

The Analysis of Offshore Industry Transition - Acceleration from Oil & Gas to Wind

P. Kołakowski & G. Rutkowski
Gdynia Maritime University, Gdynia, Poland

ABSTRACT: The present paper provides an overview of the current state and future trends of the offshore sector worldwide, as well as the relationship between the oil and gas (O&G) and the wind power industry offshore. Study on the offshore energy transition basis on review of literature, reports, and outlooks of main energy agencies, classification societies, and main offshore companies - their pathways and ambitions. A comparative analysis of the oil prices to their extraction at sea. Analysis of new build and scrapped drilling units, and their utilization. This is followed by correlation analysis between the emergence of new projects in O&G and wind farms offshore. The new and cheaper technology, and ambitions to reduce greenhouse (GHG) emission to zero levels, favor renewable. The results disclose that the main O&G companies start investing in renewable technologies. The offshore energy transition has already begun and accelerating. Nevertheless, full transition will take a while, as the global power demand is still too high to be covered only by a renewable source of energy. The number of annual O&G assets decommissioning is double in size compared to the new projects, and Mobile Offshore Drilling Unit (MODU) utilization average of 60%. Offshore wind develops dynamically, and the forecasts show that this trend stands at the same high level to cross a number 100 GW produced from offshore wind globally in 2025, but there is a visible lack of Mobile Offshore Wind Power Service Operations Units (MOWU). If well planned there is room for mutual benefits between O&G and wind within the offshore sector due to re-orientation measures.

1 INTRODUCTION

Since the last milestone, when oil becomes a global key component and the industry strengthened, the search for oil and gas (O&G) has been focused on the seas. This is how an offshore sector was created, and become a valuable member of the drilling field. The energy demand is constantly increasing due to the rising global population and power consumption. The rapid urbanization of developing countries also increases the need for energy, such as liquid fuels and natural gas. As offshore O&G wells have a longer production period than onshore, and due to improves

the efficiency of drilling automation, the drilling activities at sea have significantly increased.

As manufacturers are constantly improving the innovative technologies, offshore exploration and production (E&P) operations moving into further remote locations and deeper waters. Improvements in equipment could not only boost oilfield production but also increase the new technology adoption of offshore drilling [1]. This should lead to the expansion of the global mobile offshore drilling unit (MODU) market.

Offshore energy production is very important in the global energy structure as more than a quarter of

the world's oil and natural gas is produced at sea [2]. It would seem, that due to continuous demand for energy worldwide, the O&G offshore should continue to develop. The question arises, due to the latest downturns, geopolitical frictions, and green worldwide economy with significant limits in GHG emissions. Is the oil extraction offshore still profitable?

On the other side, the waters around many countries are seen as a major potential source of electricity supply from offshore wind power. Offshore wind is becoming competitive with other renewable energy as technology is improving, with larger turbines and higher turbine ratings [3]. The first projects using floating wind turbines and solar power plants are presently entering into operation, based on concepts widely deployed in the offshore O&G sector. Cost-competitive floating technologies would expand the economic resource base for offshore electricity generation significantly [4].

While the Paris Agreement has been defined with their ambitions [5], the international organizations, the world's largest classification societies as well as major O&G companies start presenting their pathways. The main goal of all strategies is the fight against climate change by reducing GHG emissions up to 2050 or even eliminating it up to the end of the century. To reach this goal, all parties have to reduce fossil fuels and change the power generation system to renewable technologies and alternative fuels. That would have a huge impact on the offshore sector. But, is it possible with present demand?

The present study provides an overview of the current state and future trends of the offshore sector worldwide, as well as the relationship between the O&G and wind power at sea. Study on the offshore energy transition basis on review of literature, reports, and outlooks of main energy agencies, classification societies, and main O&G companies - their pathways and ambitions is presented in section 1. Materials and data used in the herein study in section 2. The results in section 3, provide key findings to this research field's patterns. A comparative analysis of the oil prices to their extraction at sea points where is the profitability limit of the oil production. The analysis of new build, scrapped, and lay up drilling units, to their utilization, and correlation analysis between the emergence of new projects in O&G and wind farms offshore shows the real trends in which direction the sector is going. The discussion and conclusion of the study are presented in section 4.

2 LITERATURE REVIEW

To answer the question of where we are, in the global energy transition and how big an impact that will take on the offshore sector, a full objective picture from all sides is needed. As a part of this study, we have reviewed the reports and energy outlooks of main energy agencies and organizations, the world's largest classification society, and major O&G and wind offshore companies.

The recent outlooks and reports of the below-mentioned institutions and companies have been

reviewed and compared to have an overview of the latest trends in the offshore energy transition:

- The International Energy Agency (IEA) coordinates a collective response to major disruptions in the supply of oil. The agency provides data, analysis, and solutions on all fuels and technologies.
- Organization of the Petroleum Exporting Countries (OPEC) is an inter-governmental organization of 13 nations with the biggest O&G reserves. The mission of the organization is to coordinate and unify the petroleum policies of its member countries and ensure the stabilization of oil markets to secure an efficient, economic, and regular supply of petroleum to consumers.
- International Renewable Energy Agency (IRENA) is an inter-governmental organization supporting countries in their transition to a sustainable energy future. The agency facilitates access to all relevant information including reliable data on the potential of renewable energy, best practices, effective financial mechanisms, and state-of-the-art technological expertise.
- DNV is the world's largest international accredited registrar and classification society. Provides services for several industries including maritime, renewable energy, O&G, electrification. It is also the largest technical consultancy and supervisory to global renewable energy.
- The main O&G companies: BP, Shell, CNPC, Exxon Mobile, Total, Chevron, ARAMCO, SINOPEC, CNOOC, Equinor.

The mentioned reports have been reviewed mainly in terms of strategies taken or planned to take in the offshore sector.

2.1 *Main agencies and organizations' energy transition outlooks*

Following the latest update from the International Institute for Applied System Analysis (IIASA), we will arrive at a global population estimate of 9.4 billion by 2050 [6]. The global economy in 2040 is expected to be double the size it was in 2018. We also need to keep in mind that almost one billion people still lack access to electricity and three billion with no access to clean fuels for cooking [7]. The fact is, that very soon, the world will need much more energy to meet the demand.

As per OPEC forecasts, the global energy demand is to increase to more than 357 million barrels of oil equivalent a day (mboe/d) in 2040, with an average growth of about 1% per year. The long-term global oil demand is expected to increase by about 12 million barrels a day mb/d. From the other side the global level, growth is forecast to slow from a level of 1.4 mb/d in 2018 to around 0.5 mb/d towards the end of the next decade [7]. The world will need more energy neither conventional nor renewable, but shifting away from fossil fuel use to renewable sources not only reduce carbon emissions, but it would also reduce the impacts of climate change and improve conditions for society and business.

Offshore energy resources are huge, and many of the technologies to produce them are well placed to deliver competitive products [2]. Nevertheless,

questions remain as to how offshore energy production will fare in the period to 2040. OPEC states that offshore crude oil production in the medium-term should be back on the growing track because the production is growing again in the main production areas. Besides, to strong development in new areas including Brazil and West Africa. They predict that up to 2024, crude production in these areas is expected to contribute nearly 25% of non-OPEC liquids supply growth [7]. On the other side, the IEA points out that due to the world's main offshore O&G fields being fully developed, the next wave of offshore resources are generally in deeper water and much further from shore. Conduct new technological, logistical, and cost challenges [2].

As costs continue to fall for solar and wind technologies renewable has become the lowest-cost source of new power generation. Wind farms are now the cheapest renewable energy source with a leveled cost of electricity (LCOE) between 60-110 USD/MWh. Nevertheless, offshore wind farms are still one of the most expensive renewable energy production methods, with an LCOE of between 120-135 USD/MWh [7]. All agencies expect that by 2030, offshore wind power costs will approach those of onshore wind power and conventional power production ([7],[8]). IRENA expects that costs will continue to decline up to 2030 for offshore wind power technologies for another 55% [9]. This has become competitive with conventional sources. Significant advances in technology can surely only increase and improve their capacity factor.

Agencies put strong attention that the location of wind power plants needs to be carefully chosen, as evidenced by the often low capacity factor of existing wind power plants [9]. An important aspect to bear in mind with renewable energy, especially in conjunction with wind power is the fact, that the natural conditions have a key impact on energy production. In the case of wind, this concerns whether and how strong the wind blows. A high capacity factor can only be obtained where the wind blows constant and forcefully from more or less the same direction [10]. This is a characteristically offshore case. Consequently, there are significant constant improvements, mainly related to scaling up existing technology and expanding on the experience gained in the deployment of offshore wind turbines [11]. Very important for offshore wind power generation, is it no longer needs to be limited to shallow shelf regions [12]. The fixed platforms used to hold the wind turbines, limit the regions where such offshore wind farms can be built, but the invention of floating wind turbines can extend the range of potential offshore wind farms all around the world [13].

Presently, the wind is the second most important renewable power source, behind hydropower, both given generated power and installed capacity. It accounts for 18% and 24%, respectively, in renewable energy [7]. DNV Energy Transition Outlook forecasts that 30% of all global electricity production will come from wind energy by 2050, with 12% from offshore wind and 18% from onshore wind [14]. IRENA provides information that offshore wind projects in Europe are now more and more competitive with fossil fuels [9].

However, OPEC cools down the IRENA enthusiasm and puts on attention that we need to be careful with interpretation when comparing these numbers to conventional power plant capacity: "Detailed numbers from the IRENA for both renewable capacity and generated renewable power in 2017 reveal an average capacity factor for the whole renewable power sector of only around 32%. The capacity factor is very important in judging the actual contribution of additional power capacity. For example, 1 MW of PV solar capacity delivers only around 1,100 MWh in a year, 1 MW of onshore wind capacity already delivers approximately twice as much (2,170 MWh) and 1 MW of offshore wind capacity delivers again substantially more at around 3,030 MWh. However, modern coal-fired power plants used for base-load generation have a capacity factor of 80%, and nuclear power plants are typically intended to deliver a capacity factor of 90%. In these cases, significantly more electricity is generated throughout the year, namely 7,000 MWh and 7,900 MWh, respectively. To catch up with a typical coal-fired power plant generating 600 MW of electricity, 3,800 MW of PV power or 1,940 MW of onshore wind would need to be installed. Replacing a large 1,300 MW nuclear power plant would require 8,200 MW of PV, 4,200 MW of onshore or 3,000 MW of offshore wind" [7].

Offshore wind is becoming competitive with other renewable energy as technology is improving, with larger turbines and higher turbine ratings (with up to 20 MW turbines expected to be used for projects in 2030) [11]. As a result, capacity factors are increasing, boosting energy yields and reducing total installed turbines and other costs [14]. Furthermore, competitiveness and LCOE reductions have been driven by recent projects. The increased deployments and growing maturity of offshore wind markets in Europe and China between 2010 and 2020 have also reduced risks and uncertainty for investors [9].

As per IEA, the transformation of the energy sector can happen without the O&G industry, but it would be more difficult and more expensive [8]. A main and very important aspect of the world's energy transition is a fight against climate change to eliminate GHG emissions. Due to a couple of new structure regulations, like the Paris agreement regarding climate change [5], a European Green Deal [15], or IMO's new global sculpture limit of 0.5% for ships fuel oil [16], the decarbonization process has begun. The company's commitments to reduce emissions intensities are becoming more common. The impacts of the climate will become more visible and acute in the coming years, increasing the pressure on all parts of society to find solutions [8].

Agencies, institutions, research & intelligence companies, and main O&G companies are trying to aim the goals and introduce their pathways to find the best solution. The IRENA's Transforming Energy Scenario together with several other scenarios have recently been published to explore transition pathways for the energy system in the coming decades. Climate change or discussion about decarbonization and its pathways is not a subject of this study. However, is noticeable that the role of renewable share is coming to increase in a significant

way. IEA, as well as OPEC, have a common view on the pathways towards an energy transition. It is supposed to be different to each country, that further shifts in the power generation will depend on country-level policies and investments due to the varying conditions for renewable energy sources, as well as the specific nature of renewable ([2],[7]).

Governments' policies will play a key role in the amount of electricity generated from renewable sources and in limiting the burning of fossil fuels to produce power [7]. The focus on climate change will also play an important role in technological research and development like new generation marine propulsion systems ([17],[18]). The European Green Deal Investment Plan presented by European Commission in December 2019 predicts spending at least 1 trillion euro over a decade to reach the goals. That is a strong signal where the cash flow will be directed to [9]. The OPEC suggests that for the time being during the transition period it is not about choosing one energy source over another. There is a need to look to evolve, develop and adopt cleaner energy technologies that make it possible to meet expected future energy demand sustainably and more efficiently [7]. The IEA, aware that, in the absence of more concerted policy action, demand for oil and (especially) gas would continue to grow to 2040, while coal demand would remain where it is today [2].

2.2 Main O&G companies' energy transition outlooks and their strategies

The IEA classifies O&G companies into four main groups: two of these categories cover companies that are fully or majority-owned by national governments and the other two relate to privately-owned companies. In the first group are National Oil Companies (NOCs) that concentrate on domestic production. The second group of International NOCs (INOCs) has both, domestic and significant international operations.

Into the third group belongs the "Majors" the integrated companies listed on US and European stock markets include seven companies: BP, Chevron, ExxonMobil, Shell, Total, ConocoPhillips, and Eni. The last fourth group is "Independents" - either fully integrated companies, similar to the Majors but smaller in size, or independent upstream operators[8].

Along with the pace of energy transformation, several O&G companies have begun to adjust their business models. Both to reduce emissions and to mitigate climate-related business risks. Every part of the industry needs to consider how to respond therefore no single O&G company will be unaffected by clean energy transitions. The industry landscape is varied and there is no single strategic response that would be having an important effect on all. The O&G industry used to put strong attention on the Majors, as the companies have a strong influence on the industry direction [8].

Table 1. Future emission ambitions of Major O&G company's SOURCE: basis on major company's reports ([19],[20],[24],[25],[26],[27],[28])

Majors	Targets
BP	Net-zero by 2050
Shell	Net-zero by 2050
Total	Net-zero by 2050
Chevron	2-5% net reduction for gas by 2023 5-10% net reduction for oil by 2023
ExxonMobil	10% net reduction for oil sand by 2023 Several visible targets.
ConocoPhillips	Net-zero by 2045-2055
Eni	Net-zero by 2030 (upstream) Net-zero by 2040 (group)

As per Tab1. created based on Major company's outlooks and energy reports, we can observe that most of the Majors have a similar target – a net-zero greenhouse gas emissions by 2050 or sooner. To achieve that goal, the companies need to implement and accelerate the transition as soon as possible. Most of the O&G companies like Shell or BP have been changed their portfolios from petroleum companies to energy companies, to show, that they are active players in the transformation of the energy system ([19],[20]). So far, main O&G companies spending around 5% on average on projects outside the core business, with the largest outlays in solar PV and wind [2]. The investments and strategic responses to energy transition by selected companies are illustrated in Tab. 2.

Nowadays, for those companies which are planning to diversify their operations, diverting capital towards renewable businesses requires an attractive investment opportunity. Some O&G companies have also moved into new areas, for example in renewable power while stepping up research and development activity. It is noticeable that all main O&G companies worldwide have already started energy transitions (Tab. 2).

The INOC and NCO's companies like Sinopec, Petro-China, and CNOOC also want to spend billions on renewable energy assets to stay relevant in a low-carbon future. The world's largest oil refiner, Sinopec wants to lead China's hydrogen push, with plans for hydrogen refueling stations alongside its petrol stations [21]. Sinopec in their annual report states that under unstable oil price circumstances they will optimize project implementation, plans to keep a stable production of crude oil, and realize growth for natural gas. In natural gas development, the company will accelerate the capacity construction of key projects [22]. Petro-China became the first Asian state-owned company to set a target for near-zero emissions by 2050 [21], while offshore oil explorer CNOOC Limited in September 2020 announces the first offshore wind power project connected to the grid with 67 wind turbines and 300MW capacity [23].

On the other side, Saudi Aramco has another target. The company program is to diversify its energy away from crude oil and liquids for power generation, plans to be among the world's top three natural gas producers. To meet future global and domestic energy demand. The company's gas production is expected to double in the coming decade [29]. Aramco in their reports states that with the global population forecast to constant increase, even more energy will be

required to meet rising demand. Aramco predicts that it will take not only fossil fuels or only renewable, but all available sources of energy to cover all demand. While alternative energy sources are steadily making advances, they will not be capable of meeting future demand alone [30].

3 MATERIALS

Section 3.1. of this article includes a comparative correlation between crude oil prices to their extraction at sea (Fig. 1) and offshore production opex for oil fields in the main offshore regions (Fig. 2). To the analysis was taken the Brent Crude as the leading global price benchmark for Atlantic basin crude oils. The average cash cost to produce a barrel of oil was compiled using data from more than 15,000 oil fields across 20 nations. The production costs were calculated by including a mix of capital expenditures and operational expenditures. Capital expenditures included the costs involved with building oil facilities, pipelines, and new wells. Operational expenditures included the costs of lifting oil out of the ground, paying employee salaries, and general administrative duties. As a source, we have used UCube by Rystad Energy, an interactive published with open access [31].

Data used in the analysis in section 3.2. and 3.3 respectively has been acquired from Riglogix - Westwood's flagship product [32], Rystad Energy [31], HIS Markit [33], and Drilling Contractor Magazine [34]. The intelligence and research

companies offer tools, consultancy services, and analytics data to the energy industry.

4 ANALYSIS AND RESULTS

In this section, we have determined the profitability limits and breakeven price for offshore O&G production by the comparative analysis of oil prices to their extraction at sea – section 3.1. The analysis of new-build scrapped and lay-up drilling units, and their yearly utilization presented in section 3.2, provides information about the trends of MODU owners in the O&G offshore market. Section 3.3. provides analysis between the emergence of new projects and decommission, both in O&G and wind offshore. That analysis aims to point out the trends in offshore transformation.

4.1 Comparative analysis of oil prices to their extraction at sea

The oil price, in general, refers to the spot price of a barrel on benchmark crude oil. There is a differential in the price of a barrel of oil, based on its element factors such as specific gravity or API gravity, sulfur content, and location. The leading global price benchmark for Atlantic basin crude oils is the Brent Crude. Brent is used to set the price of two-thirds of the world's internationally traded crude oil supplies. It is one of the two main benchmark prices for purchases of oil worldwide, the other one is West Texas Intermediate (WTI) [38].

Table 2. Investment and strategic responses to energy transitions by selected companies - illustrative, based on 2015-19 activity SOURCE: IEA and major company's reports ([8],[19],[20],[24],[25],[26],[27],[28])

Company	Enhancing traditional O&G Operations (reducing methane & CO2 emission and sourcing of renewable power)	Deploying CCUS (for Enhanced Oil Recovery (EOR) and centralized emissions)	Supplying liquids and gases for the energy transition (low carbon gases Bio-fuels) and advanced	The transition from fuel to "energy companies" (solar PV, wind and other power generation; electricity distribution and electrified services)	Overview grade
	3 categories max grade: 3	2 categories max grade: 2	2 categories max grade: 2	4 categories max grade: 4	All categories max grade: 11
BP	2,5	1	1,5	3	8
Chevron	2,5	1,5	1	1	6
Eni	2,5	1	1,5	3,5	8,5
ExxonMobil	2,5	1,5	1	0	5
Shell	3	1,5	1,5	4	10
Total	3	1	2	4	10
CNPC	1	1,5	1	1	4,5
Equinor	3	1,5	1	2	7,5
Petrobras	2	2	1,5	2	7,5
Repsol	2,5	1	1	3,5	8

Notes: CCUS - Carbon Capture, Utilization, and Storage - encompasses methods and technologies to remove CO2. The table is divided into 4 sections which included 11 categories. Each company could get a max of 1 point from each category, in total 11. One point got a company which supported by strategic investments and/or capital/operational expenditures in commercial-scale activities; a half point received company which announced strategy and/or minor investments, venture capital and/or research and development spending; zero means that company has limited evidence of investments activity. For methane and CO2 emissions, which are not based on project and spending data, assessments reflect the presence and strength of methane reduction and emissions intensity target, as well as evidence of their implementation, the emission intensity trend of new investment, transparent reporting of absolute emissions and sources, and linking of executive and staff compensation to achieving goals. Power generation and efficiency investments in the transition section pertain to projects destined for commercial sales (not own use). Electrified services include battery storage and EV charging. Low carbon gases include low-carbon hydrogen and bio-methane.

When the financial crisis of 2007–2008 took place, the price of oil has crashed to 34 USD/bbls. The second downturn comes in 2016, the global average price of oil at that time has dropped to 30 USD/bbl - Fig. 1. While crude oil prices were above 100 USD/bbl, the ensuing profits were huge for the government as well as for O&G companies. The second downturn, in such a short period, brought a very tough time for oil producers. The prices start barely cover the average cost to get the oil out of the ground in places like the United Kingdom. Additional expenses like taxes took the breakeven price for many projects even higher, and more complex projects generally fall well above the average cash cost of production. Oil-producing nations, from Saudi Arabia to Norway start cutting down on expenses. The biggest energy companies like Shell or Chevron have made deep spending cuts and laid off thousands of workers [39].

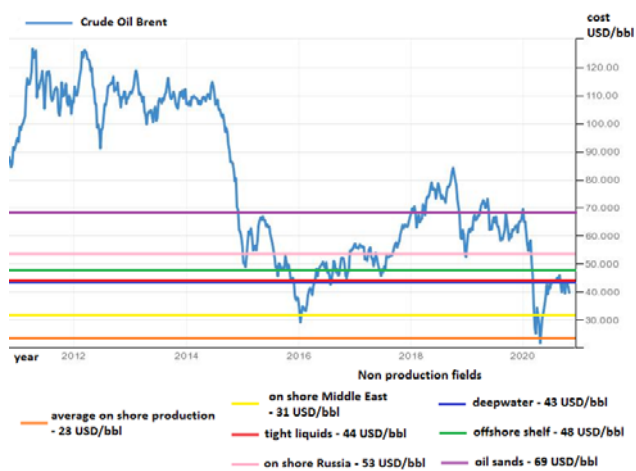


Figure 1. Price of Crude Oil Brent with her breakeven price in different product categories (USD/bbl), SOURCES: ([35],[36])

NOTES: The breakeven price is the real Brent Oil price that gives an NPV of zero given a real discount rate of 7.5%. The breakeven price includes only future costs. The lines are an average of all fields with each category.

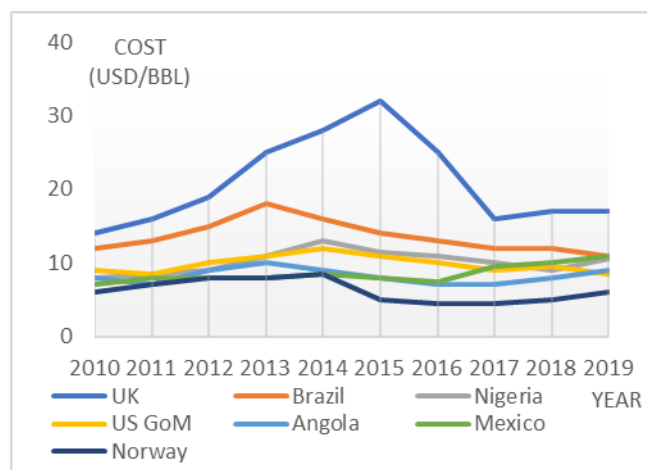


Figure 2. Offshore production opex for oil fields in the main offshore regions (excluded transportation opex), SOURCE:[37].

In 2015 the average cost of production of one barrel of oil in a dozen nations was between 8.5USD in Kuwait to 52.5USD in the UK [40]. That was a total cost including capital expenditures (CapEx) contains

major purchases that will be used in the future, and operating expenditures (opex) - an expense, represents day-to-day costs that are necessary to keep a business running. The 2016 downturn in oil prices pushed the whole industry to start looking cuts of cost on extractions and production level, especially in the offshore sector, as O&G extraction at sea, is one of the most expensive (Fig. 1). The major UK offshore operators changed from two to three weeks crew rotations on offshore installations. This action brought a huge salary and logistics savings. All companies start searching for a way to reduce the cost levels by closing older fields, changing rotation cycles, and lowering salaries. As result, the operational production costs in the all O&G industry have dropped across the globe (see Fig. 2).

The United Kingdom has become a leader in cost-cutting in all main offshore regions. In the period of 2014-2018, the UK reduced operational production costs by 31%, followed by Norway and the United States with opex reductions of 19% and 15%, respectively - Fig. 2 [37].

With more efficient maintenance management, more emphasis on strategic planning, and increased technology deployment, operating costs per barrel of oil equivalent (boe) have decreased significantly. The huge decline is attributed to two main factors: the decline in the share of production from old fields as new fields appear while the mature fields were closed, and the overall increase in global production [36].

The oil production costs have revealed that the average breakeven price for all unsanctioned projects has dropped down to around 35% between 2014 and 2020 [37]. That means, currently (2022), crude oil production is significantly cheaper compared to a few years ago, with the new deep-sea investments. This is more competitive than ever and can provide larger quantities of products at a lower price. However, the average breakeven price for most of the sources is remaining high as the supply segments have recovered differently with only marginal price increases.

Comparing the average cost of oil production with oil price for the last five years - (Fig. 1) noticeable is, that the offshore O&G companies need a price of oil above 50 USD/bbl to maintain profitability.

Oil prices below 48 USD/bbl can put many projects in the "risk zone". On average global projects are sanctioned at a breakeven oil price of 35 USD/bbl. According to Oil and Gas UK (OGUK), 2020 will be remembered as a "perfect storm" due to COVID-19. The crisis has decreased demand by approximately 16 million barrels [41], which is unparalleled. The disagreement between Saudi Arabia and Russia over production cuts, and consequentially the war for market share has decimated the industry even further. The current (2022) sharp rise in oil prices is dictated by sanctions against Russia and geopolitical reasons. The market needs stable oil prices, the trends in new projects and decommissions in O&G and wind offshore will be more developed in sections 3.2 and 3.3.

4.2 Analysis of new-build scrapped and lay-up drilling units, and their utilization

The sea bed survey continues, and the new O&G fields are discovered worldwide. When the oil price was high, the main drilling companies were expanding their fleets with a significant number of MODU and support vessels. Finally, when the following crisis struck and the profitability fell, the whole market blows out. As hundreds of MODU were already under construction, lots of companies have bankrupted, shifted, suspended, or abandoned new build projects. Fig.3 & Fig.4 presents how the oil companies used the downturn to refresh their fleets.

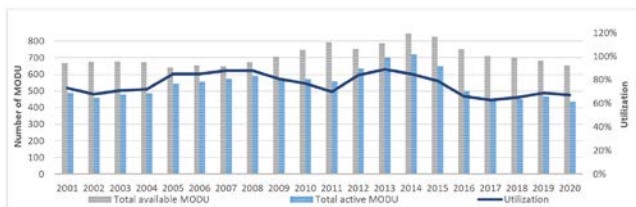


Figure 3. The worldwide number of MODU and their utilization (2001 - 2020) SOURCE: [34]

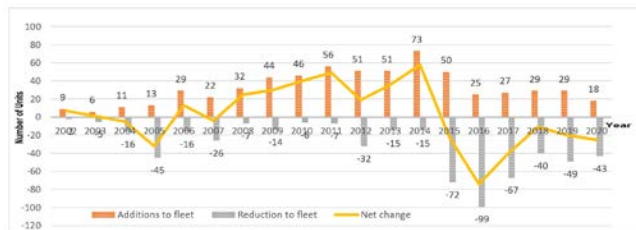


Figure 4. Change In Global Offshore MODU Fleet (Competitive Units), SOURCE: [34]

The crude oil price becomes slightly increases after mid. 2016 and the offshore O&G industry started to stabilize with less decline in offshore rig count, as compared to that in 2014 and 2015, and hence, a similar trend in demand for MODUs. The number of MODU purchases increased in 2017, both in terms of transaction and value. Crude oil price crossed 60 USD/bbl in November 2017. The opening of coastal water in the United States for exploration and production, and recovery of Brazil's O&G industry, along with increasing crude oil price, were expected to increase the demand for MODUs during the forecast period. Nevertheless, the initial optimism that the market was back on the rising track has been very quickly verified.

Despite the global increase in energy demand, the MODU net change was decreased by another 25 rigs over 2020. The market is still oversupplied with more than 200 rigs stacked at the end of 2021. The US Gulf was the region with the largest number of hot-, warm-, and cold-stacked rigs, in total 41. Southeast Asia followed with 38, then South America with 37 [42]. Drilling companies have been waiting for a recovery that has never taken, and hundreds of units have been cold stacked since 2016. Many of the idle rigs, in particular the cold-stacked units, have not worked in years and are unlikely to return to active drilling.

The worldwide MODU fleet, whose utilization has been suffering since the previous downturn can expect a new round of scrapping as a result. One-

quarter of the global floater fleet (22 drill-ships and 37 semi-sub) could be sent for scrapping as Covid-19 accelerates reformation. An evaluation of active rigs in the global floater fleet reveals that up to 59 of the 213 units are potential candidates for withdrawal from service [43].

Global demand for MODU just started to recover before the pandemic but still is expected to remain under pressure even though oil price starts rising again. Certainly, weak demand will keep utilization low unless significant and stable oil price increases are noticed. Rystad Energy has created three scenarios [28], analyzing supply and demand in rig years, which show the range of the expected utilization levels based on new build rigs and their attrition. Utilization began dropping in 2015 and has drifted between 60% and 70% (see Fig.3). Utilization could reach even 77% in 2023 if all 59 identified floaters are scrapped and all new build cased – in an optimistic scenario. If delivery of all new builds takes place then utilization will decline to 69%. In the last scenario, which assumes delivery of the new build units but not full retirement of the identified rigs, utilization could fall to as low as 52% depending on how many floaters are withdrawn from the global fleet [28].

As per Fig. 4. since 2015 we can observe a constant decrease in the global offshore MODU fleet while utilization is still on the same low level – see Fig.3.

4.3 Analysis between the emergence of new projects and decommissions in O&G and wind offshore

Since the last downturn, the awarded contracts for offshore drilling are dropped - Fig.5. The average annual number of new projects is between 40 and 70 [32].

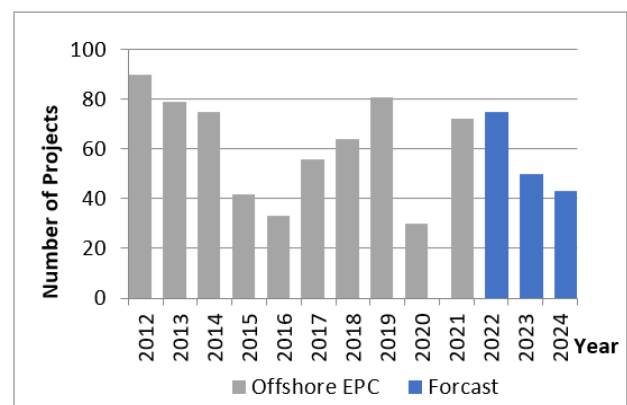


Figure 5. Offshore EPC Spending and forecast SOURCE: RigLogix [32] NOTES: EPC - Engineering, procurement, and construction refer to the steps of developing a major capital project and the industry/companies who provide these steps as a service.

Oil companies suspended or shifted new projects and have been waiting for a recovery. However, the recovery didn't take place as the covid-19 brought another wave of uncertainty on the market. Nevertheless, to meet the extensive demand for oil and gas worldwide, governments and private entities probably will take the initiative to invest in extraction. The question arises, whether they will be willing to invest offshore or increase production onshore?

International Energy Agency reports that offshore O&G assets decommissioning is nowadays on average 100 assets per year and that will even increase to 150 assets annually from 2031. As per IEA, Offshore Energy Outlook, offshore O&G assets wait for a wave of decommissioning.

Offshore activity is not limited to new investments: between 2500 and 3000 projects are likely to require decommissioning between 2020 and 2040 as they reach the end of their operational lifetime [2].

On the other hand, as per Fig.6. offshore wind develops dynamically year by year, and the forecasts show that this trend stands at the same high level to cross a number of 100 GW [44] produced from offshore wind globally in 2025. The offshore wind power service operations industry will enter a period of dynamic growth, which in turn will stimulate the huge market demand for Mobile Offshore Wind Power Service Operations Units (MOWU).

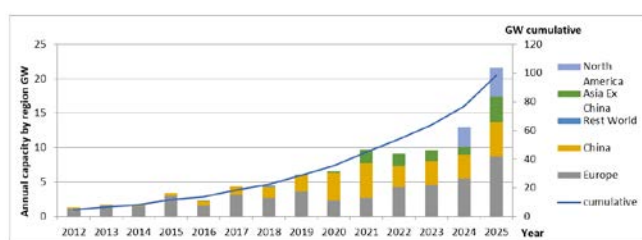


Figure 6. Offshore Wind Capacity Outlook and forecast SOURCE: Global Wind Energy Council [44]

The policy support, technology advances, and a maturing supply chain are making offshore wind an increasingly viable option for renewable-based electricity generation [45]. Investment has picked up sharply in recent years. Offshore wind turbines are becoming giants compared to their onshore equivalent. The height of commercially available turbines has increased from 100 meters (m) in 2010 (capable of producing 3 megawatts [MW]) to the 15 MW turbine design - now under development with 260 m highs [13]. Installations are also moving further from shore, tapping better quality wind resources and pushing up capacity factors [3]. Aside from lowering the cost of the electricity produced.

The first projects using floating wind turbines are also now entering into operation, based on concepts widely deployed in the offshore oil and gas sector. DNV launches industry-wide collaboration to develop the first-ever recommended practice for floating solar power plants [46]. Cost-competitive floating technologies would expand the economic resource base for offshore electricity generation significantly.

Nevertheless, the huge and heavyweight turbines need big vessels to install either fundament, towers, nacelle, and wind blades. According to IMO Marine Safety Committee (MSC) statistics, as of 2021, more than 60 MOWUs have been constructed and put into operation worldwide and more than 15 are currently under construction [47,48]. Due to sustained construction of offshore wind farms, the current fully loaded MOWU still cannot meet the needs of the industry to serve the construction of global offshore wind farms. There is a clear market demand for this type of unit.

5 DISCUSSION AND CONCLUSION

Due to the constant growth in the global population, live standards, and usage of electricity in all aspects of life, the world will need much more energy to meet the demand. We can observe noticeable progress in technology advances in offshore drilling as well as in the renewable sector. As per our analysis during the last downturns, O&G companies did a lot to cut expenses as much as possible, and not much place for cost savings left. The offshore O&G companies still need an average price of oil above 50 USD/bbl to maintain profitability.

The current crisis comes at a time when the industry is recovering from the oil price fall of 2014-2016. Due to COVID-19 most significant portion of the world's economy has aground. The crisis and pandemic have decreased demand and the offshore O&G sector is currently unstable due to the geopolitical situation around Russia. Sustained price levels below the cost of production can deter exploration and production and shift production potential for years to come.

In connection with the fight against climate change and global warming, the renewable source of energy is favorable. Offshore wind is becoming competitive with other renewable energy technologies, with developments in the full life cycle of processes. The technology is improving, with larger turbines and higher turbine ratings. Nowadays, for those companies which are planning to diversify their operations, diverting capital towards renewable businesses requires an attractive investment opportunity.

As per our study, it is noticeable that all main O&G companies worldwide have already started energy transitions and investing in renewable. However, to reach the targets and ambitions on their pathways would be required to expand and accelerate significant changes in overall capital allocation.

The energy ecosystem is evolving. Faced with the realization that fossil fuels are a limited resource and the negative impact that their emissions have on the planet. Oil and gas operators are rising to the future energy challenges surrounding security and sustainability. However other drivers are forcing the transition. The population has their expectations about how the world will work, as witnessed by new models for transport, accommodation, and food delivery. We are moving to a sharing economy. E-mobility is rising rapidly. Developing countries are likely to skip a hydrocarbon infrastructure and move straight to renewable. The electrification of transport is showing early signs of disruptive acceleration. Progress in accelerating the transition is seen in the rapid cost reductions of solar PV and wind (including offshore). The abatement technologies and alternative fuels such as green hydrogen are viewed as a potential game-changer.



Figure 7. Resources transfer from O&G to offshore winds
SOURCE: authors conception

The awarded contracts for offshore drilling are significantly dropped. The offshore O&G assets wait for a wave of decommissioning. The market is still oversupplied with more than 200 rigs. As the number of annual decommissioning is double in size compared to the new projects and MODU utilization for the last few years is on the average of 60%, half of the worldwide fleet very soon could be scrapped. The COVID-19 only accelerates restructuration.

On the other side, offshore wind projects continue to develop dynamically which in turn stimulates the huge market demand for MOWU and other support vessels. There is a lack of such huge installation units on the market, and those which are currently under construction, already have been booked for the long-term contracts.

If well planned, there is room for mutual benefits between O&G and wind operators within the offshore sector (Fig 7.). After many years of experience in building solid, efficient platforms, the O&G industry suppliers have a wealth of experience to bring to wind power. For instant cold stuck MODUs could be transformed into the MOWU. The parts and components of one unit can be transferred to the other. The billions of tons of steel after O&G assets decommission could be also used for wind turbine foundations or offshore wind platform substations. The vessels currently involved in O&G projects, like cable laying vessel (CBL), dive support vessels (DSV), remotely operated vehicle vessel (ROV), walk to work (WTW), offshore support vessel (OSV), crew transfer vessel (CTV), heavy lift vessel (HLV), anchor handling tug supply vessel (AHTS) and other tugs, dredgers and support vessels could be shifted and be on service for offshore wind projects.

We can expect that some jobs will become redundant, specifically in Offshore O&G production as oil extraction at sea is one of the most expensive. Some of these jobs will be lost, but others could be saved through re-orientation measures. Shifting to a renewable-powered future also allows for retaining existing expertise from the fossil fuel industry. Particularly for renewable industries such as offshore wind or offshore floating PV fields. For instance, the expertise of workers and technicians in building support structures for offshore O&G could potentially be used to build foundations and substations for offshore wind turbines. The structures of demobilized O&G platforms could be also used partly for wind farms.

Nevertheless, any future energy transition will require the further use of all energy sources. For the time being during the transition period, it is not about choosing one energy source over another. There is a need to look to evolve, develop and adopt cleaner energy technologies that make it possible to meet expected future energy demand sustainably and more efficiently. The world needs more concerted legisla-

tion policies action regarding renewable. Until abatement technologies and alternative fuels took over fossil fuels, for the time being, liquefied gas would be a main transition source of energy.

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