Developing NODE: Mediating Strategy for Sustainable Growth

A good system shortens the road to the goal
Orison Swett Marden

Kjell O. Johannessen, the leader of the Norwegian Offshore & Drilling Engineering (NODE), was sitting in his office following another intriguing strategy process workshop with the members of the NODE cluster. He had much to be proud of. The accumulated sales of the NODE members had grown from €0.5 billion in 2004 to €5.5 billion in 2009. The workforce had doubled from 3,202 employees in 2005 to 6445 in 2009. In the global market of the oil and gas industry, NODE members were competitive exporting almost 90 % of their products. The sun was shining on Southern Norway and with order reserves of €11 billion the future looked even brighter.

But Kjell was worried. Was he witnessing another bubble, which was soon to burst? The astonishing growth had taken its toll. Local resources were almost exhausted. Engineers were nowhere to be found in Southern Norway, not even teachers. The formidable investments from private and public sector actors had created unprecedented growth. But it was less clear how the partnership could contribute to add further value. Fossil energy, whose producers constituted the largest customer group of the NODE members, has been much criticized by environmentalists and new alternative energy sources are being explored all around the globe. Was the dream coming towards its end? Kjell had to find ways to keep the engine running, at full speed.

The historical development of the Norwegian oil industry

Up until 50 years ago, it was believed that Norway did not possess any oil and gas resources. After the discovery of gas in the Groningen field in the Netherlands, geologists directed their attention to the Norwegian continental shelf. The first to be found, and also the largest oil field in this area, Ekofisk, was discovered in 1969 with production commencing on June 15, 1971. Currently,

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there are 65 active oil fields in production. Together they produce 2.3 million barrels of oil per day, and 102.7 billion standard cubic meters of gas per annum. In current terms the industry has created value in the magnitude of €1,000 billion and has invested a total of €375 billion. It currently accounts for 22 percent of national value creation (GDP), 47 % of total exports, 27 % of state revenues and 26 % of total Norwegian investments.[i]

When oil and gas exploration started at the end of the 1960s, Norway did not possess competences related to exploration technologies like drilling, reservoir modeling and field development. However, Norway did possess considerable knowledge in shipping, shipbuilding and metal production and in how to deal with the harsh climate in Norwegian waters. In the first years of exploration, Norway was a large importer of technologies, but companies gradually started acquiring the necessary competences themselves. The Norwegian oil and gas industry has been involved in a number of technological breakthroughs based on solving pressing problems related to field development and improved oil recovery[1] on the Norwegian continental shelf. The Norwegian continental shelf has been referred to as an advanced offshore lab[ii] and innovations mostly result from pressing operational challenges.

With regards to field development, the first concrete deep water structure, the Condeep, was introduced in 1975 following the cooperation of field operators, engineering firms and ship yards. More recent innovations include floating production ships (FPSOs) and subsea installations. With regards to improving the recovery rate from an existing field, a recent report estimates that the increased recovery rates in the period 2000 to 2009 have yielded an increase in total net present value of €18 billion. For example, when Ekofisk, Norway's first oil field, was discovered in 1969, the rate of recovery was estimated to be 17 %. With successive innovations, the rate of recovery is now around 50 %. Innovations such as 3D and 4D seismic have established global players (e.g. Petroleum Geo-Services and TGS). When the pressure in reservoirs drops, production rate also drops. One way of avoiding this is to inject water, as pioneered at Ekofisk in 1986. Another way is to inject natural gas, which was pioneered at Troll and Oseberg in 1991. If production from a reservoir starts before all wells have been drilled, pressure in the entire reservoir may drop. The introduction of managed pressure drilling, pioneered by Halliburton, and further developed by SINTEF and IRIS, has made it possible to drill in reservoirs where pressure has fallen or where pressure varies within the reservoir. In 1996, horizontal drilling was developed as the standard practice of vertical drilling made it impossible to drain thin reservoirs like Troll oil, a "pancake" of oil underneath a giant gas reservoir. BakerHughes, Inteq and Hydro engaged in a partnership and developed intelligent rotary drilling systems to be used for horizontal wells.

The Norwegian reserves are being depleted (see **Exhibit 1**). The Norwegian Petroleum Directorate (NPD) estimates that the total discovered and undiscovered petroleum resources on the Norwegian continental shelf amount to approximately 13 billion standard cubic meters of oil equivalents (scm o.e.). 40 % of the total resources, that is 5.3 billion-scum o.e., have already been

[1] Oil recovery is a term within the oil business that stands for the percent of crude oil that is extracted from an oil field.

produced. The total remaining recoverable resources amount to 8.1 billion-scm o.e. Of this volume, 4.8 billion scm o.e. are proven resources, while the estimate for undiscovered resources is 3.3 billion scm o.e.[iii] In 2009, the total production of oil and gas was 238.6 million scm o.e. of which 102.6 was natural gas production and 115.5 was oil production. The production of natural gas has been gradually increasing while the production of oil and gas has been gradually decreasing. The production of natural gas alone is expected to constitute more than 50 % of total production by 2013.

Norway is home to just below 5 million inhabitants (2011 est.). GDP levels in 2009 amounted to €64,000 per capita. Educational levels among the working age population include elementary school (30 %) and high school (43 %) levels as well as an increasing number of employees with university education (21 % Bachelor and 6 % Master or higher in 2009). Unemployment among the 2.6 million Norwegian working age population remains historically low, ranging between 2 % and 3 %. Among the working age population, average annual salary reported for 2009 was €53,000 representing a growth by 4.1 % compared to the previous year.[iv]

The initiation of NODE

The main part of the Norwegian oil and gas industry is localized in the Western counties of Hordaland and Rogaland especially in Stavanger, where Statoil, the now partially state owned operator, has had its largest center ever since its incorporation. A large number of global and national oil and gas suppliers (e.g. BakerHughes, Halliburton, the IKM group) have established operations and production facilities in and around Stavanger. Oslo, the Norwegian capital, has taken a leading role in seismic and in engineering. Bergen, Norway's second largest city and the surrounding areas have taken a leading role in the development and construction of offshore vessels and equipment. These localities have created vibrant oil supplier communities that were innovating with and for operators in both field development and oil recovery technologies.

Southern Norway has historically been home to process industries including aluminum and silicon production. The rising costs, in part due to the rise of the oil and gas industry, created major challenges to the continuation of these industries. Southern Norway has also developed competence in mechanical workshops including shipyards. Many of them experienced dramatic decline or closure during the 1980's. During the mid-1990's, the focus shifted from general mechanical workshops and shipyards to large and engineering-based offshore constructions.

At a conference in Kristiansand in February 2004, INTSOK (Norwegian Oil and Gas Partners) published a report on the future prospects of the Norwegian Oil and Gas industry. The discussion following the presentation centered on the role that firms located in Southern Norway could play in the future of the Norwegian oil and gas saga. The discussion highlighted that oil and gas suppliers in Southern Norway did not cooperate very actively, and that the linkages between the oil and gas suppliers and research and development (R&D) and educational institutions in the region were weak. The discussion concluded by stating that a more organized regional forum was required to increase this cooperation for the region to be more competitive at the national and international arena. The

local business organization, Spydspissen, was assigned the responsibility of following up the proposal.

In June 2004, a meeting with representatives from key stakeholders including central oil suppliers to the oil and gas industry from the region and Innovation Norway was held in the largest town in Southern Norway, Kristiansand. The meeting confirmed the need for a joint approach in order to further strengthen the position of the suppliers from Southern Norway in the national and global industry. At this stage the regional office of Innovation Norway in Agder offered funding for a pre-project that could explore possible roles and activities for a project organization. The proposed framework was well received, and a partnership of sponsors consisting of the county authorities, the Municipality of Kristiansand, Sørlandets Kompetansefond (a regional fund for promoting competence development) and the local business community agreed to fund the project in an initial phase. The partners were looking for a project manager who knew the industry well but had no specific relations to any of them. Kjell O. Johannessen (see below for more information about the cluster manager) was appointed as project manager for the "Drilling Coast" project, later to be renamed NODE. The project manager task was defined as a 40 % position.

Coinciding with these developments, the interest for cluster development was rising in Norway. Innovation Norway, the Research Council of Norway and SIVA established the Arena program in 2002. The program was set up to support a number of network-based regional initiatives, testing ways of enhancing industry-university linkages. The Arena program funded, and offered professional support, to cluster development for a period of three years. The funding was allocated to establish a cluster management that could organize the clusters' processes and activities, mobilizing the partners to take an active role in the core activities of the cluster. These core activities were defined as networking activities between businesses, and between industry, R&D, and educational institutions. By 2005 the Arena program had taken part in the initiation and implementation of 15 regional clusters and was recognized both in regional innovation environments and by the national and regional authorities as an efficient instrument to enhance collaboration.

A first meeting between the management of the NODE and the Arena administration took place in late 2004. Kjell O. Johannessen realized that Arena could offer the NODE project what it strongly needed; a more long-term funding, and also a framework for organizing the cluster processes. NODE was recognized, by the Arena program management and Innovation Norway's regional office, as an extremely promising cluster, which would undoubtedly benefit from the Arena program.

The Arena program is based on annual calls for proposals, and a selection procedure with clear criteria for what needs to be in place to be selected for the program. When the program announced its call mid-2005, NODE was one of the applicants. NODE received high scores on its project proposals, both regarding the structural aspect of the cluster and the potential of the NODE initiative, and was consequently accepted as an Arena project for a three-year period from January 2006.

Support from the Arena program gave far better conditions to develop the cluster. Kjell O. Johannessen entered NODE as a full time cluster manager and commenced his appointment by engaging the business leaders in discussion leading to more active collaboration in the cluster. The cluster's recognition from regional as well as national authorities has also gradually increased.

As NODE developed, so did the focus on cluster and cluster development in Norway, and in December 2005 The Norwegian Centre of Expertise (NCE) program was officially launched through a call for proposals. NCE targeted regional clusters that were already, or had a potential to become, world-class clusters. The NCE program offered a long-term support (10 years) and a larger funding (based on 50/50 public/private funding). By 2009 it had invested in 9 cluster initiatives. Three more NCE clusters were to be selected in 2009, and NODE entered the competition. Given the very dynamic development of the cluster and a highly recognized cluster organization, it came as no surprise that NODE, the cluster organization on behalf of its cluster members, was accepted as one of the new NCEs.

Cluster Composition

Activity in the NODE region centers mainly on drilling systems, wave compensation systems, complete platform solutions, loading, unloading and anchoring systems. The NODE companies supplying drilling systems include National Oilwell Varco Norge AS[v] (NOV), Aker MH AS and TTS Energy. Drilling equipment has evolved over the years from simple machines to automated robotic systems. Today, advanced technology enables transfer of live information from the well in order to optimize the drilling process e.g., photos from the drill bit are analyzed and the results determine where further drilling processes should be run.

Wave compensation systems involve the use of cranes that hold large loads stable relative to the sea floor in order to ease loading operations. The crane itself is usually moving on the sea surface, but advanced technology allows the force of the waves to be compensated for and not affect the load being moved. NOV and MacGregor Hydramrine AS, are the two main suppliers of wave compensation technology in the NODE region. Both companies have developed solutions that can make lifting operations possible in more than 3000 meters water depth.

Complete platform solutions are produced by e.g. Sevan Marine that builds owns and operates floating production solutions for the oil and gas production (FPSO). Complete platform solutions are used for the processing and storage of hydrocarbons. FPSOs are designed to receive hydrocarbons from nearby platforms, process and store until it can be safely offloaded onto a tanker or transported through a pipeline. They are quickly becoming preferred platform solutions as they are easy to install and do not require a local pipeline infrastructure.

Loading, unloading and anchoring systems are employed in order to transmit oil and gas from the seabed to a buoy, ship or platform. Aker Pusnes and APL (Advanced Production and Loading, now part of NOV) are the two leading firms in this niche. The advanced loading equipment developed by NODE companies meets environmental requirements of "zero emissions". In order to successfully complete the loading and unloading of hydrocarbons, anchoring systems are of great importance. Advanced mooring systems between the seabed and the platform or a ship ensure a stable position under very tough conditions, reducing chances of spillages or leakages.

Between 2005 and 2009, the growth of cluster members was impressive. The firms doubled both employment and the book value of fixed assets. Aggregated total assets increased four-fold from €1.5 to 6.7 billions. Net income increased 20-fold while turnover four-fold. See **Exhibits 2a** and **3b** for accounting information on cluster members as a whole, and selected firm over time.

The cluster is composed of two large directly competing firms, (National Oilwell Varco Norge AS (NOV) and Aker MH AS), a large number of large medium-size firms (e.g. Sevan Marine, TTS energy AS), and many smaller firms. 80 % of turnover is generated by NOV and AKER MH AS. The medium-size firms generate 17 % of the revenue and the smaller firms 3 %.

The members have been in business over a relatively long period of time. The 27 % of the firms have been in operation for over 20 years generated 87 % of the aggregated revenue of cluster members. Firms established in the 1990's (19 % of all members) generate 6 % of aggregated revenue. Firm established between 2000 and 2004 are the largest group in terms of their share of members (44 %) and generate 6 % of aggregated revenue. Young firms, those established after 2004, constitute 10 % of all members and generate merely 1 % of aggregated revenue.

NOV was established in 1841 with a focus on providing premium products and services for oil drilling companies. As of today, NOV is a worldwide leader in their market with a truly global presence. Its shares are traded on the New York Stock Exchange. It is currently (2010) number 202 in the FORTUNE 500 list. Its headquarters are located in Houston, Texas. NOV designs, produces and sells all of the major mechanical components for offshore drilling rigs in addition to complete land drilling and well servicing rigs. NOV subsidiary in Norway was established through the acquisition of HITEC in 2000. NOV's entry into Southern Norway occurred in late 2002 with the acquisition of Hydralift. Hydralift was founded in 1965 and originally provided engineering based products in the telescopic work platforms and rock drilling rigs. In 1968 the firm, including Bjarne Skeie, developed hydraulic ship cranes, which marked a new phase in the development of the firm's offerings. In 1986, Bjarne Skeie who had left Hydalift to establish Maritime Hydraulics in 1971 (Now Aker MH AS: See below) acquired Hydralift[vi]. In 2009, the company had 1994 employees generating €2.9 billion in turnover. In the NODE region, NOV is a large and central actor in both drilling system activities and wave compensation technologies.

Aker MH AS was founded in 1971 by Bjarne Skeie as Maritime Hydraulics. It later became a wholly owned subsidiary of Aker Solutions ASA[vii]. Aker Solutions is a leading global oil services company with annual revenue of €6.2 billion and approximately 20,000 employees in about 26 counties (2010).[viii] Its headquarters are located outside Oslo, Norway. Aker MH AS has built up extensive experience in drilling rigs. The firm is a major player in the design of drilling equipment and related technologies and is located globally in key regions throughout Europe, Asia, North America and South America. Aker MH offers a wide spectrum of deepwater drilling equipment, systems and services and intends to be a one-stop-shop for its customers. To date, the firm has delivered equipment to more than 600 drilling rigs worldwide as well as more than 20 complete drilling control systems. Over recent years Aker MH has significantly expanded its portfolio through a number of acquisitions and directed its focus on innovative and technologically advanced solutions. In the NODE region, Aker MH is a large and central actor in both drilling system activities as well as in loading, unloading and anchoring systems. Twenty years after its establishment in the region, the company generates €0.9 billion of revenues, employing 1059 people in the region (see **Exhibit 2a**).

AS Nymo is a full-service engineering, procurement and construction company within the oil and gas industry, with special expertise in the design and fabrication of offshore drilling packages. Founded in 1946 in South Eastern Norway, the firm employs over 300 people from the local area and is an important actor in the NODE region. With €67 million of revenues in 2009, AS Nymo is among the largest medium-sized firms in the NODE network, (see **Exhibit 2b**).

TTS Group is a global enterprise that designs, develops and supplies equipment for the marine and gas industries. In the NODE region, it is an important actor with regards to both drilling systems and wave compensation systems. TTS is listed on the Oslo Stock Exchange, employs 1250 people worldwide and generates an annual turnover of €0.5 billion. TTS's primary activities involve the design, assembly and testing of equipment. Locally, TTS employs 188 people and generates €60.5 millions in revenues per year (See **Exhibit 2b**)

MacGregor Hydramarine AS (currently known as Cargotec Norway AS) is an important player in the provision of wave compensation systems for the oil and gas industry based in the NODE region. The firm is the world's leading provider of cargo handling solutions and its products are used in different stages of material flow in the oil and gas industry. MacGregor Hydramarine AS employs 9800 people worldwide of which 272 work in Norway. They generated revenues of €108 million in 2009. MacGregor Hydramarine AS's affiliated brands of Hiab, Kalmar and MacGregor are globally recognized as leaders in cargo and load handling.

Besides Aker MH, Advanced Production and Loading (APL) is an important player in the activities of loading, unloading and anchoring systems. On 9th December 2010, National Oilwell Varco announced its acquisition of APL, for $500 million. The acquisition enables APL to become an independent provider of technology to the FPSO industry, whilst benefiting from NOV's strong market position and reputation. It generated €0.1 billion in revenues and employed 218 people in 2009.

Sevan Marine AS was established in 2001 and has enjoyed considerable success in the provision of complete platform solutions to the oil industry. The firm trades on the Oslo Stock Exchange and currently employs 218 people. The Sevan technology that lies at the heart of the firm's business model is based around the development of a cylinder shaped floater that is suitable for all offshore environments. This signifies an important engineering innovation in the construction of offshore structures with important implications for mobility, resistance and safety. Sevan Marine is the main actor in the provision of complete platform solutions in the cluster. It generated revenue of €38.7m in 2009.

NODE is very selective with regards to membership. NODE has refused membership to some firms that have asked for entry. Cluster management have to ensure that firms are not just entering in order to take cluster benefits, but also to contribute to cluster development. Membership is restricted to firms whose activities are directly linked to NODE's vision and to its technological core. The interest in NODE has quickly spread to non-commercial organizations. Public administrators on the municipality and county levels, as well senior representatives in the county's leading educational institutions, have shown interest in the initiative. The advisory board committee laid down the foundation for the inclusion of external stakeholders in particular of local and regional authorities, thereafter also academia as observers.

The cluster manager

Kjell O. Johannessen is an engineer by education and entrepreneur by nature. He has been involved in the establishment of new firms and the management of firms for over three decades. He established Ventilasjonsteknikk Sør A/S in 1975. The firm evolved from delivering ventilation systems to delivering a broad range of technical facilities for the construction, offshore, maritime and manufacturing industries. It has started as a self-employed entrepreneurial project based in Kristiansand. It gradually extended its product variety and its geographical reach delivering technical solutions to local, regional and international customers.

Through the firm's engagements in offshore projects, he has developed offshore-related competences and an extensive network of relations. Albeit a supplier to the offshore industry, Ventilasjonsteknikk Sør A/S product range has not put the firm in competition with NODE's members. The firm was eventually acquired by Sønnico in 2000. Kjell has also taken a leading role in regional development and been both board member and chairman of the Industrial Association of Kristiansand Region. He has also taken positions in national industrial associations. Relevant to NODE's firms, he has also taken a position in the Norwegian Petroleum Society and a number of positions, including a member of the executive board, the Council of Europe, and the election committee, all in the Confederation of Norwegian Enterprise (The national employer association).

Facilitator Activities

As the new cluster manager, Kjell understood that something needed to be done for the cluster as a whole, not just with focus on the largest players. At the time of his appointment there was little cooperation between firms. The 'cluster', as it was, was better known for its world leading products in the oil cluster of Houston, Texas than in Norway. The interpretation of the U.S. Anti-trust legislation prevented cooperation between competing firms in the cluster. Kjell approached the top-leaders of potential cluster member candidates with the clear aim of evaluating the likelihood of reaching a set of common goals. In the initial conception of NODE, Kjell secured the commitment of top management of the leading large firms as well as influential entrepreneurs. This materialized by the establishment of an advisory board committee composed of senior management of NODE's members who committed their time and resources, and secured the participation of their respective firms.

The role of the cluster manager and the cluster organization had to be established simultaneously. Kjell was widely known by the group members as a successful entrepreneur and a representative in local and national interest organizations. His cluster management skills and ability to manoeuvre between competing firms and small and large firms were not proven. A crucial event occurred in this initial stage. Central entrepreneurs allowed Kjell to take a leading role in the evolution of the emerging cluster.

Having agreed on the different roles of the actors in the clusters, top management of leading firms and entrepreneurs-, with the assistance of Kjell- decided upon NODE's vision. It aimed at assisting in assuring that the oil and gas industry in southern Norway would maintain its globally leading position regardless of outside competition. The major activities conducted by NODE can be divided to three types: the creation and facilitation of purpose-based forums, coordinated projects and competence development.

NODE Forums: NODE holds meetings in order to focus on cluster development, rather than individual firms. Cluster members are able to meet in a variety of forums such as Top Manager, Health, Environment and Safety (HES), NEW (NODE-Eyde Women), SME, Human Resources, Economy and Finance. The Top Manager Forum had its inaugural session in 2007. 14 top managers attended. The number of attendees had doubled by its next meeting in 2008. At these meetings firms are encouraged to have open dialogue with others and to communicate their boundaries. At NODE, concurrence on issues that are taboo, not part of the cluster-facilitated discussions, is as important as the concurrence on issues that are to be addressed. Allowing firms to set their own limits enables cluster management to understand their needs and respond accordingly. In a setting such as this, where new members join and current members send new employees to NODE meetings, NODE administration resorts to story telling. Repeating the story of NODE development time and time again helps to spread the vision amongst members and reinforces the common goals that should be kept in focus.

HES meetings, for example, are held every other month. The topics and the location are chosen so as to appeal to a wide range of firms. The NODE region comprises a few very large firms as well as very many SMEs. These firms have inherently different agendas and priorities regarding HES, so may not be interested in attending the same meetings if the topic is too focused on specific issues rather than being broad-based. This is a fine balancing act. This affects what topics can be taken up and what must remain taboo, and reinforces the need to create an atmosphere of trust at such meetings. In order to achieve this, a HMS forum was established where participants make suggestions themselves about topics of discussion and courses that would be of interest to them. Attitudes have developed very positively at these meetings over the last year, which has led to more discussion and interaction between participants. The meetings are now more or less planned, organized and implemented by the participants and the role of the cluster manager is that of a mediator or facilitator to enable such relations to flourish in a neutral environment. Members cannot be forced to interact, but providing suitable settings and environments for exchanges, encourages cooperation rather than competition between cluster members.

SME breakfast meetings help in building understanding between SME managers of what other firms are doing. Competitors partake in workshops for problem identification and solving, that helps to increase engagement in topics e.g. at the SME forum meeting during the first quarter of 2011 participants were asked to make a 15 minute firm presentation. Members realized that while with regards to some products they directly compete, with regards to other products they could enter into customer-supplier relationships and create new business relations within the cluster.

Meetings are organized in such a manner that the informal parts of such meetings and forums are emphasized. Evening dinners are planned as much as the official meetings. Participants from different firms within the cluster are provided with the opportunity to socialise and chat informally in a friendly atmosphere. Meetings are based on as set of values specified in the 'value agreement'. The agreement allows competitive behaviour to be put on a back burner. Participants are made aware through the agreement on the limits of cooperation. After one particular meeting for one of the projects Kjell made telephone calls to the managers of some of the participants in order to report their enthusiasm and to ensure that they had permission from their firms to express themselves on the discussed topics in the presence of competitors.

NODE Projects: NODE facilitates and develops a large number of projects on behalf of and in coordination with its members. NODE junior, for example allows those employees under 30 to voice their opinions about the upcoming development of the cluster and by doing so contribute towards its future competitiveness. NODE ART is a demanding research and development project whose objective is to solve the common challenge provided by corrosion of large hydraulic cylinders. The assignment was to develop a new generation of cylinders and drill string/equipment adapted to deepwater drilling in both Arctic and tropical regions. Collaborative partners in the project are Aker Solutions, National Oilwell Varco Norway, UMOE Mandal, Elkem Research, Falconbridge Nikkelverk, Rexroth (NED), Statoil, University of Agder (UiA) and Norwegian University of Science and Technology (NTNU).[ix]

NODE Environmental Footprint is an ambitious project, which aims at assessing the environmental impact of NODE's products. There is a growing pressure from various stakeholders including non-governmental organizations, suppliers and customer, to document and continuously improve the environmental properties of products. Following the explosion on the BP-licensed Deepwater Horizon Transocean drilling rig in the Gulf of Mexico on the 20th April 2010 and the subsequent environmental effects on marine life such pressure has mounted. The project started in 2009 and has the financial backing of both the Ministry of Petroleum and Energy and Innovation Norway. With a budget of €2.2 million over a period of two and a half years, the project intends to develop a mode and a methodology for the assessment of products' environmental properties.[x]

Competence development: NODE is involved in a number of projects that aim at enhancing the competence level of its members and their employees. NODE has identified the need to be actively involved in promoting the necessary competences in both firms and academia. By means of competence development projects, future demands are identified and aimed to be met through active promotion in corporation with leading universities in the fields.

NODE Competence Center was established in 2009. Being aware of the growing demand for further education and training, the Competence Center aims at providing firms with offers for further education tailored to the specific needs of the industry. Two initiatives that address the medium and long-term needs of the industry are especially worthy of consideration. First, in order to strengthen engineering competencies, the Competence Center is cooperating with the University of Agder where individual courses in mechatronics on both Bachelor and Master level can be taken. Mechatronics (See **Exhibit 3**) is at the core of the operations of the NODE members. It combines knowledge from four distinct system knowledge bases. It combines the traditional knowledge of mechanical systems with electronic systems, hydraulics and computer technology

Second, managerial competences, change management and logistics skills are developed through cooperation with BI Norwegian School of Management, the largest Norwegian business school, where employees can take project management classes that may be extended towards a Bachelor of Management in Project Management. Moreover, a tailor-made part-time master program, the Master in Innovation and Business Development, can be taken as part of the Master of Management program at BI Norwegian School of Management. In addition to these, the center offers professional language courses for mechatronics engineers and provides financial support to invest in PhD students in the subject area. Third, the large corporations in the cluster for the most part are in possession of capabilities and resources to promote innovation processes themselves. A need on the side of small and medium-sized firms has been identified. NODE has initiated a preliminary project focusing on strengthening their capabilities.

Governmental ministers, such as the minister for petroleum and energy, academics as well as practitioners have endorsed NODE's evolution. The government, rather than other way around now approaches the cluster. In such a situation, cluster management are able to conduct lobbying at the

very highest level. It is not uncommon for NODE management to have top meetings with interest organizations e.g., The Norwegian Confederation of Trade Unions, or ministers as well as other influential bodies. The cluster administration operates as a facilitator, providing a direct informal link between public policy and firm management.

Cluster management in NODE presents a framework for the cluster and its future. It also ventures to strengthen the cluster and encourage its independent growth. NODE has entered into a cooperation agreement with related NCEs. A clear synergy in sharing cluster management knowledge between NCEs is strengthened by the members' competence complementarity. For example, such a partner is NCE systems engineering Kongsberg. It specializes in systems engineering, an interdisciplinary approach and aims to enable the successful realization of complex systems[xi] in many industries including maritime which is of specific interest to NODE's members.

The effects on the local environment

The region of Agder comprises the counties of Aust-Agder and Vest-Agder and is located in the southern part of Norway. **Exhibit 4** depicts the geographical distribution of NODE firms. Aust-Agder has a proud naval history and has been a centre for international trade for over 400 years. International influences have made their mark on the region, with the town of Arendal offering the only International Baccalaureate Diploma Program in the wider region of Southern Norway as well as having the country's only municipal international primary school, Arendal International School.

Agder has 278876 residents in an area of 16434 square kilometers, divided over 30 local municipalities. This accounts for 5 % of the total land area of Norway and 5.7 % of the total population. In the 8-year period from 2000 to 2008, the total number of employees located in the Agder regions and operating in the metal, maritime and oil industries has grown steadily from 9639 to 18684. The total employment in the private sector have shown an average annual growth rate of 4 % over the period, representing an increase from 62332 in 2000 to 85915 in 2008 (see **Exhibit 5a**).

Norway has always had a high percentage of the population in ordinary employment when compared to other countries. This figure has varied from 72 % to 74 % of the population of working age from the 1990s to today. Aust-Agder is noted to have one of the lowest percentages of inhabitants in ordinary employment (134400 individuals i.e. 5.3 % of the national total), alongside the inland counties of Hedmark, Oppland, and two of the Northern counties of Nordland and Finnmark.

Employment figures show that there are clear differences in industry structure between regions in Norway. Maritime activity, high technology industry and international trade are dominant today in the Agder region and are responsible for the majority of value creation in the region. The Agder region alongside Rogaland and Hordaland has a high level of manufacturing employment, which is related to the concentration of oil and gas activities in these regions. Aust-Agder and Vest-Agder combined contributed with 3.8 % (€10,790 m) of Norway's total GDP and were responsible for 4.2 % of the national total gross investments in 2009. During the financial crisis of 2008, the Agder

region experienced higher level of unemployment than the national average. Reductions in construction and private service firms were mainly to blame for the increased unemployment. Weak expected industrial growth in 2010 and 2011 contributes to forecasts of the Agder region having a below average economic development in the near future.

In 2001, NODE-related firms in the Agder region employed 924 out of a total 4402 local engineers. This figure has grown rapidly over the period so that in 2008, NODE-related firms employed 2217 out of 4695 local engineers. Average growth of engineer employment in NODE-related firms was 20 % per year, while the average decline of engineer employment in all other sector was 4 % per year between 2001 and 2008 (see **Exhibit 5b**). Inter-firm labor mobility within NODE members firms has been constant from 2003 to 2008 at 2 %.

By 2009, 28 % of the working population in the Agder regions had completed university education. The formal educational level of the region has been substantially lower than that of the capital city, Oslo (50 %) and slightly below the national average of 31 %. People residing in the Agder regions who are employed in the private sector have gradually professionalized. While in 2000, 82 % lacked university education by 2008, this percent decreased to 71. For those working in the metal, maritime and oil industries within the Agder region, the percent of employees without University education decreased from 83 to 70 over the same period (see **Exhibit 5c**).

Responses from a bi-annual survey administrated by Statistics Norway indicated that 21 % of NODE-related firms have introduced product innovation in a form of a new or substantially improved product in the period 2006-2008. 18 % of all other firms in Norway that were not NODE-related report such introduction of product innovation. In 2004, 28 % of NODE-related firms reported product innovation and 22 % of all other firms in Norway (see **Exhibit 5d**).

Challenges

Accumulated sales of the NODE members have grown from €0.5 billion in 2004 to €5.5 billion in 2009. How long can this growth rate persist? This is the exact question that NODE members and cluster organization have been asking themselves during 2010. The leaders of NODE initiated the NODE 2020 strategic process. As a result of an extensive strategy process exercise, which utilized scenario planning and collective strategic decision-making, a number of avenues for future growth have been proposed.

The first proposal necessitates the setting up of a technology centre -NODE Technology lab. The technology lab allows for the testing of both components and equipment. It will be accessible for all NODE members for research and development and testing of supply material projects.

The second proposed growth opportunity is in contributing to reducing costs and increasing efficiency of oil explorations. This is based on the fact that the availability of prosperous oil fields in

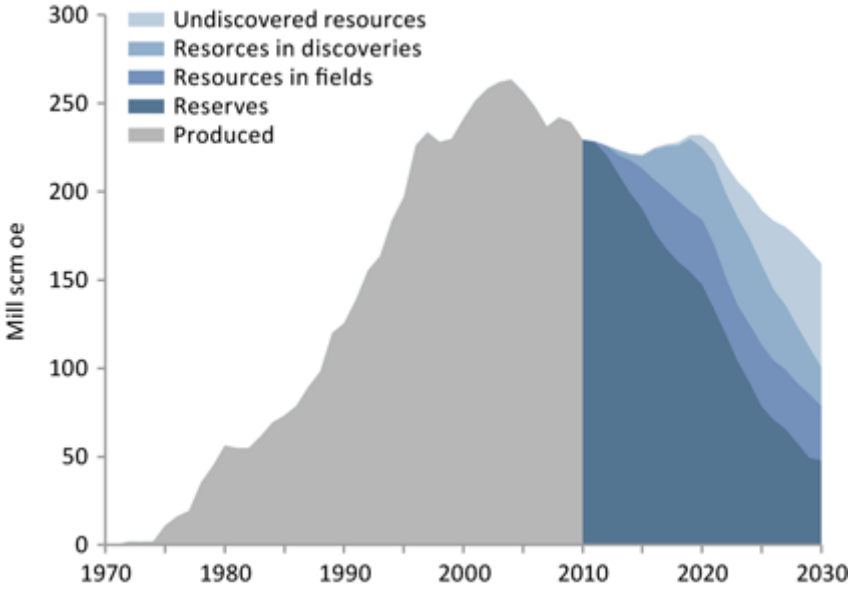
the Norwegian Continental Shelf is limited and the expectation that existing fields will reach maturity levels in the near future. There is a growing demand in the industry for cutting exploration time and costs of oil exploration especially in mature fields. NODE's idea is to explore alternative solutions to increase exploration efficiency, which in the long run may enable the cluster to have unique competencies that can be later utilized in maturing fields on a global scale.

The third proposed growth opportunity is in offshore wind. With the introduction in 2005 and subsequent amendments of the European Union Emissions Trading Scheme (EU ETS) and national commitments, which entered into force in 2005 following the Kyoto Protocol, the value of clean energy sources has increased considerably. The number and size of wind-farms is rapidly growing across the world (see Thanet Wind Farm in the UK for example). National and multi-national programs like INNWIND in the Netherlands and upwind in the EU have been introduced in recent years. The cluster already has relevant products (e.g. loading, unloading and anchoring systems), which would need to be further developed into cost effective solutions for this evolving market. Currently, offshore projects in Europe are off the shores of Denmark, Norway, Germany, the UK, and Ireland. All are within a relatively short distance of NODE's firms. Other actors in Southern Norway, which are not members of NODE, such as Metallkraft, 3B Foberglass Norway and Eramet have ongoing wind energy related projects.

Summary

As Kjell O. Johannessen, browses through the description of NODE's set of projects proposals he wonders whether the clouds are getting grey. Maybe there is a storm coming. NODE's steering committee is due to discuss the project proposals during its next meeting. Will NODE manage to facilitate the essential adaptation process to secure its members' future growth? Is Kjell the right person to lead the adaptation process? Should the cluster go into the emerging offshore wind business? Are the projects groundbreaking enough on the one hand and competitively viable on the other?

Exhibit 1: The development of the oil industry



Source: Norwegian Petroleum Directorate (2011) The Resource Report 2011.

Exhibit 2a: Structural characteristics and economical performance of NODE members: Large firms

Thousand EURO	AKER MH AS					NATIONAL OILWELL VARCO NORWAY AS				
Exchange rate: 1 EURO = 8 NOK	**2009**	**2008**	**2007**	**2006**	**2005**	**2009**	**2008**	**2007**	**2006**	**2005**
Income Statement										
Sales	917 739	955 691	900 591	448 729	142 840	2 982 512	2 462 226	1 337 318	839 755	334 736
Cost of Goods Sold (COGS)	(661 140)	(772 338)	(746 337)	(350 346)	(82 716)	(2 000 872)	(1 587 791)	(927 051)	(597 734)	(218 050)
Gross Profit	256 599	183 353	154 253	98 383	60 124	981 640	874 435	410 267	242 021	116 686
Salary Costs	(115 765)	(93 933)	(75 414)	(54 058)	(36 652)	(236 430)	(253 955)	(148 144)	(109 205)	(85 449)
Other Expenses	(55 168)	(47 988)	(37 111)	(26 238)	(12 741)	(81 151)	(98 420)	(41 754)	(35 881)	(14 500)
Operating income before Depreciation (EBITDA)	85 665	41 432	41 729	18 087	10 731	664 058	522 061	220 369	96 935	16 737
Depreciation	(9 658)	(5 457)	(1 853)	(941)	(523)	(10 342)	(5 204)	(11 893)	(12 769)	(12 726)
Operating Income (EBIT)	76 008	35 975	39 876	17 147	10 208	653 716	516 857	208 477	84 166	4 012
Financial Income	14 679	9 129	7 064	2 301	2 552	58 678	33 681	43 171	11 587	759
Financial Expenses	(6 551)	(206)	(105)	(581)	(4 982)	(32 725)	(166 257)	(10 996)	(9 644)	(29 418)
Profit before Tax (PBT)	84 136	44 898	46 834	18 867	7 778	679 669	384 282	240 652	86 110	(24 647)
Income Taxes	(20 454)	(11 790)	(12 380)	(5 053)	(2 585)	(177 922)	(165 518)	(69 222)	(26 026)	(5 185)
Net Income	63 682	33 108	34 455	13 814	5 194	501 747	218 764	171 430	60 084	(19 462)
Balance Sheet										
Fixed Assets	145 638	58 018	49 756	279 244	111 121	140 104	181 558	156 607	878 335	286 832
Current Assets	600 383	536 590	417 671	17 985	17 015	3 062 425	2 473 597	1 547 141	161 498	172 521
Total Assets	746 021	594 607	467 427	297 229	128 136	3 202 529	2 655 155	1 703 748	1 039 832	459 354
Equity	146 096	93 327	58 406	33 951	20 138	888 226	335 239	293 754	118 638	56 049
Long-term Liabilities	94 382	35 270	24 618	12 896	39 043	407 098	334 980	244 020	197 588	181 718
Short-term Liabilities	505 543	466 010	384 403	250 383	68 955	1 907 205	1 984 936	1 165 974	723 606	221 587
Total Liabilities and Stockholders' Equity	746 021	594 607	467 427	297 229	128 136	3 202 529	2 655 155	1 703 748	1 039 832	459 354
General Information										
Firm age	24	23	22	21	20	38	37	36	35	34
No. of employees	1 059	784	694	541	350	1 994	1 809	1 395	1 084	850

* Unconsolidated accounts

Exhibit 2b: Structural characteristics and economical performance of NODE members: Medium-to-large size firms

Thousand EUR *Exchange rate: 1 EUR = 8 NOK*	AKER PUSNES AS		AS NYMO		MACGREGOR HYDRAMARINE AS		TTS ENERGY AS		NODE Total	
	2009	2005	2009	2005	2009	2005	2009	2005	2009	2005
Income Statement										
Sales	120 225	52 456	67 077	31 331	108 186	30 388	60 536	18 744	5 559 829	1 433 524
Cost of Goods Sold (COGS)	(81 770)	(36 485)	(35 949)	(15 068)	(85 810)	(21 406)	(40 660)	(13 088)	(3 159 026)	(599 598)
Gross Profit	38 455	15 971	31 128	16 262	22 377	8 982	19 876	5 656	2 400 803	833 926
Salary Costs	(17 351)	(8 573)	(19 230)	(10 049)	(165)	(5 486)	(21 532)	(2 780)	(967 561)	(474 528)
Other Expenses	(7 977)	(5 425)	(8 670)	(4 182)	(10 983)	(1 371)	(12 547)	(1 521)	(549 932)	(267 476)
Operating income before Depreciation (EBITDA)	13 127	1 974	3 228	2 031	11 229	2 125	(14 203)	1 355	883 310	91 922
Depreciation	(507)	(187)	(869)	(402)	(2 544)	(222)	(7 035)	(374)	(52 703)	(24 203)
Operating Income (EBIT)	12 621	1 787	2 358	1 630	8 685	1 903	(21 238)	981	830 607	67 719
Financial Income	522	390	1 175	319	2 016	418	6 737	157	221 320	30 200
Financial Expenses	(608)	(480)	(47)	(65)	(3 564)	(647)	(10 951)	(29)	(237 059)	(46 981)
Profit before Tax (PBT)	12 535	1 697	3 487	1 883	7 137	1 674	(25 452)	1 109	814 868	50 937
Income Taxes	(3 435)	(416)	(998)	(528)	(2 004)	(499)	7 123	(230)	(190 167)	(24 172)
Net Income	9 100	1 281	2 489	1 355	5 132	1 175	(18 329)	879	624 701	26 765
Balance Sheet										
Fixed Assets	6 260	21 910	5 343	18 580	9 163	13 407	45 252	14 566	1 837 105	1 074 063
Current Assets	40 891	1 577	33 243	3 632	120 013	1 602	31 564	2 330	4 892 992	454 411
Total Assets	47 151	23 487	38 586	22 212	129 176	15 010	76 816	16 896	6 730 097	1 528 475
Equity	13 990	11 580	21 041	10 845	15 094	1 501	(12 479)	9 663	2 590 952	506 738
Long-term Liabilities	4 869	6 979	4 583	2 073	42 384	2 761	1 864	146	738 333	379 569
Short-term Liabilities	28 292	4 928	12 963	9 294	71 698	10 747	87 431	7 087	3 400 811	642 168
Total Liabilities and Stockholders' Equity	47 151	23 487	38 586	22 212	129 176	15 010	76 816	16 896	6 730 097	1 528 475
General Information										
Firm age	20	16	20	16	19	15	9	5	12 (average)	8 (average)
No. of employees	169	125	320	250	272	83	188	19	6445	3202

* Unconsolidated accounts

Exhibit 3: Mechatronics

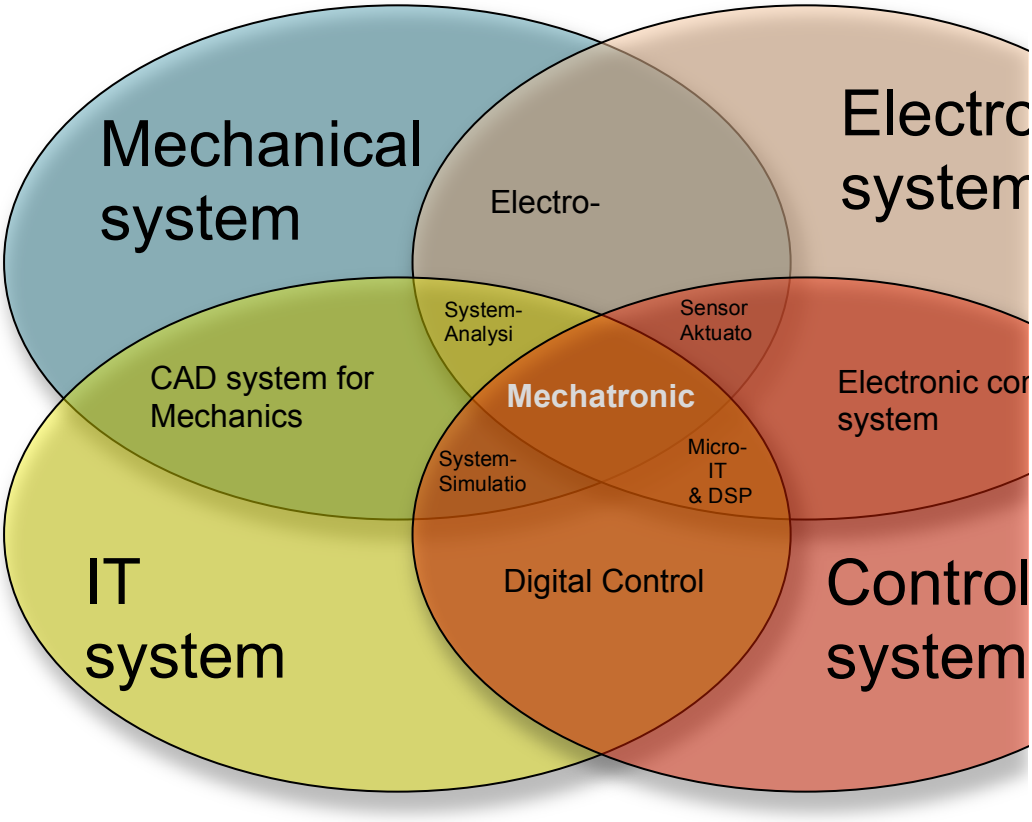


Exhibit 4: The location of NODE cluster members

Exhibit 5a: The distribution of employment

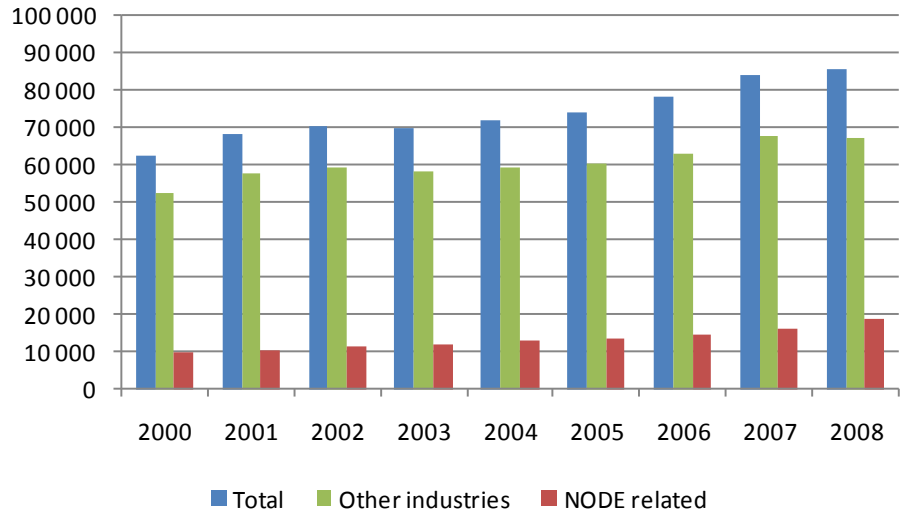


Exhibit 5b: The distribution of engineers

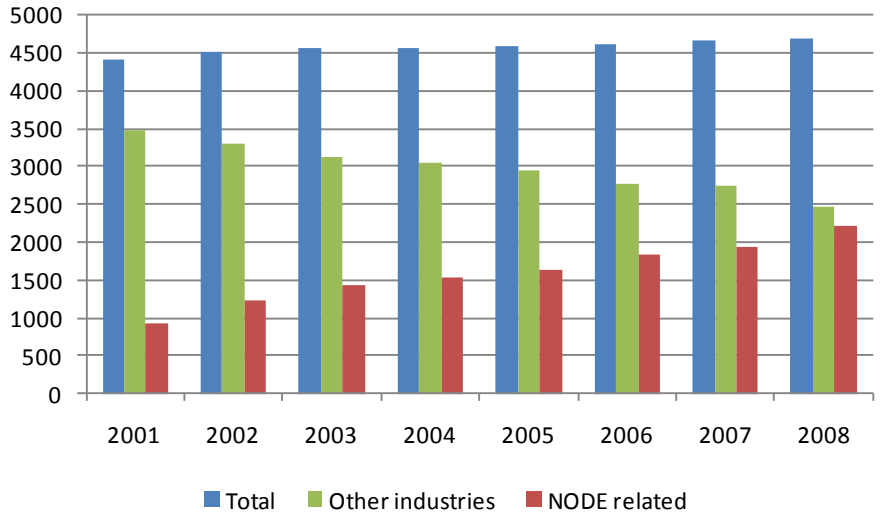


Exhibit 5c: The proportion of the workforce without university education

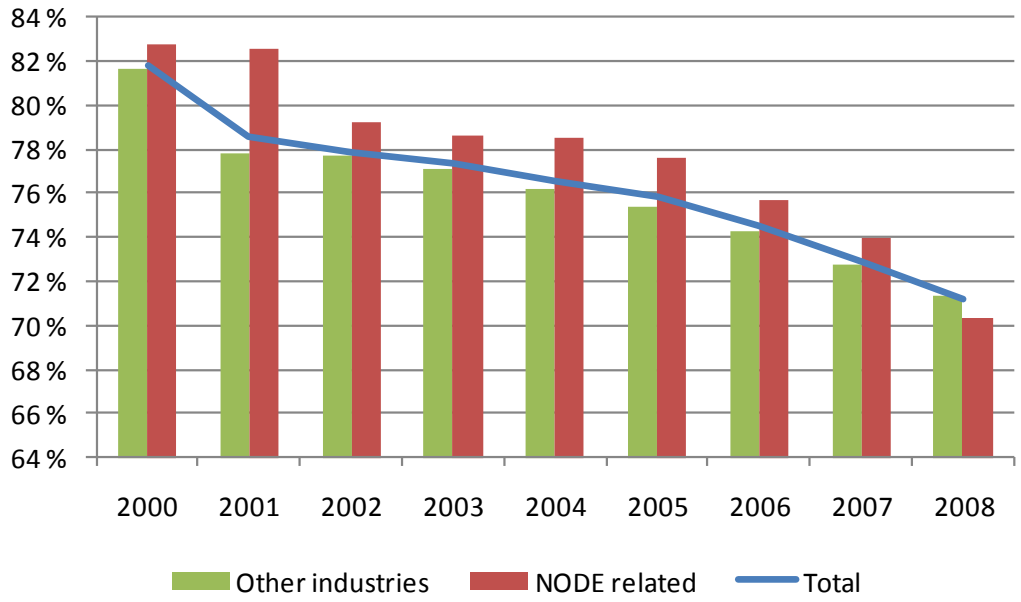
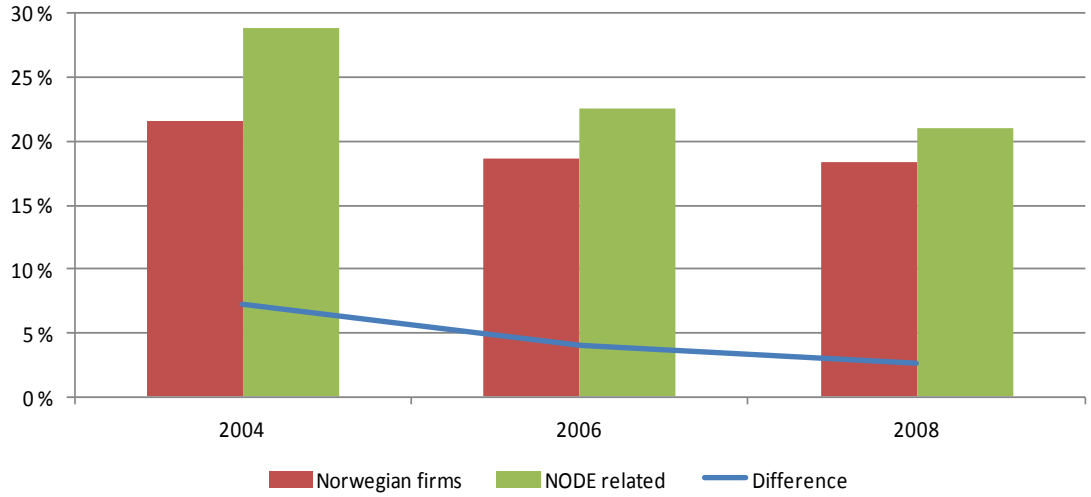


Exhibit 5d: The proportion of firms reporting product innovation in the preceding three years



[i] Norwegian Petroleum Directorate (2010)
[ii] http://www.geologi.no
[iii] Norwegian Petroleum Directorate (2011). The resource report 2011.
[iv] Statistics Norway (2011)
[v] AS is the Norwegian abbreviation for private limited liability company (Ltd)
[vi] http://www.fvn.no/mening/debatt/article897120.ece
[vii] ASA is the Norwegian abbreviation for public limited company (Plc)
[viii] www.akersolutions.com
[ix] www.ncenode.no
[x] www.ncenode.no
[xi] www.nce-se.no