



Myhre times two
Long-term Lien
Imaginative Maria
Comprehensive Diskos

Safe enough?

NORWEGIAN CONTINENTAL SHELF

A JOURNAL FROM THE NORWEGIAN PETROLEUM DIRECTORATE

NO 2 - 2015

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A half-filled glass

Many people are lining up to predict the decline and fall of the Norwegian oil industry a few years from now. Such thinking is too short-term.

We don't share that pessimistic picture, even though the industry faces challenges from oil prices and costs. It's worth noting that less than half the estimated resources on the NCS have been produced and sold.

In our view, the glass is half-

of the NCS. Almost as many as last year's 47, these applicants are looking for new opportunities despite the fall in oil prices.

And the deadline for applications in the next regular licensing round – the 23rd in Norway's oil history – expires in December. We once again expect great interest.

So is everything in the garden lovely? Of course not. We see that the companies are competing to cut costs and downsize their

cheaper than it was two years ago. And most oil market experts predict that prices will recover. The question is when, not if.

By its very nature, oil is a long-term business. Ten years usually pass between discovery and production. The profitability of a new find is not determined by current prices, whatever some might say.

Responsible politicians and those who take a pessimistic view of the NCS could contribute to a better-informed debate by taking note of this time frame.

We're also worried, at this time of cost-cutting, that important expertise will deteriorate. There's room to talk up an industry as important as petroleum a bit more. Don't forget that the engineers who'll be helping to operate Johan Sverdrup have scarcely been born yet.

“Talk up the industry a bit more”

full, not half-empty. But we, too, have been concerned for a long time about the costs, low efficiency and overruns seen in recent years.

Almost 100 discoveries are being assessed for development or in line for such evaluation. Many can be tied back to existing fields from a new subsea installation.

No less than 10 fields have been sanctioned for development or completed in recent years. Four were brought on stream in 2014 alone.

The biggest, Johan Sverdrup, is set to generate big government revenues for 50 years from 2019. It will join the 81 fields – a record – currently yielding oil and gas on the NCS.

Some 165 projects are under way or planned on these producers to boost their recovery factors even further, and thereby increase value creation for society beyond the original estimates.

The government received applications not long ago from 43 oil companies who want to explore more in the mature areas

workforces.

Every krone to be invested is keenly evaluated. Projects such as ones for improving recovery from producing fields are being postponed, along with a number of the new discoveries.

This is critical for some, because the fields or transport systems meant to handle the new resources have limited producing lives.

Our concern here means we will be paying particularly close attention to ensuring that work commitments in the licences are followed up.

Other discoveries can comfortably be put on hold until the relevant area is better developed, and it will be possible to achieve coordination gains.

Today's conditions are nothing new in the oil industry. Downturns have occurred before in this cyclical sector. It has emerged strengthened each time by getting better control over costs and with the aid of recovered oil prices.

The cost picture has improved – drilling a well, for example, is



Bente Nyland

Bente Nyland
director general



“The oil industry must also have two ideas in its head at once,,

Tord Lien accepts to some extent that **new offshore developments** may be postponed. But Norway's petroleum and energy minister has little sympathy for delaying projects on existing fields where **time-critical resources** could be lost. He calls on the companies to make the necessary investments.

| Bjørn Rasen and Sverre Chr Jarild (photos)

“We’ll make provision for value creation – over the long term.”

Dark clouds loom on a fine autumn day in Oslo in the form of yet more negative oil headlines in the Norwegian press. Statoil’s half-year profits have halved. Lien is its biggest shareholder.

The Progress Party politician seems in a buoyant mood as he sits on the ministry’s reception desk, munching an apple and taking snuff while saying farewell to his previous visitors.

His good humour is not undermined by – relatively speaking – brief downturns. Norway’s oil sector has been through troughs before in its 50-year history. And the lesson is that something can be done about it.

“I appreciate that Statoil is doing what it’s said it will – working purposefully to adapt to a different price position,” Lien comments. “That emerges from the figures published today.

“Prices have changed considerably over a relatively short time. We’d all naturally prefer them to be different. But the bottom line is still in the black. Given the present conditions, my impression is that the company is doing good work.”

Bumpy

The minister has been in the job for two years. It must have been a bumpy ride so far. He gives the following status report for the NCS:

“Two years ago, we were worried that the level of activity was too high and that this would create challenges. The concerns are different today.

“We’ve moved from a period of sharp growth lasting to 2013-14, which contributed to an unsustainable development in costs – even when oil prices were high.

“The price level we have now was difficult to envisage then. The first time I presented an oil

price expectation was in the revised national planning budget for 2014.

“Our forecast then was that prices would decline – but not by as much as they have done. That’s naturally affected the companies.”

But activity on the NCS remains at a high level in historical terms, he points out, and emphasises that major investments continue to be made in new and existing fields.

“At the same time, parts of the industry are experiencing a much tougher time than the overall figures for investment might suggest,” he accepts.

“Things have definitely changed. We were worried about finding enough people to crew all the rigs. The position has reversed today, and is very demanding for the rig and petroleum sector.

“Getting down the cost per barrel of oil produced is absolutely essential. We must recover more resources in a shorter time and with a lower investment.”

Lien’s concerns extend beyond the petroleum sector. He is also responsible for a huge hydropower output and other renewable energy in Norway. And he emphasises that the oil industry must also have two ideas in its head at once.

“We must make provision for long-term value creation. This includes providing access to new exploration acreage, for example. That’s why work on the 23rd licensing round is so important.”

This exercise includes blocks in Barents Sea South-East, the area acquired by Norway after a boundary settlement was reached with Russia.

A treaty on the dividing line and collaboration between the two countries in the Barents Sea was signed on 15 September 2010 by foreign ministers Jonas Gahr Støre and Sergei Lavrov.

“A commitment to petroleum research is also important in the

big picture,” Lien says. “That could encourage activity next year – we must maintain expertise and capacity in the industry.

“In a longer perspective, such work will contribute to realising more resources. That’s the lesson we can draw from history.”

Research

Research and development plus new blocks in the Barents Sea represent the long view. More immediately, newspaper articles are calling for action on current tax problems.

At the same time, rigs are being stacked and a certain number of developments have been postponed. Capital is being rationed by the oil companies.

That *could* hit time-critical projects, which must be implemented now to ensure that their resources are recovered before necessary platforms and transport systems shut down.

Quite a few of these projects are socio-economically profitable, but do not seem able to surmount investment constraints in the companies.

The question then is whether the minister intends to use a carrot-and-stick approach. But he maintains that this is already in place within the framework.

“We’ve created a system where a field development which is worthwhile socio-economically will also be commercially profitable. I don’t think anyone would disagree with that.

“However, you could undoubtedly ask whether the field projects are profitable enough to make it into the investment portfolios at the companies.

“We regard the postponement of new field developments with a degree of understanding. But it’s not okay when such delays involve existing fields with time-critical resources.

“These could be lost if the companies fail to make the

necessary investment. Both the NPD and my ministry must then emphasise that we expect profitable projects to be implemented.”

He maintains that the government has made this explicit all along, and feels that the companies “understand what we’re saying, and the dialogue with [them] functions by and large.”

Lien observes that the government must show understanding that not all commitments can be met at times when

which is dynamic by nature, and structured so that it can adapt to change. There’s less need to amend our regime than in many other places.”

Lien does not think the Norwegian model should be compared with that in Britain, where adjustments have been made, because the UK continental shelf has a different resource base.

He sees drawbacks in permitting active use of tax provisions as a countercyclical meas-

ing is what prospects Norway has for remaining a substantial gas supplier to other European nations. Lien is an optimist.

“We obviously have the resources and a fantastic infrastructure built up over several decades. This delivers high regularity, we have the expertise, and are a trusted exporter both as a nation and an industry. Everything’s in place.

“Our aim is to convey a clear message to the European buyers. We expect the signals



Long-term. “We’ll make provision for value creation – over the long term,” says petroleum and energy minister Tord Lien. “This includes providing access to new exploration acreage, for example. That’s why work on the 23rd licensing round is so important.”

capacity in the industry is under heavy pressure.

“But that *isn’t* the case today. The obligations inherent in being a player on the NCS remain unchanged. And I expect them to be followed up.”

He is not prepared to go into the tax position in any depth because it does not fall under his ministry. While not claiming that Norway’s tax model is perfect, he feels it is better than in most other oil-producing countries.

“It ensures a good distribution of risk and revenues between government and companies. We have a model

What then happens when oil prices again reach USD 100 per barrel – or plummet to USD 20?

“Our tax model is good and predictable, and enjoys broad support among politicians and in the industry,” the minister maintains.

Record

Bright spots are to be found even in these difficult time. The Norwegian gas machine has set a record for exports in both gaseous and liquid form this year.

With today’s energy mix, the question many people are ask-

emerging from their systems – which are more politically controlled than here in a number of EU countries – to confirm that this commodity will have a substantial role.

“Both the EU member states and the European Commission are on the right track, and I’m looking forward expectantly to the new EU gas strategy.

“This will probably be published in the first quarter of 2016, and I believe gas – including ours – will continue to occupy a big place in Europe’s energy supplies for a long time to come.”



Gives results. "A commitment to petroleum research is also important in the big picture," says petroleum and energy minister Tord Lien. "That could encourage activity next year – we must maintain expertise and capacity in the industry."

"In a longer perspective, such work will contribute to realising more resources. That's the lesson we can draw from history."

“We still need oil, and Norway has just under one per cent of the world’s remaining crude resources.”

"I've made it clear to the EU that its plans should extend to 2030-40 in order to provide the right investment incentives on the NCS. Further capital spending on infrastructure will call for a big effort."

Lien sees big scope for Norwegian gas. It is public knowledge that the big Dutch Groningen field is having problems in maintaining production. That also applies to a number of other smaller sources of European gas.

"Where we're concerned, this is about maintaining a high level of exports for decades to come," Lien observes. "The government will lay the basis for this."

"That will ensure the resources we have in the ground continue to create value for the benefit of our children and grandchildren, while helping our friends in Europe with the reliable gas deliveries they need to reach their climate targets."

Negative

Gas enjoys a greener image in the rest of Europe than it does in Norway. Petroleum has increasingly becoming a negative term among sections of the Norwegian public, and is discussed in terms very different from a few years ago.

Lien says that the government and the industry must highlight the value created in the form of revenues, employment, and spin-offs where energy plays a central role in social development.

"Oil and gas are contributing to a cost-effective energy system which is fundamental for growth, welfare and prosperity," he notes.

"The industry and this government take the climate issues seriously. We need to overcome two major challenges simultaneously."

"One is to build an energy system which is sustainable

not only in climate terms but also socially and economically. And we must produce enough energy to continue moving hundreds of millions of people out of poverty."

Norwegian gas is definitely part of the solution, Lien says. He identifies two important reasons why a clear disconnect between economic growth and greenhouse gas emissions can now be seen for the first time since the Industrial Revolution.

One relates to Chinese growth, which has moved from being driven by transport and industry to a focus on services. The other is that the Americans are replacing coal with gas. These factors explain half the changes which have been seen, he says.

"We still need oil, and Norway has just under one per cent of the world's remaining crude resources. Some people then ask whether we should shut down the country's biggest source of value creation by far, which employs people all along the cost, to save the world from one per cent of its oil."

"It would be extremely unwise politically, and lead to our production being replaced by oil from other suppliers who cause larger emissions per unit produced than we do."

He believes that people's understanding of the significance of this industry is probably greater now, with oil prices around USD 50 per barrel, than it was two years ago when they were double that.

But that is not enough. The minister says he has told chief executives in the supplies sector and at the operators that they must become more visible in the public debate to boost understanding of the industry among opinion-formers and a larger proportion of the public.

He says he is pleased that more industry leaders have

taken on this role, and are "speaking out better and more clearly than before."

Names

A relevant question for Lien where plain talking is concerned is the government's policy with regard to field names on the NCS, after a change in practice by his predecessor.

Ola Borten Moe from the Centre Party dropped the habit of using labels drawn from Norse history and mythology in favour of well-known parliamentarians such as Johan Sverdrup.

The petroleum and energy minister has the final word on such names, and has not made any change in approach public. But he recently approved a development entitled Maria.

Lien is less concerned with this issue than Moe. "It makes sense that field names convey a meaning in the public mind. But I believe the state ought to refrain from managing such matters in detail."

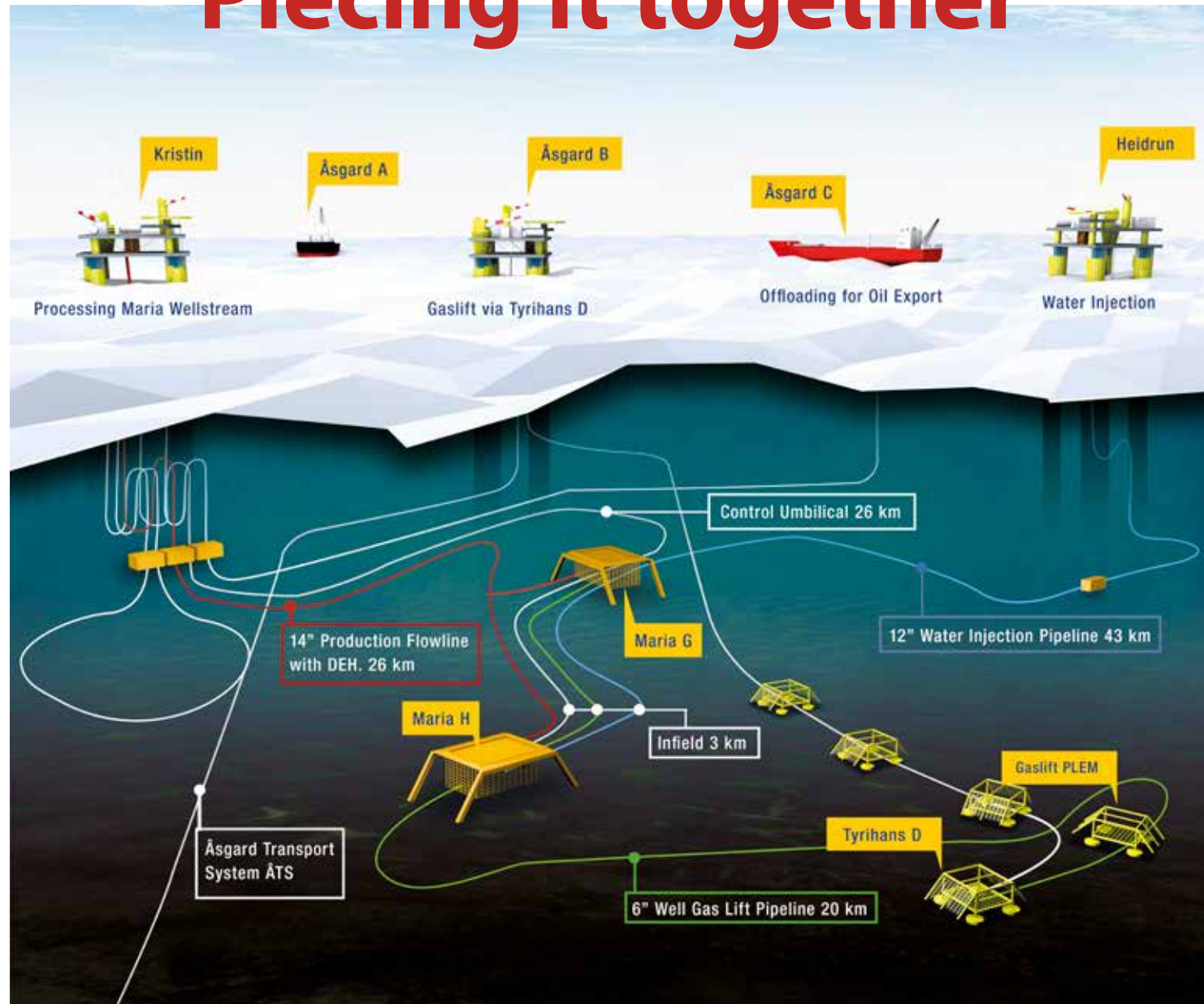
"The industry should be able to think for itself. We have formal authority to decide, but I'd nevertheless urge the companies to pick labels which mean something."

His attention is more concentrated on the challenges currently facing the industry – and the exercise of government authority.

"In times like these, the government – and the NPD is the most immediate agency here – should meet the industry in a manner which is firm but based on dialogue."

"That's more important than ever. We in the ministry must do the same. Despite demanding times, we must do the job properly so that we help to ensure the right investments are made."

Piecing it together



Bit by bit. Wintershall describes the negotiations with the neighbouring licences as complex, wide-ranging and time-consuming. But everything is now in place for bringing Maria on stream in the fourth quarter of 2018. (Illustration: Wintershall)

Developing the Maria oil discovery would probably never have got off the ground if operator Wintershall had thought along traditional lines. Luckily, imagination was given free rein.

Alf Inge Molde

A plan for development and operation (PDO) of this field was approved by the Ministry of Petroleum and Energy on 4 September, despite the biggest oil recession since the late 1990s. Maria lies 230 kilometres from land and 25 kilometres east of the Kristin field on the Halten Bank in the Norwegian Sea, and the process leading to the PDO was demanding.

But project director Hugo

Dijkgraaf at the Norwegian arm of the Germany company says the detailed preliminary work was essential for turning the development into a reality at all.

Semi-submersible *Songa Delta* drilled the discovery well, 6406/3-8, in 300 metres of water during the summer of 2010. That was two years after production licence 475 BS was issued in the 2008 awards in predefined areas.

The Halten Bank is no frontier region. Neighbours include

big producing fields such as Åsgard, Heidrun and Kristin. And the prospect was first drilled in 1986, but without much success.

Thin

This earlier well targeted the perceived top of the reservoir, and should have yielded the most crude. But the oil-bearing strata proved thin, and the licence was therefore relinquished.

New three-dimensional seismic data unavailable in the

1980s then gave the geologists an opportunity to interpret the structure in a different way.

Their re-assessment concluded that the oil-bearing zones were at their thickest in the southern and northern flanks of the reservoir, which has a saddle-like formation in the centre.

That proved to be the case, and the first well proved 60 million barrels of oil to the south. The same amount was found by an appraisal well drilled on the northern flank in 2012.

Furthermore, studies of the reservoir and drainage strategies allowed another 60 million barrels to be matured – revealing a field containing some 180 million barrels of oil equivalent.

The water depth meant that the licensees opted for a subsea development. Two approaches were studied, including a tie-back to an existing platform nearby.

A floating production, storage and offloading (FPSO) unit was the alternative, but Wintershall quickly found that this would be an expensive solution.

However, a round of tie-back discussions with the partners on the nearby producing fields also made it clear that none could offer everything Maria needed.

Something

However, each could provide something. Kristin was able to process the oil, Heidrun offered assistance with water injection, and the Åsgard B platform was in a position to support gas lift.

The last of these needed to be channelled through the Tyrihans D subsea facility. Finally, Åsgard C had the capacity to accept Maria oil for export.

So the challenge for the project was to determine how much had to be spent on each installation to serve Maria. And more than 100 kilometres of pipeline would have to be laid.

Once the jigsaw had been laid, however, Wintershall and its partners found themselves with a much cheaper solution than installing a dedicated FPSO. And it was technically feasible.

“We think we’ve been extremely creative,” emphasises Dijkgraaf.

According to Norway’s regulations on using installations

belonging to others, fields with spare capacity are duty-bound to make a detailed evaluation of such requests.

Tie-backs to existing platforms and other infrastructure make sense both for developers and for the taxpayers who bear the bulk of cost.

“Achieving this involves finding a formula for sharing risk and profit,” explains Dijkgraaf, who describes the negotiations as complex, wide-ranging and time-consuming.

Statoil is the operator for all the installations involved in the Maria project, but the counterparties to the negotiations were other partners who formed varying constellations in each licence.

Many sessions were also required with the government in order to reach a settlement. During the final phase alone, Dijkgraaf met the NPD and the Ministry of Petroleum and Energy 35 times.

New ground

The project director feels that Wintershall broke new ground in many respects with its approach, and believes that many others will follow its lead.

Kalmar Ildstad, deputy director general of the NPD, and Tove Francke, who was responsible for work on the Maria PDO at the directorate, also think that many more satellite projects will be pursued on the NCS.

The majority of the 100 or so discoveries which remain to be developed off Norway are too small to support a stand-alone solution.

However, many lie close to existing infrastructure in the North and Norwegian Seas, and could tie into this as capacity becomes available in order to achieve a profitable project.

That approach has the added benefit of helping to extend production from fields where new satellite fields connect to their facilities.

“Maria has set a Norwegian record for the number of tie-ins for a single development, and demonstrates that much is possible if the willingness to collaborate is present,” says Ildstad.

Wintershall expects to spend a total of NOK 15.3 billion on the

development – more than NOK 2 billion below the original investment estimated.

Part of the saving was achieved through optimisation in the planning process, but Dijkgraaf does not deny that developers get a lot for their money now that suppliers are hungry for orders.

The Maria licence, for example, was able to charter Odfjell Drilling’s *Deepsea Stavanger* rig for 574 days at a cost of roughly NOK 1.5 billion – considerably less than the rate two years ago.

There has been no question of postponing a development in the hope of securing even more favourable prices. Given today’s oil prices and the investment climate, however, Dijkgraaf admits that the licensees would not have considered an FPSO.

“That solution was challenging when oil prices were USD 110 per barrel, and would certainly have been out of the question when they were down to USD 45. So we had to be creative.”

Maria

This field contains 180 million barrels of oil equivalent, including a small quantity of gas. It is due to come on stream in the fourth quarter of 2018.

The development solution comprises two subsea templates, both with four well slots. Two producers and a water injection well will be drilled through each of them.

Tie-backs involve the wellstream being piped to Kristin for processing, injection water coming from Heidrun, and supplies for gas lift being provided by Åsgard B via Tyrihans D.

Processed oil will then be transported to Åsgard for storage and loading into shuttle tankers, while the gas is exported through the Åsgard Transport system to Kårstø north of Stavanger.

The licensees in the field are Wintershall (operator) with 50 per cent, Petoro with 30 per cent and Centrica Resources (Norge) with 20 per cent.

Subject to government approval, a transaction due to be completed in late 2015 will transfer a 15-per cent interest to Tellus Petroleum from Wintershall, which remains the operator.

Building stone by stone

Our last issue took a look back at Norway's oil past, 50 years after the first licensing round on the NCS. We now look at the story of safety in this sector, where trust between employees, employers and government has been a red thread.

The cost of carelessness has proved very high. Many people remember the *Alexander L Kielland* accident from 1980, and even more recall the *Deepwater Horizon* disaster in the Gulf of Mexico during 2010.

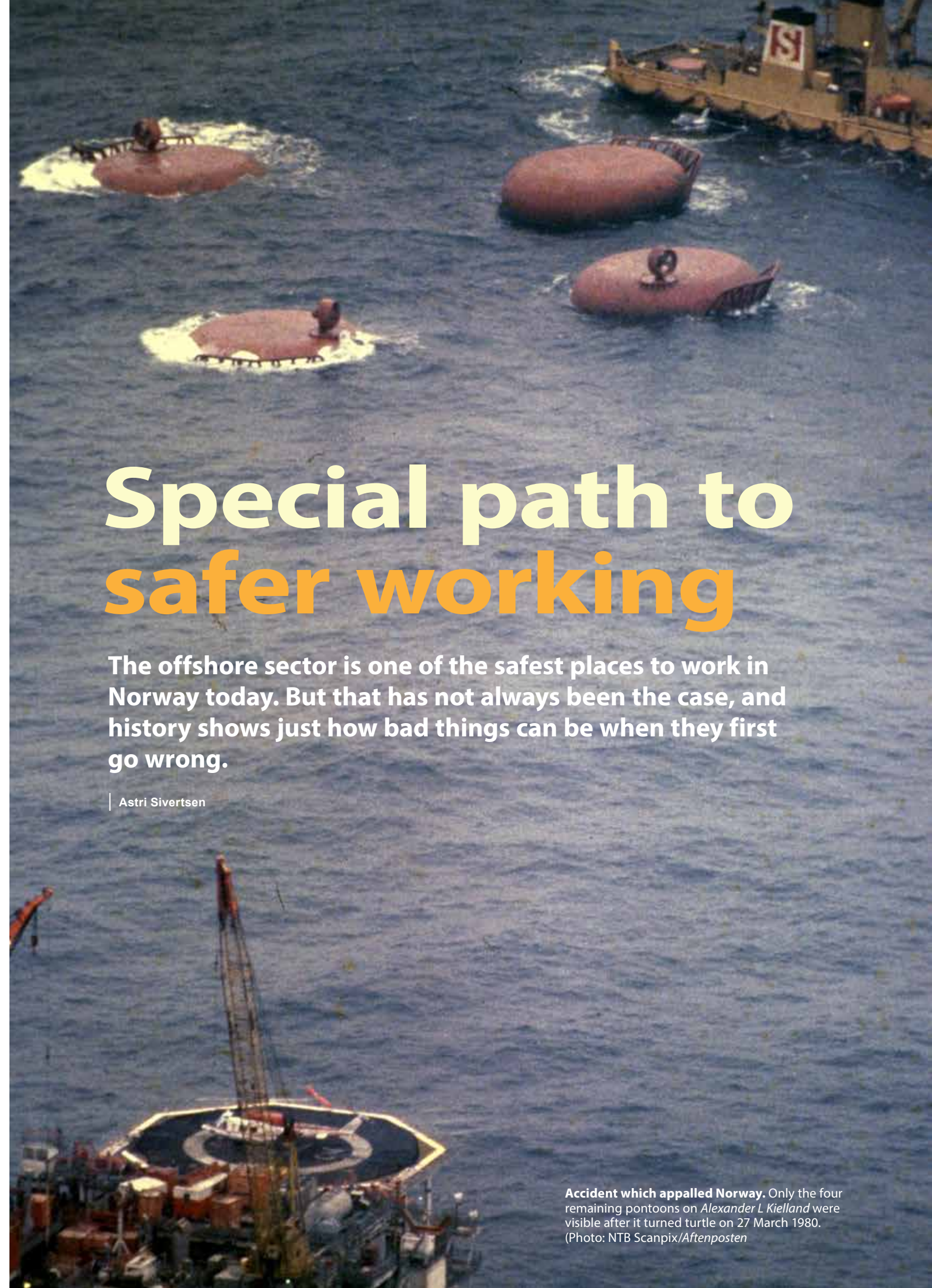
At a time of big cost cuts, everyone agrees that savings cannot be made at the expense of work on safety. We ask how much is good enough.

Another article brings together father and son Eldar and Aslak Myhre – the first a former union colossus from the Kværner group and the other now head of the National Library of Norway.

These two high-profile figures share their thoughts about the developments they have participated in since Stavanger left the canning business to enter the oil age. They talk a lot about the significance of the Rosenberg shipyard and Norwegian mentality.



Key figures from the history of oil city Stavanger. Former law-of-the-sea minister Jens Evensen (1), former Statoil CEOs Arve Johnsen (2), Harald Norvik (9) and Helge Lund (10), first Norwegian petroleum and energy minister Bjartmar Gjerde (3), former mayor Arne Rettedal (7), and former top NPD staffers Fredrik Hagemann (8), Gunnar Berge (5) and Farouk Al-Kasim (6) – while 19th century novelist Alexander Kielland (4) looms in the background. (Illustration: Roar Hagen)



Special path to safer working

The offshore sector is one of the safest places to work in Norway today. But that has not always been the case, and history shows just how bad things can be when they first go wrong.

| Astri Sivertsen

Accident which appalled Norway. Only the four remaining pontoons on *Alexander L Kielland* were visible after it turned turtle on 27 March 1980. (Photo: NTB Scanpix/Aftenposten)



Big forces. Crew on anchorhandler *REM Gambler* working to release *Bredford Dolphin*. (Photo: NTB Scanpix/Samfoto)

It may be a bit excessive to claim that explaining Norway's offshore safety regime to foreigners is always a problem, says Preben Hempel Lindøe. But this presents at least a challenge.

"People who're used to a more traditional form of regulation find it difficult to grasp how our system functions," says the professor emeritus of risk management and societal safety at the University of Stavanger.

A few years ago, he was involved in the launch of an international book project on managing risk in the oil and gas industry.

An American colleague was unable to understand how such a tough sector could be regulated through framework regulations which place responsibility for safety on the companies themselves.

But two days in a Stavanger hotel, meeting unions, the Norwegian Oil and Gas Association and the Petroleum Safety Authority Norway (PSA) gave him the answer.

"This is a small world where people know each other, and there's a level of trust in the systems which has been built up over a long time," Lindøe notes.

Forged

This "tripartite" trust between unions, employers and government was forged in the Second World War, explains the professor, who wrote his PhD on internal control in land-based enterprises.

When Norway was being rebuilt after the German occupation of 1940-45, people in key positions knew and trusted each other from the resistance movement.

Tripartite collaboration was

the cornerstone of the Working Environment Act passed in 1977, which Lindøe says encountered much resistance when it came to be extended to the NCS.

"This produced an exacting confrontation between American and Norwegian work cultures, and set its stamp on many of the labour conflicts which occurred in the early years."

Pioneer

During the pioneer years from the mid-1960s, historians have found that the risk of a fatal accident offshore was eight times greater than in the rest of Norwegian industry.

People were killed in falls or crushed by dropped objects. They died in helicopter crashes or suffocated from lack of breathing gas when diving in deep water.

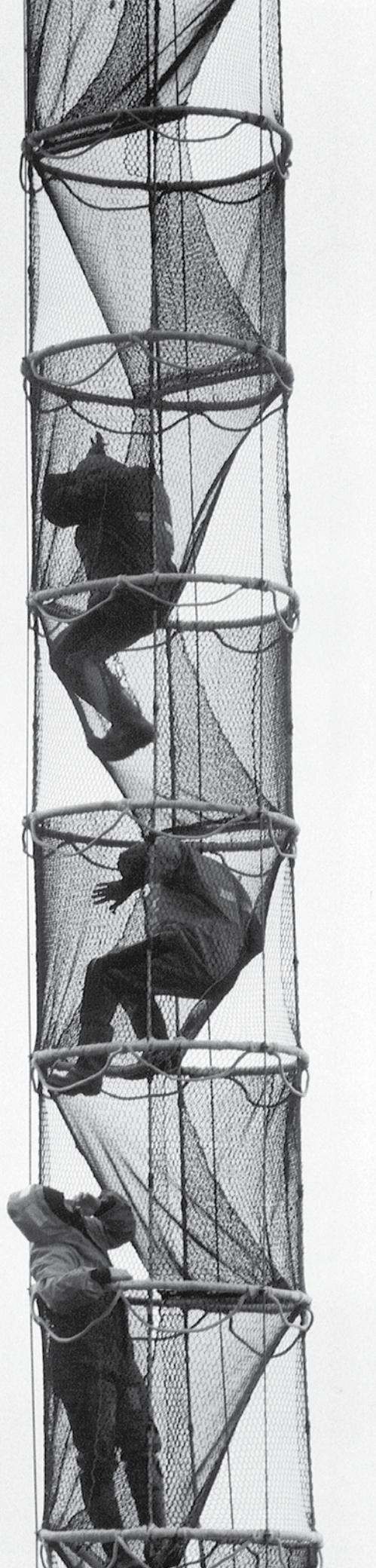
A total of 82 workers lost their lives between 1965 and 1978, more than half of them during the development of the Ekofisk field from 1971 to 1977.

All that happened before the great disaster of 27 March 1980, when the *Alexander L Kielland* accommodation rig (flotel) turned turtle in the North Sea.

Killing 123 people, this accident horrified government and public opinion alike and was crucial to the development of Norway's safety regulations and organisation.

Three decades after *Alexander L Kielland*, in April 2010, the biggest offshore disaster of modern times occurred with the *Deepwater Horizon* rig in the US Gulf of Mexico.

A blowout in a well on the Macondo field caused this unit to catch fire and sink, with the death of 11 people and an oil leak which lasted 87 days before it was finally plugged.



Escape chute. An important part of offshore evacuation equipment. (Photo: NTB Scanpix/Samfoto)

Paradoxically, the crew of the rig had been celebrating a long period of injury-free operation on the day that the blowout happened.

Lindøe explains that the safety system in the USA was such that inspectors could arrive unannounced by helicopter on a facility, bearing long checklists.

“But the question is what such lists actual reveal,” he observes. “They give you no insight into the organisation and how the system is built up. You get white spaces on the map, particularly at the interface between different operators.”

This is where the NPD initially and later the PSA have led the way by investigating the connections between technology and organisation.

They have also challenged the industry to discuss safety issues openly, Lindøe notes. “Not necessarily in public, but through dialogue meetings and technical seminars. That’s a very different approach.”

The PSA checks that safety systems in the companies are consistent, and that all decisions can be traced. That cannot be done simply with checklists, since everything usually looks fine on the surface.

Performance

Rather than prescribing in detail what equipment is required and how work should be done, the Norwegian regulations are performance-based (or functional).

In other words, they specify safety targets or functions and leave it to the companies to establish management systems which meet them – with great freedom to choose appropriate solutions.

When the government prescribes

a rule, Lindøe explains, it will also be responsible for the consequences if this is not implemented.

Requiring the companies to set their own standards means the responsibility rests with them. That is the nub of the Norwegian regime, which may not be so easy for outsiders to understand.

“Our system calls for expertise and self-awareness, and in that respects makes big demands on the enterprises,” the professor notes.

It has transpired that many small foreign companies can feel uncertain and often want to see clearer rules, he says. This is one reason for the growing use of consultants offshore.

The trust-based internal control system also calls for a high level of expertise at the regulator if the industry is to have confidence in its decisions.

That is a big problem in a number of other countries, says Lindøe. Official regulators there are unable to recruit staff with sufficient ability because the work has low status.

Financial pressures have also led to a dramatic scaling back of regulation in many countries, while the Norwegian government has been willing to maintain the number of regulatory personnel.

He adds that Norway’s regulations have largely been framed by engineers and people with practical experience. “Whether you’re a well specialist in Statoil or the PSA, you know what you’re talking about. You speak the same language, and try to find sensible solutions.”

Conflicts

The Norwegian system may be based on trust and openness, but that does not exclude conflicts between



High up. Rope access technicians prepare to change lifeboats on Oseberg East. (Photo: NTB Scanpix/Samfoto)

the various sides. This emerged, for example from the NPD’s 2000 annual report.

It contained a sharp warning that the previously positive trend in the level of petroleum-industry risk appeared to have reversed. The NPD said it could not accept that this manifested itself in the form of a larger number of serious accidents.

“Developments had moved in a negative direction for several years, and the time had come to speak out,” says Magne Ognedal, who joined the NPD in 1974 and became its safety director in 1980.

He subsequently headed the PSA after it had been separated from the NPD in 2004 until his retirement in 2013, and has made a stronger mark on the NCS safety regime than any other individual.

Good progress was achieved after a regulatory reform in 1985, he recalls. Before then, the NPD had been merely one agency among many with a formal responsibility for offshore safety.

In the wake of the serious accidents which were taking place,

however, the directorate began to agitate for something to be done.

The NPD’s safety division reported at the time to the Ministry of Local Government and Labour, and Tormod Hermansen – its top civil servant – sparked a complete shake-up.

In addition to the introduction of Norway’s first Petroleum Act, the internal control principle applied by the NPD since the late 1970s was formalised in a royal decree.

The number of agencies involved on the safety side was whittled down to just three – the NPD, the predecessor of today’s Norwegian Environment Agency, and the Norwegian Board of Health.

According to Ognedal, this greatly simplified administration and follow-up of offshore safety. “The 1985 reform was crucial, and laid the basis for subsequent progress.”

By the late 1990s, however, the curves were starting to move in the wrong direction. The NPD was sharply critical of operator Norsk Hydro after a fatal accident on Oseberg East on Christmas Eve

2000, and trust between government and companies hung by a thread. Fresh action was needed.

Significance

Two innovations from this period have acquired great significance – the annual survey of trends in risk level in the petroleum



Not an individual responsibility. Preben H Lindøe holds the bannister to please the photographer. (Photo: Arne Bjørøen)



Mexican Gulf disaster. Deepwater Horizon in flames. (Photo: NTB Scanpix/AP Photo)



Major accident defined

A major accident means an acute incident such as a major spill, fire or explosion which immediately or subsequently entails multiple serious personal injuries and/or loss of human lives, serious harm to the environment and/or loss of major financial assets (Source: PSA).

Accident statistics

A total of 44 people were killed at work in Norway last year. The four industries with the largest number of fatalities were construction (11), agriculture, forestry and fishing (eight), transport and storage (eight) and industry (six). The last fatal accident on the NCS was in 2009. (Sources: Norwegian Labour Inspection Authority, PSA)

123 lives lost. The Alexander L. Kielland after it had been righted. (Photo: NTB Scanpix/Aftenposten)

activity (RNNP) and the Safety Forum.

Various indicators had long been used to measure the level of safety, but the RNNP report has been issued every year since the start of the new millennium by the NPD and later the PSA.

This overview draws on data from such sources as the operator companies, the Norwegian Civil Aviation Authority and the helicopter operators.

Several research teams have been involved in developing the methodology, which

Lindøe believes to be unique for Norway. Other nations lack such an integrated factual base.

The advantage of the RNNP is that it provides a shared understanding of reality which all the parties can agree on. That eliminates any war of words about the facts. The RNNP report accordingly also lays the basis for taking necessary action.

All sides of the industry have met regularly in the Safety Forum since 2001, regularising the less formalised meetings held earlier between govern-

ment, employers and unions.

Ognedal highlights efforts to cut hydrocarbon leaks on the NCS, which can have very serious consequences for both people and the environment, as an example of the way the system works.

When the RNNP process revealed a very negative development for such incidents, the issue was raised in the forum. The trend had to be reversed, and the industry accepted responsibility.

"Norwegian Oil and Gas did

a very good job in that connection," Ognedal says. This work began with an extensive study of the reasons for these leaks.

That was followed by a number of measures to rectify the causes identified – right down to the level of teaching people to tighten flanges correctly.

Efforts were regularly reported back to and followed up in the forum. The result was a halving in hydrocarbon leaks from about 40 in 2000 to roughly 20 five years later.

Since then, the figure has

been halved yet again and has lain in recent years at an annual total of roughly six-nine incidents.

According to Ognedal, tripartite collaboration and common arenas such as the Safety Forum have proved very important for reducing risk in the petroleum industry. And both reflect a model developed unilaterally by Norway on its own special terms.

"The roles played by the various oil-sector participants differ from other countries," he says. "They lack the same basis.

Unions here have a very different position than in the UK, for instance."

Major accidents

Over the half-century Norway has been pursuing oil and gas operations, safety work has largely been directed at avoiding major accidents.

And that is natural enough, given the potentially disastrous consequences of a gas blowout or a design error for human life, the environment and society in general.

Staying safe from the cuts

Lindøe points to research which has shown that such accidents usually have complex causes involving the interaction between humans, organisation and technology, and are generally the outcome of a chain of decisions at many levels.

That makes it meaningless to assign responsibility for safety to individuals working offshore, despite the trend a few years ago to focus on employee behaviour.

While Lindøe accepts this is important enough, he says that safety can never be individualised or reduced to a hunt for scapegoats when an accident occurs.

Preventing and limiting the scope of possible incidents calls for the incorporation of technical, operational and organisational barriers.

The industry must adopt the precautionary principle, with both companies and government working systematically to learn from accidents in order to improve systems continuously.

In Lindøe's view, Norway's petroleum industry has been a pioneer with new methods of thinking and practising safety. That has made it a model and a reference for other sectors in society.

Contrast

"Compared with other Norwegian industries, safety on the NCS is good," he maintains. And the contrast with a business like fishing is striking.

By comparing deaths in 1990-2005, Lindøe established that – based on work-years – a fisherman is 12 times more likely to suffer a fatal accident than an offshore employee. That figure rises to 25 when helicopter accidents are excluded.

This reflects culture and history, the professor argues. Fishermen appreciate that they have a dangerous profession. Nor are they willing to accept an outside authority telling them how to do their job.

The number of accidents in Norwegian agriculture

is also high, with safety in this sector usually regarded as the responsibility of the individual farmer and their family.

"Offshore safety is a national concern," Lindøe comments. "We have historical examples that trust has been very fragile at times, and that major accidents have lurked just out of sight.

"Such incidents and their consequences are precisely the considerations which make it defensible to maintain such a high level of safety in the oil industry."

Everyone agrees that cost savings on the NCS must not be made at the expense of safety. But that poses the question of how much is good enough.

| Astri Sivertsen

"It's difficult to quantify something which hasn't happened," Magne Ognedal responds when confronted with claims that Norway's offshore safety regime is too expensive.

How much an accident would cost is what the former long-serving safety director at the NPD and subsequent head of the Petroleum Safety Authority Norway (PSA) wants to know.

The bill for the

Deepwater Horizon disaster in the Gulf of Mexico, for example, already exceeds USD 50 billion (NOK 400 billion) even before the compensation settlements are complete.

"Investing a dollar to avoid losing more than USD 50 billion – that's what this is all about," he says.

Ognedal has experienced several oil price downturns. Every time one happens, the companies launch what he calls

"the traditional measures".

These include cutting exploration activities and maintenance work – but reducing the latter presents a challenge to health, safety and the environment (HSE).

Ognedal also adds that Norway has seen nothing to match the serious delays to maintenance work observed on the UK continental shelf, where platforms have had to shut down as a result.

While holding a key



Horrified. Magne Ognedal in front of the monument to the people who died in the *Alexander L. Kielland* disaster. This incident on 27 March 1980 horrified government and public opinion alike. (Photo: NPD/Emile Ashley)



Photo: Morten Berentsen

role in offshore safety regulation, he was constantly confronted with claims that the Norwegian regime was too demanding and expensive.

"At least four commissions of inquiry have studied this issue," he observes. "They tried to identify particularly expensive requirements, assessed our rules against their British counterparts and so forth.

"Nothing specific has emerged from this work. It's clear that safety costs. But the main question, of course, is whether these costs are acceptable.



Safety weakened. Henrik Solvorn Fjeldsbø (top) in the Norwegian Union of Industry and Energy Workers fears that cost-cutting will undermine safety and emergency response.

Lower bills. Knut Thorvaldsen (above) in the Norwegian Oil and Gas Association for employers sees great willingness to cut costs, both in the industry and with government. (Photos: Astri Sivertsen)

"The answer is that we've managed to maintain the high level of safety that we've been able to achieve, and thereby avoided costly accidents and disasters."

Challenge

"The level of costs," is Knut Thorvaldsen's blunt response when asked to identify the biggest challenge facing Norway's petroleum industry.

As deputy director general of the Norwegian Oil and Gas Association, which organises 54 oil companies and 61 suppliers, he is very familiar with the reports mentioned by Ognedal.

But the big problem in his view has been the unwillingness to implement the measures proposed in these studies. "We don't need more reports. What we need now is specific action."

Thorvaldsen says the oil industry is dependent on the trust of its own employees and society as a whole to stay in business and to secure new areas in which to operate.

"An accident will naturally affect the company concerned, but would also be a setback for the whole sector," he admits.

He adds that a company may not be interested in helping its competitors to achieve the best possible financial or exploration results, but collaborating to ensure optimum safety is in everyone's interest.

Thorvaldsen refers to the PSA's 2014 report on trends in risk level in the petroleum activity (RNNP), which documented the lowest level of major accident risk since it began to be measured.

Moreover, the last fatal accident on the NCS occurred in 2009. And a further sign of a positive trend is the decline in the number of personal injuries.

The industry has long recog-

nised that its level of costs is too high, and Thorvaldsen points out that measures to rectify this had been initiated even before oil prices began to fall.

Meanwhile, the backlog of safety-critical maintenance is smaller than before. The companies ensure that such work gets done on time after setting strict priorities.

"Everyone appreciates that letting maintenance slide may yield a short-term cost saving but will be negative in the long run," says Thorvaldsen.

Oil prices are what they are. According to Thorvaldsen, the companies prefer to concentrate on what they can do something about. Norwegian Oil and Gas is contributing in part through standardisation and reducing documentation in the industry.

Lifeboats

But the government must accept its part of the job, he says, and not impose what he calls "unnecessarily expensive regulations" on the industry. Proposed new rules for lifeboats are an example.

According to the PSA, meeting these requirements would cost an NOK 8-19 billion. But the association puts the figure at NOK 60 billion – admittedly under an earlier draft of the regulations.

In its view, the safety gain is marginal while the bill would be huge, and Thorvaldsen challenges the government to base new or updated regulations on cost/benefit analyses.

He says that the Ministry of Labour and Social Affairs, which is currently considering the lifeboat issue, has shown an interest in getting the industry's costs down.

Among other moves, it has dusted off the 2012 report of the official rig commission, chaired

by Eivind Reiten, which looked at ways of improving the flow of such units over national boundaries.

Thorvaldsen regards this as positive: "There's an acknowledgement that costs are too high, and the fall in oil prices has obviously reinforced this. I see a great willingness to look at costs, both in the companies and by government."

Worrying

The risk of major accidents may have been at its lowest-ever in 2014, but this year got off to a worrying start with several serious incidents during the first quarter.

These could have led to major accidents and personal injuries, and the PSA initiated no less than six investigations – an unusually high figure for such a short space of time.

"This is probably the worst beginning to a year we've seen for a very long time," says Henrik Solvorn Fjeldsbø, head of HSE at the Norwegian Union of Industry and Energy Workers (IE).

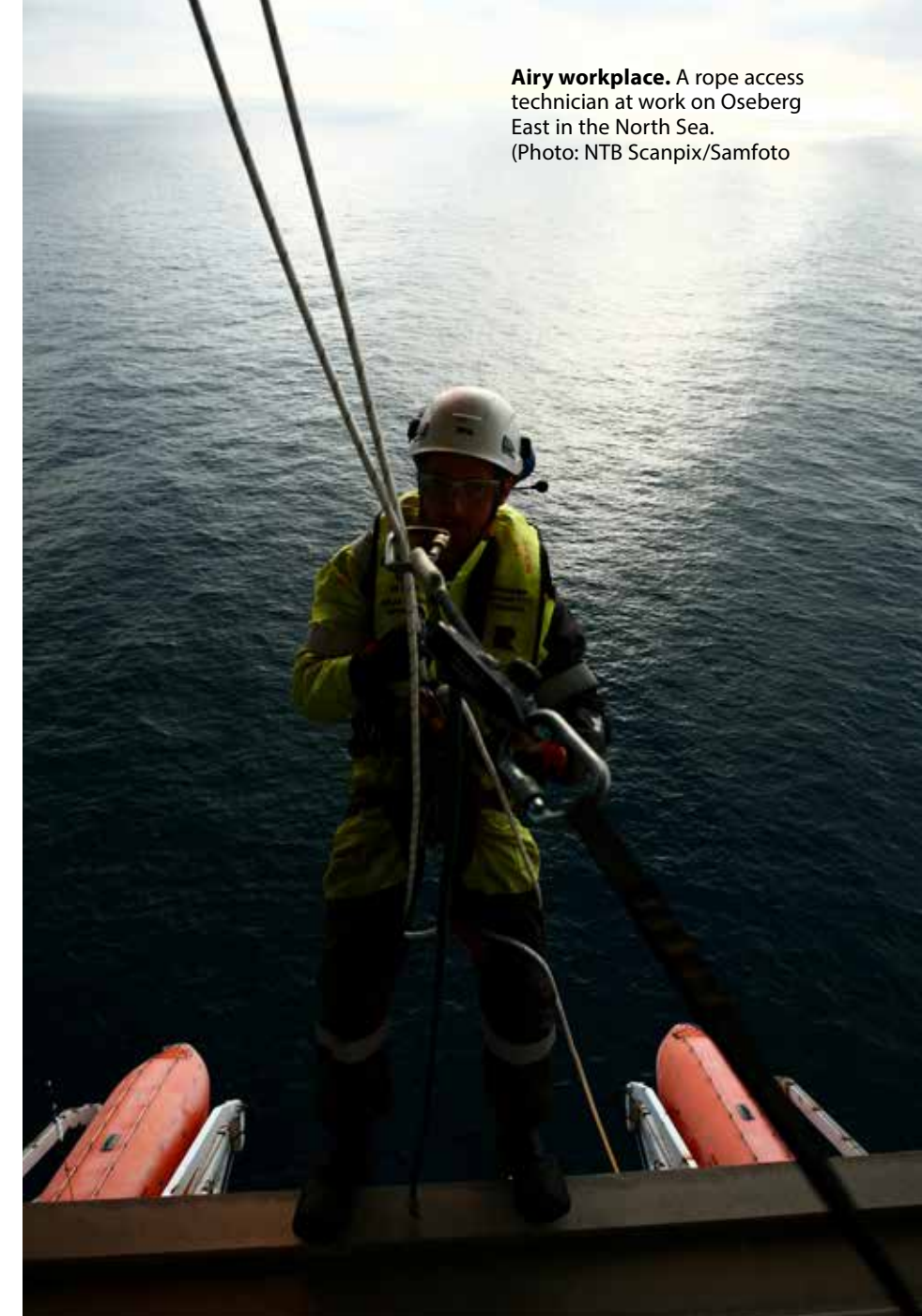
Part of the Norwegian Confederation of Trade Unions (LO), this organisation has about 17 000 of its 61 000 members working offshore.

"We're obviously concerned," says Fjeldsbø. "The question is whether this reflects changes in the industry or is simply a coincidence. It's too early to draw any firm conclusions."

The oil price slump means that the companies are cutting costs, and more than 25 000 jobs have disappeared in Norway's oil and gas industry over the past 18 months.

That estimate comes from DnB Markets, and its analysts believe that the redundancies and layoffs are likely to continue for some time yet.

Fjeldsbø's worry is that the cuts are too deep, and notes that the level of required safety and emergency response training is currently under revision.



Airy workplace. A rope access technician at work on Oseberg East in the North Sea. (Photo: NTB Scanpix/Samfoto)

The industry wants to cut the number of specialised course for personnel with response functions, company HSE staffs are being slimmed, and free time for safety delegates is being reduced.

"You lose the experience and expertise of those who know where the problems lie," Fjeldsbø points out. "If this is allowed to continue, safety and emergency response will be undermined."

Fewer employees and resources in general mean that personnel still in the companies get more to do and must cover a wider range of functions – while worrying that it could be their turn to go next.

Fjeldsbø cut his teeth in Norway's aluminium industry, and has seen the effects of

redundancy processes at close hand both on companies and on people afraid of losing their jobs.

"It has an effect on their mentality," he observes, and adds that the IE has seen relations between employers and unions sour when cost cuts and restructuring are on the agenda.

He is constantly getting reports from safety delegates and union officials that they are being involved too late in the change processes, and that employees are only informed after decisions have been taken.

"Regulations in Norway's petroleum industry are performance-based. That assumes good and close collaboration and dialogue between companies, unions and government. It's very unfortunate when the balance of power is upset."

Down with documentation

The number of documents in the Norwegian oil sector has become irritatingly large. So government and industry are collaborating to do something about them.

| Astri Sivertsen

"You can have too much information," says Bjørn Thomas Bache at the Petroleum Safety Authority Norway (PSA), which has launched a project to help cut documentation in the petroleum business.

"Important details can drown in this flood. And we've unfortunately seen many examples of safety-critical data which fail to be spotted."

With many years of experience from big oil industry suppliers, Bache heads the joint project between the government, three operators, three main contractors and three equipment providers.

Work in the project is confined to life-cycle information (LCI), and the companies taking part have been chosen because they have a relationship with each other.

Moreover, the selected suppliers also have customers across the industrial spectrum, and can

thereby see differences between the petroleum sector and other industry.

Safety regulation is a three-tier pyramid, topped by the overall functional or performance-based regulations set by the government.

Below these come the industry-wide standards, while the internal requirements and norms set by each company form the bottom layer.

The functional regulations have not changed over the years, Bache notes. But it is a different story where industrial standards are concerned.

Individual technical disciplines feature a good deal of compartmentalised (or "silo") thinking, even though the aim is integrated systems rather than specifying sets of components.

But solutions will be sub-standard unless their designers are prepared to look beyond their own specialised field,

Bache says. The same applies to documentation.

"We're becoming aware that things have got a bit over-specified, and that also represents a safety risk. Systems get too complicated in terms of maintenance and safe operation."

He also points to poor updating of key industry standards. Norway's Norsok Z-001 norm, which sets documentation requirements for technical equipment, was last revised in 1998, for example.

According to Bache, the result is that the players have produced their own standards. Company-specific requirements are rife in the various disciplines.

After meetings between everyone involved, the study will lead in the second quarter of next year to a joint final report with recommendations for use by both companies and government.

Explosive growth

Document requirements from suppliers of fabrication projects have increased 230 per cent over a decade, according to one of the main contractors delivering to the NCS.

Measured by the number of documents per tonne of topside equipment, this figure has been reached by comparing two similar contracts implemented 10 years apart.

Requirements for design documentation had doubled over the same period.

Tenfold increase in two decades

"Why does a platform need 10 times the documentation today that it required in the 1990s?" Per Harald Kongelf, regional manager Norway for Aker Solutions, at a union-organised oil and gas conference in Bergen during October 2014.



Statfjord B.
(Photo: Harald Pettersen/Statoil)

Interviewing two talkative generations of Myhres – Eldar and son Aslak – about the growth of Norway’s oil sector and Stavanger’s transformation from a canning town in decline to an oil capital is like asking for a dram and getting the whole bottle.

Bjørn Rasen and
Morten Berentsen (photos)



Different perceptions. Eldar (left) and Aslak Myhre are surprised by fellow Norwegians who believe the welfare state will persist even if the oil disappears. “The problem in Norway today is that we’ve forgotten that you need a cow if you’re going to have milk.”

Dickens?” chuckles Aslak, who is now head of the National Library of Norway. “This pub has gained far too big a place in Stavanger’s local history.

“It’s become a persistent myth. When I grew up, Dickens was a place where fans of the local Viking football team took a beer before a home game – and another if the club won.”

The point of choosing one of Stavanger’s oldest pubs for a chat with him and his trade unionist father is that reminiscences flow more freely around a table there.

This was allegedly one of the old hot spots where oil news was discussed, and where roughnecks and divers were recruited to new jobs during their time ashore.

“I don’t think so many problems were resolved exactly here,” Eldar adds. “Other things went on. The Skjenkestuen bar came later, and was more where that happened.”

Another myth, concerning heated political discussions around the kitchen table in the Myhre home, is just as effectively crushed.

“Like other people, we were interested in getting to work or school, everyday concerns,” says Aslak. “We didn’t hold any political seminars at home.”

A hectic programme of union meetings often kept Eldar out late. The home was an oasis to relax in. It was important *not* to bring the job home.

“I was otherwise up an hour earlier than Aslak, of course, and only had the cat for company. We never quarrelled. Dinner was eaten there, obviously, but we didn’t discuss the oil industry in particular.”

But Aslak admits that things did happen at home, as he notes in his book *Herskap og tjenere* (Upstairs, Downstairs) when trying to describe everyday life.

“I well remember coming home to find Dad lying there with an injured shoulder. I was young, and have never forgotten it. I read that people were injured, and when I got older somebody died.”

That was at Rosenberg Verft, which turned in the late 1970s from building

Myth-busters

tankers to fabricating platforms for the oil industry and where Eldar worked.

"What *did* matter was who won the contracts," Eldar emphasises. "The crucial question was whether the work went to us at Rosenberg or to Aker Stord [further north]."

Heavy engineering is politics, then as now. Aslak's past as chair of the Red Electoral Alliance must have been an issue at home, no matter how early they got up or how late they returned. Aslak firmly denies that he grew up in a "political seminar", where his parents tried to mould his views – although he admits to having been influenced.

"But if Dad or Mum had tried to get me to think something, they'd have got nowhere. My own political activity was shaped in quite different arenas.

"It undoubtedly reflected what I experienced at home, and our standpoints are pretty similar. But my views weren't shaped by my family.

"It was important to emphasise that they were my own. I got an earful once when I reported

that one of my friends was an anarchist, so that was perhaps where the line was drawn.

"I saw what Dad and Mum were doing, and that it meant something. I was proud of it. But I don't think I ever told Dad that." He smiles as he meets Eldar's quizzical look.

Aslak has been used to speaking out since boyhood. His grandparents had a house in the Ryfylke region north of Stavanger, which he often visited with his parents.

Equipped with a Norwegian flag on a long pole, he joined his grandfather in the local parade on 17 May, Norway's Constitution Day.

He was happy to do so, but thought the event was little tame and ended up giving a speech from a big rock. But it was far from a conventional appeal to national sentiment.

"It must surely have been the only 17 May speech in inner Ryfylke which demanded a Soviet withdrawal from Afghanistan or the USA out of Nicaragua," Aslak recalls.

"Or which rejected both

superpowers, and called for free nursery places for all children and – not least – for a six-hour working day with full pay compensation."

Eldar found he had an active son who did well on every front, and who eventually acquired his own authority. At 19, Aslak went to university in Bergen and "it was liberating for him not to be identified everywhere as my son."

Aslak nods. Bergen was a different world and the move was crucial for his political engagement.

"When Aslak became a media figure, I felt I had to reduce my own exposure a little," adds Eldar. "That was a conscious decision on my part."

Fifty years after the first licensing round on the NCS was announced, the place of oil and gas in Norway's public debate has changed. More of that later. The question for the Myhres is what should survive from this first half-century of petroleum activity.

Aslak notes that the 1970s and 1980s were childhood



Rosenberg Verft. Building the Statfjord B topsides around 1980. (Photo: Rein Øverland/Norwegian Petroleum Museum)

memories for him, but that he saw "a radical change in the way oil was talked and written about into the 1990s." That became even more noticeable in the 2000s.

"During the 1980s, the discussion focused a lot on contracts, jobs and production by the companies, while oil company finances are at the centre of attention today," he notes.

Eldar agrees with him to a degree. He observes that few people in the early days had any perception of the industry's scope and the significance it would have for society's development.

"The majors were here, of course, and we knew they were large in a world context. But that we would build up a company [Statoil] able to rank alongside the big boys who had arrived here then was beyond our ability to imagine at the time.

"But it's happened, and we've acquired step by step the know-how we initially had to fetch from abroad. Today, we're delivering expertise to others. The changes are massive and colossal revenues have been generated."

In his view, the most evident changes are to be found in the self-confidence, self-belief, mood and temper among Stavanger residents.

Most locals earlier felt oppressed, and accepted the images of them and their city created in Oslo. "Fights could break out if we ran into someone from eastern Norway. Today we meet people with our dialect everywhere."

However, Stavanger has been

proud of its technology since the early 1970s, with Kværner Rosenberg building seven groundbreaking liquefied natural gas carriers with spherical tanks in 1973-80.

"These were advanced ships developed by Kværner itself, and the company made good money from them," Eldar says. "Others began building oil platforms, but we saw no future in such primitive structures. That's why we were late to the table."

Kværner may have lagged behind initially, but it quickly caught up. And its labour force had to change their work culture to one where directives occupied a more dominant place.

"We built [our first platform] Statfjord B in accordance with plans and manuals, with no room to think for yourself," Eldar comments.

"Statfjord C then involved a number of identical structures. We took the initiative on working in parallel because there were too many people in one place. They carpeted us for that."

Statoil later took over from America's Mobil as Statfjord operator, and the methods changed. Eldar believes that encouraging workers to be creative gives Norwegian yards a competitive edge.

Aslak agrees that his father is onto something interesting. "Progress since Statfjord C in 1983, when we were well into the oil era, has been massive.

"The technology changes from manuals to something the world hasn't seen before, and becomes

City and yard

Rosenberg Mekaniske Verksted is a mechanical engineering company at Buøy in Stavanger. Founded in 1896, it has been through several changes of name and owner, and belongs today to Australia's WorleyParsons. The yard delivers to Norway's oil industry and now has more than 500 employees.

Kværner acquired the business in 1970, and it was joined with the Moss Verft yard south of Oslo as Moss Rosenberg Verft (MRV) until 2004. It ceased building ships following the shipping crisis in the mid-1970s, and converted to fabricating platform topsides.

Eldar Myhre (1949-) was a high-profile union official at Rosenberg, as well as serving as chief shop steward for the Aker Kværner group. He led opposition to the takeover of Kværner by Norwegian industrialist and financier Kjell Inge Røkke. Myhre was also a radical voice in the Norwegian Confederation of Trade Unions (LO) and at odds with the leadership on major issues such as the EU and working conditions. He served as chair of the local branch of the United Federation of Trade Unions.

National librarian

The National Library of Norway acquires and archives materials published in all media. It helps to ensure that manifestations of Norwegian culture and social life are preserved and made available for research and documentation. Read more at www.nb.no.

Aslak Sira Myhre (1973-) is the director general of the National Library, known popularly as the "national librarian". A former journalist and politician, he was a member of Stavanger's city council from 1999 to 2003. He has represented the Red Electoral Alliance and the Red Party, and chaired the first of these from 1997 to 2003. He was head of the Literature House in Oslo from 2006 to 2014.



New jobs. Welding on the Kvitbjørn platform. (Photo: Stavanger Aftenblad/Lars Idar Vaage)



Heartfelt. That Stavanger as a town has kept the Rosenberg Verft yard distinguishes Norway's oil capital from the former industrial cities of Bergen and Oslo, says Aslak Myhre. His father Eldar agrees. People in Stavanger have always seen platforms and vessels at the quay or in the yard. That brings them closer to this important industry. In Bergen and Oslo, they build flats instead.

Norway's biggest export industry after oil and gas.

"Is this development recognised by Norwegians at all? Is that where it stops? We built platforms and developed fields. Then we got b****y rich. And today it's a climate problem."

With reference to the growing number of NCS facilities built at Asian yards, he believes company executives and politicians in Norway have lost something of the plot along the way – they think a supplies industry is unnecessary, the country can simply sit on top and administer.

In his view, Norway risks losing that element which concerns industrial development and a national approach to working, with a short distance between engineers and skilled workers, between North Sea and yard, and to Statoil.

"If that element isn't any longer something you recognise about what's happened in Norway, you don't understand the future, you don't take this experience with you.

"What we take with us from this period is not only a matter of writing history, but also a question of the foundation we lay for tomorrow's developments."

He points to Statoil, "which says openly that it's building long-term expertise in South Korea. It 'knows' it'll get short-comings and follow-up work.

"That's an absurd approach because Statoil wants, as I understand it, somebody out there to know something in the future."

Eldar says that the idea of outsourcing work to east Asia arose in the 1980s, with China as the location because it was well organised and could offer cheap solutions.

"As time passes, living standards rise and everything gets more expensive," he observes. "And we dismantle our own expertise and industry."

The pair have almost inexhaustible views about Rosenberg. The yard has meant a lot for Stavanger as an industrial town and oil capital.

Aslak believes it also marks the biggest difference between his home town, Bergen and Oslo. "All three have been industrial centres," he points out. "Bergen has had Laksevåg and Solviken, in Stavanger it was Rosenberg and canning.

"When I moved from Stavanger, everyone could see a platform at the quay or out in the fjord. Not only at Rosenberg, but also the Condeep shafts in Jättåvågen and mobile units in for repair."

Rigs were laid up in the Ryfylke fjords, he recalls. The mayor of Stavanger could see a platform or rig from his office every day.

Bergen shut down what it

had while he was living there. And Oslo has not seen industry since its shipyard was converted into the Aker Brygge residential and entertainment district.

"The fact that Rosenberg has been and still is in operation means three things. Many people have worked there, several thousand at peak.

"They have spouses and children, and families who live from it. That naturally provides income for the town, but it also affects people mentally – how they perceive their city.

"Former Conservative mayor Leif Johan Sevland once said that converting the Rosenberg site to any other industry would be out of the question as long as he remained in office.

"His counterparts in Bergen and Oslo would never have dreamt of saying something similar. Stavanger thought of itself as an industrial city. That gives it an advantage today. Anyone can make money in the financial sector during a boom."

Eldar praises the local council for backing the preservation of Stavanger's industrial base, "while the Oslo councillors responsible for business development maintained it was no place for manufacturing. They wanted to build homes. Doing away with industry was seen as progress."

He believes that industrial activity should not be written

off, and recalls the struggle a few years back to raise NOK 70 million in order to save Rosenberg.

The yard was subsequently sold to Australia's WorleyParsons for NOK 1.1 billion, he notes. "That says something about the potential which some people see and others don't."

Eldar has become increasingly impressed with "the little band of politicians and industrialists who laid the basis for Norway's organisation of a future oil industry when none of them had seen a picture of what it would become".

Norway had experience of power-intensive industry, and took much of its model from there. "Without that, we'd have become like any other oil nation.

"That's what makes us distinctive, with oil as something which benefits the whole of our society rather than being milked by a few big fish."

Impressed

One question is then why the big picture has not been more strongly imprinted on the national memory and the public debate about the oil and gas industry's significance for the country.

Asked whether he feels good books on that subject are lacking, Aslak replies that Ryfylke-born author Kjartan Fløgstad has said something interesting about this.

"Mainland industries have their writers, he observed, but not the oil sector to any extent. The North Sea was inaccessible, while everyone ashore has a relationship to industry there.

"Fløgstad tried to get off-shore for 30 years, until BP managed to get him out. It's not been easy from an author's perspective. [Fellow novelist] Karl Ove Knausgård worked on building concrete platforms, but has clearly learnt nothing at all about the oil industry. How that's possible is a mystery to me."

"What we have now are climate-driven demands to dismantle the oil industry," says Eldar. Who, then, is the sinner

– the oil companies which produce or the government which wants them to? Or the consumers who depend entirely on petroleum products?

"Is this a question of sin? I don't accept that," responds Aslak.

"We could hold a debate on that," adds Eldar. "The problem in Norway today is that we've forgotten that you need a cow if you're going to have milk.

"A lot of people seem to think we can have a country like it is today – but without oil. That's not credible, and we're not going to stop the flow.

"What we do in Norway isn't for Norwegian consumption, but for a global market. And if we're not in it, somebody else will take our place.

"We Norwegians are perhaps out to obtain absolution for our sins, rather than achieve practical change. At least it wasn't us who did it, they'll say. That we produced this with lower emissions than anyone else isn't even regarded as an argument."

"Amen," interjects Aslak, and has been fired up by his father's comments.

"Do we take politics seriously or not?" he says. "This is presented as if it's a big ethical argument for the future of the world, but it's often about positioning in a Norwegian political conversation.

"This isn't about political consequences, realities or whether it means something for Norway, after all. It's just a matter of positioning.

"Like the comment by finance minister Siv Jensen that she's not sure whether all climate change is caused by human activity. As if what she says means anything.

"The questions you have to ask must be about what she might or might not do. What are her policies – that's what will have consequences."

He asks whether Norway has become so rich that it no longer needs a milch cow. "The paradox of the discussion is that, as long as you have a cow, you can afford to lose money elsewhere.

"We have an oil fund worth

NOK 7 000 billion – or something insanely large. We can even invest in something we could eventually earn money from."

Aslak recalls returning from a demonstration against gas-fired power at Kollsnes north of Bergen in 1997. The discussion was whether wind energy could replace petroleum.

"I thought we could swap the two. You can do that in a Soviet style economy where you don't have to make money. It's not possible in a capitalist system where you must sooner or later show a profit.

"One depends on the other – that's a banal economic understanding which I didn't have then. If you fail to take this into account, I can't take it seriously. It's just layman's talk."

He wants to see a better debate on the Norwegian oil and gas industry – an open discussion rather than one with the terms set by a few and other arguments unwelcome. That is often the case in Norway today, he claims.

"When you sit anywhere – classroom, boardroom, library – there's always an underlying consensus about what you're all saying.

"It's almost never explicit, but simply lies there as the basic terms of the discussion. Unless you question that basis, you'll end up like the others within a few days, weeks, months or years. That's how socialisation works.

"What I've seen with Dad, from the time we went to buy a bike when I was little until he was a worker director of Kværner, was his refusal to accept these terms.

"That was allied to an ability to ask the questions which are right viewed from outside, but are b****y uncomfortable for insiders – because they challenge the basis of the whole conversation.

"I try to stick with this way of thinking and daring to speak out even if it can be a bit uncomfortable. See now, that's made Dad proud."



Facts at his fingertips

Access to information is the key to finding more oil and gas in mature areas of the NCS, and the NPD established its Diskos database 20 years ago to provide this. Kjell Reidar Knudsen has been involved all the way.

| Alf Inge Molde and Emile Ashley (photos)

Past and present. The big rolls of paper and film in the NPD's vaults contain the information needed to find the giants on the NCS – Ekofisk, Gullfaks, Statfjord and Troll. Worth billions of kroner, this information is all in electronic databases today.

Seismic data which cost several billion kroner to secure is still stored as rolls of paper or film on many metres of shelving in the vaults at the NPD's Stavanger offices.

"But they're now actually valueless," says Knudsen as he walks through this massive archive. "Everything's been entered in Diskos."

A certain awe nevertheless attaches to this store, which holds all the data needed to find offshore giants such as Ekofisk, Gullfaks, Statfjord and Troll.

Everything is contained in these rolls – worth their weight in gold to those who can interpret them, Greek to the rest of us.

Activity used to be hectic in the vaults, since the oil companies are required to supply the NPD with copies of all their raw seismic and drilling data.

All the partners in a licence could come and ask for copies, too, and this was supplemented by purchase, sale and swap agreements.

"We used to have a lot of staff who were employed solely on this work," Knudsen recalls. "Things are considerably simpler today."

History

And few people know the history better than this man, who joined the first reservoir engineering course at what is now the University of Stavanger in 1971.

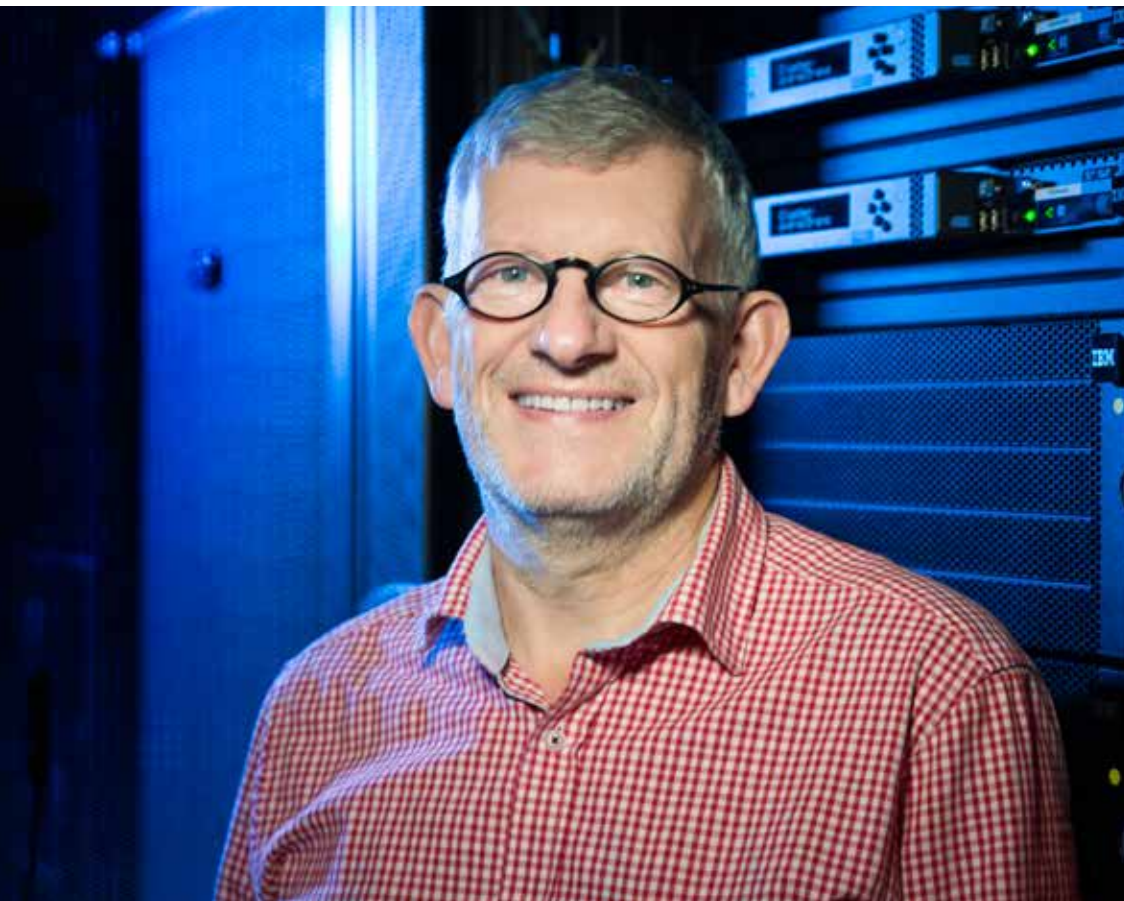
Following two years on a couple of water drilling projects in Africa, Knudsen joined the NPD in 1977 after writing his first – and last – job application.

He became interested in data management at an early stage, and was also the first NPD staffer to build a reservoir simulation model – in this case for Ekofisk.

It consisted of three layers and 350 blocks, created partially with the aid of millimetre paper, and with the calculations carried out on an IBM mainframe by Rogalandsdata.

Knudsen was later involved in simulating the Statfjord field at then operator Mobil's Dallas offices. By then, hundreds of thousands of blocks were involved.

He subsequently became section head for reservoir technology and later production technology, and took charge

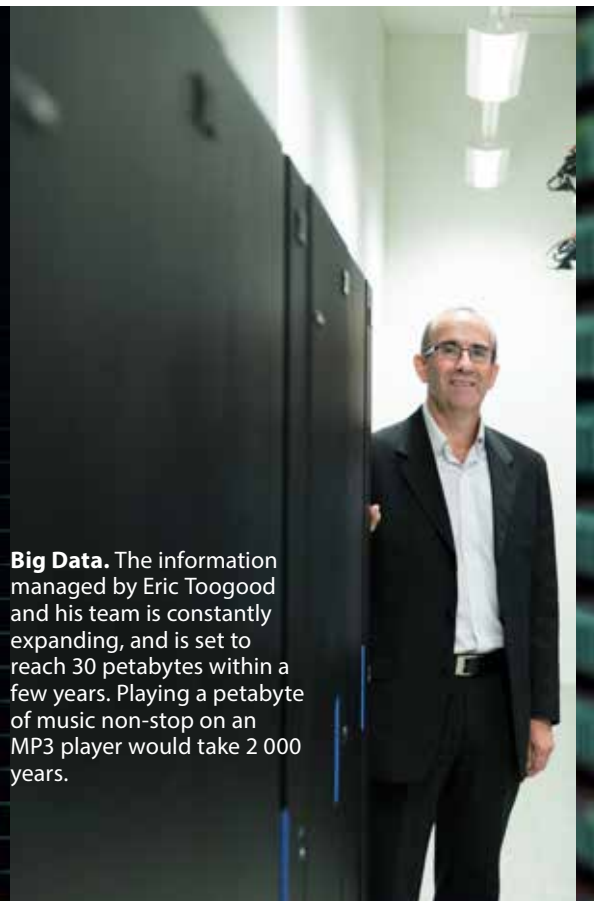


Enormous progress. Kjell Reidar Knudsen has long been involved with data management.

Openness. Data stored in Diskos becomes accessible to all its members once the period of confidentiality has expired. Raw data from wells and seismic surveys provided by licences are secret for two years, seismic results from companies for five, speculative seismic surveys for 10 and data interpretations for 20.



Big Data. The information managed by Eric Toogood and his team is constantly expanding, and is set to reach 30 petabytes within a few years. Playing a petabyte of music non-stop on an MP3 player would take 2 000 years.



More data and better accessibility

of the NPD's data management department when it was established in 1990.

The latter ensured that internal handling of information became more streamlined, and one result was the high-quality log data (HQLD) project.

This involved scanning in all the material contained on tape and paper by a specialist in Wales and storing it on eight-millimetre cassettes.

Lorryload

Seven to 10 of these little tapes could hold a lorryload of data, Knudsen recalls. It cost NOK 15 million to digitise and quality-control information from the 750 wells drilled on the NCS up to 1994.

The HQLD was the forerunner of the Diskos database, whose first members were Statoil, Norsk Hydro, Saga Petroleum and Mobil in addition to the NPD.

Others joined later, and it currently has 57 members and 19 associates. A number of universities and non-commercial research organisation also have access to its open information.

Members of Diskos can access their own data and material belonging to licences where they are a partner. They can also buy, sell and swap information through the system.

But all the material ultimately become available to every member once the period of confidentiality has expired. And that is sooner than one might think.

Raw data from wells and seismic surveys provided by licences are confidential for two years, seismic results from companies for five, speculative seismic surveys for 10 and data interpretations for 20.

After that, the material becomes freely available. Its accessibility means that the companies do not have to spend time searching for information.

Instead, they can start interpretation at once. And the company which is best at this activity wins. That benefits both the companies and the Norwegian taxpayer.

Honour

Knudsen says that many people can claim a share of the honour of making Diskos what it has become today, including project manager Eric Toogood and his deputy, Elin Aabø Lorentzen.

But he continues to play an important role, and has served as chair of the Diskos management committee and steering group from the start.

Since 2000, he has also travelled

the world to talk about Diskos and help new oil nations with the work of managing their data.

That has taken him a number of times to such countries as Nigeria, Vietnam, East Timor, Mozambique, Angola, Madagascar, Uganda, China, the Philippines and Japan.

Not all of them are as well placed to succeed as Norway. But building up a shared register of all information – with a common terminology – is very important. If Knudsen had his way, a global standard would have been established.

Memory

When Diskos was created, it was dimensioned for four terabytes of data and the memory used cost several million kroner. Such drives currently cost a couple of thousand kroner.

That price reduction is just as well. Diskos will probably contain more than two petabytes, or 2 000 terabytes, by 31 December this year.

To put this in perspective, the average coding for an MP3 music file on a mobile phone is about one megabyte per minute. Playing a petabyte of music non-stop would take 2 000 years.

Raising Diskos to a completely new level in coming years is the ambition of Eric Toogood, manager of this NPD database.

Information being posted to the facility in the recent past has grown almost explosively, with content up from 400 terabytes at 31 December 2013 to one petabyte (1,000 terabytes) a year later.

Over the next five to six years, this volume of data could increase by 20-30 petabytes – primarily because of a change in the requirements for materials stored there.

From 2012, the NPD has required the oil companies also to post all raw data – known as field and pre-stack information. Until then, most of them had only entered post-stack details.

Put briefly, field data covers all input acquired by seismic survey ships, while pre-stack material has been part-processed and compressed – and therefore contains rather less information.

The post-stack category is processed pre-stack data, with even smaller content, and has so far provided the commonest basis for seismic interpretation and analysis by the oil companies.

However, pre-stack material con-

tains 10-20 times more data and is intended to provide the company with accurate information about what might be located where.

Toogood also wants to incorporate metadata and better positioning information for survey ships, which tells users when, how and under what conditions the material has been acquired.

This is because the sound waves echoed back to the ship are influenced by a number of factors, such as wave heights, ocean currents, temperature and the salinity/density of the water.

Another technology which is expected to help Diskos continue developing is related to the Big Data concept.

The database is already one of the largest of its kind in the world. It contains well data right back to the first spudded on the NCS in 1966, and seismic survey findings from 1980.

This information has been acquired by different methods and technologies down to the present day from the North, Norwegian and Barents Seas.

The goal now is to exploit all these data simultaneously across sea areas, allowing geologists to track similarities in patterns and trends which escape even the best-trained eye.

When Big Data combines the data storage structure with new software, the result could be that information from the North Sea reveals new geological plays in the Barents Sea – or vice versa.

The huge expansion in data expected over coming years means that ever bigger transfer capacity will be required. Put simply, this need has so far been met by increasing fibre cable thickness.

However, the time taken by this approach has become a bottleneck. The answer could be for users, wherever they sit, to work directly with the Diskos database.

Another new development is that all members can also access quality-assured production data from the various fields on the NCS.

This information was previously reserved for the NPD and the relevant licensees, but could be of great interest to companies thinking of farming into a field.

French geoscience company CCG, which took over operation of Diskos on 1 January 2015, has financial incentives to offer additional services in competition with others. That opens the way to even wider and better use of the stored data.

Adding up to acclaim

| Astri Sivertsen

The city of Sandnes near Stavanger recently won the innovation prize from the Ministry of Local Government and Modernisation after adopting a Russian model for teaching mathematics in school.

State secretary (junior minister) Paul Chaffey present-

ods for maths," he observed.

"As a result, all the pupils have recorded much higher levels of attainment without the need for extraordinary resources. That's impressive."

An article in *Norwegian Continental Shelf* 3-2012 described a visit to class 4B at Smeaheia primary school in

Blank at the University of Stavanger and colleague Kjersti Melhus translated textbooks and work sheets from Russian and adapted them to Norwegian conditions.

All this was in their free time. This commitment was noticed, and the method is now in use at 27 schools - 14 in Sandnes and 13 at Skien south of Oslo.

Jan Egil Sørensen, an adviser on childhood and youth services in Skien, learnt of the Smeaheia approach through the media, and the council found it so interesting that a delegation visited Moe.

That convinced the local authority to launch a pilot project last year and then to introduce the method in all primary and lower secondary schools this autumn, Sørensen reports.

"They're very pleased with the programme so far," he says. "But they've had some running-in problems because of a lack of textbooks and web resources."

This issue is being overcome, reports Moe. She is now retired, but spends a lot of time travelling around and giving courses, and responds to e-mails from people who want to know more.

Sandnes, then the only one in Norway to have adopted the Russian system.

Known as "developmental learning", this model was brought to the school by teacher Gerd Inger Moe after learning about it during a visit to Russia.

Moe, Ukrainian Natalia

ed the NOK 500 000 award at a local government conference in the south Norwegian town of Arendal during June.

"Sandnes local authority has taken its schoolchildren seriously, collaborated with academics and introduced entirely new teaching meth-

Think for yourself

The "developmental learning" approach is based on principles enunciated by Russian psychologist Lev Vygotsky and his pupil Leonid Zankov.

This aims to encourage pupils to think, analyse and discuss their way to solving maths problems. They learn from making errors and then going through these mistakes in detail.

Impressive results

"After introducing the new teaching method, 65 per cent of pupils in year five reach the highest level of maths attainment in national tests, and none are at the lowest. The local authority has achieved impressive results from its 'Russian maths' project, which the jury knows does not just happen. This shows that complex social problems can be overcome by taking new approaches." From the jury's citation.



Facsimile from *Norwegian Continental Shelf* 3-2012.

Barentsforlaget, a small publishing company in the far northern port of Kirkenes, has published textbooks and work sheets for years one and two (six- and seven-year olds).

And two members of staff at the University of Stavanger are working flat out to prepare resources for the next two years of primary school.

Read more (in Norwegian only) at <http://matematikklandet.no>.

ROCKSHOT

Tight formations

(Photo: Janka Rom)

| Christian Magnus and Janka Rom

Basalt can form reservoirs for oil and gas on the NCS if it contains open fractures and a certain number of cavities. Such rocks have been identified in the Norwegian Sea, but have not yielded discoveries. Migmatites and basalt intrusion can be observed at Håhammeren along the Hafrs Fjord outside Stavanger.

Migmatite is a rock formed under high pressure and temperature deep in the Earth's crust, and migmatitic gneiss is a variant

which has partially melted. That gives it a veined and marbled appearance.

This rock often comprises dark, wavy laminations and bands (older material) encased in a light granitic matrix (more recent). The latter can be formed by the injection of magma, by partial melting of the rock in situ, or by a reaction in the solid phase.

After the migmatite was formed, basalt (dark rock) has intruded. Formed through vol-

canic eruptions fairly directly from the Earth's mantle, this is a fine-grained lava.

Dark and light crystals (pictured) lie in and near the centre of the basalt intrusions because slow solidification gives them time to form. That has occurred at low temperature and pressure. The contact with the migmatite is more fine-grained because of cooling.

The relentless struggle between mountain massifs and the force of gravity continues unmonitored in many rural areas around Norway. But geology holds the key to keeping people safe.

| Atle Rotevatn and Janka Rom

Detecting dangerous moves



The Sør Fjord in Hardanger is a typical west Norwegian landscape. (Photo: Arne Bjørøen)

The Wave (Bølgen) is a Norwegian film which depicts a fjord community hit by a huge flood following a massive landslide. It has proved highly successful in cinemas nationwide.

Actor Kristoffer Joner plays geologist hero Kristian Eikjord – but his real-life counterparts do indeed keep watch on unstable rock formations in various locations.

The best known of these hot spots is Mannen, in the Romsdalen area of western Norway, where 120 000 cubic metres of rock – or 12 000 lorryloads – are threatening to tumble.

Given that mountain ramparts usually move by millimetres, little about the working day of a watchful geologist involves drama or heroic deeds.

But these specialists undoubtedly do a very important job in keeping an eye on the potential threat with their instruments, their

knowledge and their experience.

Such tracking is difficult and challenging, and issuing warnings even harder. When rock motion accelerates from “barely measurable” to “just about moving”, it is hard to predict whether a slide might happen in hours, days or years.

And it may not happen at all, which was the case with Mannen last year when locals were evacuated and the whole nation followed the drama.

So sounding an alert presents a very difficult balance between ensuring that people are out of harm’s way and crying wolf by staging repeated evacuations without anything going wrong.

In the case of Mannen, moving residents away was essential – even though the mountainside eventually decided to stay put that winter. And such precautions will be necessary again.

Every spring, the Norwegian media carry reports about roads

being blocked by rock falls and landslides – particularly along the deep-furrowed west coast.

Steep-sided fjords, frost erosion and heavy precipitation represent a dangerous combination, even though luck and low population density mean that lives are seldom lost.

For the people who live in these fjordlands, however, driving along stretches of road which are most at risk from such instability can be highly stressful.

Statements such as “a geologist has carried out an inspection” or “a geologist is awaited” recur frequently in online media stories about roads cut by fallen rock.

While tempers rise in the ever-lengthening traffic queues, the experts must decide whether the road is safe enough to be reopened or has to stay closed while safety measures are instituted.

People living at the foot of Mannen may feel they are fortunate that their towering neighbour

Geology Day

The Geological Society of Norway organises a day to celebrate its discipline every year in mid-September, aided by many volunteers in societies and companies throughout the country.

With the aim of giving the general public a taste of what the subject involves, about 75 events are staged in marketplaces, museums, mines, quarries, libraries, schools and on outings.

People with an interest in the geosciences convey knowledge about and experiences with geology designed to encourage young people to maintain their interest in stones and minerals.

That will hopefully stimulate them to study a subject which normally attracts little attention in Norway. Getting youngsters to become geologists and raising awareness of the discipline are accordingly important.

is under surveillance while they sleep soundly, go to work or take their children to school.

Monitoring goes on here, funded from the government’s deep pockets. In other valleys and fjords, however, the endless struggle between rock and gravity stays unsupervised.

The same applies along roads such as the E16, the main highway between Oslo and Bergen, where the frequent rockslides usually cause little or no harm.

“Things went well this time, too,” people say, but they sleep uneasily and utter a silent prayer that things will go well again when the school bus drives past.

Geologists also participate when roads, railways and tunnels are planned, when the foundations are laid for buildings and other infrastructure, and when groundwater is assessed and channelled.

They are involved on land and at sea, by the coast, in the mountains and along the fjords, and in every Norwegian town and village. Geology is needed everywhere.

For five decades, geoscientists have been searching for and finding oil and gas on the NCS to provide revenues and prosperity from reservoirs several kilometres beneath the seabed.

Geological research is conducted into the endless advance and retreat of glaciers and on the behaviour and history of sea and land in order to understand past and present climates.

The geologist studies important subjects – the origin and development of life, fossils, carbon storage, thermal heat, wind energy and hydropower.

Think, too, about all the technical gadgets and devices

people now possess, cars and the like. All are made of materials extracted from earth and rock.

Take a look around at home, at work or perhaps at school. Ignoring food, wood and fabrics, the overwhelming proportion of objects there contain a high proportion of metals, minerals or petroleum (in the form of plastic).

A brief list would include mobiles, light bulbs, baths, ovens, porcelain, cups, bowls, computers, ballpoint pens, glasses, coffeemakers and high-voltage cables. Not to mention aircraft, trains, ambulances, cake slices, paint or selfie sticks.

And geologists, with their expertise about the planet, are crucial for ensuring the production of the mineral resources which go into these products.

Anyone with children has found them coming home with their pockets full of shells or stones after a trip to the beach or into the hills, or asking questions about *Tyrannosaurus rex*.

Geologists are often asked how the mountains have acquired their form, or to provide the name of a rock someone has found in their garden – or about the threat of landslides and earthquakes.

Both children and adults are interested in the natural world around them, fascinated by rocks, minerals, dinosaurs and volcanoes.

Norwegians enjoy being out in the countryside and the mountains, hiking through hill and dale and casting an inquisitive eye on their majestic surroundings.

Spectacular

Geology is the discipline which deals with this spectacular world and the natural processes which occur in and shape its myriad forms.

Yet the study of science – including the geosciences – is declining in Norwegian schools. If this trend continues, important expertise for overcoming tomorrow’s challenges will be lost.

Children need to have their interest in these subjects stimulated. That will give them important know-how for tackling scientific problems in the future.

If they train to become geologists, they may even find themselves one day rescuing a west Norwegian community or two from the flood waters.

Atle Rotevatn (right) is vice president of the Geological Society of Norway and a professor of geology at the University of Bergen. Janka Rom (below) is president of the Geological Society of Norway and a geologist at the NPD.



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From print to digital

A fixture on many desks in and around the Norwegian oil industry is no more. The paper edition of Facts has been replaced by the www.norskpetroleum.no website.

The content has been reorganised on the new website to tie descriptions and facts more closely together. Articles and facts are illustrated with photos, graphics and maps.

All information is accessible from any digital platform, and the content can be downloaded, printed out and shared by mail or on social media.

Links to more detailed information are provided for each topic. As with Oil Facts, part of the factual information will be synchronised on a daily basis with the NPD's fact bases.

The new site is intended for a broad audience, and accordingly represents a supplement to the NPD's own fact pages and maps. These are aimed to a greater extent at professional users.

Provided in both Norwegian and English versions, www.norskpetroleum.no contains information on such aspects as:

- the significance of the petroleum sector for the Norwegian economy
- a description of current activities on the NCS
- organisation of the petroleum sector
- regulatory parameters throughout the industry life cycle, from opening new exploration acreage to field cessation
- facts about fields, discoveries, companies, exploration activities, production and the resource base on the NCS
- emissions/discharges, measures to reduce them and oil spill response
- the supplies industry and the commitment to research and technology
- explanations of terminology and an energy calculator.



Oil Facts

The iPhone app from the NPD and the Ministry of Petroleum and Energy is available in an updated version. This can be accessed in the App Store by searching for *Oil Facts*. The app is also available for Android and Windows phones.