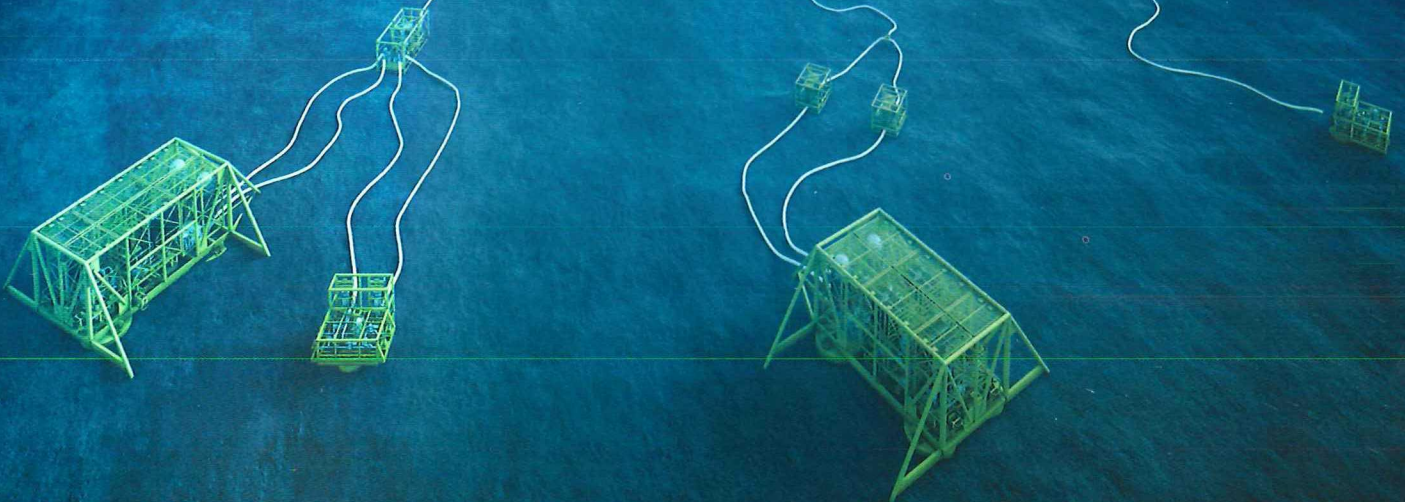


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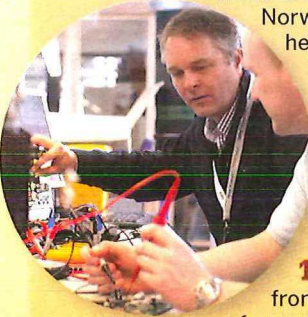
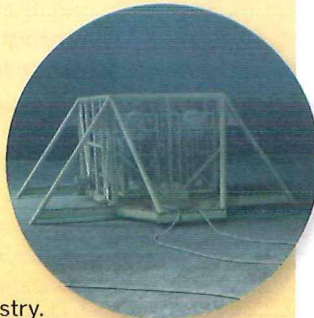


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Deeper Understanding

By Owe Hagesæther, CEO NCE Subsea

At the time of writing, nine months has passed since I took the position as CEO in NCE Subsea. So far, it has been an exciting and demanding job.

At NCE Subsea, we work to unite and promote the Norwegian subsea industry – one of the leading environments for underwater solutions in the world. Our goal has always been to contribute to the development of Norwegian subsea through stimulating innovation. The Norwegian cluster model of industry building has been very successful, and it is currently being copied by organizations all over the world. It is evident that there are many who wish to learn from us.

At the same time, the Norwegian offshore industry is experiencing a tough time. Low oil prices, high costs and reduced operating margins all take their toll on the Norwegian industry.

In times like these, it is important not to lose the ability to innovate. It is thanks to the expertise and experience that we have obtained from the extraction of oil and gas on the Norwegian continental shelf that Norway has become a force to be reckoned with in the subsea industry. We are in possession of top-class products, solutions and expertise that are all in strong demand in a rapidly growing international market.

At NCE Subsea, we believe that innovation, focused and effective work processes, standardization of solutions and expertise cooperation between different industries are all necessary to achieve good results, while at the same time facilitating for a new wave of high quality projects.

The road ahead is likely to be even more exciting. In 2015, we will once again take on the application process to be incorporated in the Global Centre of Expertise Programme – the highest level in a national program offering technical and financial support for cluster development in Norway. This is important to us – a GCE status would give us momentum, as well as more and better means of contributing to a competitive and world leading Norwegian subsea industry.

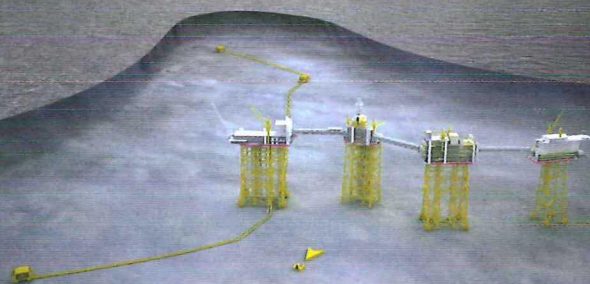
The Norwegian subsea industry has succeeded thanks to hard work, innovation and good cooperation. We wish to contribute to maintain this trend in the future. ■



World-class Subsea Solutions from Norway, is a supplement to *Offshore Engineer*, published by AtComedia. Supplement editor, Elaine Maslin, emaslin@atcomedia.com Advertising sales, Brenda Homewood, brenda@aladltd.co.uk Art and production, Bonnie James Reprints, Jill Kaletha, jillk@fosterprinting.com, +1-219-878-6068

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Meeting challenges – head-on



Norway's subsea sector has proven itself adept at overcoming challenges on the Norwegian Continental Shelf – making it well placed to tackle the coming challenges and offer global solutions. Siri Fenne, senior consultant, Lloyds Register Consulting, explains.

Subsea hydrocarbon exploration and production on the Norwegian Continental Shelf (NCS) is at a crossroads; what lies ahead are promising field discoveries, lower oil prices and rapidly escalating extraction costs.

The past few years have seen robust levels of exploration activity, but drilling costs have doubled since 2002 and operating and investment costs are escalating.

While oil production from the NCS has been steadily declining since 2000, dwindling reserves are not the main problem, at least in the short term.

In January 2014, there were 77 active fields on the NCS, a record 13 fields under development and 88 new discoveries being considered.

But, while extraction activities are likely to remain robust, their potential from a revenue-generating perspective is equally likely to be handcuffed by the rising cost of operations and investment.

Some relief may come from the development of the Johan Sverdrup, one of the largest fields ever found on the NCS, and whose operational dynamics are expected to offer an estimated break-even oil price below U\$45/bbl. Johan Sverdrup's vast reserves require new infrastructure, including several dedicated platforms and subsea satellites.

There are also plentiful potential opportunities for subsea developments: most of the newly discovered small and medium-sized fields are close to existing infrastructure. Of the 88 new discoveries, 68 are candidates for subsea connection to existing installations.

But, while the subsea sector remains promising on the projects front, any assets will need to be procured and operated in an economic environment where build costs are rising and oil prices – and therefore revenue potential – are falling.

Renewed efforts will need to be put into reducing the costs from discovery to production and beyond; tools will need to be developed continuously to improve the efficiency of existing assets, and to reduce the time it takes to build and deploy new ones.

To some extent, subsea infrastructure in itself is a solution, offering a cost-effective way to improve existing assets' productivity. On the NCS, most discoveries are within 40km of a host platform or pipeline.

Another reasonably successful option has seen NCS operators opt for "fast-track" methods such as using "off-the-rack" subsea equipment (Xmas trees, manifolds, templates, etc.) to reduce construction times, engineering hours and overall costs.

Technological solutions are also being developed and deployed, including those that support the transition of hydrocarbon processing to the seabed, decreasing the necessity for nearby host installations.

In the past few years, fields have been developed with subsea boosting pumps, subsea compression and subsea separation. The next step would be a full subsea processing factory, independent from a host platform.

Placing more processing equipment on the seabed requires a high level of technical expertise, as well as an advance in environmental monitoring techniques

Statoil's Johan Sverdrup development concept. Image from Statoil.

and a substantial amount of technology development is being done in this area.

Equipment, including drilling rigs, will need to be made more robust by design to endure tougher operating conditions such as harsh temperatures and the mounting pressure challenges. This has implications beyond protection of the environment; it makes assets safer to operate and reduces non-productive times, both potential cost centers.

Overall, the oil industry in Norway has proven adept at developing and incorporating subsea technology, positive traits of which it should be proud and which will bode well for ensuring the safety and profitability of future projects.

More research and development will be required as Norway's offshore sector enters new, more challenging economic and geographical frontiers. The subsea sector has only begun to tap the potential of academic and joint-industry partnerships with experts and independent technical specialists.

And, while subsea activities on the NCS are destined to be an exciting commercial arena for the foreseeable future, many of the technical challenges operators face will not be unique, which will give Norwegian subsea experts a unique edge.

So, when participants are considering how much and where to allocate their respective research and development budgets, they will do so in the knowledge that most technology that is proven effective on the NCS will also hold value in other busy subsea environments such as Australia, North America, West Africa, Brazil and the Gulf of Mexico. ■



Siri Fenne works as a senior consultant in Lloyds Register Consulting Kjeller office. She has been with LR Consulting since May 2011. Siri holds a Master of Physics from

the University of Oslo, 2008. Siri works mainly with technical safety, reliability and risk analysis. She has been seconded to different clients, such as FMC Kongsberg Subsea and Statoil where she has followed up technical safety in various projects. Her core competence is technical safety in offshore new build projects, with main focus on subsea tie-ins, work over systems, risk assessments and marine operations.

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(check one box only)

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- 02 Engineering or Engineering Mgmt.
- 03 Operations Management
- 04 Geology, Geophysics, Exploration
- 05 Operations (All other operations personnel, Dept. Heads, Supv., Coord. and Mgrs.)
- 99 Other (please specify)

2. Which of the following best describes your company's primary business activity?

(check one box only)

- 21 Integrated Oil/Gas Company
- 22 Independent Oil & Gas Company
- 23 National/State Oil Company
- 24 Drilling, Drilling Contractor
- 25 EPC (Engineering, Procurement., Construction), Main Contractor
- 26 Subcontractor
- 27 Engineering Company
- 28 Consultant
- 29 Seismic Company
- 30 Pipeline/Installation Contractor
- 31 Ship/Fabrication Yard
- 32 Marine Support Services
- 33 Service, Supply, Equipment Manufacturing
- 34 Finance, Insurance
- 35 Government,Research, Education, Industry Association
- 99 Other (please specify)

3. Do you recommend or approve the purchase of equipment or services?

(check all that apply)

- 700 Specify
- 701 Recommend
- 702 Approve
- 703 Purchase

4. Which of the following best describes your personal area of activity?

(check all that apply)

- 101 Exploration survey
- 102 Drilling
- 103 Sub-sea production, construction (including pipelines)
- 104 Topsides, jacket design, fabrication, hook-up and commissioning
- 105 Inspection, repair, maintenance
- 106 Production, process control instrumentation, power generation, etc.
- 107 Support services, supply boats, transport, support ships, etc
- 108 Equipment supply
- 109 Safety prevention and protection
- 110 Production
- 111 Reservoir
- 99 Other (please specify)

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Powering the deep

The next generation of subsea developments will require next generation power systems. But, should they be marinized solutions or designed for purpose? Norwegian industry is at the center of the debate. Elaine Maslin reports.

How to distribute power between an increasing number of seafloor power users has become one of the more interesting debates in the power industry, not least in Norway's subsea power sector.

It is one Kristin Elgsaas, senior product manager, Subsea Power in Subsea Systems, GE Oil & Gas, based in Oslo, has been following closely.

The need for power subsea is wholly accepted and, up to a point, users such as electrical submersible pumps or subsea boosting stations, even multi-megawatt subsea compression systems, can be supported by power cables from nearby topside facilities.

However, when the equipment – boosters, separation facilities, compression – are at longer step-outs from topside or onshore facilities, how to distribute power needs closer attention.

A central debate, led by Norwegian technologists, has been whether established power distribution systems should be marinized, for use subsea, or if new systems should be designed for subsea.

"The key technologies we have subsea are the same as what we have topside. The cables, transformers, switches, etc., are the same you would expect to find in any power system," says Elgsaas, speaking at Offshore Energy in Amsterdam late in 2014. "But the environment is very different.

There needs to be an extreme focus on reliability and also on the sealing technologies.

"When you take these products subsea there are two possible strategies; marinization, taking topsides equipment and putting it in a sealed container; and designing for subsea, i.e. design equipment that can accept the subsea environment, i.e. the pressure."

In some areas, the choice is easy, she says, particularly components that are structurally relatively simple, like the connectors, cables, and transformers. "You have conductors, insulation and

then casing protecting insulation from the water," Elgsaas says. "Operating those under pressure is not too difficult and is well proven. When you look at the more complex components, i.e. power electronics, variable speed drives (VSDs), uninterruptible power supply (UPS), here the choice is not so obvious and you see the two approaches being applied."

To date, there has been one system, deploying VSDs subsea, that has been qualified and system integration

tested. It is a marinized type system, with the power

electronics working at atmospheric pressure, for Shell's Ormen Lange subsea compression pilot project, integrated by Aker Solutions and including technology from GE, including the power electronics. Shell put the project on hold in April 2014, citing costs and reservoir data.

Kristin Moe Elgsaas

Siemens, at its Trondheim facility, is working on a pressure tolerant solution, and has been working towards full system assembly and testing.

"This is really one of the more interesting debates in the subsea power industry right now: what makes more sense for the more complex equipment? Pressure tolerant versus one-atmospheric pressure systems," Elgsaas ponders.

"Arguments tend to center around the weight and size, where the one-atmospheric pressure solutions are lighter and easier in shallower waters, and where pressure tolerant solutions are lighter in deeper waters. The cross-over point is not really known and really depends on a number of factors.

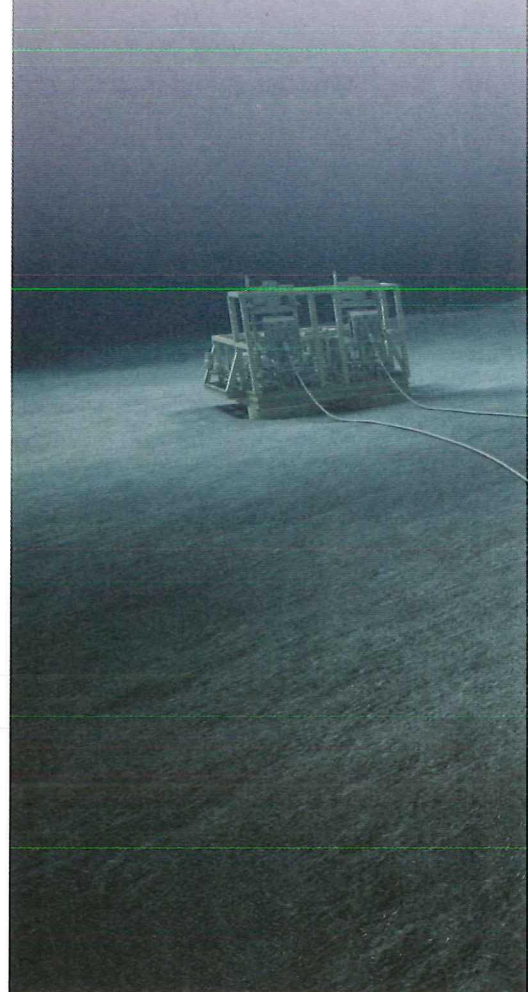
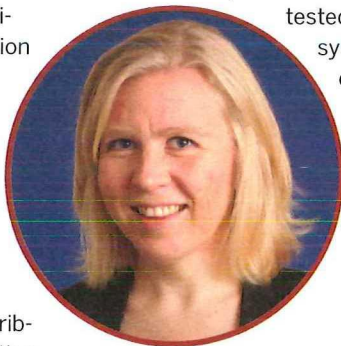
"The second argument tends to center around reliability. You have the advantage of passive cooling and no differential pressure points, with a pressure tolerant solution, versus operating in a known environment with known failure modes

and sealing technologies for the one-atmospheric solution. What ends up being the right choice will, at the end of the day, be about proving reliability at the lowest cost."

But, the debate is not just about concepts. "Subsea power systems have been proven to be technically feasible. It [subsea power] should not be a show stopper when moving forward on subsea processing systems," Elgsaas says.

Three elements are key to assessing what type of subsea power system is needed, she says. First is knowing the total power needed and how many loads there will be. Next is the distance between the load and where the power is. Finally, in a brownfield project, are there any restrictions or limitations on the topside host footprint and weight?

On the technology readiness level, all the technologies you need for an AC subsea power system have been qualified or have been installed and operated, Elgsaas says.



Elgsaas outlines three types of conceptual system seen today, type one being the simplest and comprising a power cable and high voltage penetration system. The system is simple but distance and power capacity is limited. This would be applicable for pumps.

Type two adds a transformer subsea, increasing the step-out distance possible, and the power capability, at the expense of adding the transformer and adding a number of connectors subsea at higher voltage levels.

Type three is where all the key technologies are introduced subsea – the switch gear, VSD, UPS, for the compressors – and this is where pure power electronics start to matter. The benefits of type three are significantly extending transmission distance, significantly extending the power capacity, and being able to supply multiple loads through a single cable, reducing cable costs.

Type one, is suitable for 20-25km, maybe 30km under certain conditions,

type two up to 100km for pumping and boosting applications and type three, 100-300km should be feasible, Elgsaas says. In terms of water depth, Types one and two have been qualified down to 3000m and type three qualified to 1000m.

Like Siemens, GE's vision is a full subsea power layout, with boosting, separation and compression supported, Elgsaas says. "We've installed and have operating experience on types one and two," Elgsaas says. "Type three has been integrated, but no systems are in operation. From a power perspective that would be an awesome step. The key message for me is that spending time and effort designing a robust and reliable power system is worthwhile from a cost perspective and an overall system reliability perspective."

And the work proving and then expanding these systems is set to continue. Operators are working at greater depths, so all the technologies will need to be qualified to at least 3000m depth, and increasing step out distances. This will

likely involve having line compensation subsea, reducing transmission frequency or even jumping to DC, Elgsaas says.

Further work also needs to be done to reduce the cost involved in these systems, she says, with work needing to be done around standardization and product ratings, especially around qualification testing.

"We see operators today having their own specifications or dedicated testing, which forces us to do separate testing for many different companies. And that's something we want to address," she says.

Looking at how systems are maintained will also be key, she says, especially around reducing maintenance, increasing condition monitoring, having predictive maintenance, with the overall goal of having a more autonomous system.

"That's the road we have to go if we want to go into the harsher environments such as then arctic," she says. "It is particularly important to think about power systems from day one and see it as an integral part of any processing system that you do." ■



GE's Subsea power system vision. Image from GE.

3D, real-time is here

Gaming technology and visualization – in 3D – has come to the oil industry. Visco is using it to help the industry go further.

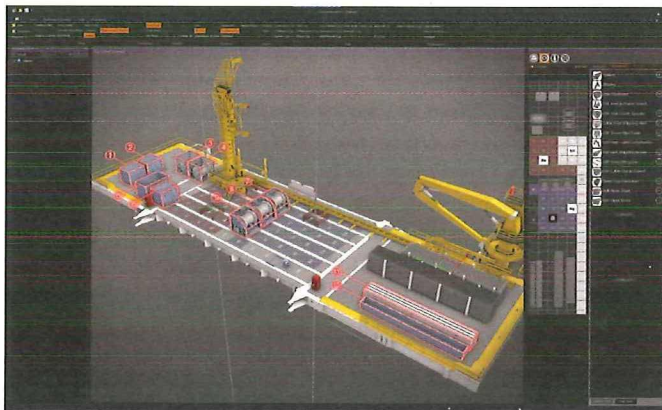
Imagine that you can move freely in an industrial complex world, an advanced virtual subsea installation or platform. The virtual model is exactly like the physical reality, you hardly see the difference. You move quite intuitively, it is uncomplicated to navigate.

"This is something our kids do every day. Why should we not apply the same method in the oil and gas industry," asks Visco's Øystein Stray.

In fact, Visco has. Drawing on 20 years of visualization experience in the oil and gas sector, inspired by the gaming industry and using an in-house developed graphics engine, Visco has been converting large and complex engineering models into visually attractive, navigable virtual reality (VR) systems using its vCog solution, short for visual cognition.

More than 60,000 research and development hours were spent developing both the virtual reality solution, but also the knowledge of how to bring "big data" onto a comprehensible platform. "This is a game changer for the industry, and a huge time and cost saver," Stray says.

Last year, the firm delivered a complete visual-virtual model of the subsea Ormen Lange field to Shell. Visco is currently working on another major project to visualize Statoil's UK North Sea Mariner platform.



Visualizations from Visco's vCog solution. Images from Visco

Both installations are visualized through advanced 3D graphics and animations, using Visco's own graphics engine, incorporating technical information and model data from the different vendors involved in the project, which is collected, systematized and modeled into one model.

But, the models are not just visual engineering aids, Stray says. Visco converts them into operative virtual worlds, for operational use, such as planning lifts or planning material and logistics handling for three parallel drilling operations on one platform.

"Imagine that you are moving along with an experienced senior engineer and a novice trainee, just as if you are in the real world and looking at the same thing," Stray says. "You are at your work desk and looking at the installation through Oculus

Rift or Google Glasses, at the same time as colleagues in Houston and Singapore," he says.

"This is not only software, we go deep into the business processes of our customers, dissect workflow, inspection and manual operational tasks, find out how to automate typical maintenance tasks to save time and to increase security," he explains.

VCog can also "see," search and retrieve information with auto-link to SAP or Smartplant, as well as offering a useful tool for crew simulation, familiarization and training. A test with an operator found it took 17 minutes to search and retrieve some technical documentation. With VCog it took 50 seconds.

"People across disciplines and locations see the same, communicate better, learn faster and make more effective decisions in their operations," Stray says.

Should users wish to, they can also immerse themselves in the virtual reality, 1:1, using Oculus Rift glasses.

With background from defense studies, Visco has developed "vCog - Field Awareness" – a virtual infrastructure to view and manage real-time data. For this, the company was a finalist for the ONS2015 Innovation Award.

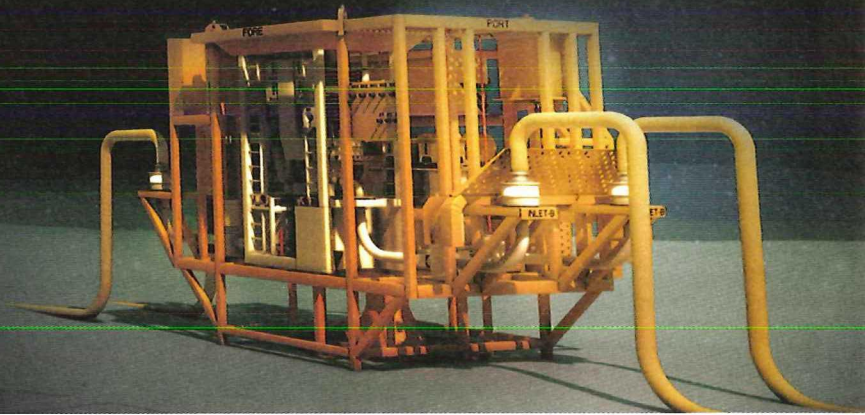
"Having seen the visual worlds of gaming and now knowing about the existence VR solutions for the oil and gas industry: can we really imagine that in 5-6 years' time this industry is running their operations the same way as today without these VR infrastructures," Stray asks. ■

Users can immerse themselves in 3D models using Oculus Rift glasses.



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Norwegian subsea oil and gas industry strength, built on Norway's Continental Shelf, is primed to become a global export, with NCE Subsea's help.

"Norway is a world-leading country on technological solutions for the subsea industry – and that is a position that we must hold on to," says Owe Hagesæther, CEO of NCE Subsea.

Hagesæther is aware of the ambitions of the cluster. "We wish to increase the scope of the work that we have done representing the Norwegian subsea industry around the world. We wish to leave a larger footprint, to increase our dedication and to share our knowledge.

"The Norwegian subsea industry will deliver the most innovative solutions in the future – there is a global demand for us, and we are a force to be reckoned with in the industry. Our industry has a market share of about 50 % worldwide," he explains.

Regional Cooperation, Global Strength

Industry building through cluster cooperation is still a new concept to many in the

Industry clusters

Cluster theory shows how companies can benefit from being situated with other companies in the same or a similar industry. Industry clusters are good arenas for cooperation, innovation and financial growth. According to international research results, clusters can contribute positively to a higher employment rate, better productivity and more start-up companies.

The fundamental idea behind the programme Norwegian Centres for Expertise (NCE) is to give the member companies a better basis for conducting demanding innovation processes, including through the companies receiving quicker access to the environments and operators that they need to succeed.

global market, but Hagesæther confirms that there is an increase in interest. "NCE Subsea receive many visitors from different parts of the world. We have knowledge that interests the market. Countries such as Brazil and Argentina do not hesitate to look to Norway and the way we build our industry, including cluster cooperation."

Hagesæther emphasises that the Norwegian subsea industry is in possession of world-leading expertise and valuable experience from the Norwegian continental shelf. "This knowledge is very valuable for effective development and operation of subsea installations elsewhere in the world," he says.

Tove Ormevik, chairman of NCE Subsea, believes that a strong subsea cluster creates strong values: "When we build our industry through clusters, we get complete environments within technology, expertise, research and development and innovation. The result is that the cluster is stronger than the individual companies are. Thus, the individual companies can reap the benefits of a larger expertise environment, both in developing their own technology and products. They also gain access to new markets, particularly on an international level."

Valuable Knowledge to the Global Markets

The Norwegian subsea industry exports knowledge and experience to the global market. At the same time, Norwegian companies share knowledge with each other – for instance about business conditions in the various markets. "This is part of the purpose and effect of clusters. This knowledge strengthens the companies and promotes Norwegian competitive

power. This is particularly important for the SMB companies," Hagesæther points out.

The North Sea is one of the largest subsea markets in the world and is situated right outside our own coastline. Furthermore, Brazil, Australia, Africa south of Sahara, the Gulf of Mexico, as well as Newfoundland and the Arctic regions are all large markets, Hagesæther emphasises.

"NCE Subsea's job is to promote the Norwegian subsea industry where the development happens," he affirms. "We assist the cluster companies by introducing them and their knowledge to these markets."

We often think that innovation is based on ground-breaking research in traditional research environments. According to Hagesæther, this is only partly the case.

"Innovation happens largely through dialogue with the market. We see needs and we gain experiences. This knowledge is valuable."

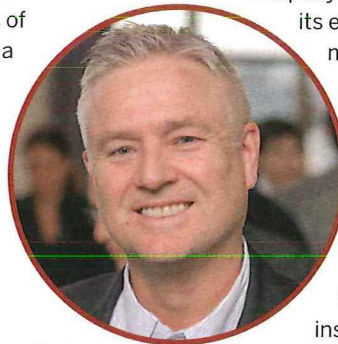
Metas Succeeds

Metas is a good example of a member company that has succeeded in its efforts towards the new markets. "We have projects underway in Brazil, in cooperation with UFRJ (Federal University of Rio de Janeiro) and Petrobras," says CEO of Metas, Olav Birkeland. Metas develops acoustics based underwater instrumentation for the oil industry. This technology can help

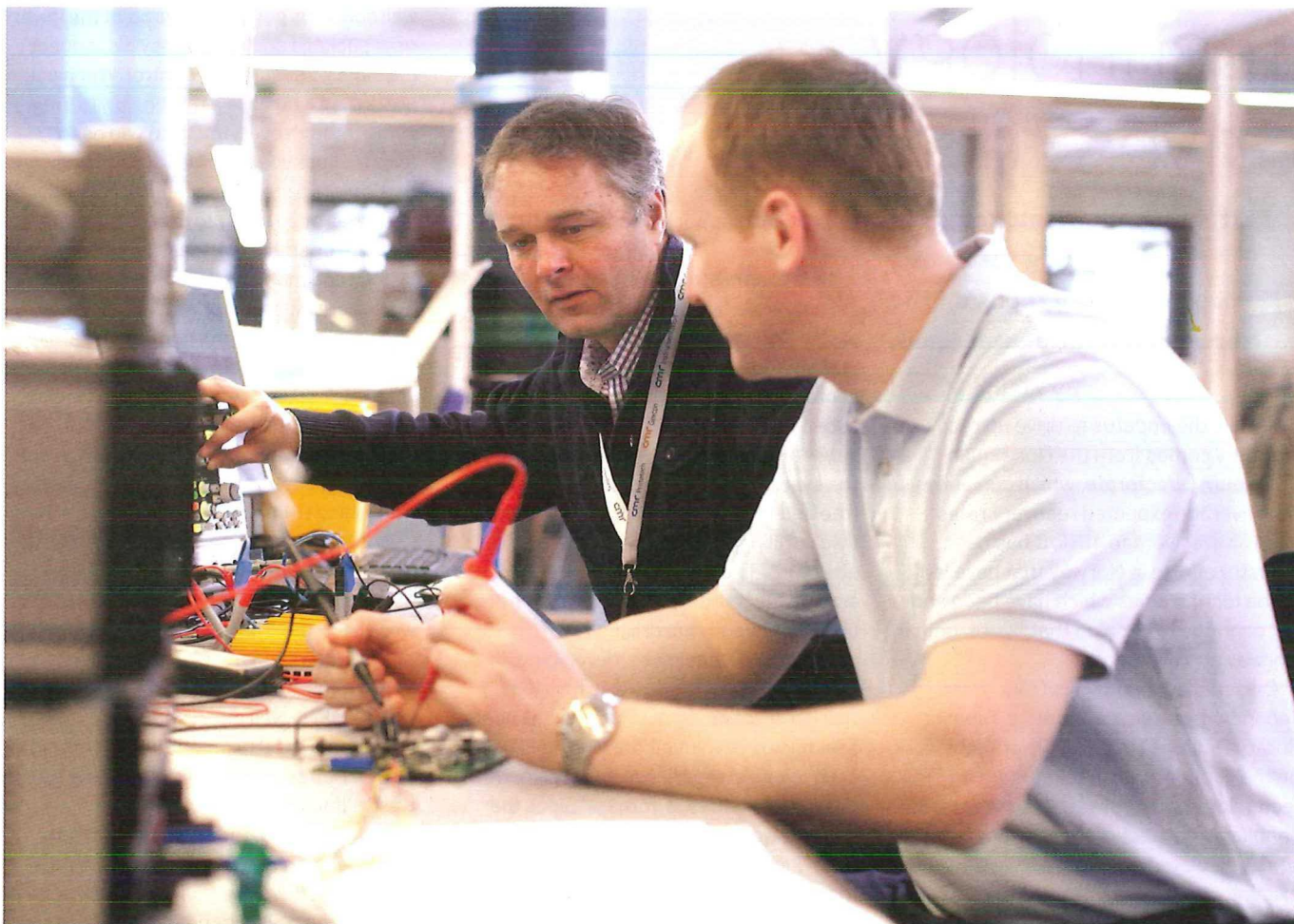
reduce industry costs: It enables monitoring of the sea environment, and the discovery of oil and gas leaks.

"The leak system helps companies register possible leaks at an early stage. Thus, the customers avoid the large costs that can follow a major leak. In some cases, discovering leaks early will help avoiding larger damage, in turn giving the installations a longer lifespan," Birkeland points out.

"We have developed a system for monitoring, detecting, analysing and alerting about oil and gas leaks at subsea installations," Birkeland explains. We have received positive feedback on the system after demonstrating it for various oil companies, and we are now in the process of qualifying it for commercial use in the



Owe Hagesæther



Research in action at Christian Michelsen Research. Photo from NCE Subsea.

subsea industry.

Metas' goal is to deliver innovative technology to a global market, and they have linked up with solid cooperative partners in the cluster. "The system for leak monitoring is our most important product for the future. We have ambitious sales objectives, which is why we have linked up with FMC Technologies, a leading force in the global market for this product segment," Birkeland says.

Metas is an example of how cluster cooperation works. "Our technology is based in fishery research. We are a spin-off company from the Institute of Marine Research, which is also an NCE Subsea partner. As a member of NCE Subsea, we have also benefited from closer contact with other suppliers as well as potential customers."

Norwegian Expertise

Hagesæther and Ormevik praise Metas for delivering technology for the future to a global market. "The Norwegian subsea

industry compete with technology from all over the world, perhaps the US in particular. We also keep a close eye on how other large subsea markets develop."

The Norwegian subsea industry must stay ahead of the competition when it comes to technological development. "We will be facing new challenges in the near

Metas

Metas develops acoustics based underwater instrumentation for the oil industry. Technology enables monitoring of the sea environment in general and the discovery of oil and gas leaks in particular. The technology can help reduce industry costs.

www.metas.no

future, with deeper and colder waters. There are opportunities here for delivering innovative solutions," says Hagesæther.

"We are able to move more and more functionality from shore and traditional platforms to subsea," Ormevik elaborates.

"Remote controlled solutions and more advanced robotics are just some of the methods used here. We are enthusiastic about the use of 'big data' to collect, technically organise and visualise data for use as decision support, which the robots are guided by.

"We have learnt and gained a lot of experience through development and manufacturing on the Norwegian continental shelf – and we have built a strong industry at home. When the investment growth stops in the North Sea, we can create growth in our own industry through selling our competence globally to markets where the industry is still growing. Expertise will be an important Norwegian export article in the future," Hagesæther and Ormevik predict.

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Technology drives recovery

Extracting additional reserves from maturing reservoirs has been a key focus on the Norwegian Continental Shelf.

By Elaine Maslin

But while the impetus to drive up recovery rates comes from the Norwegian Petroleum Directorate, which currently puts average expected recovery rates at an above average 46%, it has been industry efforts in Norway that have led to the technologies which have been and will continue to push up that figure, both in Norway and overseas.

One such technology is FMC Technologies' subsea Through Tubing Rotary Drilling (TTRD). Development work on the concept, which takes known TTRD technology and applies it to subsea wells, enabling side-track wells into new reservoirs or isolated reservoir pockets through existing completions, started in 2003/4. The first unit was built in 2008 and two side-tracks have been successfully drilled using the unit.

While the core technology is not that new, no one else is deploying it in this way in the world, says Solveig Tornås,

Oslo-based support manager, TTRD, FMC Technologies.

"It is exciting to be working on such a cutting-edge technology project," she says. "Conventionally, on subsea wells, you would have to have a blowout preventer and you would have to remove the subsea tree and pull the tubing to drill a subsea side-track. With TTRD, we just land the system and go through the subsea tree and the tubing, facilitating the side-track drilling through the subsea infrastructure. The potential cost reduction is significant compared to doing a side-track from a conventional drilling rig."

For FMC Technologies, developing subsea TTRD, which can also be used for well intervention and workovers, has been a technology evolution drawing on FMC Technologies' experience and the knowledge of its staff, says Tornås. "Since the concept was developed with Statoil, we have taken incremental steps towards a solution that works and, 10 years later, everything works well and we think this is not as difficult to do as it was initially thought."

One of the challenges was ensuring well control during drilling, Tornås says. FMC Technologies developed new equipment to

ensure full well control. "In well intervention, well control is performed through the lower riser package and emergency disconnect package, to ensure well control. When you are drilling, you have a rotating drill string going through everything, so you need to make sure you have well control and that's quite a step-change." A substantial effort has been made to develop the large offshore operations, assessing operational history and making systems more robust. "There are different forces acting on the equipment when performing a typical side-track drilling operation," she says. "Also, for side-track drilling, you need a smaller drill bit, smaller equipment than normal, to go through our equipment. It has been a challenge to get everything through and getting everything to interface."

The system was delivered in 2008 and FMC Technologies first side-track jobs using the TTRD for a subsea side-track were from the *Stena Don* semisubmersible drilling rig on the Norne and Åsgard fields in the Norwegian North Sea, both in 2009. Five well interventions have also been conducted using the TTRD from the *Songa Dee* semisubmersible drilling rig on the Gullfaks field in 2012-2014.

During its use, the system has been improved and FMC Technologies is now keen to get it working on side-track applications again. The benefits for operators could be substantial, but acceptance from the operators has been limited. Tornås thinks that since TTRD's successful operations have not been more broadly published in the industry, FMC Technologies' TTRD system has not received the attention it deserves. The system has also been tied up performing more conventional work – well intervention and workover – with Statoil under a long term contract, which has meant limited opportunity to offer it to others.

"There have been other companies trying to make similar systems, and last year there was some attention around this being extremely difficult to do and I'm afraid, in the current operating environment, the industry has forgotten that there is a system out there that is available and functions very well," she adds.

The flexibility of the system, which can be deployed from any vessel or rig with facilities for drilling, also means there are other options for its use that FMC Technologies is currently exploring. They are also improving the rig interface, to reduce hook-up time, and further simplifying some of the equipment. ■



Left: TTRD Stack in Stack-Up Tower on *Songa Dee*. Right: TTRD Support Manager in front of the TTRD Stack on *Songa Dee*. Images from FMC Technologies

A new, bright, future

Technocean Subsea is once again an independent firm – with its sight firmly set on growth. Elaine Maslin learned more from commercial director Dag Raymond Rasch.

The last five years have seen something of a transformation for Technocean Subsea. After a growth spurt, starting in 2010, and becoming part of the Reef Subsea Group, created by the firm's then co-owners GC Rieber and HitecVision, Technocean Subsea re-emerged in 2014 as a new, independent business.

Now wholly-owned by HitecVision, a Norwegian private equity outfit, the firm has its sights set on growth, in the UK and Norwegian sectors, as well as West Africa – home to an already strong base.

Dag Raymond Rasch, Bergen-headquartered Technocean Subsea's Commercial Director, says: "2010 is when this company really started to develop. HitecVision provided knowledge and capital and together with GC Rieber they decided to grow the business." In 2014, Reef Subsea split into Reef Subsea, X-Subsea and Technocean Subsea, whose core business is subsea construction, IMR, survey, decommissioning and engineering and management of projects related to these.

"It is the right thing to do for Technocean Subsea, Rasch says. "It is about being efficient and our strength is that we are able

to be quite flexible and have a safe and fast project turnaround."

The biggest transformation at Technocean Subsea has been moving from a company mostly focused on equipment and personnel, which the company, founded in 1990, had focused on. After GC Rieber first invested in the company in 2006, the company started to grow, taking on its first vessel. Its first job in West Africa was in 2009, and more vessels were incorporated in 2011, with HitecVision then joining GC Rieber in a joint ownership, before taking over total ownership in 2014.

In that time the firm has been beefing up its engineering capabilities, very quickly winning a variety of projects.

The firm has also maintained a strong presence in the West African region; having stationed their light construction vessels *Larissa* and *Despina* in the Gulf of Guinea area since January 2013, building a portfolio of 14 successfully completed projects to date, across the major West African countries.

Larissa is permanently based in the market and both ships are able to provide field maintenance support, umbilical and cable installations and light construction support tasks. Rasch says West Africa is a key area for organic growth and Technocean Subsea is focusing on the establishment of a hub to support operations within Congo, Angola, Ghana and Nigeria.

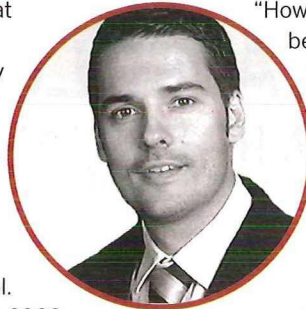
While there is some

nervousness in the subsea market, there are still projects on the horizon, Rasch says. "We believe the oil price will be staying low for quite a while," says Rasch, who worked at Norwegian seismic firm Octio before joining Reef Subsea in 2010.

"However, we also think there will be quite a lot of subsea operations for subsea companies going forward, including IMR and some of the bigger projects in the North Sea, such as Statoil's Johan Sverdrup and Mariner developments. Statoil recently said it is maintaining its production levels and also maintaining investment levels in 2015, compared to 2014."

Decommissioning work is also increasing. While there has been, on average, 2.5 projects per year in the Norwegian market, in 2014 the market ramped up, with some five fields per year now expected to be decommissioned going forward. While visibility is good, it's not work that earns operators cash, so companies need to offer good value solutions, Rasch says. For example, on Hess' Ivanhoe/Rob Roy fields decommissioning project in the UK North Sea, Technocean Subsea worked on a pipeline flushing and structure removal project, using just one vessel instead of two for the flushing operation, reducing costs.

By mid-December, Technocean Subsea already had a good backlog for 2015, with the *Polar King* and *Despina* booked well into the start of summer in the North Sea and the *Larissa* lined up for contracts for most of 2015 in West Africa. The outlook is good for Technocean Subsea. ■



Dag Raymond Rasch

Technocean Subsea's *Larissa*.

Images from Technocean Subsea.



Technocean Subsea's *Despina*.



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Promising Florø

Sogn og Fjordane is a growing base for the Norwegian subsea industry, providing a hub for operations offshore Norway as well as a for a growing number of companies looking to take their technologies overseas.

The western Norway coastal region of Sogn og Fjordane, with Florø at the heart of it, is described by those who know it as a "well-kept secret" in Norway's oil and gas industry.

It is a growing offshore support base, north of Bergen, with large and international companies providing an increasing amount of equipment and services, as well as new companies setting up and established companies investing in their operations.

The region's heritage, like most coastal areas of Norway, is in fishing and shipping. While the maritime sector is still high on the list, the petroleum industry is becoming increasingly important for the region.

Member organization Maritime Association Sogn og Fjordane has 62 members in 14 of the county's 26 municipalities,

more and more of which are from the oil and gas industry. The organization, in partnership with NCE Subsea, recently secured NOK 500,000 funding from Innovation Norway to help further develop skills in the region, particularly towards oil and gas.

Per Øyvind Voie, from Innovation Norway, says: "The maritime industry in Sogn og Fjordane is directed more and more towards the petroleum industry and to succeed in this venture expertise are crucial."

The subsea sector, especially, is a growing business area for the region. In fact, last year, NCE Subsea established a branch office in Florø. Automation, electrical and mechanical firm Hellenses also opened a branch in Florø in 2014 and Saga Fjordbase is expanding its facilities. And the investment continues - polyurethane

specialists Strukturplast is developing materials just for the subsea industry (see panel), to mention just a few. Westcon Group is also investing in its Westcon Yards at Florø, which outfitted and commissioned Subsea 7's *Deep Energy* pipe-lay vessel. Florø is also home to Westcon Design Florø (see p.18).

Saga Fjordbase, part of INC Gruppen, is a key company in the area and it has also been investing in its Florø facilities. Primarily a supply hub, the company is expanding, building a new subsea workshop, for subsea maintenance and modifications works.

Lars Holmqvist, technical manager, at Saga Fjordbase, says: "Back in the 1970s, the first oil companies established themselves in Florø. However, it was not until the mid-1980s that the first area, building and quays were completed and a new supply base was born."

In order to fulfill requirements from the oil companies, to minimize the number of subcontractors when bidding for maintenance contracts in the North Sea, the INC group was formed by Per Arvid Nødseth and Oddgeir Igland in 1985.



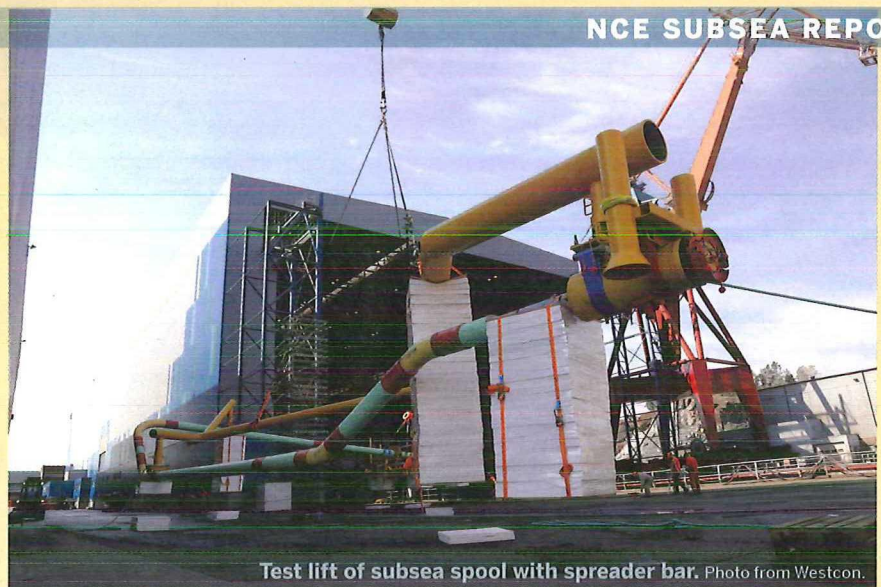
Saga Fjordbase, from the air.
Image from Westcon.

By merging their businesses, NBN Elektro (Nødseth) and West Industri Service (Iglund), INC became a bigger player and successfully won several large maintenance contracts on the Norwegian Continental Shelf. In 1985, they also became the majority shareholder in Fjord Base, the company that won the contract to operate new base.

In 2000, the operation, which has grown over the years, was transferred to Saga Fjordbase, with Fjord Base as the real-estate company. Since then, Fjordbase has grown to more than 170 acres, and it has plans to expand further in order to meet demand.

"We have more than 2200 ship calls per year and close to 60 companies are established on Fjordbase, with Statoil, GDF Suez and BG as operators," says Holmqvist.

To serve increasing subsea activities at Fjordbase, the INC group is building new facilities to increase capacity related to service, maintenance, modification and repair work for subsea related equipment. This will also include test facilities. In addition, INC is building a close relationship with the education institutions, to make sure it has a strong workforce for the future. ■



Test lift of subsea spool with spreader bar. Photo from Westcon.

Westcon invests

Westcon Yards has had its eyes on expansion in the subsea sector at Florø since 2012, when it bought STX Florø yard.

Until then, STX Florø had been a traditional shipyard, focusing solely on newbuilding of ships and ship repairs. But, as the shipbuilding market slowed, and STX Florø struggled, Westcon saw an opportunity.

Steinar Matre, manager subsea department, Westcon, said: "Westcon bought the yard with the intention of bringing the yard into also offshore and subsea markets in addition to the continued ship repair activities.

"A lot of time and resources have now been invested to lift the yard to the HSE and quality standards required when entering these new markets. This has resulted in bringing in a lot of new projects to the yard, involving advanced fabrication of subsea products with sophisticated materials as well as fabrication of structures for the offshore industry."

Westcon has delivered subsea equipment for installation globally, including in the North Sea, Gulf of Mexico and West of Africa. Late last year, the firm delivered equipment for the Smørbukk field, offshore Norway.

Just before the end of 2014, Westcon secured a string of contracts, covering ship repair, offshore module production and subsea projects. For the subsea sector, Westcon secured four contracts, covering fabrication of steel constructions, piping, fittings, welding and surface manageability for clients including EMAS, OneSubsea and Kongsberg.

The investment, however, continues. Westcon is restructuring the yard and investing in new infrastructure at the facility, including a new quay for repair and classification of drilling rigs, new automated welding machines, machining capabilities, etc. "Further investment opportunities are already on the table as well and will be constantly evaluated," Matre says.

The attraction of Florø included trained and experienced staff, the yards and indoor facilities. But the local supplier network and Subsea Bachelor education, also made Florø a very interesting site for Westcon, as it further grows its subsea capabilities and services, Matre says.

It is a good business to be in, he says. "I think the subsea industry is still a very attractive business to be in, both with regards to new field developments that benefit from having a subsea infrastructure rather than an expensive to operate topside installations, as well as the increasing need for maintenance of existing/old subsea equipment.

"There are many ongoing technology development initiatives to further expand the range of subsea applications, working towards a complete 'subsea factory.' This indicates the subsea business is still in the development phase to enable even more fields being developed with a subsea infrastructure. On the other hand, there are some threats the whole industry must overcome on the short term, including an urgent need for standardization and cost reductions.

"These are elements which also are very important for us when we now further develop our own 'subsea factory' for production and maintenance of subsea equipment at Westcon Yards," says Matre. ■



Innovating elastomers

Strukturplast, based just 1.5 hours from Florø, has been working with polyurethanes (PU) for more than 30 years – and now it is putting its PU skills into the subsea sector. Last year, the firm, a member of Maritime Association Sogn og Fjordane, launched NORSelast, a polyether-based polyurethane elastomer.

"In 2007 we decided that we wanted to develop the best polyurethane elastomer for marine environments," says Frode Lindvik, Strukturplast's general manager. "And in 2012 we achieved this target, and named it NORSelast."

The polyurethane has been named after the North Sea conditions it was designed to withstand. Polyurethane elastomers,

often called Solid PU, have for a long time been known as a good choice of elastic material in subsea environments, Lindvik says.

"The main purpose of elastic properties on a component is to absorb and reduce the effect of destructive energy," he says. "The main reason why equipment stops working, causing maintenance requirements, is that it has been damaged or worn out. Destructive energy in the form of impact, vibration or wear is often the reason why equipment fails."

Products that can be manufactured using NORSelast and other PUs are guide rings, bend restrictors, rig floor mats, impact protection, spacers, clamps, centralizers and protectors for flanges, risers, drill bits and other equipment.

But, solid PU is not a standardized material, which could pose a challenge, when subsea clients might not have enough knowledge about the material to understand its best uses or benefits, something Strukturplast is overcoming with NORSelast.

Polyurethane can have a lot of different properties, intentionally or unintentionally, Lindvik says. "It is a hot curing material and all producers have their own standards and qualities. But, it is very versatile. Its properties can be modified by a wide range of factors, like stiffness, strength, and durability, etc. If you only specify solid PU on a component you might get something that



Operations at Strukturplast's facility in Sogn og Fjordane, western Norway.

Photos from Strukturplast.

does the job perfectly, but you also risk getting something that is not suitable for the subsea environment."

A lot of polyurethane systems also contain hazardous chemicals. To tackle the lack of standardization, Strukturplast created NORSelast as a standard, branded product, to differentiate the product specifically for subsea applications. NORSelast has a tensile strength of 50 MPa and a lifetime expectancy of 50-70 years in marine environment, and it does not contain any harmful chemicals. NORSelast also has better abrasion resistance to sandblasting compared to protective steel.

Although it is standardized, it can still be tailored to specific purposes. "In combination with good bonding properties with most other materials, this provides almost unlimited possibilities of new and improved solutions," Lindvik says.

Strukturplast is now working with other companies to develop and produce tailor-made solutions based on NORSelast, as well as other polyurethanes. Petroleum GeoServices, GE Oil & Gas, One Subsea, Tomax and Rolls Royce are among Strukturplast's clients. The firm also helped develop a subsea installed pipe protection solution for Petrobras a couple of years ago.

Strukturplast's production facilities are in Sandane in Sogn og Fjordane. ■



Frode Lindvik, Strukturplast's general manager, materials testing.

Arctic ready

Tess is stepping up to the challenge to keep operations running in ever-colder, harsher environments.

by Trond Sørensen,
Development Engineer, TESS

The offshore industry is moving north, towards the Arctic areas in the Barents Sea. This means that there will be requirements for new technology, new

“There will be requirements for new technology, new types of equipment, suitable for cold areas, with ice and snow.”

types of equipment, suitable for cold areas, with ice and snow.

Tess has seen some of the challenges the offshore industry will meet in the north of Norway and have developed solutions for different types of heated hoses, to ensure stable and secure operations of

critical components in the Arctic area.

The company has developed a number of new solutions for heated hoses, designed for Arctic areas, including using heating cables.

This includes self-regulated cables, which can be used, for example, for frost protection of water hoses. The self-regulated cable is inserted inside the hose, where it will turn on/off in order to keep the water above a preset temperature, to prevent freezing and ice formation.

The heating cables might also be installed outside the hose wall. Using self-regulated cables will ensure the hose wall, and therefore the fluid inside, will maintain a set minimum temperature.

When using non self-regulated cables, the temperature of the hose and the fluid can be varied using a terminal box.

Heated hoses may be used for either heating the medium or to keep the medium at a constant temperature, without heat loss. In arctic areas, there is a specific need for heating and frost protection of fluids in hoses, for both

high-pressure and low-pressure hoses, for hydraulic oil, water, firefighting systems and other types of fluids and gasses.

In low-temperature areas, the hydraulic components need to keep their functionality to ensure stable operations

and to reduce wear of the equipment. Heated hoses are tailor made, according to customer specifications, and can be delivered with Atex certificates or EX zones.

Tess will continue its development of heated hoses together with its suppliers of hoses and heating cables, to meet new specifications and technical requirements from customers as new projects are developed, not only in Arctic areas, but also in different areas of the industry, as well as in other sectors, such as the power, process and petrochemical, aquaculture and food industries. ■



Trond Sørensen, Tess. Photo from Tess.

The world awaits Åsgard

By Elaine Maslin

The world oil industry's eyes are set on Norway this year. They are watching one development in particular - the first subsea compression system deployment.

It is no surprise the first subsea gas compression system has been developed in Norway. The industry has had strong support from Statoil, which is pursuing its Subsea Factory by 2020 vision, as well as strong, well-supported research institutions and of course a population well used to operations in harsh environments.

However, while many look at Norway with jealous eyes, for the above reasons, it is not necessarily an easy or quick ride from technology concept to deployment. In the case of subsea compression it has taken some 20 years longer than originally hoped.

Kjell Olav Stinessen, now first chief engineer at Aker Solutions, first contemplated subsea gas compression in 1985, while he was working at Norway's Kvaerner. "When

I started in 1985, we hoped we would see the first installation in 10 years," he says. "It took 30 years." But, it has been worth the wait and the timing is now right. "Now the whole oil world is more or less waiting for the results of the first subsea compression project installed. We are now set to deliver the modules for the compression train for the facility which is scheduled to come on stream in 2015."

Before considering subsea compression, Stinessen had been manager at Sintef's multiphase flow laboratory in Trondheim. Here, as a part of the Norwegian University of Science and Technology, an 800m, 8in. flowline and 60m riser were used to test flow regimes, results from which were used to help create Olga, the computer program now used globally to simulate the simultaneous transport of oil, gas and water through the same pipeline, unlocking what had before been much of a mystery.

Stinessen's initial idea for subsea compression was around gas export, and how to transport gas from the wellhead to shore over 100km or so distances. To do so would require compressor or booster stations, he says.

Using subsea compression is attractive to operators because it can accelerate subsea production, the more so the closer to the wellhead it is, and mitigating reservoir pressure drop, increasing recovery rates.

By 1993, a pilot booster station – what Stinessen describes as a "crude compression system" – had been built and tested. It included a scrubber, a 300kV pump and a 1MW compressor. "We tested it for a year and it worked," he says.

An early decision was to create a marinated system, i.e. a wet gas compression system. It hasn't got a wet compressor inside it, it is a marinated dry gas compressor with a normal topside scrubber marinated along with its motor, etc.

However, it is not as simple as it sounds. Between that first pilot and today's final product, there has been a lot of technology development, improvement and qualification, but also a degree of waiting for the market. "In 1993, not many gas fields needed boosting," Stinessen says. It wasn't until 2010 that Statoil awarded a contract to deploy the technology on the Åsgard field. Now, as the project

The modules for the Åsgard subsea gas compression system were ready to be transported from Egersund, near Stavanger in Norway, to Kristiansund in December, pending installation at the field this year. Photos from Aker Solutions.



nears commercial start-up, demand for subsea compression is growing as fields mature and compression, to keep them flowing, is required.

The Åsgard project, which will enable an additional 280 MMboe to be recovered, comprises a compressor station, housed in a 1800-tonne steel frame, containing two 11.5MW compression trains, plus a 34m-long manifold station, in 240-310m water depth. Power will be supplied from the Åsgard A facility.

Gas from the Mikkel and Midgard fields is first routed through a separator, before going into one of the compressors. As the gas is warm, it needs cooling and then is comingled with the liquid, which is pumped from the separator. The gas is then piped to Åsgard B. The design is modular, to aid inspection, repair and maintenance.

Installation is well underway, with the compressor and manifold templates installed. The compressors were due to have been installed by the end of 2014.



Åsgard modules near completion.

Commissioning will start this year. "I think this will open the market because everyone is looking to see what will happen," Stinessen says.

But, getting Åsgard online is just the start. "It is very exciting work that will continue into the future," he adds.

There is much work to be done. As well as working on the Åsgard project, Stinessen was also qualification manager on the Ormen Lange subsea compression pilot with Shell. The Ormen Lange project was designed for a 120km step out, compared to Åsgard's 40km. This meant it required subsea variable speed

drives (VSD's) to step up the low frequency current used on a longer cable, 50 Hz, to the frequency needed for the compressor motors, about 170 Hz, which required additional technology qualification on the electrical equipment involved. Because Åsgard is a shorter 40km distance, the right high frequency can be used down the line, Stinessen says. "We are working to make it [subsea compression] more compact and cheaper," Stinessen says. "We are working

to have longer step-outs and working in deeper waters."

Aker Solutions is developing a "compact compression solution," which would not have VSDs or power electronics, instead a motor and generator with a different number of poles, so the frequency can be stepped up in more reliable and smaller unit.

Pilot unit testing finished late 2014 with successful results. It would open up the ability to go 300km using AC by having very low transmission frequency, say 15Hz, and stepping it up to 100-150Hz that suits the compressor motors, Stinessen says. The world is watching. ■

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Profile - Espen Bostadløyken



After being discouraged from entering the oil industry in the 1980s slump, Espen Bostadløyken is now at its cutting edge, working for Siemens Subsea. Elaine Maslin discovered more.

Like many of the latest generation of Norwegians working in today's oil and gas industry, Espen Bostadløyken was brought up on stories about the oil industry – on Conoco's massive Ekofisk discovery and its development.

In a very short period of time, the industry had grown, fast. Massive structures were leaving Norway's shores to tower over in the harsh Norwegian North Sea's waters. It was industry, on a huge and fascinating scale.

Now, the challenge is just as big, if not bigger, more technical, and requiring ever more new technologies, not least subsea.

"The time of easy oil is over," Bostadløyken says, now Global Head of Sales - Subsea Systems, at Siemens Oil & Gas, based in Oslo. "The oil companies are going into deeper, colder, harsher environments with longer step-outs. We need more technology, we need more subsea

processing technology. The subsea factory is coming." Another big challenge is getting more out of the fields already discovered using increased oil recovery (IOR) methods, he says. "The average recovery rate from subsea is up to about 35%, which means a lot of oil is being left behind. We should really use new technology to get more and it is being done, but we are far from finished. This is an exciting area."

Bostadløyken's fascination with technology and industry started from a young age, he says, both due to the booming oil industry, but also Norway's mining and metals industries, including cutting edge aluminum production facilities. He was also keen to travel, having spent part of his childhood in Zimbabwe, where his father worked for a Norwegian overseas development organization. He gained an MSc in Science and Technology at the Norwegian Institute of Technology in 1998 and having been told joining the oil and gas industry was a bad idea in the early 1990s because of a slump caused by low oil prices, he went into materials safety in the nuclear industry.

But, oil was never far away. He left nuclear and after a period at an advisory firm, Bostadløyken moved to Nexans, working with large subsea export cables

and umbilicals, research, development and manufacturing of which occurred in Norway. He then went on to work for Aker Solutions and Parker Hannifin before joining Siemens in 2012.

Now, he's at a new cutting edge, helping Siemens Subsea get its latest technologies to market – subsea power distribution.

"One of the most exciting things I have been part of is Siemens Subsea and the development of subsea power grid solutions," he says. "They will enable the industry to do subsea processing in deepwater and on longer step-outs." Subsea automation and controls will also offer greater subsea opportunities, including in IOR, he says, with Siemens' subsea hydraulic power units available to provide local hydraulic power for subsea wellhead controls if there is an umbilical failure.

Bostadløyken is also very excited about Siemens' subsea Powerline Modem technology, which enable high data rates on long step outs, on existing copper wires in power umbilicals, to enable improved and increased communication from the increasing/extended array of sensors and controls needed on old and new infrastructure, in well or nearby for leak detection.

The work involves a lot of investment and it will not stop due to the current low oil prices, Bostadløyken says.

"Siemens has a long-term view and we are well aware of the cyclic nature of the industry. There are low oil prices at the moment, some projects have been postponed and there is a lot of discussion around cost and we are part of this. But, we have a long-term view and we are continuing to develop subsea power solutions, because there will be demand to find more oil and gas and for equipment to enable subsea processing."

It is also in the DNA of the Norwegian subsea industry to continue research. "Norway has always been a frontrunner subsea. Some of the first subsea wells were in Norway. There is a very good focus on technology development in Norway and thinking long term, trying to solve IOR, etc.," Bostadløyken says. "Driving new technology can also drive down overall field costs." ■

An illustration of a subsea power grid. On the left, a yellow offshore platform structure is shown with various cables and equipment. A large, thick yellow cable extends from the platform towards the right. In the center, a subsea power distribution unit is visible, with several smaller subsea structures connected to it. The background is a deep blue ocean with a rocky seabed. The Siemens logo is in the top left corner.

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The future of oil and gas recovery involves accessing increasingly complex reserves. Operators are moving into deep and ultra-deep waters, expanding their oil and gas production into remote regions.

Siemens is helping to make these field developments technologically and economically possible with an extensive portfolio of subsea products and systems, as well as with exemplary service and support. Covering everything from connectors and sensors to topside and onshore power supply for subsea electrical consumers, in-field subsea power distribution and power management systems, control, surveillance and pipe line power technologies, we enable enhanced recovery in the

most challenging locations.


The Siemens Subsea Power Grid will reliably supply and distribute power to numerous consumers across the seabed and to downhole electrical submersible pumping systems (ESP's) from an onshore power plant or offshore platform.

Currently undergoing detail design, assembly, and test phase, it incorporates proven high-quality Siemens industrial components, including transformers, switchgear and variable-speed drives. All power units can be installed separately or on a common structure located on the seabed. As such, it marks another milestone in powering large-scale seabed processing facilities – down to 3,000 meters and more.

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