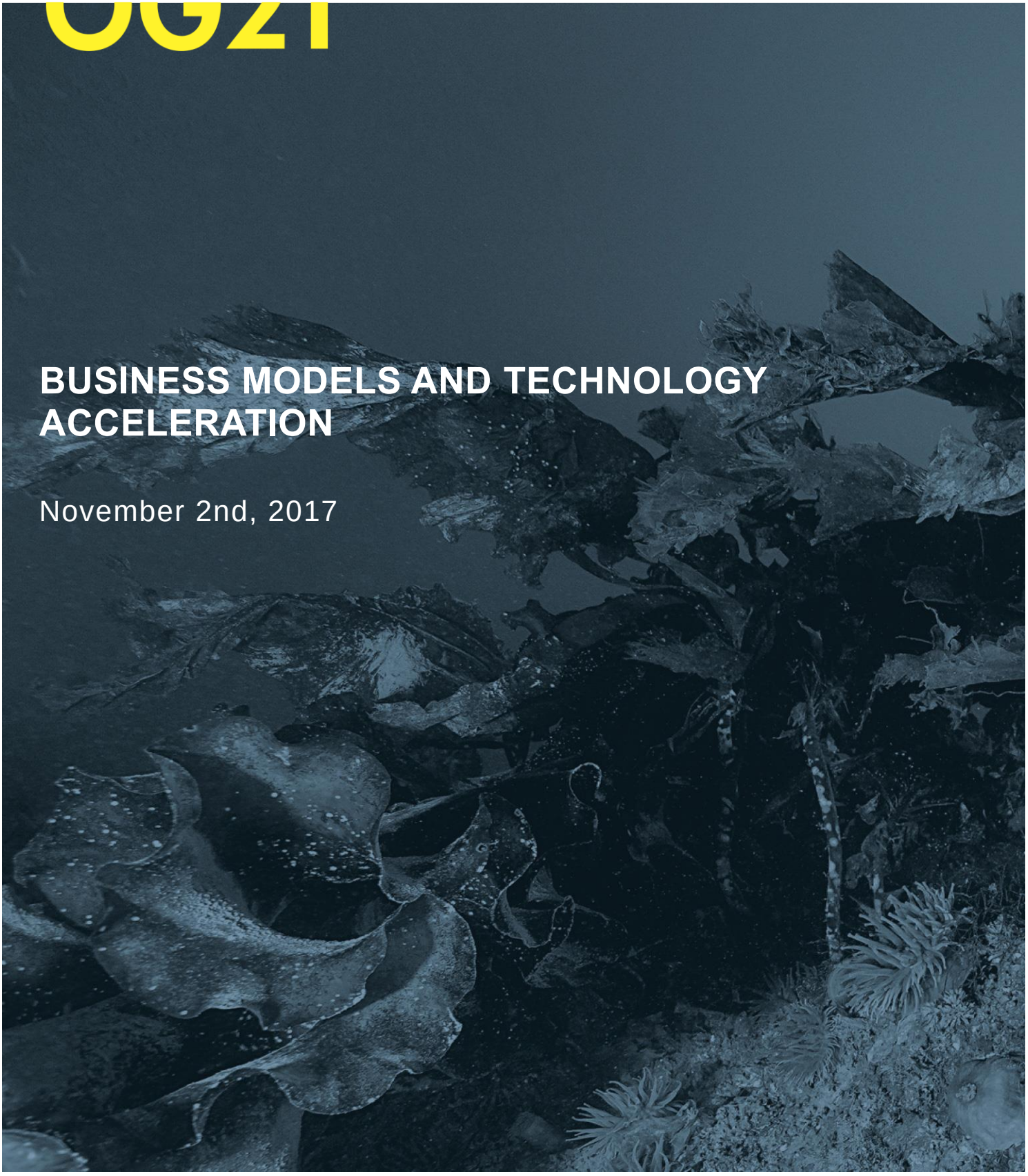
OG21



BUSINESS MODELS AND TECHNOLOGY ACCELERATION

November 2nd, 2017

Contents

1 SUMMARY

The petroleum industry is Norway's most important industry in terms of income to the state, employment, export of petroleum products and export of services and equipment to the global petroleum industry. The Norwegian continental shelf is today one of the most technologically sophisticated petroleum provinces in the world, and Norway based suppliers have become global leaders within many offshore petroleum segments.

It is likely that petroleum will continue to dominate the global energy mix for decades to come. Less than 50% of petroleum resources on the Norwegian continental shelf have been produced, and Norway is in a good position to supply petroleum to the global market also in the future.

The Norwegian Continental Shelf is maturing, and the petroleum industry faces new challenges. The NCS portfolio is increasingly dominated by mature, large fields, and small discoveries. The economical margins are decreasing, and field developments have less capacity for technology qualification and early adoption of new technologies.

The high cost level of the NCS has been a threat to its competitive position. The industry has responded efficiently with cost cut initiatives, and balance costs have decreased significantly since 2014. Other oil producers like the US shale industry, have however also improved their cost efficiency. To stay competitive, the Norwegian petroleum industry therefore has to continue its efforts to improve productivity and reduce costs.

OG21 believes that development and implementation of new technologies are instrumental to achieve the needed productivity improvements. OG21 released its latest technology strategy document in 2016, and the technology priorities are still valid and relevant.

The value of technologies is realized when technologies are applied, and faster adoption would yield higher value. OG21 has therefore in 2017 initiated a project with the purpose of discussing how changes to business models could affect technology adoption. The Boston Consulting Group was commissioned to provide input to the project. The BCG report, as well as the OG21 report are available on the OG21 website.

Business models that could stimulate technology adoption depend on the type of company and its business strategy. Where one company sees an opportunity, another company may see a threat. Nevertheless, OG21 strongly believes that productivity improvements through technology innovations will have to happen through concerted industry efforts. OG21 therefore wants to engage the industry and policy makers to discuss three key dilemmas that we believe are fundamental for technology adoption:

1. ***Dilemma #1: New technologies have the potential to unlock substantial value, but a perception of high risk and challenging project economics, drive the use of traditional technologies.***
2. ***Dilemma #2: Collaboration and early engagement of suppliers drive innovation, but may restrict competition and lock out better technology solutions.***
3. ***Dilemma #3: Digitalization offers vast opportunities, but realizing the full value requires substantial changes and determined efforts.***

Details on the key dilemmas are provided in Section 4. The way forward is described in Section 5.

2 PURPOSE AND SCOPE

2.1 About OG21

OG21 has its mandate from the Norwegian Ministry of Petroleum and Energy (MPE). The purpose of OG21 is to *"contribute to efficient and environmentally friendly value creation from the Norwegian oil and gas resources through a coordinated engagement of the Norwegian petroleum cluster within education, research, development, demonstration and commercialization. OG21 will inspire the development and use of better skills and technology".*

OG21 brings together oil companies, universities, research institutes, suppliers, regulators and public bodies to develop a national petroleum technology strategy for Norway.

Based on its mandate from the Norwegian Ministry of Petroleum and Energy, OG21 develops and maintains the technology strategy for the Norwegian petroleum industry. The strategy document was most recently revised in 2016.

2.2 About the project

The revised OG21 strategy showed how development and deployment of new technologies could result in substantially reduced costs, large volumes of additional resources, and reduced emissions to the environment (OG21, 2016).

However, the OG21 strategy also draws the attention to several challenges for the development and use of new technologies, e.g.:

- Technology opportunities not sufficiently evaluated in early project phases due to conservatism or that the right expertise is not consulted.
- Conflicting economic drivers in contracts with daily rates - some benefit from efficiency gains while others lose.
- Portfolio benefits are not sufficiently considered when decisions are made.

OG21 recommended in the strategy document that new business models and contract strategies that would stimulate technology adoption should be evaluated.

To start the discussion, OG21 in 2017 therefore launched an assessment of current business model practices and possible changes to business models and the potential consequences for enterprises in the Norwegian petroleum sector, see Figure 1. This report summarizes the results from the OG21 project.

Figure 1 Overview of OG21 project on business models to accelerate technology deployment

2.3 BCG study for OG21

The OG21 project included the commission of a study from Boston Consulting Group (BCG, 2017).

The BCG report is based on in-depth interviews with around 30 executives in the Norwegian petroleum industry as well as discussions in an OG21 industry workshop where 45 invited stakeholders participated. The report identifies technology themes of particular importance to the competitiveness of the NCS; it lists types of stakeholders and how they are positioned to drive innovation; and it suggests actions for various stakeholders.

The BCG report "New business models and contract strategies to improve NCS competitiveness" is available on the OG21 website.

During the project, it became apparent that stakeholders have very different positions on optimal business models. OG21 recognizes that the choice of business models depends on individual enterprises' business strategies: Where one company sees an opportunity, another company may see a threat. In this context, the BCG report is an important contribution to the discussion on how NCS players could adjust to meet the international competition.

3 COMPETITIVENESS OF THE NCS

3.1 Opportunities and challenges on the NCS

Opportunities and challenges on the Norwegian Continental Shelf (NCS) are thoroughly discussed in the OG21-strategy. Table 1, copied from the strategy document, lists opportunities and challenges sorted under each of OG21's five strategic objectives.

Table 1 NCS opportunities and challenges sorted under the OG21 strategic objectives (OG21, 2016)

Strategic objective	Opportunities and challenges
Maximize resource utilization	• Optimize production from existing fields – Two thirds of the NCS production in 2030 expected to come from existing fields, of which a large portion from legacy fields. Need to maintain mechanical integrity, keeping opex/bbl low and have cost-efficient wells. • Mature portfolio of discoveries to become sanctioned projects – 68 out of 88 existing discoveries (in 2016) are likely to be subsea developments w/ tie-back to existing infrastructure. This calls for life extension of hubs, de-bottlenecking and cost-efficient subsea solutions. • Exploration efforts over the next years vital to replace production after 2030. • Production and reserves forecasts are dependent upon cost levels. Keeping costs down is essential. • Develop High North discoveries with low carbon footprint. Particular challenges include shallow reservoirs, karstified carbonates, long-distances, and concerns for potential environmental impact.
Minimize environmental impact	• Improve energy efficiency of existing infrastructure – The petroleum production represented 28% of Norway's CO_2-emissions in 2015. • Develop low-carbon solutions for new fields – New large fields could produce for decades to come. • Reduce environmental risk from continuous discharges –Norway has a global leading position on low emissions and discharges, and the position should be maintained. • Reduce risk for accidental releases – Low risk acceptance, especially High North, calls for continued efforts to improve mechanical integrity, monitoring and oil spill preparedness.
Improve productivity and reduce costs	• NCS needs to stay competitive compared to onshore and offshore petroleum provinces elsewhere. • Develop and implement technologies that enable faster and higher production with less effort and with improved safety. Need for remote control, automation and autonomy. • Improve cost-efficiency of mature field through increased production/improved depletion – Currently competitive opex/bbl on the NCS, but increase in opex/bbl expected unless productivity is improved.
Develop innovative technologies	• Strengthen Norwegian technology and competence suppliers' global competitive position – Strong growth 2001-2014, drop in 2015-2016, a possible rebound within few years, if able to adapt products and services to new market realities. • Norway based suppliers need to respond to growing international competition in important market segments, e.g. market shares have dropped in subsea and drilling equipment segments. • Continue to evolve the Norwegian Continental Shelf as a province for testing and early use of value-adding technologies.
Attract, develop and retain the best talents	• Turn young people's perception of the petroleum industry – Norway's petroleum industry delivers energy to the world's growing population, and does so with the lowest carbon footprint. • The industry needs access to qualified people – Current down-sizing could make it difficult to respond to an activity rebound.

Two figures illustrate the key challenges. Figure 2 shows that subsea developments (or equivalent solutions with unmanned wellhead platforms) are the most likely solution for the many small and medium sized discoveries on the NCS. To make these economical, they would in most cases require tie-backs to existing infrastructure. Maintaining integrity of existing platforms while keeping costs down is therefore also essential.

Figure 3 shows a possible cost-demand curve for a low oil demand scenario (BCG, 2017). It illustrates that the future oil price is sensitive to the oil demand, which is highly uncertain. In addition, the oil supply side is also uncertain especially on how declining production from existing fields will be replaced. A competitive position within a range of future demand-supply scenarios requires that the NCS maintain lower break-even costs than competing oil basins globally.

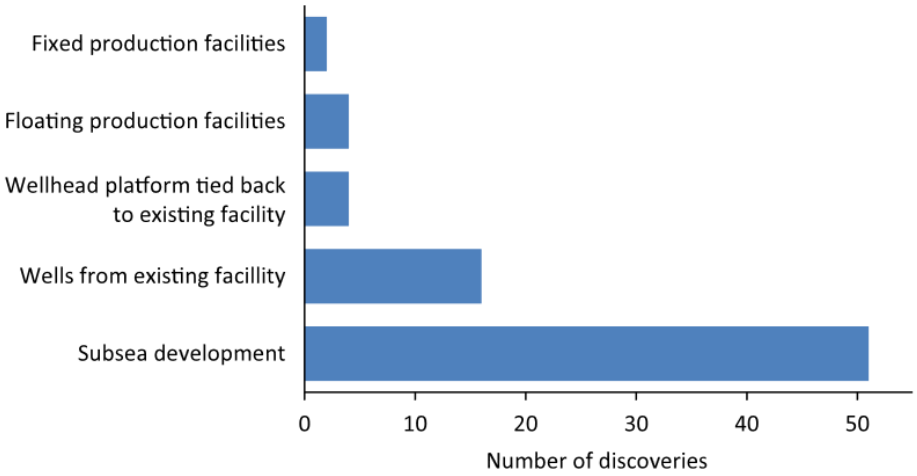


Figure 2 Expected development solutions for current discoveries on the NCS (NPD, 2017)

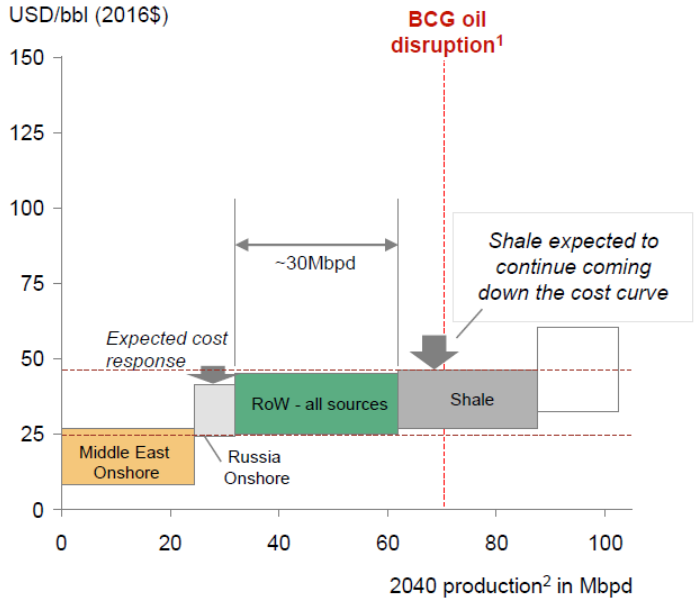


Figure 3 Schematic oil cost-demand curve illustrating the need for efficiency improvements (BCG, 2017)

[1] *Assumes demand reduction to 72 million barrels per day due to substitution of oil and energy efficiency gains.*
[2] *Includes crude oil, condensates and NGLs.*

3.2 Remarkable cost cuts on the NCS, but efforts must continue

Stakeholders on the NCS have invested considerable efforts over the last two years to cut costs and make the industry more profitable, and the results are remarkable. Figure 4 shows how investment costs for 7 typical projects have been halved from 2014 until end of 2016 (NPD, 2017).

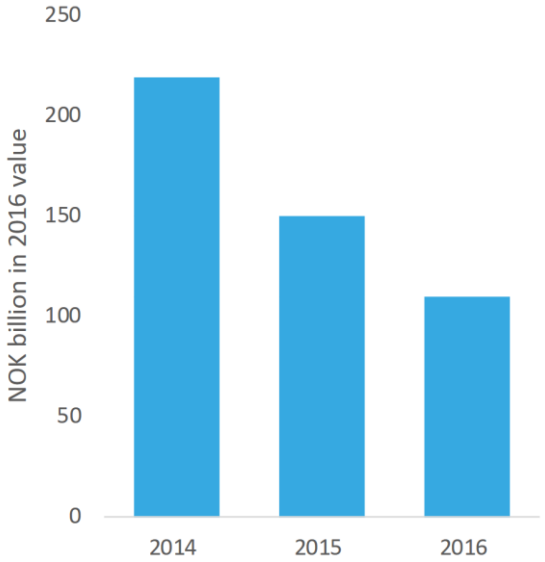


Figure 4 Cost estimates were halved for 7 field development projects[3] (NPD, 2017)

There is however no room for complacency and the efforts need to continue. OG21 believes that development and application of technology are important elements to further address cost challenges as well as environmental and resource replacement challenges on the NCS.

[3] *The seven projects concerned are Johan Sverdrup phase II, Johan Castberg, Utgard, Oda, Trestakk, Dvalin and Bauge.*

3.3 OG21 technology priorities

The OG21 strategy document lists 10 technology priorities (OG21, 2016):

- ***Improved energy efficiency***: Technologies contributing to more efficient energy production and less energy consumption.
- ***Zero carbon emissions***: Technologies enabling renewable power supply to offshore facilities, electricity from shore and CO_2 storage, CO_2 use for enhanced recovery, and cost-efficient, de-carbonized hydrocarbon value chains.
- ***Protection of the external environment***: Systems and technologies that reduce operational discharges and emissions improve management of safety barriers and minimize impacts of accidental spills.
- ***Subsurface understanding***: Technologies for better understanding of geology and reservoirs.
- ***Drilling efficiency and P&A:*** Technologies that reduce the overall work effort for well construction and well plugging, thereby lowering the costs of exploration and production wells as well as of plugging and abandonment (P&A).
- ***Production optimization:*** Processing, downhole and intervention technologies that increase the regularity, availability and productivity of wells and installations.
- ***Improved subsea and unmanned systems:*** Technologies that reduce development costs and increase the capabilities of subsea and unmanned production systems.
- ***Enhanced oil recovery:*** Offshore technologies that increase production of mobile oils and enable production of immobile oils.
- ***Digitalization***: Enabling automation, autonomy and ICT-technologies for all petroleum industry disciplines. The technology needs reach across data acquisition, data management, data quality, data integration, decision support and data security.
- ***High North:*** Technologies that address particular challenges of the currently opened areas in the Norwegian parts of the Barents Sea, including shallow reservoirs, carbonates, long distances and logistics and protection of the environment.

A further detailing and prioritization of technology needs is provided in the OG21 strategy document.

4 INDUSTRY DILEMMAS

4.1 Project economics and the bias towards traditional technologies

The OG21-strategy illustrated the large value and resource potential on the NCS related to the adoption of new technologies (2016), e.g.:

- Additional production of up to 14 billion barrels oil equivalents over the years 2017 to 2050.
- Annual cost reductions and productivity improvements exceeding 10 billion NOK.

Despite the promise of possible higher value creation, for several reasons traditional technologies are often preferred over new technologies.

Traditionally, technologies have been developed and qualified through field developments. The current NCS portfolio is dominated by large, mature fields, and small and medium discoveries. The current discovery portfolio is shown in Figure 5 (NPD, 2017). The average production license of today has less economical room to finance technology development as compared to earlier days on the NCS.

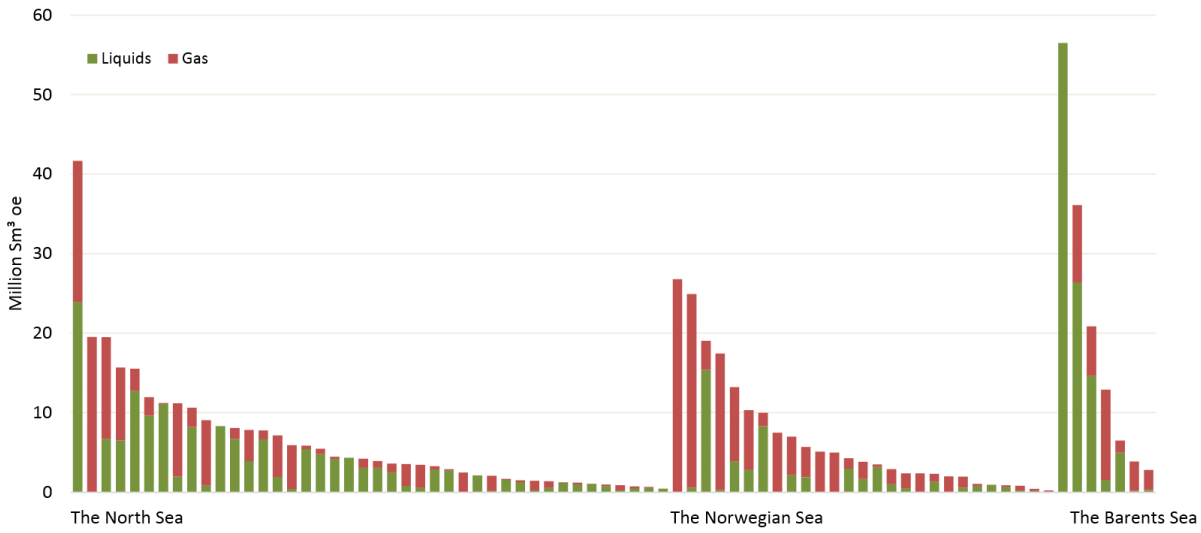


Figure 5 NCS discovery portfolio (NPD, 2017)

Large oil companies can distribute risks and rewards of new technologies on a wider project portfolio than smaller companies. As the NCS is maturing, it is however becoming less attractive for large, international companies that traditionally have been spearheading new technologies.

The uncertainty related to future oil prices and demand, make investors wary over long-term risks and returns. Oil companies, and possibly small companies owned by private equity groups more so than larger oil companies, may therefore prefer traditional technologies with low risks and early returns over unproven technologies with higher risks and potential higher, future returns.

Industry dilemma #1:
New technologies have the potential to unlock substantial value, but a perception of high risk and challenging project economics, drive the use of traditional technologies.

Some key questions related to the dilemma should be discussed in the industry:

- Are there more opportunities for collaboration on technology qualification across production licenses and oil companies? How could risks and rewards be distributed fairly?
- Will larger supplier companies develop and qualify technologies at their own risk and cost? If so, where and how would qualification and field tests be done? And how would suppliers be rewarded for the higher market risks?
- Could changes to business models that involve suppliers early in projects and with compensation related to results, provide sufficient incentives for testing out and adopting new technologies?

4.2 The innovation opportunities and risks related to close collaboration

The most important decisions are taken early in projects. Maximizing value over time require that relevant alternatives have been identified and evaluated before major decisions are taken, e.g. such as concept selection. Good decisions require a deep understanding of available technology opportunities as well as implications of alternatives across disciplines and scope. It requires competence in the operator's organization, but requires open dialogue and cooperation with partners, suppliers and academia.

Several strategic alliances have developed over the last few years. There are many benefits of close collaboration and strategic partnerships with suppliers and service providers. The suppliers are the best to know their own products and services, and may therefore bring new and exciting technology opportunities to the table. Early collaboration opens up for diversity of ideas, brings in new competencies and may spur innovation. Long term commitments may also open up for new technology opportunities that optimize value over time rather than for time-limited projects or operations.

On the other hand, a "closed" collaboration restricted to a few players will eliminate opportunities for those outside the alliance. Furthermore, suppliers inside a partnership could have a strategic interest of locking in its own solutions at the expense of potentially better solutions in the market. Over time, the reduced competition could lead to less innovation.

Industry dilemma #2:
Collaboration and early engagement of suppliers drive innovation, but may restrict competition and lock out better technology solutions.

The challenge ahead is:

- How can the industry leverage the advantages of close collaborations, and at the same time spur diversity and healthy competition?

4.3 The complexity of realizing the value of digitalization

Digitalization is a cross-disciplinary theme in the OG21-strategy (2016). The strategy describes an enormous value potential related to digital technologies such as e.g. automation, autonomous systems, robotics and drones, big data analytics for subsurface understanding, condition based monitoring, and so forth.

The oil industry has with success been developing and implementing digital technologies for decades. Taking it to the next level will however require great efforts in individual companies and across the industry.

Data is at the core of digitalization. Unlocking the value of digitalization requires efficient access to data and the ability to make sense out of the data. Oil companies are already collecting enormous amounts of data, but data is often on different formats, tailor made to the application they serve. Data standardization and harmonization would open up for implementing new, efficient tools and applications, but it is a challenging task, even within individual companies which could have fields and installations that have been developed in isolation over decades.

Since data is paramount for value creation, data represents an important strategic asset for oil companies and suppliers. There are obvious industry benefits of sharing data, e.g. realizing the full value of big data analytics, but data owners would only be stimulated to share if the benefits of sharing compensates for any loss of competitive advantage. It could for instance be a concern to established players that sharing data and standardization of data would reduce entry barriers, and therefore increase competition (Porter, 1979). In addition to the strategic and commercial considerations, sharing of data may also have legal implications that add to the complexity.

Another challenge is digital competence and access to talent. For instance, making sense out of vast amounts of data requires data analytics competence, which is scarce and attractive across industries. The oil industry needs to build digital capacity within this competitive environment. It does not necessarily have to be through organic growth – it could also be secured through services acquired in the market, strategic alliances or acquisitions.

Digitalization occurs at an increasingly higher pace, and few, if any, companies could reap the full benefits in isolation. Efficient utilization of competence and capacity requires collaboration between oil companies, system suppliers and smaller niche suppliers. Early engagement of suppliers is essential to identify the best solutions. Long-term relationships in combination with performance based contracts could be an attractive business model to secure continuity and distribute risks and rewards. As discussed in the previous section, this could however also lead to market concentration at the expense of competition and innovation.

Collaboration could also entail competitors. This has become normal in other industries, e.g. in the automotive industry where car manufacturers collaborate on topics such as R&D and component development. There is a history of collaboration also in the oil industry, e.g. through industry organizations and joint industry projects, and this provides a good starting point for also collaborating on topics related to digital transformation.

The benefits of sharing data are likely to become more obvious over time, and perceived risks may also be reduced over time. From a NCS perspective, making larger, shared data sets available, has the promise of identifying new exploration prospects more cost-effectively and evolving more optimal depletion procedures through use of new digitization technologies such as Artifical Intelligence. An attractive proposal is to start sharing insight and data with low competitive advantage, but which still offer high potential impact for all stakeholders. Some examples are operational data for rotating machinery and HSE-data.

Digitalization starts in the board rooms and administrations. Senior executives need to commit to change, communicate change expectations and allocate sufficient resources. Organizations and people will have to be motivated to change, and embrace a culture of technology adoption and new business models.

Industry dilemma #3:
Digitalization offers vast opportunities, but realizing the full value requires substantial changes and determined efforts.

Key questions for the industry to discuss are:

- Which topics should the industry start collaborating on? Which topics are out of scope for collaboration?
- How could we maintain diversity and healthy competition when the market forces drive the industry towards close collaborations and market concentration?

5 THE WAY FORWARD

OG21 presents this report as a basis for discussion between stakeholders on the NCS, and it hopefully opens for dialogue between the companies. OG21 encourage oil companies, supplier companies and their organizations to consider the key dilemmas when developing their own road maps and innovation strategies.

OG21 will drive engagement around the key dilemmas through presentations and discussions at meeting places for the Norwegian petroleum industry, including OG21's annual "OG21-forum".

Recommendations made in the OG21-strategy (2016) are still valid. The ones most relevant within the context of this study are:

- New business models to enhance technology adoption and application, should be investigated as part of the social science research in petroleum R&D programs.
- The industry should work to enhance the use of novel, value-adding technologies through measures such as:
  - Contract strategies in projects that encourage the use of new value-adding technology.
  - Commercialization strategies with robust partnerships and convincing business cases.
- The authorities should evaluate whether sufficient incentives are in place to encourage the application of new technologies with high societal value.
- Authorities should actively use established instruments to encourage implementation of value-improving technologies.
- The effects of the voting rules in NCS licenses on technology uptake should be further investigated.
- The industry should continue its standardization efforts to simplify deployment of new technology and reduce unit costs. Examples include standard material specifications, standard technical specifications, as well as standard interfaces and communication protocols to enable component interchangeability.

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