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BI Norwegian Business School - Master Thesis

How will oil in deep waters, the theory of peak oil, and unconventional oil affect the business-strategy of Norwegian companies working in the oil and gas sector?

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Audun Pilskog Oslo, September 1, 2014

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1. Introduction

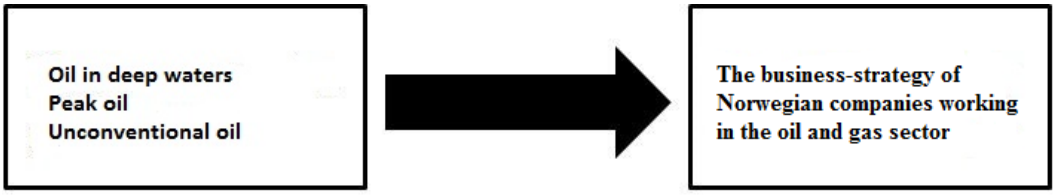
Research question: How will oil in deep waters, the theory of peak oil and unconventional oil affect the business-strategy of Norwegian companies working in the oil and gas sector?

H0: These factors undermine current strategies and will lead to a strategic change

H1: The strategies of the Norwegian companies are robust

H2: The current strategies must be developed to face these challenges

Based on the research question the following causal relationship has been assumed:



This paper will look the three factors that may affect Norwegian companies working in the oil and gas sector, with a special focus on oil service- and seismic-research companies (hereafter also referred to as "Norwegian companies" or "companies"); the increasing hunt for oil in deeper waters, the peak-oil theory and unconventional oil.

The goal is to look at how much oil, from where and at what cost will be available in the future and what effect this has on the strategy of the Norwegian companies working in this sector. Recent years has seen a surge in unconventional oil- and gas resources, as well as giant leaps in technology making it possible to extract more oil from old fields. While the peak oil theory predicts that "global production of conventional oil will begin to decline sooner than most people think, probably within 10 years" (Campbell and Laherrere 1998, 80). Yergin believes that the advocates of peak oil are missing out on important factors as they only look at the numbers of new oil-filed discoveries and neglecting the fact that most of the world`s supply comes from additions and extensions in older fields (Yergin 2011b).

The paper will analyze factors that will affect the Norwegian companies in the years to come. What new challenges is the industry facing, and is it ready to adapt to these changes? With "competition" from unconventional oil resources, are the companies trying to get involved in this new market or are they focusing on their primary business? If the peak oil predictions are correct will this mean the end of the Norwegian oil companies or are there other areas where the companies may use their technology when the world runs out of oil? What strategy should the companies aim for if they are to succeed?

The paper will start with an introduction to where the Norwegian companies work today, as well as a short introduction to Norwegian oil and gas history.

Chapter 5 will look at the peak oil theory and the different opinions regarding this theory, and discussion regarding from where oil will be available in the future with a focus on the new discovered oil-fields and new potential areas for oil exploration.

Chapter 6 will focus on two areas; the arctic and the pre-salt area outside of Brazil. When it comes to the arctic it will focus on the possibilities and the challenges the oil-companies face in this harsh environment. Also the aspect of politics will be discussed; as drilling for oil in these areas is also a sensitive political subject. The pre-salt area in Brazil is more developed than the arctic. What are the similarities and differences between this area and the Arctic? This section will conclude with a look at the different new technologies that have made this ultra-deep drilling possible.

Chapter 7 will at some of the most important technological developments that have it possible to recover unconventional oil and gas and oil and gas in deep waters. The main focus will be on hydraulic fracturing, 3-D seismic mapping and horizontal drilling.

The thesis will try to conclude with an answer to the hypotheses stated in regards to how these factors will affect the strategy of the companies in the Norwegian oil-industry and tie the questions together with an answer on how the companies should position themselves within Porter`s three generic strategies (Porter 1985, 12) . The question is interesting since all of these three factors have become more and more relevant in recent years. New technology has made drilling in ultra-deep

waters possible, the discussion around peak oil has seen an increase in interest recent years, and unconventional oil has only recently manifested itself as a potential "game-changer" with still insecure estimates of its possible effects on the oil-market.

2. Background

Ever since Colonel Edwin Drake struck oil in the world`s first oil-well in Pennsylvania in August 27 1859, oil has become more and more important to fuel the world economy. The hunt for oil started as a result of scarcity of whales, since whale oil was used to create light at the time, but overfishing led to a decline in whale population and rising prices for whale oil (Downey 2009, 1) This led to what can be compared to the California gold-rush, where oil became known as the black gold. By 1950, oil was no longer used as lamp oil, but as transportation fuel with gasoline, diesel, residual fuel and jet fuel/kerosene accounting for about two thirds of crude oil consumption. Since its beginning oil has risen to become the most important source of energy in the world, and contributes to 38% of global energy production, vastly outnumbering its "competitors". Of this 64% of the oil is used for transportation, confirming its importance for the world economy and world trade (Downey 2009, 1-29)

As the economic growth in the world gets higher, the demand for oil and gas has increased, and with that prices have become increasingly higher, even though fluctuations have at times been large. A key factor in the rising increase in demand for oil and gas lies in the increase in living standards in countries such as China and India. Recent years has also seen large changes in oil-sources, such as the unconventional Canadian oil sands. In 2003 Canada adjusted their oil-reserves from 5 billion barrels to an astonishing 180 billion. This oil which had been seen as of little importance has been the fastest-growing source of new supplies in North America (Yergin 2011b, 254).

Yergin (2011b) mentions one of the most interesting themes in the current debate of peak oil and energy security. It is the "battle" between the rising demand of energy from countries such as China and India and the fact that we might just reach peak demand, much to the fact that we get more efficient. Twenty years from now, instead of driving cars that run on gasoline, we might drive cars that

run on electricity. Yergin argues that instead of the peak oil scenario predicted by many, we might reach what he calls a "plateau" in the next 20-30 years.

There are different perspectives on what constitutes energy-security. While some argue that the main threat to energy-security is the depletion of energy reserves in the world, others argue that energy-security is a matter of bilateral relationships between countries. Campbell and Laherrere (1998, 78) claim that "global production of conventional oil will begin to decline sooner than most people think, probably within 10 years", and that oil-producing countries are deliberately not reporting correct numbers about their oil-reserves. The article states that 59 nations stated in 1997 that their reserves were unchanged from 1996, something which cannot be correct because since unchanged numbers year after year are not realistic.

Maugeri (2006, 202) on the other hand, disagrees and claims that rising oil prices will lead to more investment which in turn will lead to new oil-fields being found:

> In simple terms, searching for the ultimate figure about the earth's oil endowment is like searching for the Holy Grail—a never-ending rush with several people claiming to have discovered what in effect remains a mystery.

Winston Churchill commented that security when it comes to oil "lie in variety and variety alone" (Yergin 2006, 69). But there is also a dependence that goes both ways between the exporters of oil and gas and the importers. According to Haghighi (2007, 27) Europe is poorly diversified when it comes to gas supply. In contrast to oil, Europe is dependent on Norway, Algeria and Russia for the entire gas demand of Europe. This includes both pipelines and through LNG. Luciani (2004) on the other hand points out that there have been no major interruptions in the supply of gas from Russia, and that even though demand is increasing, so will the diversification of sources. He also gives more weight to the political aspect of gas security than the transport routes.

The increase in the world-demand for oil has been substantial in recent years. A higher standard of living and growth in economies such as China and India have triggered a surge after oil. China and India have become major consumers of oil in

recent years, and are set to increase further in the years to come (Yergin 2006, 72):

> World oil demand has grown by 7 million barrels a day since 2000; of this 2 million barrels each day have gone to China. India's oil consumption is currently less than 40 percent of China's, but because India has now embarked on what the economist Vijay Kelkar calls the «growth turnpike», its demand for oil will accelerate

Yergin (2006, 72) further states that in 2005 for the first time Asia`s oil-consumption exceeded the one of North-America, and China who was self-sufficient with oil in 1993, now imports 3 million barrels of oil per day, almost half its total consumption

Even though Churchill saw diversity as the big solution to the energy-security issue, there are good reasons to why diversification of sources may be problematic. Haghighi (2007) explains that shifting the supply from the Middle East to Russia or the other way around, could cause energy shocks, which in turn could affect the world economy. If a region that has been dependent energy revenue suddenly loses this security of income, this might lead to instability in the entire region.

According to Yergin (2009, 762) of all the energy sources oil stands out as the most problematic because of "its central role, its strategic character, its geographic distribution, the recent pattern of crisis in its supply – and the inevitable and irresistible temptation to grasp for its reward"

There are split opinions on whether energy-security should be seen from the economic perspective, that energy security is related to market rules only, or from a political point of view, including factors such as interdependence between countries and stable political relations (Checchi, Behrens and Egenhofer 2009, 1). This thesis will look at both factors related to market rules and economic perspectives, as well as look at the political factors that can affect how much, where and what price oil will be available.

3. Method

This thesis is based on what Merriam (2009, 22-24) defines as "basic qualitative research", Data is collected through interviews, observations, or document analysis. Where the thesis differ from Merriam`s framework is that it will be a

deductive analysis, as the thesis starts out with hypotheses which I through data analysis will try to see if I find support for or not.

In addition to the framework presented by Merriam this thesis will use Maxwell`s (2005, 5) interactive model of research design:

1. Goals: why is your study worth doing
2. Conceptual framework: What do you think is going on with the issues, settings, or people you plan to study?
3. Research question: What, specifically, do you want to understand by doing this study?
4. Methods: What will you actually do in conducting this study?
5. Validity: how might your results and conclusions be wrong?

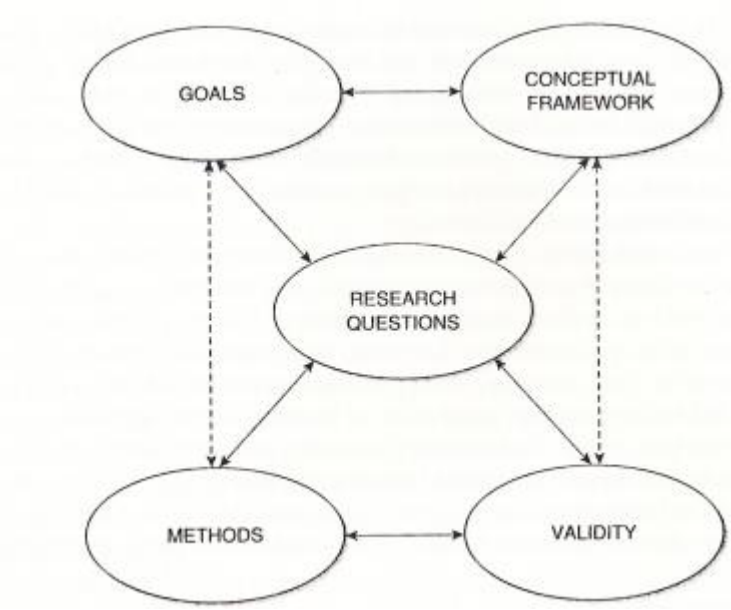


Figure 1 An interactive model of research design ((Maxwell 2005, 5)

The goal of the study is see what effect three interesting cases have on the strategy of Norwegian oil service companies, seismic research and exploration companies. The reason is the author's interest in these cases, as well as the missing literature regarding how these cases directly influence the strategic decisions of the companies.

The conceptual framework, what I think is going on with the question posed in the research question, is that the factors are debated as single cases and that all of them in such an early stage that there are no definite conclusions as to their significance. It is also my belief that these three factors have not been tied up towards a more practical view: how will the influence the strategy of the Norwegian companies.

The research question will be: "How will oil in deep waters, the theory of peak oil and unconventional oil affect the business-strategy of Norwegian companies working in the oil and gas sector?" Separately I have information about these cases, but I want to know how these factors can translate into concrete changes for the Norwegian companies.

The thesis will use the framework by Merriam and Maxwell to gather the data, and then combine the data with Porter`s three generic strategies to see how Norwegian companies can place themselves to successfully create value. The data gathered will mainly be related to the peak oil theory, unconventional oil resources, oil in deep waters and new technology and I will try to analyze how these factors affect Norwegian companies today. A historical background for the Norwegian oil and gas industry will be presented, as well as an analysis of the current status of the where and how the Norwegian companies are working today. The collected data about these cases will be used to indicate where the Norwegian companies should place themselves in Porter`s three generic strategies.

When it comes to validity I see the largest risk for wrong results and conclusions being my beliefs before conducting this thesis deciding which literature to choose and what to look for. If I enter the thesis with a specific belief of what I expect to find, I might search for data that confirms my view. I will try avoiding this by actively searching for data from different sources, and then concluding after analyzing these.

Porter (1996, 1) defines strategy as "the creation of a unique and valuable position, involving a different set of activities." In a conference in London Michael E. Porter says that choosing a strategy also means choosing what not to do. Strategy means defining what unique position we will be able to achieve and how we will be able to sustain that advantage over time (Porter 2008). For Norwegian companies it means deciding if the factors mentioned will have an

effect on their strategy, does the increase in search for oil, the theory of peak oil and/or the development of new technology change the strategy of these companies? Will they choose to participate in these markets? As Porter explains, choosing a strategy means not only choosing what to do, but also what not to do. It might not be beneficial all companies to try and participate in these areas if they cannot achieve a strategic advantage over time.

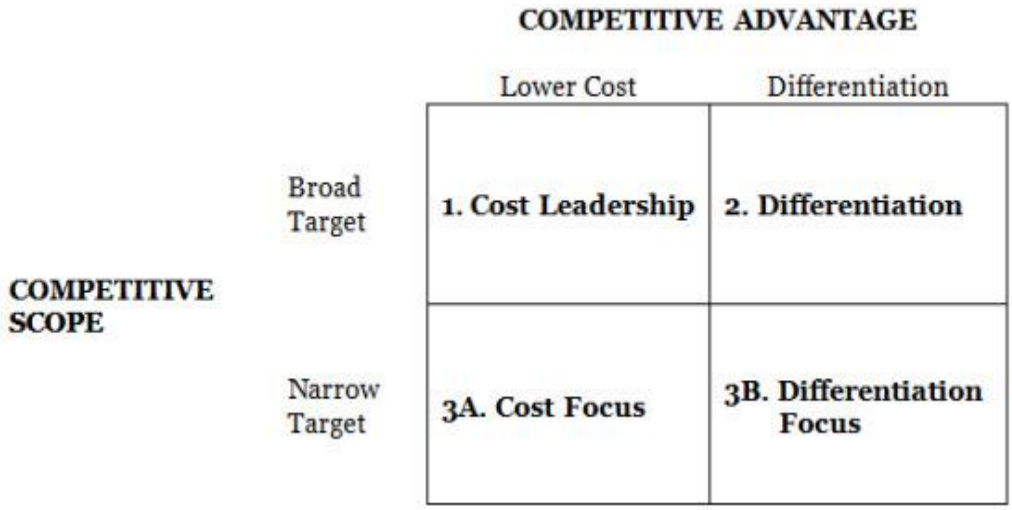


Figure 2 Three generic strategies (Porter 1985, 12)

Each of the generic strategies shown in figure 2 involves a "fundamentally different route to competitive advantage, combining a choice about the type of competitive advantage sought with the scope of the strategic target in which competitive advantage is to be achieved" (Porter 1985, 11).

In cost leadership a company seeks to be the low cost producer in its industry. It serves many industries and has a broad scope, it may also serve related industries and the sources of cost advantage may include economies of scale, proprietary technology and preferential access to raw materials. If a company wants to differentiate itself it must seek to be unique in its industry and can then be rewarded for its uniqueness with a premium price. The company must truly be unique or perceived as unique, if it is to achieve a price higher than its competitors. The third generic strategy is focus, where a company tailors its strategy to serving a segment or group within the industry, and thus excluding others. There are two variants of focus; cost focus and differentiation focus. While a cost focusing company will exploit differences in cost behavior in some

segments, a company with a differentiated strategy will exploit special needs of customers in special segments (Porter 1985, 11-17).

A company that fails to achieve any of these generic strategies may end up being "stuck in the middle" (Porter 1985, 16-17). In this position a company will possess no competitive advantage and is usually a guaranteed to end up with below-average performance. If a company ends up in this position the other companies that are focused on one of the strategies will be much more profitable and have a competitive advantage.

There are though pitfalls in differentiation, one of them being assuming that uniqueness in itself is differentiation. The fact is though that being unique at something does not necessarily make the company differentiated. Porter (1985, 160) refers to it as "uniqueness that is not valuable". If uniqueness does not lower buyers cost or raises buyer performance as perceived by the buyer it does not lead to differentiation (Porter 1985, 160).

A company must be aware so that it does not differentiate too much. There is no need to differentiate in such a way that your product or service levels are higher than what the customer needs. If this happens companies are vulnerable to competitors that offer only the needed product quality or service level (Porter 1985, 160)

This thesis will use Porter`s three generic strategies to try to see what strategy the Norwegian companies might choose if they want to join the new markets created by the factors mentioned in the research question.

In the deep waters outside of Brazil, the pre-salt area, Norwegian companies are today already represented both through seismic companies and oil service companies (Aftenbladet 2010) but in the Arctic there are still discussions on if this area will be important in the future. Existing literature is divided in the fact of whether the search for oil in the Arctic will have any substantial effect. According to Lindholt and Glomsrød (2012) extracting oil from the Arctic areas is more expensive than the already developed areas, and the interest for the Arctic areas has been ignited by factors such as rising demand for oil, the level of the oil price, the possible transport route through the Northwest passage as well as the

political side of it culminating with Russia`s planting of the Russian flag under the seabed at the North Pole in 2007.

When it comes to peak oil there are divided opinions of the validity of this theory. Campbell and Laherrere (1998) predicted "the end of cheap oil" and has since been followed up by several authors claiming that the end of oil is near, and that most of the world`s oil fields are discovered over 50 years ago and their resources are depleting (Checchi, Behrens and Egenhofer 2009, 11). On the other side you have those who predict that this will not end with the "apocalyptic vision" predicted by peak oil theory believers. Maugeri (2006, 204) states that the believers in peak oil do not take into consideration factors such as political factors, change of habits affecting consumption, price trends and technological developments. .

Some argue that unconventional oil is a true "game changer", and Maugeri (2012, 14) states that shale oil is a revolution that will change the market, while others think that the effect of unconventional oil and gas resources will be limited , and that there are few undiscovered areas in the world and none of them are likely to be anywhere near a new middle-east (Deffeys 2001, 10)

This thesis will try to tie these factors into the strategy element, and by using Porter`s generic strategy model see where the companies are placed today, and see if changes in current strategy is necessary. The three areas have been chosen since they have become more relevant in recent years, and combining these with the business-strategy element will hopefully result in a better understanding of the effect these factors will have. In the next chapter we will look at how and where the companies are operating today, to give an overview over the present situation before we look at the future challenges.

4. What is the present situation for Norwegian companies?

4.1 Norwegian oil & gas history

*"Man kan se bort fra muligheten av at det skulle finnes kull,olje eller svovel på kontinentalsokkelen langs den norske kyst" (*Nebben 2009, 11)

In connection with FN`s first convention of law of sea in Geneva in 1958, the Norwegian Ministry of Foreign Affairs had asked the Geological Survey of Norway (NGU) to consider the possibility that there could be mineral-sources under the Norwegian Continental Shelf, and NGU`s answer left no doubt about the fact that there was nothing of value to be found (Nebben 2009, 11). This would soon prove to be an understatement of epic proportions. This was in 1958, but only four years after, in 1962, Phillips Petroleum showed an interest in the exploration of the Norwegian Continental Shelf, and requested to get an exclusive right to develop the Norwegian Continental Shelf, like A.P. Møller had got on the Danish Shelf. The Norwegian government opposed this and did not want one company to control the entire shelf alone, and national control became important in developing the Norwegian petroleum-industry. The first legal framework for the petroleum exploration in Norway was adapted, with three persons from the Norwegian Foreign Ministry in central roles; Jens Evensen, Carl August Fleischer and Leif Terje Løddesøl. Especially Evensen has been mentioned as very important in this central period for Norway (Nebben 2009, 12-13). In 1965 the first 22 exploration licenses for 78 oil-blocks was awarded. A license gave an exclusive right to a company to develop that area. The disappointments were many the first years and Shell gave up their efforts to find oil in Norway in 1969. Phillips decided to drill one last well in Norway, before they also would stop their exploration on the Norwegian Continental Shelf. These coincidences led to Phillips finding oil on December 23 1969. The Ekofisk-field, one of the world`s largest oilfields, was found and Norway was officially an oil nation (Nebben 2009, 12-13).

In 1972 Statoil was established to secure national control of the oil-industry and in 1974 a giant oilfield was found: the Statfjord-field, one of the world`s largest oil-fields. In the coming years several large oilfields were found, but the “Kielland-accident” that killed 123 people in 1980 showed that there was also a dark side of oil-exploration. The oil-price is also subject to large fluctuations, in 1986 the price of a barrel of oil drops to 10 dollars, and there is panic in oil-exporting countries. In 1986 the production from Gullfaks C, the world`s largest concrete platform, begins. The 1990`s began with Statoil and BP agreeing on a common international cooperation outside the North-Sea area. In 1995 the largest construction ever

moved by man, the Troll A platform, was hauled to sea, causing international attention(Nebben 2009).

In 1997 Statoil is celebrating 25 years in business, but the event is cancelled because of the 12 people losing their lives in a helicopter-crash on their way to the Norne-platform, once again confirming the more negative and dangerous aspects of the industry (Johnsen 2008, 406). In 2001 Statoil is listed on the Norwegian Stock Exchange and on the New York Stock Exchange, and in 2006 the decision is made to merge Norsk Hydro with Statoil. The transaction in completed in 2007, and the company is given the name StatoilHydro. During these events the oil price is on the rise, and reaches 120 dollars per barrel in 2008. The last years have shown a volatile price of oil-where financial crises and political trouble in oil-producing countries have affected the oil-price (Johnsen 2008, 401-409; Nebben 2009).

4.2 Increased international presence

An increasing part of Norwegian offshore/oil-companies have their business internationally. In a report from SNF in 2006 we can see that the percentage of petro-related business increased from 29% in 1995 to 46% in 2005. The paper further shows that there was an increase in companies with a part of their business internationally, while there is a decrease in companies who are only targeting the Norwegian market from 58.9% in 1995 to 32.1% in 2005 (Heum, Vatne and Kristiansen 2006)

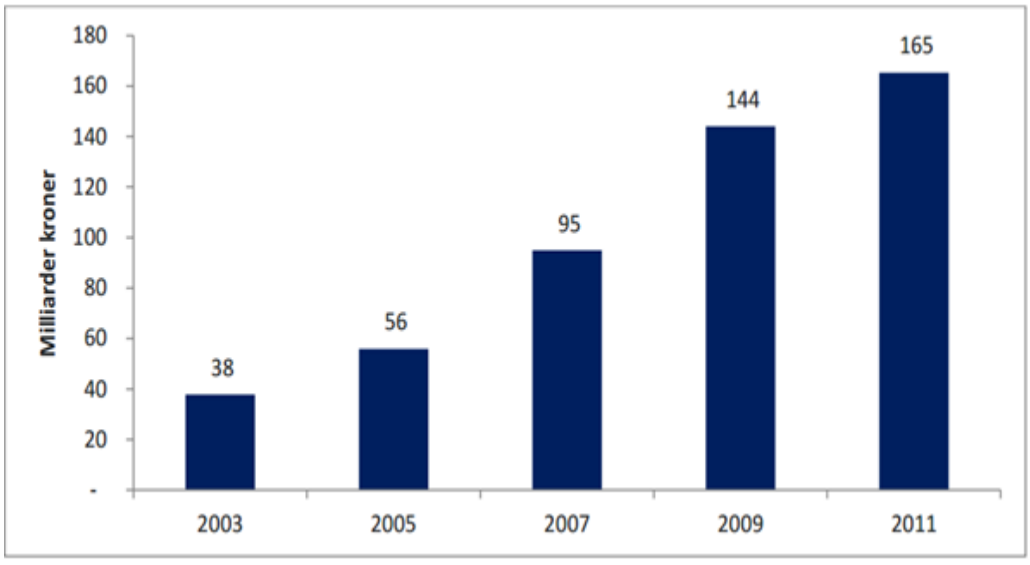


Figure 3 Foreign revenue for the Norwegian offshore industry in mill. NOK (Mellbye, Fjose and Jakobsen 2012, 5)

According to Mellbye, Fjose and Jakobsen (2012) the Norwegian suppliers are seen internationally to be leading in technology, given their extensive experience in tough conditions on the Norwegian continental shelf. This might be an indication that the Norwegian companies should position themselves with a differentiated strategy, where they promote their leading technology and avoid trying to become what Porter(1985, 12) calls "all things to all people" and achieving below-average performance. In a differentiated strategy a company selects "one or more attributes that many buyers in an industry perceive as important, and uniquely positions itself to meet those needs" (Porter 1985, 14). Their leading technology might be the uniqueness that will lead to a premium price for their products. The innovation that has been needed to succeed in the Norwegian area is now what makes the Norwegian companies preferred internationally. The increased drilling for oil in deeper waters and harsher environments makes Norwegian companies attractive since they have extensive experience from these areas over many years. The trend from both reports is clear; Norwegian companies are moving more of their business internationally, and their extensive experience is well received abroad.

The report further shows that a review of the largest companies working in the oil sector financial reports reveals an expected increase in revenue of 10-15 % in 2012. This report separates Norwegian companies' revenue from export from Norway and revenue from Norwegian companies who have established departments in other countries. The reason for this may be protectionist policies in countries such as Brazil, demanding that a certain number of employees are local or a certain number of local suppliers are to be used in manufacturing products. This might indicate that establishing foreign subsidiaries that only focus on one market and thus can narrow its strategy to focus on this market. Then they will reduce the chance of being "stuck in the middle", and not having a competitive advantage (Porter 1985, 16-17).There are several examples of Norwegian oil and gas companies that have established themselves in Brazil, such as Aker Solutions, BW Offshore, Petroleum Geo-Services(PGS), Solstad Offshore and Statoil (Aftenbladet 2010).

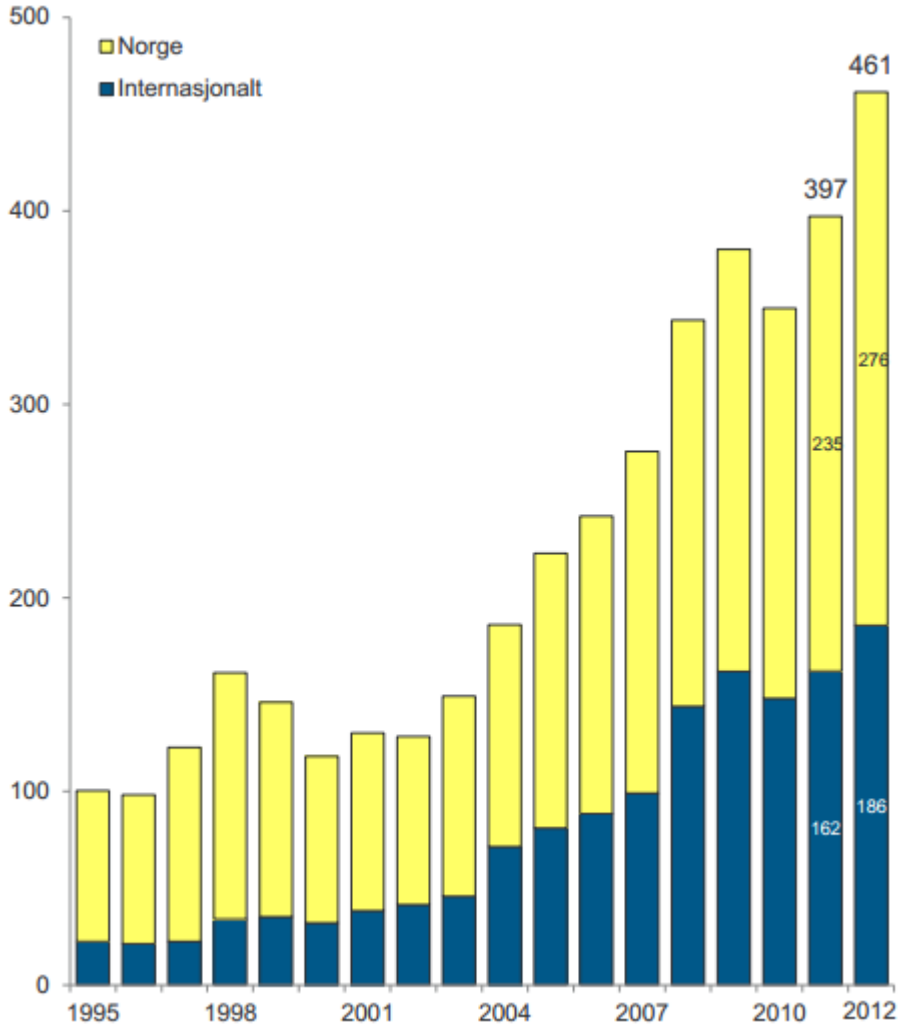


Figure 4 Total revenue of Norwegian oil service companies, Norway vs International (Rystad Energy 2013)

In figure 4 we see the revenue from Norwegian oil-service companies divided into domestic and international revenue. As the figure shows there has been a steady increase in revenue, both from the domestic sales and international. There has been a yearly revenue growth of about 17% per cent, both domestic and internationally, in the period of 2002-2009. After a small dip in 2010 as a result of projects on hold due to the financial crisis, the growth was back in 2010-2011 with an increase of nearly 14% (Rystad Energy 2013, 19)

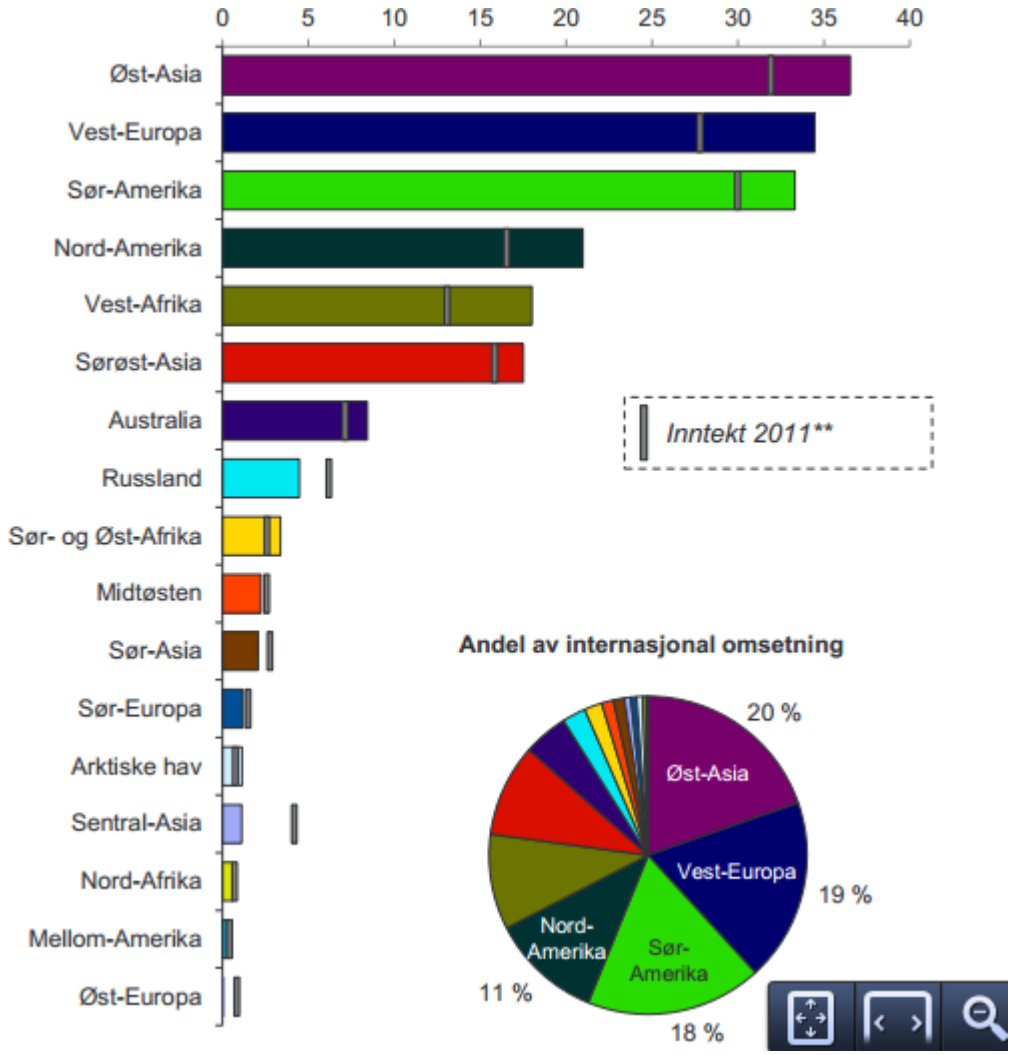


Figure 5 International revenue, ranked by region (Bill. NOK) (Rystad Energy 2013, 20)

As we can see in figure 5 Eastern Asia, Western Europe and South America are the largest contributors to Norwegian companies' revenues abroad. Figure 6 shows in more detail which countries within these areas contribute the most.

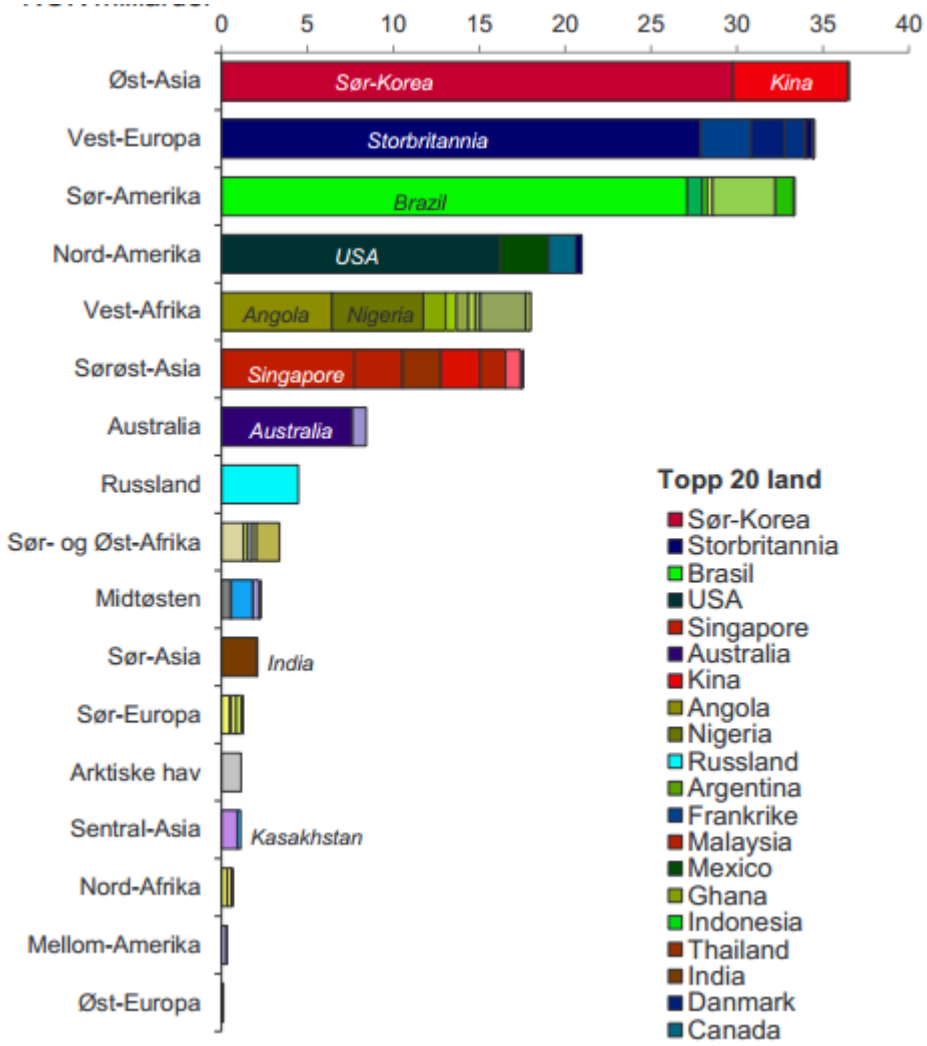


Figure 6 International revenue ranked by region, per country (Bill. NOK) (Rystad Energy 2013, 25)

In figure 6 we see the ranking of regions and the most significant countries within that region. As we can see South Korea and China represent the largest part of the revenue from Asia, due to their large shipyards. In Europe Great Britain contributes to the major part of the revenue, the rest is mostly from France due to seismic vessels that are rented out from France. Brazil is the major contributor from South-America and is a market in growth. Brazil is still a market run by search for oil and development of new oil-fields (Rystad Energy 2013, 22). This means that Brazil is in an early stage of developing their oil-industry and this should be a good possibility for Norwegian companies to position themselves for work that is planned at a later stage, such as modifications, maintenance-work and service.

Based on this data it seems that Norwegian companies are today well established internationally and in Brazil with companies such as Aker Solutions, BW Offshore and PGS (Aftenbladet 2010). Their technology is also perceived as technologically leading internationally. What the numbers do not tell us are how they are positioning themselves with regards to strategy, and if they have one focus for the international markets and one for the domestic market. The coming chapters will try to look closer at how the companies can position themselves to provide an uniqueness that customers are willing to pay for.

5. Peak oil and unconventional oil

5.1 Peak Oil

> "As proof for peak oil, its advocates argue that the discovery rate for new oil fields is declining. But this obscures a crucial point: Most of the world's supply is the result not of discoveries but of additions and extensions in existing fields" (Yergin 2011b)

Campbell and Laherrere (1998, 78) claim that "global production of conventional oil will begin to decline sooner than most people think, probably within 10 years", and that oil-producing countries are deliberately not reporting correct numbers about their oil-reserves. The article states that 59 nations stated in 1997 that their reserves were unchanged from 1996, something which is not plausible.

Campbell and Laherrere (1998, 80) further explain why we cannot trust the official numbers regarding how much oil is left in the world, and that:

> In the 1990s oil companies have discovered an average of seven Gbo a year; last year they drained more than three times as much. Yet official figures indicated that proved reserves did not fall by 16 Gbo, as one would expect rather they expanded by 11 Gbo. Reasons being that governments did not report a decline maybe to "enhance their political cachet and their ability to obtain loans". The most important reasons lie in oil revisions: oil companies replaced earlier estimates of the reserves left in many fields with higher numbers.

M. King Hubbert, known for the "Hubbert-Curve" of peak-oil, correctly predicted that oil from the lower 48 American states would peak around 1969. Peak-oil theory is based on the time when oil-production will have reached its peak and starts to decline. The flow of oil starts to fall when about half the crude-oil is gone, creating a bell-shaped production curve for the entire region. This is what Hubbert used when he correctly predicted the peak in 1969 (Campbell and Laherrere 1998).

Campbell and Laherrere (1998, 81) also do not believe that spending more money on oil exploration will change the situation with regards to their peak oil theory. In the early 1980`s oil prices surged and explorers developed new technologies for finding oil, and "scoured the world for new fields". They ended up finding few and the discovery rate continued down; "there is only so much crude oil in the world and, and the industry has found about 90% of it".

Maugeri (2006, 202) on the other hand, disagrees and points out three reasons that Peak Oil is not relevant. Firstly rising oil prices will lead to more investment which in turn will lead to new oil-fields being found:

> In simple terms, searching for the ultimate figure about the earth's oil endowment is like searching for the Holy Grail—a never-ending rush with several people claiming to have discovered what in effect remains a mystery.

Secondly a large part of the world is still not explored when it comes to oil and that:

> Consider, for example, that in Texas alone nearly 1 million wells have been drilled, against 2,300 in all of Iraq, and that today there are more than 560 000 producing wells in the United States as against slightly more than 1,500 in Saudi Arabia (Maugeri 2006, 204)

Thirdly those who believe in Peak Oil and Hubert's model are working with static analyses that do not take into account other factors affecting the price and availability of oil as "political decisions affecting production, change of habits affecting consumption, price trends and technological evolutions affecting both production and consumption, and so on" (Maugeri 2006, 204).

According to Deffeyes (2001, 9) the only unexplored promising province for the exploration of oil is part of the South China Sea and that even though it is an attractive prospect it is not likely to be anywhere near another middle east. Noreng (2012, 21) disagrees claiming there is no physical shortage of oil in the world and that large prospective areas are still to be explored. Lomborg (2001) points out that we do not know all areas that contain oil and that as time goes by we find new areas. But as the increased search for new areas to explore is linked with demand and oil-exploration is expensive, it takes time for new areas to be realized. Further Maugeri (2012, 20) in a recent analysis show that only four of the large oil-producers will show decline in production by 2020, and these are Norway, the United Kingdom, Mexico and Iran.

Ness (2013) identifies five main risks for a fall in the price of oil:

1. Unconventional oil-resources: they are already large in the US and in Canada. What if we see a large increase in other parts of the world? What happens when the US is a net exporter of oil?
2. Unconventional gas-resources: These have already led to a decrease in the price of gas in the US. The US will soon become an exporter of natural gas, what happens when this repeats itself in other countries?
3. China has in recent years been the driving force in the increased demand for oil. What happens when the Chinese demand decreases?
4. Iraq`s enormous cheap reserves. This country is the only one that has the potential of becoming a new Saudi Arabia, and can potentially reach a yearly production of 15 million barrels per day (50% more than what Saudi Arabia is producing today).
5. New technology: Will cheap alternative energy affect the price of oil and gas?

According to Noreng (2012, 20) the discussion of peak oil often ends in "apocalyptic visions of widespread disaster as demand for oil outstrips supply", but Noreng further states that demand for oil is "predicated on consumers having greater utility from using oil than from not using oil at available prices" and they are determined more by utility for consumers than by production costs. Heinberg (2005, 220) on the other hand predicts a century of "impending famine, disease, economic collapse, despotism, and resource wars" due to the collapse in oil-

availability. Further a "handbook" on how to manage the collapse is presented. With guidelines on how to prepare "you, your home and your family" on the impending energy transition the author predicts a society where extreme measures should be taken to prepare for the end of oil. Everything from reducing your debt and not buying nothing but "what you don`t absolutely need" to growing your own food and constructing your own solar oven to cook food on "cold winter days". (Heinberg 2005, 228-230).

5.2 New oil-fields and unconventional oil

"Contrary to what most people believe, oil supply capacity is growing worldwide at such an unprecedented level that it might outpace consumption. This could lead to a glut of overproduction and a steep dip in oil prices" (Maugeri 2012, 1)

According to ExxonMobil (2012, 42) "55% of the world`s oil resources remain unproduced in 2040". They believe that the world holds significant oil resources and that even by 2040 less than half of the world`s oil will have been produced, in contrast to those who believe we are approaching the end of oil in the near future. ExxonMobil also sees new technology as a factor, and expects estimates of remaining oil-reserves to be increased as new technology is introduced.

While Maugeri (2006) sees tight oil as the big revolution ExxonMobil(2012, 43) predicts that the biggest change will come in deep-water production, which is expected to more than double by 2040. Since 75% percent of today`s oil was discovered before 1980, a large part of new production will probably not come from new oilfields, but rather from new technology and unconventional oil.

In an analysis from DNB Markets(Kjus 2012, 7-8) we can see that oil demand is trending lower both in Europe and in the US. While Europe is struggling to create economic growth, the US will demand less oil due to efficiency gains and substitution. Even China has a declining demand for oil since peaking at about 1.5 million barrels of oil a day around 2010.

According to Maugeri (2012, 11) the world consumed about 32 billion barrels of oil in 2011, while proven reserves we about 1.3 billion barrels. This level of oil should last more than 40 years. While these are the proven reserves, we have seen in recent years that increased exploration, unconventional resources and new

technology have changed the estimates of how much oil is available and there is much more oil on this planet than what has already been discovered. Most major oil-producing countries do still not have a recovery rate of more than 25 %. This is due to factors such as old technology and the lack of opening up to competing international oil companies. While in Norway the recovery rate for the entire continental shelf is 47% and Statoil has a goal of a recovery rate increasing its recovery rate from todays 50% to 60% in the future (Hovland 2012). The Statoil-case shows the potential for improving the recovery rate with increased competition and increased focus on new technology. Maugeri (2012, 11-12) mentions Iraq as a country that has, despite its many years of producing oil, enormous potential. In addition to being unexplored, it has never used modern techniques such as hydraulic fracturing, horizontal drilling or 3D seismic mapping. Finansavisen (Ness 2013) also mentions Iraq as one of the factors that can affect the oil market, as it has a potential of 15 million barrels a day, 50 percent more than what Saudi-Arabia is producing today. They characterize it as the only country that has the potential to become a new Saudi-Arabia. In June 2011 Iraq`s crude production overtook Iran`s for the first time in two decades (Nguyen 2012).

Trond Omdal in Arctic Securities says that Iraq has the potential to become a "game changer" and further states that "if a US-oriented dictator would succeed in overtaking Southern Iraq, the Basra-region alone has potential for a production of 12 million barrels a day within 2020, and if you include the rest of Iraq and Kurdistan the potential is over 15 million barrels a day" (Ness 2013, 42). Even though the potential in Iraq is there, there are forces such as Iran that have no interest that Iraq should increase their production dramatically and "drown the world-market with cheap oil" (Ness 2013, 43).

Maugeri (2012, 14) predicts that the world will probably not see more gigantic oil-fields like the one`s discovered in the early 20$^{th}$ century in the Persian Gulf or in Texas even though they might be hidden in ultra-deep offshore areas or other environmental harsh places. Only one third of the world`s possible oil-fields has been thoroughly searched with modern technology, such as advanced seismic prospecting and deep exploration drilling. Even in matured areas such as the Norwegian continental shelf we have seen a renewed optimism as recent years have shown the largest oil-fields in the last 10 years being discovered. In 2010 the

by far largest oil-field the last 10 years was discovered, the Johan Sverdrup field is believed to contain 1761 million barrels of oil, making it larger than the combined size of the nine others on the top 10 list the last 10 years and placing it as the fifth largest oil-field on the Norwegian sector (Ramsdal 2012).

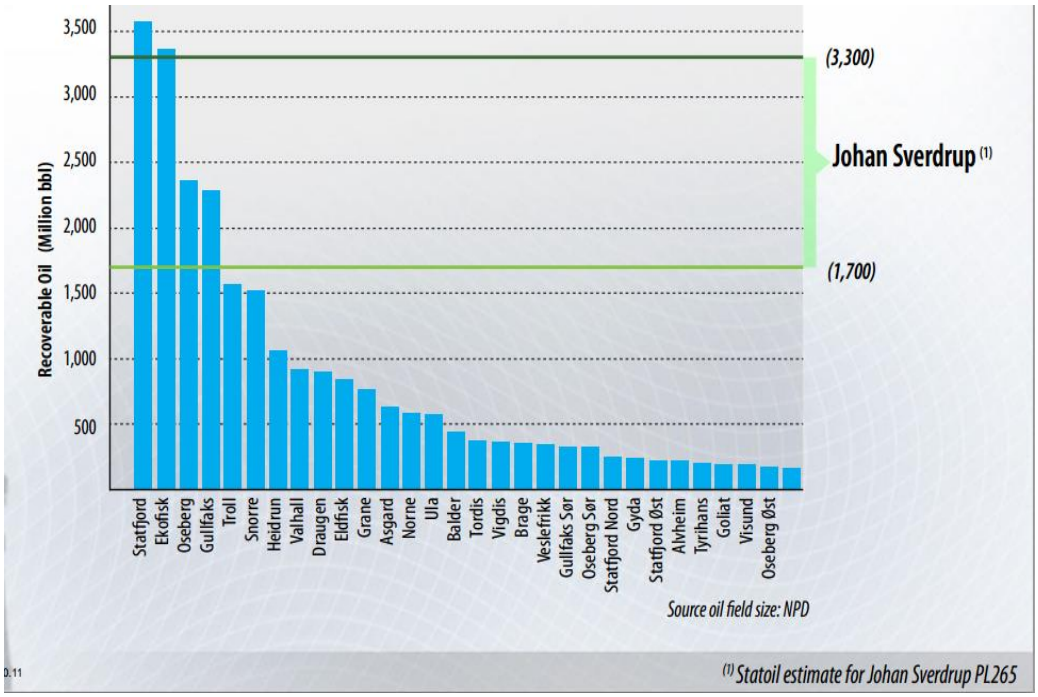


Figure 7 Largest discovery since 1980`s on Norwegian Continental Shelf (Lundin Petroleum 2012, 7)

The Johan Sverdrup oil-field has the potential to become one of the largest fields ever discovered on the Norwegian continental shelf. The potential lies in the interval between 1700 million and 3300 million barrels of oil in a field which has "excellent reservoir quality" and "easily producible oil" (Lundin Petroleum 2012, 8). Johan Sverdrup is believed to possibly contain as much as 3570 million barrels of oil, and if this estimate is correct it is the largest ever discovered on the Norwegian continental shelf ahead of Statfjord and Ekofisk where the former was discovered in 1974 and the latter in 1969 (Endresen 2012b).

In an interview CEO of Lundin Norway says that there is absolutely more potential left in the Johan Sverdrup field. The company is preparing to drill several new fields adjacent to where they found oil the first time. Lundin`s part of the field is said to contain between 800-1800 million barrels of oil, but this might be grossly underestimated and time will tell if this field is by far the largest ever found in Norway (Endresen 2012a). If Johan Sverdrup turns out to be the largest

field ever discovered on the Norwegian continental shelf, it is a reminder for those who predict that there are no large oil-fields left in the world that even in one of the most developed areas for oil and gas exploration there is still possibilities for large oil-discoveries.

The new oil-field on the Norwegian continental shelf has triggered a new optimism amongst the oil "super majors" in the world. One of the most exciting areas is the Barents Sea where the large fields Skrugard/Havis and Norvarg were discovered in 2011. After years of little interest from the "Super majors" on the Norwegian continental shelf, they are now back and want to be a part of what Shell CEO Peter Voser defines as an area of "great prospectivity" after recent years large oil-discoveries. (Njøsen 2012). Oil companies Lundin, Statoil and Det Norske have all opened offices in Harstad in Troms in the northern part of Norway to cope with the increasing opportunities in the Barents Sea. This also has effects for other companies working in the oil-sector, such as Aker Solutions, who provides oilfield products, systems and services for customers in the oil and gas industry, has also established themselves in the northern parts of Norway to be involved in the increased area in the region. Region manager of Aker Solutions activities in Northern Norway, Kjell-Are Vassmyr, says that they are experiencing increase interest from major oil companies such as Shell and Statoil, and that this also gives increased work for oil-service companies such as Aker Solutions (Njøsen 2012).

6. Oil in deep waters

6.1 Intro

The pre-salt area outside of Brazil has seen an enormous increase in activity since the first oil discovery, despite the oil being located at extreme depths. It is also predicted to become one of the most important areas in the years to come (Yergin 2011a). Norwegian companies are today represented in Brazil through both oil-service and seismic companies.

In the Arctic there currently not a significant activity with all projects at an early stage and political decisions that need to be decided before the activity can start.

As we will see the search for oil in the Arctic depends on a large part on oil prices being high and is also linked to how

This chapter will look in more detail on the present situation for Norwegian companies in Brazil and the Arctic, how they are operating and where they might place themselves to create value that customers are willing to pay a premium price for.

6.2 The Pre salt layer in Brazil

"We had to find oil" – Josè Sergio Gabrielli, President of Petrobras (Yergin 2011a, 252)

According to Petrobras pre-salt "makes reference to an aggregation of rocks located offshore in a large portion of the Brazilian coast and with potential to generate and accumulate oil. It was called pre-salt because it forms a rock interval that ranges under an extensive layer of salt, which in certain areas of the coast can be as much as 2000 meters thick. Further Petrobras explains that the "pre" expression is used because, through time, these rocks were deposited before the salt layer and the oil may be as far as 7000 meters below sea level (Petrobras 2014).

Petrobras made its first discovery with the Parati Field, which was located at a depth of 6000 feet of water and another 15000 feet under the seabed, the operation required "significant new technology to cope with the peculiarities of the salt layer, which, like sludge, keeps shifting " (Yergin 2011a, 253). These depths are expensive to work in and extremely technically demanding, one of the problems was doing seismic research in the area, which is necessary to know where and at what depths the oil is located, as the salt was so thick that it was hard to get a good reading, but Petrobras `President Gabrielli stated that "we developed algorithms that enabled us to take out the disturbances and look right through the salt-layer" (Yergin 2011a, 253). The largest discoveries of oil in Brazil have been made between the states of Santa Catarina and Espirito Santo, and the oil is of high quality with a "gravity of 28.5o API, low acidity and low sulfur contents" which means that this oil has a very high market value (Petrobras 2014).

Yergin (2011a, 252-253) predicts Brazil being one of the foundations of world supply in the decades ahead, predicting them to be producing six million barrels

per day, the double of the dominant producer in Latin America, Venezuela. Maugeri (2012, 2) also predicts Brazil as one of four countries that has the highest potential when it comes to effective production capacity growth, behind Iraq, the U.S. and Canada.

In 2008, Statoil`s chief of exploration in Brazil, Kjetil Solbrække, proclaimed Brazil as one of the most exciting countries for many of the largest oil-companies. A very exciting area, where the possibilities for finding oil are good and where the potential volume is enormous. Statoil has a 50% share in the Peregrino-project making it the one of their largest international fields (Lynum 2008).

In 2006 the leader of Innovation Norway South America, Erik Hannisdal, predicted that the Brazilian market would be important for Norwegian, and that Norwegian export within oil and gas has doubled in 5 years, due to the increased activity in Brazil. The experience that Norwegian companies have from the Norwegian continental shelf has made them very competitive and their experience is a competitive advantage (Halvorsen 2006) . As we have seen in chapter 4 this has become a reality with a steady increase in international activity and Brazil as the largest contributor from South America. This is impressive considering Brazil`s protectionist politics. Where earlier oil-companies could compete for concessions on equal terms in the pre-salt areas, they can now only act as junior partners of Petrobras (Economist 2011).

An example of Norwegian companies benefiting from the boom in Brazil is Aker Solutions receiving a large contract from Jurong Shipyard of drilling equipment to six ships that will operate outside of Brazil. According to Arne Håverstad, head of Aker Solutions‘drilling technologies business, this confirms Aker Solutions` strong position in the Brazilian market. The six drilling ships will be operated by Seadrill and Odfjell Drilling on 15-year contracts from Petrobras (Halvorsen 2012; Seglem 2012) Another one is Dolphin Group who in 2011 was awarded a contract for doing 2D-seismic research for Spectrum in the Northern part of Brazil (Offshore-mag 2011) .

There has been speculations of Statoil acquiring the Brazilian activities of company Anadarko, which would strengthen Statoil`s position in Brazil. Anadarko, who has licenses for 1m gross acres in Brazil, has made 4 discoveries

in Brazil. The largest one in the Campos Basin, Itaipu, which has 300m barrels of oil (Reuters 2012; Sakoui 2012) .

The present high activity in Brazil is a sign that the Norwegian companies have positioned themselves in such a way that their products and services are preferred. For Brazil who is in the start of the oil-production it would be natural to look at other areas with similar challenges when it comes to weather conditions, water depths and the need for advanced technology. It is then natural that Norwegian companies with extensive experience from the North Sea have been preferred. The fact that the companies have been selected because of their technological expertise is a sign that a strategy where they differentiate themselves as a unique supplier with technological expertise that customers are willing to pay a premium price for, should be the goal also in the future (Porter 1985, 14).

6.3 The Arctic

The Arctic area has been mentioned as the next large, prospective area to be developed, but it is an area characterized by harsh environmental conditions, deep waters and political discussions. The need for oil-exploration in the arctic depends much on the price of oil in the coming years. If the prices rise to the levels we saw before the financial crisis of 2008, we will probably see an increased interest for oil-exploration in the Arctic. On the other hand in a situation where unconventional oil-resources and new technology creates a situation with easily available, cheap oil the arctic is because of its harsh environment not likely to be explored in many years. Lindholt and Glomsrød (2012, 1456) predict that even though 25% of the world`s oil resources is located in the arctic, oil-production from this area will be only 8-10 % of total resources.

Even though there might be other, cheaper alternatives to the arctic oil and gas, there might be a political aspect to this area as well. In 2007 Russia planted a Russian flag on the seabed of the North Pole, marking its strong interest in the Arctic area (Parfitt 2007) . The Arctic is believed to contain as much as 90 billion barrels of oil (U.S. Geological Survey 2008).

Figure 8 The Arctic area (Geographicguide 2014)

Lindholt and Glomsrød (2012, 1468) further explain that extracting oil from the Arctic areas is generally more expensive than already developed area, and that for Norway "cost of new Arctic fields is set to 50% above the cost level of the most expensive Norwegian non-Arctic field category" . The authors mention three factors that helped create the interest in looking for oil in the Arctic; the rising price of oil combined with the increased demand for countries such as China, India and Brazil and that new areas was needed to cope with the increased demand from these countries. Secondly increased ice-melting in the arctic region opened the Northwest Passage as a possible transport-route. Third the planting of the Russian flag under the seabed at the North Pole in 2007 signalized Russia`s interest in this area (Lindholt and Glomsrød 2012, 8037) . All of these factors have seen a substantial change the years since they were presented as important for the exploration of the Arctic. While the oil price reached a record high of approximately 140$ in 2008 encouraging the exploration of new areas, it fell

dramatically during the financial crisis of 2008 and has since "stabilized" in an interval between 90-120 $ (Indexmundi 2014).

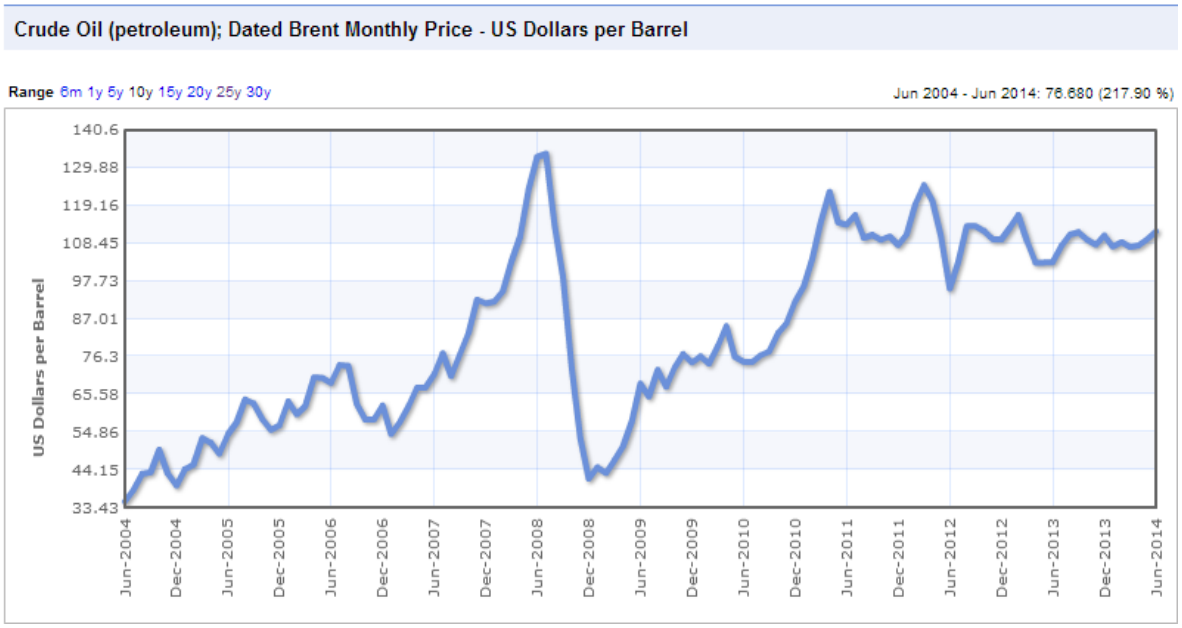


Figure 9 Brent Spot prices last 10 years (Indexmundi 2014)

This combined with new technology making the unconventional resources such as shale oil possible to extract at a cheaper cost than previously believed, might push the expected exploration of the Arctic forward in time. Russia, who has been in front in marking their interest in the Arctic-area, has also seen an increase in their shale oil resources. The Bazhenov area in Russia might turn out to be 80 times larger than the Bakken area in the United States (Lamphier 2012) taking focus away from the Arctic if these resources turn out to be cheaper and easily available. We have in recent years seen large oil-companies such as Statoil engaging in partnerships with Rosneft, and the enormous potential resources are surely one of the reason for the interest in the cooperation (NTB 2012). Statoil has already positioned itself for the shale oil resources when they bought US oil-company Brigham Exploration, establishing themselves as one of the 10 largest holders of Bakken acreage in the US (Stigset and Treloar 2011). Russia`s oil giant Rosneft will surely try to use Statoil and other oil company's technological competence in this area. With Statoil involved in this area, this might be an opportunity for other Norwegian companies to increase their activities in this area like they have done

when Statoil has moved its production to other areas. One example is Africa where Statoil has awarded Norwegian companies contracts, such as the seismic company Dolphin Group who was awarded a contract for the exploration of a 5500 km2 area outside of Tanzania (Scandoil 2012).

If we see the same trend in the Russian case, there might be large opportunities for the Norwegian oil-service and seismic companies working with Statoil also in Russia. Statoil will have the benefit of working together with partners known from other projects, and the Russians will benefit from the technological expertise from the same companies. There are worries when it comes to Statoil cooperating with Rosneft, the leader of the Norwegian environmental foundation Bellona, Frederic Hauge, is afraid that Statoil has been too naive when cooperating with the Russians in the Shtokman-field, and that instead of technology cooperation, the Russians have used Statoil and their Norwegian suppliers to get a hold of the technology. He states that the Russians have deliberately acquired Norwegian technology, and that Statoil`s sub-suppliers should be worried. NUPI-researcher Jakub M. Godzimirski disagrees, saying that he does not believe that the Norwegian companies have given up this technology that easy as it is their strongest card in future negotiations with the Russians (E24 2012)

It looks as if there is a common interest in the cooperation between Rosneft and Statoil. Rosneft looks to Statoil to get expertise in harsh areas and deep waters, as well as Statoil`s new knowledge in the Bakken area through the purchase of Brigham Oil. Statoil on the other hand is interested in involving themselves in Russia`s enormous oil-fields as well as the new potential unconventional resources.

Lindholt and Glomsrød (2012, 1468) predict three different scenarios for the Arctic oil production. First scenario is the reference scenario from IEA with an oil price that rises to 100 $ a barrel in 2020 and 115 in 2030 (in 2008 prices) with a constant level of the oil price from 2030-2050. Second scenario is the high price scenario where the oil price rises to 140 $ by 2030 and stays constant to 2050. The third scenario is a low resource scenario where only 50% of the estimated resources in the Arctic are possible to extract.

Figure 10 The Arctic Oil Production. Reference, high oil price and low resource scenario. Mtoe. (Lindholt and Glomsrød 2012, 1469)

The Arctic with its harsh conditions, demand a different approach than any other area in the world as in the hunt for oil a vessel might have to break through the ice to get anywhere. A company working in this area is Aker Arctic Technology (Sintef 2014). In its research lab in Finland, Aker has "pioneered a design for "double-acting vessels": ships driven by an electric-powered azimuth propeller that can rotate 360 degrees, allowing them to smash through ice stern first, creating less friction and leaving less of a carbon footprint". They are currently working on several projects that will help with the exploration of these hard-to-get-to areas (Hammer 2010). This can be seen as an example of establishing a subsidiary that caters for a very specific and narrow market, with very special needs. By having only the Arctic to focus on you can differentiate your company and be rewarded for your unique competence with a premium price (Porter 1985, 14)

The Dolphin Group example and Aker example are two examples of what may happen when Statoil awards contracts to Norwegian sub-suppliers. Just as the relatively small company Dolphin Group (market capitalization of 1.5 billion NOK) follows Statoil to Tanzania, Aker might see their next big contract come from Statoil in the Arctic or even from Rosneft if the cooperation between the two oil-companies is successful (Jakobsen and Hokoholt 2012). The Aker-group has a long relationship with Statoil and will likely be one of the top contenders when contracts in the Arctic are to be announced (Aker Solutions 2012).

There might also be political difficulties with drilling for oil in the Arctic-region. In a recent moratorium, the Environmental Committee of the EU decided that the EU is to work against oil-extraction in the Arctic-area. The committee will also forbid its member-countries to award licenses for drilling in the area. There are few countries, obviously, that are affected by this decision, but Norway might just be one of them. Even though Norway is not a part of the EU, the proposal is said to be valid also for the European Economic Area (EEA) which Norway is a part of. The Norwegian Minister of Petroleum and Energy, Ola Borten Moe, comments that this suggestion from the EU will not be relevant for Norway as the EEA-agreement is specifically not valid on the Norwegian Continental Shelf, and that this area is completely under Norwegian control (Bertelsen 2012). Even though this is a proposal that has to be acknowledged in several other EU bodies before it can be made part of Norwegian law, it is a signal that this is a highly sensitive area where political decisions, not just harsh environment and deep waters, might just as well be the barrier to break to develop this region for oil exploration

6.4 Above ground; politics

> "…..But this is no done deal. There are many "buts," having to do with what happens above ground. The policies of governments around the world—especially concerning taxes and access to resources—have a major impact on whether and when oil is discovered and developed." (Yergin 2011b)

According to Noreng (2006, ix) the doubling of the oil price during the US invasion of Iraq in 2002 confirms that "the international oil market is essentially shaped by politics and bargaining strengths rather than by conventional market forces such as supply costs and demand" and that "the only prolonged periods of relative oil price stability since 1973 have been the years 1974-78, 1981-85 and 1991-1997" (Noreng 2006, 11).

Killian (2009) distinguishes between three demand and supply shocks; shocks to the current physical availability of crude oil(oil supply shocks), shocks to the current demand for crude oil driven by fluctuations in the global business cycle (aggregate demand shocks) and shocks driven by shifts in the precautionary demand for oil (precautionary demand shocks). Precautionary demand arises

from the uncertainty about shortfalls of expected supply relative to expected demand (Kilian 2009).

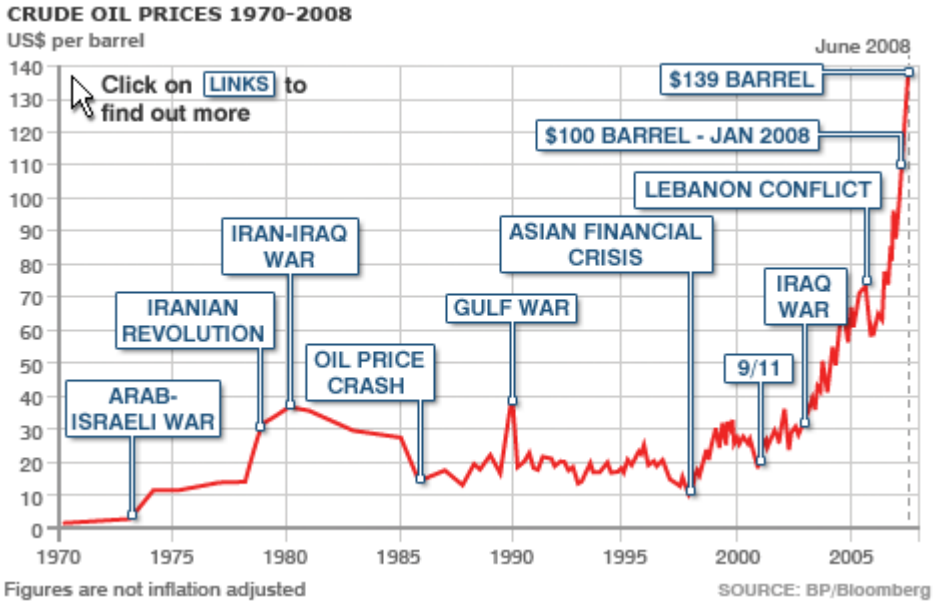


Figure 11 Why the oil price keeps rising (BBC 2008)

One of the historical events that have affected the supply and demand of oil is the Iranian revolution, where after taking control of Iran in 1979 Ayatollah Khomeini nationalized the country`s oil industry sending all large oil-companies out of the country and thus all the most experienced oil-workers. This led to Iran production halting reducing production and at one point almost completely stopping production. This forced other Arab suppliers to tome together and increase their supply, but still the oil price rose from $15.85 to 39.50$ the next twelve months (Baxter 2009; BBC 2008)

Other examples are the Iran-Iraq war and Iraq invading Kuwait/Gulf war. The Iran-Iraq war combined with the Iranian revolution was part of the doubling of the oil-price as mentioned above. Iran, who was weakened after the Iranian revolution in 1979, was invaded by Iraq in September 1980 and by November the combined supply from the two countries was reduced from 6.5 million barrels per day to 1 million barrels per day (BBC 2008). Iraq invaded Kuwait in 1990 to seize control over the supergiant oilfield Rumaila and get more control over the world market. Saddam Hussein used an excuse of Kuwait stealing oil from the field, who lies on the border of Iraq and Kuwait, to invade Kuwait leading to the first Gulf War (Baxter 2009; BBC 2008)

In figure 12 we can see a ranking of largest global oil supply disruptions, and as we can see these are examples that when companies are considering what areas to focus on and what strategy to choose, political factors has to be taken into consideration

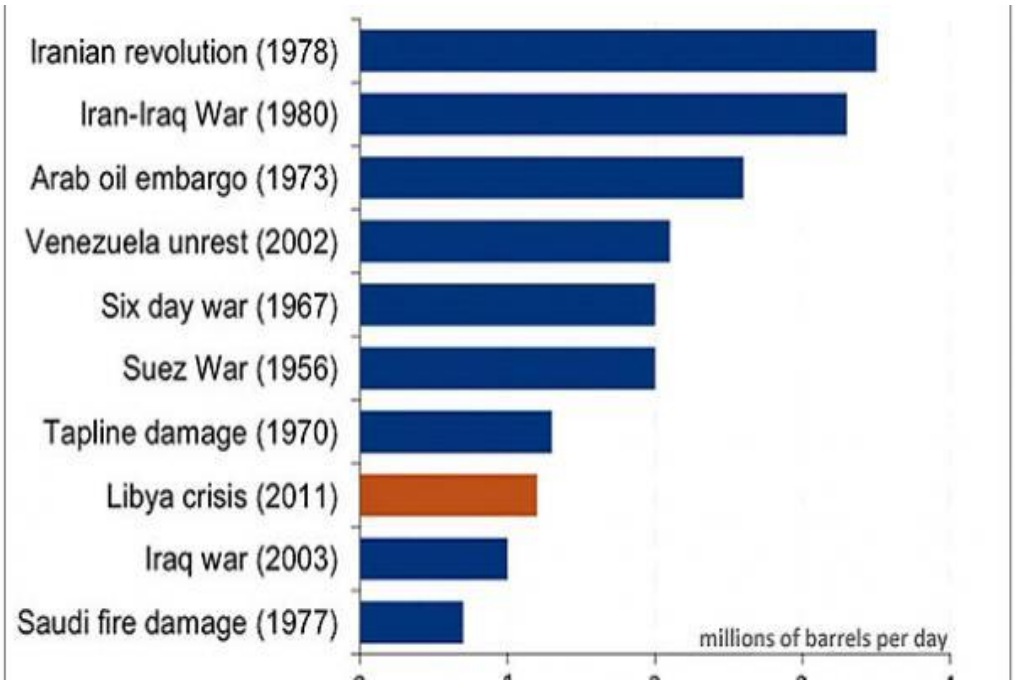


Figure 12 Global oil supply disruptions by average gross supply losses (Weisenthal 2011)

One of the more recent incidents threatening the supply side of oil was in late 2011 when Iran threatened to block the Strait of Hormuz if the West continued to put sanctions on its nuclear program. Iranian Vice-President Mohammad Reza Rahimi said that no oil would pass through the strait if these sanctions continued. About 40% of the world`s tanker-borne oil passes through the strait, and links the Gulf to the Indian Ocean (BBC 2011). If Iran would go through with its threats, the price of oil would skyrocket and could rise as much as 50% within days. The United States has made it clear that they will open the strait if Iran tries to close it, and if necessary answer with military action towards Iran (Crauss 2012)

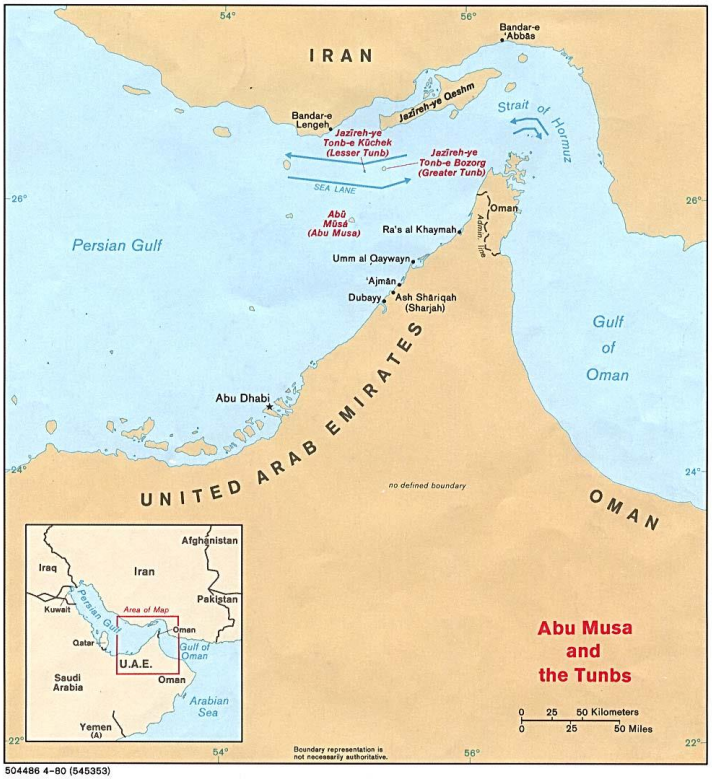


Figure 13 The Strait of Hormuz (GlobalResearch 2012)

These examples serve as reminders that even though companies choose the correct strategy and position themselves in the correct market, they must consider the macroeconomic and geopolitical risks that exist. This shows that it is even more important to choose the correct strategy, and be the premium supplier, whether you choose a cost focus or a differentiated focus, in your market if these risk factors manifest. It might also be that the rising concern of geopolitical risk factors could be the reason why the North Sea and the Arctic has got a revival in recent years, as there are more stable

6.5 Present situation and the way forward

This chapter has shown that while the challenges in the Arctic seem to be the harsh weather conditions the main challenge with the Brazilian pre-salt is the changing formations under the seabed and the extreme depths. In the Brazilian market Norwegian companies are well established on the supplier-side, even though the protectionist policies make it more difficult than in other regions. Statoil`s increased presence and focus on this area should also be a factor in increasing the activity in Brazil in the coming years. In the Arctic there currently not a significant activity with projects at an early stage and political decisions that

need to be decided before the activity can start. Research also indicates that a start in the Arctic will depend on a high oil price since the cost of exploration is, currently, much higher in this area than in already developed areas (Lindholt and Glomsrød 2012, 1468). There is however similarities between the activity in Brazil and the Arctic when it comes to challenging weather-conditions, the advanced technology needed and political hinders that need to be overcome.

A similarity also lies in the fact that Statoil has been a door-opener for the Norwegian companies in Brazil, and other areas in the world, and might through their increased cooperation with Rosneft also be the way into this market for the Norwegian companies when and if this area becomes as important the most optimistic scenarios.

7. Technological developments that has made it possible to recover unconventional oil and gas, and oil and gas in deep waters

7.1 Technological developments

Recent years has seen a substantial development in technology that has made it possible to extract more oil from already existing oil-fields, technology to make it possible to extract unconventional oil as well as technology to extract oil in deeper water. As we have seen in previous chapters, Norwegian companies are perceived internationally to be leading in technology, and as Porter point`s out it is this uniqueness or perception of extra value that makes companies be able to claim a premium price for their product or service (Porter 1985, 14).

Below we will have a closer look at three of the most important and relevant technologies for the questions posed in this thesis; hydraulic fracturing, 3D-seismic mapping and horizontal drilling.

7.2 Hydraulic fracturing

Hydraulic fracturing, also known as “fraccing”, is a technique that was first used in the 1940`s to extract oil from shale formations. It ‘injects large amounts of

water, under high pressure, combined with sand and small amounts of chemicals, into the shale formation." By doing this it breaks up the shale rock and creates paths for the oil to flow through the well (Yergin 2011a, 327-328).

This has made it possible to extract more oil in areas that earlier were not accessible, and according to the American Petroleum Institute it has unlocked large reserves of shale oil and gas in the U.S, creating security, economic growth and jobs (American Petroleum Institute 2014).

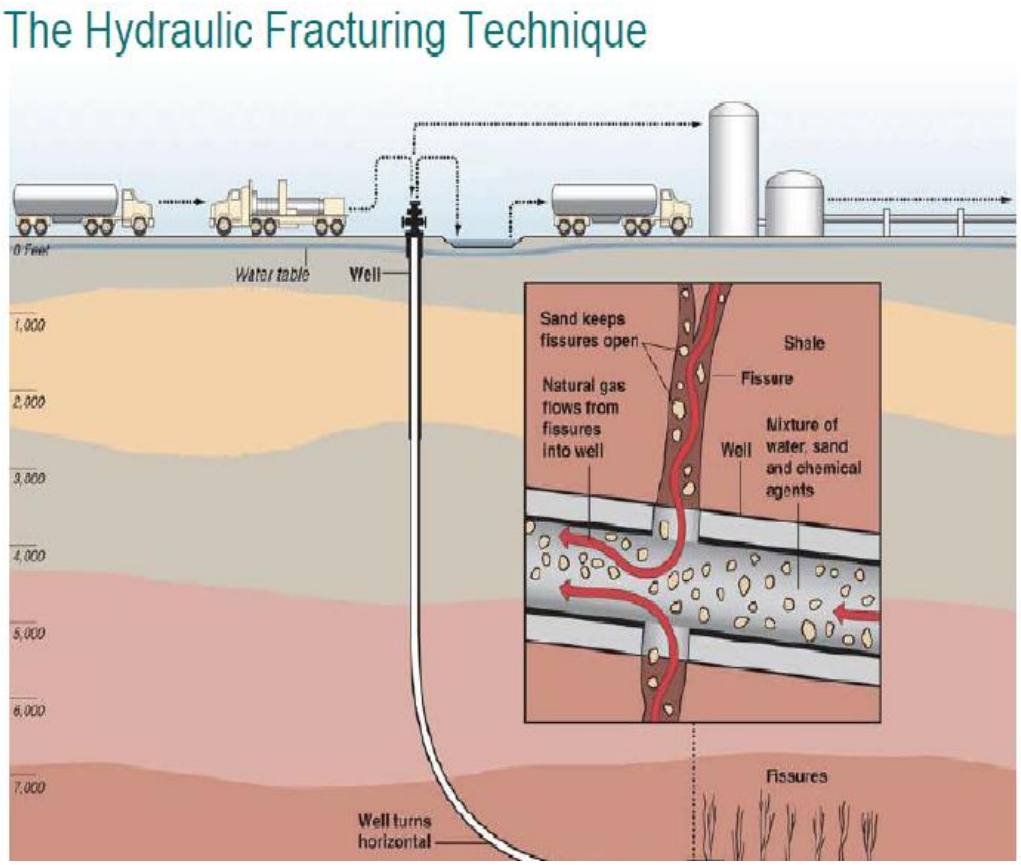


Figure 14 The hydraulic fracturing technique (Kjus 2012, 27)

In figure 14 we can see an example of how the hydraulic fracturing technique works.

Statoil establishing themselves within this area with their acquisition of Brigham Exploration in the Bakken area in the United States may lead to opportunities for Norwegian companies. Statoil is also involved in the U.S onshore areas Marcellus and Eagle Ford (Stigset and Treloar 2011). In this area the companies would

not have the same strategic advantage as when moving from the North Sea to Brazil since the technologies in use are not that similar as it is when drilling for oil in deep waters. Here Norwegian companies might use the fact that they are perceived as leading in technology in other areas that require high class technological competence. According to Porter(1985, 14) you can claim a premium price and differentiate yourself if you are "perceived" as unique, meaning you do not have to be unique if you can sell the perception that your service is unique. Here lies an opportunity; to position themselves so that because of their technological leadership in deep waters they will be perceived as a high technology differentiated supplier, even in other areas than the deep water areas.

Mergers and acquisitions of companies that possess either the technology or the customer-base to enter this market is also a possibility.

7.3 3-D seismic mapping

Up until the 1990`s there was only 2-D seismic analysis available, which takes longer time to analyze and is more difficult to understand than 3-D seismic analyzes (Downey 2009, 100). Seismic surveys is a technique used to create an image of subsurface rock and "involves bouncing sound waves against subsurface material and then measuring the time it takes for sound reflections to be picked up using devices called geophones" (Downey 2009, 99). The development of 3-D seismic surveys has revolutionized the exploration for oil, as it not only finds and estimates the size of the reservoir, but also makes it easier to know exactly where to start drilling. Where earlier the seismic data was printed on meters of paper, the oil-industry is now one of the largest users of "supercomputers" to analyze the seismic data (Downey 2009, 99-100).

According to ExxonMobil (2012, 43) there is also an environmental advantage to the increased use of 3-D seismic analyzes as it reduces the need for drilling a well to find out if there is oil, and therefore saves energy and reduces pollution associated with drilling wells.

As we have seen in previous chapters Norwegian companies Petroleum Geo-Services, TGS Nopec and Dolphin Group are among the Norwegian seismic

companies that are offering both 2D and 3D seismic services, and are benefiting from the increased need for seismic research in new areas of the world as well as in increased depths

7.4 Horizontal drilling

As with 3-D seismic mapping horizontal drilling also reduces the environmental impact as it makes it possible to extract oil from a single location, also minimizing the need for work and thus the related pollution (ExxonMobil 2012, 43). It also means that much more of the reservoir can be accessed, since wells can be drilled both vertically, at an angle or sideways controlling the entire process with sophisticated tools. (Yergin 2011a, 17)

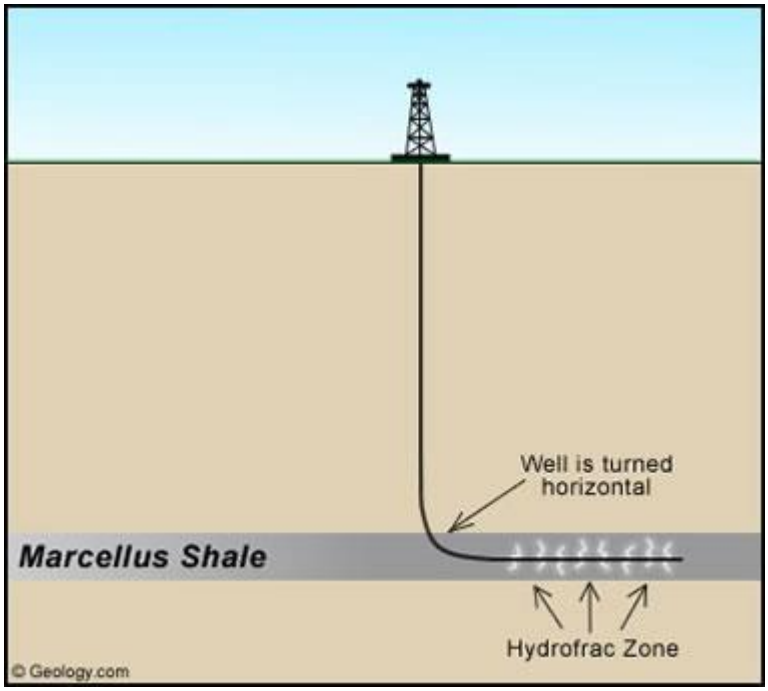


Figure 15 Horizontal drilling (Geology.com 2014)

As we can see in figure 15 horizontal drilling minimizes the need to drill several wells as you drill at an angle to reach a larger area. The figure also illustrates the part where hydraulic fracturing is performed.

Figure 15 shows an example from the Marcellus shale where Statoil is represented, and as mentioned this might be an area where Statoil can be a "door-opener" for the Norwegian companies.

7.5 Implications for Norwegian companies

All these three technologies have made it possible to extract oil and gas in areas earlier unavailable. The need for 2D and 3D seismic mapping has generated substantial activity for Norwegian seismic-companies, and we might just see that the hydraulic fracturing and horizontal drilling technology may open up a new market for Norwegian companies as well. For the Norwegian companies it is important maintain the status as high technology supplier to still keep their uniqueness and be able to claim a premium for their services. Better technology might reduce the time it takes to perform the needed task, as well as make sure that it is performed in a safe and effective manner. One example is 2D-seisimic versus 3D-seismic, where 3D-seisimic might be more expensive at first, but in total can reduce cost by eliminating the need for multiple seismic research and reduce time it takes to analyze the data.

There are also possibilities in the Russian unconventional area, both for seismic research, hydraulic fracturing and horizontal drilling. This is increasingly seen as Statoil and other companies are increasing their partnership with Russian companies as Rosneft and the fact that the Russian unconventional oil-areas might be significantly larger than for example the Bakken area in the U.S. (Lamphier 2012; NTB 2012; E24 2014)

8. Conclusion

The increased search for oil in deep waters have already led to an increase in the workload for Norwegian oil-companies as their technology is preferred in areas such as Brazil, after gaining experience in deep waters and harsh weather conditions on the Norwegian continental shelf for over 30 years. Based on the findings in this thesis the Norwegian companies should position themselves even

more in Brazil to overcome some of the protectionist policy as well as in the arctic which could be another potential area for Norwegian companies to showcase their technology. The Brazilian oil fields are per now a much more developed area than the Arctic, and there is debate on how important the Arctic will be in the future. Even though 25 % of the world`s undiscovered oil and gas is said to be located in the Arctic, the exploration of these resources will only sum up to between 8-10 % of the global production by 2050 due to the high exploration-cost compared to other oil and gas resources in the world (Lindholt and Glomsrød 2012). The exploration of the Arctic depends on oil-prices still being high, and if there is cheap available oil in the Middle East and from new unconventional resources. Even though the oil is expensive to develop now compared to other sources, at one point in time it will become important as oil is per definition a finite resource, and when the cheap oil is gone this area will more and more important. The recent development in new technology to extract more oil from existing oil-fields tells us that if we look some years ahead the technology may have reached a level making oil-exploration an extraction in these areas easier than we can imagine today.

The peak-oil theory is heavily debated and if we look at the most pessimistic predictions, companies working in the Norwegian oil and gas sector should be preparing for the end of oil. According to Campbell and Laherrere (1998, 81) "there is only so much oil left in the world, and the industry has found about 90% of it". Yergin (2011b) on the other hand says that in the period of 2007 and 2009 1.6 new barrels of oil was recovered for every barrel of oil produced . Even though the world will run out of oil at some stage there is no physical shortage of oil in the world and still large unexplored areas (Noreng 2012, 21).

The unconventional-oil aspect in judging the future strategy of the oil companies depends on the role that these unconventional resources will play in the future. According to Maugeri (2006) tight oil is one of the unconventional oil-resources that will change the market, while others think that these unconventional resources will not be able to change the dynamics of the oil-market. A key challenge in the future is if the Norwegian companies can use their experience and technology from the deep waters to enter the unconventional oil-market. Statoil buying Brigham Exploration, a major shale oil-operator in the Bakken area in the U.S., may lead to contracts for Norwegian companies, just as we have seen in Brazil. If unconventional resources are becoming both cheaper and larger in size

than the traditional oil sources, Norwegian companies should position themselves so that they are prepared for the growth that will come in these areas.

With regards to the research question and the hypotheses posed, this thesis finds support for the hypothesis H0, these factors undermine current strategies and will lead to a strategic change, when it comes to the unconventional oil aspect, where the findings indicate that the Norwegian companies are currently not participating within this area in a relevant way, and need to position themselves as differentiated companies, with a focus on technology and experience.

We do not find significant support for the peak oil theory, and therefore do not consider this as a factor that will have any substantial effect on the strategic choices of Norwegian companies, and thus find their current strategies robust. The advocates of the peak-oil theory seem to disregard the advances in technology, the effect of unconventional oil and the still large unexplored areas of the world that can contain the next large oilfields.

In the H1 hypothesis, the strategies of the Norwegian companies are robust, this thesis finds support for that in the deep waters aspect, where Norwegian companies have positioned themselves in Brazil with a differentiated focus and are seen as leading in technology. They also seem well positioned for an increase in the Arctic-areas, which is an area where factors that are out of the companies' control, such as political decisions and the future oil-price, will decide the level of activity.

The thesis finds some support for hypothesis H2, the current strategy must be developed to face these challenges, when it comes to the deep waters part. Even though we have seen that their current strategy seems robust, it is important to still be perceived as unique for the Norwegian companies and keep their uniqueness by sticking to their differentiated focus strategy, and not falling for the temptation to be both cost leader and differentiated supplier and end up with no competitive advantage and below average-performance. They will be end up being "stuck in the middle" and receive lower profit than the companies specializing in one of the areas (Porter 1985, 11-17).

In total this thesis concludes that the effect the areas posed in the research question will affect Norwegian companies in a varying degree. Norwegian

companies should try to position themselves in what Porter defines as the differentiation strategy, and most likely within the differentiated focus. This is characterized as a company that will try to exploit special needs of customers in special segments and thus achieve a price higher than its competitors (Porter 1985, 11-17). This is mostly due to the fact that their competitive advantage lies in technology and not in for example cost leadership. One possibility for the oil service- and seismic research companies is to establish subsidiary companies that focus only on one market. One example might be subsidiary companies in Brazil with a larger part of local employees as well as local content that focus only on the Brazilian market. Another one might be establishing subsidiary companies that focus only on the unconventional oil and gas markets. Such a separation of the business-units is possible, but unless the different units are strictly separated into two generic strategies, it might end up with none of them achieving its competitive advantage (Porter 1985, 17-18).

The same goes for the search for oil in deep waters, Norwegian companies will have an advantage with their experience from the Norwegian continental shelf and should try to position themselves as a high technology option, and achieve a status as unique in its industry and be rewarded for its uniqueness with a premium price (Porter 1985, 11-17).

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Appendix 1: Preliminary thesis report

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MSc Political Economy – Preliminary thesis report

Norwegian Business School BI

"Energy Security: Peak Oil, new technology, unconventional sources of gas and oil and challenges for the oil-service sector"

GRA1902 – Preliminary thesis report

16 January - 2012

Supervisor: Øystein Noreng

BI Oslo

Master of Science in Political Economy

SYNOPSIS

1. THEME

Ever since Colonel Edwin Drake struck oil in the world`s first oil-well in Pennsylvania in August 27 1859, oil has become more and more important to fuel the world economy. The hunt for oil started as a result of scarcity of whales, since whale oil was used to create light at the time, but overfishing led to a decline in whale population and rising prices for whale oil. This led to what can be compared to the California gold-rush, where oil became known as the black gold. By 1950, oil was no longer used as lamp oil, but as transportation fuel with gasoline, diesel, residual fuel and jet fuel/kerosene accounting for about two thirds of crude oil consumption. Since its beginning oil has risen to become the most important source of energy in the world, and contributes to 38% of global energy production, vastly outnumbering its "competitors". Of this 64% of the oil is used for transportation, confirming its importance for the world economy and world trade (Downey 2009, 1-29).

As the economic growth in the world gets higher, the demand for oil and gas have rocketed, and with that prices have become increasingly higher, even though fluctuations have at times been large. A key factor in the rising increase in demand for oil and gas lies in the increase in living standards in countries such as China and India. Recent years has also seen large changes in oil-sources, such as the unconventional Canadian oil sands. In 2003 Canada adjusted their oil-reserves from 5 billion barrels to an astonishing 180 billion. This oil which had been seen as of little importance has been the fastest-growing source of new supplies in North America (Yergin 2011, 254).

Yergin (2011, NY times) mentions one of the most interesting themes in the current debate of peak oil and energy security. It is the "battle" between the rising demand of energy from countries such as China and India and the fact that we might just reach peak demand, much to the fact that we get more efficient. Twenty years from now, instead of driving cars that run on gasoline, we might drive cars that run on electricity. Yergin argues that instead of the peak oil scenario

predicted by many, we might reach what he calls a "plateau" in the next 20-30 years.

There are different perspectives on what constitutes energy-security. While some argue that the main threat to energy-security is the depletion of energy reserves in the world, others argue that energy-security is a matter of bilateral relationships between countries. Campbell and Laherrere (1998, 78) claim that "global production of conventional oil will begin to decline sooner than most people think, probably within 10 years", and that oil-producing countries are deliberately not reporting correct numbers about their oil-reserves.

The article states that 59 nations stated in 1997 that their reserves were unchanged from 1996, something which cannot be correct because "reserves naturally drop as old fields are drained and jump when new fields are discovered, perfectly stable numbers year after year are implausible" (Campbell and Laherrere 1998, 80)

Maugeri (2006, 202) on the other hand, disagrees and claims that rising oil prices will lead to more investment which in turn will lead to new oil-fields being found:

> In simple terms, searching for the ultimate figure about the earth's oil endowment is like searching for the Holy Grail—a never-ending rush with several people claiming to have discovered what in effect remains a mystery.

Maugeri also stresses the fact that a large part of the world is still not explored when it comes to oil and that:

> Consider, for example, that in Texas alone nearly 1 million wells have been drilled, against 2,300 in all of Iraq, and that today there are more than 560 000 producing wells in the United States as against slightly more than 1,500 in Saudi Arabia. (Maugeri 2006, 204)

Winston Churchill made the famous comment that security when it comes to oil "lie in variety and variety alone"(Yergin 2006, 69). But there is also a dependence that goes both ways between the exporters of oil and gas and the importers. In the EU when it comes to gas, the discussion of security mostly lies in the fact that the EU is poorly diversified when it comes to the importation of gas. The fact that

there has to be a physical connection between the exporter and the importer of gas, distinguishes gas from oil. Where oil is a global market, gas is a regional one. The EU is very much dependent on gas-deliveries from only three countries; Russia, Norway and Algeria. But the fact that Russia is to a much larger degree reliant on the income from exportation of gas to the EU than the EU is on Russian gas, gives strength to the argument that being dependent on Russia is per se not a security of supply issue.

According to Haghighi (2007, 27) Europe is poorly diversified when it comes to gas supply. In contrast to oil, Europe is dependent on Norway, Algeria and Russia for the entire gas demand of Europe. This includes both pipelines and through LNG.

Luciani (2004) disagrees and points out that there have been no major interruptions in the supply of gas from Russia, and that even though demand is increasing, so will the diversification of sources. Luciani also gives more weight to the political aspect of gas security than the transport routes.

The increase in the world-demand for oil has been substantial in recent years. A higher standard of living and growth in economies such as China and India have triggered a surge after oil. China and India have become major consumers of oil in recent years, and are set to increase further in the years to come (2006, 72)

> World oil demand has grown by 7 million barrels a day since 2000; of this 2 million barrels each day have gone to China. India's oil consumption is currently less than 40 percent of China's, but because India has now embarked on what the economist Vijay Kelkar calls the «growth turnpike», its demand for oil will accelerate

Yergin (2006, 72) further states that in 2005 for the first time Asia`s oil-consumption exceeded the one of North-America, and China who was self-sufficient with oil in 1993, now imports 3 million barrels of oil per day, almost half its total consumption

Even though Churchill saw diversity as the big solution to the energy-security issue, there are good reasons to why diversification of sources may be problematic. Haghighi (2007) explains that shifting the supply from the Middle

East to Russia or the other way around, could cause energy shocks, which in turn could affect the world economy. If a region that has been dependent energy revenue suddenly loses this security of income, this might lead to instability in the entire region.

Of all the energy sources oil stands out as the most problematic because of "its central role, its strategic character, its geographic distribution, the recent pattern of crisis in its supply – and the inevitable and irresistible temptation to grasp for its reward" (Yergin 2009, 762).

There are split opinions on whether energy-security should be seen from the economic perspective, that energy security is related to market rules only, or from a political point of view, including factors such as interdependence between countries and stable political relations (Checchi, Behrens and Egenhofer 2009, 1).

2. IMPORTANT RESEARCH-QUESTIONS

A key concern of oil today is the diminishing inventory of oil. About half the world`s oil-production comes from 116 giant oil-fields, each producing more than 100 thousand barrels a day, and in addition to this most of them are over 50 years old, and their resources are depleting (Checchi, Behrens and Egenhofer 2009, 11). Jesse and van der Linde (2008, 30) argue that because the OPEC-countries does not have a large enough spare capacity to cope with unexpected events such as terrorism and under-investment in the upstream sector and the fact that oil-companies have to invest in difficult areas, the price of oil will go up.

According to the pessimist we can postpone the oil peak until 2015 and then they predict "oil prices to skyrocket causing economic issues, social and environmental collapse, massive dislocation and a dying civilization", on the other hand you have the optimists who believe that unconventional oil sources, such as oil-sands and shale-oil, will postpone the oil-peak and not make it visible before 2030 (Checchi, Behrens and Egenhofer 2009, 11).

Veteran oil analyst Charley Maxwell puts it like this:

> In 1930 we found 10 billion new barrels of oil in the world, and we used 1.5 billion. We reached a peak in 1964, when we found 48 billion barrels and used approximately 12 billion. In 1988, we found 23 billion barrels and used 23 billion barrels. That was the crossover when we started finding less than we were using. In 2007, we found perhaps 6-7 billion, and we used 31 billion. These numbers are just overwhelming. (Downey 2009, 25)

This is one classical perspective supporting the view that the world is running out of oil, since new discoveries are not keeping up with the increase in consumption of energy. What might be more important than new discoveries of oilfields is the ever evolving technology, which makes it possible to extract more oil from already existing fields. In 2011 for the first time in ten years Statoil had an equal amount of new resources and production. . Three quarters of this came from increased extraction from existing fields (Aftenposten 2012).

As higher oil-prices will affect the costs of all companies requiring energy for their production, higher and more volatile prices of oil will have a negative effect on the welfare of energy importing countries in Europe (Checchi, Behrens and Egenhofer 2009, 12). About half of the energy needed in Europe is imported, so the data supports the fact that many net oil-importing countries might have a disadvantage if oil-prices rise (Checchi, Behrens and Egenhofer 2009, 4).

Downey (2009, 29) summarizes the discussion about the fact that oil is diminishing like this:

> One way or the other, in the 22nd century there will be transportation energy. It may be much more expensive, perhaps not. It is almost certain that the source of that energy will not be conventional petroleum

The thesis will look at the unconventional sources of oil and gas such as shale oil, liquefied natural gas (LNG) and oil sand and how these sources change the premises for the peak oil theory and the notion that the world is running out of oil. This combined with the exploration of new technology allowing for new discoveries of oil and gas as well extracting more from previous areas will make for an interesting theme put up against the peak oil theory/depletion of oil.

The thesis will shift focus to interviews with several large oil-service companies with regards to their perception of the future within the oil-market. Interesting questions might be questions with regards to:

Technology

If we look at Peak Oil theory one of the factors it lacks when considering when the peak in oil-production is the development in new technology. New technology makes it possible to find new oilfields on depths that were never possible earlier, as well as bring more oil out of already existing oilfields. These oil-service companies are at the forefront in developing new technology for the industry.

The new Norwegian oilfields

How do the companies look at the new large Norwegian oilfields? Especially the Aldous/Avaldsnes field which was discovered in 2011 gave new incentives for oil companies to explore the Norwegian Continental Shelf. The field was the third largest oilfield ever discovered on the Norwegian Continental Shelf. Also the Skrugard-field discovered in April 2011, which Tim Dodson in Statoil characterized as the "one of the most important events on the Norwegian Continental Shelf the last 10 years" (Statoil 2011).

New exciting areas

Brasil:

The large oilfields Campos and Santos. Large newly discovered oil fields such as the Tupi field and the Carioca field (World`s third largest oil field ever discovered) (Bloomberg 2008).

Brasil is also one of the pioneers when it comes to deepwater drilling as after years of work, -Petrobras in 1992 "broke the deepwater barrier by successfully placing the Marlim platform in 2562 feet of water" (Yergin 2011, 245).

Australia:

"According to the 2008 BP Statistical Energy Survey, Australia had 2007 proved natural gas reserves of 2.51 trillion cubic metres, 1.41% of the world total. Reserves are located in all of Australia's states except New South Wales and Tasmania. Australia had 2007 natural gas production of 39.95 billion cubic metres

and consumption of 25.14 billion cubic metres. Australia is the fifth largest exporter of LNG" (Mbendi 2012).

Africa:

Ghazvinian (2007) explains that even though Africa is thought to have only about 10 % of the world's oil-reserve, the continent is interesting for oil companies for other reasons. Africa has oil that is characterized as "light" and "sweet", in contrast to the middle eastern oil which "tends to be lacking in hydrocarbons and is therefore very "sticky" "(Ghazvinian 2007,9). It is therefore easier and cheaper to refine oil from Africa than from the Middle East. Another factor is the one of variety in sources of supply, which is an advantage for oil-importing countries.

Future challenges

How do the oil-service companies look at the most important future challenges in the industry? How are they affected by the peak-oil theory and the newly discovered oilfields?

Oil price

How does the price of oil affect the oil-service companies? Does a higher price automatically lead to more activity, which leads to more work for the oil-service companies? Does their activity correlate with the price of oil? Is there a preferred oil-price or interval for the companies?

Competition

How is the competition situation on the sector?

3. METHOD

The method part will need to be structured more coming weeks, but a very short plan would look like this:

1. Data gathering to do the first part of the thesis. Peak Oil, new discoveries of oil and gas, possible new unconventional sources of oil and gas.

2. Work on questionnaire for interview with oil-service companies.

3. Make appointments with oil-service companies. Possible candidates: Aker Solutions, Subsea 7 and Aibel.

4. Interview

5. Compare the first part of the thesis to second part. Integrate the two parts.

4. DATA

The thesis will be a qualitative paper with regards to the question of peak oil theory and questions with regards to the depletion of oil/new oil-fields/unconventional oil-resources and new technology. The paper will use a wide variety of sources, ranging from books about peak oil and the question of whether the world is running out of oil and national data concerning the oil resources in different countries. Some of the most helpful data when it comes to oil has been found in the works of Daniel Yergin. Especially the Nobel Prize winning book "The Prize" has been of great value in understanding the role of oil in our society. Also Yergin`s article "Ensuring energy security" and his new book The Quest has been very valuable. Morgan Downey`s Oil 101 has been very valuable in explaining the history of oil as well as the functioning of the oil markets.

Further, various books and articles as well as web pages from trusted sources such as BBC, has been used to supplement the above mentioned sources.

5. CONTRIBUTIONS FROM THE PAPER

The paper will seek to provide a discussion of peak oil, and put this theory up against the recent discovery of very large oil-fields, the improvement in technology and unconventional sources of oil and gas such as oil sands.

Even though the end of oil has been predicted so many times the last years, the fact is that human kind is evolving and creating new and better technology, as well as the fact that there are enormous areas not explored in the world. Think about the fact that in the North Sea there has just been made an enormous oil-discovery, Aldous/Avaldsnes, in one of the most developed areas.

To make the thesis interesting and to give it a unique perspective, I will look at the oil-service sector and try to connect it to the depletion of oil/peak oil question. The paper will first focus on the relationship between the possible depletion of oil put up against the evolving technology making it possible to extract more oil from already existing oil-fields, and the fact that the recent years there have been several major new oil-fields found, in contrast to the theory of peak oil which states that the peak in oil-production is already here. The fact that the technology has evolved enormously since the theory of peak oil was established makes it interesting to look at the oil-service companies which are at the forefront in developing new solutions for the sector.

When involving the oil-service industry in the thesis I will get a new perspective on the topic, as well as it will give the assignment a more practical angle as it will include direct perspective from the industry, not just a theoretical point of view.

Thus the thesis seeks to answer two main questions;

1. How does peak oil/depletion of oil relate to the discoveries new large oil-fields, the advances in the technology and the new unconventional sources of oil and gas?
2. How will the future challenges of energy security affect the Norwegian oil-service industry

6. Preliminary Literature

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