

Decommissioning Challenge Fund: Circular Economy Strategy, Business Case and Impact Assessment

Objectives

The brief for this Decommissioning Challenge Fund project was two fold:

1. Firstly, to look at Circular Economy (CE) strategy, with a focus on Tayside Cities Region, for the reuse of assets and materials from oil and gas decommissioning into different industry sectors,
2. And secondly, to look at the business case and an impact assessment for a Circular Economy and Decommissioning Innovation Network, possible funding mechanisms and how it may work in practise.

This paper focuses and reports on Objective 1, the Circular Economy Strategy.

Contents

1) Circular Economy Strategy Overview.....	02
2) Methodology and Approach.....	02
3) Discussion and Results.....	04
a) Circular Economy terminology.....	04
b) Triple Helix Model of Innovation and the Stakeholder mapping.....	04
c) Challenges and Opportunities.....	05
i) Priority focus areas.....	05
ii) Summary of challenges and opportunities.....	05
d) Reuse opportunities in industry sectors.....	07
e) Projects.....	08
4) The Tayside Offering.....	09
5) Conclusion.....	10
Appendix 1 – Recommended reading.....	11
Appendix 2 – Acknowledgements.....	12

1. Circular Economy Strategy Overview

It is clear that the reuse and/or repurposing of decommissioned materials from the offshore North Sea oil and gas sector is a highly challenging area. The Circular Economy (CE) is economically driven - reuse/repurposing must add value before a company will progress this as an economically viable option. In other words, there needs to be sufficient value against scrap/recycling.

At present, brokers and industry stakeholders advise that demand for reused items is poor, and as such, most reuse/repurposing success is currently derived from the sale of unused and/or surplus inventory.

Much has been written and discussed on this topic (see Recommended Reading, page 11), but in order to move this forward from much discussion to action, the viability of reuse (economic and otherwise) must be properly assessed, with appropriate actions identified by key experienced stakeholders, and of course appropriate funding made available in order to ensure optimal delivery of these actions.

This project set out to identify the key stakeholders from industry, academia and government for the UK Continental Shelf decommissioning sector, with a focus on Tayside and Scotland, who have an active interest in CE for decom, assess who is currently doing what with whom, any relevant activities in development or delivery, thus aiming to identify and minimise duplication of effort. Specific reuse/repurposing opportunities and their destination were also identified. A ranking was applied which showed the varying levels of challenge facing reuse/repurposing of decommissioned materials from the oil and gas sector into other industry sectors, and the subsequent difficulty in analysing added value vs added cost. It has been recommended that future activity on economic viability be linked with, or led by, already ongoing project activity (see Projects, page 8).

Four priority areas were identified as being critical for moving reuse/repurposing of North Sea oil and gas decom materials from being ad-hoc to common place activity. These are (1) "D-Bay" digital inventory system, (2) Incentivisation contracting models, (3) Regulatory intervention and (4) Standardisation of equipment. Recommendations, including who to engage with, have been made for each (see Challenges and Opportunities, page 4).

The potential development of an Innovation Network (as per Objective 2) would ideally be resourced by key stakeholders identified during the mapping exercise. The delivery of these objectives build upon the Tay Cities Growth Deal proposition, and align with the vision for Tayside to be a Resource Management Hub (see The Tayside Offering, page 9).

2. Methodology and Approach

The project commenced with an inception meeting between the client project partners (Oil and Gas Innovation Centre (OGIC), Dundecom, Zero Waste Scotland (ZWS), Abertay University and University of Dundee) and the contractor (Ironside Farrar (IF) with Karen Seath Solutions (KSS) and EKOS) to confirm collective understanding of the project objectives, scope, activities and timescales. KSS indicated she would provide weekly updates via a project Tracker document.

Further project meetings were held through March and April.

KSS met/spoke with each of the client partners to gather their knowledge, ideas and ensure alignment.

Key stakeholders from industry, academia and government, were identified using the extensive knowledge, experience and insight of the decommissioning sector and its incumbent network, as gained by KSS

throughout her career in academia, industry, tenure with Decom North Sea and subsequent projects. This included accessing:

- (1) Already well established relationships with academic, industry and government organisations,
- (2) Previous capability and reuse of decommissioned materials studies, the publication of many of which were overseen and/or directly managed by KSS,
- (3) Knowledge and insights gained by KSS during discussions for, and recent completion of, (i) the Scottish Enterprise (in collaboration with ZWS) Decommissioning Circular Economy study, which had a particular focus on reuse of decommissioned equipment/materials coming onshore and opportunities for the supply chain in Scotland, (ii) the Decommissioning Facility (Phase 1), Energy Park Fife: Supply Chain and Market Engagement study, for Ironside Farrar, Fife Council and Scottish Enterprise, and (iii) the strategic brief to inform supply chain capability for oil and gas decommissioning for Fife Council.

The extensive experience of the project and contracting partners was also accessed and utilised.

From the above exercise, over 80 organisations were identified, ranging from offshore marine logistics contractors, to onshore dismantlement companies, environmental and waste management companies, original equipment manufacturers (OEMs), operators, universities, associated institutes, trade and membership bodies, regulators, government and other funding organisations.

Following this initial assessment, the identified organisations were engaged directly via meetings or phone calls to better understand their roles, remit and relevant activities, including projects currently in development or delivery, knowledge/experience of and lessons learned with regards to challenges and opportunities for reuse/repurposing of decom materials, and any subsequent onward use into other industry sectors.

All information, along with full company details and recommended actions for follow up, were recorded via two “Tracker” Microsoft Excel documents – the “Stakeholder Mapping” Tracker and the “CE Strategy” Tracker, both of which accompany this report.

Due to the short time frame of the project, it was deemed beneficial for a workshop to be organised with as many of the key stakeholders as possible to help in the gathering of information and identification of key routes and partners going forward. A total of 45 stakeholders attended a short focused session, which was held immediately prior to the launch of Forth & Tay Decommissioning.

Specific information captured in this report and the Tracker documents include:

1. Priority focus areas with recommendations
2. Summary of insights, challenges and opportunities, with industry sector overview
3. Stakeholder mapping identifying key organisations across academia, industry and government which are actively involved with CE (see Stakeholder Mapping Excel document, Sheet 1)
4. Stakeholder mapping across the 12 industry sectors identified in the RSA ZWS 2015 Great Recovery Report (see Stakeholder Mapping Excel document, Sheet 2)
5. Operator mapping (see Stakeholder Mapping Excel document, Sheet 3)
6. Workshop feedback (see Stakeholder Mapping Excel document, Sheet 4)
7. Reuse/repurposing opportunities in the 12 industry sectors (see CE Strategy Excel document, Sheet 2)
8. CE related projects in development and delivery (see CE Strategy Excel document, Sheet 3)
9. The Tayside offering (from Forth & Tay Decommissioning), and supply chain capability in Tayside (see CE Strategy Excel document, Sheet 4).

3. Discussion and Results

a) Circular Economy terminology

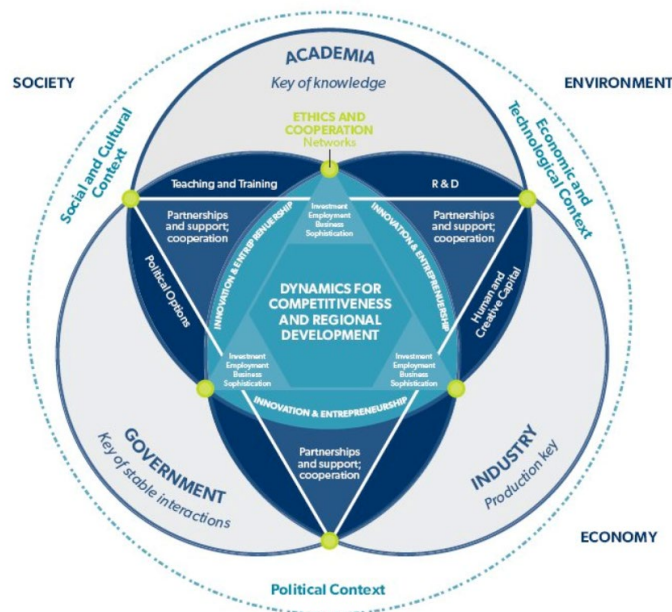
It has been noted that the word “reuse” is used widely and often incorrectly, when what is actually being referred to is reconditioning, refurbishing, remanufacture or recycling.

As such, for ease and to ensure a common understanding, the current definitions as agreed by ZWS, SEPA and related national institutes/bodies are captured below.

Activity	Definition
Reuse	Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived
Repair	Corrects specified faults in a product and gives a warranty less than the newly manufactured product that may not cover the entire product
Reconditioning/ Refurbishing	Returns a product to a satisfactory working condition that may be inferior to the original specification and a gives a warranty less than the newly manufactured product.
Remanufacture	Returns a used product to at least as new performance specification and gives the resultant product a warranty that is at least equal to that of a newly manufactured equivalent
Recycle	Recovers materials for the original purpose or a new purpose

b) Triple Helix Model of Innovation and the Stakeholder Mapping

For innovation to happen efficiently and effectively, academia, industry and government must work together. This interaction is often referred to as the Triple Helix Model of Innovation and forms the basis of this study. A visual example is displayed below.



Farinha and Ferreira’s Triple Helix Triangulation Model

The comprehensive and detailed stakeholder mapping (see Stakeholder Mapping Excel doc, Sheet 1) of over 80 organisations from across all three areas of the triple helix, provides visibility of who is doing what with whom, with regards to CE for oil & gas decommissioning. Through this process relevant projects in development or in delivery are identified, which highlights potential partners for future projects and/or where to avoid duplication of effort. An improved understanding of the viability of reuse/repurposing of decom materials is also gained.

Additionally, the mapping provides visibility of the resources available to a Circular Economy and Decommissioning Innovation Network (as covered by Objective 2).

A series of recommended actions for follow up are captured for the client team to progress.

c) Challenges and Opportunities

A number of good reports have been produced in collaboration with ZWS, Scottish Enterprise, Decom North Sea and other organisations (see Recommended Reading, page 10), which identify a range of challenges and opportunities for reuse/repurposing of decom materials in O&G decom. The challenges are cited time and again as reasons for *not* reusing, refurbishing, reconditioning.

Through the consultation and mapping process, as well as the workshop, these challenges and opportunities were validated and further explored, with potential solutions and priority focus areas identified. The aim being to move this topic forward from much discussion to action.

i. Priority focus areas

Priority areas with recommended actions are captured below.

a) "D-Bay" inventory/brokerage system

- A North Sea basin wide, nationalised and digitised inventory system, catering for both supply and demand of reuse/repurposed items, ideally linked with case history and accreditation information, is cited as key.
- Seven systems were identified through the course of the project, which in the interests of not wishing to duplicate efforts, could potentially be utilised/extrapolated to house a "D-Bay" (see Projects).
Conduct a pilot study to (1) identify the scope and requirements for a "D-Bay", and (2)
- **Recommendations:** assess the existing systems for their potential to be used as such.

b) Contracting models

- Incentivisation of the operator and having a ready, visible supply chain in place are key to optimising and realising reuse options.
- An example of a successful model is the "Pain and Gain Share" model (as used by Veolia), between the asset owner and onshore decom yard/waste contractor.
- **Recommendations:** (1) Engage with Veolia regarding the "Pain & Gain Share" model lessons learned, (2) Engage with Jim Christie, Decide Wisely, who has authored/brokered incentivisation contracts between operators and contractors.

c) Regulatory intervention

- Reuse is currently aspirational. Regulatory intervention is seen as key to changing behaviours and moving CE forward, e.g. tax incentives, legal requirements, incentivisation.
Engage with the regulatory bodies involved with decom (OGA, BEIS, SEPA etc.), ideally
- **Recommendations:** through the SEPA led Regulatory Hub, and explore options for regulatory incentivisation through to legislation.

d) Standardisation of equipment

- North Sea equipment is generally bespoke. There is a need to drive standardisation of equipment, which would ultimately facilitate reuse/repurposing (as seen in the US).
 - (1) Engage/consult with regulatory bodies (E.g. OGA, BEIS), trade organisations (OGUK, DNS - for access to their membership), and industry in the first instance to explore the
- **Recommendations:** feasibility of standardising equipment in the North Sea,
 - (2) Conduct a feasibility study for standardisation of equipment in the North Sea, which includes a workshop with key stakeholders.

ii. Summary of Challenges and Opportunities

The key challenges and opportunities are cited as:

Challenges: Lack of demand, obsolescence of equipment, recertification, lack of service history, operator mindset, liabilities, contracting models, late sight of inventory, short onshore timescales, transportation costs, storage costs.

Opportunities: Design for decommissioning, digitised/nationalised inventory, early operator engagement, incentivisation, "pain and gain share" contracting models, standardisation of equipment, regulatory intervention.

A detailed summary of challenges and opportunities gathered during the course of this project are highlighted below. Full details can be viewed in CE Strategy Excel doc, Sheet 2 .

Contracting models/Incentivisation

Incentivisation of the operator is key to facilitating reuse, e.g. pain and gain share contract model. Operators see demolition yards, onshore waste contractors and recyclers as responsible for identifying reuse opportunities. A ready, visible and in place supply chain is key.

Demand:

At present there is insufficient demand for reuse/repurposed materials, the 2nd hand market is poor. It is currently not a sustainable market for many companies.

Design for decommissioning

Assets and equipment must be designed for decommissioning. This would create more reuse opportunities. "Protect tomorrow today".

Early operator engagement/Inventory

Earlier inventories, pre Cessation of Production (CoP), and early site of inventory are required for reuse to be viable. Early engagement with the operator is key. Demand for reuse could be driven by increasing visibility of inventory materials through use of a national North Sea (NS) wide "D-bay" system.

Economic/Business models

Reuse/repurposing of decom materials is very challenging to achieve under current business/economic models in the North Sea. Models tend to be led by an Exploration & Production (E&P) mentality, which is not effective for decom. A systemised and business performance approach, rather than an engineering or accounting approach, could progress CE. CE is economically driven. Reuse/repurposing must add value before a company will progress this as a viable option. There needs to be sufficient value against scrap. New entrants to the North Sea may create different economic models which are more conducive to a productive CE.

Operator mindset/behaviours

Operators will consider facilitation of reuse/repurposing, BUT economics, time delays, effort required and reputational risk will impact decision making. Time on board a platform to identify reuse items is not permitted at the expense of production time (if pre CoP), or helicopter/bed space if either are needed for operations/decom activity. Operators impose tight frames on decom projects (both on and offshore) to keep costs down, which in some instances come with financial penalties if timing is not met. Operators feel they are currently meeting requirements for recycling, so why should they do more? CE has value to the decom yards, brokers and waste management contractors, not to the operator.

OEMs/History/Standardisation:

The Original Equipment Manufacturers (OEMs) main aim is to produce new equipment - it is not in their economic interests to refurbish, sell used items or spare parts. Obsolescence therefore becomes a major challenge for older equipment.

North Sea inventory/equipment is generally bespoke and not standardised, rendering reuse challenging. There is a need to drive standardised equipment and tooling across the North Sea, for example, through regulatory intervention, e.g. as per in the US.

Most reuse/repurposing success is currently derived from the sale of unused/surplus inventory. A good service history is critical, and items are worth more with certification.

Regulatory intervention:

Reuse is currently aspirational as there is no regulatory driver.

Regulatory intervention is seen by many as key to moving CE forward, e.g. tax incentives, legal requirements. A change in behaviour will only happen through government mandate or incentivisation.

A standardised approach across all the regulatory bodies responsible for decom requirements is required. SEPA have funding to establish a Decom Regulatory Hub, with the aim of de-siloing the regulatory bodies and regulations.

Two case studies can be viewed in the Stakeholder Mapping Excel document, Sheet 1, for Veolia and Westlord Associates, where key experiences, lessons learned and key projects are cited. It is recommended that both parties are engaged directly as their capabilities and knowledge could add immense value to the effort of moving this topic forward.

d) Reuse Opportunities in Industry Sectors

Through discussions with key industry stakeholders and brokers, we are aware of specific opportunities for reuse/ repurposing of decom materials which are currently being realised in a range of industry sectors.

Full sight of all examples can be viewed in the CE Strategy Excel doc, Sheet 4. Prioritisation of industry sectors by added value vs added cost is difficult within both the short time frame of this project and with limited information, for example, actual monetary value is challenging to ascertain due to information on sale value generally being commercial in confidence. Each identified reuse/repurposing example was therefore ranked 1 to 5 according to ease/difficulty of selling and high/low £ value, where 1 equates to easy to sell and high value, and 5 equates to difficult to sell and low value. This ranking was achieved through discussion and validation with brokers, OEMs and other industry stakeholders, and shows the varying levels of challenge facing reuse/repurposing of decommissioned materials from the oil and gas sector into other industry sectors.

Opportunities certainly exist across a range of sectors, including energy/utilities/power generation, construction/civil engineering, marine/shipping, transport, agriculture, aquaculture and oil and gas itself, but when one averages the ranked items no sector clearly stands out.

Through this process and other discussions, however, it is clear that niche business models exist for the resale of generators, engines and tubulars, where there are ready global markets, especially in the utilities, power generation and construction sectors respectively. Most other opportunities are however ad-hoc or “one-off” opportunities, with many items being difficult to sell due to age, size, condition and/or poor demand.

Much discussion and research has been carried out on the reuse of steel in the construction sector, including that by the Construction Scotland Innovation Centre (CSIC), Decom North Sea (DNS) and the Steel Construction Institute (SCI). The latter reports that 70% of steel is currently exported for recycling, and that reusing would retain more economic activity within the UK. The economic case for widespread reuse today is

however marginal. The SCI concluded that under current UK economic and legislative conditions, other than some small-scale and niche markets, and certain project specific circumstances, mainstream structural steel reuse is not viable. The lack of economic incentive is compounded by the lack of any legislative drivers, and as such, in the short-term the situation in the UK is unlikely to change dramatically. The SCI do however emphasise that they believe planning for a circular economy future is the smart and responsible thing for the steel sector to do, and that designing for deconstruction (and reuse) is central to this concept. On this topic, the CSIC, with ZWS, DNS and Alex West (consultant Westlord Associates) are currently shaping a design competition for the reuse of steel, and Pluton Engineering (Tom Hay) is involved with some interesting concepts on designing for reuse of steel and utilisation of a different marketing approach.

Some repurposing opportunities exist in the aquaculture sector such as for anchor chain as net weights, or wire rope for nets, but through discussions with the Scottish Aquaculture Innovation Centre it is clear that current operating models and available capital expenditure for fish farming (many orders of magnitude lower than CAPEX for oil and gas) would mitigate against further aquaculture uses. This being said, old onshore yards and structures can make good logistical bases for fish farms. The Scottish Association for Marine Science (SAMS) are also researching ideas for seaweed farming, and have some interesting ideas with regards to utilisation of platforms to house anaerobic digestors to convert the seaweed into biogas.

Reuse of oil and gas materials back into the oil and gas sector is not common place for the North Sea due to the uncertainty of risk. Items can be sold, dependant on age and condition to less regulated global markets, such as Africa and the Middle East, as well as for specific projects. Some operators will reuse refurbished equipment internally amongst their own assets. It is thought that new entrants into the North Sea may create different economic models, which may in turn lead towards a more productive circular economy.

The Aerospace sector is often cited as an example where reuse, remanufacture and repair is common place. This however is due to a different operating model, where components have to be recertified every 5 years. This also means that the value of components and their resale can be more readily determined.

e) Projects

During stakeholder discussions a range of projects, either in development or delivery, related to circular economy and the reuse/repurposing of decommissioned materials, were identified. Full details can be viewed in the CE Strategy Excel document, Sheet 3.

A key priority area identified by stakeholders was the need for a “D-Bay” system, i.e. an open access, artificial intelligence (AI), digitised, North Sea basin-wide inventory system, which would ensure clear early visibility is given to decommissioned assets, equipment, materials. During the course of this project, seven systems were identified which could potentially be developed to house such a system (see Table below).

Organisation(s)	Description / Additional notes	Funding/Partners	Development or Delivery
DecomMarket (D3/ Soltan)	DecomMarket - Tool to identify a Technically Possible Supply Chain for removal + inventory identification	Self (in discussions with other organisations)	Development
EC-OG / Xodus	Data capture system for service history capture		Development
Louiseville Consulting	Decommissioning supply chain mapping tool (DSCM)	Self	Development
SEA	Legacy Locker - Repository for reuse/ refurb equipment and spares	Self	Development
Sharecat	UK Hub Digital Data Exchange - National online source of technical equipment information	OGTC, Shell, Chevron, 3 tier 1's (including Aker Solutions)	Delivery
Targe Environmental	AI (Artificial Intelligence) cross sector inventory software	OGIC, RGU	Development
WasteVu	WasteVu - Digital track and trace inventory tool by image recognition	OGTC, Shell	Development

In the interests of not duplicating effort, a pilot project is recommended to assess the feasibility/viability of developing (one of) these systems for such a purpose.

In the previous section we discussed the difficulty in assessing the economic viability of CE according to added value vs added cost. Professor Bitici at Heriot-Watt University and Alex West (Consultant, Westlord Associates) are proposing to model CE for decommissioning and assess the economic viability and behaviours needed to enable change, thus potentially finding a route to making CE a viable option for projects. As above, in the interests of not duplicating effort within this project with effort already in progress, a further key recommendation is to engage with Heriot Watt University and Westlord Associates on this topic.

With regards to remanufacturing projects (the return of a used product to at least as new performance specification), a number of companies (several hundred) are working with/through the Scottish Institute for Remanufacture (SIR) (which is 50% ZWS funded) and the Advanced Forming Research Centre (AFRC), both hosted by Strathclyde University. SIR and the AFRC are working with the oil and gas sector to develop remanufacturing processes which can be applied to oil and gas relevant components and systems. Further engagement with both organisations is recommended to explore opportunities for future projects.

For awareness, a number of commercial online equipment/auction sites through which equipment can be sold/bought were also identified. Three examples are cited in the Excel document.

4. The Tayside Offering

This project is part of a wider strategic plan to maximise the potential economic benefits of offshore decommissioning to the Tay Cities region, and maximise opportunities to build supply chain capabilities and new technologies in the context of the wider Scottish and UK industry.

A ready, visible and in-place supply chain was identified as one of the key routes to facilitating a circular economy for decommissioning. In Tayside, this is being realised through the newly established Forth & Tay Decommissioning, which is an informal network of companies forming a strategically positioned hub at the Port of Dundee. This alliance is a non-legal entity between seven founding partners and six supporting partners, managing all steps of the decommissioning process, from well plug and abandonment (P&A), to removal, to onshore recycling and monitoring. This is seen as the start of the journey towards Tayside realising its vision to support the circular economy by creating a Centre of Excellence for Resource Management, which would look at reuse, repurposing, remanufacture and recycling of metal and non-metal resources, including hazardous materials. It is felt by focusing in on Resource Management this offers a differentiated and achievable ambition, and as such builds upon the Tay Cities Growth Deal proposition.

Partners and capabilities can be viewed in the table opposite.

Concept	Capability	Partner Companies
Decommissioning/Resource Management Hub with focus on Reuse, Repurposing, Recycling	(1) Well abandonment	Well-Safe Solutions
	(2) Offshore removal	ODS, COES, AF Offshore UK
	(3) Port facility	Forth Ports
	(4) Onshore deconstruction/dismantlement	AF Offshore UK, John Lawrie
	(5) OEM, base for reuse/refurb of equipment	Motive Fabrication, Texo Group, ABB
	(6) Waste Management/NORM handling	Augean NS Services
	(7) Recycling/reprocessing of materials	John Lawrie, Robertsons Metals Recycling, Binn Group
	(8) Logistics	(Ferguson Transport at Methil), Forth Ports, John Lawrie
	(9) Broker, asset recovery, crane/heavy lifting	OM Heavy Lift, Oilmac

5. Conclusion

This project, and a number of which have gone before, highlight the challenges around the reuse and repurposing of decommissioned oil and gas materials, and their subsequent journey into other industry sectors. It is clear this is a topic which currently sits in the “too difficult” box for many within industry, academia and government.

Through taking the Triple Helix Model of Innovation approach and mapping those parties actively involved with this topic across all three areas, capturing their experiences, lessons learned and their subsequent thinking on priority focus areas, as well as projects in the planning, development or delivery phase, and the current reality of reuse opportunities, it is hoped that this project will provide the base requirements and information needed to move this topic from (what is often viewed as) an idealistic, socially responsible, ad hoc approach to one which is part of everyday process and commonly executed.

What is clear is that it will take concerted collaborative effort from all three areas of industry, academia and government to ensure this topic moves from being much discussed and thought about, to that of one based in reality. Action on the outlined priority focus areas and the formation of an Innovation Network, populated by key stakeholders as identified by the mapping process, is seen as integral to making this reality happen.

Appendix 1. Recommended Reading

Aquaculture: Subsea Engineering Opportunity: International Market Insights Report Series, *Scottish Enterprise (2018)*

Business Outlook 2018, *Oil & Gas UK (2018)*

Circular Economy in the Oil and Gas Sector, *Decom North Sea and Zero Waste Scotland (2015)*

Circular Economy Opportunities Tayside, *Zero Waste Scotland (2019)*

Circular Economy Scotland, *Green Alliance, SCDI (Scottish Council for Development and Industry) (2015)*

Completing the Circle: Creating effective UK markets for recovered resources, *Green Alliance (For the Circular Economy Task Force) (2018)*

Decommissioned Steel Reuse in Construction, *Decom North Sea, Zero Waste Scotland and AMEC Foster Wheeler (2016)*

Decommissioning Circular Economy Study: Oil and Gas Decommissioning, Opportunities to Increase Circular Economy Activity, *Scottish Enterprise and Karen Seath Solutions (2018)*

Decommissioning Facility (Phase 1), Energy Park Fife: Supply Chain and Market Engagement, *Karen Seath Solutions (for Ironside Farrar, Fife Council and Scottish Enterprise) (2018)*

Supply Chain and Market Engagement Decommissioning Insight 2018, *Oil & Gas UK (2018)*

Decommissioning in the North Sea: Review of Decommissioning Capacity, *Decom North Sea, Scottish Enterprise and ARUP (2014)*

Economic Report 2018, *Oil & Gas UK (2018)*

Fife Supply Chain Capability for Oil & Gas Decommissioning: Strategic Insight, *Karen Seath Solutions (2017)*

Mattress Solutions, *Decom North Sea, Zero Waste Scotland and Jee (2015)*

North Sea Oil and Gas Rig Decommissioning & Re-use Opportunity Report, *RSA Great Recovery and Zero Waste Scotland (2015)*

Offshore Floating Asset Decommissioning Market Study, *Westwood Global Energy Group (2018)*

Platform Removal Methods, Inventory Characterisation and Reuse Solutions, *Decom North Sea, Zero Waste Scotland and ABB (2015)*

Resource Resilient UK: A report from the Circular Economy Task Force, *Green Alliance (2013)*

Status Capacity and Capability of North Sea Decommissioning Facilities, *CRF Consultants (For GMB Union) (2016)*

Tay City Region Deal: Heads of Terms Agreement, *Scottish Government, Tay Cities, UK Government (2018)*

The Future of the Oil and Gas Industry, *House of Commons Scottish Affairs Committee (2018)*

The Management of Decommissioned Materials in a Circular Economy, *Decom North Sea, Zero Waste Scotland and SLR (2015)*

The Social Benefits of a circular economy: Lessons from the UK, *Green Alliance (2015)*

UKCS Decommissioning Supply Chain Capacity Report, *Decom North Sea, Scottish Enterprise, Oil & Gas Authority and Accenture (2018)*

Appendix 2. Acknowledgements

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Binn Group	George Buchanan, John Ferguson
CessCon	Lee Hanlon
COES	Norman McLellan
Control Valve Solutions	Mick Beavers
D3 Consulting / DecomMarket	Martin Bjerregaard
Decide Wisely	Jim Christie
Dales Marine	Michael Milne
DeepTek	Moya Crawford
EC-OG	Robert Cowman
Ecosse IP	Dorothy Burke
Ferguson Transport	Alasdair Ferguson, Kevin Ferguson
BHGE	Andy Livingston
Glacier	Duncan McDougal
Hargreaves	Ian Slater
Hawk Enviro	Richard Newman
John Lawrie	Ray Grant
Louisville Consulting	Dave Ingles
MVV	Mimi Mwasame
Neptune Marine Services	Kevin Stephen
Oceaneering	Steven Cowie
ODS	Lee Johnson
Oilfield Machinery (Oilmac)	Alex Fyfe
Parsons Peebles	Jordan Ferguson
PD&MS	Derek Thoms
Petrofac	David Hutchison
Pluton Engineering	Tom Hay
Ramco Tubular	Zak Fleming
Rever Offshore	Vikki Thom
Robertsons Recycling	Sandra Robertson
Score Group	Bill Urquhart
Scotoil Services / TradeBe	Chris Joliffe
Scotvalve	Scott Gauld
Systems Engineering & Assessment	Matt Blair
Targe Environmental	Liam Manderson
Tayside Diesel Engineering	Eric Kydd
Texo Group	Colin Pearce

UTROV
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WasteVu
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Regulatory / Funded / Membership bodies

Aberdeen & Grampian Chamber of Commerce
Construction Scotland Innovation Centre (CSIC)
Decom North Sea (DNS)
Dundecom
Dundee & Angus Chamber of Commerce
Dundee City Council
Green Alliance
International Association of Drilling Contractors (IADC)
Marine Scotland
National Decommissioning Centre (NDC)
National Manufacturing Institute Scotland (NMIS)
National Subsea Research Initiative (NSRI)
Oil & Gas UK
Oil & Gas Authority (OGA)
Oil & Gas Innovation Centre (OGIC)
The Oil & Gas Technology Centre (OGTC)
Opportunity North East (ONE)
Offshore Renewables Energy (ORE) Catapult
Scottish Aquaculture Innovation Centre (SAIC)
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