ONE OCEAN FOUNDATION

Ocean Disclosure Initiative

OIL AND GAS INDUSTRY REVIEW

SDA Bocconi SCHOOL OF MANAGEMENT
SUSTAINABILITY LAB

McKinsey & Company

CSIC
Consejo Superior de Investigaciones Científicas

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About One Ocean Foundation

This research is an initiative of the One Ocean Foundation, as part of its project Ocean Disclosure Initiative.

The mission of the Foundation is to accelerate solutions to Ocean issues by inspiring international leaders, institutions, companies, and people; promoting sustainable blue economy and enhancing ocean knowledge through ocean literacy.

Thanks to an international network of contacts (companies, institutions, entrepreneurs, sportsmen, yacht clubs, influencers, etc.) the One Ocean Foundation intends to develop a leading platform, bringing together and strengthening the voices speaking out on behalf of the ocean around the world, from a collaborative, not competitive, perspective.

The distinctive feature of the One Ocean Foundation is its scientific scope and, at the same time, its strong educational drive, in order to increase awareness and establish constructive relationships between all stakeholders engaged in marine preservation at different levels.

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About the Ocean Disclosure Initiative

The Ocean Disclosure Initiative project is part of the multi-year research “Business for Ocean Sustainability” promoted by the One Ocean Foundation (OOF), in collaboration with SDA Bocconi School of Management Sustainability Lab, McKinsey & Company and CSIC (Consejo Superior de Investigaciones Científicas) and aimed at building knowledge about the relationship between the business and the ocean.

The project started in 2019 with the goal of investigating the role of companies in addressing ocean challenges, focusing on the pressures on marine ecosystems, the level of awareness within the business community and the main (technological and organizational) responses implemented.

The Ocean Disclosure Initiative has the ambition to be a science-based framework and methodology aimed at supporting businesses from all industries in taking action on ocean-related issues, promoting prevention and/or mitigation responses and favouring disclosure and reporting.

Introduction to the oil and gas industry

The oil and gas industry is one of the industries analysed in the framework of the "Business for ocean sustainability" research that has paved the way for the development of the Ocean Disclosure Initiative (ODI), and one of the sectors that has been confirmed to exert significant pressures on the health of marine ecosystems. For these reasons, it has been selected as the third focus sector of the Ocean Disclosure Initiative and its main pressures on the ocean are presented in the following paragraphs.

This analysis has been conducted by reviewing relevant material and sectoral publications on the environmental pressures of the oil and gas industry along with sustainability reports from the main stakeholders in the sector, with the core objective of better understanding the pressures exerted on marine ecosystems and lay the basis for the industry-specific Oil and Gas ODI tool. It is also useful to specify that, while the scientific research previously conducted took into consideration only the phase related to the oil and gas extraction (upstream stage), the present report intends to capture, at a high-level, the pressures exerted by the oil and gas operations across all phases.

The availability of sufficient energy to meet the needs of a continuously growing population is key to ensuring economic development that needs to be sustainable and nature positive. Despite the urgent need to turn towards renewable energy sources, such as solar and wind energy, in the framework of a complex energy transition, oil and gas are currently still in demand as contemporary sources of energy at the global level and will continue to be for the coming years.

OIL AND GAS REPRESENT AT PRESENT THE MOST IMPORTANT SOURCE FOR ELECTRICITY PRODUCTION, PROVIDING OVER 60% OF THE TOTAL GLOBAL SUPPLY.

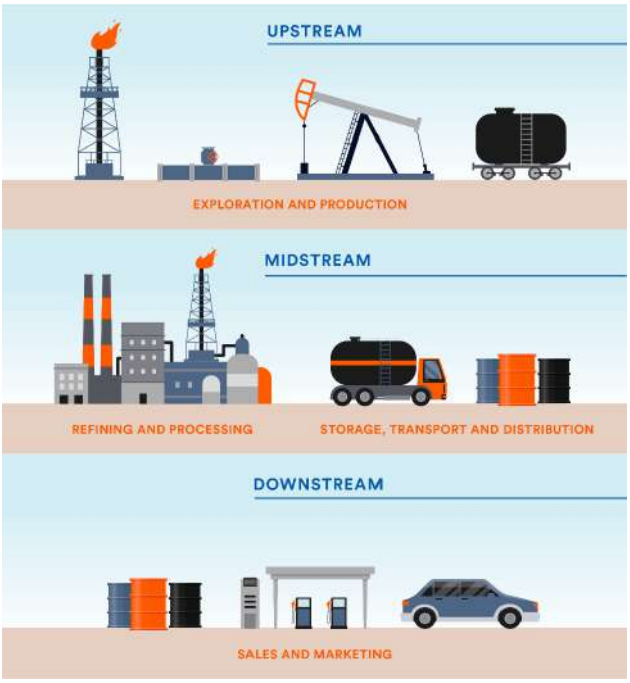
Nowadays, they represent the most important resources for electricity production, providing over 60% of the total global supply[1] and, in 2020, 90% of the transportation sector's energy needs were met by oil-based products[2].

It is thus critical that oil and gas companies remain committed to managing their operations in a way that reduces environmental pressures. Indeed, the oil and gas industry, with its global presence and enormous economic value, has the opportunity to effectively contribute to the achievement of all 17 SDGs, including SDG 14 related to the conservation and sustainable use of the oceans, seas and marine resources for sustainable development.

Production of oil and gas takes place across the globe, both onshore and offshore. Onshore refers to oil extraction activities conducted on land, while offshore denotes the extraction of oil from the seafloor.

The oil and gas industry is usually divided into three major stages, with some overlap between aspects of the phases: upstream (locating and extracting raw materials), midstream (transportation and processing) and downstream (sales and marketing).

FIGURE 1: The three segments of the oil and gas industry



SOURCE: Author's elaboration

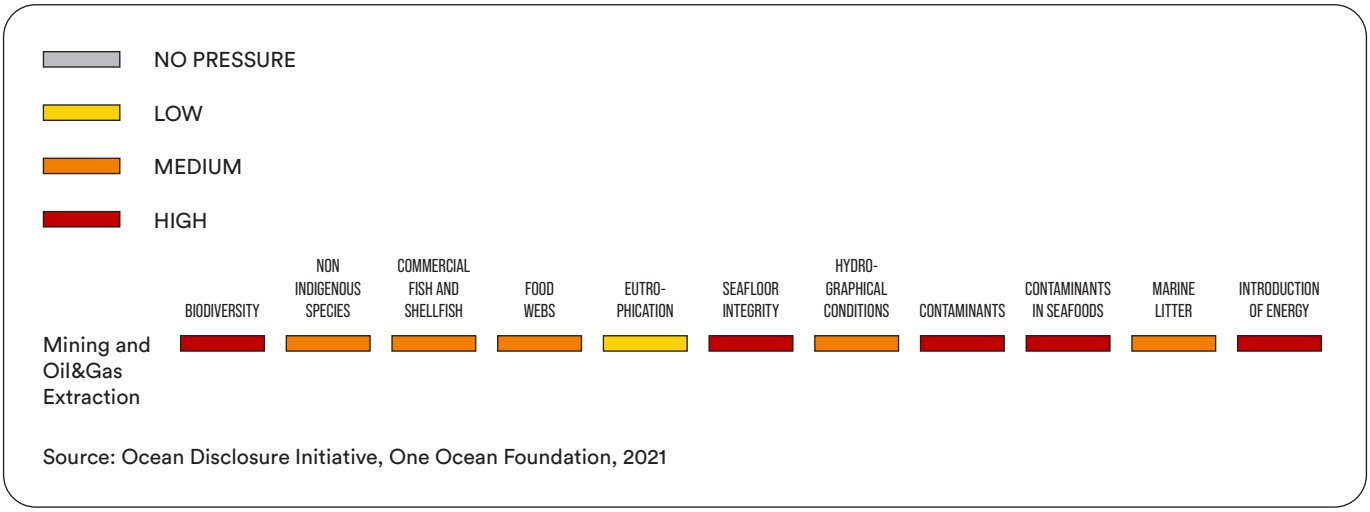
1. International Energy Agency IEA (2022), World Energy Outlook.
2. International Energy Agency IEA (2021), Net-zero by 2050: A Roadmap for the Global Energy Sector.

Each of these stages is responsible for different kinds of environmental pressures which need to be managed, mitigated or even remediated. Specifically, oil and gas operations can exert significant pressures on the marine environment, with direct pressures mainly associated with offshore operations and indirect pressures mainly associated with in-land operations. The type and seriousness of these pressures depend upon many factors, including i) the stage and timing of an activity; ii) the size and complexity of an operation; iii) the nature and sensitivity of the surrounding physical environment.

As indicated in the table showing the identified pressures (figure 2 below), which focuses specifically on the oil and gas industry production phase[3], the scientific review conducted verified that the most significant pressures for the ocean health concern:

— Loss or reduction of biodiversity
— Marine water contamination and deterioration of chemical conditions integrity
— Deterioration of seawater and seabed physical integrity
— Introduction of energy

FIGURE 2: Review of the negative direct and indirect pressures of the oil and gas extraction sector



Source: Ocean Disclosure Initiative, One Ocean Foundation, 2021

3. Mining has not been included because it has been considered as a sector per se

The main pressures exerted by the oil and gas industry

The above-mentioned pressures are caused by core activities of the oil and gas industry that have the potential to affect ocean health:

1. GHG emissions and other polluting air emissions

Global warming caused by GHG emissions also has important consequences in relation to water temperature as the ocean absorbs excess heat from the atmosphere. This exerts a negative pressure on marine species and ecosystems as rising water temperature leads to deoxygenation, which results in a high level of mortality for marine species, loss of breeding grounds and mass migration.

This is coupled with the uptake of carbon dioxide responsible for progressive ocean acidification, with detrimental pressure on marine species and food webs.

OIL AND GAS OPERATIONS ARE RESPONSIBLE FOR NEARLY 15% OF ALL ENERGY RELATED GHG EMISSIONS AND FOR NITROGEN DEPOSITION, WHICH IS AN IMPORTANT CONTRIBUTOR TO THE EUTROPHICATION OF WATERS.

Oil and gas operations are responsible for nearly 15% of all energy related GHG emissions. Emissions are generated directly from the oil and gas industry itself (Scope 1 emissions) and indirectly through the consumption of energy that is purchased by the oil and gas industry (Scope 2 emissions)[4]. Nevertheless, the largest emitter of GHG emissions remains the use of fuel by the end users (Scope 3 emissions).

Moreover, nitrogen deposition due to emissions, inter alia, represents a contributor to the eutrophication of seawater, engendering loss in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters[5].

Best practices. Several companies in the sector are putting in place a set of concrete actions for full decarbonisation of processes and products through research and technological innovation. In this framework, the Best Available Techniques (BAT), which are the best available technologies to avoid environmental damages, and the

4. UNEP, United Nations Environment Programme Finance Initiative (2022) Harmful Marine Extractives: Understanding the risks & impacts of financing non-renewable extractive industries.
5. European Union, Good Environmental Status, https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

Best Environmental Practices (BEP) available are used by the operators as guidelines. In particular, the companies are investing in i) renewables and less polluting new types of energy; ii) decarbonised solutions to reduce, capture, transform or store CO_2, increasing energy efficiency, reducing emissions, and promoting low-carbon energy such as energy from hydrogen and methanol; iii) circular economy and bio-based products.

2. Contaminants and marine litter

A range of non-hazardous and hazardous chemicals is required during all phases of the oil and gas sector, and accidental spills and oil operations discharges into the marine environment are very likely to occur[6]. Operational discharges occur during routine operations, while accidents can happen because of equipment failure, criminal damage, human error, inadequate cleaning operations, and poor storage/handling of waste and chemicals. Contaminants negatively affect water's physical and chemical parameters, potentially determining water toxicity. Most of these substances have a low toxicity, while others can contribute to greater damage to the ocean; in fact, although it might seem that contaminants can be diluted in the vastness of the ocean, continued exposure of marine water to such components affects marine organisms and biological processes.

THE OIL AND GAS SECTOR IS RESPONSIBLE FOR ACCIDENTAL AND OPERATIONAL DISCHARGES OF CONTAMINANTS WITH THE POTENTIAL OF AFFECTING WATER'S PHYSICAL AND CHEMICAL PARAMETERS.

Examples of these substances include salts, heavy metals, radioactive materials, benzene, ethylbenzene and xylene, toluene, oil and grease, plus other compounds like hydrocarbons, alkenes, volatile and semi-volatile organics. Contaminants, regardless of their degree of toxicity, contribute to changes in the chemical composition of seawater and water quality.

The oil and gas industry is also responsible for the release of production water or processed wastewater in the marine environment, meaning water produced during operations, which could contain natural substances such as salt and waste rock but also oil residues, chemicals from hydraulic fracturing and drilling fluids.

Wastewater in the oil and gas industry also includes ballast water from mobile offshore drilling units and ships. One of the harmful consequences of the uptake and discharge of ballast water is the introduction of non-indigenous marine species. In certain cases, non-indigenous species can become invasive, representing a serious threat to native species, because of issues such as competition for space

6. IOGP and IPIECA (2020), Environmental management in the upstream oil and gas industry.

and food, predation, introduction of diseases and pathogens, and thus cause problems for the marine habitats and marine-based commercial industries.

PRODUCTION WATER, WHICH MIGHT CONTAIN NATURAL SUBSTANCES BUT ALSO OIL RESIDUES, CHEMICALS FROM HYDRAULIC FRACTURING AND DRILLING FLUIDS, IS CONSIDERED ONE OF THE LARGEST WASTE PRODUCTS GENERATED BY HYDROCARBON PRODUCTION.

In fact, if not managed appropriately, production water is considered one of the largest waste products generated during hydrocarbon production. Potential impacts are dependent on several factors such as discharge volume, components of the produced water (i.e. metals and production chemicals), toxicity of the water produced, and the sensitivity of the environment.

In terms of consequences, chemical contamination can lead to ocean degradation with damaging effects on its health and functioning. Effects from seawater toxicity depend on the toxicity profile of the chemicals, their synergetic or antagonistic composition, bioavailability and persistence, as well as the ability of marine organisms to take up, accumulate and metabolise them.

These substances can thereby enter food chains and end up being consumed by humans, mainly in the form of commercial fish and shellfish[7]. Moreover, the discharge of chemicals could entail a nutrient enrichment of surface waters and consequent eutrophication, in addition to the effects of the GHG emissions already mentioned above.

Besides chemicals, the accidental production of marine litter, such as paper, rope, sacking, timbers, scrap metal, domestic packaging, plastic, can also occur during oil and gas operations, because of inadequate storage or disposal procedures, thus increasing the pollution of the marine environment.

Best practices. Advanced technological solutions are used in order to remove chemicals from wastewater and efforts are made to replace them with more environmentally friendly alternatives. For instance, with regards to marine fuels, the increasing introduction of alternative options, such as biofuel, methanol and liquefied natural gas (LNG and bio-LNG) is likely to contribute to a shift to more sustainable solutions for the sector's operations.

In general terms, the adherence to international guidelines and conventions (e.g. MARPOL and BWM) set out by international organisations (e.g. International Maritime Organization – IMO) and the implementation of appropriate management and response plans related to the handling on board of waste, marine litter, accidental spills, ballast waters, etc., are vital in order to reduce the pressure on the marine ecosystems.

7. IOGP and IPIECA (2020), Environmental management in the upstream oil and gas industry.

As an example, according to the BWM convention (International Convention for the Control and Management of Ships' Ballast Water and Sediments), all ships are required to implement a proper ballast water management plan to limit the introduction and spread of non-indigenous species in the marine environment[8]; while Annex V of MARPOL sets out the procedures for collecting, processing and disposing of ship-generated waste.

Finally, operators in the sector are also engaged in implementing mitigation measures; some examples are better maintenance of infrastructures to avoid oil spills and implementing activities for early detection of leaks or any kind of damage.

3. Extensive water usage

The oil and gas industry is characterised by extensive withdrawal and consumption of fresh, sea and brackish water. The water is mainly used for drilling and hydraulically fracturing wells, as well as for refining and processing oil and gas.

Unfortunately, some of the most water-stressed regions in the world also represent the locations of intense oil and gas activity, such as the Middle East. Water scarcity represents a serious threat to the health of marine environments because it causes intrusion of saline water in groundwater bodies, thus increasing the pollution that enters the ocean. Therefore, effective water management is needed to handle the volumes of freshwater and non-freshwater withdrawn or consumed, the protection of water quality and the maintenance of access to reliable sources of water, which is essential for the industry.

EXTENSIVE WITHDRAWAL AND CONSUMPTION OF FRESH, SEA AND BRACKISH WATER IS CHARACTERISTIC TO THE OIL AND GAS INDUSTRY OPERATIONS.

Best practices. To reduce freshwater withdrawal and consumption, best practices include the use of water from secondary sources such as rainwater, reclaimed groundwater or treated wastewater. Moreover, companies are studying new ways to re-inject treated production water and reuse it for industrial purposes.

8. International Maritime Organization IMO (2019), Ballast Water Managemen https://www.imo.org/en/OurWork/Environment/Pages/BallastWaterManagement.aspx

4. Introduction of energy

Oil and gas operations entail the introduction of energy into the marine environment, mainly in the form of noise, vibration and light. Moreover, such operations can lead to localised thermal impacts by altering seawater temperature. With regards to noise and light pollution:

INTRODUCTION OF NOISE, VIBRATION AND LIGHT RESULTING FROM THE OIL AND GAS OPERATIONS MIGHT HAVE NEGATIVE CONSEQUENCE ON MARINE LIFE AND ESPECIALLY MARINE MAMMALS.

— Noise and vibration generated through all the activities of the oil and gas sector, including seismic surveys, aerial surveys, construction, drilling and production phases, road or air transportation, might alter the behaviour of marine mammals - with short-term or long-term modifications - and lead to physical damage to their auditory systems, with consequent disruption of their communications, including the echolocation used for navigation (specifically for cetaceans).

Best practices. In order to avoid damage caused by noise and vibration, operators are being encouraged to consider sensitive locations, timings for critical activities in relation to the presence and movements of marine megafauna and regionally important feeding and breeding/nesting areas for marine mammals, seabirds and reptiles (sea turtles).

Moreover, it has proved useful to adopt a ‘soft start’ (i.e. starting acoustic activity at the lowest feasible level and gradually increase it to the required level) to give marine life the opportunity to move away from the source of noise.

— Lighting is an important requirement for the safe operation of equipment and infrastructures. Sources of artificial light can include navigational functional lighting on vessels, drill rigs and facilities and hydrocarbon flaring.

However, light pollution can create disturbance to wildlife, also affecting food availability and thus impacting biodiversity.

Best practices. To avoid light pollution and the related issues for animals, best practices include the reduction of external lighting and the use of spectral modified, green lighting or shielding options.

5. Seafloor integrity

The oil and gas industry can have a detrimental effect on seafloor integrity because of routine operations such as drilling, extraction, pipeline laying and any kind of subsea construction.

Direct impacts of these operations include, among others, physical disturbances due to, for example, drill cutting and anchor chains.

Sedimentation and increased turbidity, associated with smothering, may alter the hydrographical conditions of water (e.g. temperature, salinity, depth, currents, turbidity) thus affecting not only benthic communities but also other fauna living in deep waters.

Best practices. To reduce impacts on the seabed, best practices include the implementation of management plans and monitoring programmes to detect any significant change in the marine environment caused by sector operations and the adherence to international conventions that set out strict regulations on the management of activities and impacts, especially with regards to drilling.

In general terms, additional issues for marine fauna are represented by accidental collisions of marine mammals, large fish and turtles with ships and vessels used for transportation of oil and gas. In order to avoid these types of risks, as a best practice, operators work with Marine Mammal Observer (MMO) and Marine Fauna Observer (MFO) teams during the various stages of projects in order to better plan their activities. Moreover, adherence to the Vessel Code of Conduct and international best practices for vessels is considered a useful mitigation measure.

Finally, decommissioning of oil and gas infrastructure is also an important part of the process to be carefully managed in order to avoid negative impacts on the marine ecosystem. Indeed, decommissioning activities can result in the re-introduction of contaminants into the environment and several other direct impacts. Companies are being encouraged to dismantle and remove or reuse facilities in accordance with environmental standards applicable to the local contexts.

OIL AND GAS OPERATIONS SUCH AS DRILLING, EXTRACTION, PIPELINE LAYING AND ANY KIND OF SUBSEA CONSTRUCTION MIGHT HAVE CONSEQUENCES ON THE INTEGRITY OF THE SEAFLOOR, AFFECTING BENTHIC ANIMALS AND OTHER FAUNA LIVING IN DEEP WATERS.

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