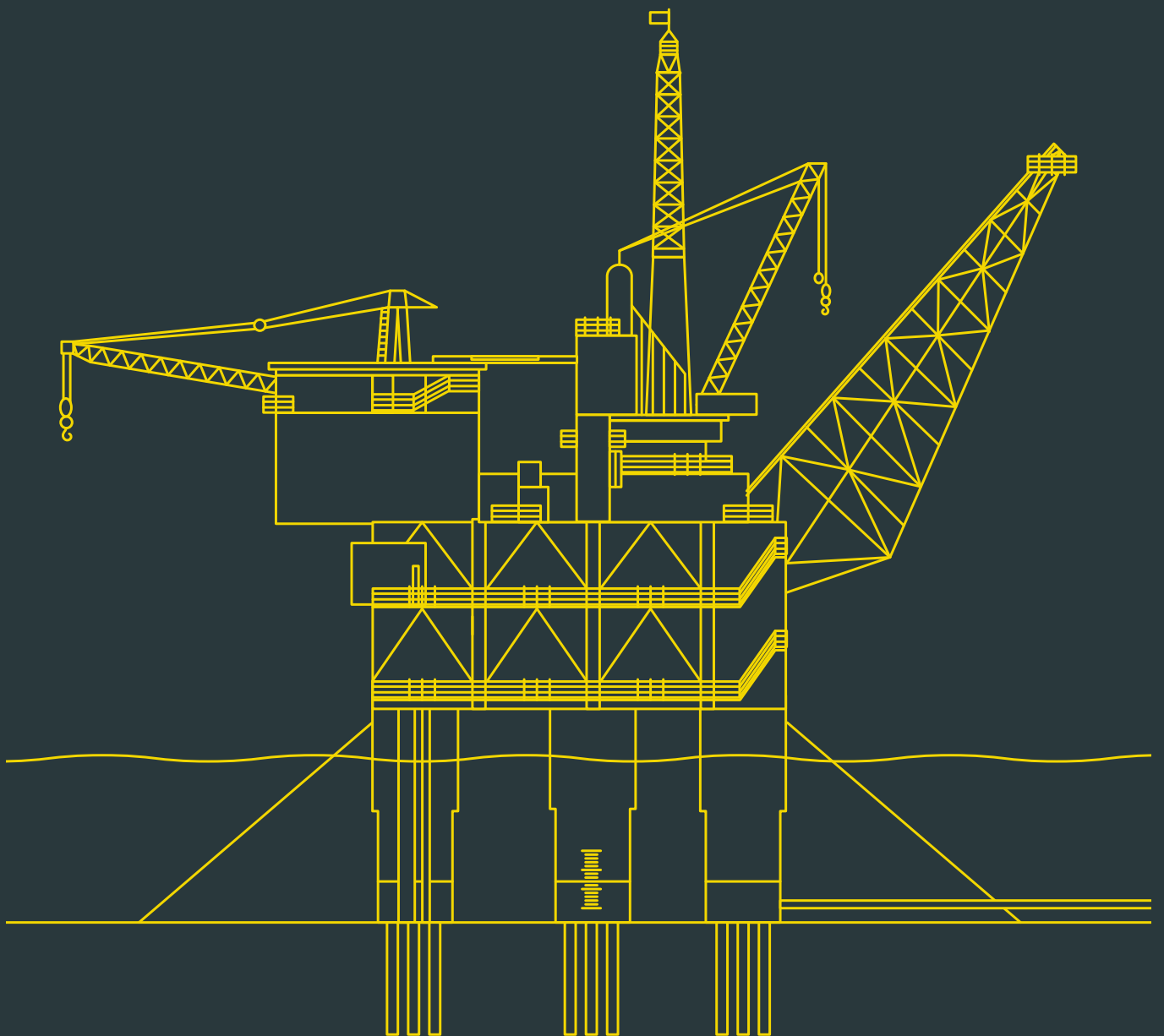


# The RSA Great Recovery & Zero Waste Scotland Programme

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## North Sea Oil and Gas Rig Decommissioning & Re-use Opportunity Report



# The Great Recovery

“  
Design will play a key role in the transition  
to a circular economy.

Sophie Thomas

Project Director, The Great Recovery

## The RSA Great Recovery

*The RSA Great Recovery aims to build new networks to explore the issue and how we can design, manufacture, use and dispose of products in a more sustainable way, moving towards a more circular system.*

*The Great Recovery is funded by the Royal Society for Arts Manufacture and Commerce (RSA) and Innovate UK.*

*This project has been delivered in collaboration with our delivery partner Useful Simple Projects, who work with organisations to develop and deliver sustainability objectives through strategy, design and innovation.*

## Zero Waste Scotland

*Zero Waste Scotland is funded by the Scottish Government to support the delivery of its Zero Waste Plan and other low carbon and resource efficiency policy priorities.*

*Zero Waste Scotland is helping Scotland to become more efficient in its use of resources. As a facilitator and enabler of change, we help to reduce waste, increase energy efficiency and promote responsible water use – all as part of a journey towards a low-carbon, sustainable economy.*

# Contents

- E** Executive Summary
- 1** Introduction
- 2** Background: Opportunities & barriers
- 3** Identifying re-use opportunities
- 4** Recommendations
- 5** Conclusions & next step
- A** Appendices



## The oil and gas decommissioning re-use opportunity study

**This study explores how to realise the value which the application of circular economy principles could bring to the Oil & Gas decommissioning industry. The report identifies six classes of asset which appear to provide re-use opportunities. We present a generic process for assessing and developing these opportunities and recommend developing a more detailed evidence base to support the transition to a more circular economy**

## Executive Summary

The RSA Great Recovery and our delivery partner Useful Simple Projects have been working with Zero Waste Scotland to investigate opportunities for increasing levels of re-use in the North Sea oil and gas decommissioning sector. This project is part of a wider programme of work between the RSA Great Recovery and Zero Waste Scotland, to help accelerate Scotland's transition towards a circular economy.

The potential benefits of adopting circular economy principles within the Oil and Gas ('O&G') sector in Scotland would be to:

- reduce the environmental impacts associated with recycling/disposal of materials;
- reduce the net cost of decommissioning; and
- develop new oil and gas industry sub-sectors which could offer additional market and job creation opportunities for supply chain companies in a lower oil price economy.

The total value of decommissioning across the North Sea to 2040 is estimated to be £46bn, with 40 platforms being decommissioned by 2017 at an estimated average annual cost of £1.8bn. Over 50% of the assets will come from the UK sector of the North Sea, comprising of over 470,000 tonnes of topside, substructure and subsea installation. [Source: Oil & Gas UK Decommissioning Insight Reports 2013, 2015].

Currently the majority of the materials and equipment from these platforms is recycled, with very little re-use or remanufacturing. The potential value inherent in re-use of platforms has been shown to be significantly higher than recycling.

In countries like the US, the barriers to re-use are being addressed to some extent. The United States International Trade Commission reported that re-use and remanufacturing of heavy equipment including on-shore oil and gas was worth \$7.7 billion in 2011 and the market was growing. Lessons may be learned from the more mature US onshore markets to help increase levels of re-use in the North Sea.

Our experience and research suggest that a shift from the current practice of recycling of the material and equipment from offshore assets, towards component/equipment reconditioning and re-use could add to the value of end of life assets. If this value can be retained in the UK, then this will be a benefit to the economy. We therefore consider that encouraging re-use and reconditioning activity in the UK as worth exploring further.

The aim of this project, therefore, has been to identify materials, components and equipment from O&G platforms that could be re-used or reconditioned at the end of their life and to propose feasibility studies to develop the business case for re-use or reconditioning. We have also made some recommendations which seek to increase the chances of the enhanced value being retained in the UK.

This is the second stage of the project, the first having produced an interim report on the opportunities in the sector to move towards a circular economy. This report is reproduced in Appendix 1.

Our interim report described the outcome of our initial review of the decommissioning sector and showed that the potential for re-use in the O&G sector is significant. However, realising that potential is very challenging as there are considerable barriers within the industry limiting re-use and remanufacturing.

Given the presence of these barriers to re-use in the O&G sector, we consider that the most effective way to develop a market for re-used and reconditioned components and equipment is to explore opportunities in other industries.

The workshop identified 186 re-use propositions, many of which are outside of the O&G sector. Six opportunities which were considered to have significant re-use potential were selected for further exploration. The opportunities are split between component re-use and equipment reconditioning and re-use:

#### Component re-use

1. Steel sections from jacket & topsides
2. Pipelines
3. Anchor chains & cables

#### Equipment reconditioning and re-use

4. Vessels and tanks
5. Accommodation blocks
6. Winches

Other significant opportunities for re-use exist, for example, rotating equipment such as turbines, pumps and compressors. However, other organisations are already looking at these opportunities. After discussion with the client we have chosen not to duplicate this work.

We consider that barriers inhibiting greater re-use may be overcome if there is political will and a commitment to strategic investment. In particular, this exercise has confirmed our view that whilst there is resistance to re-use of components and equipment within the O&G industry, there may be considerable opportunity to re-use products and create value in other industries.

#### **Recommendations – developing the business case for re-use**

This report provides examples as to how each class of asset might be removed, assessed, decontaminated (offshore or onshore), refurbished, tested, certified and taken to market. These examples indicate that there may be a viable route to market for each of the 6 classes of asset. However, to gain a deeper understanding of the opportunities, more detailed work is required to understand the market place.

#### Recommendation 1: Conduct industry studies

We recommend that further work is undertaken to understand the size and value of the market for the identified classes of components and equipment in different industries.

#### Recommendation 2: Conduct component/equipment studies

We further recommend that a detailed feasibility study is undertaken on the market for re-use for each of these classes of components and items of equipment to explore and demonstrate the economic and technical viability of the re-use opportunities.

#### **Recommendations – securing re-use value in the UK**

The decommissioning forecasts indicate that there will be capacity constraints in the onshore decommissioning yards over the period to 2022, particularly associated with deep water access for larger ‘single lift’ vessels and the quayside capacity and storage for large topsides.

This could mean an increasing number of platforms will be taken to other countries, such as Norway or Turkey, with the associated loss of employment, income and resources from the UK economy.

Through our work on this project and discussions with stakeholders, we have developed recommendations on broader, more strategic steps which ZWS and Decom North Sea could consider to help retain the potential value of re-use in the UK under two themes:

#### **Developing structural interventions**

##### Recommendation 3: Create a government and industry working group to demonstrate and incentivise re-use.

We recommend that ZWS, Decom North Sea and Oil & Gas UK bring together key industry, regulatory and Government stakeholders to develop the evidence base supporting the case for government intervention in the decommissioning industry.

##### Recommendation 4: Establish an industry cluster for the decommissioning and re-use sector

We recommend that ZWS (in conjunction with the Scottish Government and economic development agencies) investigate setting up a new industrial cluster or ‘circular economy hub’ in Scotland in partnership with the O&G decommissioning sector.

#### **Stimulating the UK supply chain**

##### Recommendation 5: Engage with industry and professional bodies to promote and lead a drive towards a circular economy

Many of the barriers to increased re-use require the O&G companies and their supply chains to show leadership and producer responsibility. Appropriate leadership can help to reduce the end-of-life environmental impacts of operations and drive re-use.

##### Recommendation 6: Design residences, ‘tear down, design up’ workshops with the decommissioning supply chain and onshore yards

In our experience, the best way to help designers understand how their design impacts on end of life options is to provide a space for them to explore current disposal routes and what is driving them. They can then be empowered to challenge how the decommissioning process works and to consider how assets could be redesigned to create new products opportunities.

##### Recommendation 7: Create design challenges

To encourage university engagement with circular economy ideas and practices we recommend engaging the O&G and decommissioning supply chains to establish design briefs and competitions based on platform decommissioning and the design of future products and systems for a circular economy.

# 1. Introduction

The RSA Great Recovery is working with Zero Waste Scotland (ZWS) to help accelerate Scotland’s transition towards a circular economy.

One of the three workstreams within The RSA Great Recovery / ZWS programme of work, this report focuses on identifying opportunities for circular economy principles to be applied to the North Sea oil and gas (‘O&G’) decommissioning sector.

The sector produces significant amounts of waste and end of life materials. This waste is currently mostly recycled, with very limited re-use or remanufacture.

The aim of this project has been to identify opportunities for re-use and remanufacturing of equipment and material in non O&G industry sectors, and to recommend a limited list of assets to explore through feasibility studies.

Within the O&G platform/asset re-use workstream, The RSA Great Recovery’s scope is to:

- Review existing studies already undertaken
- Engage with stakeholders in the O&G decommissioning sector to understand issues and opportunities for adoption of circular economy principles and practice
- Identify a shortlist of re-use opportunities for feasibility testing in the next phase of this project
- Produce a final report with recommendations

Our interim report, included as Appendix 1, presents the outcome of our review of existing studies and our early engagement with O&G sector stakeholders.

This report presents our approach to and results of our work to create a shortlist of re-use opportunities to take forward to a feasibility study. It also presents our recommendations to help accelerate the move towards a circular economy and an increase in re-use over recycling.

This report is structured as follows:

2. Background: opportunities and barriers
3. Identifying the opportunities for re-use
4. Recommendations
5. Conclusions and next steps

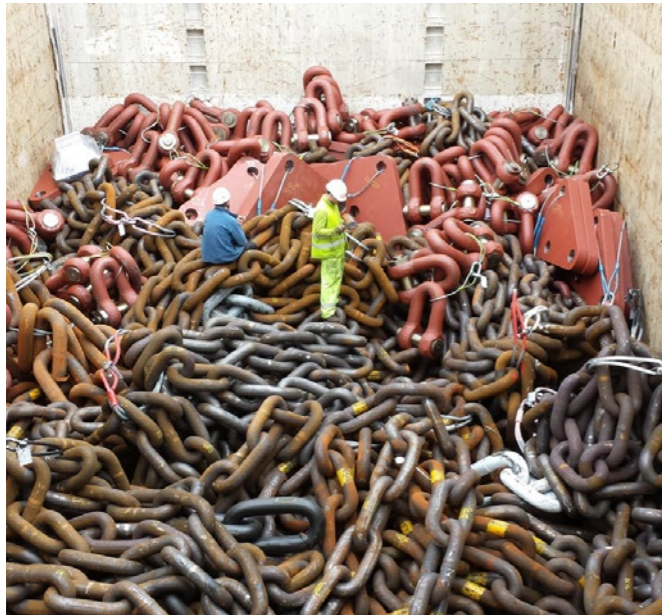
This report has been prepared by The RSA Great Recovery and our delivery partner Useful Simple Projects.



## 2. Background: Opportunities & barriers

The O&G industry is a key economic sector in Scotland. Studies including Green Alliance's 'Circular Economy Scotland' and other reports for Decom North Sea and Zero Waste Scotland identify that the O&G sector has significant circular economy opportunities associated with decommissioning.

The recent 'Circular Economy Evidence Building Programme - Oil and Gas Sector Report', produced by AMEC for Zero Waste Scotland summarises the scale of the O&G sector decommissioning industry in the North Sea, and the opportunities and barriers presented by the circular economy. Key findings and opportunities in these reports are set out below.



According to the OSPAR 2015 installations inventory for the UK Continental Shelf (UKCS), there are 651 (2013 - 674) operational installations, 81 (2013 - 74) decommissioned installations, 24 (2013 - 40) closed installations and 4 (2013 - 4) other installations in the North Sea. According to DECC there are 19 offshore installations listed as "decommissioning projects".

It is estimated that over the period to 2023 almost 500,000 tonnes of end of life assets will be removed from the UK Continental Shelf. Total decommissioning spend is forecast to reach £46 billion in real terms, and average £1.8 billion per year for the remainder of the decade. Investment in topside and substructure removal has been estimated at £280 million per year in the period to 2023. This offers significant potential for Scotland to capture a share of emerging re-use activity and for this to contribute towards the 40% cost saving target that the industry has set in the North sea.

The OSPAR Inventory distinguishes between steel and concrete installations and Floating Production and Storage Offloading units (FPSO) installations. For the steel installations, by weight, 97% of the installation materials is steel, 2% is valuable reusable equipment and 1% rare metals. Concrete platforms are estimated to be 92% concrete, 5% carbon steel, 2% valuable reusable equipment and 1% rare metals.

Currently, up to 98% by weight of materials are recycled back into raw material at the end of their life with only a small fraction of the components being recovered for re-use in some other way. The majority of this material recovery is smelting in steel mills and is outside the UK.

Estimates suggest that increasing re-use over the recycling of equipment and structures on installations can increase values by between five and seven times. This could add up to a third to the total value of an installation at the decommissioning stage.

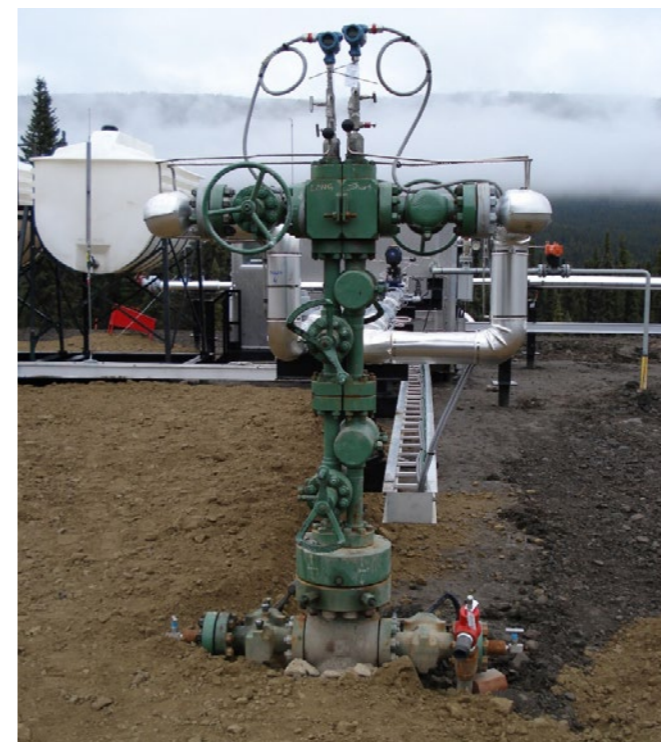
### Barriers

The reports identify many barriers that prevent a move towards greater circularity within the O&G industry. These include:

- Attitudes to Health and Safety and fear about the risks associated with using reconditioned materials
- A pre-disposition to engineer and buy new products
- The bespoke design of each platform and the need to design for specific conditions
- Concern about the quality and conditions of materials that have been operating in extreme environments
- The difficulty of recovering materials that haven't been designed for re-use
- The drive to minimise the cost of decommissioning
- The relatively low value of salvage in relation to life cycle costs
- Obsolescence of systems, products and plant
- Difficulty of obtaining warranties and assurances
- Poor data management or knowledge about products being recovered
- Insufficient capacity in Scotland to handle and process decommissioned rigs
- Lack of integration across the supply chain

### Sources:

- Circular Economy Evidence Building Programme - Oil and Gas Sector Report', produced by AMEC for Zero Waste Scotland
- Oil & Gas UK Activity Survey 2013
- Oil & Gas UK Activity Survey 2015



Discussions held during this project support the findings on the scale of the opportunity and barriers. As a significant proportion of decommissioning costs are covered by UK Government in the form of tax relief, some 60%, we expect that reductions in the net cost of the decommissioning process would be welcomed by the government.

Given the high reported rates of material recycling it seems that there is inadequate consideration of re-use over recycling due to the perceived barriers. The requirement to apply the Waste Hierarchy (including re-use before recycling) is driven by DECC Decommissioning Guidelines in line with the OSPAR convention.

In countries like the US, the barriers to re-use are being addressed to some extent. The United States International Trade Commission reported that re-use and remanufacturing of heavy equipment including on-shore oil and gas was worth \$7.7 billion in 2011 and the market was growing (<http://www.usitc.gov/publications/332/pub4356.pdf>).

Lessons may be learned from the more mature US onshore markets to help increase levels of re-use in the North Sea. To avoid the barriers and realise the potential value that could be achieved by increasing the level of re-use and remanufacturing, this study has explored opportunities for re-use in non O&G industries where there is experience of re-use and recycling and the perceived risks are fewer.

### The focus of this study

Currently there is considerable investment and increasing innovation in decommissioning but little innovation in terms of recovery and re-use of materials, components, sub-assemblies or equipment during decommissioning. Only a handful of case studies exist. Research to date has focused on generic opportunities and barriers to moving the O&G decommissioning sector towards a more circular model.

Other opportunities or approaches that the O&G sector could take to promote the circular economy in other industries are yet to be explored - for example the re-use of surplus O&G pipelines and valves in the water sector.

The primary focus of this project has been to identify specific materials, components and equipment from decommissioning that could be re-used in other industries, such as civil engineering, chemical, agriculture or utilities.

# 3. Identifying re-use opportunities

## 3.1 Project Methodology

There have been two stages to our work, which are described below.

### Stage 1: Understanding the sector and opportunities to move towards a circular economy

The first stage of the project focused on increasing our understanding of the sector and opportunities to move towards a circular economy.

Our activities included:

- Desk based research
- Site visit to John Lawrie Group (JLG) in Montrose in January 2015 - one of the larger businesses involved in recovery and recycling of North Sea decommissioned materials
- Holding a first industry workshop in January 2015. This workshop was attended by 15 people including representatives from Decom North Sea, Scottish Enterprise, Zero Waste Scotland, industry, consultancy groups and salvage companies. The workshop sought to identify barriers to the circular economy, potential solutions to the barriers, and possible business models to support a transition to a circular economy.

In our Interim Report we recommended that 3 strategic threads be adopted:

- Engagement with operators to promote and lead a drive towards a circular economy
- Market development for end of life decommissioning (identifying a shortlist of practical re-use opportunities)
- Engaging designers: working on the beginning and end of life of a platform

See the Interim Report (Appendix 1) for detailed findings and recommendations from Stage 1.

### Stage 2: Identifying a shortlist of re-use proposals for further investigation

This stage of the project involved engaging with a cross-industry group to identify opportunities for re-use and remanufacture that might be taken forward to a feasibility study.

The agreed approach for this stage of the project is summarised diagrammatically here:

It was agreed that Stage 2 of the project would focus on the second of these - 'Market development for end of life decommissioning' - specifically, identifying opportunities for the re-use of materials and products from decommissioned oil and gas assets in other sectors.



The methodology implemented is described below.

Options identification: From a selection of industry reports and discussions with oil and gas industry re-use specialists, we identified a shortlist of 24 systems and components that are being decommissioned and appear to offer opportunity for re-use in other industrial sectors.

These were:

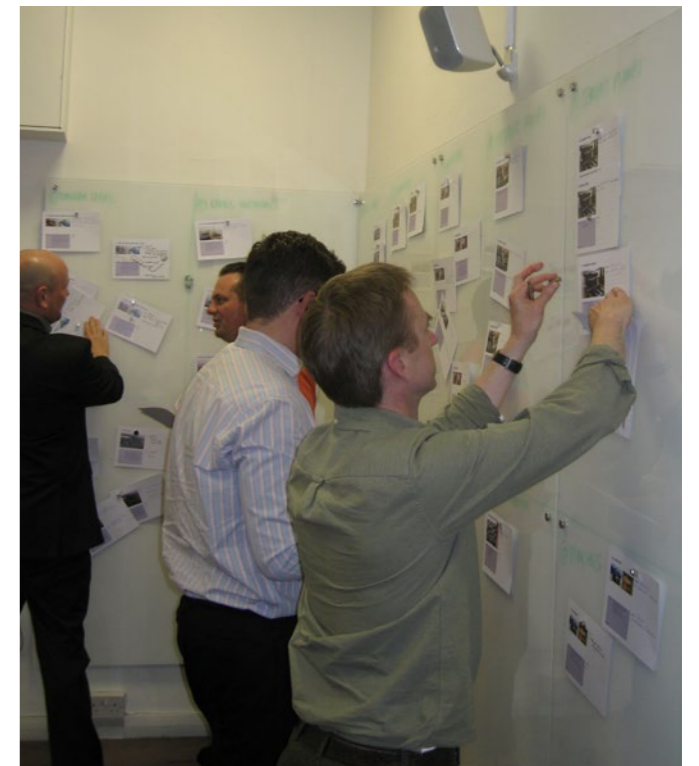


1. <b>Tubular steel</b> (from the jacket)	7. <b>Vessels and tanks</b>	13. <b>Lifting equipment</b>	19. <b>Anchor chains</b>
2. <b>Steel sections</b> (from the deck/topside)	8. <b>Compressors</b>	14. <b>Process equipment</b>	20. <b>Helidecks</b>
3. <b>Pipelines</b>	9. <b>Drilling packages</b> (set of equipment for drilling)	15. <b>Cement pumps</b>	21. <b>Christmas trees</b> (Large metal sea-bed structures above the wellheads)
4. <b>Power cables</b>	10. <b>Engines</b>	16. <b>Water pumps</b>	22. <b>Subsea wellheads</b>
5. <b>Concrete mattress</b>	11. <b>Generators</b>	17. <b>Winches</b>	23. <b>Platform piles</b>
6. <b>Valves</b>	12. <b>Hydraulic pumps</b>	18. <b>Accommodation blocks</b>	24. <b>Floating production storage and offloading (FPSO) - offshore production facilities</b>

We held an ideas generation workshop on 29 April 2015 to identify potential re-use options in non-O&G sectors. This was attended by 13 leading industry representatives from civil engineering, design, construction, the energy and waste management industries, specialists in resale and re-use in developing countries, O&G product re-use specialists, as well as members of the RSA Great Recovery/Useful Simple Projects Team. Representatives from the water industry were invited but were unable to attend. They have however given feedback via teleconference.

Following a brief introduction, attendees were each given a set of 24 cards - one for each of the component /equipment systems that are being decommissioned - and asked to generate ideas for their re-use in other sectors. At the end of the session, a discussion was held on how to stimulate the re-use market.

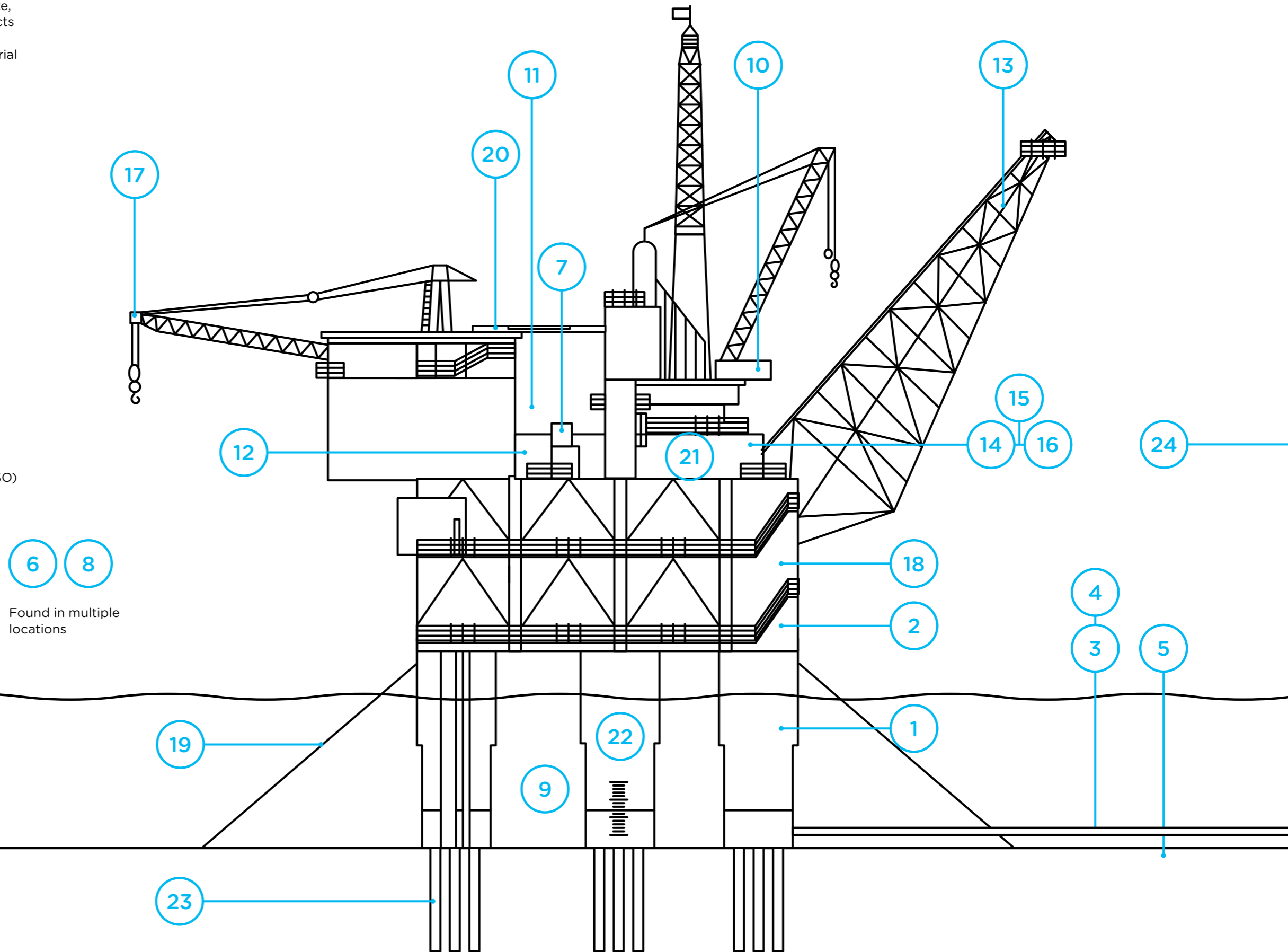
The workshop generated 186 unique proposals across the 24 component and equipment systems, and participants indicated fruitful cross-sector opportunities. See Appendix 2 for the 'long-list' of opportunities generated. The general findings from the workshop are summarised in Section 3.2.



**Options identification**

From the AMEC report, Decom North Sea reports, the Oil Mac website and the Network International website, amongst others, we identified a shortlist of 24 products and materials that are being decommissioned and appear to offer opportunity for re-use in other industrial sectors. These were:

- 1. Tubular steel (from the jacket)
- 2. Steel sections (from the deck)
- 3. Pipelines
- 4. Power cables
- 5. Concrete mattress
- 6. Valves
- 7. Vessels and tanks
- 8. Compressors
- 9. Drilling packages (set of equipment for drilling)
- 10. Engines
- 11. Generators
- 12. Hydraulic pumps
- 13. Lifting equipment
- 14. Process equipment
- 15. Cement pumps
- 16. Water pumps
- 17. Winches
- 18. Accommodation blocks
- 19. Anchor chains
- 20. Helidecks
- 21. Christmas trees (protecting well heads)
- 22. Subsea wellheads
- 23. Platform piles
- 24. Floating production storage and offloading (FPSO) - offshore production facilities



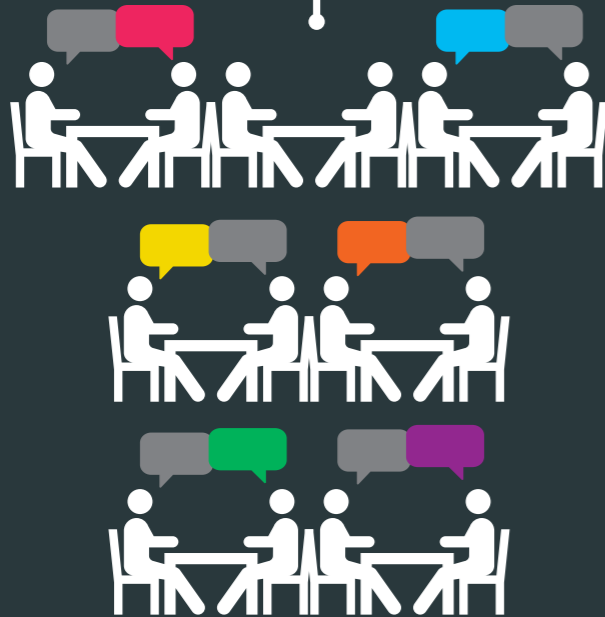
6 8  
Found in multiple locations

13  
People

24  
Products

186  
Ideas

12  
Sectors



from  
decommissioned  
assets



Agriculture  
Aquaculture  
Chemical  
Civils  
Construction  
Energy  
Health  
Marine  
Oil & Gas  
Transport  
Shipping  
Utilities



2hour  
workshop

- Tubular steel
- Steel Sections from the deck
- Pipelines
- Valves
- Vessels and tanks
- Compressors
- Drilling packages
- Engines
- Generators
- Hydraulic pumps
- Lifting Equipment
- Process equipment
- Cement pumps
- Water pumps
- Winches
- Accommodation block
- Anchor chains
- Helideck
- Concrete mattress
- Christmas tree
- Subsea Wellhead
- Power cables
- Platform piles
- Floating production storage & offloading



**High level appraisal**

The 186 ideas generated can be analysed in several ways, for example by destination sector; by component type; by proposed end-use; or by proposed nature of re-use.

On reviewing the data, it became clear that there were 3 broad categories of resources coming out of the decommissioning process, each defined by the nature of the product and the appropriate sales proposition. The three categories are material recycling, component re-use and equipment reconditioning & re-use. These are described in more detail below. (The analysis of the categories is shown in Appendix 3.)

**Shortlist of proposals:** Following our appraisal exercise, we have developed a shortlist of opportunities/business proposals that we recommend are feasibility tested in the next phase of work. These are described in Section 3.3.

**Material recycling**

Material recycling describes the process by which a formed material or component is removed from the platform and processed to change its form. The purpose of this processing is that the material can be re-used in any number of industries. The key feature of this category of uses is that the assets are reduced to their material parts, as far as possible, so that it can be remade into something different. An example of material recycling would be the use of crushed concrete as aggregate, or the re-smelting of steel.

The sales proposition for these materials is relatively low unit value (eg scrap steel £90/tonne), high volume or weight materials. The purchasing companies are highly cost sensitive. Material recycling can be considered relatively low-grade 'business as usual', and is what we are aiming to shift away from.

**Component re-use**

Component re-use requires the disassembly of a larger system or piece of equipment.

The component parts of the system can be re-used in either the same or other industries without significant reprocessing. The proposals falling into this category are characterised by the relative simplicity of the components and no working parts, such as structural steel members.

Components tend to have high embodied energy and are generally plentiful on a rig, with a higher value than scrap: the cost per tonne of a steel beam is around ten times the spot price of scrap steel<sup>1</sup>. There is generally a large competitive market for these standardised components when new.

**Equipment reconditioning & re-use**

This represents a process enabling the re-use of specialised, often complex, equipment. Equipment is characterised by having an operational element involving several components working together in a system. Equipment often has high embodied and operational energy impacts.

The products are usually low volume, high value items, with a relatively high cost of selling. For example, steel winches are priced at a per tonne equivalent of around 10 times that of a steel beam<sup>2</sup>. Selling is generally done through personal interaction. An example of equipment reconditioning & re-use would be the refurbishment & re-use of winches.

Reconditioning involves the refurbishment of equipment and components and any testing or certification required to address barriers to uptake in target markets. Not all sales routes will require product certification, and so a distinction is drawn between refurbishment and reconditioning.

The final product value is expected to increase as we move from material recycling through component re-use to equipment re-use. Re-use has more value than recycling from both a financial and resource perspective because it preserves some or all of the function of the product.

Currently the majority of recovered material during the decommissioning process is recycled. This is a straightforward 'end of pipe' solution to waste reduction. As the approach has become more efficient with time and experience, the industry has become 'locked in' to this recycling approach. It has developed a path dependent inertia.

Overcoming this inertia and opening access to the higher values available through component and equipment re-use requires investment and intervention. Such an investment of time and money can help to develop a new product pathways as described in Section 3.3, or the environment in which such pathways can be explored. However, projects to develop such environments can have long lead times, and so early exploration of the these requirements is suggested.

We have also developed a generic proposed process for increasing material & component re-use (Section 3.2). Each of the opportunities or business proposals described in Section 3.3 is broadly structured around this process.

<sup>1</sup> Estimate based on price of a new 254 X 146 X 43KG universal beam.

<sup>2</sup> Estimate based on the price of a new Superwinch Husky 8.

**3.2 Proposed process for increasing material & component re-use**

This section sets out a proposed generic process for increasing the amount of materials and components that are re-used as opposed to recycled. This process is then applied to specific opportunities identified after the idea generation process, described in Section 3.3.

The process is shown here diagrammatically and briefly explored below, along with some of the challenges to be addressed. Not all routes will require all of the steps outlined, or necessarily appear in the same order.

Each step of this process may be undertaken by different companies, and the companies involved are likely to vary depending on the material/product being re-used. This adds a layer of supply chain complexity.

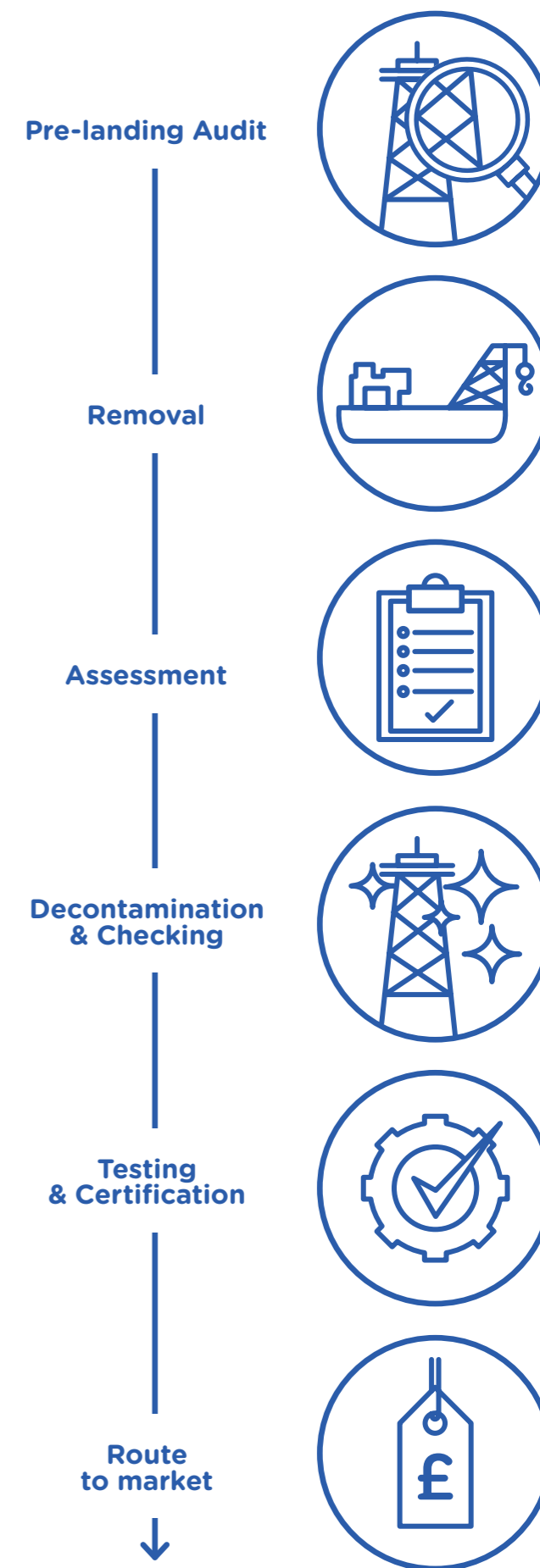
Section 3.3 shows examples of the types of companies that would need to be involved at each process step, for different products and materials. The need to build and define the relationships between the companies involved will be a key challenge.

**Pre-landing Audit**



An important early step in the decommissioning process is the creation of an inventory of materials, components and equipment which may become available from the platform. This step is common to all of the opportunities explored in Section 3.3.

This inventory can provide detailed information on the size, age and condition of the assets on the platform, giving an early indication of the quantity and quality of resources which may available for re-use from each oil and gas platform before the cessation of production.



## Removal



Removal is the process by which the resources of the platform are delivered to shore, removed/separated, isolated and stored ready for further processing. It may be that removal may be carried out offshore, using 'piece small' methodology, but for the purposes of this study, a 'single lift' or 'modular' removal process is assumed. The removal process requires cost effective storage facilities to be available locally to provide a supply and demand storage buffer.

At this time, there are limited facilities in the UK for decommissioning large platform topsides and jackets and storing the material and equipment. According to Decom North Sea (October 2014), the main sites in the UK with relevant experience of decommissioning work are in Greenhead, Wallsend and Seaton Port. Other yards across Scotland and the UK may lack relevant infrastructure, deep water access or decommissioning experience at this time, but many are investing in upgrading their facilities in line with anticipated growth in decommissioning projects. However, with the expected increase in decommissioning, the UK yards are anticipated to be at or near capacity by 2017.

In the absence of the required domestic capacity, decommissioned platforms will have to be shipped overseas. The embedded value of the resources in those assets is then lost to the UK economy along with the employment and upskilling opportunities resulting from re-use and remanufacturing schemes.

The scale of the investment required to set up the required onshore facilities to retain the benefits of decommissioning in the UK suggests that such onshore infrastructure is unlikely to be solely underwritten by the private sector. The Government may be required to provide a degree of cover against market risk provide certainty and to encourage private investment.

## Assessment



Once materials, components and equipment have been separated in the onshore yard, typically the next process step is for the condition of each item to be assessed. This assessment happens before storage, breaking down or onward processing, but may happen at an earlier step in the process - even when it is still in-situ on the platform, sometimes even before cessation of production, during the pre-landing audit.

This assessment process acts as a sorting criterion for each part of the topsides, ensuring that materials, components and equipment are moved towards the highest value next use, maximising the opportunity for re-use.

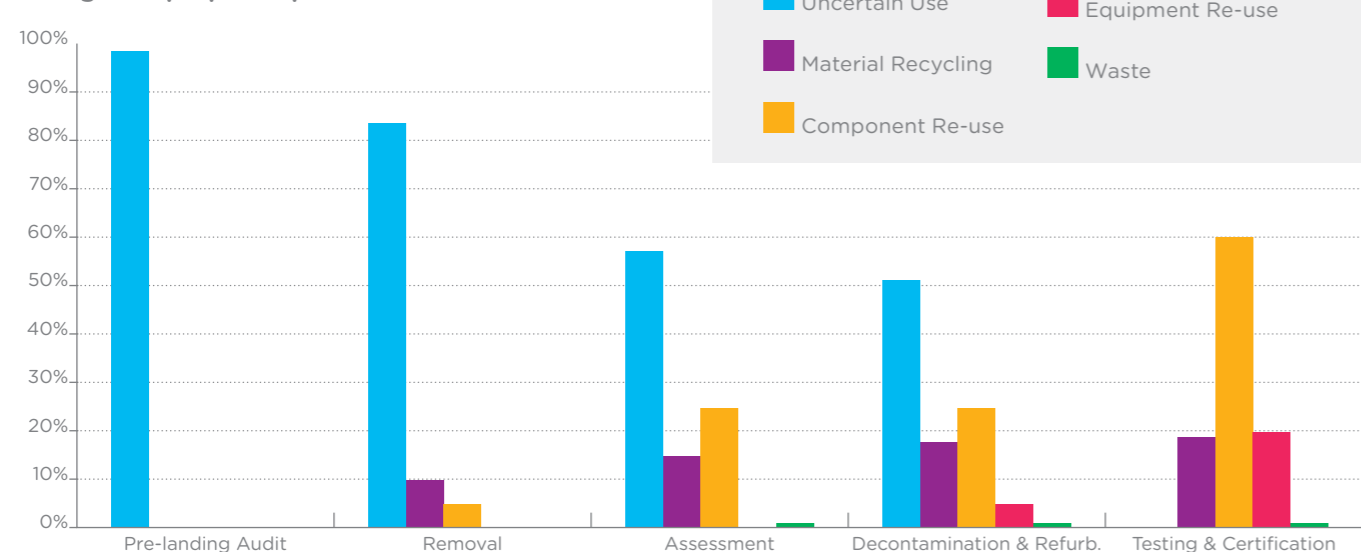
The assessment process reduces uncertainty over the likely volume and character of the items available for re-use and begins to narrow the range of likely financial outcomes, reducing perceived risk. This increasing certainty is described graphically below in Figure 1, and explored further later in this section.

Based on our experience, the expertise in assessment does not necessarily lie in the organisation which removes or audits the platform. For example, vessel companies may not have the skills to adequately assess the likelihood of a winch being suitable for re-use.

Accordingly, a key decision at this point is whether the resources are transferred to another party to undertake the assessment or whether they remain within the removal yard and an external assessor with the appropriate expertise is bought in.

If the items are sold ahead (i.e. on before assessment) the inherent uncertainty over the final value of the material will be reflected in the agreed price.

**Figure 1: Indicative increases in value and certainty through the proposed process**



## Decontamination & refurbishment



Many of the materials, components and equipment landed from the North Sea will have been operating under challenging conditions, exposed to salt water, wind and wave damage and to the products and by-products of O&G extraction.

Accordingly, under each of the proposed pathways, the resources may require some degree of both decontamination (removal of residues) and refurbishment (cleaning and making good) in preparation for taking to market. These processes may require specialist skills and technologies which again could be bought in, or the item ownership could again be transferred for refurbishment and onward sale.

The degree of processing will depend on the nature of the component or equipment under consideration and the proposed end use. For example, this could be simply washing for onward transport.

However, in the case of some component and equipment re-use, the decontamination and refurbishment required to return the element to a contaminant-free condition in which it is suitable for onward sale may be significant. Refurbishment will determine the need for the replacement of key equipment parts, such as valves or other sub components.

This process introduces cost uncertainty and therefore further risk into the process of re-use. However, there are specialist companies in onshore re-use in petrochemical, pharmaceutical and chemical industries for example, who can provide advice and expertise.



## Testing, certification & warranty



One of the major hurdles which the re-use of components and equipment face at the point of sale is the uncertainty over the use history. Many materials recovered from the platforms may have potential end-uses in contexts where performance and reliability is life or business critical.

If the future performance of an item is uncertain, some buyers may be unlikely to purchase the item, irrespective of its comparative advantages in terms of cost or re-use benefits. Later, material failure will affect the specifying organisation's profitability, insurance policies and generate health and safety risk and uncertainty.

To address this uncertainty, used materials, components and equipment may need to be tested and certified before being made available for re-sale. Alternatively, assets may be 'sold as seen' with the purchasing organisation accepting these risks. When comparable new products are available, it is unlikely that potential purchasers would consider reconditioned products unless there is a significant cost or lead time benefit over new products.

Therefore pre-testing and certification enables the vendor company to provide warranties over the item. To reduce the market perceptions of risk and overcome a potentially significant barrier to the uptake of re-used components and equipment, the warranties should be tailored to the requirements of the particular market for new products.

It may be that in the development of business models for certain resources, alternative markets become evident which have lower performance and reliability requirements. If this is the case, then testing criteria may be revised to suit the market of the end customer.



## Route to market



The final step in the process of re-use is making the sale. The diversity of the materials coming out of the decommissioning process is such that there is no 'one-size-fits-all' when it comes to the sales model. The reference to the 'sale' here is the final sale to a new use for the component or equipment, rather than to an intermediary in the process leading to re-use. The sale to an intermediary may take place at any stage in the process.

Reconditioned equipment is likely to be re-sold as one-off items via specialist resellers who understand the product's functional capabilities and can respond to queries. These will be termed here as 'bespoke' sales.

The key challenge with bespoke sales is to ensure that resales/brokerage organisations (for example specialist oil and gas resellers such as Oilmac or Network International) function effectively and can operate across industries, creating the market linkages.

These types of organisations may have opportunities to move towards more direct, effective and higher-profile brokerage services, providing routes to market. Appropriate sales development models will need to be fine-tuned as the market develops.

Components, such as steel beams, are relatively standardised and available from a large number of suppliers, although the re-use market may be dominated by a small number of specialists. The sales proposition for components is about meeting the market expectations for a generic product, being price-competitive, and leveraging the re-used credentials of the component (eg cost competitive and available with much shorter lead times).

These 'branded sales' may best be channelled through companies which already have market position in the market for the new components. This ensures that the re-used elements become part of their portfolio, rather than attempting to compete with their product range. This also has the advantage that the existing infrastructure of these organisations can be used. There may also be an opportunity for a more disruptive path in which a third party company reconditions, certifies and sells the components with warranties – perhaps an offshoot of a waste management or secondary materials brokerage company, for example.

Material sales, such as scrap metals, will generally be sold by weight or volume. The key for this sales area will be to use cost effective material recovery facilities to receive, process and distribute the materials cost effectively with a minimum of transportation.

In each case, the components and equipment will need to be sorted, catalogued and stored until such time as a buyer for the product is identified. This is one of the major challenges in component and equipment re-use.



## Key risks - uncertainty & value transfer

The primary risks which need to be addressed when considering increasing re-use surround the quality, value and ownership of the various materials at each step in the process.

At the beginning of the process, when the platform /equipment/components/materials reach the yard, aside from items identified for re-use in the pre-landing audit, the scrap value is the expected minimum achievable value. Supply chain participants will probably base their expectations on this value point.

While our experience shows that re-use and remanufacturing can increase the value recoverable from assets, at this early point in the platform recovery process there is likely to be a high degree of uncertainty as to the additional value achievable. The key uncertainties are the quality and quantity of materials which are available for re-use and remanufacturing.

To reduce this uncertainty, it will be helpful to establish early benchmarks to provide estimates as to the likely proportion of elements emerging from the decommissioning process that will be suitable for each end use.

As re-use increases across the decommissioning industry, specialists will develop an increased understanding of the quality and quantity of resources which are likely to become available through the process of pre-inspection, assessment testing and certification. This increased awareness is expected to help reinforce re-use and remanufacturing as an end of life option.

More accurate knowledge of availability and quality will tend to narrow the band of uncertainty as to the financial value which the recovered resources will attract, and hence increase the likely value.

The process described in this section aims to increase the value and certainty over value that can be attained through increasing the re-use and remanufacture of components and equipment. This increase in value is achieved in stages by assessing and enhancing the compatibility of the recovered components and equipment with the requirements of potential markets.

Where the different steps shown in Figure 1 are undertaken by different entities, there will be risk and value transfers along the supply chain, with each organisation seeking reward for the value which they add to the product. We see from the construction industry that such supply chain fragmentation can lead to complexity in transactions and potential conflict.

To the extent that ownership of assets is transferred as part of the process, the purchasing organisation will want to minimise their risk. Accordingly, they would prefer high levels of certainty about the quality of components and equipment that they are receiving.

If the quality of the materials they are receiving is lower than that required by the target market for their product, they will be required to incur additional costs to remediate the item, or sell on for a lower value use.

To address this issue and reduce the exposure of individual organisations to excessive risk, alternative commercial structures should be considered further. One option might be to create an overarching joint venture between companies involved in the decommissioning and re-use process which operates under a profit/loss sharing regime. Another is to set up a public-private partnership.

We consider that the O&G industry needs to demonstrate producer responsibility/product stewardship to reduce the end-of-life environmental impacts, to drive the re-use market and thereby support the growth of a new area of expertise in the UK.

Although adherence to the Waste Hierarchy is required by legislation through 'Directive 2008/98/EC on waste (Waste Framework Directive)' and 'The Waste (Scotland) Regulations 2012', this is clearly not sufficient in itself to increase re-use in the O&G decommission sector.

Government intervention will probably be required to incentivise or require re-use to be considered over recycling/downcycling in this sector.

Section 4.2 explores how this intervention might be developed

### 3.3 Shortlist of re-use opportunities

As we are most interested in pursuing high value re-use opportunities over recycling/ downcycling, we have considered 2 main re-use approaches for decommissioned materials: component re-use and equipment reconditioning & re-use in other industries.

Following the ideas generation session, the USP team identified the six asset classes that we consider most warrant early consideration. Our view was based both the discussions in the workshop and our preliminary exploration of existing potential markets for reuse.

- Specifically we considered the following factors:
- the potential scale of the supply of the asset (both in terms of relative financial value and quantity of material or equipment);
  - the cost and complexity of removing and processing the materials and components;
  - the potential scale of the market (in value terms);
  - the relative difficulty of developing the market for these assets.

Although necessarily subjective, we consider that the analysis forms a reasonable basis for these early decisions.

The selected asset classes are:

#### Component re-use

1. Steel sections from both jacket & topsides. (Together, the jacket and topsides account for around 97% of materials from the platforms.)
2. Pipelines (noting the expectation that buried pipelines will be exempted from the need for removal)
3. Anchor chains & cables

#### Equipment reconditioning and re-use

4. Vessels and tanks
5. Accommodation blocks
6. Winches

Concrete mattresses have been excluded from this analysis as they are the subject of a separate study being undertaken for ZWS.

Further, while rotating equipment (such as turbines, pumps and compressors) also have significant re-use potential, this market seems to have gained traction and therefore we consider that it does not need to be stimulated.

To demonstrate the possible processes of taking these assets to market, we have developed example business processes for each of the six asset class opportunities. These models are introduced below.



## Example 01

### Opportunity

Steel sections from jacket and topsides re-use

### Category

Component re-use: high embodied but no operational energy and relatively low in value. There is expected to be a large, well defined market for equivalent new products.

### Description & Characteristics

Steel elements extracted from the jacket and topsides can be made good and tested for re-use in industries such as construction, agriculture, civil engineering or renewable energy.

### Branding & marketing

The branding of the component might be developed to reflect its origins and “super” sustainability credentials, for example ReSea Steel or Reco Steel.

The market proposition is cost effective, low carbon, closed-loop steel for the conscientious construction or development company (or other sector which may be using the reconditioned product).



### Removal & Assessment

Once landed by, for example, Allseas at an appropriate facility, the jacket and topsides would be deconstructed to allow for assessment of the available steel sections. This process would be informed by the pre-landing audit and be managed by an organisation with appropriate decommissioning experience. Particular attention should be given to potentially fatigued areas which will be monitored closely towards cessation of production.

To the extent that ‘as built’ drawings are available, these may help identify which steels are suitable for re-use. However, these drawings are often out of date or misplaced. In such cases, detailed inspection surveys may be required from companies such as R2S.

Individual steel elements are then visually inspected for quality and dimensions. Then, where appropriate, they are extracted from the larger structure. Steels which are unsuitable for re-use on this first examination will generally be recycled.



### Decontamination & refurbishment

The isolated steel elements undergo any required decontamination (eg by companies such as Veolia) such as the removal of intumescent paints, before a detailed visual checking and sorting process is undertaken.



### Testing, certification & warranties

Key to the re-use of steel sections is the availability of certification and warranties. To provide certainty over the material content, samples of each steel section should be tested. Companies such as Sandbergs provide the required testing facilities and services, but these may also be available through steel manufacturers (including potential purchasers of the material). A site based testing facility might best deal with the volume of anticipated materials.



### Route to market

Component sales could be through companies which already supply the market with the same components, such as Tata, or for a more specialist re-used steel provider, e.g. James Dunkerley steel.

3.3 Shortlist of re-use opportunities

# Example 02

## Opportunity

Pipeline re-use

## Category

Component re-use: high embodied but no operational energy and relatively low in value. There is expected to be a large, well defined market for equivalent new products.

## Description & Characteristics

Used and unused pipes can be landed and made good for re-use in industries such as water, construction or utilities. (Entire pipelines and infrastructure may be re-used in-situ in for example Carbon Capture and Storage projects)

## Branding & marketing

The branding of the component might be developed to reflect its origins and “super” sustainability credentials, for example ReSea Pipeline or Reco Pipeline.

The market proposition is cost effective, low carbon, re-used pipes for the conscientious construction company (or other sector which may be using the reconditioned product).



## Decontamination & Removal

Decontamination of used pipelines/pipework is likely to be one of the key elements in the process of re-use as they are likely to be expected to carry non-oil products. Decommissioning must be in accordance with the Petroleum Act 1998 and other relevant environmental regulations. Primary decontamination will generally take place before the pipelines are removed from the seabed or the pipework removed from the asset. This is to ensure that pollutants are not released to the sea in the environment of the pipes.

The process of decontamination and removal will need to be explored in more detail to understand whether changes can be made to the process to enhance the likelihood of re-use. It should be noted that buried pipes are expected to be subject to an exemption from removal.



## Assessment

Once landed by, for example, Allseas, the pipes can be visually inspected, in particular for saltwater corrosion by, for example, RAM tubulars, and the sections suitable for re-use can be isolated, cleaned and stored.



## Testing, certification & warranties

Each sector of the market which might have a use for the pipework is likely to have differing technical requirements (gas / liquid). Testing will need to be undertaken by a company such as Exova on the pipes and joints as required to demonstrate compliance with the relevant standards. It may be that a site based testing facility could be established to deal with the volume of anticipated materials.



## Route to market

Component sales would be through companies which already supply the market, such as FT Pipeline Systems or Hacketts.



# Example 03

## Opportunity

Anchor chain and cable re-use

## Category

Component re-use: high embodied but no operational energy and relatively low in value.

## Description & Characteristics

Anchor chains and cables can be landed and made good for re-use in the O&G sector or shipping sectors as is. Other high value component re-use of the chain links may be available in industries such as construction, civil engineering, renewable energy, fish farming and more.

## Branding & marketing

The branding might be developed to reflect the origins and “super” sustainability credentials of the component, for example ReSea Chains or Reco Chains.

The market proposition is cost effective, low carbon, chains for the conscientious construction company (or other sector which may be using the reconditioned product).



## Removal

The chains and cables are readily removed from rigs and can be shipped to land as a separate item following a pre-landing audit by a company undertaking these audits, such as Arup.



## Assessment & sorting

Once landed, the chains can be inspected for quality and dimensions by a company with the requisite skills, such as Sotra. Chains and cables which have unacceptable wear for re-use can be set aside for disassembly and component re-use or material recycling.



## Decontamination & refurbishment

The chains, cables and any isolated steel elements undergo any required decontamination, including the removal of any foreign bodies, before a more detailed inspection process is undertaken to establish any chain remediation works required with links being replaced as required.



## Testing, certification & warranties

Given the operational requirements of chains and cables, the primary concern for their re-use will be their strength and weight-bearing capacity. Warranties can be provided after appropriate testing.



## Route to market

Component re-use: Chain links can be separated and re-used in alternative industries with minimal re-processing. Suggested uses include as security bollards or bike stands with large chain links being set in poured concrete.

Equipment re-use: There is already a market for second hand anchor chains in Aberdeen which could be enhanced.



3.3 Shortlist of re-use opportunities

# Example 04

## Opportunity

Winch reconditioning and re-use

## Category

Equipment re-use: specialised, often complex, equipment for re-use either within or without the O&G industry. The products are usually low volume, high value sale items with a relatively high cost of selling.

## Description & Characteristics

Removal, reconditioning and re-use of winches in the O&G sector or in utility, construction, rail, marine and forestry industries amongst others.

## Branding & marketing

The branding might be developed to reflect the origins and “super” sustainability credentials of the equipment, for example ReSea Winches or Reco Winches.

The market proposition is cost effective, low carbon winches for the conscientious construction company (or other sector which may be using the reconditioned product).



## Removal

Winches will be removed once the platform has been landed, having been catalogued prior to cessation of production. This audit information could be made available to the market in advance of decommissioning.



## Decontamination & refurbishment

It is understood that, in general, winches are well maintained over the life of the installation. Accordingly, the need for an onshore assessment is likely to be minimal. However, to confirm the condition of the winches once landed they should be tested as there may have been a dormant period between cessation of production and removal to shore.



## Testing, certification & warranties

Testing and certification will be required to provide comfort that the winches will perform as required. There are many companies which can provide these services, Rotrex Winches being an example.



## Route to market

The proposed route to market is through an existing supplier of winches (hire or sale); typically one which already offers used winches for sale. An example of such a company is Rotrex Winches who sell both new and used winches into many sectors.

Several companies offer a winch leasing model (such as Ace Winches) in which constant ‘re-use’ of winches is carried out. Refurbishment and re-use of decommissioned winches would be a natural extension to such a business model.



# Example 05

## Opportunity

Accommodation block reconditioning and re-use

## Category

Equipment re-use: specialised, often complex, equipment for re-use either within or without the O&G industry. The products are usually low volume, high value sale items with a relatively high cost of selling.

## Description & Characteristics

Removal, reconditioning and re-use of accommodation blocks in the O&G sector or in construction, disaster relief, prison, education, or renewable energy industries.

## Branding & marketing

The branding might be developed to reflect the origins and “super” sustainability credentials of the equipment, for example ReSea Accommodation Block or Reco Accommodation Block.

The market proposition is low cost, refurbished accommodation blocks.



## Removal

The accommodation blocks would generally be removed from the platform through reverse installation and brought to land as individual components. This process would be undertaken by a decommissioning company such as Allseas.



## Assessment

A pre-landing audit can be made of the blocks to identify the work required to remediate the block for onwards use, and the develop the business case for reconditioning. This will include a detailed inventory of the waste streams likely to arise from the refurbishment process. This audit information could be made available to the market in advance of decommissioning.



## Decontamination & refurbishment

Once on land, the block can be refurbished to suit the needs of the next anticipated use. Any residual waste product from this process needs to be carefully managed to ensure that the waste sent to landfill and recycling is minimised and re-use is maximised.



## Route to market

The key challenge with bespoke sales is to ensure that brokerage organisations exist, function effectively and can operate across industries, creating the market linkages.

There are already organisations in the offshore sector which deal in accommodation block re-use and re-purposing (for example Aiken Marine) who might be appropriate outlets for both onshore and offshore uses. Other organisations, such as the Ferguson Group hire out blocks and may help to create a competitive market for the blocks. An example of accommodation block re-use is in the Able Seaton yard where the former BP NW Hutton block was refurbished and is now used as mobile offices which can be transported to different locations across their extensive site.



3.3 Shortlist of re-use opportunities

# Example 06

## Opportunity

Vessel and tank reconditioning and re-use

## Categories

Equipment re-use: specialised, often complex, equipment for re-use either within or without the O&G industry. The products are usually low volume, high value sale items with a relatively high cost of selling.

## Description & Characteristics

Removal, reconditioning and re-use of vessels and tanks in the O&G sector, or re-use in agriculture, chemical, construction, energy and leisure sectors. There is considerable scope for creative re-use of the tanks and support structures, similar to that for shipping containers which can be explored with designers

## Branding & marketing

The branding might be developed to reflect the origins and "super" sustainability credentials of the equipment, for example ReSea Vessels or Reco Vessels.

The market proposition is low cost, low carbon, refurbished, warranted vessels and tanks for the conscientious company; or modular components for creative re-use.



## Removal

The vessels and tanks are expected to be removed from the rig structures at the onshore yard as modular components. The landing process could be undertaken by a decommissioning company such as Allseas with disassembly typically being undertaken by the receiving yard.

A pre-removal audit can be made of the vessels and tanks to identify the current quality and quantity of vessels and tanks and any work required to remediate them for onwards use. This audit information could be made available to the market in advance of decommissioning.



## Assessment

Once on land, the previous audit information is validated and the suitability of vessels and tanks will be confirmed for the proposed market(s). Those which are found to be unsuitable for re-use will be deconstructed to component elements and uses sought. Any waste product from this process needs to be carefully managed to ensure that the waste sent to landfill and recycling is minimised and re-use is maximised



## Decontamination & testing

The tanks and vessels can be refurbished to suit the needs of the next anticipated use. For some uses, there may be a need for confirmation of integrity or compliance with environmental regulations. In addition there may be a requirement to meet standards such as the European Pressurised Equipment Directive (PED) for tanks which operate in pressurised processes. Companies such as Darcy are able to provide these services.



## Route to market

The proposed route to market could be through existing suppliers of bulk storage solutions such as Bulk Storage and Process systems or another member of the tank storage association, utilising their existing routes to market and infrastructure.



# 4. Recommendations

## 4.1. Develop the evidence base for re-use

Findings from our work, coupled with those from other reports, suggest that there are a wide range of possible markets in industries which are open to the re-use of reconditioned equipment. Routes to market in these industries could be developed for components and equipment arising from the O&G decommissioning industry. Accordingly, we make the following recommendations to help further explore the market for re-use.

This phase of the project engaged a small number of people from a selection of industries in which we considered there to be re-use potential. To support the business case for increased re-use, further work needs to be undertaken to better understand and quantify the market opportunity in different industries.

### Recommendation 1: Conduct industry studies

We recommend that Zero Waste Scotland and Decom North Sea commission a deeper and more comprehensive investigation into the potential re-use market for end of life O&G equipment and components in other industries. The investigations could be through a series of industry specific workshops and engagements.

Based on our discussions, we have seen that there are several industries which might be markets for refurbished or reconditioned O&G components and equipment including:

- construction;
- transport;
- utilities (energy, water, sewage and waste);
- chemical; and
- agriculture.

To deliver maximum impact, workshops should be held, with key players from across the supply chain in each sector invited to explore re-use potential for a range of carefully selected equipment and components. The workshops could provide a better understanding of the nature of those markets, potential barriers, specific needs, geographical

distribution, existing supply chains, and prices paid for re-used components and equipment etc. The analysis should be based, where possible, on an inventory from a current live decommissioning project.

As a starting point we would suggest engaging with Able UK, the yard contracted for the onshore decommissioning of the Shell Brent Oil Field. This is an innovative project, with the first 'single lift' project of this scale, by the newly launched Allseas 'Pioneering Spirit' vessel. It therefore provides opportunities on a significant scale to increase the uptake of re-use on this landmark project and in future North Sea decommissioning.

The output would give a better understanding of the potential market for components and equipment within various industries and increased understanding of the needs of different sectors. The output could be used as evidence to support the case for government action to facilitate a managed transition towards a circular economy.

### Recommendation 2: Conduct component/equipment studies

We further recommend that the six high level opportunities discussed in Section 3.3 of this report are explored in more detail through a series of feasibility studies.

We recommend that for each class of asset a more detailed feasibility study is commissioned to explore:

- Potential markets for the product;
- The size of those markets;
- Barriers and risks to increasing re-use in those markets;
- The (circular) business model for re-use of the product;
- The social and environmental case for re-use;

If resources aren't available to take all six opportunities to feasibility testing, given the relative abundance of winches and storage tanks and the diversity of industries into which they might be accepted, we propose that these two equipment re-use proposals are prioritised to act as test cases.

As with recommendation 1, to provide evidence that there are markets of significant value for re-use of components and equipment from decommissioned platforms and assets, the output of the feasibility studies should be designed to provide insights into how those markets can be developed.

## 4.2. Develop structural interventions

In the course of our work on this project we have spoken with many stakeholders in the decommissioning supply chain. Through those discussions we have formed opinions on broader, more strategic steps which might help move the UK oil and gas industry towards a circular economy.

Following the presentation of our observations at the ZWS/Decom North Sea conference on 28th May 2015, it was suggested that the recommendations presented be included with our project findings. The following section provides a summary of the presentation themes for consideration by Zero Waste Scotland, Decom North Sea and other organisations such as Oil & Gas UK.

This section introduces the structural interventions which we consider might be required to provide a context in which a re-use and remanufacturing industry might develop. Section 4.3 contains recommendations which we consider could help stimulate and engage the decommissioning supply chain.

The decommissioning forecasts indicate that there will be capacity constraints in the onshore decommissioning yards over the period to 2022, particularly associated with deep water access for larger 'single lift' vessels and the quayside capacity and storage for large topsides.

This could mean an increasing number of platforms will be taken to other countries such as Norway or Turkey, with the associated loss of employment, income and resources from the UK economy.

However, this could be overcome, in part, by using different removal methods such as 'piece small' (effectively the specialist offshore 'demolition' of platforms) which enables the materials to be taken to shore in smaller vessels, which can consequently access a much wider range of yards in the UK.

Our experience suggests that the Scottish Government and DECC may have to intervene to encourage the landing of platforms in the UK and incentivising or requiring re-use to be considered over recycling/downcycling in this sector. Such interventions will help the growing North Sea decommissioning sector to transition towards a circular economy.

Governments are able to help stimulate this market by taking action such as:

- introducing legislation that requires target levels of re-use;
- providing incentives to support higher levels of re-use e.g. tax breaks;
- investing in port infrastructure to enable topsides/jackets to be landed, disassembled and stored;

- stronger enforcement of the Waste Hierarchy through 'The Waste (Scotland) Regulations 2012' to require evidence that a full range of re-use markets have been explored;
- phased introduction of targets for percentage re-use - such as those introduced in the car industry;
- setting up joint programmes with industry to encourage investment, research and development into re-use.

If the UK Government aims to achieve the material, employment and economic benefits from a growing decommissioning sector in the country, incentives to retain the materials in the Scottish and UK economy should be explored.

We therefore recommend that Zero Waste Scotland, Decom North Sea and Oil & Gas UK bring together key industry, regulatory and Government stakeholders to develop the evidence base to support the case for such government intervention in the decommissioning industry.

### **Recommendation 3: Create a government and industry working group to demonstrate and incentivise re-use**

While the direct financial benefit to the gas and oil sectors may be small in relation to the overall costs of decommissioning, partnership in such a venture would enhance the reputation of the UK's oil 'majors' and would be expected to support the creation of new enterprises and jobs at a time when the sector is suffering from the effects of oil price volatility.

The benefit to government would be to stimulate and diversify the regional economy. There is an opportunity to trail blaze in a sector that has global reach and the importance of re-use will grow in importance over time as natural resources become increasingly constrained.

We recommend that the evidence base Working Group consists of a range of interest groups for example:

- operators from the O&G industry
- the decommissioning supply chain
- waste management companies
- re-use organisations/brokers
- end users such as the civil engineering, water and energy industries
- circular economy organisations such as The RSA Great Recovery and the Ellen MacArthur Foundation
- Zero Waste Scotland
- DECC
- SEPA
- Local community and special interest groups
- Academics specialising in the circular economy and other related areas

If greater value is to be derived from decommissioning in Scotland, there must be facilities to land, dismantle, assess, refurbish, test and warranty complete assets (or parts of the asset) onshore in Scotland. These facilities would ideally be established alongside a port facility which can accommodate the largest of rigs.

### **Recommendation 4: Establish an industry cluster for the decommissioning and re-use sector**

We recommend that Zero Waste Scotland (in conjunction with the Scottish Government and economic development agencies such as Scottish Enterprise/HIE) investigates setting up a new industrial cluster or "circular economy hub" in Scotland in partnership with the O&G decommissioning sector.

An example of a similar initiative is the work Veolia Environmental Services UK are about to embark on in Lutelandet, Norway, where the aim is to re-use and recycle 99.7% of the 14,000 tonne YME oil platform.

The business cluster could include representatives from all the different areas of the O&G sector as well as non-industry organisations such as the waste industry. The cluster will need to attract a wide range of specialists to the area.

Skills in removal, assessment, decontamination, testing and certification, reprocessing and reconditioning of equipment and components, brokerage, marketing and sales could be brought together in one area. This would create a critical mass of services which could be shared by the decommissioning industry, reducing costs and barriers associated with re-use.

This would provide an infrastructure and a business ecosystem to efficiently and effectively realise the value inherent in the offshore platforms and infrastructure.

The industry cluster could lead to higher value re-use being preferred over scrapping and smelting. This, in turn, could lead to higher potential resale margins, lower carbon emissions, substitution of virgin materials, less waste disposal and growth of new businesses, jobs and skills.

Developing such a cluster would require long term planning and a commitment to landing decommissioned offshore platforms or components on or near the site. This would allow the materials reprocessing industry to invest in this sector and region with confidence.

The National Industrial Symbiosis Programme (NISIP) has been promoting circular economy initiatives for some time and could perhaps be contracted to help develop the proposition.

Whilst this concept of a circular economy centre or hub for North Sea decommissioning goes beyond our scope, the evidence from this project demonstrates that there is likely to be potential to sell products to other sectors of the economy and thereby deliver economic, social and environmental value to the Scottish economy.



### 4.3. Stimulate the UK supply chain

Once the economic context is amendable to developing a specialised decommissioning industry in the UK, existing industry participants will need to be encouraged to adopt principles of a circular economy. This section presents recommendations which seek to increase awareness and understanding of the benefits of re-use and remanufacture in the O&G decommissioning supply chain.

The shift towards a more circular economy will require new approaches to the design, construction, installation, maintenance and decommissioning of the infrastructure being used to extract, distribute and process North Sea reserves of O&G.

It is clear that a shift in culture, skills, briefs, specifications and contracts and supply chain management will be needed to promote circular economy practices and ensure that the sector and Scotland benefit from the opportunities identified in the AMEC report.

Many of the issues and barriers to increased re-use which have been identified require the O&G companies and their supply chains to show leadership and producer responsibility/product stewardship. Appropriate leadership can help to reduce the end-of-life environmental impacts of operations and drive the re-use market.

**Recommendation 5: Engage with industry and professional bodies to promote and lead a drive towards a circular economy**

In our Interim Report (Appendix 1), we recommend that organisations such as Decom North Sea and Oil & Gas UK engage with O&G operators to promote leadership and a transition towards a circular economy.

We now extend this recommendation to include professional bodies such as the Royal Academy of Engineers, the Institute of Civil Engineers. These bodies are able to raise awareness about the importance of these issues to the wider economy. We have had informal discussions with some of these professional bodies and it is clear that there is an interest in exploring the potential for a circular economy.

Our experience suggests that in addition to engagement with leading O&G and professional institutions, it would be very valuable to promote cross sector knowledge sharing exchange. This could include meetings and workshops between the O&G sector and businesses from other sectors which are leading the way in re-use and remanufacturing.

Expertise outside of the oil and gas decommissioning sector could provide insight on methods of decommissioning and removal. For example, industries such as marine salvage, specialist onshore demolition

in nuclear, petrochemical and pharmaceutical may have valuable lessons which they can share. This is both in terms of decommissioning techniques and in opportunities for re-use.

To be successful, engagement should be underpinned by a strategic plan which helps identify appropriate stakeholders to engage and the levers of change. The plan will also provide a framework for discussions, and agree the best approach to engagement.

As set out in our Interim Report, we recommend a stream of work focused on engaging with clients, designers and specifiers to explore design interventions which will support a circular economy. For this work to be of maximum benefit to the UKCS, it should focus on both the early phases of commissioning, as well as developing innovative approaches to decommissioning.

The RSA Great Recovery proposes to set up a much more extensive engagement process and campaign to work with designers and engineers in the O&G industry to explore possible design interventions that could support the transition towards a circular economy. Designers rarely have a good understanding about how assets are decommissioned at the end of their life, or how their design decisions impact on recovery rates and processes.

From work we have done in other sectors it is clear that salvage and material processing companies have a lot of experience and knowledge about how product and process design could facilitate recovery, increase rates of recovery and enhance end of life value. That experience is rarely shared with other parts of the supply chain.

We have found that the best way to help designers understand how their design impacts on end of life options is to provide a space for them to explore current end of life disposal routes and to understand what is driving them.

**Recommendation 6: Establish design residencies and 'tear down, design up' workshops with the decommissioning supply chain and onshore yards**

To engage designers in product and process redesign, we recommend establishing a programme of design residencies to embedded designers in O&G platform end of life processing sites. This will give designers a chance to see first-hand the products and materials that are being recovered from platforms. They can then be invited to consider and test how those products could be reprocessed to create new products and to challenge how the decommissioning process works.

The RSA Great Recovery has set up such design residencies in other sectors. We have found that we achieve most from them when we develop strong partnerships with the whole material recovery supply chain and designers are given the time and scope to explore opportunities for re-use and product and process redesign.

The outputs from these residencies are tangible, often in the form of new products and services, or product or process redesigns which facilitates recovery and re-use. There are also intangible benefits to be gained as all parties develop a new appreciation of the value that design thinking and skills can bring to end of life recovery.

As part of the residency, the decommissioning process on early projects could be filmed and interviews conducted to understand from a design perspective the issues which decommissioning specialists and salvage companies face. We call this process a 'tear down'.

The 'tear down' process creates understanding of, and introduces a different way of thinking about, product life. This could then lead to a series of 'design up' or redesign workshops in which asset and process design is reconsidered from an end of life perspective.

Guidance could be developed to inform industry as a whole about how they can design products and processes for end of life recovery in addition to the critical operational requirements. We would also create a programme of dissemination on design for decommissioning.

Recommendations could also be developed for government, setting out how they can incentivise design for end of life recovery.

This approach has already been explored on end of life recovery of concrete mattresses for example. This identified the need to address corrosion and break up of mattresses when they are lifted, which in turn has led to the redesign of mattresses with polypropylene rope, rather than wire rope, which corrodes in saltwater subsea.

Circular economy ideas and practices have yet to become mainstream in the UK.

Universities act as a key centre for developing and disseminating ideas and practices which can lead to long term changes. Therefore, they have an important role in encouraging the transition to a more circular economy.

**Recommendation 7: Create design challenges**

To encourage university engagement with circular economy ideas and practices we recommend working with ZWS, O&G operators and the decommissioning supply chain to establish design briefs and competitions based on platform decommissioning and the design of future products and systems for a circular economy.

One opportunity would be to run an annual competition within Scottish Universities to develop:

1. Innovative approaches to reduce the cost of decommissioning while maximising re-use
2. The development of secondary markets and business opportunities for decommissioned equipment. (This could build on some early work carried out by Robert Gordon University on behalf of Decom North Sea/Zero Waste Scotland)
3. New design approaches for sub-assemblies, parts and works that enhance longevity, re-use, reconditioning or recovery.

The design challenges need not be limited to universities, with creative thinkers from many industries being potential sources of solutions to the barriers to re-use.

## 5. Conclusions & next steps

### Conclusions

Our observations from literature reviews, meetings, site visits and workshops are that decommissioning in the O&G sector represents a significant opportunity for the application of circular economy principles and practice. As well as having significant environmental benefit, adopting circular economy principles during the decommissioning process could

- reduce the net cost of decommissioning
- reduce the environmental impacts associated with recycling/disposal of materials
- develop new oil and gas supply chain sub-sectors
- offer additional opportunities for supply chain companies in a lower oil price economy
- add value to the Scottish economy
- create new skills, jobs and enterprise

The existing evidence base shows there is significant potential to move away from recycling towards re-use, and this project has reinforced this. However, based on our experience in the circular economy and our initial explorations of the market, we consider that further work would help to substantiate the potential value gains at a more detailed level.

There are key barriers to re-use that will need to be overcome to significantly shift current practice. One of these is an enterprise gap, particularly in finding routes to market, as described in Section 3.3. Overcoming key risks associated with uncertainty and value transfer are additional barriers that have come to light.

Through this study, 186 potential re-use ideas have been identified, many in other industries. This indicates that there may be significant unexplored potential to develop cross-industry markets for re-use. These opportunities have been analysed and been reduced to six re-use and re-manufacturing opportunities that we consider should be explored in feasibility studies. The opportunities arise in different industries and fall under two categories:

#### Component re-use

1. Steel sections from both jacket & topsides
2. Pipelines
3. Anchor chains & cables

#### Equipment reconditioning and re-use

4. Vessels and tanks
5. Accommodation blocks
6. Winches

As mentioned previously, we understand that rotating equipment has re-use potential, but the market for these products is already forming. Concrete mattresses are the subject of other investigations.

In summary, this study has shown that there are sufficient materials and products being decommissioned with significant re-use potential in other industries to justify further exploration of the potential opportunities.

### Next steps

Outputs from our work, coupled with findings from other reports, suggest that there are a wide range of possible markets in industries which are open to the re-use of reconditioned equipment. These markets could be developed for components and equipment arising from the O&G decommissioning industry.

The recommendations we make, which are summarised on the page opposite, are designed to move the decommissioning industry towards a more circular economy. The proposed approach to increasing re-use has 3 elements:

- Develop the evidence base
- Develop structural interventions
- Stimulate the supply chain

In this report we have identified six classes of assets which appear to have potential for increased re-use. The next key steps revolve around developing a rigorous and detailed evidence base to support the arguments for action to encourage re-use. The evidence base should consider the technical, economic, environmental and social impact and viability of increasing re-use for each class of asset explored.

The evidence gathered will help to define the size of the potential market for each class of asset, as well as providing insight into likely quantity and quality of the assets that are potentially available. This review of the market, together with an understanding of the expected volume of materials, will provide a better estimate of the true value uplift that could be realised if circular economy principles were applied. The work should also help to draw out specific barriers to increasing re-use in each class of asset.

This evidence gathering, covered by our first two recommendations, can inform the nature and structure of the interventions required by government. The findings will also help determine the most effective means of encouraging circularity in the decommissioning industry (recommendations 3, 4 and 5).

We view the stimulation of the supply chain as an ongoing parallel activity which creates the context in which the other work can be carried out. As such, we suggest that our final two recommendations be started early so they can support the evidence base.

### Recommendation 1: Conduct industry studies

To support the business case for increased re-use, further work should be undertaken to understand and quantify the size and value of the market in different industries.

We recommend that Zero Waste Scotland with partners commissions a deeper and more comprehensive investigation into the potential re-use market for end of life O&G equipment and components in other industries. The investigations could be through a series of industry specific workshops and engagements.

The output would give a better understanding of the potential market for components and equipment within various industries and increased understanding of the needs of different sectors. The output could be used as evidence to support the case for government action to facilitate a managed transition towards a circular economy.

### Recommendation 2: Conduct component/equipment studies

We further recommend that the six asset class opportunities described in Section 3.3 of this report are explored in more detail through a series of feasibility studies.

We recommend that for each class of asset a more detailed feasibility study is commissioned

If resources aren't available to take all six opportunities to feasibility testing, given the relative abundance of winches and storage tanks and the diversity of industries into which they might be accepted, we propose that these two equipment re-use proposals are prioritised to act as test cases.

The output of the feasibility studies should be designed provide insights into how those markets can be developed.

If the UK Government wants to achieve the material, employment and economic benefits from a growing decommissioning sector in the country and by moving to a more circular economy, incentives to retain the materials in the Scottish and UK economy should be explored.

### Recommendation 3: Create a government and industry working group to demonstrate and incentivise re-use

We recommend that Zero Waste Scotland, Decom North Sea and Oil & Gas UK bring together key industry, regulatory and Government stakeholders to develop the evidence base to support the case for such government intervention in the decommissioning industry.

### Recommendation 4: Establish an industry cluster for the decommissioning and re-use sector

To develop a centre of excellence and to achieve efficiency improvements and economies of scale, we recommend that Zero Waste Scotland (in conjunction with the Scottish Government and economic development agencies such as Scottish Enterprise/HIE) investigates developing a new industrial cluster or "circular economy hub" in Scotland in partnership with the O&G decommissioning sector.

### Recommendation 5: Engage with operators to promote and lead a drive towards a circular economy

It is clear that a shift in culture, skills, briefs, specifications and contracts and supply chain management will be needed to promote circular economy practices and to ensure that the sector and Scotland benefit from the opportunities identified in the AMEC report.

Many of the issues and barriers to increased re-use which have been identified require the O&G companies and their supply chains to show leadership and producer responsibility/product stewardship. Appropriate leadership can help to reduce the end of life environmental impacts of operations and drive the re-use market.

We recommend that organisations such as Decom North Sea and Oil & Gas UK engage with O&G operators to promote leadership and a transition towards a circular economy.

### Recommendation 6: Design residences, 'tear down, design up' workshops with the decommissioning supply chain and onshore yards

To engage designers in product and process redesign, we recommend establishing a programme to embed designers in O&G platform end of life processing sites.

This will give designers a chance to see first-hand the products and materials that are being recovered. They can then be invited to consider and test how those products could be reprocessed to create new products and to challenge how the decommissioning process works.

### Recommendation 7: Create design challenges

To encourage university engagement with circular economy ideas and practices we recommend working with ZWS, O&G operators and the decommissioning supply chain to establish design briefs and competitions based on platform decommissioning and the design of future products and systems for a circular economy.



# Appendices

## Appendix 01

RSA Great Recovery interim Oil & Gas Decommissioning study

## Appendix 02

Long list of opportunities for re-use

## Appendix 03

Opportunities for re-use by re-use category

## Appendix 04

Opportunities for re-use by industry

## Appendix 01

RSA Great Recovery interim Oil & Gas Decommissioning study

**The RSA Great Recovery/ Zero Waste Scotland programme  
North Sea Oil and Gas Decommissioning Study  
Initial report, 30 January 2015**

### 1. Introduction

The RSA Great Recovery is working with Zero Waste Scotland (ZWS) to help accelerate Scotland's transition to a circular economy. One workstream is on the Oil and Gas decommissioning sector. Within this, the scope of The RSA Great Recovery's work is to:

- Review existing studies already undertaken in Scotland and in circular economy opportunities
- Engage with stakeholders in the Oil and Gas decommissioning sector to understand issues and opportunities for adoption of circular economy principles and practice
- Identify ways in which The RSA Great Recovery could practically support the Oil and Gas sector transition towards a circular economy through its system design centred approach to the circular economy.

This initial report provides feedback from The RSA Great Recovery document review, site visit and industry workshop on 15 & 16 January 2015. It summarises the potential to engage and implement design approaches to support the adoption of circular economy principles in the decommissioning of oil and gas rigs in the North Sea.

This report is structured as follows:

- Section 2: Findings from reports
- Section 3: Findings from site visit
- Section 4: Findings from the industry workshop
- Section 5: Recommendations
- Section 6: Conclusion and next steps

### 2. Findings from reports

In preparation for the workshop and site visit the team reviewed the reports and presentations forwarded by ZWS including, most significantly, the Circular Economy Evidence Building Programme – Oil and Gas Sector report produced by AMEC E&I UK Ltd.

#### General findings

Currently there is little innovation in terms of recovery and reuse of materials, components, sub-assemblies or parts during decommissioning. All of the obvious approaches are being taken but nothing more. This is due to a lack of incentive. Indeed, there is a dominant culture of risk adversity that hinders innovation. We are not suggesting that caution should be abandoned. However, it would make sense to try and stimulate or reward innovation in terms of circular thinking and the reuse and refurbishment of equipment. Ford pioneered this approach in the late 1990s by increasing payments made to suppliers who were able to increase recycle in components. Innovation usually comes from external market stimuli such as legislation, collapse of supply or the arrival of a new competitor. It is possible, however, to kick-start innovation with incentives. This also addresses one of the most significant challenges to adopting circular economy principles in this sector: the scale of savings are dwarfed by the cost of new exploration and development. Applying the right incentives rewards the supply chain rather

than the supply-chain champion. The possible financial benefits are of greater significance to these players.

The main four circular economy strategies are widely acknowledged as:

- 1 Design for longevity
- 2 Design of re-use
- 3 Design for refurbishment
- 4 Design for material recovery

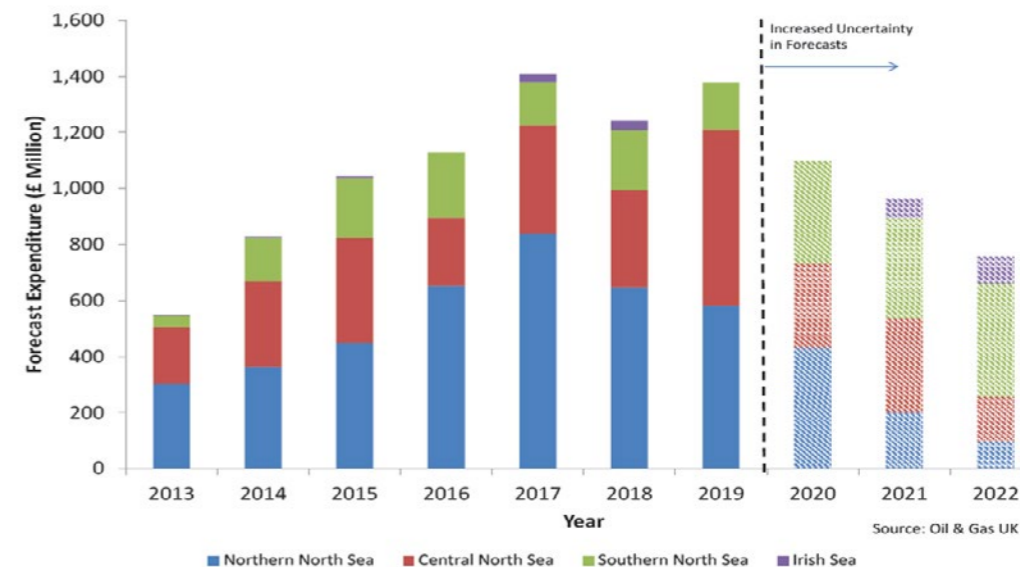
The Oil and Gas Industries focus on the first and last of these. This is admirable. However, there are significant opportunities to move up this list and to look seriously at re-use and refurbishment.

**Findings from the Oil and Gas Sector report produced by AMEC E&I UK Ltd**

The AMEC report provides a comprehensive review and useful insights into the existing market and barriers that the sector faces in transitioning towards a circular economy. The report identifies that there is a great deal of steel and other high value materials that are or will be decommissioned including carbon steel, stainless steel and duplex stainless steel pipework. In addition there are other valuable products including valves, vessels and tanks, installation cranes, helidecks, pipes and other process equipment that has potential to be recovered.

- There are 4 broad categories of rig; small (<4000 tonnes), large (>4000 tonnes), large concrete (150-350 tonnes) and floating production storage. They are either steel or concrete structures.
- In the steel structures circa 97% of material is steel, 2% is valuable reusable equipment and 1% rare metals.
- The concrete rigs typically consist of 93% concrete, 5% carbon steel, 2% valuable reusable equipment and 1% rare metals.
- The total number of rigs in UKCS includes 674 operational installations and 74 decommissioned installations, 24 closed installations and 4 other installations. DECC report that there are 19 offshore installations listed as decommissioning projects.
- The total value of decommissioning between 2012-2040 is estimated to be £31b, with 40 rigs being decommissioned by 2017 at a cost of £4.5b. Over 50% of these will come from in the North Sea. This represents over 470,000 tonnes of topside, substructure and subsea installation.
- Whilst the decommissioning market is growing there is concern that Scottish industry will not be able to take advantage of this material as there is a lack of heavy lift companies in the UK or facilities that are able to accept single lift topside rigs.
- Currently 98% by weight of materials are recycled back into raw material at the end of their life with only a small fraction of the components being recovered for reuse in some other way, or disposed of. The majority of this material recovery is smelting in steel mills and is outside the UK.

	Number of installations in UKCS	Number of installations in Scottish Territorial Waters (assuming 44% share)
Small steel installations (<4000 tonnes)	592	260
Large steel installations (>4000 tonnes)	113	50
Large concrete installations (~150-350k tonnes)	11	5
Floating installations	56	25
<b>TOTAL</b>	<b>772</b>	<b>340</b>



- The number of oil and gas rigs that will be decommissioned is large and growing. The potential to set up industries that can reuse and upcycle more of the material that is being generated and deliver value to the Scottish economy is significant.
- There are a number of different strategies that could be adopted to enable movement up the waste hierarchy by increasing the level of recovery and reuse rather than material recycling. Different components of the rig and associated infrastructure will lend themselves to different strategies. These strategies include:
  - Re-manufacturing. Other sectors have more developed approaches to re-manufacturing. For example the aeronautical industry maintains a highly organised database of parts, condition and service records for all components which are often reconditioned and reused; Caterpillar have their remanufacturing business which delivers a high quality service and product to

- their customers<sup>1</sup>. There are significant opportunities to increase the levels of re-manufacturing but the culture in this sector doesn't currently support this as it is risk averse to the point of hampering innovation.
- Re-use. As above there are many industries that are looking at re-use as a way of increasing value whilst reducing environmental impact. The industry has some experience of this but it is very much the exception.
  - Recycling. Recycling is prevalent in the industry especially in the North Sea where regulation and control over disposal have resulted in very high recycling rates. The majority of the steel is sent for smelting to steel mills around the world. Our understanding is that very little is recycled in Scotland. This is because there are no active steel mills in Scotland. There is a major opportunity to build this sector within the country.
  - Design for reuse, disassembly and standardisation. More effort could be made during design and construction of new rigs to ensure they are designed and installed in a way that facilitates cost effective recovery of valuable components. Simple strategies could be employed; this would include developing a disassembly guide, colour coding high-value materials or using barcodes to identify which elements of sub-assemblies have value.
  - Supply chain integration. The supply chain is extensive and a large proportion is located in Scotland. However this supply chain is not currently set up to support circular processes although there is a lot of expertise in maintaining rigs. There tends to be little integration across the sector.
  - Carbon capture and storage. This is interesting, but the technology is still underdeveloped and would change the way the industry approached decommissioning, extending the life of the wells and the equipment associated with them.
- The report lists many barriers that prevent a move towards greater circularity including;
    - Attitudes to Health and Safety and fear about the risks associated with using recycled and reconditioned materials
    - A pre-disposition to buy new products
    - The bespoke design of each rig and the need to design for specific conditions
    - Concern about the quality and conditions of materials that have been operating in extreme environments
    - The difficulty of recovering materials that haven't been designed for reuse;
    - The drive to minimise the cost of decommissioning;
    - The relatively low value of salvage in relation to life cycle costs
    - Obsolescence of systems, products and plant;
    - difficulty of obtaining warranties and assurances;
    - Poor data management or knowledge about products being recovered
    - Insufficient capacity in Scotland to handle and process decommissioned rigs
    - Lack of integration across the supply chain;

The report stops short of developing detailed opportunities or approaches that the industry could take forward to promote the circular economy. [The following text has been amended from the original text to maintain confidentiality] However, it does indicate that increasing re-use over recycling of equipment and structure on installations can increase values by up to seven times and could add a third to the total value of an installation at the decommissioning stage. [Amendments ends]

<sup>1</sup> <http://www.caterpillar.com/en/company/sustainability/remanufacturing.html>

- It is not clear how these figures have been calculated or what would need to be done to realise these opportunities. Some case studies are provided of recovery and reuse but these appear to be the exception.
- The biggest constraints preventing a transition towards a circular economy across the industry and particularly in decommissioning appears to be cultural rather than technical. An example of the prevailing attitude is the demand by rig operators for destruction certificates for many of the products that are salvaged to ensure they are not reused and the cutting off of pipe ends which significantly reduces the value of those pipes to other industries.

### 3. Findings from site visit to John Lawrie Group in Montrose (15 January)

The meeting was held between John Lawrie Group (JLG) (both metals and tubulars), ZWS (Cheryl Robb, Leah Gourley and Maurice Golden) and The RSA Great Recovery team (Ed McCann, Mark Shayler and Dan Epstein).

JLG is one of the larger businesses involved in recovery and recycling of North Sea decommissioned materials. They have built a successful business buying and selling surplus drill pipe which they market to the construction industry for piling. Recovery rates are high and the quality of the materials easily meet those needed in the new build residential sector and for retaining embankments. The majority of the pipe that has been recovered is of a small diameter. JLG is responsible for buying, inspecting, sizing, cutting and marketing the materials. They have an extensive network of customers who buy the entire product they can produce largely because it is cheaper than new pipe. In total JLG are selling circa 200k tonnes of pipe a year. Importantly they are required by the rig operators to cut off the threads to ensure they can't be reused in the oil and gas industry. This potentially reduces their reuse value in other areas for example as irrigation or sewage pipe in the water sector where pipe is only required to withstand a pressure of 3-5 bars.

The value of the product would potentially be highest if it could be re-conditioned and sold back to the Oil and Gas sector. However it is clear that the industry is not prepared to use reconditioned or repaired pipes. Some of the pipe that JLG purchase has never been used and was either condemned on inspection by the Rig operators or was surplus to requirement. The difference in price between recycled pipe (for the construction industry) and new pipe used in the Oil and Gas sector is between \$1300- \$1700 a tonne depending on quality. The cost to overhaul the couplings and threads of used pipe in order to ensure the seal meets approved standards can be as much as \$ 1500 a tonne. The risks associated with defective pipe however dwarf these costs or other potential benefits and there is no incentive to re-manufacture defective pipe.

JLG have strong markets for their surplus pipe and hitherto there is little incentive to develop new markets for the piles.

Other technical issues that were raised include the difficulty in creating high quality welds on these pipes. It is noted that surplus gas pipes were used on the Olympic Stadium in the roof structure including the main ring beam.

JLG is looking at potential reuse and recycling opportunities for other products including reuse of concrete mattresses. The quality of these is very unpredictable but there are a number of uses they could be put to and markets are being explored.

It was mentioned that there is also 20,000 km of high quality flexi pipe made with stainless steel inner linings, plastic pipe and steel hose that are difficult to recycle but are in good condition

and could potentially be reused in other sectors. In addition, products like umbilicals that connect rigs to well heads and include copper pipe, hydraulic pipe, plastic pipes and other materials may also lend themselves to recovery for remanufacturing and reuse.

Whilst JLG are recovering some materials for reuse the majority (75%) of the material they handle is sold for scrap to Southern Spain and other overseas locations. It was uncovered that it is currently more expensive to move material to steel smelting plants in the UK than ship it to sites in Southern Spain.

A lot of the product they ship for smelting could potentially be reused if a market was found. We witnessed steel anchor chains being cut up and cabins being crushed, both of which have the potential to be reused by other industries and sectors.

A discussion was held about potential alternative uses for some of the materials that are being salvaged including using piles as tubular sections for bailey type bridges, using the mattresses in agricultural sheds for hard standing, and marketing pipe to the water industry for raw water and sewage supply for example.

The discussion was cursory but our reflection was that a detailed technical review and in depth market research would be beneficial to look at potential re-use of North Sea materials across to different sectors both within the UK and internationally.

#### 4. Findings from the industry workshop (15 January)

This industry workshop was attended by 15 people including representatives from Decom North Sea, Scottish Enterprise, Zero Waste Scotland, industry, consultancy groups and salvage companies.

Collectively the group had a lot of in-depth experience of the Oil and Gas industry and the issues around decommissioning.

It was explained that the current cost to install a medium sized rig is circa £2b, the cost to decommission the rig is about £200m and the value of the scrap is £2m. The recovered value is very low and the incentives therefore small. A more developed market for recovered materials could significantly increase the value at end of life but the markets are immature and within the Oil and Gas sector there is currently very little interest in using remanufactured or second hand systems.

##### Barriers

Workshop attendees identified many barriers that were preventing a transition towards a circular economy (they largely mirrored that barriers identified in the AMEC report) including:

- Liability associated with decommissioning and the transfer of ownership. The Oil and Gas companies are responsible for decommissioning and have little incentive to promote circularity. Their interest is to dispose of the rigs at the lowest possible cost.
- Salvage companies have the knowledge and skill to increase rates of recovery and reuse but can't afford to take on liability for the rigs.
- The prevailing attitude in the industry is to buy new and ensure that the minimum quality standards are met and risks are minimised.
- Decommissioning rigs is a necessary cost but not part of the Oil and Gas industries core interest or competence.
- Whilst the materials in rigs are understood and documented it appears to be very difficult to get access to the documentation that would allow salvage experts to provide potential

markets with the information they need and it is very difficult and costly to test, assure and warranty product for secondary markets.

- Little is known about the condition of the materials being decommissioned until they have been dismantled and shipped to the docks.
- Rigs are sitting in very challenging environments for many years and the materials can be contaminated, fatigued or damaged.
- There is no coordination or system across the industry about how a rig will be decommissioned, dismantled and recycled. It is therefore difficult to forward plan for recovery and reuse.
- Reuse and recovery is seen as a post decommissioning issue in which companies interested in recovery and reuse only get sight of products very late in the process.
- Oil and Gas rig operators are reported to have had bad experiences with reuse.
- The logistics (storage) and movement of components and materials is expensive.

Solutions exist around many of these problems but without support across industry it is very difficult to create momentum and inertia is considerable. The industry needs to establish some agreed protocols and targets for recovery and value creation.

##### Solutions to barriers

Workshop participants were invited to offer solutions to some of the barriers identified. The list produced was not comprehensive and more time is needed to explore solutions, however the ideas generated are worth highlighting:

- Some of the products arising from decommissioning are potentially very valuable.
- Whilst the quality of the materials is variable, some of the materials have either never been used (surplus to requirement) or were condemned because they didn't meet the very high specification required by the operator.
- There are a number of successful case studies that have demonstrated that there is potential to recover and reuse a range of components from Oil and Gas rigs.
- There is potential to set up a brokerage service to facilitate higher levels of recovery and reuse. A number of participants suggested that an eBay type service ("de-eBay") should be established. Others suggested that this was a highly technical market and sellers needed to know their market.
- New Technology could allow new markets to open up in Scotland. For example Allseas have developed a new single lift vessel that can remove, transport and load-in whole topside platforms. Shell UK is the first company to use this technology in the North Sea. The first contract has been awarded to recover 4 rigs and it offers salvage experts new opportunities to recover materials. (However there are no locations in Scotland that can receive these platforms).
- Scottish Enterprise and the Scottish Government have an interest in getting better value from decommissioned rigs as they are subsidising this work through tax incentives.
- Other sectors (car industry for example) are increasingly using reconditioned parts in new products successfully.
- As the cost of exploration increases and the cost of oil falls there is a drive to both extend the life of existing rigs and to reduce the cost to decommission rigs that are no longer viable.

## Business models

Participants were asked to suggest possible business models to support a transition to a circular economy.

Suggestions ranged from the development of a brokerage service that would develop markets for decommissioned materials to the use of carbon credits to promote higher levels of reuse.

It was felt a champion in the sector would help highlight the opportunity and promote higher value recovery and reuse but it was not obvious who this should be.

A suggestion was made that ownership should be transferred at the end of life from the oil and gas business to salvage experts, with the generator retaining liability. Salvage companies could be incentivised to maximise value from salvage with contracts to decommission being awarded on the basis of which company could realise the highest value.

Suggestions were made for storing material either on low cost government sites like former military bases or offshore in order to keep costs down.

Ultimately whilst the participants recognised the potential for circular economy, there was a deep sense within the room that shifting culture, habits and processes would be very difficult.

These concerns are not unusual. The RSA Great Recovery has experienced similar responses in other industries but have also seen significant shifts once these attitudes and approaches have been explored with the right networks in play. The drivers of change are typically:

- Growing awareness and concern among market leaders about the impacts of waste disposal
- Developing understanding of the potential value of component reuse as well as material value.
- An understanding about the economic, social and environmental benefits a shift towards a circular economy can deliver.
- A desire to demonstrate altruism through corporate social responsibility
- A willingness to innovate in business
- A growing body of evidence and case studies demonstrating potential for creating shared value from circular economy approaches
- Development of markets for new products
- Developing awareness among designers, engineers and specifiers about closed loop design and their role in finding solutions that support a circular economy.
- Engaging and incentivising the supply chain to engage and innovate in product design and service delivery for a circular economy.
- Developing policies, regulation and fiscal incentives that support a circular economy.
- Engaging and working with the waste industry to understand how current disposal systems and design impact on end of life disposal.

## 5. Recommendations

Our reflection based on this first phase of work (reports review, site visits and industry workshop) is that there is real potential to work with the Oil and Gas sector to promote circular economy practices.

The RSA Great Recovery recognises, and indeed is used to, addressing the many barriers that prevent adoption of the circular economy.

This sector appears to have many advantages that other sectors lack. They include:

- A growing decommissioning industry
- A steady and growing flow of high value materials and products
- Concentration of materials in a small number of ports that could become the centre for an industry founded on the reuse of these materials.
- Legislation that supports decommissioning and recycling with encouragement to move up the waste hierarchy towards reuse.
- The operators already have to cover the costs of decommissioning which are considerable and the steps required to transition towards a circular economy are relatively small.
- The potential value to the Scottish economy and job creation is high.
- Good precedents and case studies exist but they have not been scaled
- Materials are being cleaned during decommissioning to prevent pollution using nitrogen and other chemical treatment systems.
- Very high specification materials.

We believe that a 3 pronged approach is needed as follows:

- Engagement with operators to promote and lead a drive towards a circular economy
- Market development for end of life decommissioning
- Working on the beginning and end of life of a rig

These are summarised below.

### Approach 1: Engagement with operators

#### Leadership and culture

Many of the issues and barriers identified require the Oil and Gas companies and their supply chains to show leadership. The shift to circularity will need new approaches to the design, construction, installation, maintenance and decommissioning of the infrastructure being used to extract, distribute and process North Sea reserves of oil and gas.

Our understanding is that Decom North Sea is engaging the industry to create leadership that supports a transition towards a circular economy. It is clear that a shift in culture, skills, briefs, specifications and contracts, supply chain management is needed in order to promote circular economy practices and ensure that the sector and Scotland benefit from the opportunities identified in the AMEC report.

#### Raising awareness

We believe that high level discussions with industry leaders both within the sector but also in eminent bodies like the Royal Academy of Engineers, the Institute of Civil Engineers and other organisations is required to raise awareness about the importance of these issues. We have had informal discussions with some of these bodies and it is clear that there is an interest in exploring the potential for a circular economy.

**Strategic planning**

We also think that a strategic planning exercise is needed to systematically understand where the levers of change are and to work through these with industry leaders. We use a process called Key Success Factor Modelling (KSFM) to support a shift in the industry towards a circular economy.

**Background to KSFM**

Typical strategic planning models are built around a framework of:

- Vision Objectives Strategies Tactics (VOST) used with systems or organisations or
- Mission Objectives Strategies Tactics (MOST).

The basic approach is to establish the Vision or Mission, identify the Objectives, do a situational analysis, and devise strategies and tactics to deliver the strategies.

This approach works best for relatively simple projects, systems and organisations. When dealing with more complex circumstances it proves very difficult to map and to know that you have mapped all of the objectives. Moreover, in complex systems it is usually helpful to adopt a structured approach to the mapping of objectives which places them in hierarchical groups.

In practice the difficulties in mapping objectives in complex systems can and often do result in incomplete situational analysis and consequent gaps in the strategic plans. It is often the thing that you didn't think about in the planning stage that causes the problems later on.

Key Success Factor Modelling is a technique and associated tools that help with strategic planning in large and complex systems. It is a powerful way of dealing simply with complex systems like the ones of interest here. We use the term Key Success Factor instead of the term Objective, which we find causes much confusion with audiences because of its general use as aim or goal.

In the implementation of strategies and the development of individual initiatives KSFM is extremely helpful in identifying a comprehensive range of issues that need to be considered.

**Developing the KSFM**

The steps in the process are as follows:

- The Vision is defined as usual. In this case our Vision would be: transition towards a circular economy.
- The system influencing the Vision is mapped and represented in a series of sub systems. The definition of sub systems is essentially pragmatic but in principle it is helpful to map social, technical or organisational structures.
- Working through each of the sub-systems, key success factors are identified, mapped and grouped. The idea is to build structure into the model. This is typically done in a facilitated workshop after the consultant has seeded the model with generic key success factors. The benefit of this approach is that it reduces the workshop time and increases the chances that all relevant Key Success Factors will be identified.
- A model is created to enable participants to identify priorities to be addressed.
- Strategic plans are then developed to address the priority areas. This can be done in a bespoke fashion but it is possible and sometimes desirable to have

an additional step where generic solutions are linked to individual key success factors and we would look to do that here. The strategic plans are usually developed by or with significant input from the consultant.

**Approach 2: Market development for end of life decommissioning****Market potential**

From the discussions held with JLG and during the workshop we believe there is real potential to get much higher value from the materials that are being extracted during decommissioning than that is currently being recovered through traditional recycling.

We think there are a number of industrial sectors that would find the products very valuable. After the workshop we had discussions with contacts in the construction and infrastructure sectors (specifically water industry) to gauge their interest and they have expressed an interest.

Other sectors may also have an interest in the waste materials being generated including for example the agriculture and chemical industries (irrigation pipe) hard standing, valves and pumps etc.).

**A study into decommissioning markets**

We recommend that a study should be undertaken to explore this further. This would involve looking at the use of products and systems for close to original use as a priority (i.e. pipe as pipe or chain as chain) with lower value uses coming second (i.e. pipe as pile or structural steel in a bridge).

The RSA Great Recovery could undertake high-level technical reviews and a scoping exercise to look at potential markets. Support would be needed on possible reuse of large plant and equipment and it would also be valuable to engage a construction economist to review costs and potential value.

Such a study would look both at potential markets and the quality and quantity of materials arising and could cover issues like:

- Establishing an inventory of materials and products being generated
- Collating and collating data on materials
- Setting up forums in different sectors to look at reuse potential
- Setting up an eBay or similar site
- Developing a specification for a design and testing centre that can assess, grade and certify product quickly and effectively
- Carrying out a market assessments across a range of sectors

**Approach 3: Focusing on the beginning and end-of-life of a rig**

The third approach focuses on engage with clients, designers and specifiers to look at design interventions to support a circular economy principally focused on the early phases of commissioning but also to look at end of life solutions.



## Appendix 02

### Long list of opportunities for re-use

#### Engagement with designers and engineers

The RSA Great Recovery proposes to set up a much more extensive engagement process and campaign to work with designers and engineers in the Oil and Gas industry to look at possible design interventions that could support the transition towards a circular economy.

The teardown/ design up methodology would take place simultaneously with other work around the challenges set by current decom in order to build understanding in an iterative design process for current commissioning and future rig design.

#### Redesign of products and systems for a circular economy

We recommend that we set up a forum of leading Oil and Gas companies, suppliers, designers and decommissioning and salvage companies to identify a number of products that lend themselves to higher value recovery and reuse.

We would work with ZWS and ideally operators to set up design briefs and competitions around the redesign of these products and systems for a circular economy.

It would be important to engage key operators like BP who have expressed an interest in supporting this type of initiative. Supply-chain champions like BP are likely to have a greater impact in terms of supporting and encouraging circular design strategies than relying on the market benefits of recovery. Re-use and refurbishment offer up to a factor of 100 improvement in revenues over recycling. However, the supply-chain champion needs to take a clear and strong lead in demanding such solutions.

One interesting opportunity would be to run an annual competition within Scottish Universities to develop either:

- 1 New design approaches for sub-assemblies, parts and works that enhance longevity, reuse, refurbishment or recovery.
- 2 The development of secondary markets and business opportunities for decommissioned equipment.

These two approaches ensure a broad engagement by a number of university departments. It would also ensure that the benefits, constraints and opportunities of the circular economy are built into mainstream further education. These skills are in significant demand.

## 6. Conclusion and next steps

There is real potential to work with the Oil and Gas sector to promote circular economy practices. There is clearly lots of interest from industry, but the transition from linear to circular approaches will be a challenge. We have summarised our recommended 3-pronged approach in Section 5 above:

- (i) Engagement with operators
- (ii) Market development for end of life decommissioning
- (iii) Focusing on the beginning and end-of-life of a rig

This is a significant area to explore – much of which is outside of The RSA Great Recovery's current scope of work. We welcome the opportunity to discuss how to approach this workstream with ZWS – and where we can best focus our attention, avoiding overlap with the work of other organisations such as Decom North Sea.

Opp no.	Description	Sector	Use	
1	Tubular steel (from the jacket)	Water	Pipelines	
2		Landscaping	Sculptures	
3		Construction	Portal frames for industrial sheds	
4		Construction	Temporary works; props; walking beams	
5		Civils	Bridges - foundations or spanning	
6		Railway	Sleepers	
7		Construction	Scaffolds	
8		Construction	Piling	
9		Construction	Housing where there might be integrity issues	
10		Leisure	Leave in situ; hotels; diving	
11		Aquaculture	Fish farming	
12		Construction	Replace RSJ design with tubes	
13		Renewable energy	Support for concentrating solar power	
14	Steel Sections from the deck	Agriculture	Reusable steel stockist	
15		Civils	Bridge decking	
16		Civils	Linkspans	
17		Civils	Port structures	
18		Civils	Bridges	
19		Construction	large span storage sheds	
20		Renewable energy	Substation platform (floating)	
21		Marine construction	Recover good bits for re-use	
22		Construction	Re-use	
23		Pipelines	Construction	Structural components - piles
24	Water		Piping	
25	Emergency		Flood relief	
26	Water		Water wells	
27	Water		Water supply / irrigation / networks	
28	Construction		structural components - Portal frame elements	
29	Water		Third world water provision	
30	Water		Pressurised water pipe	
31	Water		Sewage	
32	Utilities		Distribution & protection	
33	Dredging		Pumping water/sand to shore	
34	Valves		Oil & Gas	Valve re-use
35			Water	Distribution systems
36			Energy	Distribution systems
37			Energy	District heating / CHP
38			Chemical	Valve re-use
39		Marine	Merchant shipping	

40	<b>Vessels and tanks</b>	Construction	Water attenuation tanks
41		Water	Water attenuation tanks
42		Various	Temporary accommodation
43		Leisure	Games
44		Various	Storage
45		Leisure	Capsules hotels
46		Emergency	Temporary accommodation
47		Whiskey	Distillery
48		Oil & Gas	Re-use for other oil business
49		Various	On-site storage of fossil fuel
50		Energy	Storage of biogas
51		Agriculture	Storage of biogas
52		Chemical	Onshore chemical storage
53		Water	Irrigation systems - harvesting & storage
54		<b>Compressors</b>	Oil & Gas
55	Various		Product re-use
56	Energy		Decentralised power grids
57	<b>Drilling packages</b>	Energy	Methane [hydrate?] drilling
58		Leisure	Tower for [leisure?]
59		Oil & Gas	Re-use
60		Emergency	Forest fire observation (and extinguish)
61		Construction	Piling
62		Construction	Borehole drill for GSHP networks
63		Water	Well drilling
64	Recycling	Cranes	
65	<b>Engines</b>	Various	Product re-use
66		Energy	Biomass {?} developing world
67		Agriculture	Irrigation systems - harvesting & storage
68		Energy	Small community energy supply
69		Relief	For deployment as required
70	<b>Generators</b>	Energy	Gas engines for Biomass / Biogas power / CHP
71		Construction	Back-up generators
72		Construction	Decentralised power grids, CHP, Community schemes
73		Oil & Gas	Re-use
74		Agriculture	Decentralised power grids
75		Various	Containerise, temporary generators
76		Relief	Containerise, temporary generators
77	<b>Hydraulic pumps</b>	Support vessels (?)	Power packs
78		Oil & Gas	Re-use
79		Utility	Re-use
80		Agriculture	Re-use

81	<b>Lifting Equipment</b>	Recycling	Cranes for material sorting
82		Construction	Re-use (Add tracks to make mobile)
83		Forestry	Re-use (Add tracks to make mobile)
84		Oil & Gas	Re-use
85		Timber yards	Re-use (Add tracks to make mobile)
86		Construction	Concrete laying at height - or long reach
87		Civils	Port structures
88		Aquaculture	Re-use
89	<b>Process equipment</b>	Landscaping	Sculptures
90		Oil & Gas	Refurb & re-use
91		Chemical	Refurb & re-use
92	<b>Cement pumps</b>	Construction	Large batching plants / large pours
93		Construction	High rise construction
94		Oil & Gas	Refurb & re-use
95		Construction	Grouting pre/post tensioned concrete
96		Civils	Ground stabilisation
97		Railway	re-use
98	<b>Water pumps</b>	Water	Water bore pumps in remote areas
99		Agriculture	Irrigation systems
100		Oil & Gas	Refurb & re-use
101		Relief	fresh water supplies
102		Construction	High pressure washing
103		Various	Re-use
104		Relief	Flood alleviation
105	<b>Winches</b>	Construction	Re-use
106		Railway	Re-use
107		Shipbuilding	Re-use
108		Oil & Gas	Re-use
109		Energy	Re-use
110		Leasing	refurb & rental
111		Marine construction	Re-use
112		Forestry	Skyline machines
113		Decom	Recovery & rehandling
114	<b>Accommodation block</b>	Construction	Integrated into new building projects (cf shipping containers)
115		Oil & Gas	Re-use
116		Construction	Temporary / flexible / mobile accommodation
117		Governance	Prison Blocks
118		Relief	Temporary / flexible / mobile accommodation
119		Governance	Refugee accommodation
120		Education	Temporary schools
121		Health	Community health centres
122		Leisure	Event management blocks
123		Renewable energy	Offshore wind - construction phase round 3 projects

124	<b>Anchor chains</b>	Construction	Anti-terrorist barriers	
125		Civils	Crash barriers	
126		Civils	Sea defences / breakwaters	
127		Oil & Gas	Re-use	
128		Aquaculture	Weighting	
129		marine	Test & re-use	
130		Renewable energy	Scour protection	
131		Renewable energy	Anchor for floating turbines (japan / Portugal / US)	
132		Construction	Dampeners in large buildings in seismic zones	
133		Shipping	Ship anchors	
134		Shipping	Dry docking restraints	
135		Construction	Deadweight against uplift	
136		Marine construction	Leave in situ; coral growth	
137		<b>Helideck</b>	Leisure	Platform for concert stages
138			Construction	Raft foundation
139			Construction	Ground floor / roof of a building
140	Various		Re-use	
141	Renewable energy		Offshore wind - offshore accommodation platform	
142	Renewable energy		Offshore wind - offshore substation platform	
143	<b>Concrete mattress</b>	Construction	Road base / subgrade	
144		Oil & Gas	Re-use	
145		Construction	Sea defences / breakwaters	
146		Civils	Footpath reinforcement (e.g. Ben Nevis)	
147		Renewable energy	Scour protection	
148		Civils	Break up - use as kerb stones	
149		Civils	Embankments	
150		Renewable energy	Protection of export cables	
151		Renewable energy	Inter-array cables (designed & retrofit)	
152		Civils	Erosion control - dams and river protection as part of bio-engineering solution	
153		Agriculture	Foundations for hardstanding	
154		Construction	Foundations for hardstanding	
155		Aggregate	Crush & recycle	
156		Civils	Ground stability	
157		Marine construction	Leave in situ; coral growth	
158		Construction	Piling mat	
159		Civils	Haul roads	
160	<b>Christmas tree</b>	Agriculture	Irrigation, flow control	
161		Relief	Flood alleviation	
162		Oil & Gas	Re-use	
163		Process industry	Re-use	
164		Shale gas	Re-use	
165		Water	Flow control in sewage / water	
166	Renewable energy	Hot water control in geothermal installations		

167	<b>Subsea Wellhead</b>	Oil & Gas	Re-use
168		Renewable energy	Water extraction
169	<b>Power cables</b>	Renewable energy	Grid connection
170		Oil & Gas	Re-use
171		Renewable energy	Connecting desert installations to communities
172		Renewable energy	decentralised feeds between engine and mains
173		Railway	HS2 power supply
174		Marine construction	Sea defences / breakwaters (cut to length)
175		<b>Platform piles</b>	Leisure
176	Civils		Viaducts
177	Civils		Bridges
178	Marine construction		Sea defences / breakwaters
179	<b>Floating production storage and offloading</b>	Renewable energy	Offices maintenance for offshore wind power
180		Oil & Gas	Re-use - can be re-used lots of times
181		Leisure	Remote (and nomadic) offshore hotel
182		Marine construction	Base for creation of flood defences
183		Marine construction	Base for creation of barrages
184		Marine construction	Base for creation of arctic research
185		Leisure	Remote (LOUD) nightclub
186		Leisure	Mobile brewery

# Appendix 03

## Opportunities for re-use by re-use category

### High level analysis of the ideas

#### By component

Component	No. of ideas	Component	No. of ideas
Tubular steel (from the jacket)	13	Process equipment	3
Steel Sections from the deck	9	Cement pumps	6
Pipelines	11	Water pumps	7
Valves	6	Winches	9
Vessels and tanks	14	Accommodation block	10
Compressors	3	Anchor chains	13
Drilling packages	8	Helideck	6
Engines	5	Concrete mattress	17
Generators	7	Christmas tree	7
Hydraulic pumps	4	Subsea wellhead	2
Lifting equipment	8	Power cables	6
Platform Piles	4	Floating production stage/offloading	8

#### By destination sector

Component	No. of ideas	Component	No. of ideas
Aggregate	1	Marine	2
Agriculture	8	Marine construction	9
Aquaculture	3	Oil & Gas	18
Chemical	3	Process industries	1
Civils	17	Railways	4
Construction	33	Recycling	3
Dredging	1	Relief	6
Education	1	Renewable energy	16
Emergency services	3	Shale gas	1
Energy	9	Shipping	3
Forestry	2	Support vessels	1
Governance	2	Timber	1
Health	1	Utilities	2
Landscaping	2	Various	8
Leasing	1	Water	13
Leisure	11		

#### By re-use class (note total is greater than 186 due to dual opportunities)

Reuse class	No. of ideas
Material re-use	2
Component re-use	53
Equipment re-use (in O&G)	27
Equipment re-use (in other industry)	117

# Appendix 04

## Opportunities for re-use by industry

### Summary of re-use ideas

#### Summary of component re-use ideas

Component	No. of ideas	Component	No. of ideas
Tubular steel (from the jacket)	10	Anchor chains	7
Steel Sections from the deck	9	Concrete mattress	3
Pipelines	11	Water pumps	6
Valves	5	Power cables	1
Platform Piles	1		

#### Component re-use by sector

Component	No. of ideas	Component	No. of ideas
Agriculture	2	Marine	1
Aquaculture	1	Marine construction	3
Chemical	1	Railways	1
Civils	9	Relief	2
Construction	14	Renewable energy	3
Dredging	1	Utilities	1
Emergency services	1	Various	1
Energy	2	Water	9
Landscaping	1		

#### Summary of equipment re-use ideas (outside of O&G industry)

Component	No. of ideas	Component	No. of ideas
Tubular steel (from the jacket)	4	Process equipment	2
Steel Sections from the deck	3	Cement pumps	5
Pipelines	0	Water pumps	6
Valves	0	Winches	7
Vessels and tanks	13	Accommodation block	9
Compressors	2	Anchor chains	4
Drilling packages	7	Helideck	6
Engines	5	Concrete mattress	10
Generators	6	Christmas tree	3
Hydraulic pumps	3	Subsea wellhead	0
Lifting equipment	7	Power cables	4
Platform Piles	2	Floating production stage/offloading	7

#### Equipment re-use ideas by sector

Component	No. of ideas	Component	No. of ideas
Agriculture	5	Leisure	10
Aquaculture	2	Marine	1
Chemical	2	Marine construction	4
Civils	10	Railways	3
Construction	20	Recycling	3
Education	1	Relief	5
Emergency services	2	Renewable energy	13
Energy	6	Shipping	3
Forestry	2	Support vessels	1
Governance	2	Timber	1
Health	1	Utilities	1
Landscaping	1	Various	12
Leasing	1	Water	5



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