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DECOMMISSIONING OFFSHORE OIL AND GAS PLATFORMS: IS THE RIGS-TO-REEFS PROGRAM A MORE SUSTAINABLE ALTERNATIVE?

Eduardo G. Pereira*, Opeyemi Omotuyi, Aaron Koenck***, Pedi Obani****, Meagan Gopaulsingh* & Shaniah Mohammed***

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ABSTRACT

One of the most conspicuous global challenges in the 21st century is global warming and climate change, attributable to long-term shifts in global temperatures and weather patterns due to persistent greenhouse gases emissions in the atmosphere. Fossil fuels production had been identified severally as a major culprit in the continous release of greenhouse gases in the atmosphere. Hence, there have been agitations from various stakeholder groups including international organizations, national governments, civil societies, etc., seeking ways to address these challenges. These agitations have led to the evolution of the global energy transition agenda, whereby the world is making a shift from fossil fuels production and consumption to cleaner and more sustainable energy sources. Such energy transition implies that fossil fuels facilities, including oil and gas facilities, are fast approaching the end of their productive life. The question therefore is, what becomes of these facilities at the end of their productive life? This invariably calls for an increased attention to oil and gas decommissioning. This is because proper and sustainable decommissioning of oil and gas facilities is significant for environmental protection and sustainable development. Hence, this paper evaluates the various options available for oil and gas decommissioning so as to identify their adverse environmental impacts, and other challenges posed by their implementation. The paper further evaluates the emerging rigs-to-reefs program, and proposes this program as a more sustainable decommissioning option for oil and gas platforms.

Keywords: Oil and gas decommissioning, offshore platforms, climate change, rigs-to-reefs, sustainable development.

1. INTRODUCTION

There have been persistent long-term shifts in temperatures and weather patterns, resulting in global warming over the last decade. Accordingly, these issues have attracted global attention. This is more so as the impacts of such climate change are becoming more intense ranging from droughts and flooding, to rising sea levels and biodiversity loss, among others. The phenomenon has been attributed to human activities, especially the burning of fossil fuels, leading to the emission of various greenhouse gases into the atmosphere.[1] In response, national governments worldwide are individually and collectively pledging to take actions to slow down global warming. The United Nations, as part of its objectives to maintain international cooperation in achieving a better and more sustainable future for the world, launched the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. This was the first global treaty to expressly address global warming and climate change by establishing an annual forum referred to as 'Conference of the Parties' (COP) to aid international discussions on relevant actions needed to stabilize the concentration of greenhouse gases in the atmosphere.[2] One of the recent and most significant outputs of the UNFCCC is the Paris Agreement which requires all State-parties to set emissions-reduction targets to limit the global average temperature to below 1.5° C compared to preindustrial levels. It further aims for global net-zero emissions and a carbon-neutral society.[3]

With fossil fuel burning being cited as the primary cause of climate change, the implementation of the Paris Agreement has far-reaching implications for fossil fuel industries including coal,

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* University of São Paulo
** Federal University Oye-Ekiti
*** Attorney, Hall Maines Lugrin
****Associate Prof, University of Bradford

1 United Nations, 'What is Climate Change?' <https://www.un.org/en/climatecha nge /what-is-climate-change>

2 Lindsay Maizland, 'Global Climate Agreements: Successes and Failures' (Council on Foreign Relations, 4 November 2022) <https://www.cfr.org/backgrounder/ paris-global-climate-change-agreements> accessed 27 December 2022.

3 The United Nations Framework Convention on Climate Change, "Paris Agree ment" <https://unfccc.int/sites/default/files/english_paris_agreement.pdf> access ed 27 December 2022.

and oil and gas industries. This has occasioned the global energy transition agenda, which emphasizes a shift from fossil-based energy production and consumption to renewable energy systems such as wind and solar, which might speed up the number of redundant or stranded fossil fuel facilities and resources in the years to come. In addition, oil and gas fields have their life cycle and several facilities have been producing for decades. It is therefore reasonable to conclude that many oil and gas facilities are fast approaching the end of their productive lives. With more than 12,000 offshore oil and gas platforms reported worldwide in 2021,[4] the big question is what becomes of these structures when they turn defunct? This realization has resulted in an increased attention on offshore decommissioning options. This is because proper and sustainable decommissioning of oil and gas facilities is significant for environmental protection and sustainable development.[5] Even though decommissioning occurs at the end of an operational cycle, the proposed procedure is usually included as an integral aspect of applications for operation licenses due to the complexity of removal, exorbitant costs, environmental impact and regulatory requirements.

Rig-to-reef programs were introduced to address the adverse environmental impact, including the carbon footprint, and high costs associated with the complete removal of offshore facilities. Such programs use existing materials to introduce intentional reefs for environmental betterment.[6] The United States offers other jurisdictions vital lessons regarding the implementation of a rig-to-reef program through its robust legislative framework and empirical research to determine whether ideal conditions exist for rig conversion. Currently, the rig-to-reef alternative to complete removal of offshore platforms is not yet a common practice

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4 Isabelle Gerretsen, 'The New Use for Abandoned Oil Rigs' (BBC, 27 January 2021) <https://www.bbc.com/future/article/20210126-the-richest-human-made-marine-habitats-in-the-world> accessed 25 July 2022.

5 Ibrahim Khalidov, Konstantin Milovidov and AnzorSoltakhanov, "Decommissio ning of Oil and Gas Assets: Industrial and Environmental Security Management, International Experience and Russian Practice" (2021) 7(7) Helyon 1; Li Jia et al., "Decommissioning in Petroleum Industry: Current Status, Future Trends and Policy Advices" (2019) IOP Conference Series: Earth and Environmen -tal Science 237.

6 Dolly Jørgensen, "OSPAR'S Exclusion Of Rigs-To-Reefs In The North Sea" (2012) 58 Ocean & Coastal Management 57.

amongst other jurisdictions. However, it is hoped that this will change soon, as artificial reefs appear to be a viable option to achieving sustainable decommissioning of offshore oil and gas platforms. Hence, this paper examines the significance and relevance of reefing as a sustainable decommissioning option for offshore oil and gas facilities and the legal implications from a sustainable development perspective.

The paper is divided into five sections. Section one provides a brief background and introduction to the study. Section two discusses the concept of oil and gas decommissioning, including what it entails, and the implications of various decommissioning options. Section three evaluates the possibility of more sustainable oil and gas decommissioning options particularly, the rigs-to-reefs program. Section four presents relevant and feasible recommendations for ensuring sustainable decommissioning of oil and gas platforms globally. Section five concludes the paper with a summary of the study.

2. DECOMMISSIONING

Decommissioning entails officially taking equipment or other industrial facilities out of use or withdrawal of equipment or other industrial facilities from service.[7] With regard to the oil and gas industry, it refers to the end-of-life processes for oil and gas infrastructure.[8] In other words, it is the final stage of an oil and gas project in that, viable fuel has been processed, project facilities removed or reused, and the environment restored to its original state.[9] Hence, decommissioning is a costly and complex process involving planning, gaining approval and implementing the removal, disposal or reuse of an installation when it has neared the

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7 See the Cambridge English Dictionary <https://dictionary.cambridge.org/dictionary/english/decommission> accessed 27 December 2022; and Merriam Webster English Dictionary <https://www.merriam-webster.com/dictionary/decommission> accessed 27 December 2022.

8 Sean van Elden, Jessica J. Meeuwig, Richard J. Hobbs, and Jan M. Hemmi, 'Offshore Oil and Gas Platforms as Novel Ecosystems: A Global Perspective' (2019) 6 Frontiers in Marine Science 1.

9 Jess Melbourne-Thomas et al., "Decommissioning Research Needs for Offshore Oil and Gas Infrastructure in Australia" (2021) 8 Frontiers in Marine Science 1.

end of its operational cycle.[10] This process also entails the removal of debris from the seabed and supervising the structures or parts which remain post-removal. The environmental remediation or restoration aspect focuses on developing and implementing strategies to reverse negative environmental impacts and return the site to a reasonable similar or better position as it was before the oil and gas development.

The removal processes can be achieved through either traditional decommissioning or a more 'sustainable approach'.[11] Thus, operators are faced with the choice of leaving in situ, full removal, partial removal, or alternative solutions such as rig-to-reef programmes, often considered a 'sustainable decommissioning' option.[12] This choice depends on factors such as what is technically practicable and beneficial from an environmental, economic and societal standpoint. Therefore, this discourse examines whether leaving offshore installations *in situ* provides a more beneficial decommissioning option or worsens the ecological environment and instead requires complete removal.[13] Such choices can be made in line with the circular economy model, which seeks to move a company away from the linear "take, make, and dispose" system.[14] While recycling materials to make new materials is most commonly associated with the circular economy,[15] partially removing an offshore facility can promote the circular economy by reusing the offshore jacket to encourage sea life.

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[10] Dominic D. Ahiaga-Dagbui et al., "Costing And Technological Challenges Of Offshore Oil And Gas Decommissioning In The U.K. North Sea" (2017) 143(7) Journal of Construction Engineering and Management 1.

[11] MohdHairilMohd et al., 'Reefing Viability Index For Rigs-To-Reefs (R2R) In Malaysia' (2020) The Scientific World Journal 1.

[12] Scott P. Burton, 'Offshore Platform Sustainable Decommissioning - "Rigs To Reefs" Goes Global' (PipelineLaw, 2022) <https://www.pipelinelaw.com/2020/01/30/offshore-platform-sustainable-decommissioning-rigs-to-reefs-goes-global/> accessed 25 July 2022.

[13] Sylvia Jagerroos and Paul R Krause, "Rigs-To-Reef; Impact Or Enhancement On Marine Biodiversity" (2016) 6 Journal of Ecosystem & Ecography 1.

[14] Andrew Gray 'How Aramco's Circular Economy Thinking Can Help the Planet' (Aramco Americas, 19 August 2021) https://americas.aramco.com/en/ magazine/elements/2021/circular-economy accessed 5 March 2023.

[15] Lin, 'How Can Old Oil Platforms Contribute to the Circular Economy?' (Energy Review, 7 September 2021) https://www.energyreviewmena.com/article/news-interviews/item/1378-how-can-old-oil-platforms-contribute-to-the-circular-economy accessed 5 March 2023.

2.1 Implications of Decommissioning Options for Offshore Oil and Gas Facilities

The decommissioning process consists of a complex chain of activities involving multiple stakeholders and considering relevant economic, environmental, health and safety, technical and social issues.[16] Given that decommissioning involves considerable expenses and the risk of environmental harm if done improperly, the issue of partial or complete removal versus leaving platforms *in situ* remains a controversial issue.[17] For instance, the decommissioning cost for offshore platforms globally is estimated at US$42billion by 2024.[18] Similarly, the approximate total cost of removal in the North Sea alone is estimated at between US$107billion by 2040.[19] It is noteworthy that the accuracy of decommissioning costs is uncertain, as approximate estimates are extremely volatile, causing the actual costs to be sometimes 40% in excess of the initial budget.[20] These fluctuating prices can influence an operator's overall decision on whether or not to decommission, and the decommissioning option to utilize. Nonetheless, costs might decrease as technologies improve and more experience is gained. Thus, operators in areas with rigs-to-reefs programs have another option in reduce decommissioning costs and liability when this option is more economically feasible. Three main options for decommissioning (complete removal, partial removal, and leaving *in situ*) are explored next.

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16 Dominic D. Ahiaga-Dagbui et al., 'Costing And Technological Challenges Of Offshore Oil And Gas Decommissioning In The U.K. North Sea' (2017) 143 Journal of Construction Engineering and Management 1.

17 Rachel E. Salcido, "Enduring Optimism: Examining the Rig-to-Reef Bargain" (2005) 32(4) Ecology Law Quarterly 863.

18 Rystadenergy, "Global Oil & Gas Decommissioning Costs To Total $42 Billion Through 2024, Dominated By UK North Sea" (2022) https://www.rystadenergy.com/newsevents/news/press-releases/global-oil-gas-decommissioning-costs-to-total -$42-billion-through-2024-dominated-by-uk-north-sea accessed 27 July 2022.

19 Genesis and DECC (Department of Energy and Climate Change), "The real costs of decommissioning" (2015) <http://decomnorthsea.com/news/the-real-costs-ofdecommissioning> accessed 12 May 2016.

20 Dominic D. Ahiaga-Dagbui et al., 'Costing And Technological Challenges Of Offshore Oil And Gas Decommissioning In The U.K. North Sea' (2017) 143 Journal of Construction Engineering and Management 1.

2.1.1 Option 1 -Complete Removal

Article 5(5) of the United Nations Convention on the Continental Shelf 1958 (Geneva Convention) provides that '…Any installations which are abandoned or disused must be entirely removed'.[21] The complete removal process entails that oil wells are correctly plugged, the structures are dismantled, and the scrapped materials are moved to various destinations. This requires deciding whether to use explosives instead of non-explosive cutting methods to sever the platform jacket and conductors, and whether to remove or leave shell mounds.[22] Even though explosives are cheaper, they are harmful as they disturb wildlife. With the growing sense of environmental awareness and sustainability, the goal is to either re-use or recycle some of the material. This is mainly achieved through reclaiming and re-using steel since it is the most prominent material in making the structures. However, this option is the least sustainable as the amount of re-use after decommissioning the platform remains minimal, with some research estimating the figure as a mere one percent (1%) of the structure's weight.[23] Such low figures certainly do not contribute to the attractiveness of reusing or recycling, especially when one considers that the savings from reusing such material is limited and does not significantly contribute to the enormous costs associated with the complete removal of the platforms. For example, researchers in California have compared the energy usage and resultant air emissions from total and partial removals to understand the potential for a rig-to-reef program better.[24] The research concluded that completely removing a particular deepwater platform jacket and topsides creates approximately 6.75

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21 The Geneva Convention on the Continental Shelf 1958, art 5(5).

22 Max Henrion, "A multi attribute decision analysis for decommissioning offshore oil and gas platforms" (2015) Integrated Environmental Assessment and Management 1551.

23 Maxine Perella, 'Can North Sea Installations be recycled or decommissioned sustainably?' The Guardian on Sustainable Development (2014)

24 Peter Cantle and Brock Bernstein, "Air emissions associated with decommissioning California's offshore oil and gas platforms" (2015) 11 Integrated Environmental Assessment and Management 564.

times more air pollution than partial removal down to 85 feet below the sea surface.[25]

Complete removal also poses another challenge: the prospect of massive oil rig graveyards whereby scrapped materials from dismantled oil rigs are illegally dumped. To promote sustainability, there must be viable avenues in which the metals of the scrapped rig platforms can be reused instead of being dumped unlawfully in marked-up areas of Global South countries, for instance.

In addition, the complete removal of offshore facilities may prove challenging in several other ways, particularly concerning cost implications.[26] The cost of complete removal differs depending on the type of infrastructure. Factors to be considered include the weight, height, age, and location of the platform, as well as the climate and governing regulations implemented by the host government. The estimated average decommissioning cost ranges depending on the platform's height and water depth. For example, costs vary from $50,000 to $400,000 for short platforms (20 to 100 feet) in shallow waters to $15 million for tall platforms (200 to 400 feet) in deep waters in 2005.[27] Another crucial factor that affects the economic viability of complete removal is lifting technologies and their availability. Multiple methods exist to remove offshore platforms, including single lift, piece-small, and reverse installation. Although single lifts are the more efficient choice, the latter options are adopted due to the lack of heavy-lift vessels to conduct this procedure. Notwithstanding, the cost of all these methods accumulate to pay for the manpower required. [28]

Furthermore, some platforms, like those in the North Sea, were not created with decommissioning at the forefront of production, posing innumerable challenges for deep-water removals. The deconstruction of these giant installations necessitates using heavy

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25 Ibid.

26 Proserv Offshore,"Decommissioning cost update for removing Pacific OCS Region offshore oil and gas facilities" (2009) Houston, Texas: Minerals Management Service Report MMS M09 P C00024.

27 Rachel E. Salcido, "Enduring Optimism: Examining the Rig-to-Reef Bargain" (2005) 32(4) Ecology Law Quaterly 863.

28 Ibid.

machinery such as cranes and barges.[29] Some parts, such as the platform's jacket, are costly to remove and cannot be reused or recycled leaving the jacket to be disposed on land.[30] Thus, the removal of these challenging and redundant structures negatively affects overall costs except where derogations have been granted.

Moreover, even though returning the seabed to its original state appears to be the most environmentally sound option, available evidence suggests otherwise.[31] Studies show that disused oil and gas platforms emit harmful greenhouse gas methane leading to an increased carbon footprint.[32] Paradoxically, the process of removing such abandoned installations have been found to further increase greenhouse gases such as carbon dioxide and nitrogen oxide concurrently.[33] For instance, the United States Environmental Protection Agency stated that 276,472 tonnes of methane equivalent to 9.5 million metric tons of carbon dioxide is emitted as a result of disused wells per year.[34] Resultantly, the plugging and abandoning of wells can aid in the reduction of methane production, restoration of agricultural use and CO2 sequestration.[35]

Also, complete removal involves using diesel-powered equipment for extended periods during all stages, for dismantling, lifting and transporting parts of the disused structure, causing high levels of

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29 Ibid.

30 Ibid.

31 Peter I Macreadie, Ashley M Fowler and David J Booth, "Rigs-To-Reefs: Will The Deep Sea Benefit From Artificial Habitat?" (2011) 9 Frontiers in Ecology and the Environment 1.

32 Mary Kang, Christian, S.; Celia, M. A.; Mauzerall, D. L.; Bill, M.; Miller, A. R.; Chen, Y.; Conrad, M. E.; Darrah, T. H.; Jackson, R. B. 'Identification and Characterization of High Methane-Emitting Abandoned Oil and Gas Wells' (2016) 113 (48) Proceedings of the National Academy of Sciences, U. S. A. 13636–13641.

33 Brock B Bernstein et al., 'Evaluating alternatives for decommissioning California's oil and gas platforms' (2015) 11(4) Integrated Environmental Assessment Management 537.

34 Intergovernmental Panel on Climate Change, 'Climate Change 2013: The Physical Science Basis' Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; Stocker T.F., Qin D., Plattner G.K., Tignor M., Allen S.K., Boschung J., Nauels A., Xia Y., Bex V., Midgley P.M. (eds), Cambridge University Press: Cambridge, UK and New York, NY, 2013; 372. (2013).

35 Haden Chomphosy William et al., "Ecosystem Services Benefits from the Restoration of Non-Producing US Oil and Gas Lands" (2021) 4 Nature Sustainability 547–554.

CO_2 emissions and other pollutants. Removing structures, pipelines and drill cuttings can therefore generate adverse environmental effects due to increased energy use and air emissions.[36] This was evident with the estimates for the complete removal of the Harmony offshore platform in California. The removal of the platform produced substantial amounts of air emissions including 29,400 tons of CO_2, 600 tons of NOX and 21 tons of fine particulates.[37] Further, the complete removal of Harmony's jacket, as opposed to partial removal resulted in 6.75 times more air pollution.[38]

In addition, offshore platforms constitute artificial reefs during their lifespan, supporting various marine habitats. When these platforms are decommissioned by complete removal from the sea, these artificial reefs are destroyed, resulting in the potential loss of important habitats.[39] Seemingly therefore, a clear seabed derived from complete removal methods does not equate to reduced decommissioning costs or lower carbon footprint, and is not more ecologically beneficial.

2.1.2 Option 2 - Partial Removal

The requirement to completely remove oil and gas facilities proved troublesome in many ways. Platform owners and operators were concerned about the huge expense of complete removal.[40] There was also the issue that uprooting such an enormous structure from beneath the water will be quite difficult for engineers and more so, for the surrounding marine wildlife whose safety will be jeopardized when the infrastructure is lifted from the water. Consequently, the United Nations Convention on the Law of the Sea 1982 (UNCLOS) altered the decommissioning

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36 Paul Ekins, Robin Vanner and James Firebrace, 'Decommissioning Of Offshore Oil and Gas Facilities: A Comparative Assessment Of Different Scenarios' (2006) 79 Journal of Environmental Management.

37 Peter Cantle and Brock Bernstein,'Air emissions associated with decommissioning California's offshore oil and gas platforms.' (2015) 11 Integrated Environmental Assessment and Management 564–571.

38 Ibid.

39 Sean van Elden et al., "Offshore Oil and Gas Platforms as Novel Ecosystems: A Global Perspective" op cit.

40 Proserv Offshore,'Decommissioning cost update for removing Pacific OCS Region offshore oil and gas facilities' Houston (TX): Minerals Management Service report MMS M09 P C00024 (2009).

provision by allowing the partial removal of offshore installations instead of total removal, provided generally accepted international standards are considered.[41]

Partial removal involves the removal of offshore platforms from the surface to about 26m depth, thereby leaving the submerged jacket portion of platforms in the sea.[42] Since removal expenses are congruent to platform size, partial removal allows for lower costs regarding structure removal and project planning.[43] An illustrative cost scenario indicated that the cost of completely removing some 27 offshore platforms totals US$1.09 billion,[44] while the partial removal of the same platforms approximates to US$478 million.[45] Moreover, using smaller heavy lifting vessels and shorter project duration may allow for lower levels of air emissions. Also, while complete removal is likely to eliminate most existing fish biomass and secondary production, an average of 80% of fish biomass and 86% of secondary fish production is likely to be retained after a partial removal.[46] This is because the submerged jackets left *in situ* serve as artificial reefs under rigs-to-reefs

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41 Article 60 (3) of the United Nations Convention on the Law of the Sea 1982 provides that: 'Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, considering any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed'.

42 Jeremy T Claisse et al., "Impacts from Partial Removal of Decommissioned Oil and Gas Platforms on Fish Biomass and Production on the Remaining Platform Structure and Surrounding Shell Mounds" (2015) 10(9) PLoS ONE; Ann Scarborough Bull and Milton S Love, "Worldwide Oil and Gas Platform Decommissioning: A Review of Practices and Reefing Options" (2019) 168 Ocean & Coastal Management 274-306.

43 Andrew Bressler and Brock B Bernstein, 'A Costing Model For Offshore Deco mmissioning In California' (2015) 11 Integrated Environmental Assessment and Management.

44 Proserv Offshore, 2010. Decommissioning cost update for removing Pacific OCS Region offshore oil and gas facilities. Minerals Management Service report MMS M09PC00024 (2010).

45 Ibid.

46 Jeremy T Claisse et al., "Impacts from Partial Removal of Decommissioned Oil and Gas Platforms on Fish Biomass and Production on the Remaining Platform Structure and Surrounding Shell Mounds" op cit.

programs, providing several means of survival for various marine species.[47]

The partial removal of offshore platforms is seen as a middle ground, as it mitigates many disadvantages of complete removal of the structures, such as destruction of the surrounding marine habitats, disturbance of the ocean floor which housed the rig and the additional costs attached to complete removal. Still, on the other hand, the partial platform left submerged ensures that the environmental advantages of leaving the submerged structure continue. These advantages include but are not limited to increased fish biomass and increased fish production. However, with partial removal, topsides must be removed entirely in the process and removal here 'would entail the most expensive removal costing'.[48]

2.1.3 Option 3- Leaving in situ

Leaving the entire platform in place involves appropriately shutting down and stripping away all equipment directly involved in oil and gas extraction.[49] The first few steps leading up to abandoning the oil well include plugging the well with either standard or specialized cements or mechanical plugs. The plugging of wells always carries the risk of environmental hazards, as poorly plugged wells provide an easy outlet for gas to escape to the surface and can cause dangerous fires or pose various health hazards. The costs are not very substantial when one compares the expenses associated with the towing and disposals of the platform on land, in that plugging a well requires minimal planning and time for proper execution.

Researchers have recently found new ways to create alternative energy sources from the decommissioned platform.[50] Research has

47 Ibid.

48 Noor Wan Abdullah Zawawi, 'Decommissioning of Offshore Platforms: A sustainable framework' (2012) Colloquium on Humanities, Science & Engineering Research (CHUSER).

49 Noor Wan Abdullah Zawawi, 'Decommissioning of Offshore Platforms: A sustainable framework 'Colloquium on Humanities, Science& Engineering Research (CHUSER) (2012).

50 Snieckus , Darius "Old North Sea Oil Infrastructure 'Could Be Reused' for Off shore Wind-Fuelled Hydrogen" (Recharge September 16, 2021) <https://www.re chargenews.com/energy-transition/old-north-sea-oil-infrastructure-could-be-

found that decommissioned platforms can be transformed into sites for wind turbines or sites to hold wave energy converting equipment.[51] This has led to policy initiatives to support these new developments, including the West Coast Governors' Agreement Alternative Energy Working Group in the United States, a federal programmatic Environmental Impact Statement (EIS) for the outer continental shelf, and regulations on the reuse of oil and gas platforms.[52] Remarkably, offshore platforms have been proposed as service and electrical interconnection hubs for offshore wind and wave farms. There are over 570 offshore oil rigs in the North Sea alone, many of which provide ideal wave and sea conditions for deploying wave energy converters devices for electricity generation.[53]

However, there have been challenges with the practical implementation of these ideas. Currently, there are no projects in the planning stage in the United Kingdom or the United States,[54] and there is the risk of the hefty steel structure hampering the operation of the turbines. This situation makes alternative renewable energy largely an impracticable idea, at least at this present time. Upon further research however, engineers may be able to come up with a more practicable method for converting the decommissioned rig to work in tandem with the turbine to provide renewable energy. Many benefits would accrue from such development, including restoring use to abandoned structures, protecting marine wildlife, and generating employment opportunities, revenue, and clean energy.

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reused-for-offshore-wind-fuelled-hydrogen/2-1-1068354>; accessed March 5, 2023.

51 Ibbetson, Connor, "Engineers Convert Old Oil Rigs into Wave Energy Sites" (New Civil Engineering June 19, 2019) <https://www.newcivilengineer.com/latest/engineers-convert-old-oil-rigs-into-wave-energy-sites-03-04-2019/>; accessed March 5, 2023.

52 Max Henrion, 'A multi attribute decision analysis for decommissioning offshore oil and gas platforms' (2015) Integrated Environmental Assessment and Management [1551-3777].

53 U Azimov, M Birkett, 'Feasibility study and design of an ocean wave power generation station integrated with a decommissioned offshore oil platform in UK waters' (2017) International Journal of Energy and Environment. <https://ezproxy.sastudents.uwi.tt/login?url=https://www.proquest.com/scholarly-journals/feasibility-study-design-ocean-wave-power/docview/2091579549/se-2> accessed 14/07/2022.

54 Ibid.

3. THERE OTHER SUSTAINABLE OPTIONS FOR DECOMMISSIONING?

The challenges of decommissioning offshore oil rig platforms are substantial due to the rising concerns of sustainable development, the complexity and uniqueness of each removal activity, the different costs involved with each activity, and the complex regulatory structures[55] attached to each method. The process is further complicated by the need to consider and balance the various perspectives put forward by different stakeholders, such as the oil and gas operators, the government, and the public, and then having to arrive at an amicable decision. For example, air quality regulators are concerned about the air emissions from decommissioning activities,[56] resource managers are seeking to preserve the health of the ecosystems and biological production associated with platforms,[57] and some environmental advocates prefer a strict compliance approach that would hold operators to the terms of their original leases, which require complete platform removal.[58]Thus far, this paper has examined the implications of the various decommissioning options available for offshore facilities. This section, however discusses the growing trend of converting

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[55] G. Evans, 'Decommissioning the North Sea'(2012) date accessed 6/07/2022.

[56] P Cantle and B Bernstein, 'Air emissions associated with decommissioning California's offshore oil and gas platforms' [2015] Integr Environ Assess Manag564–571.

[57] DJ Pondella , LA Fink , MS Love, D Siegel, B Bernstein, 'Modeling fish production for Southern California's petroleum platforms'[2015] Integr Environ Assess Manag584–593.

[58] BB Bernstein, A Bressler, P Cantle, M Henrion, D John, S Kruse, D Pondella, A Scholz, T Setnickaand SSwamy, 'Evaluating alternatives for decommissioning California's oil and gas platforms: A technical analysis to inform state policy' 92010) California Ocean Science Trust. Available from: http://www.ocean sciencetrust.org/project/oil-and-gas-platform-decommissioning-study/ accessed 15/06/2022.

decommissioned oil platforms into artificial reefs; which is viewed as a more sustainable option for dealing with disused offshore platforms. This trend has been most prominent in certain states within the United States, such as Louisiana, Texas and Florida, and the trend has been steadily advancing in some South-East Asian countries like Malaysia.[59]

3.1 Rig-to-Reef as a Viable Alternative

A rig-to-reef program involves repurposing obsolete offshore oil and gas platforms as permanent artificial reefs instead of being completely removed from the sea. Hence, artificial reefs may be defined as 'submerged structures deliberately placed on the seabed to mimic some characteristics of natural reefs'.[60] *Prima facie*, complete removal may seem to be the best environmental practice for decommissioning offshore oil and gas facilities. However, given that the facilities have been embedded into the seabed for decades, complete removal may do more harm than good. It is noteworthy that experts have described offshore oil rigs as one of the most productive fish habitats because such rigs provide marine habitats with food, shelter from marine predators, and a safe breeding ground deemed better than natural reefs.[61] Moreover, converting an obsolete offshore platform to a reef is cheaper than its complete removal. In fact, reefing platforms is estimated to save the oil and gas industry several millions of dollars each year.[62] In addition, some environmental experts believe reefing presents a win-win situation for the oil and gas industry and host

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59 "Thailand's First-Ever Rigs-to-Reefs, a New Initiative for Marine Conservation" (https://www.bangkokpost.comDecember 11, 2020) <https://www.bangkokpost.com/thailand/pr/2031399/thailands-first-ever-rigs-to-reefs-a-new-initiative-for-mari ne-conservation>; accessed March 5, 2023.

60 The European Artificial Reef Research Network (EARRN)

61 Isabelle Gerretsen, "The New Use for Abandoned Oil Rigs" op cit.

62 Ibid.

governments. It is believed that with reefing, oil and gas companies spend half of their decommissioning budgets on maintaining obsolete platforms as artificial reefs thereby enhancing the conservation of marine life. Such marine conservation is of economic value to host governments and the larger society.[63] For example, reefed platforms in the Gulf of Mexico have been identified as hotspots for diving, snorkeling and recreational fishing due to its abundance in marine species.[64] Meanwhile, studies have proven a connection between the fostering marine life and disused oil and gas structures in the Gulf of Mexico.[65]As the Gulf lacked extensive natural reefs on its own, the need to prevent the loss of biodiversity that was created during petroleum operations was necessary, hence the development of the NFEA.[66] Given that platforms had to be removed entirely until the 1980s, the Bureau of Safety and Environmental Enforcement (BSEE) and the National Enforcement Act initiated successful rig-to-reef programs in the United States by reusing hundreds of rigs for the establishment of artificial reefs.[67]

Therefore, considering the high costs, negative carbon footprint and ecological impact of complete removal of offshore platforms, partial removal in rig-to-reef programs provides a more sustainable decommissioning option. This is because rig-to-reef offers reduced environmental harm, increased ecological resources, and

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63 Ibid.

64 Ibid.

65 MJ Ajemian, JJWetz, B Shipley-Lozano, JD ShivelyandGWStunz, 'An analysis of artificial reef fish community structure along the northwestern Gulf of Mexico Shelf: Potential impacts of "Rigs-to-reefs" programs' [2015] < https://ezproxy.sastudents.uwi.tt/login?url=https://www.proquest.com/scholarly-journals/analysis-artificial-reef-fish-community-structure/docview/1982584338/se-2. doi:>.

66 Mark J. Kaiser and Allan G. Pulsipher, 'Rigs-To-Reef Programs In The Gulf Of Mexico' (2005) 36 Ocean Development & International Law.

67 BSEE's policy regarding reefs in set out in "Rigs-to-Reefs" Policy, BSEE Interim Policy Document , 21 June 2013 https://ww.bsee.gov/sites/bsee.

reduced decommissioning costs for operators and governments.[68] More so, rig-to-reef program offers increased provisioning services: marine resources, and cultural services such as recreational activities[69] including fishing which promotes food security.[70] In other words, converting rigs to reefs can foster sustainable resource management, including creating new habitats, conserving the marine environment, and restoring marine life.[71] This is evident from the increased production of Red Snapper species,[72] and the creation of complex food chains resulting from sessile invertebrates thriving on submerged infrastructure, attracting mobile invertebrates and larger fish species in the Gulf of Mexico.[73] Likewise, deep-water reefs can conserve and restore threatened species of deep-sea benthos.[74] Thus, these ecological benefits have been held far more sustainable than present decommissioning practices.[75]

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68 P. Scott Burton, 'Offshore Platform Sustainable Decommissioning - "Rigs To Reefs" Goes Global' (PipelineLaw, 2022) <https://www.pipelinelaw.com/2020/01/30/offshore-platform-sustainable-decommissioning-rigs-to-reefs-goes-global/> accessed 25 July 2022.

69 Chi-Ok Oh, Robert Ditton and John Stoll, 'The Economic Value Of Scuba-Diving Use Of Natural And Artificial Reef Habitats' (2008) 21 Society & Natural Resources.

70 MohdHairilMohd and others, 'Reefing Viability Index For Rigs-To-Reefs (R2R) In Malaysia' (2020) 2020 The Scientific World Journal.

71 Jeremy T Claisse et all, 'Oil platforms off California are among the most productive marine fish habitats globally.' (2014) 111 Proceedings of the National Academy of Sciences of the United States of America.

72 Strelcheck AJ, Cowan JH, Shah A. Influence of reef location on artificial reef fish assemblages in the northcentral Gulf of Mexico. Bull Mar Sci. 2005; 77(3): 425–440.

73 Mark J. Kaiser and Allan G. Pulsipher, 'Rigs-To-Reef Programs In The Gulf Of Mexico' (2005) 36 Ocean Development & International Law.

74 Peter I Macreadie, Ashley M Fowler and David J Booth, 'Rigs-To-Reefs: Will The Deep Sea Benefit From Artificial Habitat?' (2011) 9 Frontiers in Ecology and the Environment.

75 Salem Y. Lakhal a, M.I. Khan b,1 , M. Rafiqul Islam (2009)'An "Olympic" Framework for a Green Decommissioning of an Offshore Platform'. Ocean & Coastal Management Volume 52, Issue 2.

3.2 Implications of Decommissioning Options vis-a-vis Rig-to-Reef Program

Remarkably, only the rigs-to-reefs option eliminates the ultimate need for platform removal while other options discussed above simply postpone the decision of complete removal since the platform, even if it is converted to an alternate use such as wind energy, will one day reach the end of its structural life. Hence, once the decision is made to convert into a reef, the operator no longer bears the burden of further decommissioning.

Many of these enormous steel structures provide an excellent habitat beneath the waves.[76] Past conversations revolved around these structures' real impacts on the health of the oceans and its biodiversity. However, the merits of leaving these structures under the sea required further research,[77] as there were constant calls for governments, oil companies and environmentalists to undertake joint research. Many recent studies highlight that the reef program benefits the environment through increased fish production, oyster farming, a flourishing habitat for marine animals as coral growth increases and recreational activities for tourists, including diving and snorkeling.[78]

While artificial reefs may benefit coastal habitats through increased fishing opportunities, studies regarding impacts on seabed communities are lacking. Establishing artificial reefing may harm benthic communities,[79] cause changes in

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76 David Bignold, 'Oil Rig Decommissioning and the Environment: The next challenge' (2019).

77 Reuters Events, 'Offshore oil rigs: Can decommissioning ever be green?' (2009).

78 Macreadie, P.I., Fowler, A.M. and Booth, D.J. (2011), Rigs-to-reefs: will the deep sea benefit from artificial habitat? Frontiers in Ecology and the Environment, 9: 455-461. https://doi.org/10.1890/100112

79 Peter I Macreadie, Ashley M Fowler and David J Booth, 'Rigs-To-Reefs: Will The Deep Sea Benefit From Artificial Habitat?' (2011) 9 Frontiers in Ecology and the Environment.

food chains and the introduction of invasive species.[80] Due to new environmental changes by artificial reefs, eutrophication may give rise to toxic blooms.[81] Reefing may also cause changes in the quality of water, seabed ecology and chemistry, impacting the biodiversity and surrounding environment. However, due to the lack of research, the risks mentioned above are not properly assessed to give concrete conclusions. Consequently, further studies must be conducted before implementing reefs to mitigate any of these risks.

Notwithstanding, there are concerns about environmental risks accruable from rigs-to-reefs programs. Regardless of whether a platform was decommissioned or reefed, there remains a potential for leakage and long-term pollution.[82] Climate change activists allege resulting changes in the ocean, such as increased water temperature or acidification, which may adversely affect environmental sustainability and the reef's survival.[83] Over time, the platform's metal structure and anodes can cause erosion that leeches into the surrounding ecosystem.[84] Although the structures tend to have low leaching rates,[85] this remains an environmental risk, albeit minute.

However, a major issue with the rig-to-reef option is regarding the liability for maintaining an artificial reef: who bears the responsibility for maintaining the structure left on the seabed? The alternative options to reefing described above are straightforward in apportioning

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80 Ibid.

81 Ibid.

82 Rowe M, "The Terrifying Cost of Scrapping the World's Ageing Oil and Gas Rigs" (GeographicalJune 14, 2022) <https://geographical.co.uk/science-environment/cost-scrapping-worlds-ageing-oil-and-gas-rigs> accessed March 5, 2023

83 Ibid.

84 Keith Carlson, 'Viewpoints: Rigs To Reefs - Mission Blue' (Mission Blue, 2022) <https://mission-blue.org/2017/07/viewpoints-rigs-to-reefs/> accessed 20 July 2022.

85 Ibid.

liabilities to parties. Even in the case of an assignment of interests of one party to another, the leaseholders remain jointly and severally responsible and liable for decommissioning obligations.[86]

Notwithstanding, the benefits accruable to the environment from an artificial reef outweigh the advantages of other decommissioning options when one considers the overriding sustainability objective. The structure left *in situ* will not interfere with marine life but actively encourage a more vibrant marine ecosystem. The sheer number of converted reefs speaks to these benefits. For instance, the Louisiana Artificial Reef Program (LARP), the largest rigs-to-reef program in the world, covers over 83 sites with approximately 120 decommissioned platforms,[87] with numbers set to multiply soon.

Overall, the best option for decommissioning depends on factors such as the size and age of the structure, and the depth of the seabed[88] on which it rests. It could be quite straightforward to dismantle and tow a small rig to shore. For larger platforms supporting multiple wells, cutting large metal can pose threats to humans and the environment, and the procedure can be quite costly. In such cases, reefing is attractive because overheads are generally fifty percent (50%) lower than removing the entire structure.[89]

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86 Mark J. Kaiser and Allan G. Pulsipher, 'Rigs-to-Reef Programmes in the Gulf of Mexico' (2005) 36 Ocean Development and International Law 119, 12.

87 M.K. Kaiser, the Louisiana Artificial ReefMarine Policy, (2006) 605-623.

88 Mark Rowe, 'The terrifying costs of scrapping the world's ageing oil and gas rigs' (2022) Geographical.

89 Ibid.

4. RECOMMENDATIONS

As stated earlier, liability for the maintenance of artificial reefs constitute one of the major challenges with rigs-to-reefs programs. The United States, being a fore-runner of reefing programs, has some lessons to teach the world in this regard. The US has an effective system that allocates liability from the beginning, where liability is transferred from the oil company to the State for the donated material on the seabed, but the oil companies remain liable for the actual well site below surface.[90] This means the liability is on the company if there is oil leakage due to improper abandonment. The liability question has been partly addressed by requiring oil and gas companies who participate in the rig-to-reef projects to donate half of their removal cost savings, the cost difference between partial and complete removal of the platform, to the State that accepts ownership of the artificial reef.[91]

Essentially, the leaseholders may have to contribute financially towards the actual process in converting the platform into the artificial reef whereby once the process is completed, the liability for the residues would fall on the State.[92] This system is effective as it allocates liability clearly from the onset so that these complex questions do not arise later on when faced with enormous decommissioning costs. The donating oil company

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90 Jaime-Jean Hunter, 'Rigs 2 Reef: Beyond OSPAR exclusion: could the North Sea benefit from a US approach to decommissioning?' (2018) International Energy Law Review 279.

91 Rigs-to-Reefs Information: What is Rigs-to-Reefs and how does it relate to the mission of the Minerals Management Service (MMS)? Bureau of Ocean Energy Mgmt .Reg. and Enforcement > http:// www.gomr.boemre.gov/homepg/regulate /environ/rigs-to-reefs/information.html<date accessed 24/07/2022.

92 Eduardo G. Pereira, Tolulope O.Taiwo&NgoziChinwa Ole, Addressing Residual Liability and Insolvency in Disused Oil and Gas Infrastructure Left in Place: The Cases of Brazil, Nigeria, and Trinidad and Tobago (The Journal of Sustainable Development, Law and Policy, 2020) 326-361.

benefits as it is more economical to convert the already existing structure into a reef rather than the traditional decommissioning route of dismantling the structure and towing its pieces to shore. This traditional method is expensive, timely and high risk and must adhere to strict safety protocol. However, by accepting ownership over the installation itself, the State acquires residual liability, which translates into a financial burden, hence the need for and existence of trust funds. The potential of residual liability means that United States taxpayers play a vital role in properly maintaining artificial reefs. This system is laudable as it is a meeting point between the interests of the leaseholders and the State, and the financial burdens are divided between both and no party is responsible for the full decommissioning costs.

Secondly, it is important for the ecological benefits that arise from rig-to-reef programs to be balanced against the risks from leaving the infrastructure in place. In this regard, location is one of the most significant aspects to consider when establishing a successful rig-to-reef program. To foster marine ecosystems, the site must be evaluated before selection to ensure a high probability of success.[93] Studies show that access to natural source habitats such as larval is necessary for the reef to thrive. In addition, oceanographic conditions, geographic criteria and geological aspects play a significant role.

Third, rigs-to-reefs programs require proper regulatory and legal frameworks to operate successfully.[94] The roles of relevant actors in this development must be clearly

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[93] Sylvia Jagerroos and Paul R Krause, 'Rigs-To-Reef; Impact Or Enhancement On Marine Biodiversity' (2016) 6 Journal of Ecosystem & Ecography.

[94] National Oceanic and Atmospheric Administration, US Department of Commerce, Artificial Reef Plan (as amended) Guidelines for siting, construction, development and assessment of artificial reeds (2007) > http://www.nmfs.noaa.gov/sfa/PartnershipsCommunications/NARPwCover3.pdf < accessed 28/06/2022.

delineated for a rig-to-reef program to succeed in any part of the world. Lessons may also be taken from the US in this regard. In the US, coordination between the government and the oil industry is backed up by an efficient legal framework that guides their liabilities and obligations to each other; for instance, the Louisiana Fishing Enhancement Act 1986, Texas Artificial Reef Act of 1989.

Presently, there is no international law providing substantial guidance on the creation of artificial reefs through decommissioning. The paucity of rigs-to-reefs programs in many oil and gas jurisdictions may be attributed to the lack of international jurisprudence on the topic. Countries lack the guidance they need to safely and successfully execute this new alternative to decommissioning. Therefore, international law must be updated to incorporate relevant jurisprudence and guidance on reefing as a sustainable decommissioning option. Such an d international effort would motivate nation-States to develop policy frameworks on reefing within their national jurisdictions.

From a regulatory perspective, reefing programs face challenges, complexity, and uncertainties that hinder the global spread of reefing programs. In the North Sea where there are hundreds of offshore platforms, for example, the regional sea convention OSPAR requires completely removing offshore installations. The guidelines on artificial reefs indicate that these may only be created from new material rather than disused offshore installations.[95] The North Sea has taken "hands of the ocean aproach" which does not allow for reefing

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[95] Kristen Ounanian, Jan P.M. van Tatenhove & Paulina Ramírez-Mon salve (2020) Midnight at the oasis: does restoration change the rigs-to-reefs debate in the North Sea?, Journal of Environmental Policy & Planning, 22:2, 211-225, DOI: 10.1080/1523908X.2019.1697657

platorms, even though reefing is considered a resotrative aproach. Zooming out further, uncertainty around the acceptability of rig-to-reef programs under various international treaties and conventions pose a challenge for nations. As discussed below various international agreements have been implemented to ensure safe navigation of vessels and reduce ocean dumping.

The former, safe vessel navigation, is generally a global concern as safe global shipping secure manufacturing and foof supply chins for many countries. Thus, international agreements such as the 1958 Geneva Convention (United Nations Convention on the Continental Shelf) and the 1989 International Maritime Organization Guidelines and Standards for the Removal of Offshore Installations & Structures on the Continental Shelf & in the Exclusive Economic Zone were put into place. The former requires "[d]ue notice must be given of the construction of [...] installations, and permanent means for giving warning of their presence must be maintained. Any installations which are abandoned or disused must be entirely removed."[96] On the other hand, the latter IMO agreement provides "abandoned or disused offshore installations or structures on any continental shelf or in any exclusive economic zone are required to be removed, except where non-removal or partial removal is consistent with the following guidelines andstandards."[97] The challenge here is not whether a signatory can create an artificial reef from a decommisioned platform. Rather, it is the logitiscs of creating local legislation and institutions to appropriately implement standards and evaluate if those standards have been met in conformance with the relevant international obligations. As already noted, rig-to-reef programs, such as the one in Louisiana rely significantly on funding from

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96 Article 5(5)

97 Section 1.1

reefing projects. Thus there is need for political and monetary commitments to develop and implement a rig-to-reef program.

A rig-to-reef program may appear to implicate anti-ocean dumping agreements such as the 1972 London Convention (on the Prevention of Marine Pollution by Dumping of Wastes and other Matter) and the 1996 London Protocol (to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter). However, a rig-to-reef program likely does not constitute abandonment at sea as topling and *in situ* programs are for a specific and legitimate purpose, and not mere disposal.[98]

5. CONCLUSION

Reefing provides an efficient and sustainable approach to deal with complex and costly decommissioning processes. Although reefing offshore oil and gas platforms is challenging, its economic and environmental benefits outweigh those of other decommissioning options. It is possible that the challenges and complexities earlier indicated, and in the case of the North Sea prohibition, have chilled the instances of reefing programs globally as countries are left with mainly the Gulf of Mexico as template for establishing a reefing program. Nonetheless, a rig-to-reef program is commendable on many factors including a healthy eco-system, the possibility of eco-tourism and the fact that conversion of the structure is

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[98] Kristen Ounanian, Jan P.M. van Tatenhove & Paulina Ramírez-Mon salve (2020) Midnight at the oasis: does restoration change the rigs-to-reefs debate in the North Sea?, Journal of Environmental Policy & Planning, 22:2, 211-225, DOI: 10.1080/1523908X.2019.1697657

in essence recycling but with the addition of re-purposing. This makes it a more sustainable decommissioning option for offshore oil and gas platforms when compared with other options.