WP 4: Socio-economic trends and EU policy in offshore economy

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Chapter 6 – Offshore Oil and Gas

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About MARIBE

MARIBE is a Horizon 2020 project that aims to unlock the potential of multi-use of space in the offshore economy (also referred to as Blue Economy). This forms part of the long-term Blue Growth (BG) strategy to support sustainable growth in the marine and maritime sectors as a whole; something which is at the heart of the Integrated Maritime Policy, the EU Innovation Union, and the Europe 2020 strategy for smart, sustainable growth.

Within the Blue Economy, there are new and emerging sectors comprising technologies that are early stage and novel. These are referred to as Blue Growth sectors and they have developed independently for the most part without pursuing cooperation opportunities with other sectors. MARIBE investigates cooperation opportunities (partnerships, joint ventures etc.) for companies within the four key BG sectors in order to develop these companies and their sectors and to promote the multi-use of space in the offshore economy. The sectors are Marine Renewable Energy, Aquaculture, Marine Biotechnology and Seabed Mining. MARIBE links and cross-cuts with the Transatlantic Ocean Research Alliance and the Galway Statement by reviewing the three European basins (Atlantic, Mediterranean, and Baltic) as well as the Caribbean Basin.
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Chapter 6 – Offshore Oil and Gas
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Executive summary
Favoured by low selling prices, high production costs and the development of new onshore exploitation techniques, offshore oil and gas activities are experiencing an important decline. The European sector is mainly composed of private companies that operate mostly at the global scale. However, the production from its territorial waters accounts for 9% and 13% respectively of the total oil and gas consumption in Europe, respectively. Thus, this decline can undermine the energy interests of the EU and especially, the economic activity of the North Sea countries (responsible for the production of virtually all of the oil and more than 80% of the gas).

Despite this negative outlook, the development of new and more efficient subsea exploitation systems can provide an important boost to the sector. However, in a MARIBE context, the main importance of this industry relies on its important legacy of knowledge and experience (skills, business models, concepts of permanent occupation of the marine environment, infrastructure, etc.).

With this in mind, this report describes the main features of the offshore oil and gas industry along with the opportunities and barriers that it can suppose for the development of Blue Growth and MUS/MPP concepts.

6.1. Introduction
By value, technology and geopolitical status, the offshore oil and gas sector (O&G) is by far and away the most important sector in the contemporary Blue Economy. Offshore O&G came to prominence in the 1970s and currently accounts for about 37% and 28% of the total O&G global productions respectively (WOR, 2014). Companies continue to extend their areas of operations, with "Exploration and Production" (E&P) in ever more extreme and hostile areas. E&P is set to take off in the Arctic Ocean as the ice retreats; fields are already in production at the so called ‘Atlantic Frontier’ between Scotland and Faroe. The 1970s extreme of North Sea working at depths of up to 300m is replaced by a contemporary technology of working at depths in excess of 1500m. In contrast to the transient activities of fisheries and shipping, the offshore O&G sector introduced the concept of semi-permanent occupation of maritime space. It introduced the idea of fixed platforms at sea which could be supplied with materials and services for the production of O&G and a safe home for thousands of workers over hundreds of kilometres from land. The sector has led the way in maritime health and safety and in the development of risk assessed regulation to control operations and protect the environment.

However, the offshore O&G sector is also in decline. Recent, and possibly sustained, falls in the oil price render offshore production uneconomic compared to adequate low cost onshore resources and the rise of the ‘fracking’ process for onshore gas. Industry sources believe that the rapid advance of offshore technology peaked in the 1990s and has slowed very considerably. The whole (land and marine) oil sector has been driven by global dependence on fossil fuels as the main resource to supply a burgeoning energy demand. Many companies have employed successful business models and made
their fortunes. The economic and political drivers have been with them. Others have been attracted to the sector by its successes but have not had the skills, or the luck, to flourish.

In 2015, the O&G sector has achieved maturity as the world approaches what is believed to be the ‘peak oil’ event. Pressure grows for emissions restraint and alternative sources of clean energy. Notwithstanding this, and in spite of efforts to move to new energy technologies such as renewable, the use of fossil fuels continues to dominate energy supply and is forecast to continue to do so (well in excess of 50%) for the next fifty years or so. An as yet undetermined transformational technological event, perhaps in renewable and energy storage technologies, might possibly change this equation but current forecasts anticipate continuing dominance of fossils sourced primarily from terrestrial areas. The economic factors are, though, not the complete picture. Geopolitical factors have played a hugely significant role in O&G markets and will continue to do so. Oil has been used as a weapon by major producers to exploit their resources to the full and to punish those states they do not agree with. Wealthy states with smaller resources have therefore acted to exploit their own, even at uneconomic rates, for the purposes of energy security. Poor developing states have been anxious to develop any easily recoverable reserves to generate economic growth and foreign exchange. These will include the more accessible offshore resources.

6.1.1. The offshore Oil and Gas sector in the development of Blue Growth.

The global O&G market is highly complex and largely beyond the scope of this report. Although the offshore O&G industry may be at or past its peak, its products (not only fuels, but also e.g., synthetic materials) still will be necessary for the development of marine economic activities. In any case, its true value to Blue Growth is what it bequeaths at many levels. The successful offshore operators have established technologies, infrastructure and operational skills of enormous value to the Blue Growth sectors while, so far, demonstrating little appetite for diversification themselves. Many O&G companies started small preliminary investment in renewables but most have pulled back from serious participation. A few have gone further, like Statoil in the development of floating wind. However, with the depletion of traditionally exploited fields a new factor will enter into force in the short term: decommissioning. In the North Sea alone, 7% of the existing facilities are in the decommissioning process, and it is estimated that over the next 30 years this process will affect to 500-690 additional infrastructures (RAE, 2013).

With all this in mind, the great resource transferability from the O&G industry to the new Blue Growth sectors is clear, being:

- infrastructures,
- technologies,
- operation procedures,
- human skills,
- supply industries and
- financial resources.
6.2. Market

6.2.1. Products
The need for energy has been the principal driver for the development of the O&G industry. While fuels needed by transport activities are the main oil products, gas is widely used in electricity generation and heating processes. However, O&G products and by-products have a wide applicability in day-to-day lives as they are used, among others, as raw materials for plastics, lubricants, waxes, tars, synthetic clothes, rubbers, paint or photographic films (Figure 6.1).

![Figure 6.1. Consumption of O&G products in different industrial sectors (Source: WOR, 2014)](image)

6.2.2. Market trends.
These are not good times for the O&G market. Imbalances between supply and demand, still tangible effects of the financial crisis, enforced environmental policies, changing consumer preferences or the development of more efficient transport systems have severely hit the industry. However, and despite of its marked and sustained slowdown, the global O&G consumption continues increasing driven by developing economies. As observed in Figure 6.2, two general global trends are observed (Mitchell et al., 2012; BP, 2015):

- Non-OECD countries: Growth markets. Developing economies (mainly China) are responsible for the net growth in global consumption. However, these economies are facing an important deceleration, which is being reflected as a slowdown in the consumption growth rates of the sector.
- OECD countries: Non-growth markets. Opposite to developing economies, the O&G consumption growth rates in the OECD economies remain stagnant or even declining. Noteworthy in this regard are the cases of Japan and the EU, which have suffered, respectively, the largest O&G consumption declines over the last decades.
6.2.3. Prices

Hydrocarbon products are not common trading goods and complex factors influence their prices. Traditionally, their prices have been determined by the fundamentals of supply and demand, being directly influenced by factors like weather, changes in supply/demand patterns or the supply capacity of the producing countries. However, geopolitical and speculative factors have become of special relevance over the last decade. In geopolitical terms, the control over the production, distribution and prices provides economic and political power. Following the opening of the sector to financial markets, O&G products have become assets of great interest, strongly subjected to speculative interests. Although these factors are strongly interconnected, their individual influence degree on prices varies depending on specific political and economic situations or interests. As a result, prices in the sector are extremely volatile and unpredictable (Figure 6.3).

Figure 6.2. Global, OECD, Non-OECD and EU O&G consumptions for the 2004-2014 time period (Source: BP, 2015).

Figure 6.3. Evolution of Oil (Brent Barrel) and Gas (Average German Import Price) prices for the 1977-2014 time period (Author’s compilation based in: NRCan, 2010; Owen et al., 2010; BP, 2015)
6.2.4. Future supply and demand gaps

As finite resources, existing O&G reserves can’t, by definition, be able to meet the growing demand. In absolute figures, important disagreements exist between oil companies, which affirm to handle enough reserves for the decades ahead, and the critical voices that warn about the near depletion of stocks. Considering the industry as a whole (onshore + offshore) both the discovery of new reserves (e.g. deeper offshore fields) and the development of non-conventional exploitation techniques (e.g., fracking, tar sands) will increase the availability of the resource, extending its potential supply capacity over time. However, these new reserves and non-conventional techniques characterise by their higher exploitation costs. Therefore, the inability of the sector to commercially exploit its resources at prices assumable by the global economy may turn in a more crucial determinant, rather than the amount of reserves themselves (Owen et al., 2010). This might be of particular importance for offshore activities in which the trend towards exploiting even more hostile and remote areas implies a huge increase in operational costs. This may result in making them even economically unfeasible.

In addition, the O&G industry faces a great competitiveness that can influence its future supply-demand trends (Mitchell, et al., 2012). In terms of intra-sectoral competition (Oil vs. Gas), the oil sector has largely relied on the transportation market (see Figure 6.1). Lower prices of gas can be a driver for the development of gas-fuelled engines and encourage the replacement of oil as a principal fuel. On the other hand, the growing pressure from new fuels, new energy supply types and users requiring alternative non-fossil energy types, may further decrease the demand for O&G products (new biofuels and materials; electric vehicles; environmental protection policies; diversification of energy sources, e.g., renewables).

6.3. Sector industry structure and lifecycle

6.3.1. Lifecycle

Although for the following decades O&G will remain as the main supplier for the global energy demand, the decline affecting the sector is particularly relevant for offshore activities. Following the depletion of traditionally exploited shallower fields, the production at deeper and more hostile areas presents important economic barriers. Even more, the new non-conventional exploitation techniques (e.g., fracking) can redirect the focus of the industry towards onshore activities to the detriment of offshore production.

6.3.2. Industry sectors and segmentation

Depending on the processes involved, the O&G industry is divided into upstream (exploration, drill wells, production), midstream (transportation and storage) and downstream (refining and marketing) activities. However it is important to take into account certain aspects. First, only upstream and midstream activities relate to offshore activities. And second, as onshore activities, downstream processes do not offer interesting alternatives for Blue Growth or potential combinations with other marine economic activities. Thus, considering the scope of this report, only upstream and midstream sectors activities will be considered (Table 6.1).
6.3.3. Horizontal and vertical integration

Major oil companies usually have a fully integrated structure (vertically and horizontally). Given their huge resources they cover the whole O&G supply chain, from exploration and production of new reserves, to transportation, and, to the final refining and sale to the consumer (upstream-midstream-downstream). On the other hand, small companies do not have enough resources (or interest) to cover the entire supply chain. Usually they develop their activities in very specific segments of the industry (e.g., geophysical surveys, activities exclusively focused on production or transporting) and sell their products/services to third parties of the supply chain. Finally, mergers and acquisitions are common in the industry, so the release or subcontract of certain activities are a common practice of oil companies (horizontally within the different segments and vertically along the supply chain- Figure 6.4).

<table>
<thead>
<tr>
<th>Sub-Sectors</th>
<th>Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upstream</strong></td>
<td>Search and exploration of resources, well drilling and extraction of raw materials</td>
</tr>
<tr>
<td><strong>Midstream</strong></td>
<td>Transportation (pipelines, LNG/oil tankers) and storage of extracted raw materials</td>
</tr>
</tbody>
</table>

**Table 6.1. Sectors and segments of the O&G industry**

Figure 6.4. Activities developed within the supply-chain of the O&G industry (based on DTI, 2001).
6.3.4. Centres of activity

Currently, more than 600 active offshore extraction platforms exist in the EU-28, a value that significantly increases if those located in Norwegian waters are considered. The European offshore production constitutes 9% and 13.8% of the total O&G consumption, respectively. Therefore, the offshore production of hydrocarbons represents an important energy resource for Europe (JRC, 2015). Figures 6.5 and 6.6 show the distribution of the major O&G reserves and their associated infrastructure in the studied basins.

In the Atlantic basin, most of the exploration and production is developed in the North Sea. Practically all of the oil and more than 80% of the gas produced in Europe are produced by countries bordering the area (i.e., Norway, UK, Denmark, the Netherlands and Germany). Undeniably Norway, and the UK to a lesser extent, are the leading countries in terms of production (Figure 6.5). This is clearly reflected by the greater number of reserves and development of infrastructures within their territorial waters.

Compared to the North Sea, the offshore production in the Baltic seems minimal. Production activities mainly develop along the Polish coast and represent only 0.1% of the total offshore production (Figure 6.5). However, this basin plays a very important role in strengthening the energy security of the EU. With a length of 1,224 km and a combined transport capacity of 55 bcm/yr (27.5 bcm per line), the Nord Stream twin pipeline crosses the Baltic Sea serving as a connection between the vast Russian gas reserves and the European markets (Nord Stream, 2014).

In regards to the European territories of the Mediterranean, traditional production areas have been located in Spanish, Greek, Maltese and Adriatic waters (mainly Italian). In this latter case, of special attention is the increase in the offshore production of Croatia. Although these activities can improve the energy self-sufficiency of the country, many critical voices warn about the danger for a so tremendously important sector for the economy of the country as it is tourism. In any case, the main production areas in the Mediterranean are outside the territorial seas of the EU, being especially important the North African coast and the recent discoveries in the eastern Levant basin. These latter findings, partially located in Cypriot waters, have enabled the cooperation between the EU and some eastern Mediterranean countries (e.g., Israel, Lebanon). The agreements relate to issues such as, optimisation of exploitations, development of infrastructures, access to European markets, or pricing. Among the regarded options, the construction of the Cyprus-Greece pipeline or the building of a LNG terminal in Cyprus can be highlighted (EC, 2013). Romania and Bulgaria on the one hand (intra-EU) and Turkey and Ukraine (extra-EU) on the other, have been the main hydrocarbon producers in the Black Sea. Historically, countries bordering the Black Sea have shown little interest in the exploitation of their massive energy resources. Importation (mainly from Russia) has been proven as an easy and cheap option for them. However, changes in the energy markets, the discovery of new reserves in the Bulgarian, Romanian and Turkish coasts or political tensions with Russia, are strengthening the development of offshore production in the region.

Finally, the Gulf of Mexico and the Caribbean Sea have major actors in the energy sector (Figure 6.6). The offshore production infrastructure in the Gulf of Mexico accounts for 17% and 5% of the total US O&G production respectively (EIA, 2015). However, despite being one of the main global energy producers, given its high internal demand for energy, the US is at the same time one of the leading energy importers (IEA, 2014). It is striking that, in contrast to the US, Mexico has not diversified its
production towards the deepest areas of the Gulf despite its own jurisdiction over the area. The reason for this is that the offshore production of Mexico has been traditionally focused on the reserves of the Cantarell complex. This complex is one of the largest hydrocarbon reserves in the world, which given its shallow depth is more easily accessible. However, the decreasing level of this reserve and the negative balance of the restitution rate is accelerating the search of new resources in the deepest area of the Gulf (PEMEX, 2014). In Caribbean waters, together with Venezuela and Trinidad and Tobago, Colombia forms the group of countries with more activity in the sector. Although somewhat belatedly in comparison with its neighboring countries, Colombian authorities have increased their interest in the offshore industry. According to recent estimates, Colombia’s offshore reserves, if proven, could multiply by 6 and triple their current O&G reserves respectively (ANH, 2014). As such the country is undergoing an intense process of evaluation and exploration of its marine resources. Venezuela is engaged in several projects of exploitation (mainly gas) in order to ensure its energy auto-supply capacity and to consolidate itself as one of the main producers and exporters worldwide. In this sense, the “Rafael Urdaneta” (northwest coast) and “Mariscal Sucre” (northeast coast) projects are noteworthy, whose purpose is to reach a production of 1200 million cubic feet per day. Finally, the “Plataforma Deltana” project, aims to exploit the gas resources along the border with Trinidad and Tobago. This project is part of the agreement signed between both countries for the unification of their shared deposits. The exploitation of these shared deposits (operated with the participation of international private partners) has as main objective to generate revenue for the social and economic development of both countries. Finally, Trinidad and Tobago has been actively involved in the construction project of the Eastern Caribbean Gas Pipeline, which will ensure the supply of gas from Trinidad and Tobago to the Eastern Caribbean islands.
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 652629

Figure 6.5. Distribution of main Oil and Gas fields and associated infrastructure in the Atlantic, Baltic and Mediterranean basins (Authors’ compilation based in: ENTSOG, 2015; JRC, 2015; Lujala et al., 2007).
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Figure 6.6. Distribution of main Oil and Gas fields and associated infrastructure in the Gulf of Mexico and Caribbean basin (Authors’ compilation based in: ANH, 2016; BOEM, 2016; Lujala, et al., 2007; Petróleos de Venezuela SA; Theodora. com).
6.3.5. Types of ownership

In the same way that the demand for O&G presents two differentiated patterns (OECD and non-OECD economies), the ownership of O&G reserves also shows two main actors: private companies and National Oil Companies (NOCs). In any case, given the importance of the energy sector for the world economies, purely private companies do not exist. Even in the most developed economies, where O&G is supplied by private companies, the sector is strongly influenced by government policies (e.g., subsidies on exploitations and transport, taxes to consumption, price manipulation...).

Private companies have as main objective to make profits for their shareholders (e.g., Shell, BP, Exxon Mobil). Typically, they exploit and produce their resources more quickly than NOCs (10-12% depletion rates, compared to 3-5% of NOCs). While their resources and infrastructure have a global coverage, their headquarters are normally located in developed economies and direct their production to competitive markets (OECD).

Although NOCs share about 86% of proven reserves, their production rate is comparable to that of private companies (55% of the total). Apart from their national economies, their main customers are located in emerging economies (non-OECD). NOCs normally belong to countries with a high economical reliance on their O&G exports. Hence, their production and reserve exploitation policies are highly conservative in comparison to those of private companies. The protectionism degree of governments towards their NOCs, closely relates to the diversification of their economies. As a result, there exist two types of NOCs. The NOCs organised as corporations have strategic and operational autonomy. Although mostly controlled by governments’ interests, part of their shares are publicly traded and subject to private funding (e.g., Petrobras, Statoil, Gazprom). Thus, they are subjected to the rules of the Stock Exchange, and characterise by their commercial objectives and income generation. The NOCs that operate as an extension of government are aimed to support national policies, both strategically and financially (e.g., Pemex, Saudi Aramco, Petróleos de Venezuela). Their objectives do not directly relate to the markets, as they seek to boost the national and foreign objectives of their countries (e.g., offering lower prices to domestic consumers or generating long term incomes for their economies). In any case, operation agreements between both types of companies (privates and NOCs) are a common practice in the sector that permit to leave in hands of private companies the operation of NOC owned reserves.

6.3.6. Rules and regulations

Since it is a source of important incomes (e.g., by means of taxation, awarding of exploitation licenses, etc.), the O&G industry is crucial for the economies of producing countries. This regulation not only affects to the economic activity itself, but also it is subject to strong requirements on environmental safety. All this complexity is at the same time, the main cause for investor’s reluctance. They opt to invest in countries with favourable regulatory frameworks. Therefore, regulation can become a double edged sword, as both strict and lax regulations may impair the economic interests of producing countries. As a result, the regulation in the sector is strongly influenced by constant challenges and opportunities in order to maintain a balance between national interests and concessions to the private sector (e.g., changing fiscal regimes, socio-political and environmental sensitivities, etc.). Annex 6.1 shows the main regulations affecting the sector in terms of economic activity, environmental protection and liability and compensation.
6.4. Working environment

6.4.1. Economic climate

As already observed, economic and geopolitical factors have a great influence on the performance of this sector. The slow recovery of major economies (e.g., Europe, Japan, China) and current political conflicts in the Middle East and Russia-Ukraine (together with the sanctions imposed by the EU and US), fuel the mistrust of markets in the industry. As a result, the industry has to face an uncertain economic climate (Hays, 2015), in which producer countries adopt different response strategies.

NOCs, are an important support for their economies. As an example, PEMEX revenues have accounted approximately for 35% of the Mexican federal government’s budget, and PDVSA is the main company sustaining the Venezuelan economy. Therefore, the decline in demand and prices can cause a fatal impact in the socio-economic development of these countries. Thus, the attraction of foreign investments is part of the solution to get cash in both cases (e.g., potential denationalisation of certain fields, exploitation agreements, sale of international assets...). In the case of European private companies, the ageing of their reserves is an additional factor to be considered. Waiting for favourable regulatory and economic changes, these companies have opted to avoid or minimise new investments.

6.4.2. Employment, skills and migration

Figure 6.7 shows the direct employment created by the sector in some of the considered countries. It provides a picture of the most important countries in the sector and its relative importance to their national economies: countries with higher production capacity, are those generating a greater number of direct jobs in the sector. The importance of the industry in terms of employment relies on its ability to create indirect employment. In the North Sea alone, it is estimated that each direct employment in the sector induces up to 7.5 other indirect jobs (ECORYS, 2013).

In the coming years, skill shortage will be one of the main problems to be faced by the sector. The rejuvenation of the workforce (added to a poor transfer of knowledge), the retirement of experienced workers, the poor update on technological advances, or strict immigration laws that prevent the access to global talent are among the main causes for this shortage. Much of the expertise required in the sector relates to fields such as science, technology, engineering or mathematics (STEM), in which women have a strong and increasing presence. The industry is highly masculinised industry and in order to balance the lack of skills, O&G recruiters are increasingly putting their sight on the incorporation of women to the sector (Hays, 2015).

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1 In general, the information provided in this section refers to the Oil and Gas sector as whole (inland + offshore activities). However, the main European Oil and Gas producers develop their activities at sea. Thus, at least for European countries these figures can be considered fairly representative of specifically offshore activities.

2 The data in this section must be considered as indicative as:
- it has not been possible to find data for all the countries involved in offshore activities
- depending on the sources, direct employment data can vary significantly

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Regarding the migration and mobility of workers, the areas of interest for this report (Europe, Africa, and North/South America) rely principally on their local workforce (Figure 6.8). However, the mobility of workers shows two differentiated patterns:

- **Africa and North/South America**: most of its workers are based in their home countries. Given their larger reserves and higher presence of NOCs (Africa and South America), the activity in these areas might be mainly focused on their territorial waters.

- **Europe**: in this case there is a balance between the workers who work in their countries of origin and those overseas. In general, and in contrast to the previous areas, Europe is characterised by its smaller reserves and by an industry dominated by private companies. These companies commonly operate at the global level, developing much of their production out of European territorial waters and favouring the displacement of workers outside their countries of origin. In addition, the high skills of its workforce can act as additional drivers for the mobility of European workers.

- **Middle East** industry depends mainly on imported labour.
6.4.3. Economic indicators
6.4.3.1. Contribution to GDP

Figure 6.9 shows the contribution to GDP of the rents derived from the extraction of hydrocarbons in the producing countries around the studied basins. Despite exceptions (e.g., Trinidad and Tobago, Ukraine, Netherlands, Israel), incomes derived from the exploitation of oil exceed those obtained through gas exploitation. Probably this is due to the fact that oil has been traditionally a more intensively exploited and marketed resource than gas, and consequently, more heavily taxed. However, it is likely that this pattern will change in the future: the depletion of oil reserves, along with changes in the preferences of the markets (lower prices of gas, replacement of oil as a primary fuel in transport) can help the expansion of the gas sector and increase the amount of rents collected by producing countries.

Driven by their higher amount of reserves and the lower diversification of their economies (a probable consequence of the former), Caribbean and North African countries are those with a higher reliance on the Oil and Gas sector.
6.4.3.2. Wages

Exceeding a global average of $81,000 annually, salary is one of the main attractions for workers in this sector (Hays, 2013). The countries bordering the North Sea, the US, Colombia and France are at the top of the list, exceeding that average for either their local or imported workforce (Figure 6.10).

In contrast to Norway where salaries of local workers may be up to 60% higher, the remainder of the North Sea countries, US and France present a balance in the wages for both types of workers. These cases should be considered exceptions and indicative of their highly skilled local workforce. In the rest of the countries the salaries of foreign workers are significantly higher, which may be due to two main reasons:

- The allocation to foreign subsidiaries or exploitations of workers from private US and European companies
- Attempts to attract talent by countries with much production capacity but with a lack of skilled labour.

The bonuses received by the workers are another important aspect to be considered in relation to wages. Companies commonly offer incentives in order to ensure and maintain their skilled workers. Almost 80% of the staff in North Africa and South and North America receives some kind of bonus, while in Europe this value drops to 60%. Bonuses, health plans, home allowances or retirement plans are among the most common incentives.
6.4.3.3. Export potentials

Table 6.2 shows major O&G exporting and importing countries. At the EU (+ Norway) level, the only countries with a certain gas export potential are Norway and the Netherlands. In fact, despite of the production activity developed by some Member States, the EU as a whole, is a net energy importer. Outside its territorial waters, the Caribbean and Mediterranean basins are those with a higher exports potential. In the Caribbean, the development of new offshore exploitations can strengthen the role as exporting countries of Mexico, Venezuela and Trinidad and Tobago. In this latter case, the construction of the Eastern Caribbean Gas Pipeline which will ensure the supply of gas from Trinidad and Tobago to the Eastern Caribbean Islands, will reinforce its role as gas supplier in the region. The recent discovery of huge gas reserves in the Eastern Mediterranean, not only increases the production capacity of the basin (mainly developed in North Africa) but also the export potential of the Eastern Mediterranean countries. In this sense, the agreements signed by the EU and these countries (e.g., Israel), involve a series of advantages for the EU in terms of imports-exports, which might be helpful to ensure its energy security.
6.4.4. Infrastructure and Support services

Given its complexity and the risks involved, the oil and gas industry requires a large amount of supporting services. Although some large companies integrate these services within their structures, contracting third-parties for support services is a common practice in the sector. These services include a variety of additional economic sectors, which among others, relate to shipping, port services, R&I, construction or health and safety. Following the NACE classification of economic activities (EUROSTAT, 2008), Annex 6.2 shows the main economic sectors involved in the services provision to the offshore O&G industry. In any case, it must be noted, that the annex shows a simplified image of supporting services since only the sectors which can have a more direct impact in the E&P process are shown (excluding activities related to e.g., the fabrication of basic tools and goods, the habitability of the platforms or the accommodation of workers).

6.5. Innovation

6.5.1. Innovative aspects on technology

The depletion of the more accessible offshore reserves (< 400m depth) has pushed the search for hydrocarbons towards deepwater (~ 1500m) and ultra-deepwater (> 1500m) areas. The use of the most advanced geophysical exploration techniques has enabled the detection of vast deposits at depths of up to 12 km. According to recent estimates, these deepwater /ultra-deepwater deposits account for more than 50% of the newly discovered larger offshore fields (i.e. fields with an estimated minimum recoverable reserve of 170 billion barrels). However, the high costs of production at such deep locations, puts in risk the economic viability of these deepwater/ultradeep water reserves (WOR, 2014).

In this sense, the development of subsea completion systems offers a series of advantages and alternatives to the traditionally use of large platforms (Figure 6.11). Integrated by several components
for the processing of oil and gas (compressors, pumps, and separators), these systems are directly deployed onto the seabed, and underwater robots connect the different components to form large production ensembles. Among the advantages provided by these subsea systems, the following are innovation areas currently being explored:

- Simplification and efficiency improvement of the extraction, cleaning and processing processes: improves the performance of pumps and compressors and avoids the need for pumping to drilling platforms.
- Reduction of the amount of offshore production infrastructures
- Increase of the exploitation radius: possibility to deploy within a wider radius different wells which pump to a common production station
- Reduction of operating costs

Although several fields operated by these subsea systems already exist (e.g., Gulf of Mexico, South America, Norway), its full commercial development is still subject to a number of technological innovation aspects. In traditional platforms the maintenance of production infrastructures (pumps, compressors, etc.) may be relatively simple. However, these tasks turn highly complex when working subsea and at such great depths. In order to solve these issues, much of the innovation work in the offshore industry is focused on the development of robust, highly reliable and commercially operative submarine production systems (WOR, 2014).

Figure 6.11. The Ormen Lange exploitation operated by Shell (Norway). A: processing land facility; B,D: pipeline system; C: Drillship; E: subsea templates supporting up to 8 wells (>1000m depth); F: wells; G: reservoir; H:export pipelines (Source: http://www.shell.no/products-services/ep/ormenlange/en.html).
6.5.2. Decommissioning and cross-sectoral opportunities

Decommissioning is the dismantling process of O&G infrastructures once the exploitations reach the end of their lifecycle. Given the rapid decline of the reserves in the North Sea, most of the information on decommissioning relates to that area. It is estimated that all of the existing facilities will require decommissioning over the next 30 years (RAE, 2013). These operations will not only require strong economic investment (estimations in the North Sea exceed £30 billion over the next 30 years) but also great human and technical capital. In any case, it can be expected that with the future depletion of existing exploitations, decommissioning will also acquire an increasing importance in the other MARIBE basins. However, considering the scope of this report, it presents some interesting characteristics and possibilities for Blue Growth:

a) From a strict point of view, decommissioning is not considered a sector within the O&G industry. However, as a result of the decline of the sector, it may emerge forcefully as a new offshore and highly technical activity that may absorb and replace the loss of highly skilled employment from E&P activities.

b) Development of MUS / MPP activities: existing offshore O&G platforms can turn into assets of great value, as they can provide the infrastructure needed for the combination of maritime activities. However, based on previous experiences from the Gulf of Mexico (BOEM, 2007) the success of these combinations may vary greatly.

b.1) Active platforms: apart from being the owners of the platforms, oil companies assume elevated risks and costs in their production activities. For this reason, it cannot be forgotten that in any combination including the use of any active facility, the interests of the O&G industry will always predominate against additional industries. Thus, oil companies may be reluctant to combine and share their infrastructures with sectors that add risks to their operations without obtaining any direct benefit (e.g., aquaculture, immature renewable technologies). As an exception, the combination with wind energy can arise more interest, since the combination of these fully developed technologies can provide short term benefits to all parties.

b.2) Obsolete platforms: this seems to be the most suitable option for the combination of activities, since it reduces either the power positions between industries or the risks associated with the oil industry (e.g., spills, contamination of farmed species, etc.). It can also be an incentive for oil companies, which can consider it as an option to delay and reduce the expenses of the future decommissioning of their infrastructures (rental agreements, leases, etc.). However, this option also poses a series of challenges, related mainly to the regulatory framework. Despite some exceptions that enable derogation (e.g., sub-structures weighing more than 10,000 tonnes), most of regulations on decommissioning dictate the complete removal of all the infrastructures once they become obsolete (e.g., UNCLOS Article 60 (3); OSPAR Decision 98/3). Therefore, the possible re-use or reconversion of obsolete platforms must be regarded as a case-by-case study of the available options and applicable regulations.
6.6. Investment

Government incentives, public donors (e.g., EU) and private investors are the main funding source for oil companies (ECORYS, 2013).

The O&G industry is very lucrative not only for companies, but also for Governments, that receive large amounts of revenues through the taxation derived from the whole sector chain (from producing companies to final consumers). To ensure these revenues and attract and retain the investment in the sector, Governments often provide support to oil companies (Table 6.3).


<table>
<thead>
<tr>
<th>Intervention type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural resource access</td>
<td>Policies governing the terms of access to domestic onshore and offshore resources (e.g., leasing)</td>
</tr>
<tr>
<td>Cross-subsidy</td>
<td>Policies that reduce costs to particular types of customers or regions by increasing charges to other customers or regions</td>
</tr>
<tr>
<td>Direct spending</td>
<td>Direct budgetary outlays for an energy-related purpose</td>
</tr>
<tr>
<td>Government ownership</td>
<td>Government ownership of all or a significant part of an energy enterprise or a supporting service organization</td>
</tr>
<tr>
<td>Import/export restriction</td>
<td>Restrictions on the free market flow of energy products and services between countries</td>
</tr>
<tr>
<td>Information</td>
<td>Provision of market-related information that would otherwise have to be purchased by private market participants</td>
</tr>
<tr>
<td>Lending</td>
<td>Below-market provision of loans or loan guarantees for energy-related activities</td>
</tr>
<tr>
<td>Price control</td>
<td>Direct regulation of wholesale or retail energy prices</td>
</tr>
<tr>
<td>Purchase requirements</td>
<td>Required purchase of particular energy commodities, such as domestic coal, regardless of whether other choices are more economically attractive</td>
</tr>
<tr>
<td>Research and development</td>
<td>Partial or full government funding for energy-related research and development</td>
</tr>
<tr>
<td>Regulation</td>
<td>Government regulatory efforts that substantially alter the rights and responsibilities of various parties in energy markets or that exempt certain parties from those changes</td>
</tr>
<tr>
<td>Risk</td>
<td>Government-provided insurance or indemnification at below-market prices</td>
</tr>
<tr>
<td>Taxes</td>
<td>Special tax levies or exemptions for energy-related activities</td>
</tr>
</tbody>
</table>

Funding through their own reserves, private equity funds, bank loans or bonds are the main forms of private investment. While government investments seek to secure revenues for the development of their national economies, private investments try to maximise benefits. Thus, private investors use to opt for high risk investments (in more hostile areas or new explorations), which provide the opportunity to obtain greater benefits.

6.7. Uncertainties and concluding remarks

Although the dominance of the O&G industry as the principal energy supplier is expected to continue in the future, its offshore activities are in decline. The depletion of the more accessible reserves has driven the search and exploitation of hydrocarbon resources towards more remote and therefore, more expensive areas. This, together with the development of new onshore techniques and the general fall of prices, can turn offshore activities economically unfeasible. While the big European...
Companies operate at the global scale, the production in European territorial waters accounts for 9% and 13.8% of the total oil and gas consumption of the EU, respectively. Within territorial waters, most of the activity is developed in the North Sea, being Norway and UK by far the principal producers. The Caribbean is one of the main producers worldwide and the Mediterranean holds recently discovered enormous deposits. However most of these deposits are located outside the EU’s territorial waters. Therefore, the decline of the North Sea reserves may limit even more the supply capacity of the EU and increase the need for importation of hydrocarbons.

In any case, the decline of the O&G sector also presents a series of opportunities and challenges for the development of BG industries, which principally rely on two fundamental aspects of the industry: skills and infrastructure.

- **Skills.** The extensive working experience in the marine environment, has resulted in a competitive industry which holds a highly skilled workforce. In this sense, the high human skill transferability and the experience dealing with adverse situations (both environmental and financial), are of great interest and a good example for the development of new offshore economic activities.

- **Infrastructure.** The sector has a large number of offshore infrastructures, which could be an important support for BG sectors, and more specifically, for the development of MUS/MPP concepts. However, most of the current marine legislation dictates the dismantling of all the existing infrastructures once they reach the end of their lifecycle. Despite certain exceptions that permit for derogation, decommissioning is an extremely complex process. These difficulties not only rely on the huge financial and technical requirements, but also in the possible environmental and socio-economic impacts (e.g., pollution, conflicts with fisheries/aquaculture, restrictions on the use of space, ecological impacts). At national levels, the development degree of policies and guidelines on decommissioning, varies depending on the maturity of the O&G industry and the previous experiences of countries. In this way, countries like Norway and UK have regulatory provisions on decommissioning in their legal frameworks. These requirements range from constitutional provisions to specific requirements (World Bank, 2010b). The creation of a common and clear regulatory framework not only will allow to operators know the requirements to be met, but it can also set the conditions that will allow the conversion of already existing infrastructures. Thus, for the moment, the reuse for new purposes of an existing O&G infrastructure, will be subjected to a case by case study, in which either the type of infrastructure or the regulatory framework to which it is subject must be considered.
6.8. References


ANH (2016). Mapa de Tierras. Agencia Nacional de Hidrocarburos. (http://www.anh.gov.co/Asignacion-de-areas/Paginas/Mapa-de-tierras.aspx)


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## Annex 6.1- Regulation in the Oil & Gas industry

<table>
<thead>
<tr>
<th>Economic activities (reserves, licenses, exploration and production...)</th>
<th>EU</th>
<th>US</th>
<th>Mexico</th>
<th>Venezuela</th>
<th>Colombia</th>
<th>Trinidad and Tobago</th>
</tr>
</thead>
</table>
| **EU** | • Directive 94/22/EC on the conditions for granting and using authorisations for the prospection, exploration and production of hydrocarbons  
• Decision 1999/280/EC regarding a Community procedure for information and consultation on crude oil supply costs and the consumer prices of petroleum products  
• Decision 2003/796/EC on establishing the European Regulators Group for Electricity and Gas  
• Regulation (EC) 715/2009 on conditions for access to the natural gas transmission networks  
• Directive 2009/119/EC imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products  
• Regulation (EU) 994/2010 concerning measures to safeguard security of gas supply  
• Regulation (EU, Euratom) 617/2011 concerning the notification to the Commission of investment projects in energy infrastructure within the European Union and repealing Regulation (EC) No 736/96 | | | | | | |
| **US** | • Outer Continental Shelf Lands Act (OCSLA)  
• Oil and Gas Royalty Management Act  
• Petroleum Marketing Practices Act | | | | | | |
| **Mexico** | • Ley de Hidrocarburos | | | | | | |
| **Venezuela** | • Ley Orgánica de Hidrocarburos  
• Ley Orgánica de Hidrocarburos Gaseosos | | | | | | |
| **Colombia** | • Ley 1274 de 2009 por la cual se establece el procedimiento de avalúo para las servidumbres petroleras | | | | | | |
| **Trinidad and Tobago** | • The Petroleum Act  
• The Petroleum Regulations  
• The Petroleum Taxes Act | | | | | | |
| **Environmental protection** | | • Annex III on elimination of offshore pollution sources  
• Recommendation 2010/18 on the prevention of significant acute oil pollution from offshore drilling activities | | | | | |
| **Regional conventions** | | • Annex VI on prevention of pollution from offshore activities | | | | | |
| **OSPAR (North East Atlantic)** | | • Protocol for the protection of the Mediterranean sea against pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil | | | | | |
| **HELCOM (Baltic)** | | | | | | | |
| **Barcelona (Mediterranean)** | | | | | | | |
| **Cartagena (Caribbean)** | | | | | | | |
• Directive 2013/30/EU on safety of offshore oil and gas operations. | | | | | | |
<table>
<thead>
<tr>
<th>Liability and compensation for damages</th>
<th>International Law Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barcelona Convention (Mediterranean)</td>
<td>Protocol for the protection of the Mediterranean sea against pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil</td>
</tr>
<tr>
<td></td>
<td>Guidelines for the determination of liability and compensation for damage resulting from pollution of the marine environment in the Mediterranean sea area (not binding)</td>
</tr>
<tr>
<td>EU</td>
<td>Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage</td>
</tr>
<tr>
<td></td>
<td>Directive 2013/30/EU on safety of offshore oil and gas operations.</td>
</tr>
</tbody>
</table>
Annex 6.2 - Economic activities providing support services to the O&G industry, according to NACE Rev.2

<table>
<thead>
<tr>
<th>NACE Group/Class</th>
<th>Description</th>
<th>Related activities</th>
</tr>
</thead>
</table>
| 09.10            | Support activities for petroleum and natural gas extraction | - Traditional exploration services: core samples; geological observations  
- Directional drilling  
- Derrick erection, repairing and dismantling  
- Cementing O&G well casings  
- Pumping of wells  
- Plugging and abandoning wells  
- Liquefaction and regasification of natural gas for transportation  
- Draining and pumping  
- Test drilling  
- O&G field fire fighting |
| 26.51            | Manufacture of instruments and appliances for measuring, testing and navigation | - Manufacture of physical properties testing and inspection equipment  
- Manufacture of surveying instruments  
- Manufacture of flame and burner control  
- Manufacture of spectrometers  
- Manufacture of pneumatic gauges  
- Manufacture of consumption meters (e.g., water, gas, electricity)  
- Manufacture of flow meters and counting devices  
- Manufacture of search, detection, navigation, aeronautical, and nautical equipment, including sonobuoys  
- Manufacture of environmental controls and automatic controls for appliances  
- Manufacture of laboratory analytical instruments  
- Manufacture of laboratory scales, balances, incubators, and miscellaneous laboratory apparatus for measuring, testing, etc. |
| 28               | Manufacture of machinery and equipment n.e.c. | - Manufacture of general-purpose machinery (28.1)  
- Manufacture of other special-purpose machinery (28.9) |
| 30.11            | Building of ships and floating structures | - Building of vessels (tankers, LNGs, FPSOs)  
- Construction of drilling platforms, floating or submersible |
| 33               | Repair and installation of machinery and equipment | - Repair of fabricated metal products, machinery and equipment (33.1)  
- Installation of industrial machinery and equipment (33.2) |
| 39               | Remediation activities and other waste management services | - Cleaning up oil spills and other pollutions on land, in surface water, in ocean and seas, including coastal areas  
- Other specialised pollution-control activities |
| 42               | Civil engineering | - Construction of utility projects for fluids (42.21) |
| 43.99            | Other specialised construction activities n.e.c | - Construction activities specialising in one aspect common to different kind of structures, requiring specialised skill or equipment  
- Subsurface work |
| 46.71            | Wholesale of solid, liquid and gaseous fuels and related products | - Wholesale of crude petroleum, crude oil  
- Wholesale of liquefied petroleum gases |
| 49.50            | Transport via pipeline | - Transport of gases, liquids, water, slurry and other commodities via pipelines  
- Operation of pump stations |
<p>| 50.20            | Sea and coastal freight transport | - Transport of freight over seas and coastal waters, whether scheduled or not |</p>
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Subcategories</th>
</tr>
</thead>
</table>
| 71    | Architectural and engineering activities; technical testing and analysis     | - Architectural and engineering activities and related technical consultancy (71.1)  
- Technical testing and analysis (71.2) |
| 72    | Scientific research and development                                        | - Research and experimental development on natural sciences and engineering (72.1) |
| 74.90 | Other professional, scientific and technical activities n.e.c.              | - Environmental consulting  
- Security consulting  
- Other technical consulting |
| 77.3  | Renting and leasing of other machinery, equipment and tangible goods        | - Renting and leasing of construction and civil engineering machinery and equipment (77.32)  
- Renting and leasing of water transport equipment (77.34)  
- Renting and leasing of other machinery, equipment and tangible goods n.e.c. (77.39) |
| 81.2  | Cleaning activities                                                         | - Other building and industrial cleaning activities (81.22) |
| 82    | Office administrative, office support and other business support activities | - Office administrative and support activities (82.1) |