Institution: University of Aberdeen

Unit of Assessment: 12 (Engineering)

Title of case study: [IC4] Informing decommissioning strategies in the UK

Period when the underpinning research was undertaken: 2009-present

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g., job title):	Period(s) employed by submitting HEI:
Richard Neilson	Professor in Engineering	10/1985 to date
Alireza Maheri	Senior Lecturer in Engineering	09/2016 - to date
John Paterson	Professor in Law	01/2004 - to date
Kate Gormley	Research Fellow in Biological Sciences	05/2016 - to date
Alex Kemp	Professor in Petroleum Economics	01/1966 - to date

Period when the claimed impact occurred: 2018-2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Interdisciplinary research led by the University of Aberdeen has supported the oil and gas sector in addressing its technological, environmental, legislative and financial challenges around decommissioning. In 2018, this research led to the University securing investment of GBP12,700,000 from the Oil and Gas Technology Centre (now OGTC) to establish the National Decommissioning Centre (NDC). The NDC has been identified by the UK government as core to the trialling, adoption and deployment of new technology and data solutions for decommissioning projects. It is also influencing taxation policies and attitudes towards long-term liability, improving standards and assessing environmental impacts. All of which will contribute to the overall aim of reducing the estimated UK decommissioning cost of GBP50,000,000,000

2. Underpinning research (indicative maximum 500 words)

The University of Aberdeen spearheads a novel and inter-disciplinary approach to this decommissioning research, led and hosted by the School of Engineering. Working closely with industry and regulators, researchers lead four main themes, which deliver research into the technological, environmental, legislative and economic aspects of decommissioning.

Theme 1: Technology development

The School of Engineering focuses on technology development and process optimisation for the sustainable and safe decommissioning of structures, examples are as follows:

Working with industry to develop novel tools for decommissioning

In 2009, an industry consortium of BP, Shell and Conoco Phillips, with input from the Industry Technology Facilitator, enabled Professor Neilson and his team to prove the concept of using lasers for underwater cutting. It also enabled them to develop a cost-effective laser-based device capable of cutting structural steel underwater while being small enough to enable cutting in confined spaces, an option not yet available to industry [P1]. In 2012, the team successfully demonstrated that solid-state fibre lasers of 4kW power were capable of cutting steel at speeds competitive to techniques available commercially [1], and that the system could be deployed in a single standard 20ft container. Claxton Engineering, a subsea supply chain company, is currently partnered with the University in developing the technology with

over GBP500,000 of support from OGTC, ensuring industry uptake and deployment.

Informing decision-making for offshore windfarm decommissioning in the UK and EU

Since 2018, Dr Maheri, has led the University's partnership in the EU INTERREG (EU interregional cooperation programme) "DecomTools" research project, coordinated by Emden-Leer [P2]. This research has, and is, addressing the gap posed by the end of lifecycles of offshore windfarms by producing a decision support system (DSS). DSS allows optimal decommissioning scenarios to be defined and evaluated against CRE (Cost, Risk and Environmental impact) measures to determine the best delivery option. This has been a key challenge to the renewables industry [2].

Theme 2: Environmental assessment

Developing new methods for environmental assessments of biofouling

Dr Kate Gormley, from the School of Biological Sciences has over 12 years' experience working directly with industry operators and consultancies. In 2016, Gormley delivered a scoping project [P3], to test the use of automated image analysis (open access) software on marine biofouling of offshore platforms [P3]. The project assessed whether this software, originally developed for coral reef surveys, could be used to assess biofouling in the UK Continental Shelf (UKCS). Using survey footage provided by a leading oil and gas company, Gormley found that the use of automated software provided a more efficient and consistent approach to biofouling analysis [3]. This provides the basis for a convenient tool to assess the extent of biofouling on decommissioning platforms as required by the regulator.

Theme 3: Legal

Residual Liability and its implications for the decommissioning sector

In 2018, Professor John Paterson (Law) published work examining the issue of residual liability, an increasingly pressing issue within the decommissioning sector. Paterson examined the liability remaining for any installation left wholly or partially in place under exemption from the general position described by the Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) Decision 93/8 [4]. Importantly, his work demonstrated that any residual liability would remain with the owners in perpetuity – this would mean that any claims for compensation from their parties arising from damage caused by any remains would be a matter for the owners and affected parties – as covered by general law. As such, under both English and Scots law, Paterson has crucially highlighted implications for decommissioning sectors, specifically that the owner of such an installation would be liable in damages for loss arising from negligence in circumstances where a duty of care is owed to the other party.

Theme 4: Economics

Re-use of facilities in the UKCS to reduce costs associated with decommissioning

Professor Alex Kemp (Business School) specialises in the economics of the oil and gas sector with particular emphasis on the UK Continental Shelf (UKCS). In 2006, Kemp published a seminal research paper [P5, 5], which provided an in-depth analysis of the economic effects of various instruments, which could be deployed to procure financial security for decommissioning seen from the viewpoint of both investors and Government. The instruments included Letters of Credit, Surety Bonds and Decommissioning Trust Funds. Reacting to the growing interest in CO_2 capture and storage, and the realisation that the related economics was very challenging, Kemp later produced a detailed study based on a collection hub at St. Fergus followed by reuse of redundant trunk oil pipelines and sequestration of the CO_2 in depleted oil and gas fields in the Central North Sea/ Outer Moray Firth regions. This work demonstrated how reuse of oil-related assets plus adoption of the cluster concept could substantially reduce the costs of decommissioning, which has been a challenge to date [6].

The National Decommissioning Centre (NDC), established in 2019 and co-funded by the University and OGTC [P1], is a research hub led and hosted by the School of Engineering, which enables the University of Aberdeen to pull together research findings from across these various disciplines, providing research-led evidence for industry and policy makers. The aim

of NDC-associated research is to reduce the cost of decommissioning whilst supporting economic development.

3. References to the research (indicative maximum of six references)

[1] **Neilson R. D**., Gledhill P., Farran, A. (2013). Final Report to BP, Shell and Conoco Phillips on the ITF Novel Underwater Cutting Project Phase 1a.

[2] **Maheri A**, Jalili, S. (2020). A decision Support System for Decommissioning of Offshore Windfarms: The Data Platform. EFEA.

[3] **Gormley, K**., McLellan, F., McCabe, C., Hinton, C., Ferris, J., Kline, D. I. & Scott, B., Automated Image Analysis of Offshore Infrastructure Marine Biofouling (2018), Journal of Marine Science and Engineering 6, 1, 2.

[4] **Paterson, P**., "Decommissioning of Offshore Oil and Gas Installations", in Gordon, Paterson and Usenmez (eds), UK Oil and Gas Law: Current Practice and Emerging Trends (3rd ed.) Edinburgh University Press, 2018, Vol. 1, pp391-434

[5] **Kemp A**. "Financial Liability for Decommissioning in the UKCS: the Comparative Effects of LOCs, Surety Bonds and Trust Funds", University of Aberdeen, Department of Economics, North Sea Study Occasional Paper, No.103, October 2006, pp.1-150.

[6] **Kemp A**. "Economic and Tax Issues Relating to Decommissioning in the UKCS: the 2016 Perspective", University of Aberdeen, Department of Economics, North Sea Study Occasional Paper, No.137, July 2016, pp.1-63.

Grants

[P1] Neilson R. D., National Decommissioning Centre, Oil And Gas Technology Centre Ltd, 1/9/2018-30/9/26, (GBP12,700,000)

[P2] Neilson R. D., Novel Underwater Cutting – Phases 1 (GBP 239,139) and 1A, funded by BP, Shell and Conoco Phillips through the Industry Technology Facilitator, 1/12/2009-31/12/2012 (Phase 1 GBP239,139) (Phase 1A, GBP 104,937)

[P3] Maheri 'Eco-innovative concepts for the end of offshore wind energy farms lifecycle (DecomTools) 'EU-InterReg, 2018-2022 (GBP240,000)

[P4] Gormley Automation of Marine Growth Analysis for Decommissioning Offshore Installations', NERC Oil & Gas Decommissioning Innovation, 2016-2017 (GBP71,349)

[P5] Kemp 'North Sea Oil and Gas Economics', funded by group of oil companies. 01/06-12/06 (GBP105,727.40)

4. Details of the impact (indicative maximum 750 words)

The Decommissioning sector is in a state of flux, with challenges such as cost and lack of capacity and the drive towards net-zero. Through the NDC and significant investment from industry and the Scottish and UK governments, Aberdeen research is enhancing capability in the sector, through establishment of the centre itself, as well as setting the decommissioning agenda and delivering industry-led programmes to address key gaps in the sector as follows:

Establishment of the National Decommissioning Centre (NDC)
Led by Professor Neilson as Director, the NDC aims to reduce the cost of decommissioning through innovative, inter-disciplinary and industry-led work programmes. The centre is funded through investment of GBP12,700,000 (GBP2,313,523 spent by 2020) from OGTC as part of the Aberdeen City Regional Deal with the University co-funding GBP5,800,000. The NDC attracts matched funding from project partners, industry and other investors demonstrating its crucial role for the sector.

Setting the Decommissioning Technology Agenda
The NDC is cited within Action 3 of the Government Response to the Call for Evidence on

"Strengthening the UK's offshore oil and gas decommissioning industry", published in December 2020 [S1]. This states:

"*The Decommissioning Task Force, Oil and Gas Technology Centre (OGTC) and* ***National Decommissioning Centre (NDC)*** *to develop a plan with regulators and industry to encourage the trialling, adoption and deployment of new technology and data solutions for decommissioning projects on the UKCS, especially where there is scope for cost reduction."*

To support this, the Scottish Government's Decommissioning Challenge Fund has provided GBP4,000,000 in the NDC to underpin technology development for the industry including:

- GBP2,360,000 allocated for a test facility allowing developers to qualify new, cost saving, well plugging and abandonment (P&A) technologies before being deployed offshore. The test facility will help deliver the 50% cost reduction target for well P&A set by the OGA in 2017.
- GBP500,000 contribution to a GBP1,320,000 real-time, real-physics marine simulator supplied by the Offshore Simulator Centre, allowing virtual deployment of new decommissioning technologies before their use and facilitating basin-wide decision making.
- GBP550,000 towards a 15kW laser for trials of the underwater laser-cutting tool being developed by the NDC in conjunction with Claxton and OGTC, as noted in section 2.

Setting the Decommissioning Environmental and Monitoring Agenda

The NDC is driving the agenda around environmental and monitoring issues related to decommissioning evidenced through two examples of industrial partnerships:

Working with Chevron, three PhD students and a Post-Doc across Engineering and SBS are developing techniques to assess longevity and fate of structures left in place, acoustics to monitor fish and quantitative risk assessment of mercury in aquatic environments. While Chevron no longer operates in the North Sea, the projects are relevant to their assets in Thailand and Australia as well as to other operators in the North Sea. A Senior Staff Environmental Scientist at Chevron, said: "*For Chevron, the partnership was timely and offers a range of advantages including the opportunity to tap into world class research into relevant topics (longevity of structures, metals speciation/bioavailability and fish tracking/monitoring techniques and technologies), specific to our business need and at an established centre*" [S2].

Working with Shell, a team is assessing post decommissioning monitoring and producing guidelines for the sector. The guidance will help Shell and other operators and inform the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) on cost effective monitoring, for structural collapse and environmental protection [S3].

Complementary studies with groups in Chulalongkorn University, Thailand and Curtin University, Australia are looking at the safe handling, removal and disposal of contaminants during decommissioning. In the collaboration with Chulalongkorn University and United Waste Management Co., Ltd, staff from Engineering developed a research roadmap reflecting industry needs in the area of waste management from offshore decommissioning, specifically the mitigation of mercury contamination [S6, 7].

Implementation of Decision-making Tools for Windfarm Decommissioning

The first version of the Decommissioning Decision Support System (DSS) was developed by Maheri as part of the INTERREG project (WP4), designed in line with the stakeholders' requirements for example, service providers, windfarm owners and port authorities, to ensure its impact on the industry. The tool is now available to stakeholders and employs detailed cost models developed by Maheri's team. Cost models take into account a vast number of influencing factors to ensure accurate estimation and address a capability gap of current assessment tools. Its unique design allows generating undocumented and innovative removal scenarios with the purpose of defining reutilisation and repowering scenarios, hence further reduction of Cost, Reliability and Environmental impact (CRE) measures [S5].

Informing environmental assessments of biofouling in the UKCS

Gormley delivered a scoping study to test the use of an automated image analysis software on images of marine growth, collected from offshore platforms on the UKCS, which was adopted by Marine Scotland Science. The software performed well for classification of the primary fouling species:

> "*The results and outcomes of Dr Gormley's image analysis project were used to develop the SAMS & Marine Scotland Science NorthSea 3D project, which was awarded funding [GBP700,000] under the NERC INSITE [INfluence of man-made Structures In The Ecosystem] Phase 2 programme. The aim of the NorthSea 3D project is to estimate the mass and volume of marine growth on offshore energy structures using standard underwater imagery. The mass and volume estimates will support engineering decisions and assessments of the environmental consequences of deploying and decommissioning offshore structures."* [S4]

As part of the NorthSea 3D project, the Scottish Association for Marine Scotland (SAMS) are now training machine-learning algorithms to automatically identify North Sea epifaunal species within video footage. By combining auto-ID with 3D imaging techniques, rapid generation of accurate, high-resolution automated faunal identification has enabled the development of a new monitoring tool for industry.

Influencing attitudes on Liability in Perpetuity

Paterson's work on Liability in Perpetuity [4] has been reported widely through the media, influencing debate and attitudes amongst the industry, regulators and Government. Set up by the Oil and Gas Authority, the Decommissioning Task Force (now the Decommissioning and Re-purposing Taskforce work stream on Liability in perpetuity) is tasked with reviewing the issues and assess if there is a more cost-efficient way to manage post decommissioning liability. Paterson is an invited member of the group and the research is referenced to inform the review of the current position "*Residual liability remains with the Owners in perpetuity"* [S8].

Aligning the Maximising Economic Recovery (MER) UK Strategy with Net Zero targets

In May 2020, the Oil and Gas Authority (OGA) opened consultation on proposals to revise the MER UK Strategy [S9]. Kemp submitted a memorandum, which supported OGA's proposal that key objectives should be modified to include commitment of the UK and Scottish Governments to Net Zero emissions and encouragement of investment in projects, which advance the Energy Transition. In December 2020, the OGA published their response to the consultation, taking into account Kemp's proposals, including commitment of the UK and Scottish Governments to Net Zero emissions and encouragement of investment in projects which advance the Energy Transition [S9].

5. Sources to corroborate the impact (indicative maximum of 10 references)

[S1] Government Response to the Call for Evidence (2020), https://bit.ly/38YOCPq, see p8 and p11
[S2] Supporting statement from Chevron
[S3] Supporting statement from Shell
[S4] Project Testimony from Offshore Energy Environmental Advice Group Leader, Marine Scotland Science, Scottish Government
[S5] Testimonial statement from Business Development Manager at REBO NV (INTERREG)
[S6] Letter of support from Chief Production Manager, United Waste Management (UWM) a subsidiary of Unithai Shipyard and Engineering Co., Ltd. (UTSE)
[S7] Supporting statement from Thailand Oil and Gas regulator
[S8] Scoping paper for the Decommissioning Taskforce and workshops on Liability in Perpetuity
[S9] OGA consultation: details of memorandum; OGA response to the Call for Evidence (2020) and acknowledgement of University of Aberdeen contribution