proportion of Platform Wells
417	£1.7 billion	80%

Historical Variation in Well Plugging and Abandonment Cost Forecasts in the Southern North Sea and Irish Sea

The cost of well P&A is significantly lower in the SNS and IS than in the CNS and NNS areas. This is due to the fact that well P&A completions are often simpler as the more benign fluids in these regions cause fewer problems of corrosion. As seen in Figure 8, platform well P&A in the SNS and IS is cheaper to perform and shows the smallest variation in cost estimates.

Figure 8: Historical Variation in Well Plugging and Abandonment Cost Forecasts in the Southern North Sea and Irish Sea (2011 to 2014 Surveys)



Source: Oil & Gas UK

Well P&A	2013 Average	2014 Average
Platform wells	£3.5 million	£2.7 million
Subsea E&A wells	£4.8 million	£5 million
Subsea development wells	£6.9 million	£7.6 million

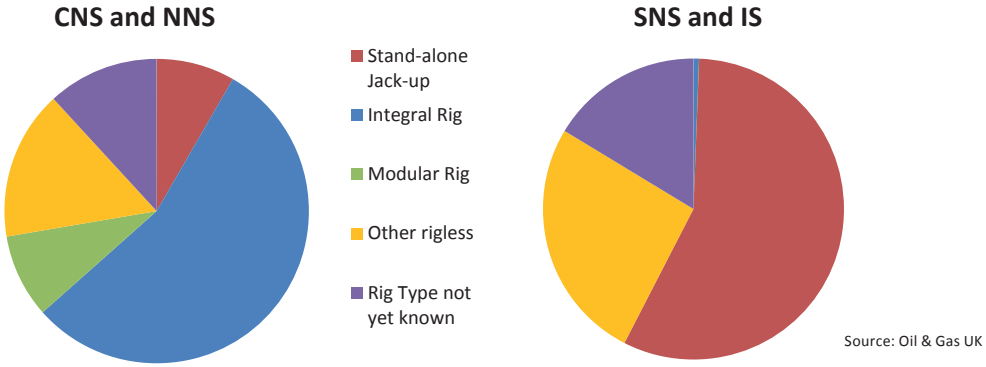
The average and range in subsea well P&A forecasts have increased slightly since the 2013 survey, although the overall variation in cost is much less than that in the CNS and NNS. While the higher end of the range in costs are only reported by a small number of wells, these higher cost forecasts are reported by more than one operator.

Rig Type for Well Plugging and Abandonment

There are a number of methods that can be used for platform well P&A (see Figure 9). In the CNS and NNS areas, close to 15 per cent of wells will be plugged and abandoned in phases. The first phase is typically rig-less and uses lower cost methods such as wireline, coil tubing, and a hydraulic workover unit or LWI vessel, while the second and third phases will normally use a rig. The type of vessel will depend on whether the original derrick is still in place and the water depth where the platform is located. The remaining 85 per cent of wells in the CNS and NNS will be plugged and abandoned in a single phase.

Due to shallower waters in the SNS and IS, all subsea wells in these areas plan to use a jack-up rig for P&A. This has implications on cost as the semi-submersible rigs required in the CNS and NNS are more expensive.

Figure 9: Forecast Rig Type for Platform Well Plugging and Abandonment on the UK Continental Shelf from 2014 to 2023



	Central and Northern North Sea	Southern North Sea and Irish Sea
Platform well P&A		
Integral rig	54%	1%
Modular rig	9%	-
Jack-up rig	9%	57%
Rig-less intervention	16%	26%
Not yet known	12%	16%
Subsea well P&A		
Jack-up rig	25%	100%
Semi-submersible rig	75%	-

6.2 Facilities Making Safe and Topside Preparation

Prior to removal, facilities must first be made safe and prepared for removal in line with environmental and safety considerations. The 'making safe' of facilities includes cleaning, freeing equipment of hydrocarbons, disconnection and physical isolation, and waste management.

Following this, the topsides and process and utilities modules are separated and appropriate engineering, such as the installation of lift points, can take place to enable removal. The topside preparation required will depend on the removal method used.

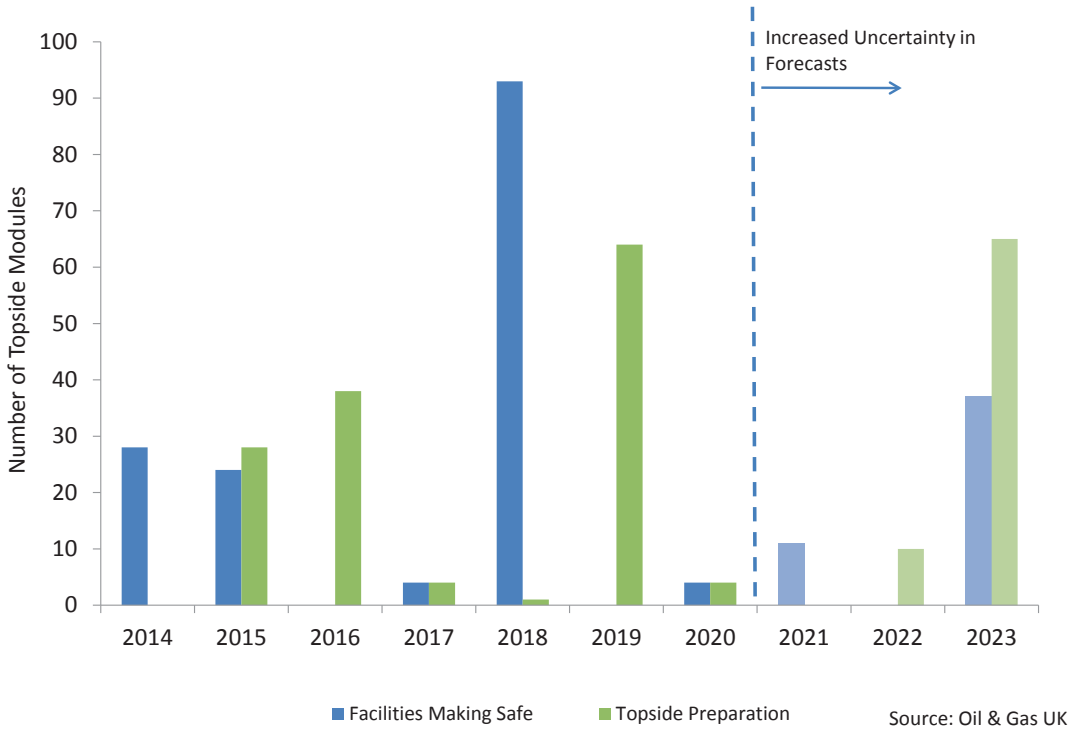
Over the next decade around 300 topside modules on 86 platforms are scheduled to be made safe and prepared for removal on the UKCS, at a total cost of £560 million. The 'making safe' of pipelines is discussed fully in section 6.4.

Central and Northern North Sea

In the CNS and NNS areas 'making safe' is typically carried out two years prior to removal, and topside preparation in the year prior to removal. It is also possible to carry out 'making safe' several years ahead, thus the two activities are not completely aligned in Figure 10.

There are several years of higher activity levels as a number of large projects gear up for removal. For 'making safe' these are in 2014, 2015 and 2018 and for topside preparation these are in 2015, 2016 and 2019. Activity levels for both increase in 2023 suggesting further removal activity outside the survey timeframe.

Figure 10: Forecast Number of Topside Modules for 'Making Safe' and Topside Preparation in the Central and Northern North Sea from 2014 to 2023



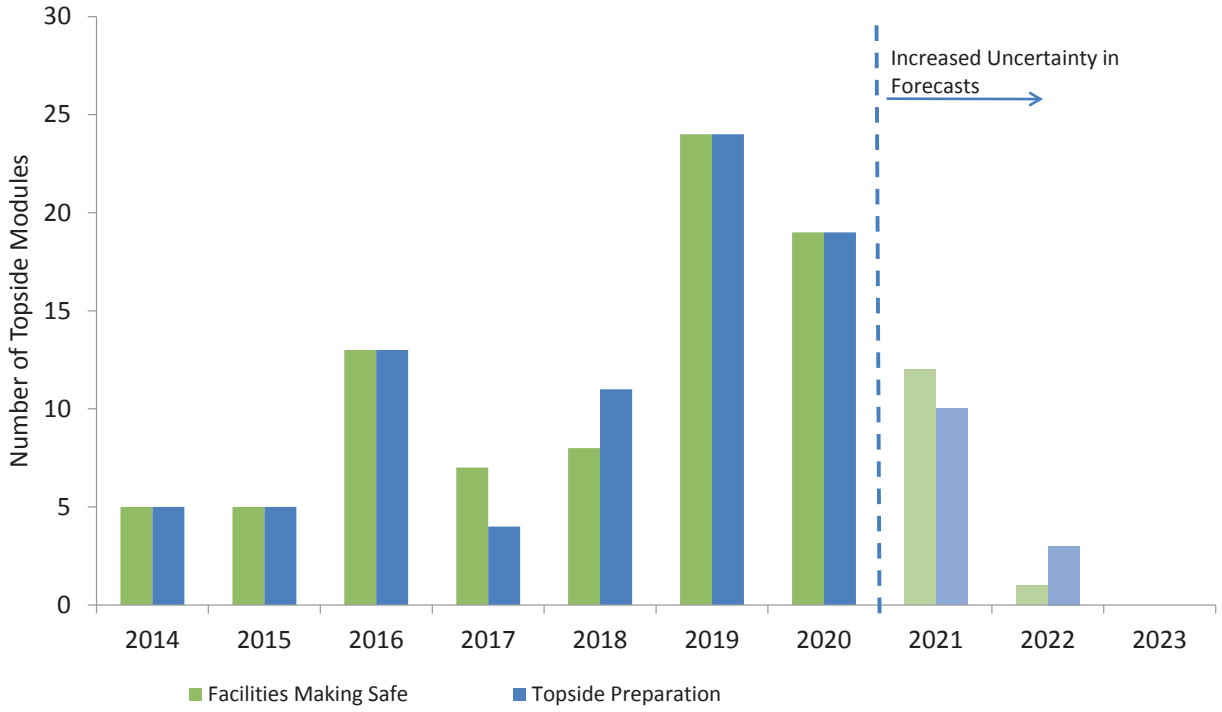
	Number 2014 to 2023	Total Expenditure 2014 to 2023
Facilities making safe and topside preparation	12 platforms	£420 million
Number of topside modules – facilities making safe	201	
Number of topside modules – topside preparation	214	

Southern North Sea and Irish Sea

The number of topside modules per facility is significantly lower in the SNS and IS areas than the CNS and NNS due to the large proportion of small satellite installations and NUIs. Their smaller size means that both 'making safe' and topside preparation can be carried out in a single year. This is reflected in Figure 11 where the two activities are closely aligned.

Activity is forecast to peak in 2019 at 24 topside modules on 12 installations. The peak in activity occurs one year prior to the peak in removal activity discussed in section 6.3.

Figure 11: Forecast Number of Topside Modules for 'Making Safe' and Topside Preparation in the Southern North Sea and Irish Sea from 2014 to 2023



Source: Oil & Gas UK

	Number 2014 to 2023	Total Expenditure 2014 to 2023
Facilities making safe and topside preparation	94 topside modules on 20 platforms and 54 NUIs	£140 million

6.3 Removal

The removal of substructures, topsides and subsea infrastructure accounts for 19 per cent (£2.8 billion) of the total decommissioning expenditure on the UKCS from 2014 to 2023. Pipeline decommissioning has been addressed separately in section 6.4.

Topside removal is most commonly achieved using piece-small, reverse-installation or single-lift methods which can involve re-engineering and cutting topside modules. Larger structures seen in the CNS and NNS areas often require sectioning into manageable pieces and involve multiple removal lifts. Conversely, smaller substructures, such as those common in the SNS can be removed in a single lift and transported onshore via barge or lift vessel.

To date, the largest single lift achieved on the UKCS using a heavy lift vessel during decommissioning was in 2009 for the removal of the Frigg TCP2 module support frame at 8,500 tonnes. However, construction of the Pieter Schelte heavy lift vessel will allow single lift removal of the heavier Brent Alpha, Bravo and Delta topsides and the Brent Alpha substructure. The topsides weigh between 18,900 and 29,600 tonnes[17] each. The Brent Alpha substructure, weighing 14,200 tonnes, will be the first self-floater substructure removed from the UKCS[18].

Topside Removal in the Central and Northern North Sea

The picture for removals has changed significantly in recent years as a number of projects have been deferred to extend field life. Decommissioning of Ninian North, for example, has been postponed following receipt of the Brown Field Allowance[19], whilst Goldeneye's decommissioning programme has been put on hold following the decision to use the facility for a carbon capture and storage project[20].

In the next decade, 80 per cent (116 modules) of topside module removal activity in these areas is concentrated in the NNS. Almost all topside removal is forecast between 2016 and 2020, although it is likely that activity will level due to the flexibility in removal timelines. A small number of topside modules are forecast to be removed between 2021 and 2023, coinciding with the spike in topside 'making safe' and preparation activity discussed in section 6.2. This reflects the start of removal activity for projects largely outside the survey timeframe.

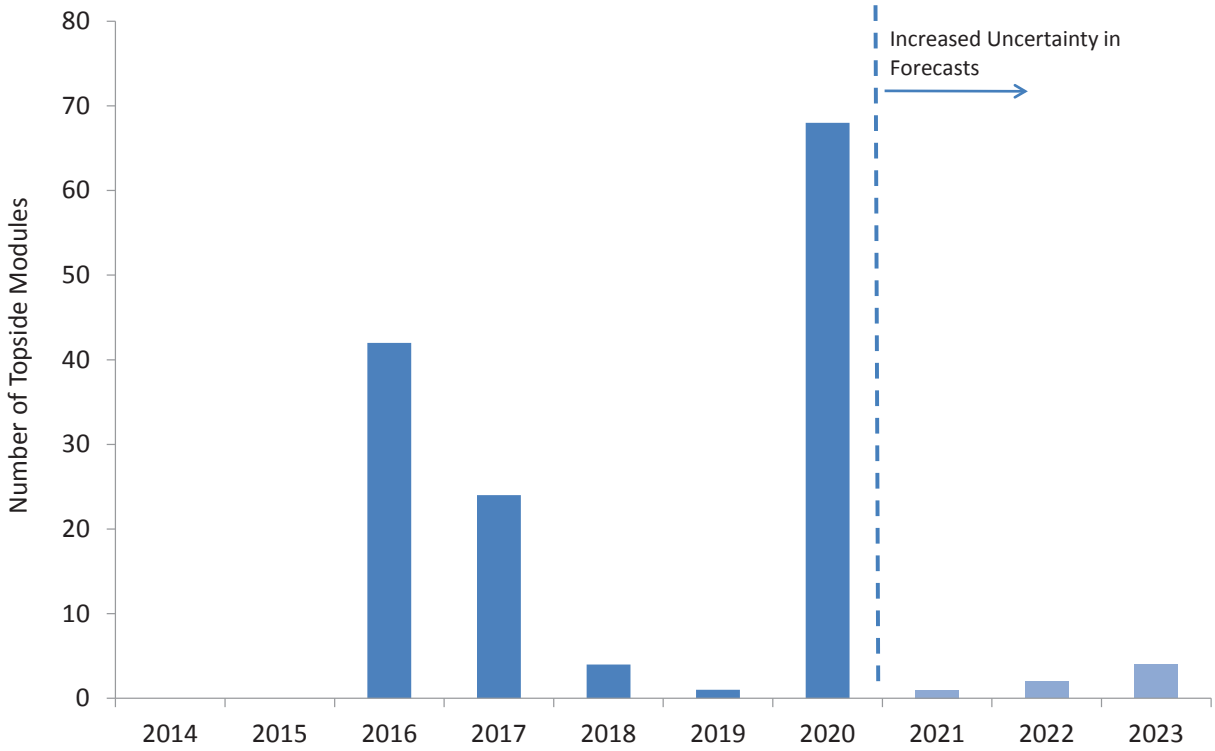
[17] See Brent E-News at http://s04.static-shell.com/content/dam/shell-new/local/country/gbr/downloads/pdf/upstream/brent-enews-november-2013.pdf

[18] Oil & Gas UK's publication on *The Decommissioning of Steel Piled Jackets in the North Sea Region (October 2012)* is available to download at www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/OP074.pdf

[19] See www.cnri-northsea-decom.com/News&current-Status.htm

[20] See http://s06.static-shell.com/content/dam/shell-new/local/country/gbr/downloads/pdf/peterhead-ccs-brochure.pdf

Figure 12: Forecast Number of Topside Modules to be Removed in the Central and Northern North Sea from 2014 to 2023



Source: Oil & Gas UK

	Weight (tonnes) 2014 to 2023	Number 2014 to 2023	Total Expenditure 2014 to 2023
Topside removal	159,600	146 modules on 13 platforms	£1 billion
Platform types			
Integrated platforms	130,000		
Platforms	27,000		
NUIs	2,600		

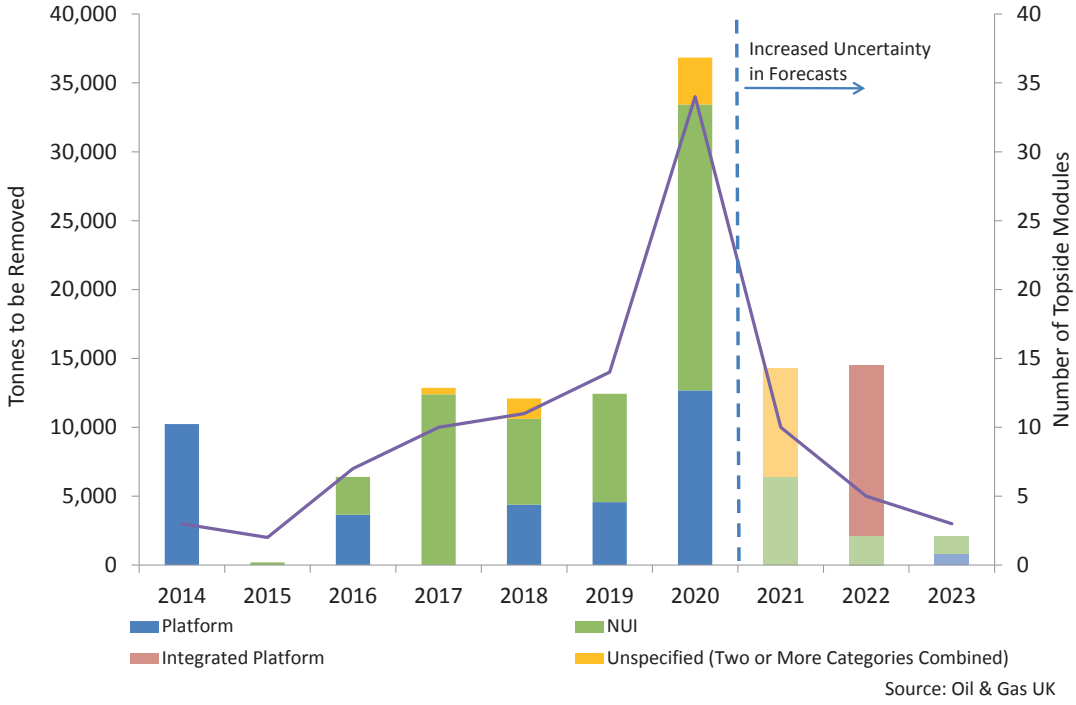
Topside Removal in the Southern North Sea and Irish Sea

Ninety-four per cent (94 modules) of topside modules forecast to be removed in these areas are in the SNS. While the pattern of activity is consistent with the forecast in the 2013 report, a number of projects have been included in the 2014 report for the first time, increasing the forecast significantly.

Activity is forecast to be largely stable across the decade at an average removal weight of 12,000 tonnes per year, peaking at five platforms and 17 NUIs in 2020.

Fifty per cent of the topsides to be removed are NUIs, with an average weight of around 900 tonnes. While heavy lift vessels can be used for removal, smaller barges are also capable of single lifts of this weight.

Figure 13: Forecast Number of Topside Modules and Topside Weight to be Removed in the Southern North Sea and Irish Sea by Facility Type from 2014 to 2023



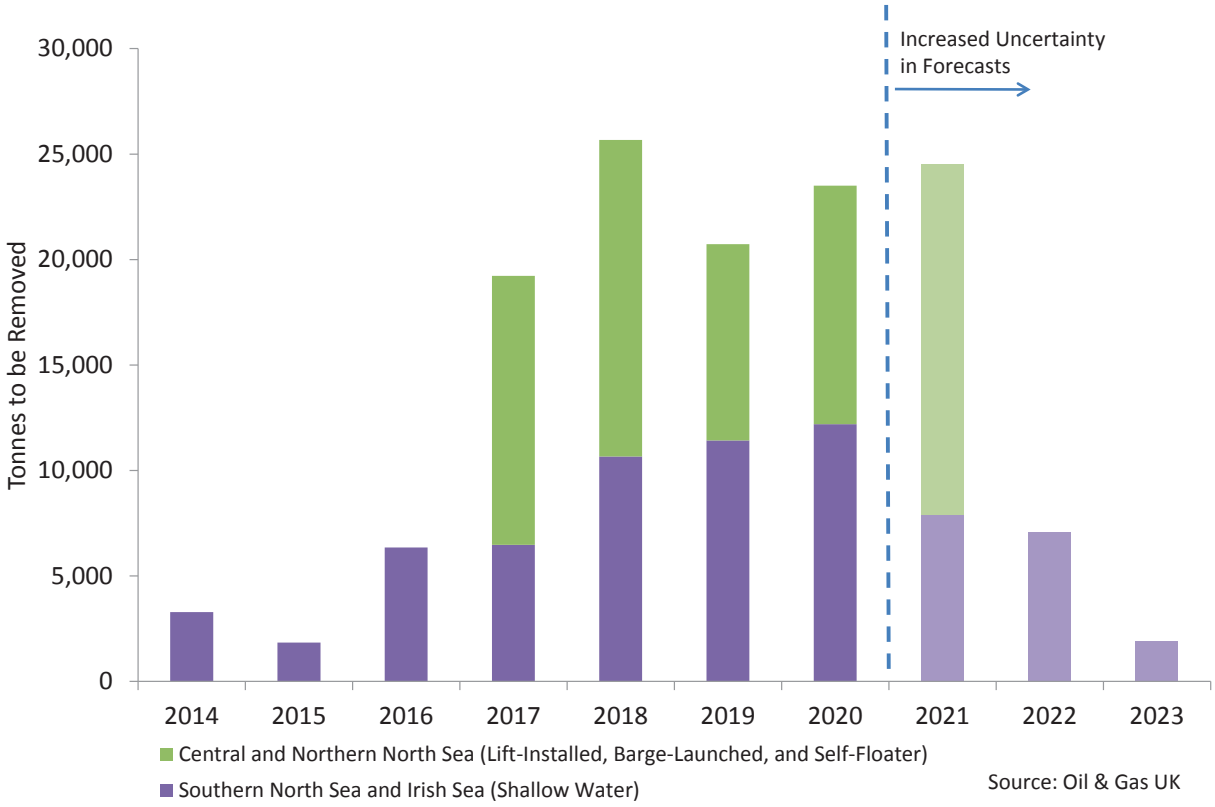
Source: Oil & Gas UK

	Weight (tonnes) 2014 to 2023	Number 2014 to 2023	Total Expenditure 2014 to 2023
Topside removal	122,000	100 modules on 91 platforms	£450 million
Platform types			
Integrated platforms	12,400		
Platforms	36,300		
NUIs	60,000		
Unspecified	13,300		

Substructure Removal on the UK Continental Shelf

Substructure removal activity in the CNS and NNS areas is concentrated between 2017 and 2021, largely mirroring the peak activity years for topside removals (see Figure 12). Activity in the SNS and IS areas is spread across the ten-year period.

Figure 14: Forecast of Substructure (Jacket) Weight to be Removed from the UK Continental Shelf from 2014 to 2023



Source: Oil & Gas UK

Substructure Removal	Weight (tonnes) 2014 to 2023	Total Expenditure 2014 to 2023
Central and northern North Sea	65,000	£590 million
Southern North Sea and Irish Sea	69,000	£320 million

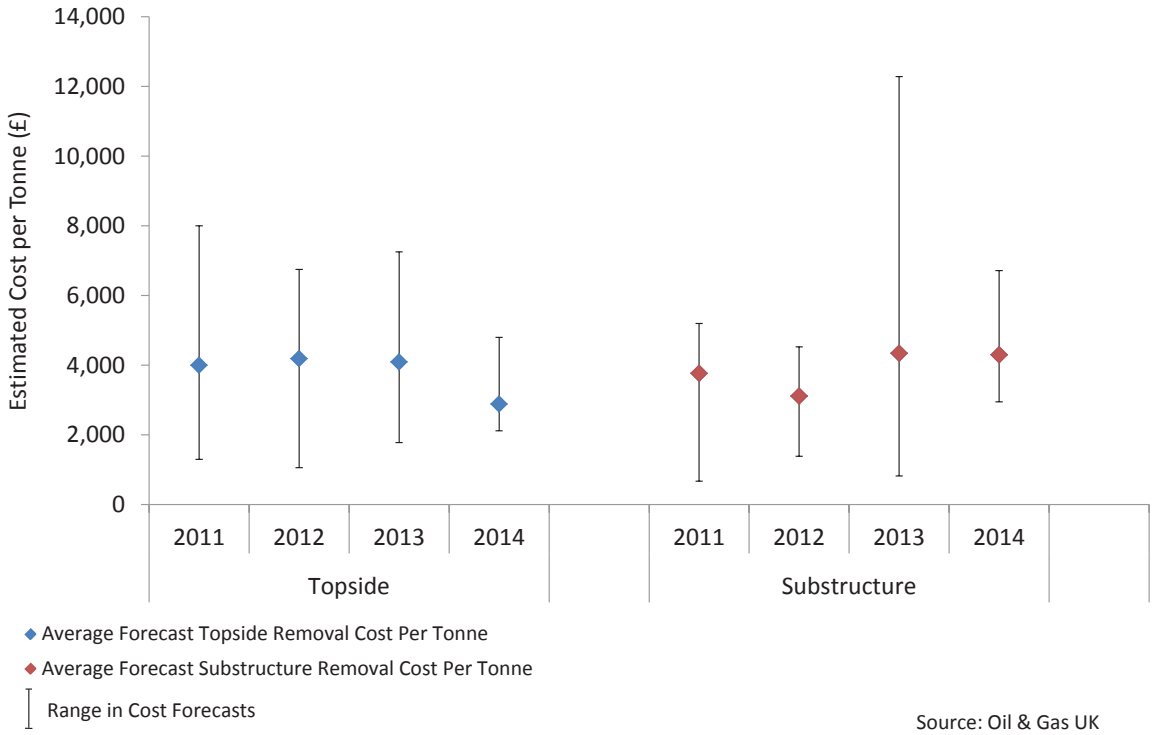
The substructures for removal in the SNS and IS areas are shallow water jackets, which usually weigh less than 2,000 tonnes and are typically deployed in water depths of 55 metres or less. In the CNS and NNS a combination of lift-installed jackets weighing less than 10,000 tonnes; self-floaters, which weigh in excess of 12,000 tonnes; and barge-launched substructures, which weigh between 5,000 and 25,000 tonnes, are forecast to be removed over the next ten years.

The higher proportion of expenditure in the CNS and NNS (£590 million) is due to the size and complexity of these projects.

Historical Variation in the Removal Cost per Tonne Forecasts on the UK Continental Shelf

The average forecast cost per tonne for both topsides and substructures has seen a relatively small variation across the last four surveys in the CNS and NNS areas (*Decommissioning Insight* Reports 2011 to 2014).

Figure 15: Historical Variation in the Removal Cost per Tonne Forecasts for Topsides and Substructures in the Central and Northern North Sea (2011 to 2014 Surveys)

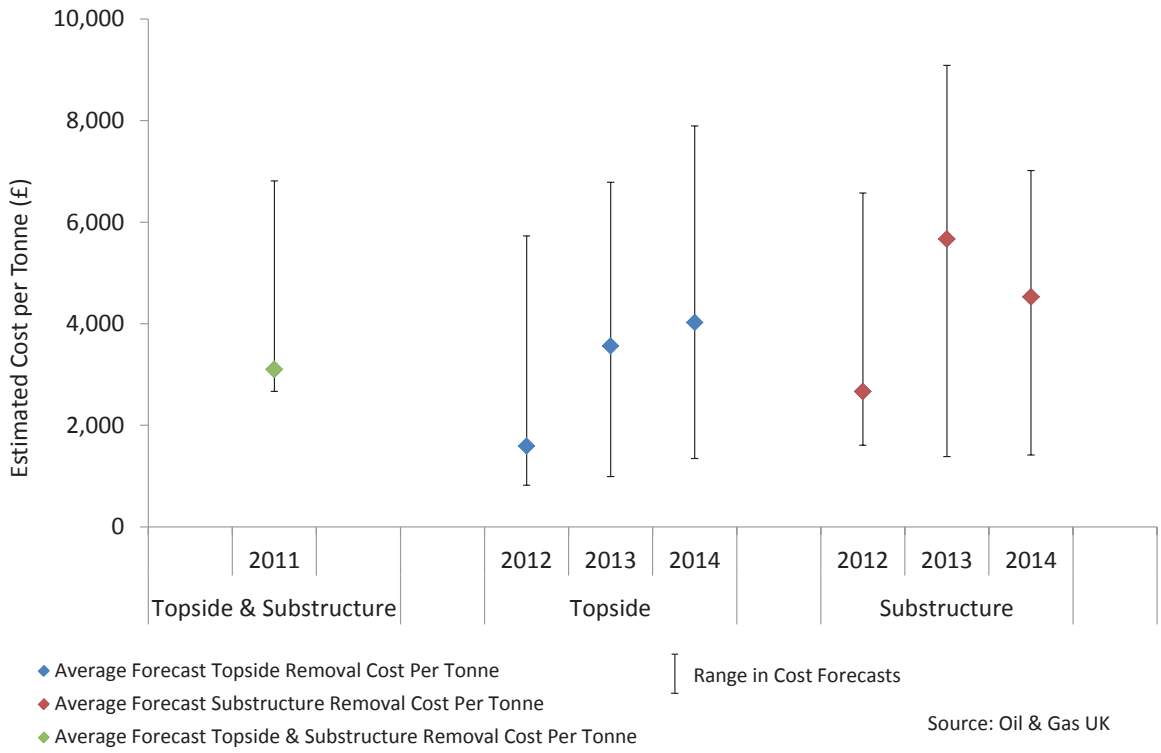


Source: Oil & Gas UK

Removal Cost per Tonne	2013 Average	2014 Average
Topsides	£4,100	£2,900
Substructures	£4,300	£4,300

There is a higher forecast cost per tonne for topside and substructure removal in the southern North Sea and Irish Sea (see Figure 16). This could be attributed to the fact that a vessel will have the same mobilisation costs for removing a small 500-tonne NUI or a larger structure, as well as due to the longer duration of removals in the CNS and NNS areas which, in turn, reduce the cost per tonne. Although the cost per tonne is higher in the SNS and IS, the variation across the UKCS is relatively small.

Figure 16: Historical Variation in the Removal Cost per Tonne Forecasts for Topsides and Substructures in the Southern North Sea and Irish Sea (2011 to 2014 Surveys)



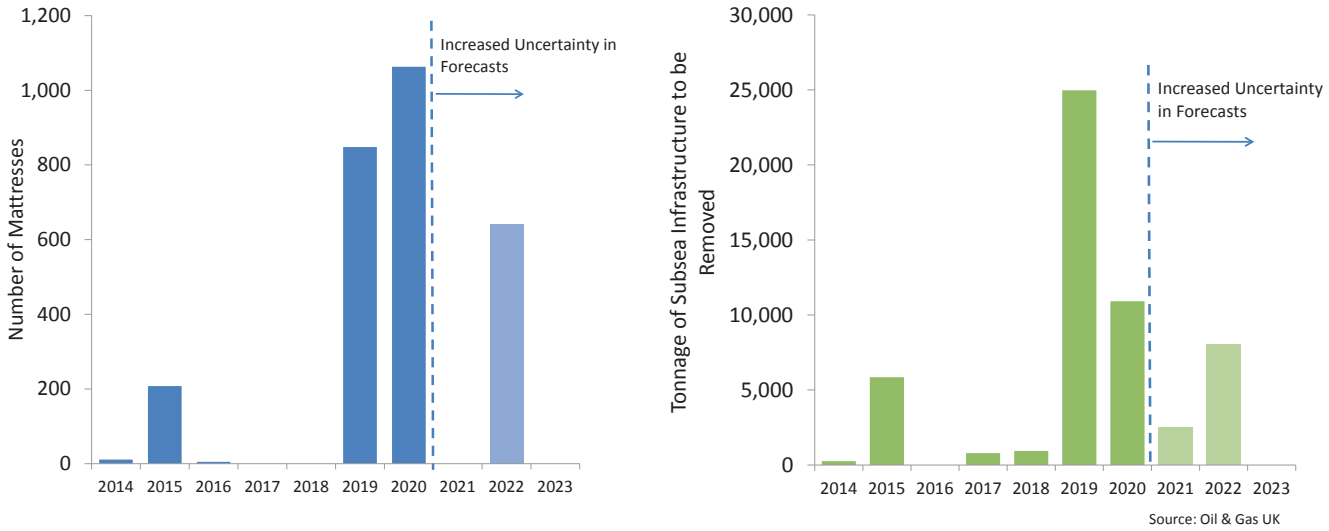
Removal Cost per Tonne	2013 Average	2014 Average
Topsides	£3,600	£4,000
Substructures	£5,700	£4,500

Subsea Infrastructure Decommissioning on the UK Continental Shelf

The years of high subsea infrastructure decommissioning activity in the CNS and NNS areas are from 2019 to 2022, while in the SNS and IS they are from 2016 to 2020. The decommissioning of mattresses and removal of other subsea infrastructure typically occur in the same year (see figure 17 and 18). Mattresses are usually removed from the seabed at decommissioning although they can be decommissioned *in situ* if badly degraded and approval has been obtained from the Department of Energy & Climate Change (DECC). Other subsea infrastructure includes manifolds, christmas trees, risers, spools, jumpers, anchors and subsea isolation valves (SSIVs). Pipelines are discussed in section 6.4.

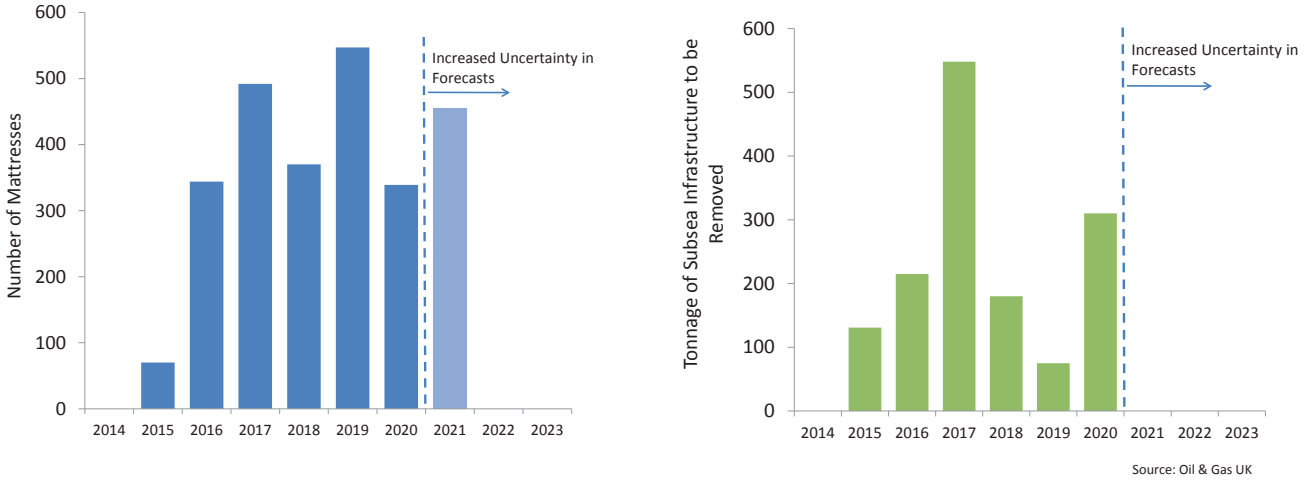
Due to the inclusion of additional subsea projects in the CNS and NNS areas in the 2014 survey, the number of mattresses and weight of subsea infrastructure have more than trebled the forecast in the 2013 report.

Figure 17: Forecast of Mattress and other Subsea Infrastructure Decommissioning in the Central and Northern North Sea from 2014 to 2023



	Number/Weight 2014 to 2023	Total Expenditure 2014 to 2023
Mattresses and subsea infrastructure	-	£330 million
Mattresses	2,800	-
Subsea infrastructure	54,100 tonnes	-

Figure 18: Forecast of Mattress and other Subsea Infrastructure Decommissioning in the Southern North Sea and Irish Sea from 2014 to 2023



Source: Oil & Gas UK

	Number/Weight 2014 to 2023	Total Expenditure 2014 to 2023
Mattresses and subsea infrastructure	-	£165 million
Mattresses	2,600	-
Subsea infrastructure	1,500 tonnes	-

6.4 Pipeline Decommissioning

Pipelines are integral to field life extension and future development opportunities and it is therefore of benefit to the UKCS that major pipelines are not decommissioned prematurely. The pipeline networks currently installed in the North Sea collectively provide the transportation infrastructure for the region's oil and gas production to be delivered to host platforms and to shore. In many cases, the existence of nearby pipeline infrastructure has led directly to the economic exploitation of marginal fields, which would otherwise be considered uneconomic.

Due to the importance of certain pipelines, the deferral of pipeline decommissioning to the end of the field life or for possible reuse is sometimes carried out under the Interim Pipeline Regime (IPR), where future reuse of the pipeline is considered viable. In these circumstances, DECC may request that the pipeline owner carry out pipeline 'making safe' activities and maintain the condition of the pipeline for possible future reuse.

The 'making safe' of pipelines involves cleaning activities such as flushing the pipelines of hydrocarbons, purging, and removal and management of hazardous waste. The pipelines can then be decommissioned in accordance with DECC's Guidance Notes[21] or maintained under the IPR.

The decommissioning of pipelines can involve either removal to shore, through reverse reeling or cut and lift, or where pipelines have obtained approval from DECC to be left *in situ* they can be trenched and buried. The Murchison export line, for example, will be decommissioned and left *in situ*, with remedial rock placed over the exposed sections. The main pipeline tie-in spools at either end will be removed and returned to shore for recycling or disposal[22].

[21] DECC's Guidance Notes on Decommissioning Programmes are available to download at http://www.og.decc.gov.uk/regulation/guidance/decomm_guide_v6.pdf

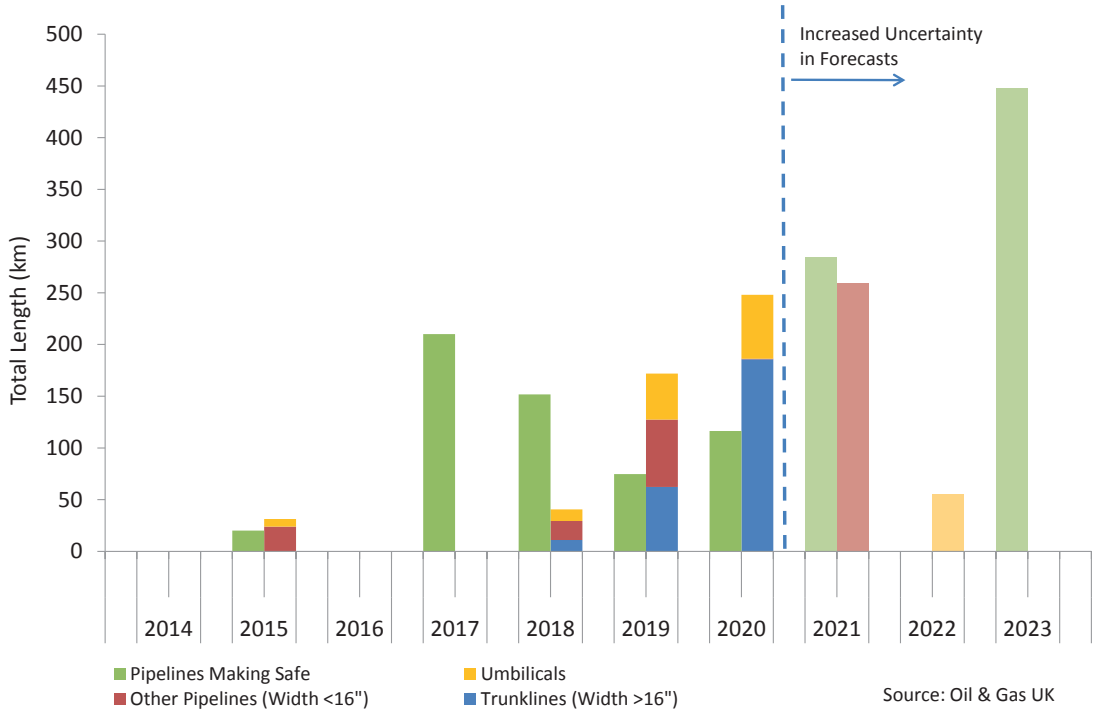
[22] See www.cnri-northsea-decom.com/Decommissioning-Programme.htm

Pipeline Making Safe and Decommissioning in the Central and Northern North Sea

Fewer pipelines are scheduled to be decommissioned over the next ten years in the CNS and NNS areas than forecast in the 2013 report, due to the deferral of some projects to outside the survey timeframe.

'Making safe' of pipelines in this area typically occurs one year before pipelines are decommissioned, but it can also be carried out several years ahead. The majority of 'making safe' activity is forecast post-2017 with an average of 185 kilometres (km) of pipeline per year over the period 2017 to 2023.

Figure 19: Forecast of Making Safe and Pipeline Decommissioning Activity in the Central and Northern North Sea from 2014 to 2023



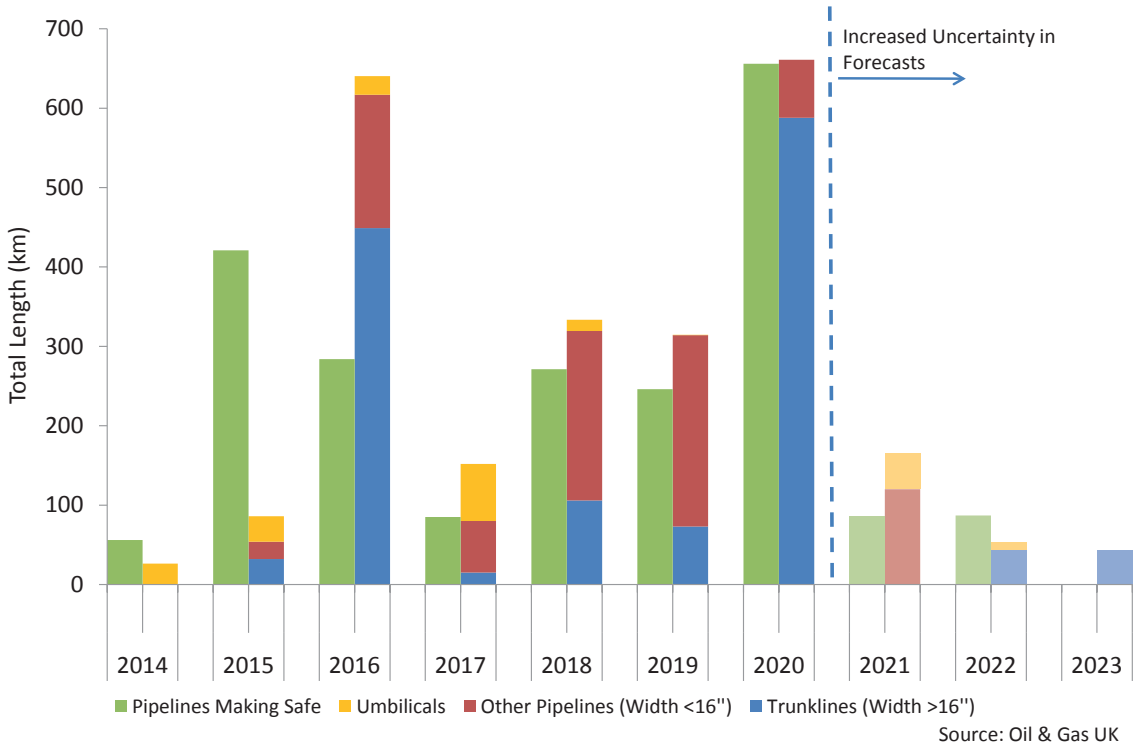
	Number 2014 to 2023	Length (km) 2014 to 2023	Total Expenditure 2014 to 2023
Making safe	-	1,300	£125 million
Pipeline decommissioning		807	£490 million
Umbilicals	73	180	
Trunklines	18	259	
Other pipelines	215	368	
Peak year of 'making safe' activity			
2023	-	448	
Peak years of pipeline decommissioning activity			
2019	45	170	
2020	47	250	
2021	153	260	

Pipeline decommissioning activity is higher between 2019 and 2021, correlating with the peak years of activity in pipeline 'making safe'. The spike in 'making safe' in 2023 coincides with that of facilities 'making safe', suggesting further removal activity outside the survey timeframe. However, activity towards the end of the timeframe can be expected to level out when forecasts are revisited. All of the pipelines to be decommissioned are inter-field connectors, and none are considered to be critical for third party access.

Pipeline Making Safe and Decommissioning in the Southern North Sea and Irish Sea

The forecast for pipeline decommissioning in the SNS and IS areas has increased significantly since the 2013 report. This is due to increased activity forecasts from existing projects as well as the addition of new projects to the survey.

Figure 20: Forecast of Making Safe and Pipeline Decommissioning Activity in the Southern North Sea and Irish Sea from 2014 to 2023



Source: Oil & Gas UK

	Number 2014 to 2023	Length (km) 2014 to 2023	Total Expenditure 2014 to 2023
Making safe	-	2,200	£285 million
Pipeline decommissioning		2,470	£150 million
Umbilicals	32	220	
Trunklines	37	1,350	
Other pipelines	111	900	
Peak year of 'making safe' activity			
2020	-	650	
Peak years of pipeline decommissioning activity			
2016	37	640	
2020	15	660	

In contrast to the CNS and NNS, several operators in the SNS and IS areas forecast to carry out pipeline 'making safe' and decommissioning in the same year, although 'making safe' can also occur earlier.

The peaks in 2016 and 2020 reflect operators' current best estimates and not sanctioned decommissioning programmes, a complete list of which can be found on DECC's Project Pathfinder website[23].

In order to meet government and industry objectives of maximising economic recovery from the UKCS, a Southern North Sea PILOT Rejuvenation Work Group has been established to carry out a joint industry project focused on understanding the remaining reserves and resource base in this region and to identify the requirements to protect reserves and enable maturation into development opportunities. The work group aims to create a blueprint of what the area will look like in ten years' time and assess whether fiscal incentives are required to extend the region's life.

6.5 Onshore Recycling and Disposal

Topside and substructure recycling includes activity and expenditure related to onshore cleaning and handling of hazardous waste, deconstruction, reuse, recycle, disposal and waste management accounting.

The preferred options to deal with disused offshore structures follow the waste hierarchy of reuse; recycling; and onshore disposal. Once the structures are brought onshore, dismantling and processing is handled by specialist licensed sites.

Reuse is defined as any activity that lengthens the life of an item while still being used for its original purpose. This can often be confused with recycling, which is the reprocessing of an item into a new raw material. Although more challenging, reuse often proves to be particularly cost efficient and can help to address the challenge of waste disposal. The decision to reuse, recycle or dispose to landfill can often be driven by a number of common factors including the amount of maintenance required, or prevalence of obsolete technology and the amount of hazardous material on an asset.

Topsides are made from a variety of materials and safe dismantling and waste management of these structures can pose a greater challenge than the management of substructures which are predominantly made of steel and can be processed and recycled. Recent decommissioning projects demonstrate high levels of reuse and recycling at 95 per cent of all recovered material[24]. Examples of reuse and recycling of material from the UKCS include Perenco's reuse of topsides from their southern North Sea Welland platform for a new development in West Africa and the use of North West Hutton's accommodation module as an office facility at a disposal yard.

Just over 481,000 tonnes are forecast to come onshore from 2014 to 2023, 60 per cent of which is concentrated in the CNS and NNS. In addition to tonnage from topsides and substructures, this also includes tonnage from subsea infrastructure.

The chosen offshore removal method has implications for onshore disposal as the size of vessel, as well as the weight and dimensions of the material removed, will dictate where disposal can take place. The decommissioning of the Brent A, B and D topsides and Brent A substructure will become the largest single-lift to date on the UKCS, and, as such, will require a large enough load-bearing quay to receive them. The structures will be taken to Able Seaton Port which is currently undergoing construction to expand the port's capacity[25].

[23] See the Department of Energy & Climate Change Pathfinder website at www.og.decc.gov.uk/pathfinder/decommissioningindex.html

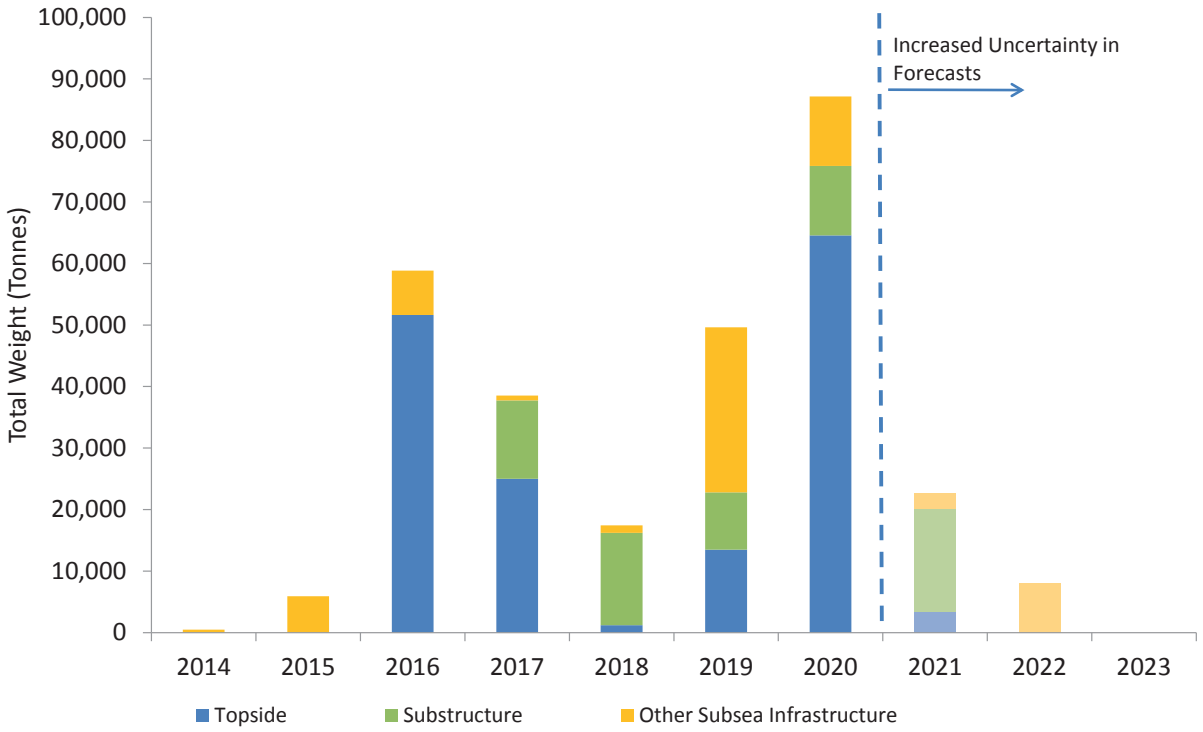
[24] Oil & Gas UK's publication on *The Decommissioning of Steel Piled Jackets in the North Sea Region (October 2012)* is available to download at www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/OP074.pdf

[25] See www.ableuk.com/able-lands-another-rig-recycling-contract

Topsides and Substructure Onshore Recycling in the Central and Northern North Sea

Correlating with the forecast for topside and substructure removal, recycling activity is forecast to be higher from 2016 to 2020 in the CNS and NNS areas, reaching 87,100 tonnes in 2020. However, it is likely that this peak in activity will level out.

Figure 21: Forecast of Tonnage Coming Onshore for Recycling and Disposal in the Central and Northern North Sea from 2014 to 2023



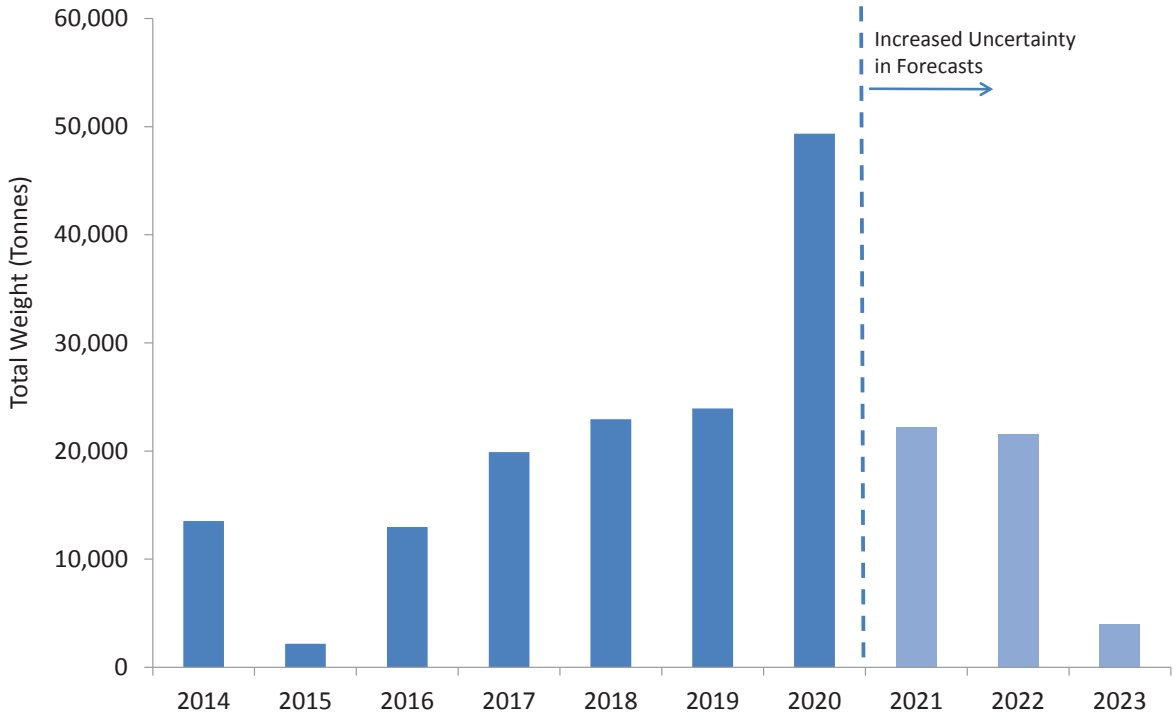
Source: Oil & Gas UK

	Weight (tonnes) 2014 to 2023	Total Expenditure 2014 to 2023
Onshore recycling		£150 million
Topsides	159,600	
Substructure	65,000	
Subsea infrastructure	64,200	

Topsides and Substructure Onshore Recycling in the Southern North Sea and Irish Sea

Recycling activity is relatively consistent in the SNS and IS areas from 2016 to 2021, reflecting the forecast outlined in the removals section of this report. In 2020, activity reaches 49,000 tonnes, although it is likely that this will smooth out when forecasts are revisited.

Figure 22: Forecast of Tonnage Coming Onshore for Recycling and Disposal in the Southern North Sea and Irish Sea from 2014 to 2023



Source: Oil & Gas UK

	Weight (tonnes) 2014 to 2023	Total Expenditure 2014 to 2023
Onshore recycling	192,600	£125 million

6.6 Site Remediation and Monitoring

Site remediation activities include pile management, clearing decommissioned oilfield debris (with a 500-metre zone and 200-metre pipeline corridor) and over-trawl surveys to demonstrate that the seabed is safe for fishermen.

Expenditure for site remediation is forecast at £270 million between 2014 and 2023. Almost 95 per cent of this is forecast to be spent in the CNS and NNS areas and it is expected to peak in line with topside and substructure removal.

Monitoring is the final stage in the decommissioning process. Operators are required to carry out post-decommissioning surveys and monitor the site beyond physical decommissioning. The specific details of the programme are agreed with the regulator on a project-by-project basis.

Forecast expenditure on monitoring on the UKCS is £67 million across the ten-year period, over 80 per cent of which is in the CNS and NNS. The expenditure forecast has more than doubled in the 2014 report compared to 2013, which reflects the impact of the new projects included in the survey for the first time, as well as increased expenditure from existing projects.

7. Appendices

Appendix a) Work Break Down Structure Definitions

STAGES - LEVEL 1	
Operator project management	Activities include project management core team, stakeholder engagement, studies to support decommissioning programme and scope definition/method development, decommissioning programme preparation and decommissioning programme reporting/close-out (admiralty charts, fish safe etc.).
Facility running/owner costs	Activities include logistics (aviation and marine), operations team, deck crew, power generation, platform services, integrity management (inspection and maintenance) and operations specialist services e.g. waste management.
Well plugging and abandonment	Activities include rig upgrades, studies to support well programmes, well suspension (spread rate/duration), wells project management, operations support, specialist services e.g. wireline, conductor recovery, cleaning and recycling, vessel.
Facilities/pipelines making safe	Activities include operations (drain, flush, purge and vent), physical isolation (de-energise, vent and drain), cleaning, pipeline pigging and waste management.
Topsides preparation	Activities include engineering-up of temporary utilities (power, air and water), module process/utilities separation, dropped object surveys and subsequent remedial actions.
Topsides removal	Activities include removal preparation (reinforcements and structural separation for removal), vessel operations, sea-fastening, transportation and load-in.
Substructure removal	Activities include removal preparation, removal, vessel, sea-fastening, transportation and load-in.
Topsides and substructure onshore recycling	Activities include cleaning and handling hazardous waste, deconstruction, re-use, recycle, disposal and waste management accounting (traceability of all streams).
Subsea infrastructure (pipelines, umbilicals)	Activities include vessel preparation for subsea end-state (remove, trench, rock-dump), sea-fastening and transportation, load-in, subsea project management and waste management accounting (traceability of all streams).
Site remediation	Activities include pile management, oil field debris clearance (500m zone and 200m pipeline corridor) and over-trawl surveys.
Monitoring	Activities include navigation aids maintenance and monitoring programme for any facilities that remain.

Note – Although logistics (aviation and marine) are only itemised here for facility running/operator costs they should be assigned to each stage, as appropriate.

Appendix b) Association for the Advancement of Cost Engineering Classifications

	Primary Characteristic	Secondary Characteristic		
Estimate Class	Level of Project Definition (expressed as % of complete definition)	End Usage Typical Purpose of Estimate	Methodology Typical Estimating Method	Expected Accuracy Range Typical Variation in Low and High Range
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgement or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorisation or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 70%	Control or bid/ tender	Detailed unit costs with forced detailed take off	L: -5% to -15% H: +5% to +20%
Class 1	50% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take off	L: -3% to -10% H: +3% to +15%

Notes

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