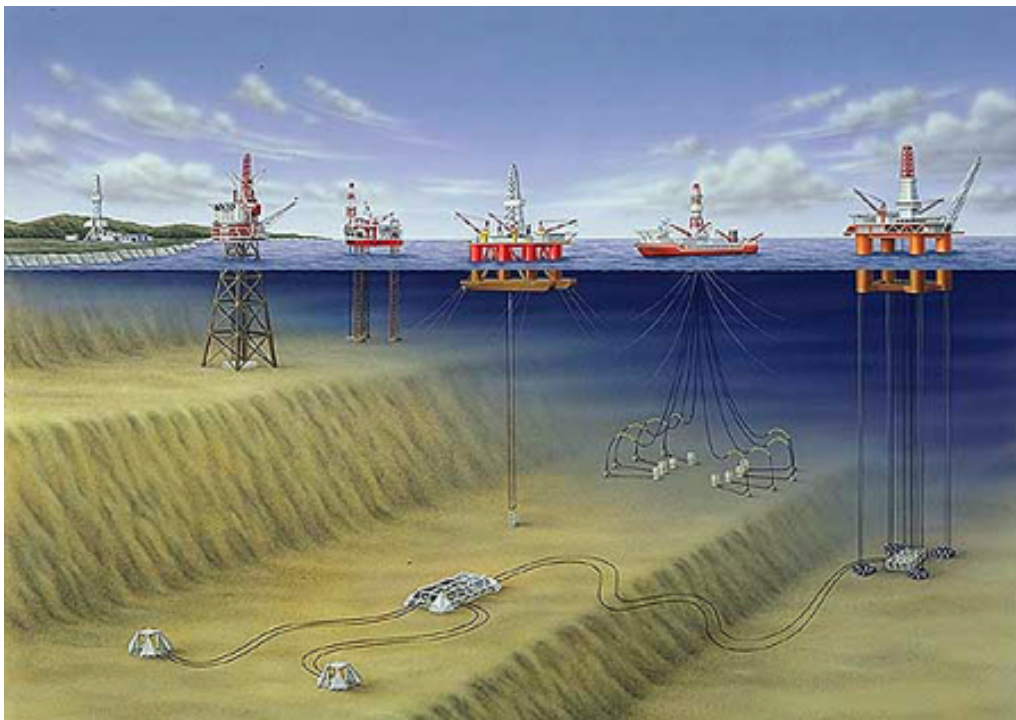


Offshore Oil and Gas as Industrial Driver

Yuriy Zhovtobryukh, Marius Nordkvelde
and Torger Reve



Forskningsrapport 3/2013

BI Norwegian Business School

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About the study

The project “Oil and gas as Industrial Driver” is a further development of professor Torger Reve’s nation-wide research project “Knowledge-based Norway” (2012). Common for the two projects is the cluster perspective on industry development as opposed to the traditional industry-neutral view. The key issue addressed in this project is the ability of the Norway-based suppliers to the offshore oil and gas industry to create value for society both directly through the core activities and by generating innovations that give Norway a competitive edge in other industries.

The project is undertaken by BI Norwegian Business School on behalf of the Norwegian Oil and Gas Association (Norsk olje og gass), with Professor Torger Reve as Head of Research, Marius Nordkvelde as Project Leader and Yuriy Zhovtobryukh as Project Coordinator.

In particular, we would like to thank research assistant Karthik Gowda for his significant and excellent contribution to the process of writing the business cases. We would also like to thank Atle Blomgren, Christian Quale, Katja Hydle and researcher Anne Marthe Harstad from IRIS for helping us with the data and for conducting interviews with companies doing innovation projects. However, the researchers from IRIS are not responsible for any of the conclusions in this report.

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1. Definitions and abbreviations

Value creation: The economic resource created by an operating firm for distribution among its employees (salaries), capital owners (capital yield net of taxes) and the government (taxes on labor and capital). It is calculated simply as a company's turnover less cost of goods/services. This is the same as payroll costs plus earnings before depreciation and amortization (EBITDA).

NCS: Norwegian Continental Shelf

Operators: Firms holding production licenses or those which have been granted operatorships of oil or gas fields. Examples of operators include Statoil, Shell, Total, etc.

Oil and Gas Suppliers: Firms which provide oil & gas-specific services and/or generic services modified for use in the oil & gas industry. Examples of suppliers include Aker Solutions, Schlumberger, Halliburton, etc.

Geology, Seismics and Reservoir: This is the smallest supplier industry sub-sector with 149 entities and 4,000 employees. Activities are divided into computer-assisted modeling of reservoir data (engineering-based services), and acquisition and processing of seismic data (maritime operations). Large firms within data processing are Schlumberger Information Technology Services, Geoservices and Landmark Graphics. Large firms within maritime operations are WesternGeco, PGS Geophysical and Electromagnetic Geoservices.

Drill and Well: This is a medium-sized supplier industry sub-sector consisting of 235 entities with total employment of 20,000. The sector can be divided into four subcategories: 1) engineering-based firms running drill and well operations (e.g., Halliburton, BakerHughes, Seawell, etc.); 2) manufacturing of drill and well equipment (e.g., the NODE cluster in southern Norway); 3) equipment supply (M-I Swaco); and 4) administration of rigs and FPSOs (e.g., Seadrill, BW Offshore).

Topside Equipment and Vessels: This is the largest supplier industry sub-sector comprising 404 entities with 43,000 employees. Sector activities include construction of offshore-related vessels, construction of surface installations, and maintenance and modification of onshore and offshore production facilities (MMO). The sector can be divided into four subcategories: 1) engineering-based firms (e.g., Aker Solutions, Fabricom, Apply Sørco); 2) manufacturing of construction-related equipment (e.g., Rolls-Royce Marine, Kongsberg Maritime); 3) equipment supply (e.g., Solberg & Andersen, Grenland, KSI, Proserv); and 4) construction and maintenance of onshore and offshore facilities (e.g., firms from the Aker Group, Aibel, STX, Beerenberg).

Field Development Subsea: This supplier industry sub-sector includes 96 entities and employs 13,000 people. The segment can be divided into four subcategories: 1) engineering-based design (e.g., Aker Subsea, FMC Production Services); 2) manufacturing, including design and development (e.g., Roxar, Framo Engineering, MPM, FMC), and fabrication of units (e.g., Malm Orstad, Matre Instruments); 3) construction and maintenance (e.g., FMC Kongsberg Subsea, Aker Egersund, Aker Verdalen), and 4) maritime-related engineering and

services (e.g., Oceaneering, Subsea 7, Deep Sea, Technip, DOF Subsea, Island Offshore Subsea).

Operations Support: This is the second-largest supplier industry sub-sector with 1,393 entities and employment of 34,000. The sector can be divided into six subcategories: 1) engineering-based services, consisting of firms providing operational support (e.g., Omega, Scandpower) and firms offering personnel for operations support (firms in the IKM Group, Manpower Professional, etc.); 2) manufacturing of equipment for production and safety (e.g., Frank Mohn Fusa, Autronica); 3) equipment supply (e.g., SFF, Scan Tech, Ahlsell Oil & Gas); 4) construction and MMO, consisting largely of firms providing auxiliary services such as scaffolding, insulation or painting (e.g., BIS Production Partners, the STS Group); 5) maritime operations, i.e., supply vessels (e.g., Solstad Shipping, DOF, Island Offshore); and 6) support services, such as offshore catering (e.g., Esso Support Services, Sodexo), helicopter transport (e.g., CHC, Bristow), land transport (e.g., SR Transport) and bases (e.g., Norsesea base).

CAGR: Compounded Annual Growth Rate

2. Introduction

The start of production on the Ekofisk field in 1971 marked the establishment of the Norwegian oil and gas industry. At that time, Norway had an international maritime industry, companies with expertise in fabrication and construction, but no specialized competence in offshore oil and gas. Investments in oil and gas production on the Norwegian continental shelf (NCS) over the last four decades have turned it into a major contributor to the country's GDP. Even more important, oil and gas production on the NCS has stimulated development of the industry into a global knowledge hub (Reve & Sasson, 2012) with a critical mass of companies in all segments of the value chain. The knowledge dynamics within this hub attracts not only talent and investments but also generates innovations that address the practical challenges of the oil and gas industry, as well as having potential applications in other sectors of the economy. In short, the oil and gas industry and especially its specialized technology-intensive supplier segment creates knowledge commons that the whole economy can benefit from in the future.

3. Value creation by Norway-based oil & gas supplier companies

3.1. A longer term perspective on value creation in the industry

Value creation in the Norway-based oil & gas-related supplier industry has grown at a rate of 11.6% over the last eleven years, which is comparable to the growth rate of 14.1% demonstrated by operator companies and almost 5.5 percentage points higher than the growth of the Norwegian economy overall. As a result, value creation in the industry in 2012 corresponded to about 5.5% of the country's GDP (see Figure 1¹).

¹ GDP is in 2005 constant prices. CAGR for GDP is adjusted by the inflation rate over the period given by the GDP deflator series from www.data.worldbank.org

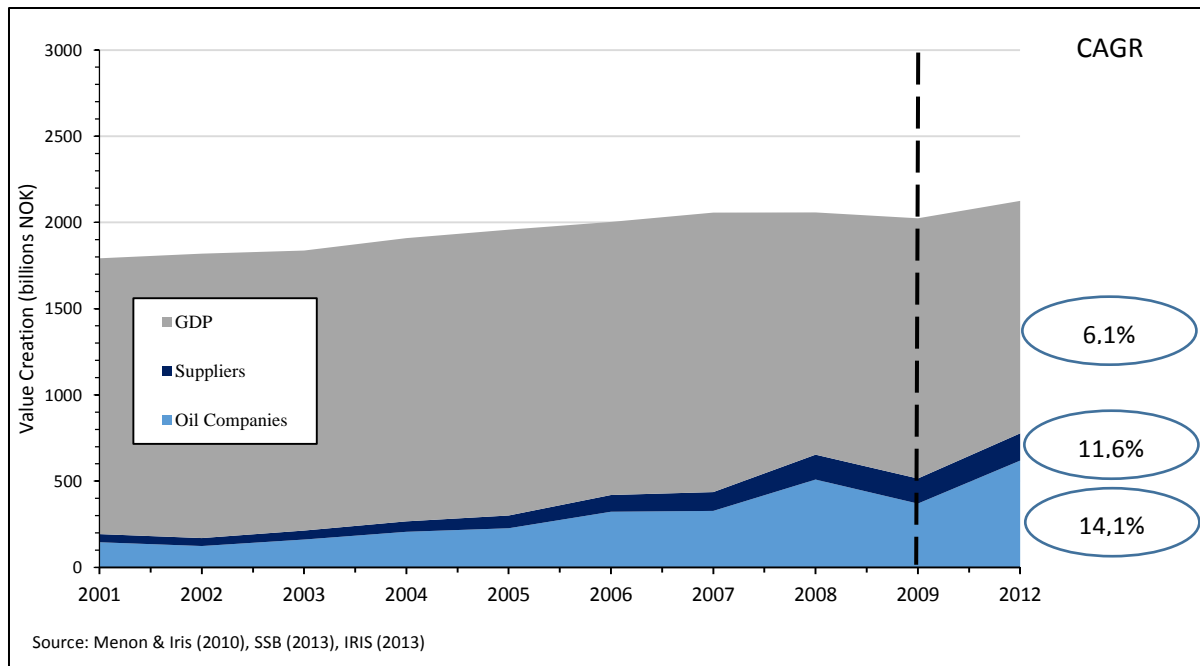


Figure 1 Value creation in the Norwegian oil & gas industry 2001-2012

3.2. Drivers of value creation in the Norwegian oil & gas industry during the period 2008-2012

During the period 2008 to 2012, value creation by oil & gas-related industry increased by approximately 3% from NOK 144 to NOK 158 billion (see Figure 2). This was significantly lower than both the growth rate of 5% by operators and the double-digit average growth of the supplier industry itself over the last decade. Understanding the decline in the growth rate requires analyzing two drivers of value creation: employment and productivity. It needs to be emphasized that the SDFI is included in figure 2, giving the high value creation for operators. The growth in the number of employees in the oil & gas-related supplier industry was 6.7% in 2008-2012 compared to an employment growth of 7.6% in operator companies. However, in absolute terms supplier companies created 4.5 times more jobs than operators. The number of employees in supplier companies grew by 33,500 reaching 147,500 in 2012, while the number of employees in operator companies grew by 7,510 to 29,510 in the same period (see Figure 3).

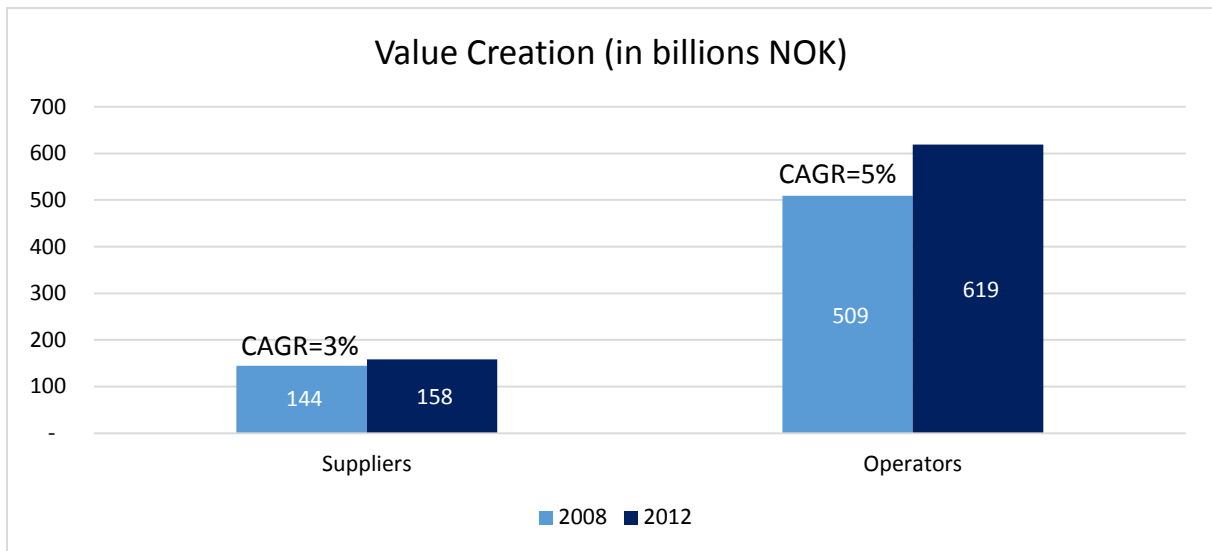


Figure 2 Value creation in the oil & gas industry in 2008-2012. Source: EKN (2008), IRIS (2012)

However, employment grew much faster than productivity, or value creation per employee, in the industry in the given period. Particularly, value creation per employee in supplier companies decreased on average by 4% from NOK 1265 thousand in 2008 to NOK 1073 thousand in 2012, while value creation in operator companies decreased on average by 2.4% from NOK 23140 thousand in 2008 to NOK 20998 thousand in 2012 (see Figure 4). In fact, productivity in the Norway-based oil and gas-related supplier industry was below the average productivity level in the economy in 2012, which was approximately NOK 1123 thousand per employee measured as GDP per employee. However, value creation per employee in the supplier industry is much higher than value creation per employee in mainland Norway, which was approximately NOK 730 thousand in 2012. Thus, the flattening of the growth rate was driven primarily by the productivity decline in recent years (see Figure 5). However, there was substantial variation across different segments of the oil & gas-related supplier industry.

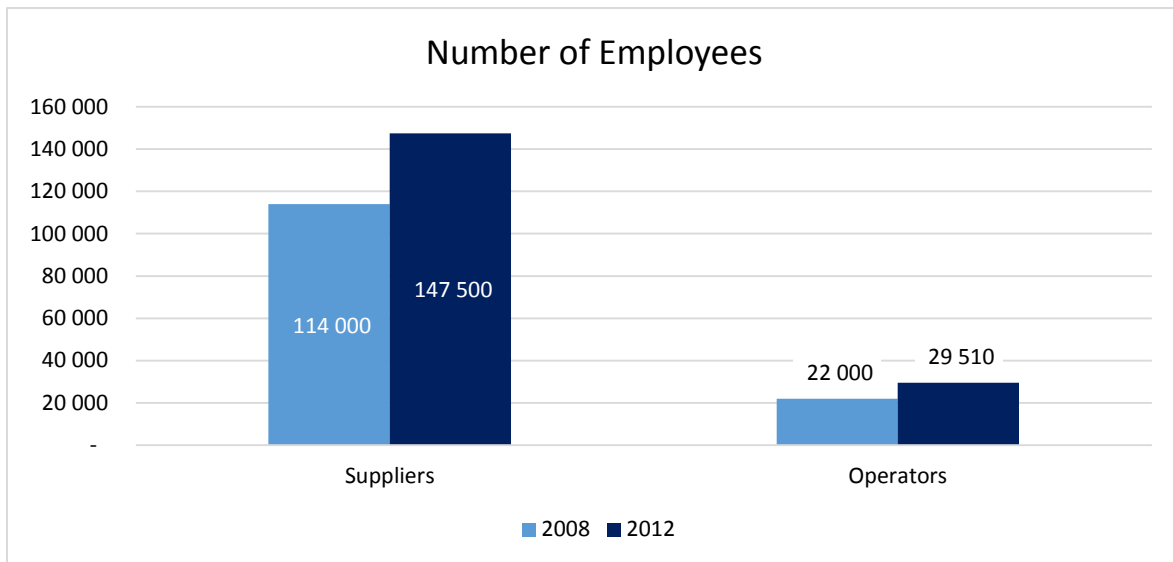


Figure 3 Number of employees in the oil & gas industry in 2008-2012. Source: EKN (2008), IRIS (2012)

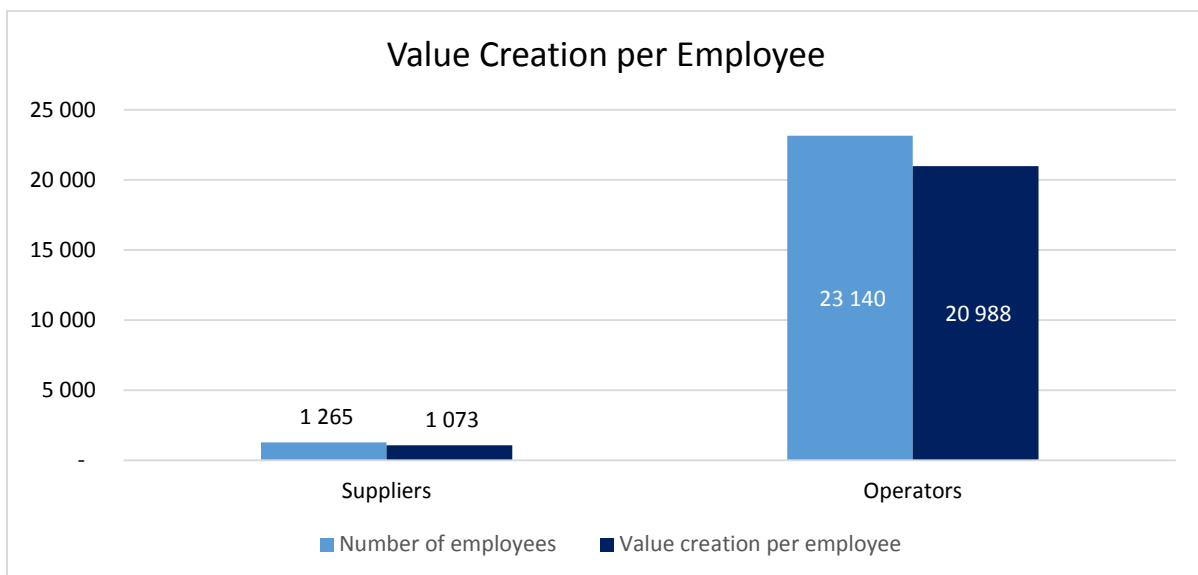


Figure 4 Value creation per employee in the oil & gas industry in 2008-2012. Source: EKN (2008), IRIS (2012)

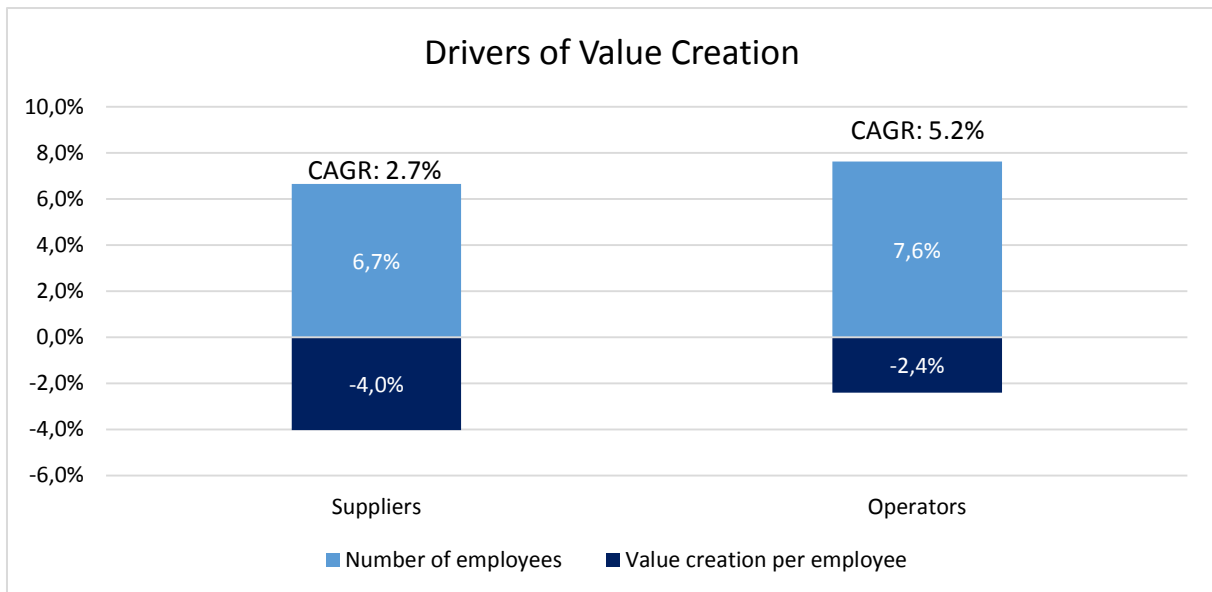


Figure 5 Drivers of value creation in the oil & gas industry in 2008-2012.

3.3. Segment analysis of value creation during the period 2008-2012

Following the earlier EKN study (2012), we distinguish between five segments in the Norway-based oil & gas-related supplier industry: geology and seismic, drilling and well, topside, subsea, and operations support.

Topside and drilling and well are the two largest segments in terms of total value creation in the industry in 2012, generating about NOK 56 and 50 billion respectively. Together they accounted for approximately 67.1% of the total value-creation by supplier companies. Moreover, total value-creation grew on average by 10% annually in topside and 7% annually in drilling and well, which is much higher than the CAGR of 5% in operator companies (see Figure 6).

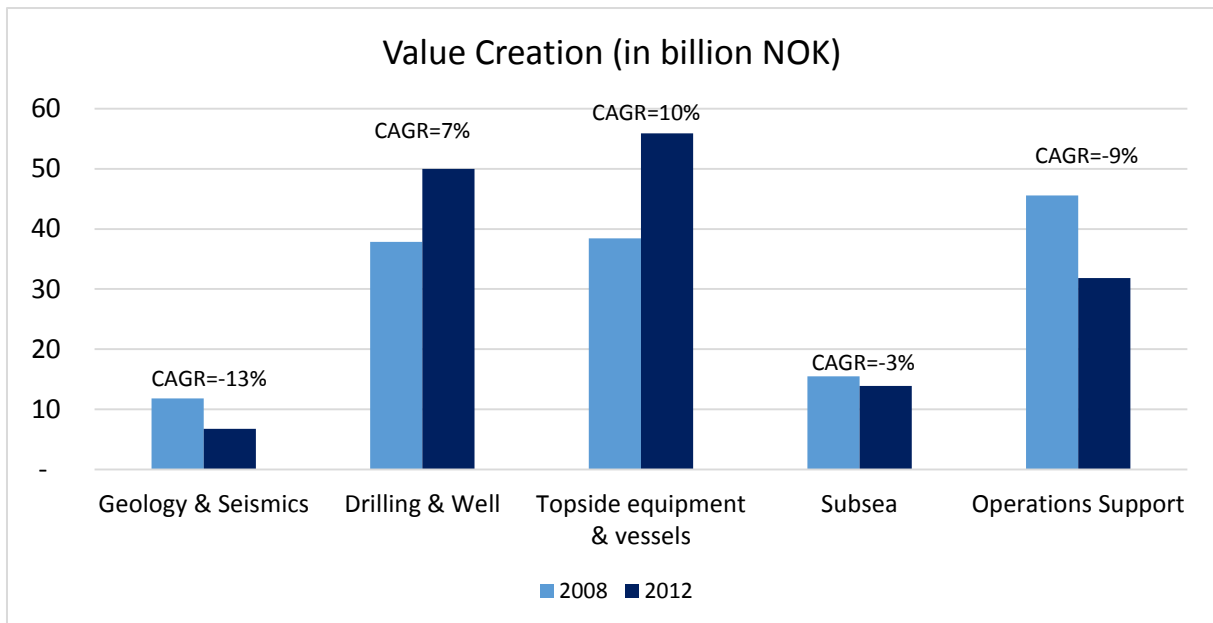


Figure 6 Value-creation across segments of oil & gas-related supplier industry in 2008-2012. Source: EKN (2008), IRIS (2012)

In the drilling and well segment this growth in total value creation was driven by both growth in employment from 20000 in 2008 to 24740 in 2012 (see Figure 7) and productivity growth from NOK 1891 thousand per employee in 2008 to NOK 2020 thousand per employee in 2012 (see Figure 8). It should be noted that drilling and well is the only segment that had increased value-creation per employee during the period 2008-2012 (see Figure 9).

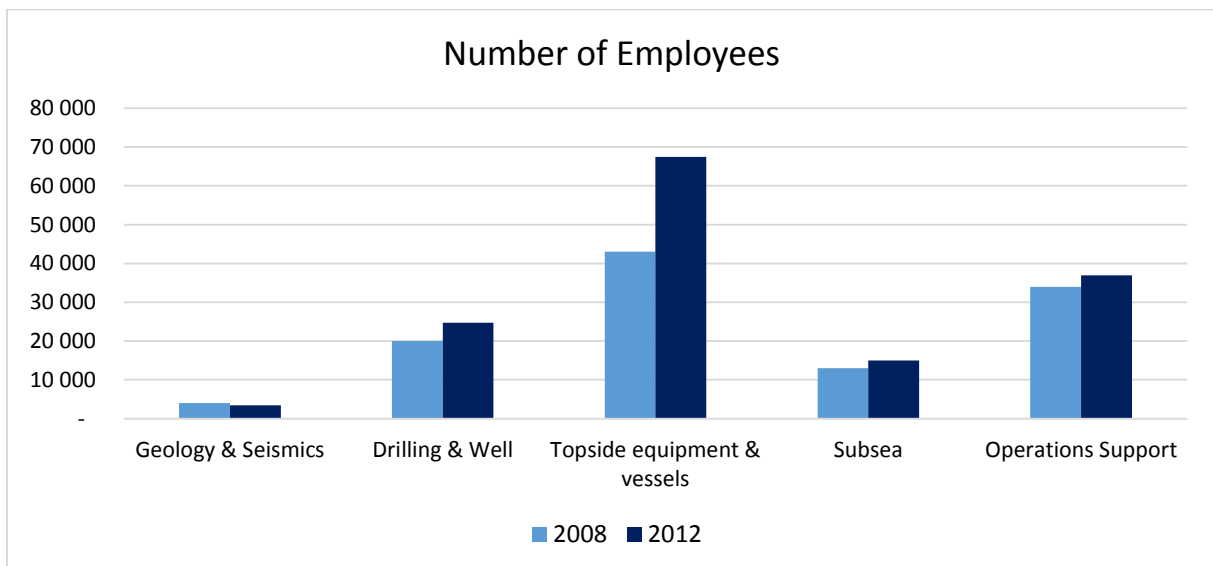


Figure 7 Number of employees across segments of oil&gas-related supplier industry in 2008-2012. Source: EKN (2008), IRIS (2012)

By contrast, the topside segment grew due to an average annual increase in the number of employees of 16% ,from 43000 in 2008 to 67480 in 2012 (see Figure 7). Value creation per employee in the segment decreased slightly on average, from NOK 894 thousand in 2008 to NOK 829 thousand in 2012 (see Figure 8).

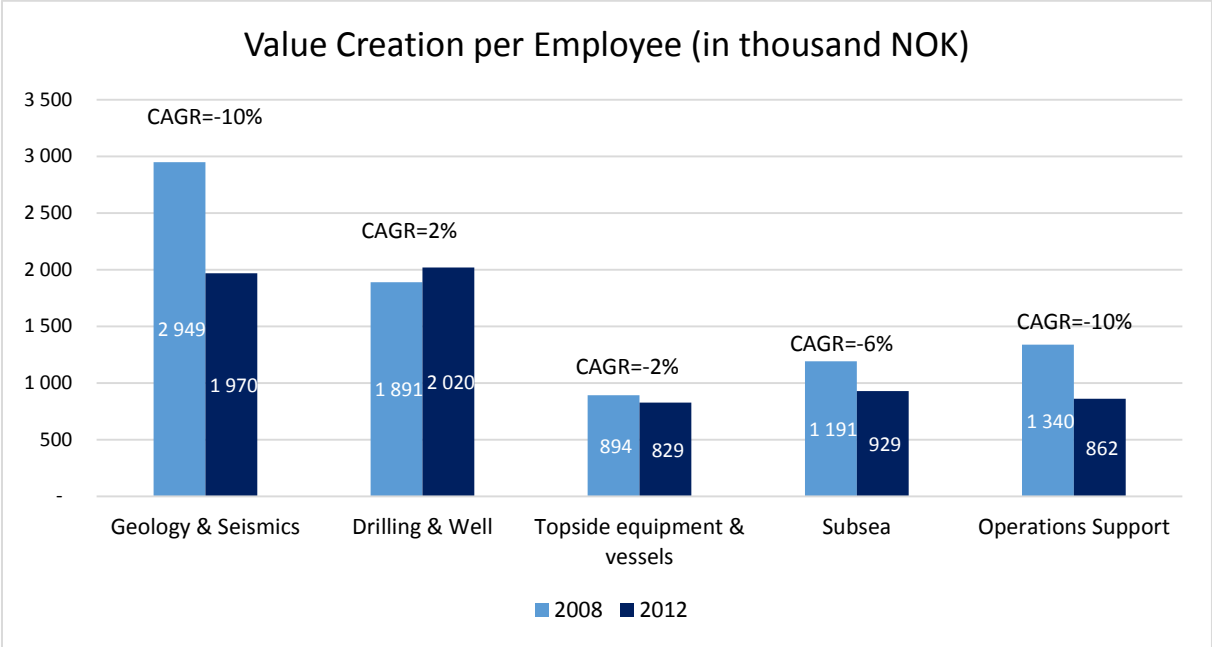


Figure 8 Value creation per employee across segments of oil & gas-related supplier industry in 2008-2012. Source: EKN (2008), IRIS (2012)

The geology and seismic segment saw the sharpest decline in total value creation in the given period, down approximately 13% from about NOK 12 billion in 2008 to about NOK 7 billion in 2012 (see Figure 6). Although the total number of employees in the segment decreased somewhat in the period, the major cause of the decline was the decrease in value creation per employee from about NOK 2950 thousand in 2008, which was the highest in the supplier industry, to approximately NOK 1970 thousand in 2012, which constituted an annual decline of about 10% (see Figure 8).

Total value creation in the operations support segment also declined significantly in the period 2008-2012 from about NOK 46 to NOK 32 billion (see Figure 6). The decline was driven primarily by the sharp decline in value creation per employee (see Figure 9).

Total value creation in the subsea segment decreased on average by 3% annually from about NOK 15 billion in 2008 to NOK 14 billion in 2012 (see Figure 6). This trend can also be explained by an increase in the number of employees from 13000 to 14960 in the period, combined with a decrease in the value created per employee from NOK 1191 thousand in 2008 to NOK 929 thousand in 2012 (see Figure 8).

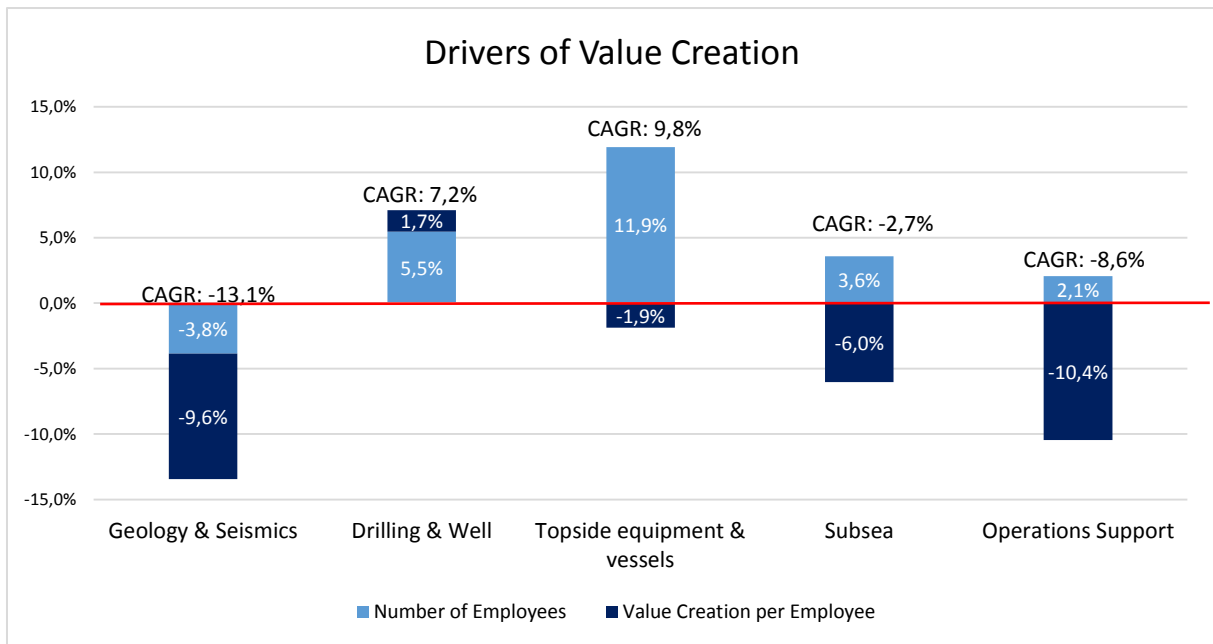


Figure 9 Drivers of value creation across segments of the oil & gas-related supplier industry in 2008-2012. Source: EKN (2008), IRIS (2012)

3.4. The role of foreign ownership

In this study, we define companies where foreign entities own more than 30% of equity as foreign.

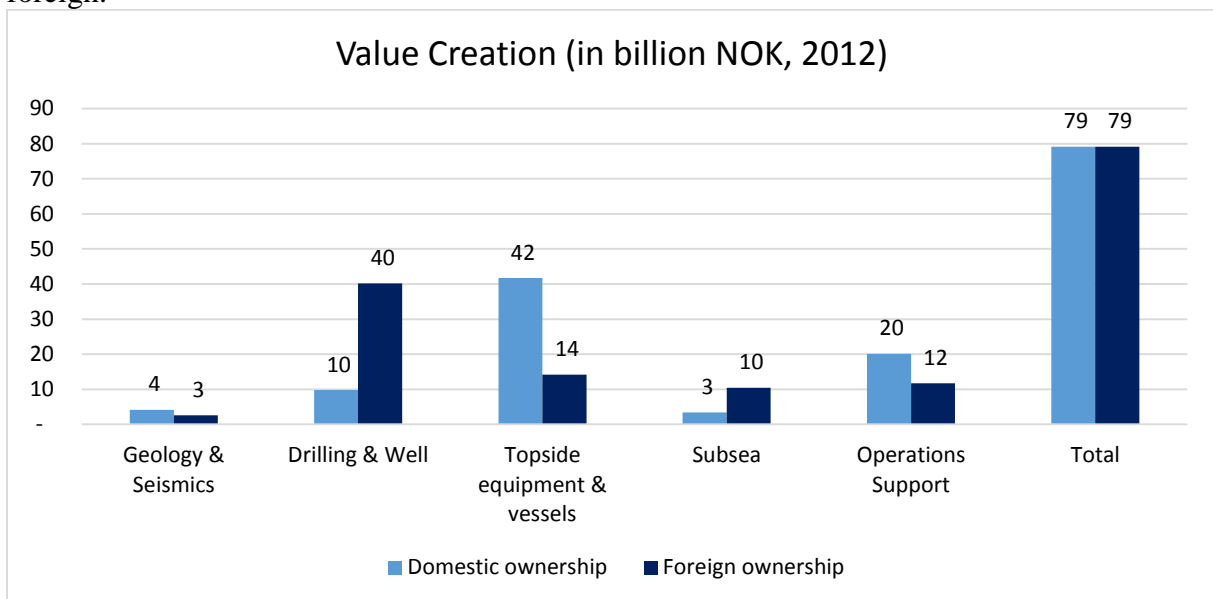


Figure 10 Total value creation by domestic and foreign companies by segments in 2012. Source: IRIS (2012)

In 2012, companies with foreign ownership contributed about 50% to the total value creation in the oil & gas-related supplier industry based in Norway. Particularly, they accounted for 80% of the total value creation in the drilling & well segment, 25% - in the topside segment, 77% - in the subsea, 37.5% - in operations support, and 42.9% - in geology & seismics (see Figure10).

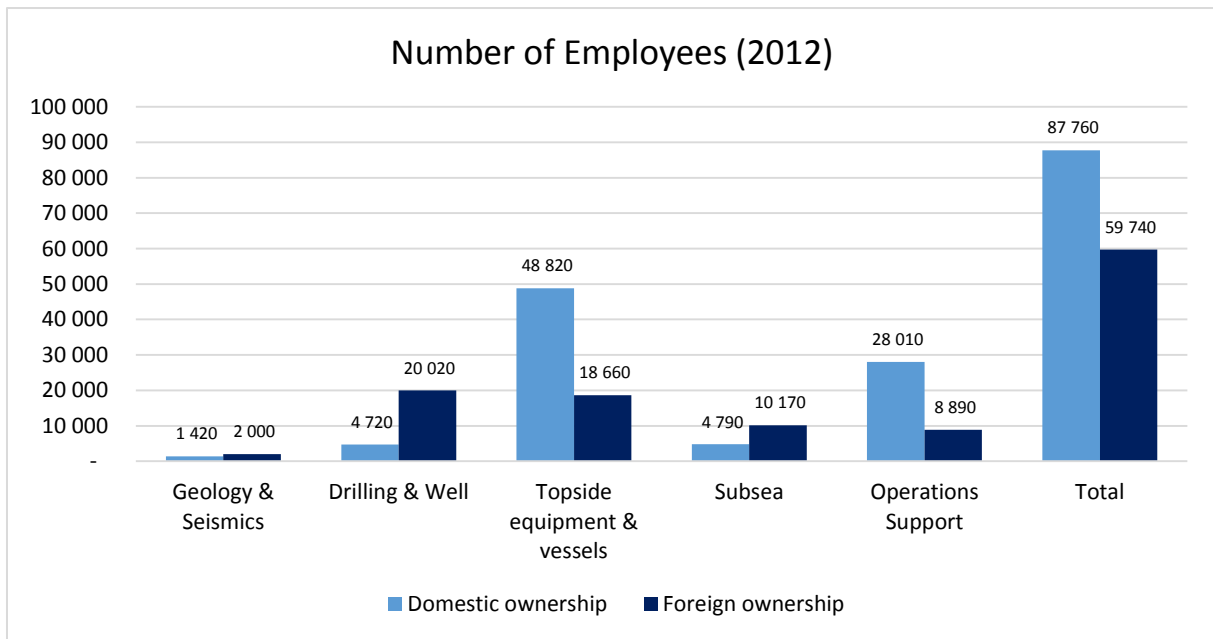


Figure 11 The number of employees in domestic and foreign companies across segments in 2012. Source: IRIS (2012)

Companies with substantial foreign ownership accounted for 40.5% of total employment in the industry in 2012. The proportion is much higher in the geology and seismic (58.5%), drilling and well (80.9%) and subsea (68%) segments. In the topside segment foreign companies accounted for 27.7% of employment, and in the operations support – for 24.1% (see Figure 11).

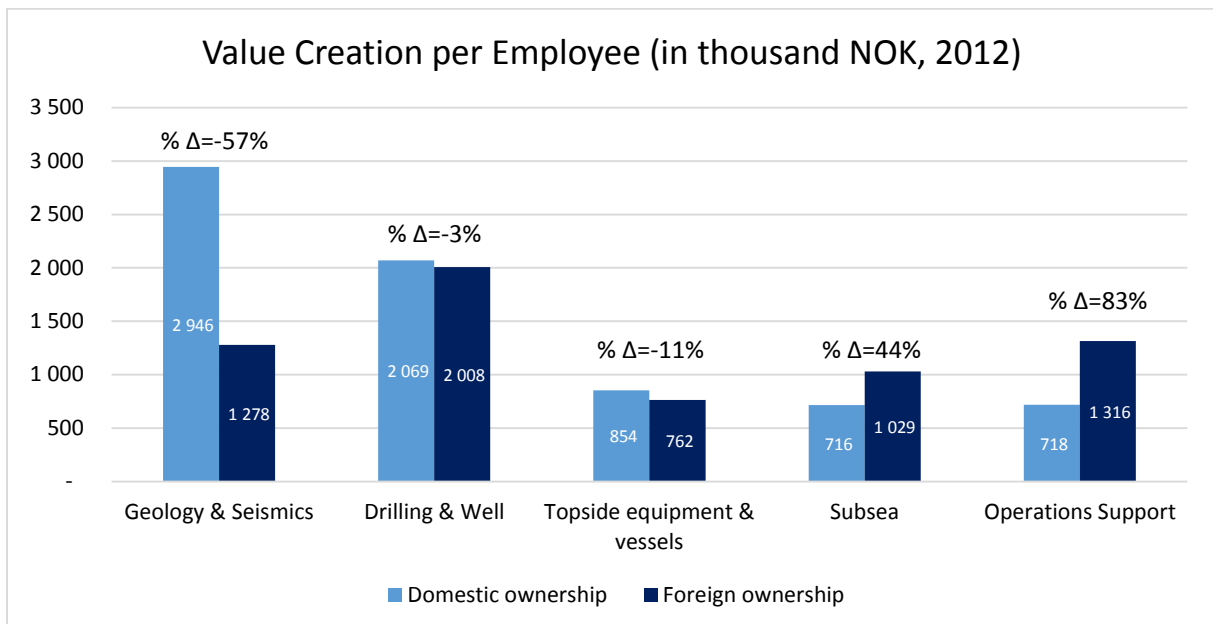


Figure 12 Value creation per employee in domestic and foreign companies across segments in 2012. Source: IRIS (2012)

Value creation per employee in companies with substantial foreign ownership was significantly higher than that of domestic companies in the subsea (NOK 1029 thousand compared to NOK 716 thousand) and operations support (NOK 1316 thousand compared to NOK 718 thousand) segments where productivity declined significantly between 2008 and 2012. However, domestic companies were marginally more productive in the drilling and well segment (NOK 2069 thousand compared to NOK 2008 thousand per employee in foreign companies), and had higher value creation per employee in the geology and seismic (NOK 2946 thousand compared to NOK 1278 thousand) and topside (NOK 854 thousand compared to NOK 762 thousand) segments (see Figure 12).

3.5. The stock market perspective on industry performance

To gain a more holistic picture of the industry performance, it is necessary to complement historical accounting data with forward looking stock market performance, which also incorporates consensus expectations regarding future growth.

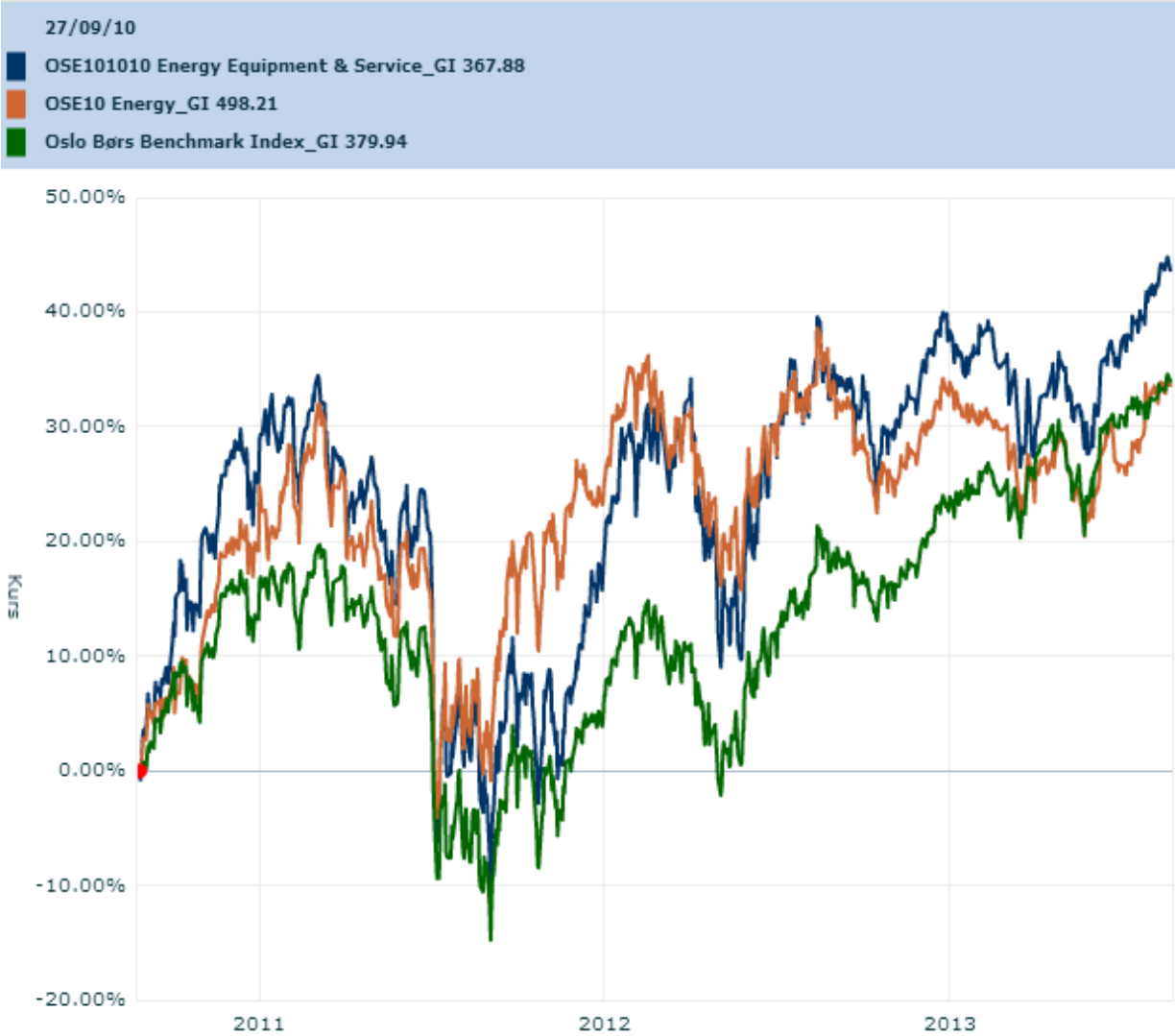


Figure 13 Performance of oil & gas-related supplier firms vs. broader energy and market indices. Source: Oslo Stock Exchange

Figure 13 shows that the Energy Equipment & Service index comprised of stocks of oil & gas-related supplier companies grew by approximately 10 percentage points more than the broader Energy index, which also includes operators and companies providing infrastructure and services for LNG, and the market overall. However, the difference in the market cap in the base year should be taken into account.

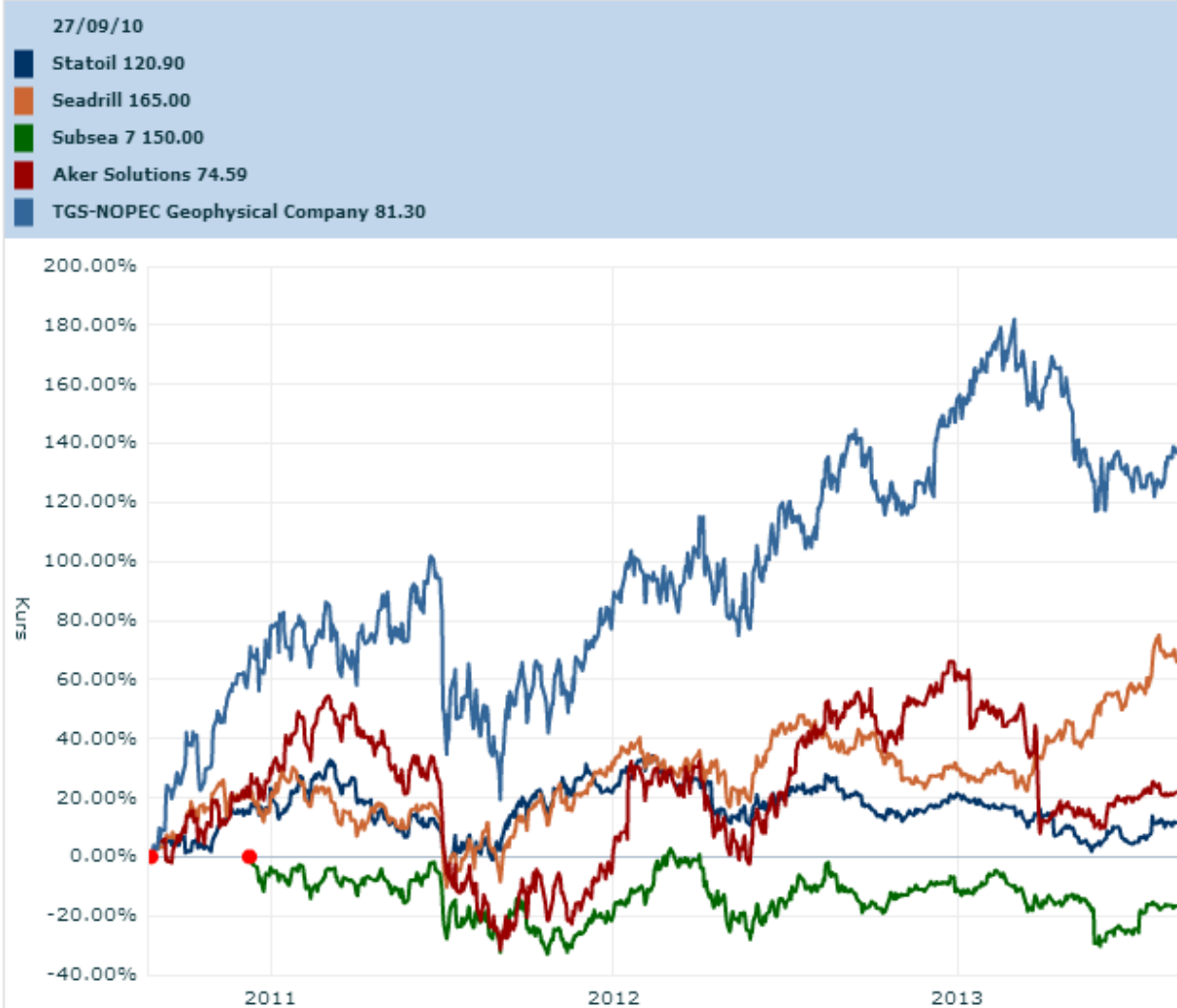


Figure 14 Performance of the five largest cap energy stocks. Source: Oslo Børs

We have also analyzed the market performance of the five energy stocks with the largest market cap. Consistent with the prior findings, companies in the drilling & well and topside segments grew faster than Statoil, while Subsea 7 substantially underperformed it. The spectacular growth of TGC-NOPEC stock also suggests a positive outlook for growth in the geology and seismic segment (see Figure 14).

4. Innovation by Norway-based oil & gas supplier companies

4.1. A historical overview of the industry innovation performance

Innovation is the key driver of productivity on country, industry and company levels. Historically, Norway had median performance in terms of the ability to convert R&D spending into patentable innovations (see Figure 15).

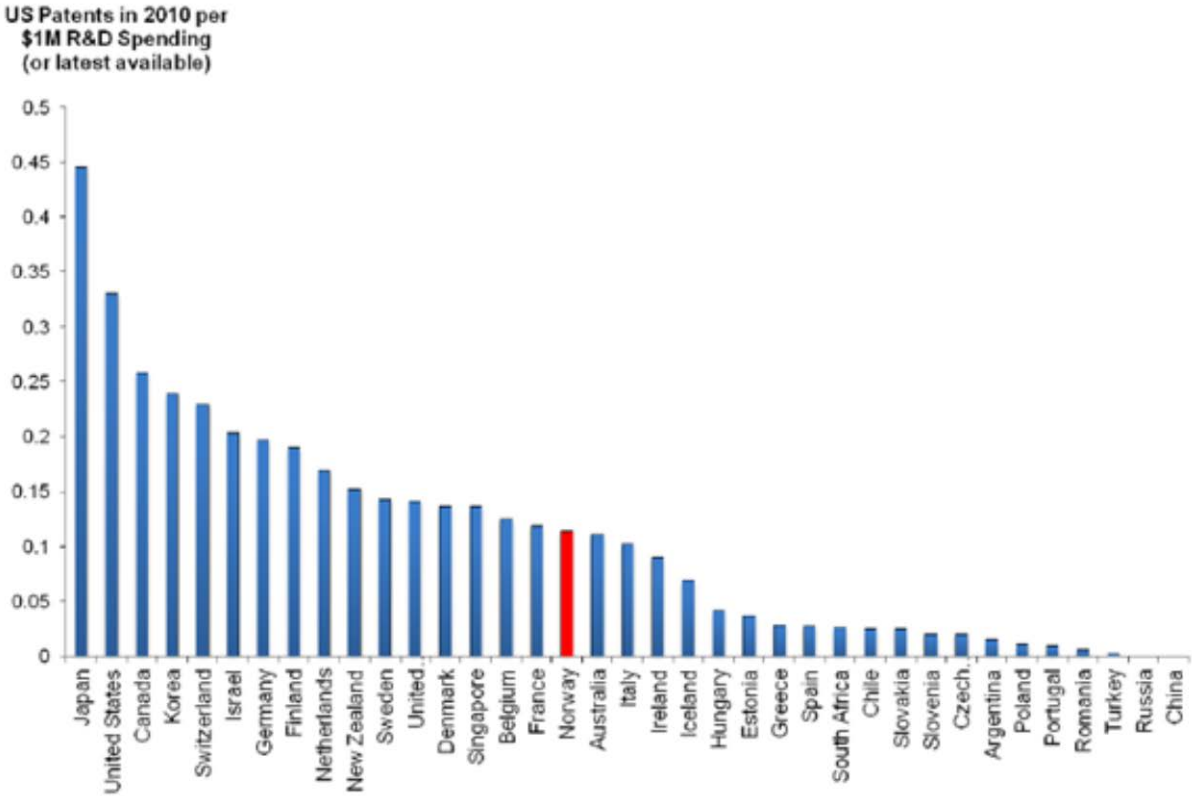


Figure 15 Source: EKN (2012)

The oil & gas industry demonstrated significant growth in related academic staff and publications in 2001-2008 as well as higher than the national average research productivity (EKN, 2012). This suggests the potential of the industry to be a locomotive for innovations and productivity in other industries relying on related technologies.

As part of this study, we assessed the current portfolio of innovations generated in the oil & gas-related supplier industry and identified a number of solutions that can be applied in other sectors of the economy to both diversify the risks of unbalanced development of the oil-related activities and leverage productivity in other industries.

Examples of such innovations are the following:

- Petrel Geophysics Software – technology is used by NASA;
- Cyberbase (control system) – generic technology can be applied in a variety of industries for automatization;

- Dual sensor cable – can potentially be applied in medicine;
- Valves developed for subsea – can be used for water supply and sewage;
- Heavy lifting – can be used for offshore windmills;
- Multilateral drilling – has a potential for application in geothermal energy;
- HiLoad solution – can be used in shipping.

Historical data shows that geology & seismic is leading in service innovations in the Norwegian economy. With the highest R&D expenditure as a percentage of sales in 2008 and the largest share of domestic and foreign R&D personnel (EKN, 2012), the share of companies that reported service innovations was higher than in other oil & gas –related sectors and other industries in Norway in 2008 (see Figure 17).

At the same time, subsea companies exhibited strength in product innovations and introduction of new business practices. The share of subsea companies that reported product innovations and new business practices was largest among other sectors in 2008, followed by the topside companies in product innovations and drilling & well companies in new business practices (see Figure 16 and Figure 18).

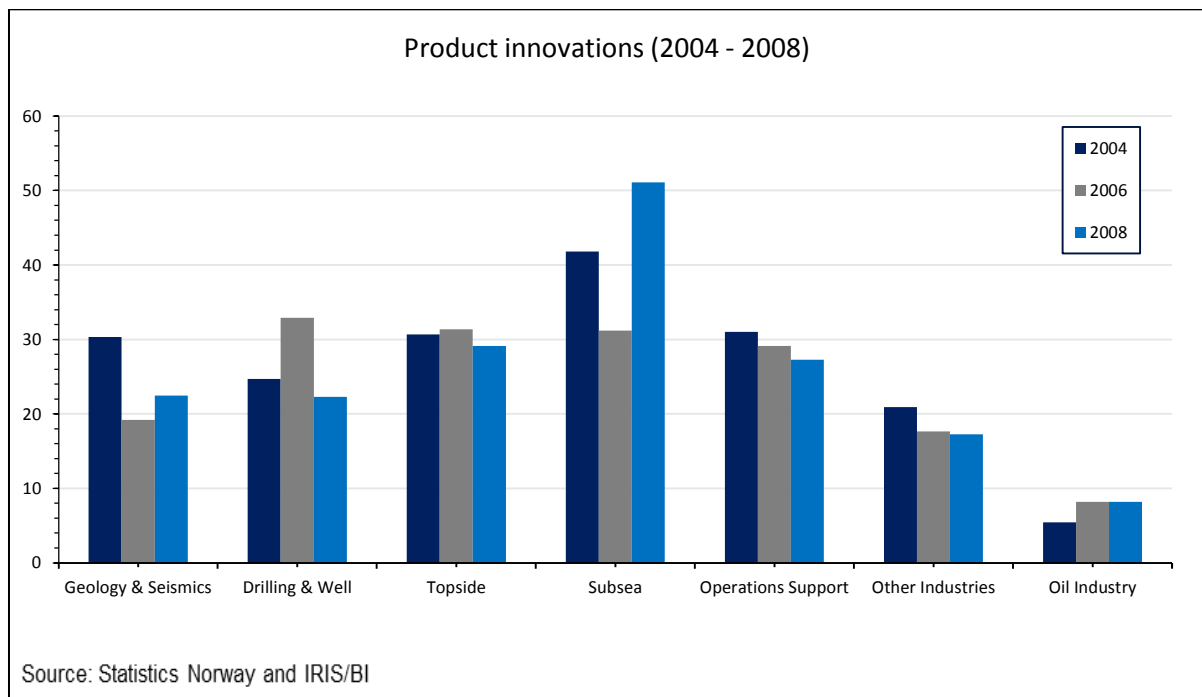


Figure 16

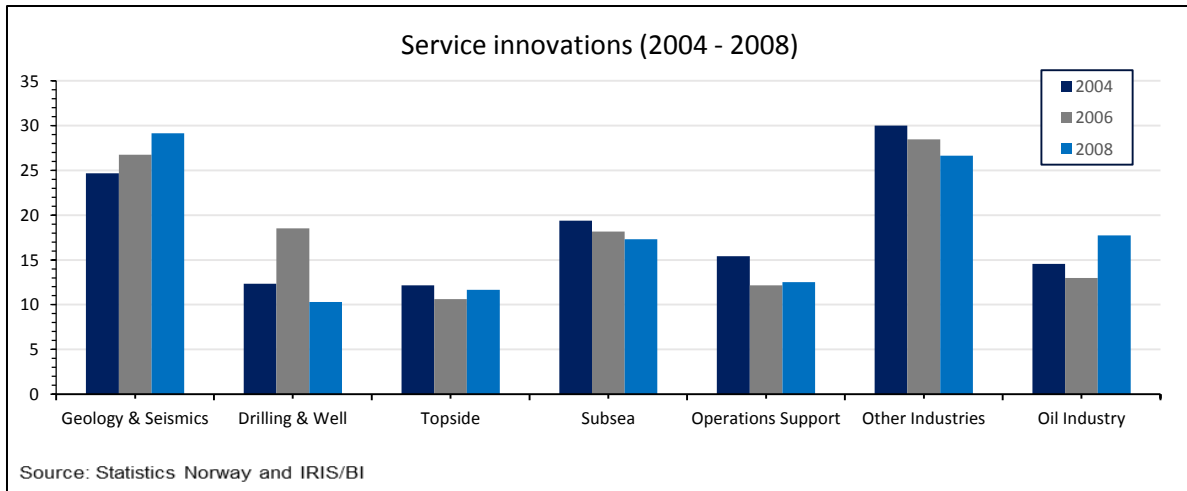


Figure 17

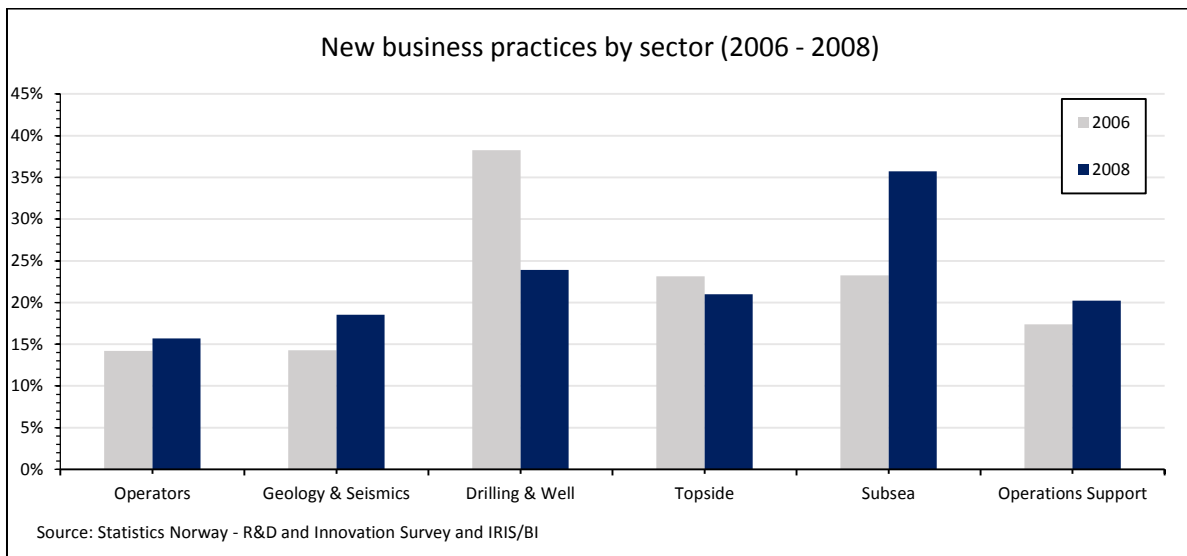


Figure 18

To gain a more specific and updated picture of innovations in the industry we have conducted in-depth interviews with key market players. The results are summarized in the following mini-cases.

4.2. Current innovation portfolio (mini case studies)

4.2.1 Halliburton

Halliburton's approach to technology development tends to be centralized on a general level. This centralization is predominantly driven by the resource availability and access to competence facilities. Operations on the NCS allow them to identify local technological needs and commercial potential which is fed into a regional or global technology center where the actual technology development occurs. A more commonly seen aspect of development occurs on the process innovation side, often associated with new technology. As the NCS offers a



diversity of challenges, new products and applications are often complemented by process innovations from the local content within the oilfield service sector.

Halliburton, like other big oilfield service firms, frequently looks for smaller Norwegian companies as potential M&A targets. Once acquired, the technology development takes place within Norway for a period of time, and is then targeted for global adaptation. Once globalization

and cross product portfolio innovation is possible, the technology development is again centralized to the global and/or regional technology centers. One good example of this for Halliburton is the acquisition of Easywell in Norway, a product that now represents a product service line within Halliburton. Development work is still ongoing in Norway; however, a wider cross product development program is centralized.

4.2.2 Teekay

Teekay is a company with a background from the shipping industry. It offers, amongst other services, floating oil and gas production facilities (FPSOs) and crude oil transportation and



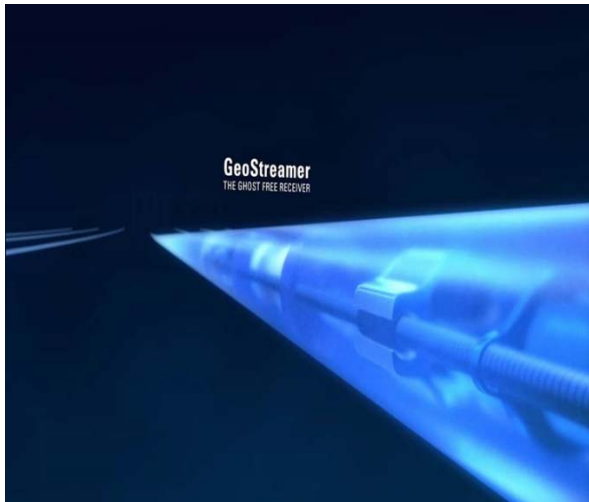
storage. Teekay actively uses acquisition of small Norwegian companies to bring in fresh ideas and innovations. One of their more prominent innovations is “HiLoad solution” which was acquired through buying a stake in Remora, a technology company based in Stavanger. The HiLoad solution essentially keeps oil tankers steady adjacent to an FPSO by using Dynamic Positioning in rough seas while offloading crude oil from FPSO to the oil tanker.

This innovation has potential application in the conventional shipping industry for tanker offloading

and for other offshore logistical operations. Future innovation focus according to our sources would be in increased oil recovery solutions, well intervention and more cost efficient solutions.

4.2.3 PGS

Petroleum Geo-Services (PGS) offers various seismic and reservoir services. PGS, which is based in Oslo, has global division of markets, while relying on expertise regardless of where the competent engineers are situated, whether, for instance, in London, Houston, Perth or Oslo. An example of innovation would be that of the Geostreamer dual sensor cable which



was launched in 2007. This cable was a step change in the way seismic data was acquired and provided significant improvement in the resolution of the data.

Such a technology is currently not used in any other industry, but could be related to medical disruptive technologies. Future focus area of innovations in this industry would be directed towards data processing of acquired data as against the historic trend on getting better quality data through improved data acquisition technologies.

4.2.4 NorSea

In most other oil and gas provinces the supply functions for offshore operations are handled either by the various service companies' own bases or through ordinary ports with certain supply base facilities (often only warehouses and tanks). These set-ups imply that many



BASE AND LOGISTICS

companies needed to carry out the functions of a supply and support base (e.g. providers of offshore containers, mechanical workshops, transport companies), tend to be located away from the bases. The NorSea bases, on the contrary, are set up as integrated bases that house both operators (e.g. Statoil), specialized service companies (e.g. Halliburton) and other service companies (e.g. mechanical workshops, transport companies). When all functions are covered, the bases become 'one-stop shops' where, say, a drilling company may have its risers fixed locally instead

of having to ship them to the company's own workshop. For NorSea the array of services provided on the bases matters for their ability to attract new customers in the form of operators, specialized service companies, etc. For the local communities the array of services provided on the bases matters for regional economic development, with the bases in effect functioning as industry parks or 'mini clusters'. In the region of Nordmøre, Vestbase in Kristiansund is by far the most vibrant industry park. Vestbase now not only offers logistics and mechanical workshops, a number of engineering companies have also established themselves at the base.

4.2.5 Subsea7

Subsea 7 is a global company with corporate headquarters in London but with significant operations and development activities taking place in Norway. Client operational requirements including the need for harsh weather operations are significant drivers for innovation in Subsea 7. A well-recognized example of innovation is the vessel "Seven



Viking”, which is a next generation IMR (Inspection, Maintenance, Repair) vessel. This innovation was developed through close collaboration between Subsea 7, Eidesvik and Ulstein. Innovation for the offshore wind industry is not driven from Norway but primarily through UK and Dutch based affiliates. Future innovation focus in Norway, as reported by Subsea 7, would be in pipeline and riser solutions as well as

continuous technological innovations in fleets and equipment to match requirements of new field developments.

4.2.6 NOV

Amongst other services, NOV offers rig solutions which include design, development, manufacturing and servicing of rig equipment. R&D for this segment is conducted jointly from Norwegian locations and Houston (US). An example of NOV’s leading innovation is



that of the “Cyberbase Chair” which is an integrated control system that supports automated drilling operations. This was originally developed by Stavanger based Hitec. Innovations from NOV which pertain to control systems have potential applications in other industries too. Innovations in heavy lifting have seen application in complementing offshore industries such as windmill construction. Future

innovation focus in NOV is targeted towards further automation, a shift from controlling single machines to controlling the complete drilling process, and towards further integration of ICT (Information and Communication Technology) into its products.

4.2.7 Aker Solutions’ well intervention services



For the purpose of this study, we have focused on Aker Solutions’ WIS segment (well intervention services). Much of Aker’s development activity takes place in Norway. A prime example of innovation in the WIS segment is that of a “well tractor”. Wireline in general terms offers a lighter way of well intervention and tools are guided into horizontal wells by means of these tractors. Tractors also help in logging downhole data, in addition to bringing wireline tools to the intended location.

Alternative application of this high-technology innovation in other industry is not a commercially viable option. As per our sources in Aker Solutions, future innovation would be focused on advanced well robotics, composite materials, and advanced logging techniques.

4.2.8 Tess

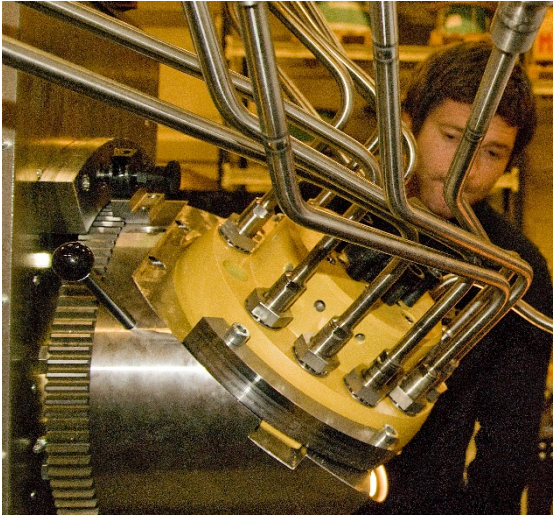


Tess is a very interesting Norwegian company which grew from selling hoses and pipes to the retail/construction industry to selling solutions to the oil industry. Innovation in Tess is about composing existing components together to become advanced technological systems to be used subsea. The innovation is followed up with services and operational experience exchange with customers. An example of its innovation is when they became the first supplier to provide an all-welded leak

proof piping solution. This project was done in collaboration with FMC technologies.

Innovations in Tess are most suitable for export. However, they could potentially also be used in the renewable energy industry. Future innovation focus according to sources in Tess would be towards coupling ICT with existing solutions.

4.2.9 Weatherford

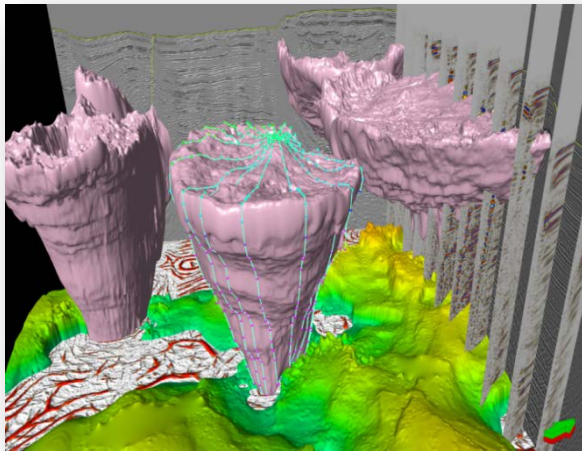


Weatherford, which is a major oilfield service provider across the entire lifecycle of a well, has a long history of operations on the NCS. Throughout that history, Weatherford has actively acquired small Norwegian niche companies to gain access to expertise and innovations. Weatherford acquired premium liner technology by acquiring Nodeco AS in 1996, and similarly acquired know-how and important niche well intervention tools by acquiring Bakke Oil Tools AS in 2003. While further development in these technologies for the most

part is located in the US, Norway is still used for testing and qualification of these technologies on facilities such as the Ullrigg test rig.

Innovations in Weatherford are generally not commercially viable for application in other industry. Our sources reported that future innovation focus in Weatherford would be towards new generation liner technology, late phase production, platform to subsea transition and higher reliability of equipment.

4.2.10 Schlumberger



Schlumberger is the world's largest oilfield service provider. Schlumberger Norway is active in all aspects of the oil and gas value chain: seismic, reservoir and drilling, and well services. In Norway, Schlumberger is growing through acquisitions as a means to absorb Norwegian competence and innovation. Schlumberger has a track record of investing locally thus enabling further growth, resulting in a considerable research, product development, and manufacturing activity in Norway.

An example of Norwegian innovation in Schlumberger is the global market-leading Petrel* E&P software platform, which is a comprehensive modeling platform for developing 3D models of oil and gas reservoirs. This software, which was reported to us as having no equals

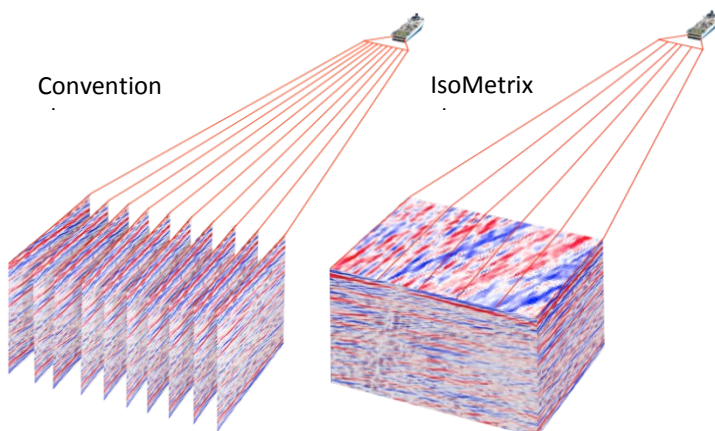


Petrel

Shared earth—critical insight

in Oslo and Stavanger are continuously developing further innovations for the platform. The software recently won the *Best Visualization and Collaboration* award in the 2013 World Oil Awards in Houston.

in the market, was initially developed by the Oslo-based company, Technoguide, acquired by Schlumberger in 2002. The Petrel organization in Norway has since grown to more than 10 times its original size and researchers at centers



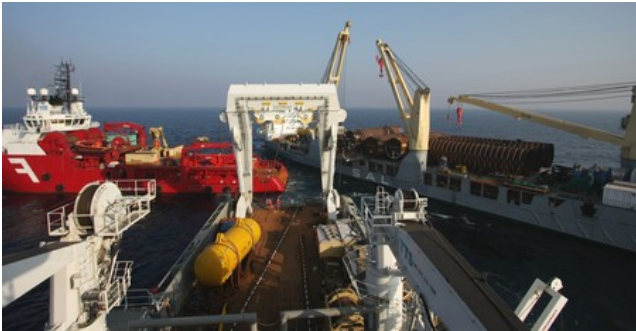
Another example of Norway-developed innovation is the IsoMetrix* marine seismic acquisition technology. This new generation system includes a revolutionary seismic streamer design that gives a much higher resolution when imaging the subsurface. Developing this technology has been one of the largest R&D projects in Schlumberger ever, and it was

located in Norway.

Alternative applications of innovations in Schlumberger in other industries are limited by commercial viability. Schlumberger technologies have occasionally found unlikely application with some of the same sensor equipment used to monitor oil wells launched into space by NASA to measure asteroid properties. In return, the degree of technology used by Schlumberger is often so high that the company turns to the aerospace industry to find suitable materials.

Future innovation focus in Schlumberger is directed towards achieving better resolution in seismic technologies, technology for exploration in Arctic regions, and towards advanced downhole measurement systems.

4.2.11 BW Offshore



BW offshore is a Norwegian contractor with innovation focus on, among other projects, subsea mooring systems and valves. Development often takes place through fruitful collaboration with their suppliers. One example of innovation in BW Offshore is anchorage of an FPSO to achieve safer connection when connected

below the water surface.

In addition to usage in the oil service industry, innovations in valves have potential applications in the water supply and sewage industry. Further, connectors can potentially be used in the renewable energy industry. Future innovation focus as per our sources would be cost reductions through operational efficiency improvements, smart procurement and maintenance, and HSE compliant operations. Technology in relation to separators, mooring, offloading and maintenance will be in focus.

4.3 Major drivers of innovations in the industry

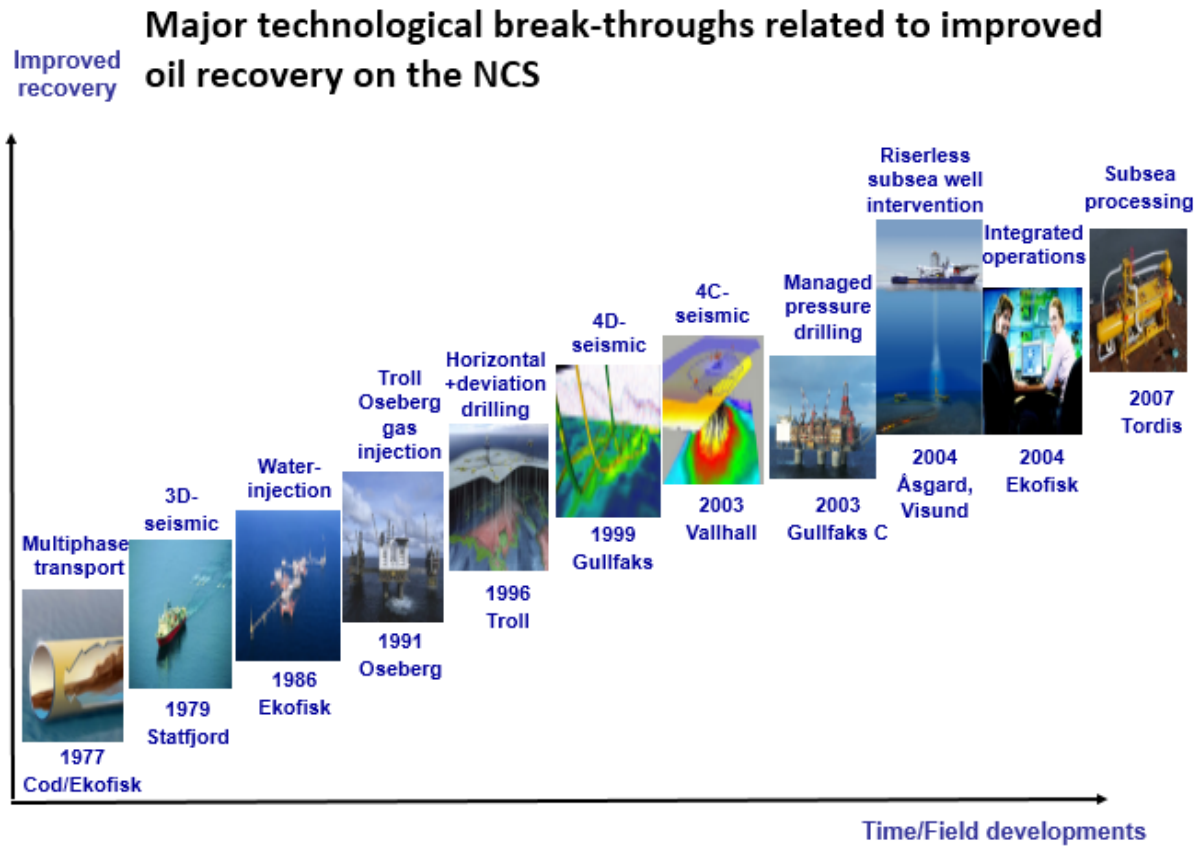


Figure 19 EKN (2012)

Figure 19 shows that activities on the NCS have been a major driver for innovation in the industry. However, most new innovations seem to be more incremental in nature after 2007. The focus is more on longer term system solutions, i.e. Subsea Factory. It might be that the technological breakthroughs to a larger extent will take place in more challenging conditions and deep water abroad.

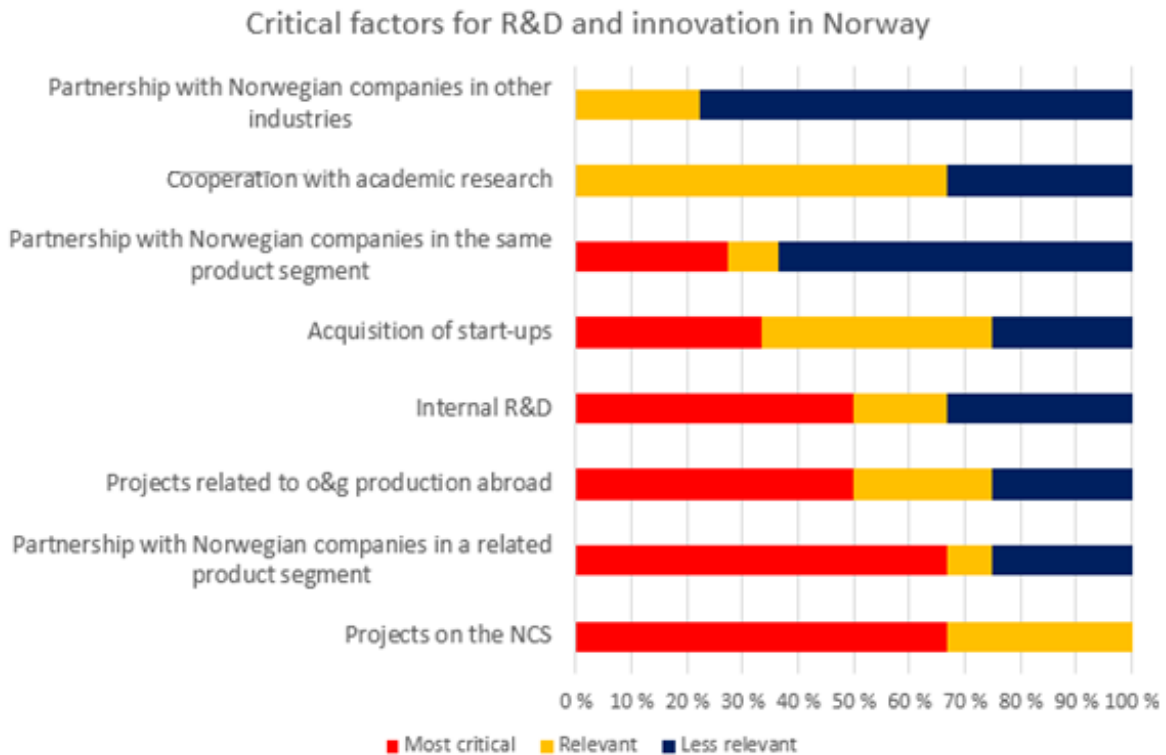


Figure 20 In-depth interviews with major companies in the oil & gas-related supplier industry (2013)

Our interviews have shown that partnerships with Norwegian companies in related product segments are perceived as equally important drivers for innovation activity in the industry (see Figure 20). Figure 21 demonstrates the linkages between segments of the oil & gas industry discovered during the earlier EKN study. Jointly, these imply the necessity of keeping the whole value chain in Norway to ensure innovation and productivity growth in the industry. It also shows the importance of projects on the NCS. An important question for further analysis is to what extent the knowledge base and the cluster strengths in the industry will force important industry players to locate in Norway in the future, despite new and/or challenging projects on the NCS.

Cluster linkages within the Norwegian offshore oil industry

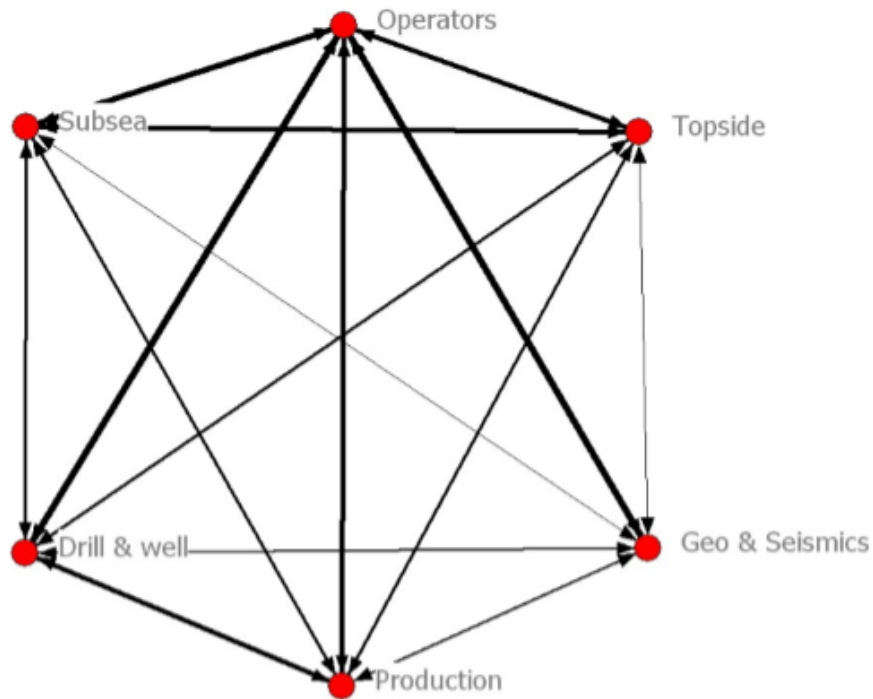


Figure 21 EKN (2012)

5. (Re-)location decisions

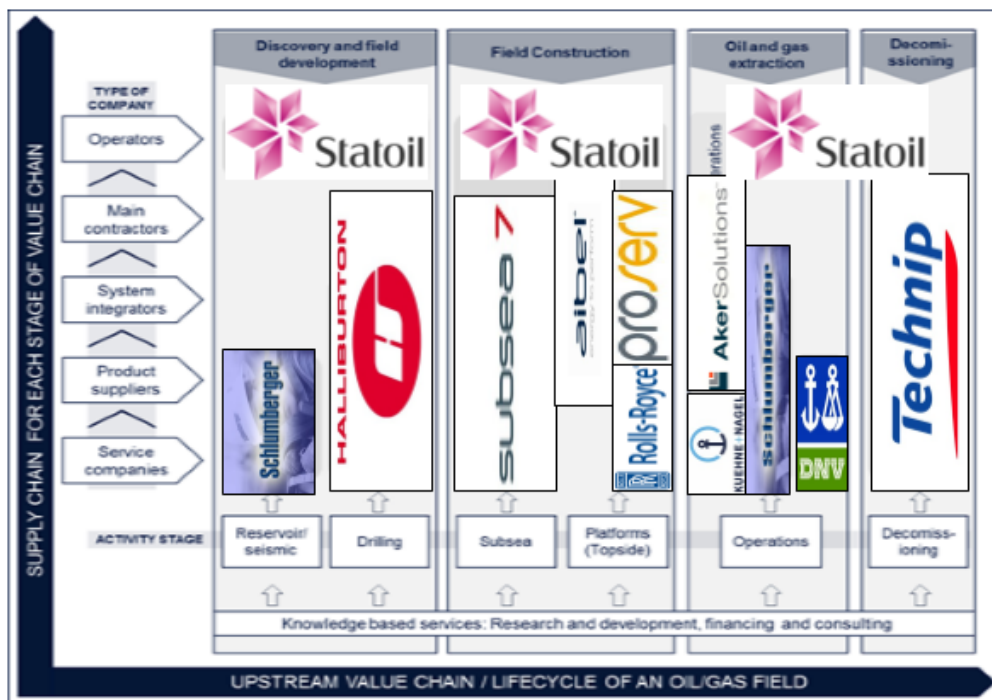


Figure 22 Value chain in the offshore oil & gas industry

Figure 22 illustrates the completeness of the value chain within the offshore oil & gas industry in Norway. The completeness is one of the key strengths for the industry in order to be competitive. An important question is to what extent it will stay this way in the future.

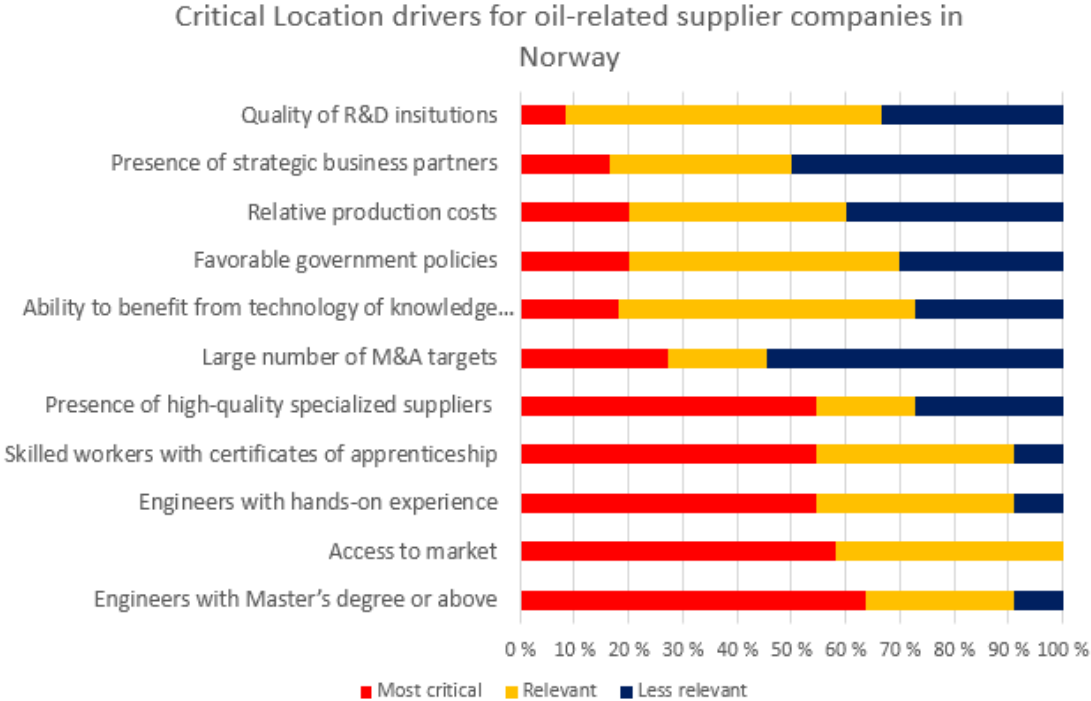


Figure 23 Factors affecting the location decision

Our interviews indicate that access to the market, highly qualified labor, specialized suppliers and a large number of potential acquisition targets are critical factors of location decisions in the industry (see Figure 23). In addition, some foreign companies mentioned decrease in the level of activity on the NCS and deterioration of the collaborative environment in the industry as potential triggers for relocation from Norway.

However, at this point the key question is which types of activities are likely to be moved abroad. An earlier study by the Boston Consulting Group shows that these are: detailed engineering, fabrication, and completion (see Figure 24).

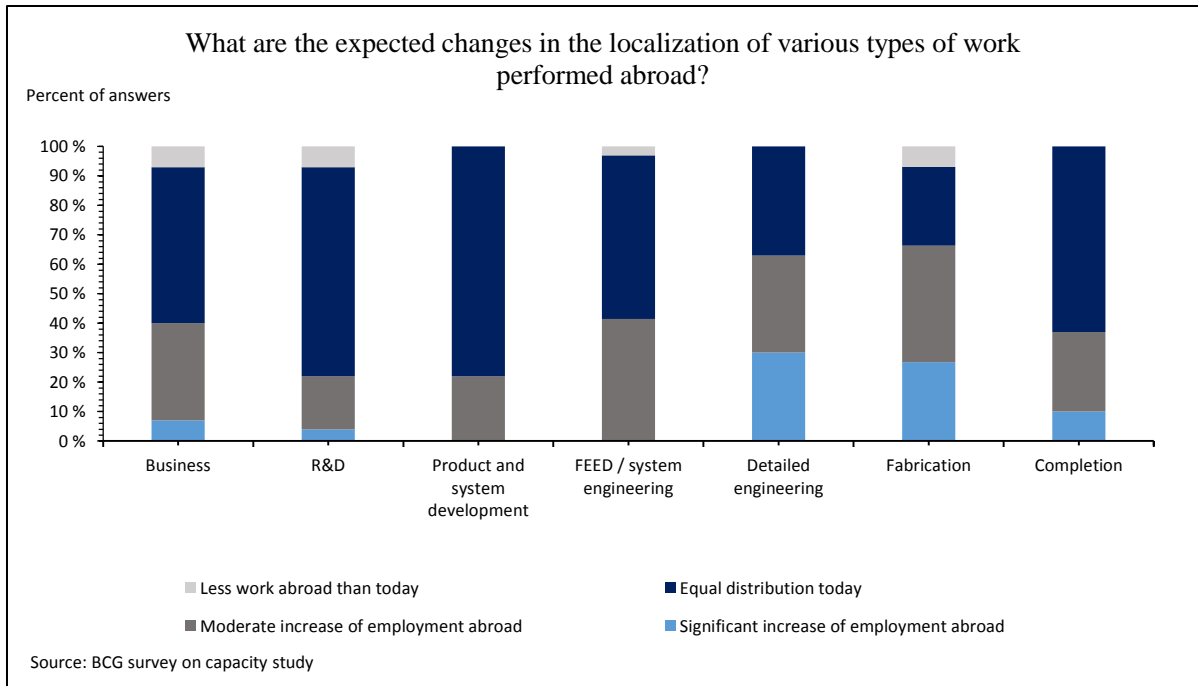
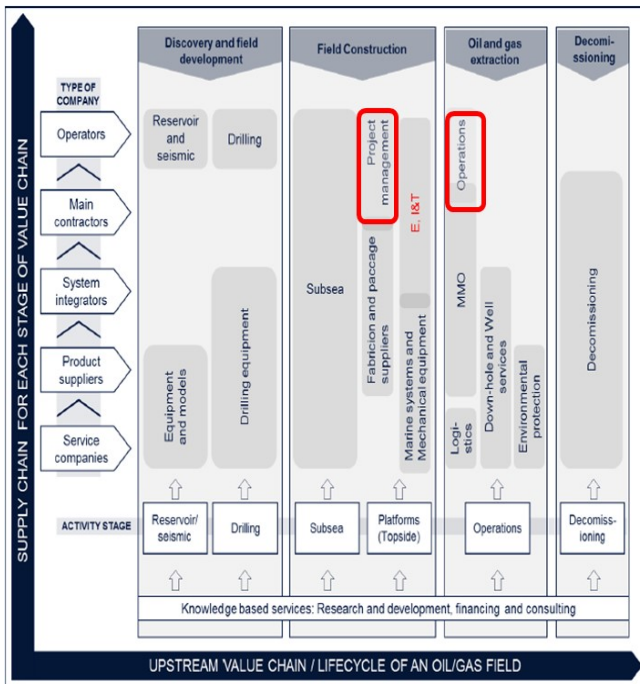


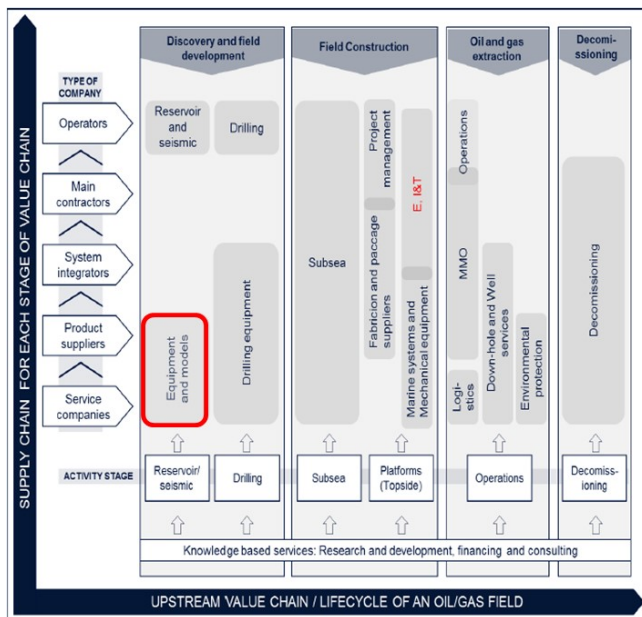
Figure 24

5.1. Mini-case Teekay



Teekay is a Canadian company which generates about a quarter of its turnover (\$1.95 billion global revenue) from its Norwegian market and employs about 2500 people in Norway. Their activities in Norway are varied ranging from business development, detailed engineering and operations on the NCS. The key reasons cited by our sources for Teekay's presence in Norway are proximity to oil operators and Norwegian expertise in maritime as well as subsea segments. It is not likely that Teekay will relocate out of Norway and if this did happen, it would be because of disappearance of a collaborative environment.

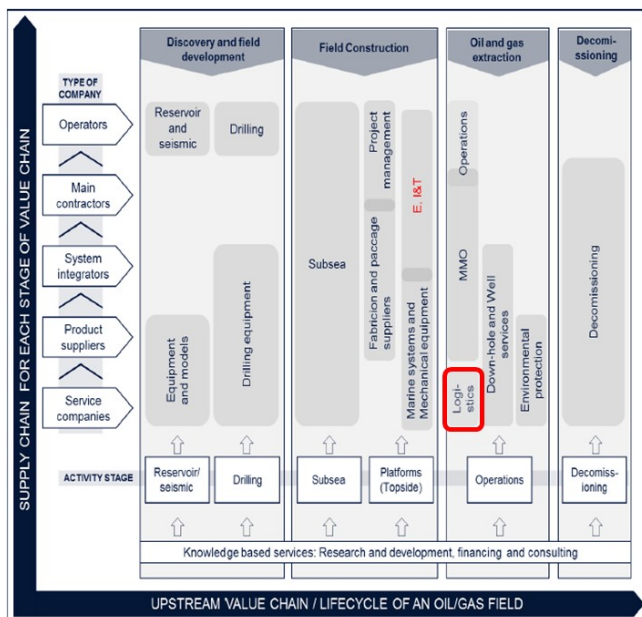
5.2. Mini-case PGS



Petroleum Geo-Services (PGS) is a company listed on the Oslo stock exchange with revenues of roughly \$1.5 billion and about 2195 employees worldwide. Activities in Norway are economic administration, development and operations (seismic vessels, data processing, etc.) for the NCS. Key reasons for PGS to remain in Norway are a friendly maritime tax regime and access to highly qualified people. It is important to note that PGS qualifies under maritime tax as it operates vessels and is categorized as a shipping company. Relocation out of

Norway is not likely. However a change in tax regime or a major technological change might increase the likelihood of relocation.

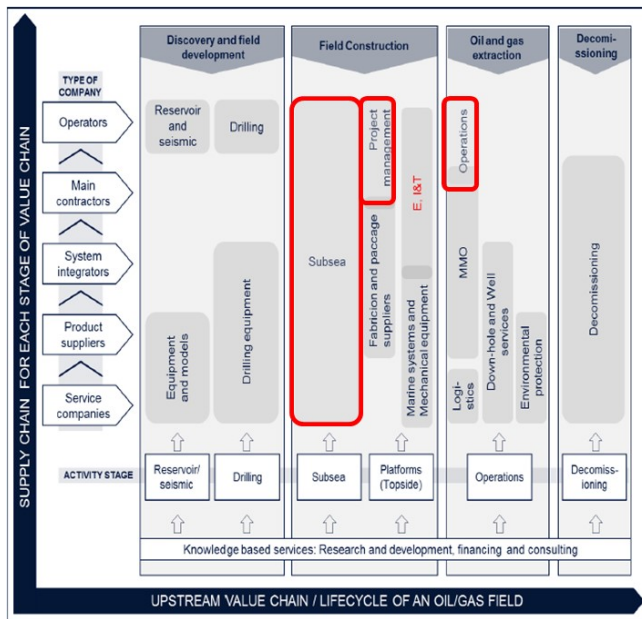
5.3. Mini-case NorSea



NorSea Group is a Norwegian-owned provider of supply and support bases that has ownership in nine bases along the coast of Norway from Stavanger in the south to Hammerfest and Kirkenes in the far north. NorSea Group has a total of 750 employees. NorSea is involved in logistics services, marine operations, project services and real estate for the development of the bases to function as complete 'one-stop service centers' for the oil and gas industry. All kinds of service companies are located on the bases (offshore containers, transport, service for drilling operations, etc.) with each base housing up to 70 different service companies, making the bases a strong cluster for supporting offshore operations.

The number of employees of the various companies renting facilities on the bases far outnumbers NorSea's own employees. Vestbase in Kristiansund has 210 own employees but rents out facilities to more than 60 companies (including Shell, Statoil, Schlumberger, IKM, etc.) with a total of 7-800 employees located on the base. The bases obviously bind NorSea to Norway, but NorSea is now also expanding their operations outside of Norway, e.g. in the UK.

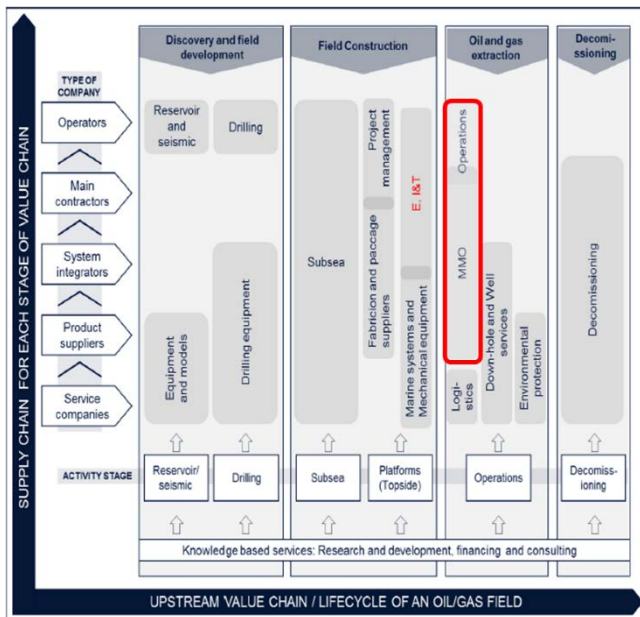
5.4. Mini-case Subsea7



Subsea 7 employs approximately 1400 people onshore and offshore and generates revenues above \$1 billion in Norway. Activities in Norway include project management, engineering and other disciplines supporting large and small subsea projects, business development, technology development and offshore operations in subsea field development and life of field. Norway provides challenging, high technology projects, with good visibility, volume and a predictable operating and regulatory environment. Norway also provides the company with access to top quality resources such as

engineers with relevant training from the Norwegian University of Science and Technology (NTNU).

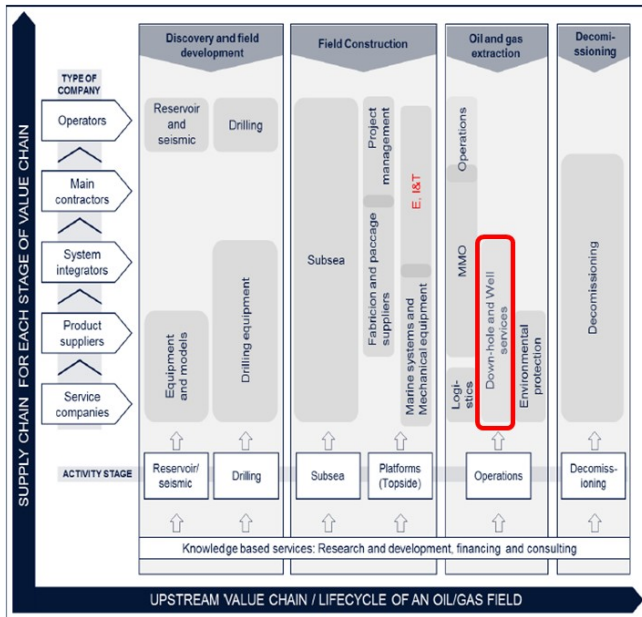
5.5. Mini-case NOV



NOV in Norway operates primarily in the rig solution segment and employs about 4500 people. Their activities include business development, R&D and operations. They generate about \$4 billion in revenue from the Norwegian market, which is about 20% of their global revenues. Proximity to activity locations, cluster competence and the ability to continuously innovate are the prime reasons for staying in Norway.

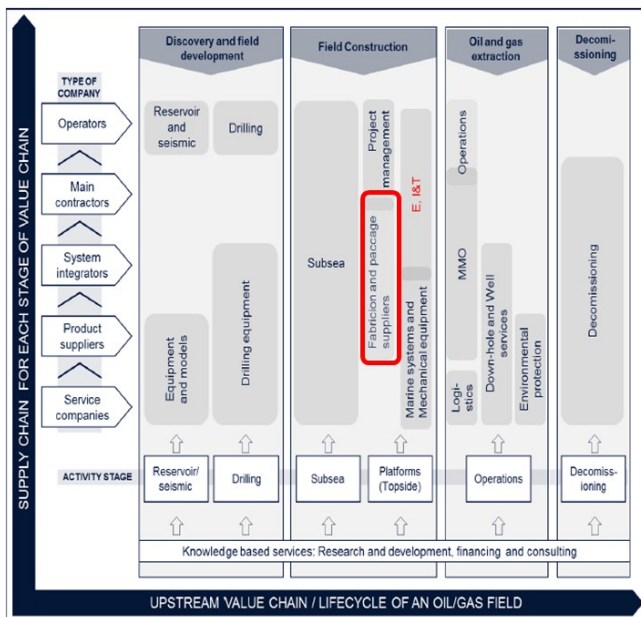
5.6. Mini-case Aker Solutions WIS

As mentioned previously, we have focused only on Aker Solutions' WIS segment (well intervention services). This segment contributes about \$0.36 billion worldwide to turnover (\$0.18 billion to the Norwegian turnover) and employs about 1700 people globally (900 employees in Norway). Activities in Norway include business development, R&D and operations for the NCS. Proximity to activity location, culture and a flat organizational



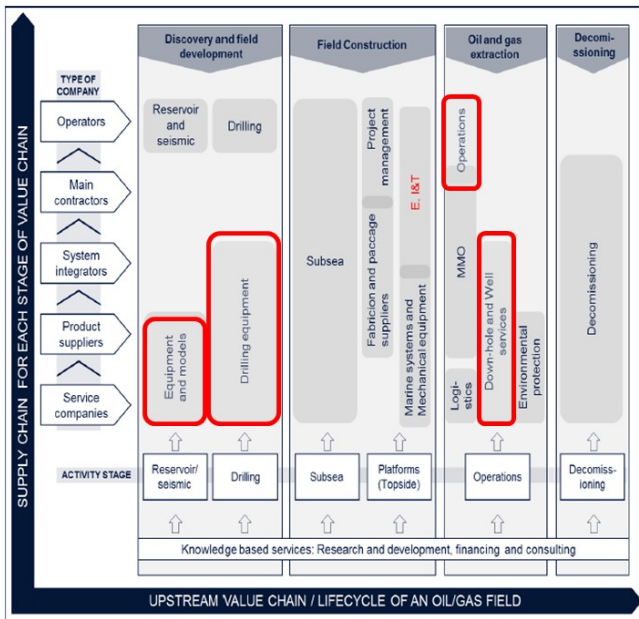
structure are prime reasons for Aker Solutions to stay in Norway. Relocation out of Norway is highly unlikely.

5.7. Mini-case Tess



Tess is a \$0.5 billion Norwegian company headquartered in Drammen. The company employs about 900 people. Its activities in Norway include business development, R&D, and production (of hoses, fittings, etc.). Proximity to customers, Norwegian ownership, quality of life in Norway along with a chance to collaborate are prime reasons for Tess to stay in Norway. It is highly unlikely that Tess would consider relocating their main office out of Norway, strategically located in the middle of Subsea Valley.

5.8. Mini-case Weatherford

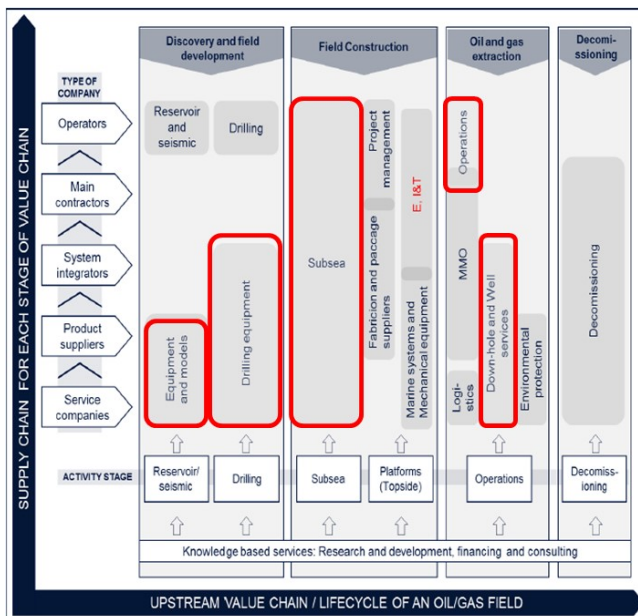


As mentioned earlier, Weatherford has a long history of operating on the NCS. Today Weatherford employs about 600 people in Norway and generates about \$1.4 billion in revenue from the Norwegian market operating across various segments in well life-cycle. Their activities in Norway include operations across well segments, G&G and reservoir consultancy services, core-lab analyses and storage along with business development, product qualification and validation services. Our sources report that opportunities for long-term contracts in a stable (yet growing)

market along with political stability are key reasons for Weatherford to operate in Norway. The key relocation trigger for Weatherford to move out of Norway would be if we saw a dramatic decline in activities on the NCS.

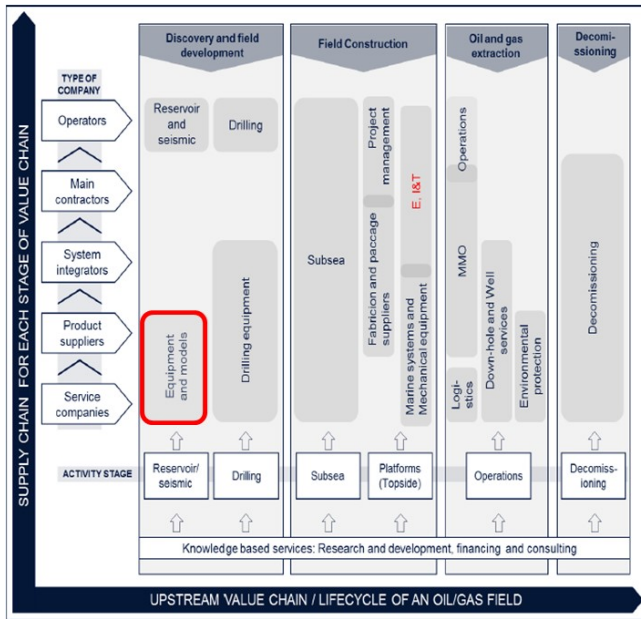
5.9. Mini-case Schlumberger

Schlumberger is a \$42.15 billion oilfield service giant with operational headquarters in Houston. In Norway they employ about 3900 people who perform key activities such as



operations (entire life cycle), business development, R&D and manufacturing. Close proximity to operations, political stability, high productivity, competitive R&D costs, and a higher propensity to adopt new technologies were cited by our sources as key reasons for staying in Norway. Schlumberger points out quite uniquely that even though general cost levels in Norway are high, Norwegian R&D is still competitive when compared to the US.

5.10. Mini-case BW Offshore



BW Offshore is a \$1 billion Norwegian company employing about 2,100 people worldwide. In Norway, their activities include business development, engineering, operations and R&D. BW Offshore increased their presence in Singapore over the past years, but emphasizes the importance of a solid presence in Norway due to the availability of top-qualified engineers.

6. Knowledge-based industrial policy

The oil-and gas industry accounts for a substantial portion of GDP in Norway. The question is how long it will remain a major driver of value creation in the economy. It certainly depends on the amount of resources on the Norwegian continental shelf (NCS) and future oil prices. But this is only part of the story. It also depends on the extent to which the industry can create a national knowledge base that can drive it independently of the oil and gas production on the NCS.

In this respect, the Norway-based oil-and gas-related supplier sector plays a key role as an important driver of innovation in the economy. In this report, we have described a number of product and service innovations developed by the supplier companies that not only contribute towards solving practical challenges related to oil and gas production, but also have potentially broad applications in the renewable energy, water supply, maritime and medical sector, as well as other industries.

Our survey clearly shows that operations on the NCS are an important source of innovations in the industry. In fact, activity on the NCS gives the industry a “laboratory” for technological development. This factor should be taken into account when evaluating opportunities for opening new areas for oil and gas activities.

At the same time, it is important to set high environmental demands that will not only protect the environment in Northern Norway, but also ensure that Norway-based companies stay at

the forefront of environmentally friendly solutions. Investments that can improve the conditions for development of such solutions should be made before raising the demands. To ensure sufficient supply of engineers, the government should promote education focused on natural sciences from an early age as well as implement the Australian and Singapore model of attracting immigrants with higher education.

In addition, the government should invest in a “knowledge infrastructure” by financing oil and gas-related research programs, industrial PhD programs, investments in NCE and Arena programs, and advanced test facilities in cooperation with R&D institutions and NCEs.

Our study has also revealed some disturbing trends, particularly the decline in productivity in many sectors of the supplier industry. Though the reasons behind this trend still need to be researched, it is an important signal, especially for the subsea and operations support segments. While the subsea segment is leading in terms of innovations, had grown in terms of employment and total value creation, the decline in productivity over the last four years indicates that the full potential has not yet been achieved. The decline in the productivity of the operations support segment is important to address, as it is the third largest segment in the supplier industry in terms of value creation and a local industry important for the Stavanger area.

Reve, T., & Sasson, A. 2012. *Et Kunnskapbasert Norge*: Universitetsforlaget.

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