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Alternate uses of retired oil and gas platforms in the Gulf of Mexico

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ABSTRACT

The number of fixed oil and gas platforms are declining in the Gulf of Mexico, there were ~3674 platforms installed the since 1942 and today there are ~1320. Eventually, ~30,000 jobs will be lost in related industries because of platform removals. Retired oil and gas platforms could be redeployed for alternate uses such as CO_2 capture and storage, renewable wind energy, and sustainable fisheries and employ citizens in coastal areas. Elsewhere around the world, offshore platforms are used for purposes other than producing oil and gas. U.S. Federal legislation (Energy Policy Act 2005 Section 388 of Public Law [PL] 109-58); 30 CFR 285.1000 Subpart J) authorizes the use of retired oil and gas platforms for alternate uses. If the retired oil and gas structures are preserved, the infrastructure could also be used to recover stranded petroleum using CO_2 enhanced oil recovery (CO_2-EOR). We examined the socio-economic incentives, environmental impacts, and regulatory issues associated with the alternate uses. We suggest that CO_2-EOR is the most economically efficient way to store CO_2 offshore and that offshore wind turbines may assist with the energy requirements for oil and gas production and CO_2-EOR. Data suggest that in our study area offshore platforms are more successful at producing fish and invertebrates if they are left standing instead of toppled over. The greatest regulatory issue facing the use of retired platforms is the transfer of liability. If the structures are redeployed, the previous oil and gas owner/operators are still responsible for eventual removal and catastrophic events. A variety of future economic activity in the Gulf of Mexico could take advantage of this infrastructure, if it remains in place.

1. Introduction

1.1. Background of the offshore oil and gas platforms, Gulf of Mexico

The oil and gas industry has installed ~3674 fixed offshore oil and gas platforms since 1947, although they are rapidly disappearing, and today there are only ~1320 (Bureau of Safety and Environmental Enforcement [BSEE] 2018). There are a several types of offshore structures, spars, tension-leg platforms, caissons, well protectors, and fixed platforms. Fixed platforms are the largest of the stable structures (jackets and decks) and they are installed in waters < 400 m. They constitute ~60% of all the various production structures in the Gulf of Mexico and are suitable for managing the alternate use operations described below. Based on an average production life of 17 years, most of the remaining structures could be decommissioned by 2025 (BSEE, 2018). Table 1 presents the number of fixed platforms installed and removed, cumulatively existing structures in the Gulf of Mexico over time.

In the Gulf of Mexico, the offshore platforms are currently used only to produce hydrocarbons, although sometimes retired platforms are toppled over to create artificial reefs (Kaiser and Pulsipher, 2005). Elsewhere, offshore platforms are used for purposes other than producing hydrocarbons.

The concept of utilizing offshore platforms for alternate uses has been addressed before. The idea was discussed previously in reports and literature: Reggio, 1989,1996; Kaiser JB et al., 2003; Louisiana Department of Natural Resources (LDNR) 2005; Kolian and Sammarco 2005, 2008, 2018; Love et al., 2006; Minerals Management Service (MMS) 2007; Kaiser MJ et al., 2010, 2011; Legorburu et al., 2018.

1.2. Carbon sequestration - CO_2-EOR processes

Around the world, five offshore CO_2 storage demonstration projects are currently or are about to be put into operation, with plans to store 4 to 7 million metric tons of CO_2 per year. Another five projects using offshore platforms are planned for 9 million metric tons per year (GCCSI, 2017). The most notable of these projects in operation is the Sleipner project off the coast of Norway. As of June 2016, they had

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Table 1
Offshore Platforms in the Gulf of Mexico.
Source: BSEE 2018, List of all platform structures, 1 Jul 18.

Years	Installed	Removed	Existing Fixed Platforms
1942–1969	719	–	719
1970–1979	768	23	1464
1980–1989	875	153	2186
1990–1999	766	508	2444
2000–2009	486	724	2206
2010–2018	60	946	1320
Total	3674	2354	

The number of installed, removed, and existing fixed platforms in the Gulf of Mexico.

stored over 16 million metric tons of CO_2 (Furre et al., 2017). Nonetheless, the CO_2 storage offshore potential is most promising if the CO_2 is used to help extract stranded oil utilizing methods such as CO_2 enhanced oil extraction (CO_2-EOR). The potential of this hydrocarbon recovery method is large, and is globally dispersed (Dahowski et al., 2009; DOE/NETL 2014; International Energy Agency Greenhouse Gas (IEA GHG) 2009a, b; Vidas et al., 2012; Asia-Pacific Economic Cooperation [APEC] 2013).

1.3. Wind energy and platforms

A number of offshore wind projects have been initiated along the U.S. Atlantic seaboard using structures similar to the oil and gas platforms (Kaiser et al., 2010); however, to date, no projects using retired platforms have been implemented in the Gulf of Mexico. Other countries are using offshore platforms to produce wind-energy (Higgins and Foley, 2014). For example, in the Scottish North Sea, offshore wind turbines have been installed next to the Beatrice offshore platforms to supplement their energy needs for hydrocarbon extraction (Bilgili et al., 2011; Legorburu et al., 2018).

1.4. Sustainable fisheries and platforms

Offshore platforms are known to host some of the most prolific ecosystems in the oceans (Wilson et al., 2003; Claisse et al., 2014). They are habitat for protected, threatened, and endangered species, such as sea turtles (Gitschlag et al., 1997), coral (Sammarco et al., 2004, 2012a,b; Kolian et al., 2013, 2017), and fish (Stanley and Wilson, 2000; Shipp and Bortone, 2009; Ajemian et al., 2015). Offshore platforms are home to coral, algae, sponges, and bacteria possessing bioactive compounds shown to have valuable pharmaceutical properties (Rouse, 2009; Schippers et al., 2012; Florida Atlantic University, 2016).

1.5. Authorization for alternate uses of offshore platforms

The Energy Policy Act (EPAct) of (Public Law [PL] 109-58) authorizes the use of Outer Continental Shelf (OCS) facilities (offshore platforms) for alternate uses. On June 29th, 2009, the Minerals Management Service (MMS) implemented the “Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf” program (30 CFR 285.1000 Subpart J). This Federal program allows retired oil and gas platforms to be utilized for alternate uses such as the wind, wave, and current energy production, or any “marine related purpose”.

1.6. Existing oil and gas industry

In the Gulf of Mexico, the offshore oil and gas fields are aging and the oil and gas industry is presently spending $1.2 billion per year removing platforms, and the total cost could reach $45 billion for removal by the time the shelf is cleared (Decomworld, 2010, 2015). Regulations that provide incentives to leave the platforms offshore are helpful, but the oil and gas companies and the relevant managing Federal agencies are reluctant to do so because of concerns over lingering liability (Notice to Lessee [NTL] 2010-G05).

Greater than 60 years of experience have demonstrated that fixed offshore platforms are the most efficient method to provide housing for workers and production equipment, and they are operational and accessible > 95% of the time. They are designed to survive up to 100 years standing in place (Kaiser et al., 2011), and if they are toppled over and used as artificial reefs, it is estimated that they could maintain their structural integrity for up to 300 years (Reggio, 1989).

1.7. Research questions and objectives

Here, we examine the following questions regarding the use of these offshore structures in a post-petroleum production phase for CO_2 capture and storage, CO_2-EOR, wind energy, and sustainable fisheries. Specifically, we raise the following questions and discuss their potential answers:

- What are the potential alternate uses for retired platforms, and are they viable?
- What areas or depths in the Gulf of Mexico are suitable for such operations, and why?
- What potential energy resources are associated with these platforms?
- Likewise, what are the fishery resources, and
- What are the probable environmental and socioeconomic impacts of implementing such activities?
- What regulatory issues must be addressed if alternate uses of platforms are to be successfully implemented?

2. Using CO_2 capture and sequestration on offshore platforms

Carbon capture and storage (or sequestration) is the process of capturing CO_2 from large point-sources and transferring it to an underground geological formation. The aim is to reduce the release of large quantities of CO_2 into the atmosphere, and mitigate the contribution of fossil fuel emissions to global warming and ocean acidification. Substantial opportunity exists for storing CO_2 offshore, both in depleted oil and gas fields and in deep saline aquifers. Accessibility to existing offshore petroleum infrastructure is likely to be essential to make the storage of CO_2 economically feasible.

Perhaps the most commercially viable alternate use of existing offshore platforms is enhanced oil recovery using carbon dioxide (CO_2-EOR). Enhanced oil recovery (EOR) is a generic term for a wide variety of techniques to increase the amount of crude oil that can be extracted from an oil field. The CO_2-EOR process is one where CO_2 is injected under high pressure into deep, oil-bearing submarine geological formations/strata to increase recovery of oil and gas in partially depleted fields. CO_2 injection is presently the most-commonly used approach for EOR. Oil displacement by CO_2 injection relies on the phase behavior of the mixtures of gas and crude oil. These behaviors are strongly dependent on reservoir temperature, pressure and crude oil composition. CO_2-EOR results in CO_2 being introduced into the reservoir as part of the process, and thus is stored for the long-term. CO_2-EOR can help maintain profitable offshore oil production into coming decades.

2.1. Energy resources on the GOM continental shelf

In a report, the U.S. Department of Energy (DOE) considered the future of retrievable oil reserves in the Gulf of Mexico. They concluded that, depending future technological developments, and assuming oil prices of $90 per barrel and a CO_2 cost of $50/MT, economically viable recovery of oil could produce an additional 15 billion barrels. This would require nearly 4 billion metric tons of CO_2 to facilitate that