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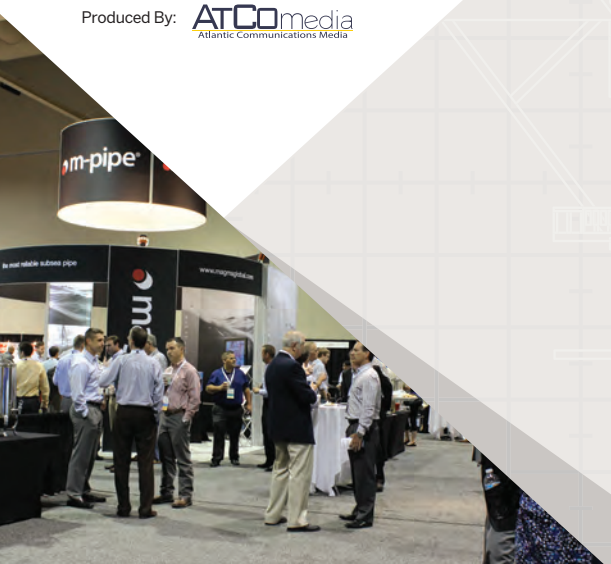


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# Stronger innovation in a challenging market

**Tove Ormevik,**

**Offshore installation manager, Skarv floating production, storage and offloading vessel, Aker BP**

**Chairman of the board GCE Subsea**

This year, GCE Subsea celebrated its 10th anniversary. From the start in 2006, to 2016, member count has grown steadily to 140. About 120 companies and organizations now form the GCE Subsea cluster. In addition, we have 23 collaborative agreements with various Norwegian and International research and design and academic institutions, clusters and network organizations.

In our first year with status as a Global Centre of Expertise (GCE), the market situation has continued to be challenging for our members within the oil and gas industry, due to low activity and investments. A survey among our members showed that a majority are looking in to new areas and markets.

To be able to achieve the goal of increasing the cluster dynamics and attractiveness, we have focused on building collaboration with neighboring value chains in order to supply the Norwegian subsea industry with new qualifications. This can increase the rate of innovation and competitiveness and open up opportunities in new markets for the use of Norwegian subsea expertise

Research has shown that companies in business clusters typically have higher value creation, productivity and growth than the industry in general. It is also easier to generate change, entrepreneurship and innovation within clusters, with the cluster management playing an important role as facilitator.

Through participation in typical cluster events, companies increase their networks and even find new market opportunities among other cluster members. Cluster initiated business acceleration programs help overly technology focused companies in improving their business orientation.

Benefits do not only arise within clusters; there is also much to be gained by more work across cluster boundaries in order to spark cross-industry innovation.

GCE Subsea has several joint projects with GCE NODE and GCE Blue Maritime, and all three are also part of the global MIT REAP program on regional entrepreneurial acceleration and scale-up. The GCE clusters also have many initiatives together with other ocean space clusters with the aim to position Norway as a world leader within ocean space innovation.

For the year to come, our main objectives will continue to focus on cost-efficiency, international markets, research and development collaboration and new related markets outside the oil and gas industry. ■

# Inside



World-class Subsea Solutions from Norway, is a supplement to *Offshore Engineer*, published by AtComedia.

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**Coast Centre Base – the centre of the activity.** Photo from CCB.

# Doing things differently

**While cost cutting has been a top priority for many, if not all, in the industry, GCE Subsea members are also look to do things differently – to change the game. Elaine Maslin reports.**

A challenge was made on the Norwegian Continental Shelf. After years of cost inflation in the subsea business, increasing engineering hours, bespoke design, there was a call for change, standardization and rationalization. And then the oil price crashed and the situation was amplified.

In this new lower oil-price order, companies have been rising to the challenge and the result could see a re-shaping of the industry, across different segments. Those challenging the established norms include GCE Subsea member companies, which are looking to change how things are done.

Coast Centre Base (CCB), which has played a strong part in creating the coastal support facilities that enable others to operate, as well as project managing rig maintenance work, is now positioning itself as a supplement to the established, original equipment manufacturer-led subsea equipment maintenance market, offering an alternative lean and more efficient service.

The product itself also has to change, says Kristian Karlsen, founder and managing director at Fjell Subsea Products. For too many years, product was being designed almost to be too complicated and geared to drive follow-on or spare parts sales, he says. While the oil prices were high, oil companies went along with it, sticking to habits and what they know. Fjell is looking offering a simpler modular approach.

"Thirty years ago, Snorre held more spares on land than it hard parts in the sea. Suppliers just wanted to sell parts. We're thinking totally differently," Karlsen says.

## CCB

CCB already has a large footprint. It is looking to grow its role, however, and will be another challenger to the OEMs (original equipment manufacturers). It is already one of the two top rig recertification companies in Norway, a task that is project managed, drawing on the CCB cluster resources. Now it wants to do the same in the subsea business, becoming an aftermarket third party player.

Earlier this year, it bought a majority stake in Logiteam, which has a track record managing and maintaining subsea systems, and created a new business unit (CCB Subsea). As part of the move, CCB Agotnes, home to the likes of Aker Solutions and FMC Technologies, is becoming CCB's subsea center of excellence. Just as the firm heads up rig re-certification projects, drawing on and managing local resources, often actually on its own coast bases, it wants to do the same for subsea equipment maintenance as the OEMs. This will be overseen by its in-house expertise in the likes of engineering, standards for documentation, technical procedures, etc.

CCB Subsea has already won a contract with Statoil, for maintenance of subsea equipment and tools. This covers demobilization, maintenance and overhauling of subsea equipment under a two-year contract with two, three-year extension options. While Agotnes is the base, it

will draw on CCB's and NorSea Group's bases up and down the Norwegian coast. Furthermore, the company is rolling out the model globally and taking in inspection, maintenance and repair work.

Driving forces for the move include Statoil wanting more competition in the market, but there is also an opportunity to do things differently, says Arne Aarvik Sales & Marketing Manager at CCB.

This means having one point of contact, which manages the various interfaces involved in maintaining a fleet of subsea equipment, instead of each OEM having an interface with the operator. CCB Subsea can be a leaner organization, with core in-house expertise, but leaning on the cluster. It also wants to look differently at periodic maintenance. Instead it's looking at risk-based maintenance, reducing costs for the operator, which will become more and more important as the installed base of subsea equipment requiring maintenance increases.

Recent adjustments to recertification of well control equipment barrier systems guidelines provides and opening to do this and make such services less costly, says Nils Fr. Fjærvik, CEO of CCB Subsea and previously CEO of Logiteam.

"At the moment, the cake is smaller than 2-3 years ago and there are more wanting a slice of it, OEMs and third party suppliers," he says. "But, with this model, we have an opener in terms of low cost. When volume picks up, it will be very attractive. We will have scalability. If OEMs still have ambition in the aftermarket they will have to adjust to a new cost level. This is a shift in how the market operates. The oil companies agree, it [the current market] is not a sound market."

CCB is also looking to the future, including decommissioning, i.e. plugging and abandonment. "There's no turn key supplier for this range of services for subsea decommissioning," says Fjærvik. "But, after you plug the well, there is a lot of activity and you need equipment to do this and what will you do with that equipment once you get it ashore? We are looking at that and talking with specialist providers to put together turnkey solution."

### Fjell

Fjell Subsea is a new entrant to the subsea equipment market. The firm wants to offer modularized subsea equipment, which can be more easily produced and assembled from a set of standard components, reducing engineering hours, procurement time (the parts can be ready in stock), and costs.

The firm was founded in 2012, by Karlsen. To date, it has been developing its products, with the next step being commercialization. While it's still a small company, it has big ideas led by its modular philosophy.

Late last year, the firm got NOK5.2 million in public funding as part of a NOK30 million project it is working on sponsored by Shell, to qualify a "unified and modularized flying lead system.

"Many cakes can be baked from a few ingredients," as Karlsen puts it, allowing a small company to do bigger things. "Today, the industry is talking about modularization, standardization of products. We started in late 2011, and founded the company in 2012 to do this," Karlsen says.

The firm is developing a suite of subsea components, including couplers, hydraulic fluid, or chemical line connectors, ball valves and multi-quick connector (MCQ) plates, all built in a modular way. Fjell's MQC plate can take up to 52 connectors. Or Fjell can supply just one, using the same components, for example. Similarly, its connectors are designed to take different seals, so that the same components can be used even if a different seal is required, instead of having to have different design connectors.

The coupler systems and MQC plates are ready and now the firm is working on high-pressure ball valves, initially from ½in and ⅜in and then up to 6in for gas lift and injection valves.

Fjell is also starting a qualification program for flying leads, as well as the NOK30 million program to qualify a modularized flying lead system, with funding from Innovation Norway's IFU program and Skattefunn and help from Innovation Norway and GCE Subsea, which helped with the applications. The firm will also look to deliver ROV panels and larger structures in the future.

But it's not just about the design, for functionality, it's also about how product is designed for efficient manufacturing. "We are going to the machining center, seeing how we can design this to get it faster through the machine with best finish and quality," says Karlsen. "We are going through every step to make this as optimized as possible."

While activity is low right now, with the entire industry holding its breath for new orders, this year is looking hopeful, says Karlsen, who is eying a global market, from Brazil and Australia to Asia and the North Sea.

Fjell recently participated in a market entry program for Brazil. This program was a huge success leading to a partnership with the well-known and recognized Brazilian umbilical supplier MFX. MFX will work in partnership with FSP during the qualification program. ▪

## History

CCB was founded nearly 45 years ago. It is owned 50-50 by Bernhard Larsen Holding and NorSea Group and has been providing services for the offshore industry since the 1970s.

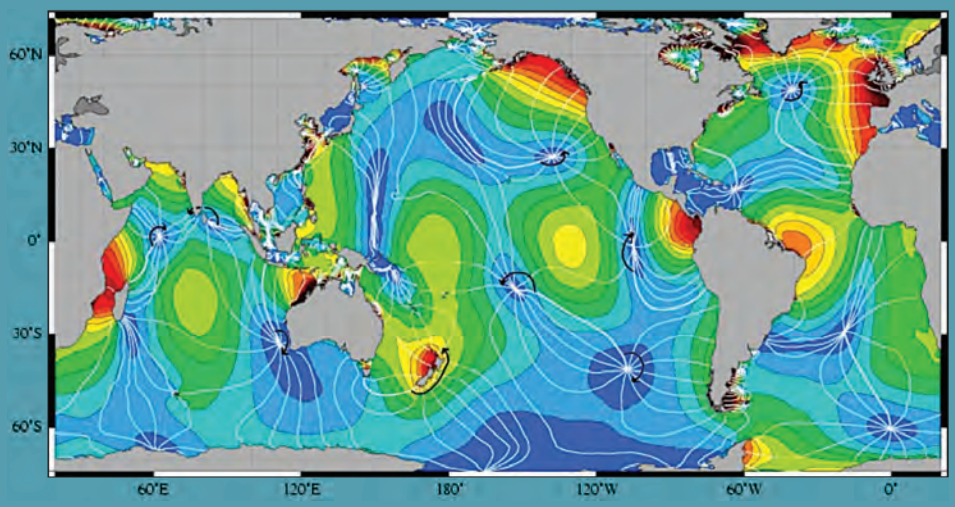
The firm has a string of sites along the coast of Norway, including Mongstad and Agotnes. At Agotnes, CCB covers 90ha, with more than 1000m of quays, 68,600sq m of workshops and warehouses and 20,600sq m of office buildings.

CCB together with NorSea Group is also involved in real estate development, with 13 sites along the coast of Norway and expansion ongoing into Denmark, the Netherlands, Scotland and Las Palmas on the Canary Islands.


**A new player: CCB Subsea.** Photo from CCB.

# Green credentials

**Norway already has strong green credentials, with 98% of its electricity coming from renewable energy sources, primarily hydropower. Elaine Maslin looks at initiatives to harness the power of the ocean and to help reduce offshore wind costs.**




**Sites where NeoTurbine has potential.** Images from NeoTurbine.

Bulgarian-born Norwegian Nikolay Hroulev hopes to add to the mix with a scalable tidal energy convertor.

The Oslo-based engineer has a varied career on which to draw, having worked in South Africa, Canada, Sweden and Norway, in the mining, food and structural steel industries – always as a design engineer. He's designed industrial conveyors, dehumidifiers, and special weighing machines. For the last 10 years, he has worked in Norway's subsea industry.

It's an environment in which he has pursued an idea he had while at university studying automotive engineering: a turbine-type engine powered by water. Now, those ideas are being put into action. In 2002, he came up with the NeoTurbine concept, working on it in his spare time.

In 2014, he presented the concept to Connect Norge and Innovation Norway. Last year, Hroulev formerly set up NeoTurbine and, with the help of some funding from Innovation Norway and backing from Global Maritime Group, Hroulev was able to build a 75cm-diameter scale prototype, and put it through testing at the Stadt Towing Tank laboratory in Måløy, western Norway. The tests were successful, Hroulev says, with 25% efficiency achieved, and now NeoTurbine is working with Sogn Industri, which is preparing a tidal test site west of Norway, at which a full scale, 2m diameter NeoTurbine could be tested, to be followed by 5m and 10m diameter versions.

"The challenges with tidal and ocean current are extreme conditions, high water velocity, environmental impact on marine life, corrosion, installation, and accessibility," Hroulev says. "Our solution is a vertical axis turbine, which is the most efficient and environmentally neutral turbine technology. It has low manufacturing and running costs and can be used in deep and shallow water. It is durable, efficient and scalable."


**The NeoTurbine concept.**

The idea is based on a Darrieus type turbine, a type of vertical axis turbine which curved aerofoil blades. This will be mounted inside a structure, which makes sure the water continues through the bi-directional turbine, instead of just being dissipated by the blades, unless it's mounted underneath a floating structure, in which case it would be open.

The blades, mounted vertically as two sets of four blades in each system, will generate power through a gear box to a permanent magnet generator, even in very slow water speed, Hroulev says. "NeoTurbine can perform in very lower water current, up to 2m/sec," he says. The system will generate power from as low as 0.1m/sec, compared to others which do not start until 2-4m/sec, and up to 15m/sec, which is above any current found naturally, he says.

Hroulev says full scale turbines will be 2m (40kw rating), 5m, and 10m (1MW) in diameter, with the different sizes being used according to the site or application.

"The good thing with my turbines is that they can be installed next to each other and on top of each other, like Lego bricks," he says, using concrete gravity-based foundations. "So, you can create a kind of tidal fence across a fjord, for example. You cannot do this with others." In such a scenario, fewer generators per turbine would be required as they could be connected, he says. If mounted beneath a floating, anchored facility, the generator would be onboard the floating structure.

So far a number of companies have been supporting him, including Global Maritime Group, Nordikraft, Havkraft and HydroWave, as well as organizations including Connect Norge, Innovation Norway, and GCE Subsea.

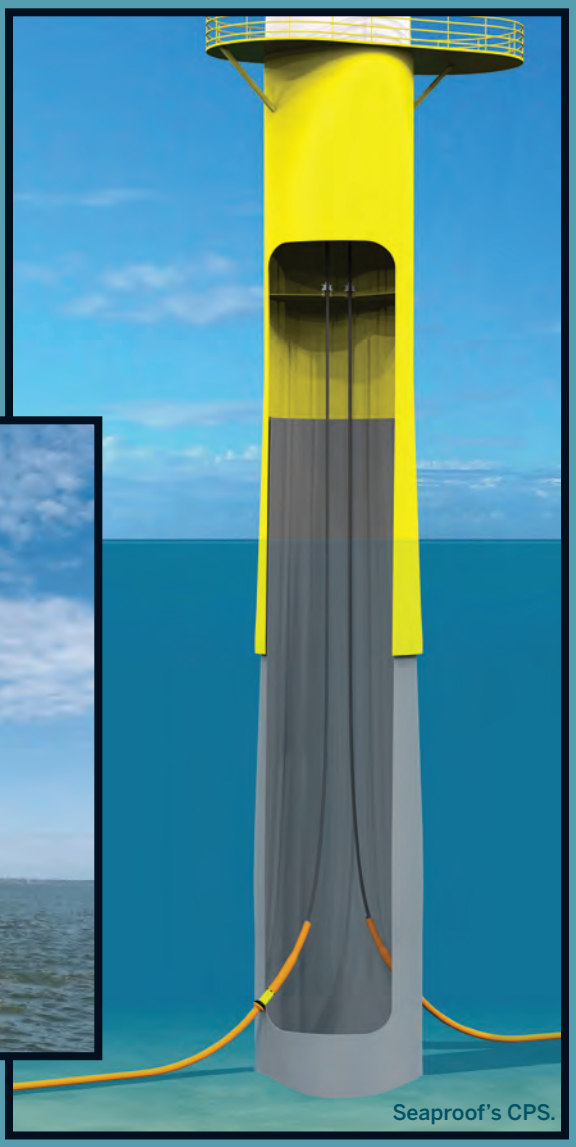
He's also been working with universities, including the Norwegian University of Life Sciences, and the University of Bergen, which have produced market analysis and engineering comparison studies.

The next step is securing funding for a prototype to be tested at sea. He needs about US$240,000, which he would be able to get matched by government funding. ▪

# Cable protection

**Using expertise developed for the oil and gas industry, Seaproof Solutions has carved out a market in offshore wind.**

**Seaproof's J-tube interface.**
Images from Seaproof Solutions.



Seaproof's CPS.

In a short period of time, Seaproof Solutions has gone from having zero market share in cable protection systems (CPS) for the offshore wind industry to a 20% market share and growing.

Over the past three years, it has sold some 700 of its systems and, while they've proved a hit, the company is hard at work making systems that are even easier, faster and safer to install.

It's a critical area for the offshore wind industry. While offshore power cable installation isn't the highest cost segment of wind farm installation costs, it has been one of the more troublesome areas, due to cable damage.

Seaproof, based outside of Bergen, used its 25 years of expertise in polyurethane composite engineering to design a solution for seismic cables as well as applications in the defense and research sectors.

It is a modular system created from sections of hard, fiber reinforced polyurethane tubes, a monopile interface unit, a ventilated section where the cable in the tube is out of the water, with pull-in head, and hang off connector interfaces. These can be pre-installed offshore, ahead of cable pull-in, or installed as part of the cable pull in – with both methods protecting and reducing stress on the power cable.

The system has been designed without need of ROV intervention or a diver, and has been deployed with installation times of just 30 min achieved on some projects.

"This type of application didn't exist in oil and gas, so something new had to be designed," says David Vallee, technical sales and key account manager, Seaproof.

The CPS addresses concerns around stress points, where cables enter and hang off offshore wind turbine structures. In many, there's a pre-made 34cm-diameter hole in the foundation, about 2.5m from the seabed, into which the cable is pulled through. It then hangs from this hole, creating a free span out to the burial point, which means there are significant stress points, during and after the pull-in.

Seaproof's fiber reinforced polymer tubes have monopile interface units that allow the cable end to be pulled in through the hole, using a messenger wire, and up into the turbine, without the cable being exposed, put under stress or strain.

The system, which is flexible and strong, is pre-installed on the cable, either on the quayside or on deck, surrounding a section of the pull-in end of the cable. It is then pulled up into the turbine hole. Once the monopile interface section reaches the hole, it locks in place under tension, then releases the cable to run free up into the turbine to its termination point.

The system comes in 4m-long sections, which are connected to create what are usually 20-25m-long systems, but can be up to 60m, says Vallee.

One of the benefits of using fiber is the ability to create end connections that can work with steel work, something which has been difficult for other technologies, says Vallee. Seaproof has a patented system to allow this, which is also used to connect the 4m sections. Small steel flanges connect the sections with fiber running between each flange, which creates a rib-stop net preventing breaks and effectively stops cracks in the polymer.

But, Seaproof is not resting on its laurels. The push to reduce costs in offshore wind is as hard, if not harder, than in the current oil and gas market. Some cost reduction can be made by making operations simpler and by doing them onshore, before offshore work starts.

Seaproof has designed a new, diver and ROV-less system, which is a little like a J-Tube. The pre-installed CPS, into which the cable is pulled-in through a wide opening at the bottom.

But, now that Seaproof has developed these systems for renewables, the firm is looking at introducing similar technologies into the oil and gas industry, although not in exactly the same form. ▪

# WORLD-CLASS SUBSEA SOLUTIONS FROM NORWAY

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GCE Subsea is an industry driven initiative for strengthening and internationalisation of businesses, research and education. We represent the world's most complete cluster for subsea life -of-field solutions. Our goal is to increase the cluster's competitiveness and global market share, and take a leading position in sustainable utilisation of ocean resources.

In order to achieve these goals we focus on:

- Develop competence and attract talents and investors
- Develop subsea solutions beyond oil and gas
- Stimulate technology development
- Create new entrepreneurs and grow businesses
- Succeed in the global market
- Improve work and production processes

About 120 companies and organisations form the GCE Subsea cluster today.

GCE Subsea is supported by: Innovation Norway, the Industrial Development Corporation of Norway and the Research Council of Norway.



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# Digitizing riser inspection

**The AMOS concept.** Photo from 4Subsea.

**Elaine Maslin reports on how technologies we've come to take for granted in the connected onshore world are making their impact offshore, reducing man hours and increasing insight.**

In most public spaces, there is a very clever piece of kit. It's a wall-mounted defibrillator, which anyone can use by following simple instructions. These machines have made what is otherwise the work of a highly skilled medical professional easy to do.

Now imagine that system can issue an immediate report on the current heath of the patient, comes with an iPad on which time series data (aka trending) can be seen and a chat function through which the user can discuss (via a "chat" system, Skype or even phone) the results with an expert – who also has access to the same data – based somewhere else in the world.

Sounds good? Norway's 4Subsea, founded in 2007, has developed such a system allows operators to learn about the health of their flexible risers. The rapidly growing firm, which started life as a consultancy, has been providing automated riser monitoring services since 2013. This year, it has taken the technology to another level.

Peter Erik Jenkins is the firm's CEO and one of its founders. While initially more of a consultancy, 4Subsea invested in its own in-house software systems, supported by Microsoft, to manage the data it handled. This has evolved into systems – such as AMOS (annulus monitoring system) – that provide the hardware and software to offer health monitoring services for risers. These systems can alert the operator if there is any change in the riser, such as water, oil or gas ingress, so it can be resolved quickly and avoid any potential damage it might cause.

**Peter Erik Jenkins**

AMOS, launched in 2013, helped to take riser integrity assessment from a manual periodic test to a permanently installed, continuous monitoring system (typically retrofitted). 4Subsea is one of a few vendors offering such a system. Now, the firm has launched PAT, a portable riser annulus testing kit ("a very small AMOS," Jenkins says), for sites where permanent systems are not installed. The PAT can be used by offshore staff, a little like the defibrillators, reducing bed space and strain on logistics. The staff can have a hand-held device where the results can be displayed on screen and make use of a chat function to talk to 4Subsea (they can also phone or use Skype). The system saw its first offshore deployment in September last year [2016].

4Subsea currently does about 250 tests a year offshore, involving sending two staff out, which can now be eliminated, by just sending the PAT machine out, saving 30-50% costs, Jenkins says. The operator subscribes to 4Subsea's service and rents the PAT. "They do the test and get immediate results and trending data. The data also comes back to us and they then get a 4Subesa report," says Jenkins, who previously worked at DSND Subsea and Kongsberg SeaFlex. "The process is also a lot quicker (than sending the

**An AMOS kit.**

team out)." And it's the only such system on the market.

All the data can also be used across the operator's suite of risers to help monitor across assets – and can be seen, from fleet wide to individual riser detail, through a web portal (FlexTrack) from 4Subsea.

But, the firm recognizes that being a specialist in this field isn't just about offering a service. The firm has also been heavily involved in research projects to better understand fatigue and aging mechanisms in flexible risers. This information can then feed into the monitoring service, along with actual data from monitored risers, helping to constantly improve the results in order to predict failures before they happen – or start to happen.

"The key is digitalizing the services, developing automated test equipment to monitor risers and providing the software to monitor the integrity of these assets," Jenkins says. "We've built this based on operational experience we have from managing assets for operators, but also our knowledge and experience from the research that we do."

One of the research programs the firm is involved in is Flexible Pipe Annulus Corrosion Monitoring with the Research Council of Norway Petromaks 2 program. This two-year project aims to improve the assessment of structural integrity and to close technology gaps on the understanding of corrosion mechanisms within flexible pipes, with the aid of laboratory testing at the Institute for Energy Technology (IFE) and with support from Shell, BP, ExxonMobil and Statoil.

"We're looking to understand how corrosion mechanisms work in flexible risers," Jenkins says. "It is a challenge if you have a damaged riser. Many risers, if they have water ingress and are treated correctly, can live happily ever after. In some instances, which are fairly rare, but do happen, the same riser type, with the same damage, corrodes very suddenly. We are working on understanding how this happens and what the drivers are. The ultimate goal is knowing what we are looking for, to use in monitoring systems."

Today, the firm is looking after about 300 risers on the Norwegian and UK continental shelves. The goal is to increase that number rapidly, Jenkins says, without being drawn on a more specific time frame. Our goal is to cover about 30% of the global market. He adds: "We think that's pretty realistic with a digital service."

"From our perspective it is about reducing cost," Jenkins says. "The industry has gone from being focused on finding new resources to focusing on being more effective with the resources they have." ▪

**GCE Subsea members are at the center of Norway's subsea industry.** Images from GCE Subsea.

# A world-class subsea cluster

**More than 100 companies and organizations form GCE Subsea: a cluster, representing a near complete cross-section of the subsea life of field supply chain. When coupled with the innovation ecosystem in the region of southwest Norway, it becomes even stronger.**

The GCE (Global Centre of Expertise) status is the highest level in the Norwegian Innovation Clusters program (see fact 1). The cluster members and partners in GCE Subsea, comprise a near complete subsea life-of-field supply chain. Approximately half of the members are system and equipment suppliers, including the three leading subsea engineering, procurement and construction (EPC) contractors: Aker Solutions, FMC Technologies and OneSubsea.

The second largest segment is inspection, maintenance and repair (IMR), technical services and yard services, which account for approximately 20% of the members. Support services is also a significant segment, and includes non-technical support services such as financial and legal services, transport and logistics services, insurance and other consultancies.

Size-wise, GCE Subsea has the full range; from the large multinationals with thousands of employees, to one-man-bands.

## Capital

Among their sponsors (Innovation Norway and the Research Council of Norway, and some of

## Clusters program

The Norwegian Innovation Clusters is a federally funded three level cluster program (Arena, NCE and GCE) that contribute to value creation through sustainable innovation. Each program extends over 10 years.

The program aims to trigger and enhance collaborative development activities in clusters. The goal is to increase the cluster dynamics and attractiveness, the individual company's innovativeness and competitiveness. The program is organized by Innovation Norway, and supported by Siva (The Industrial Development Corporation of Norway) and the Norwegian Research Council.

their members and associates), GCE Subsea has actors providing pre-seed and seed funding, pre-project and project funding, business start-up grants and risk loans. Although they do not have equity and venture capital actors as members, they make a point of keeping up to date with this sector as well, to be able to advise their members on which funding is best suited for the different stages in the life of a company.

### International Efforts

The export of Norwegian subsea technology has grown considerably, and with it the cluster members' international ambitions and engagement. Small- and medium-sized enterprises often have limited resources, and it is important to learn from each other, and customers, to succeed in new markets. Bigger companies are eager to get Norwegian sub-suppliers to join them internationally.

GCE Subsea works closely with its members and help them join forces towards international markets and have increased the collaboration with related ocean industries to help their members expand into new subsea related markets.

One part of its plan has been to hire an EU (European Union) Advisor in collaboration with the NCE Seafood Innovation Cluster. The EU Advisor will especially contribute in strengthening research, development and innovation (RDI) cooperation in the ocean industries on themes where the subsea and seafood clusters are world leading and complement each other.

Their main goal is to mobilize to increased participation in international RDI projects, which will strengthen the knowledge base and competitiveness of the cluster companies. The EU research and innovation programs are key instruments in achieving this.

### Exhibitions and Conferences

To form new ties with international business partners and RDI environments, GCE Subsea is actively present at several international conferences and exhibitions every year. As in 2016, this year it is organizing a joint Norwegian delegation, called Norway2OTC, for OTC Houston 2017. Furthermore, it is an organizing partner of the Underwater Technology Conference in Bergen, in June.

### Cluster-to-Cluster Collaboration

Benefits do not only arise within clusters; there is also much to be gained by more work across cluster boundaries in order to spark cross-industry innovation. The Houston-based Pumps & Pipes initiative is a good example of this, where medicine, oil and gas and space industries innovate together.

In Norway, GCE Subsea has several joint projects with GCE NODE and GCE Blue Maritime. They are all a part of the global MIT REAP program on regional entrepreneurial acceleration and scale-up. Furthermore, they collaborate on a project regarding the fourth industrial revolution, commonly labelled Industrie 4.0. They, also have several initiatives with other ocean space clusters.

### Why Cluster?

Research has shown that companies in business clusters typically have higher value creation, productivity and growth than the industry in general. It is also easier to generate change, entrepreneurship and innovation within clusters, with the cluster management playing an important role as facilitator.

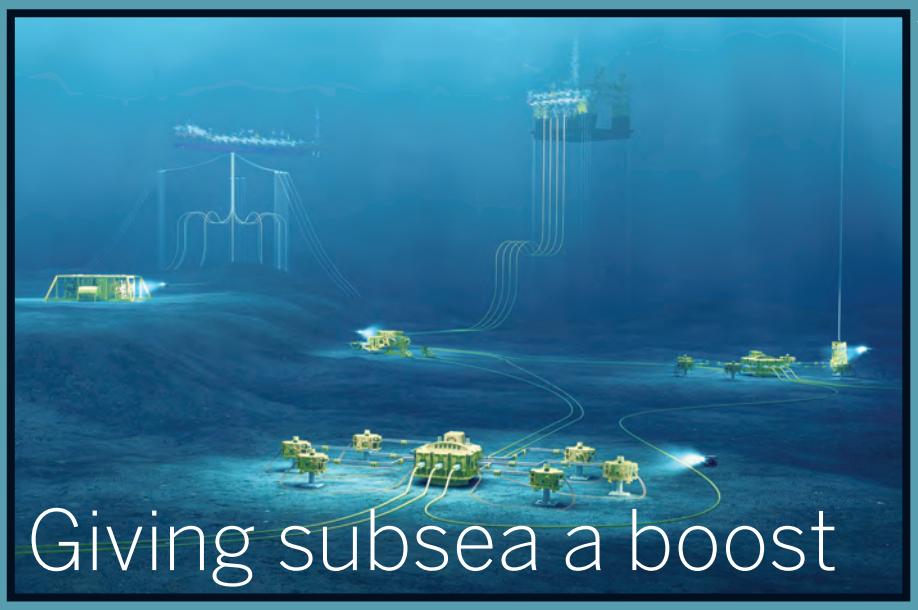
Through participation in typical cluster events, companies increase their networks and even find new market opportunities among other cluster members. Cluster initiated business acceleration programs help overly technology focused companies in improving their business orientation. Cluster theory and experience have shown that it is very important to stimulate increased collaboration within the innovation ecosystem between industry, government, finance, academia and research and development (R&D) institutions. GCE Subsea have therefore enrolled many of the major universities, university colleges and R&D institutes, along with county and municipal authorities. ▪

## GCE Subsea Services and Benefits

GCE Subsea strengthens innovation and knowledge collaboration in the subsea cluster. Increased innovation and internationalization is the main goal. All our activities and services will target six focus areas, where we aim to:

- Develop competence and attract talents and investors
- Develop subsea solutions beyond oil and gas
- Stimulate technology development
- Create new entrepreneurs and grow business
- Succeed in the global market
- Improve work and production processes

Go to **www.gcesubsea.no** to read more about membership.



**Subsea infrastructure.** Illustration from DNV GL.

# Giving subsea a boost

**A bid to reduce costs to increase subsea processing deployments is bearing its first fruit. Elaine Maslin reports on the first phase of a subsea processing joint industry project.**

Subsea processing holds considerable promise for the offshore oil and gas industry. But, high cost levels and bespoke system design leading to relatively few deployments (there are only about 17 subsea boosting systems operating globally) has meant the industry is stuck in a bit of a chicken and egg situation: with more deployments, costs could come down, but until costs come down, deployments will be limited.

Cost inflation across the industry, up to 2013, hasn't helped. Subsea-costs on the Norwegian Continental Shelf tripled in that period, according to calculations made by Norway's OG21, a situation replicated elsewhere around the world.

Last year, building on several recently completed joint industry projects, targeting the standardization of forgings, documentation, and subsea electrical power, Norway's DNV GL launched a subsea processing joint industry project (JIP), with the first target being standardization of subsea pumping. The first phase of the project, which had operators Woodside, Petrobras, Shell, and Statoil on board, alongside technology firms OneSubsea (part of Schlumberger) and FMC Technologies (now merging with Technip), completed in December. Phase 2 is set to start imminently and future phases could tackle other areas, including subsea compression, separation and injection.

"There's considerable potential for subsea processing," says Kristin Nergaard Berg, Principal Engineer on the JIP, with DNV GL. "It's a technology the oil and gas industry needs, but the cost level, maybe combined with there being some decision makers who think it's still fairly new, makes it challenging to get projects sanctioned.

**Kristin Nergaard Berg**

"There are other options than subsea pumping and if they're seen to be cheaper and with more experience, the decision could be to go for the more conservative solution. It is a chicken and egg situation. If the cost would go down I think the volume would go up. But that's what we're trying to attack in this project," she says.

Finding out where exactly costs could be saved isn't easy. "It's very complex because the cost is added through the different parts of the supply chain," Berg adds.

A mapping exercise looking at costs throughout representative pumping systems and found that there wasn't one particular area that stood out as a cost driver. "One way of interpreting that is that the cost is spread out and that could be due to the fact that we have different standards and requirements and systems, custom made from project to project," Berg says.

In addition to looking at areas that impact cost, the JIP is also looking to capture industry practice, through input and review from suppliers and operators, find alignment on key areas and reference standards and limit operator specific requirements (a task akin to taming a mythical sea monster).

Early December, after going through many iterations, the first phase of the project delivered a functional description, and defined classes, for subsea pumping, as a platform for working toward standardization in phase two.

"Of course there are different opinions, priorities and outlooks, different business cases and different levels of experience, but I feel we have had very positive contribution, including from the suppliers that have really broadened and supplemented the team," Berg says. "There's always a trade off when working with standardization. Of course each field is different and we cannot change that. So we have to tried to focus on what can been common from field to field and left space for optimization."

As an example, module classes, welding, engineering philosophies, and documentation, have potential for commonality, and so could be standardized and save cost and time. These are some of the areas that will be focused on in the second phase of the project, as standards, functional requirements and specifications become more defined. Other areas include control systems and instrumentation, power systems, materials and qualification, work processes and test requirements.

Standard pump system data sheets, as well as standard documentation and where pump module, structures and pressure containing equipment size and interfaces could be standardized will also be looked at. "We're not likely to standardize 100%, but we want to align on key principles to allow for as much repetition as possible," Berg says.

It's also important that the project leverages rather than duplicates existing work, such as the Subsea Electrical Power Standardization project, DNV GL's Forging Material recommended practice (RP), the DNV GL Subsea Documentation RP and API's 17X Subsea Pumps RP, Berg says.

"There's also some work to be done on system design. We plan to look at standardizing minimum upfront tie-in solutions," she says, i.e. future proofing. It's also making sure that brownfield applications are covered, as subsea pumping could have an important role to play in enhanced oil recovery schemes, as well as greenfield projects.

It's a complex project, but progress is being made, Berg says. "At last we're getting away from talking about whose fault it was that costs became so high, to finding solutions instead." ▪

**Kystdesign's Ægir 6000 ROV.** Photo from Centre for Geobiology, University of Bergen.

# The Midas touch

**Scientific research in deep Arctic waters is helping to discovery more about new species as well as the potential for mineral mining.**

A potential area of growth for the global offshore industries could be the emerging deep sea mining market.

It's an area already under sharp focus at the University of Bergen, one of GCE Subsea's partners. The university's Centre for Geobiology (CGB) is exploring active geothermal springs on the Arctic Mid-Ocean Ridge, in order to both find new animal species and examine how mining operations on the seabed could impact the environment.

**Rolf Birger Pedersen**

The center is using a new sonar technique called synthetic aperture sonar (SAS), which provides images with more than one hundred times the resolution attained previously. Using this technique, researchers from CGB survey collect samples from recently discovered volcanic deep sea areas around the island of Jan Mayen, a volcanic island in the Norwegian Arctic Ocean.

In these icy waters, 600km northeast of Iceland, and at depths ranging from 150-2500m below sea level, CGB has identified active geothermal vents. The researchers are now mapping the unknown animal life and potential mineral deposits found near these vents.

"This [work] provides important new knowledge about volcanic and hydrothermal activity. It has also given us new information about the presence of metal deposits in the seabed," says Prof. Rolf Birger Pedersen from CGB.

## Life in extreme conditions

The researchers use the University of Bergen's Ægir 6000, a 6000m-rated remotely operated vehicle (ROV) – named for the Norse god of the sea and built by Norway's Kystdesign in 2015 – on their expeditions aboard the *G.O. Sars* marine research vessel.

To date, the researchers have collected geological and biological samples from the seamounts (up to 3000m-high submarine mountains) along the Mohns Ridge, some 80km north-east of the Jan Mayen islands, as well as the Kolbeinsey Ridge and the Loki's Castle vent fields.

The samples include unusual animals, including microorganisms that can survive in extreme temperatures. These microorganisms may provide insights into the first life on earth, Pedersen says.

"We have discovered more than 50 new species in these areas since the center commenced operations in 2007," Pedersen says. "We are talking about newly-formed geological landscapes and unique ecosystems. The data and samples we collect provide important, unique information about deep sea biology and geology."

## Going for gold

The researchers are also interested in identifying metal deposits. Large amounts of minerals and metals such as iron, copper and zinc, as well as gold and silver in some instances, are deposited around the geothermal springs.

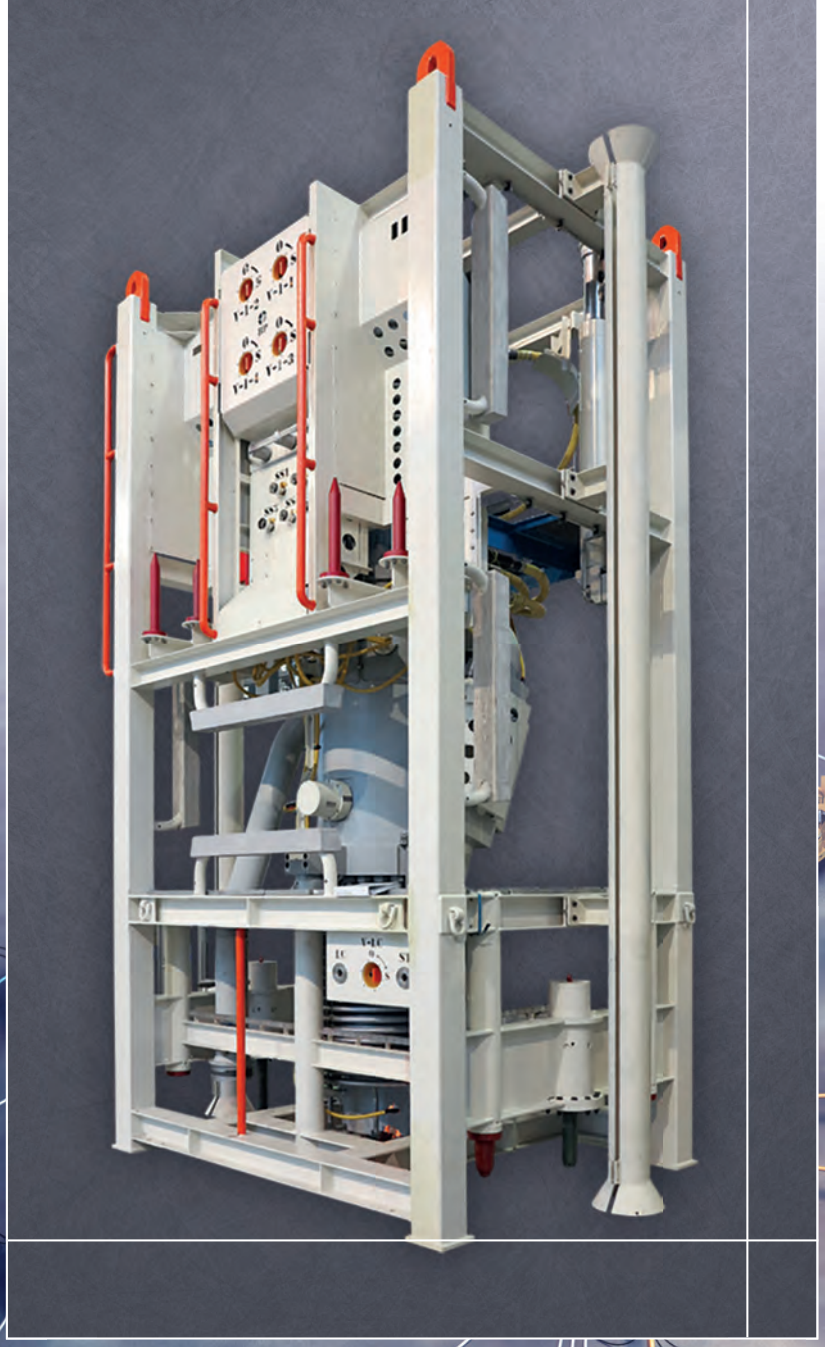
"The geological experiments are part of the EU-financed project Midas (Managing the Impact of Deep Sea Resource Exploitation)," Pedersen says. Midas is a multidisciplinary research program investigating the environmental impacts of extracting mineral and energy resources from the deep sea environment. This includes the exploitation of materials such as polymetallic sulfides, manganese nodules, cobalt-rich ferromanganese crusts, methane hydrates and the potential mining of rare earth elements.

"The goal is to gain an understanding of the possible environmental impact of mining operations in the deep seas," Pedersen says. "Norway has enormous deepwater areas with large amounts of resources. Even though we are, first and foremost, conducting basic research, this research may result in commercial operations in the long-term."

The CGB researchers will use special incubators to attempt to cultivate microorganisms on and below the seabed in their natural environment. "These include bioprospecting experiments, searching for special enzymes that can be used in industrial processes in the pharmaceutical and chemical industries," Pedersen says. ▪

## Centre for Geobiology

- The Centre for Geobiology is a research center at the University of Bergen.
- The center is funded under the Research Council of Norway's Centre of Excellence scheme.
- CGB's objective is to bring together researchers from different academic disciplines in an international and multidisciplinary group to generate new, fundamental knowledge in a new field at the intersection of geology and biology.
- Project website: uib.no/en/geobio



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