

# Mad about maps

- Taxing talk
- Cleverer with chess

# NORWEGIAN

CONTINENTAL

# SHELF

A JOURNAL FROM THE NORWEGIAN PETROLEUM DIRECTORATE

NO 1 - 2014

# CONTENTS



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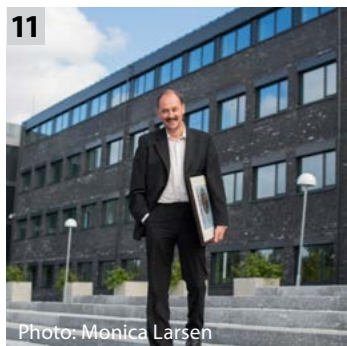


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Interview: The elephant man.....	4
Man in the money.....	11
Big pay-off from 4D.....	14
Atlantis theory sunk.....	19
Rockshot: Dug deep.....	20
NPD profile: Updated data source.....	21
Science: Game plan for education.....	21
Turning the tide for drilling.....	24
Where fractions really count.....	30
Fruitful collaboration.....	38
Knowledge on tap.....	40



NORWEGIAN PETROLEUM  
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Astrid Espe  
(Photo: Emile Ashley)

LEADER



# The paradox

More wells are very necessary on the NCS for realising substantial assets, particularly in mature fields. At the same time, we see with concern that operators are not delivering the number of planned production wells.

Given that oil prices are also declining, the picture has become even more serious for petroleum production from the NCS. A pertinent question is whether the high level of oil prices meant it

field's producing life. Spending here has shown a particularly sharp rise in recent years. So it is important that the industry manages to emerge strengthened from a period which threatens reduced activity and a flattening-out of investment.

Working with wells presents a complex picture involving rigs, drilling, completions, contractors, technology development and so forth. The sector's inability to

greater extent on how to do more for the same budget.

In my view, the industry faces a Catch 22, with increased costs, the need to drill more wells, more old wells needing more workovers, permanent plugging of wells, upgrading of rigs and so forth. The list could be extended.

Nor do I think the industry should look back too much. Focusing on the future is preferable. The NCS has always been far ahead on technology development, but the industry seems unable in the present conditions to realise the potential of these advances.

Something must be done about that.

“A pertinent question is whether the high level of oil prices meant it was acceptable to neglect costs or efficiency improvements”

was acceptable to neglect costs or efficiency improvements.

While expenses have risen, the industry has not become better at working more effectively, adopting new tools, or devoting enough attention to what could be done better. It has not managed to take the next step.

Far fewer production wells are now being drilled from fixed installations than 10 years ago, and at many times the cost per well. That naturally makes it harder to reach the target of improving recovery factors on mature fields.

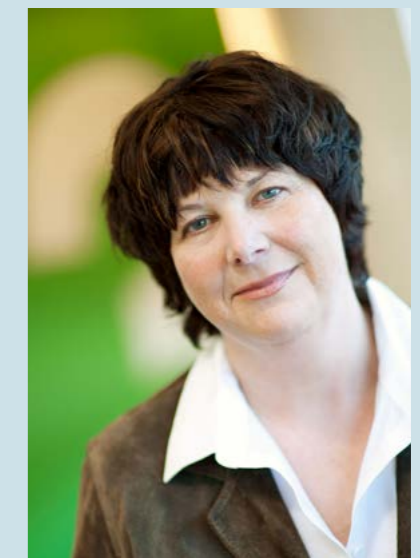
Drilling and wells account for 30-50 per cent of costs over a

deliver in a way we all want to see, despite much talk of standardisation, integrated operation and technological progress, is thought-provoking.

It may be the case that the industry has been a little “sated” for a time. The challenge has been lack of capacity, but that is now changing.

At the same time, avoiding an overly negative view of developments is important. The goal must be to emerge strengthened from this downturn.

Everyone talks about costs, but changing ingrained practices is not easy. Attention must perhaps be concentrated to a



*Bente Nyland*

Bente Nyland  
director general



# The elephant man

Philip Lambert is open about the need for the oil and gas industry to fight its corner harder. But Norway is nevertheless where this highly-regarded financial adviser would put his money.

| Bjørn Rasen and Andrew Parker (photos)

An imposing but anonymous facade in London's fashionable Mayfair fronts the offices of Lambert Energy Advisory Ltd and its 20 or so analysts and advisers. Nestling among three others, a small brass plate is the only external sign of a company which works closely with a number of major global players on big strategic processes involving mergers and acquisitions in many parts of the world.

Lambert himself was a key adviser to the Norwegian government when Statoil secured a stock market listing in 2001 and management of the state's direct financial interest (SDFI) was eventually transferred to Petoro.

The day we meet him, he is standing on the pavement outside and guiding passers-by through a cluster comprising himself and his office neighbours in jovial conversation.

But he can be pretty direct in his view on tax. "This is a sort of 'elephant in the room' which nobody talks about, but the fact is that across most of the global economy now, tax rates are coming down.

"People want to encourage high-tech business, or indeed any business, in their economy. The only sector where that philosophy hasn't remotely permeated is oil and gas, where tax rates across the world average 70 per cent or more.

"In any other industry, that would have been considered punitive. You can't debate cost in isolation from the biggest cost of the lot."

Costs are indeed the challenge, and are currently too high for exploration. So it is high time to hold a new debate about the industry's terms, says Lambert.

The companies must also look

## The quiet advisers

Lambert Energy Advisory Ltd was established in 1999, and one of its first major assignments was to support Norway's Ministry of Petroleum and Energy in the partial privatisation of Statoil – at a time when oil prices were below USD 10 per barrel.

Philip Lambert and his roughly 20 colleagues in London provide strategic advice to companies on mergers and acquisitions. It is no secret that a number of the big international oil companies are on the client list for the agency, which is also represented in Oslo, Moscow, Kuala Lumpur and Tokyo.

"Some 150 million barrels of oil equivalent are produced every day, worth trillions of dollars," says Lambert. "Our goal is that mergers and acquisitions should create added value."

“ He notes that the oil price on the day we meet is USD 83. 'There's gloom and Armageddon. You have to put it in the perspective.' ”

themselves in the eye, he adds, and finds it amazing that the industry is pleading almost the same poverty now that it did when the oil price was nine times lower. "Cost have admittedly gone up. But my view is that they will go down again through the workings of supply and demand, just as they have done earlier with rig rates."

He maintains that the efficiency improvements and discipline now

view, then you shouldn't spend your USD 1 billion in oil and gas anyway. You should choose another industry or put it in the bank and earn one per cent interest.

"The whole point of investing in oil and gas is that you're taking a 30-year view. It's a quirk of human nature that the short term becomes the long term in people's thought processes. But that's precisely the best way of losing

head of ExxonMobil or Shell felt was required to keep an independent oil company (IOC) solvent and investing.

"Out of that mix came the answer that the oil price should be USD 20-25. So, even if the price was USD 10, we were happy to plan for a price of USD 20-25."

He notes that the oil price on the day we meet is USD 83. "There's gloom and Armageddon.

alternative to some of the 90 million oil barrels consumed every day. Part of the transport sector could convert to this fuel. But he asks rhetorically whether gas might lose market share.

"That's what's happening in Europe because coal is much cheaper, and in the very countries which say they're concerned about climate change. So they talk one policy while burning the fuel which adds to the problems."

He thinks gas will increase its market share, particularly if it tells its story in the right way. Gas is part of the solution rather than

that solar power has become competitive with oil and gas.

"Well, fine, if it is then it doesn't need a subsidy. None of the renewables can survive without a subsidy. Show us the calculations so that people can compare for themselves. A realistic debate needs openness about the real cost of different energy bearers."

He emphasises that the potential of the NCS has not been fully realised, which is why Norway has always been a good place to invest.

And he praises the transfer of

"I just thought that this had to be wrong. In 1999, 750 exploration wells had been drilled since the beginning. That couldn't be enough to show if the NCS was mature or not."

He recalls that the debate in the UK was the same around 1985. Its continental shelf was widely regarded as very mature, and people thought it would all be over in a decade.

Then, in what Lambert calls the second phase, a number of big discoveries were made which created another production peak in 2000.



being signalled by the industry will help to do the job. But the biggest cost of all is not wells or equipment, but tax.

Lambert is often described as "the quiet man in the wings" – the person who provides the crucial strategic advice. He seldom gives interviews, but promised to meet me after a brief but pleasant chat immediately after he spoke at the ONS conference in Stavanger during August.

The starting point for his presentation was where and why he should consider investing USD 1 billion for his hypothetical Great-Aunt Gwendoline.

Virtually the whole petroleum industry has started to retrench since then, some companies more than others. So the first question is whether Lambert's thinking remains unchanged.

"If you allow a few weeks of oil price volatility to change your

money.

"The secret of investing in oil and gas is using the short term to your advantage. When it's creating panic and gloom and despair, that's the very best time to invest. We see clear signs of panic and despair this autumn. So yes, I'd still spend Auntie's billion dollars on the NCS."

Lambert looks to the underlying conditions. The big question many ask – and which few or any can answer, regardless of how many millions of words are written on the subject of oil prices – is whether Saudi Arabia has changed its oil policy.

"It was the same question we asked in Norway in 1999-2001, when oil prices had dipped below USD 10 per barrel: what was the Saudi Arabian oil policy.

"We also asked what the Russians needed to keep their economy going, and what the

You have to put it in the perspective. I think it's more likely to be a short-term problem than a 20-year one."

Lambert Energy takes the view that oil and gas will remain the primary energy sources over the next 20-30 years. In addition comes coal.

According to Lambert, the world uses energy corresponding to 250 million barrels of oil equivalent (boe) per day, broken down into 90 million oil, 60 million gas and 70 million coal. Nuclear power and renewables account for the rest.

What Lambert calls the "green noise about renewables" contains constant demands to replace oil. "Doing this with biofuels has been a profound failure, simply causing massive environmental damage across the world. It's not going to work."

In his view, gas is the only

**Environmentally aware.** If people are really interested in reducing carbon emissions, they should work hell for leather at replacing coal with natural gas, says Philip Lambert.

the problem, he says, in a clear counter to sections of public opinion in Norway.

"We think renewables are going to struggle because they're still extremely expensive. And the people who have to pay for most of that are the poorest in our community."

Americans currently pay about USD 30 per boe for energy, while renewable European supplies cost around USD 150. Lambert is dubious about claims

substantial assets from Statoil to Centrica and Wintershall at prices perceived by the market as fair to both buyer and seller. That is one reason why people are reshaping their view of the NCS and its opportunities.

History repeats itself. When Lambert worked for Norway's Ministry of Petroleum and Energy in 1999, a prevailing view existed that the NCS was ultra-mature and that its prospects were not of the best.

"I felt in my bones that writing off this province as having no upside and not being worth exploring was a complete misperception," he says of Norway.

"But it needed everybody to shift gear, with the operators wanting to explore again, different views being taken, new eyes coming onto the NCS."

He believes a turning point for the country came in 2005, with the introduction of the tax credit for exploration, and says

“ I hear people writing off the Barents Sea, and that's absolutely crazy. How can you write it off when you've only drilled just over 100 wells? ”

this transformed everything.

Smaller companies, with new ideas, benefitted from the tax shelter and could drill new wells with high risk. Without the opportunity of the credit, they would not have gone ahead.

Lambert says the scheme has been a success for Norway, and notes that the Johan Sverdrup discovery was a result of the new exploration regime.

"I hear people writing off the Barents Sea, and that's absolutely crazy. How can you write it off when you've only drilled just over 100 wells?

other players.

The mould was broken in 2001, when first Paladin and then other independents were admitted to the NCS. This was followed by a restructuring of the state's holdings, with Statoil part-privatised and Petoro created to manage the SDFI.

"Both trustee and fund managers must work in the right way," observes Lambert. "And it's in the everyone's interest to land the big fish out there, whether Lundin, Det Norske or Statoil do it.

"I think there's a spirit in Norway saying 'let's go out and

"We allow the world to be so rude about us and, to be honest, so dishonest. Some of the things said about our industry are plain wrong.

"What would happen if suddenly the entire oil and gas industry went on strike, and 150 million boe per day were suddenly not there?

"We're talking about catastrophic impoverishment of the entire world. We couldn't survive if we were plunged back into mass global deterioration in health, welfare and everything else."

“When future generations look back at the NCS, they'll ask how it proved impossible to reap more than 50 per cent of the oil and gas in place.”

result of this passivity has been overtaxation.

"Tax is getting in the way of investment and decent margins, and margins aren't a pre-tax issue but a post-tax issue. So this is a post-tax debate, and we are not having it."

He maintains that the thinking behind his tax proposals are not about being philanthropic to the

150 million barrels, day in and day out. Governments have to recognise what the industry is trying to do under increasingly difficult conditions."

Lambert says that the NCS is in a new and more mature phase, and that recovery factors now represent the big challenge. They currently average 46 per cent of reserves originally in place.

industry.

"Punishing the tobacco industry is one thing, but doing the same to an industry producing well over half the energy the globe needs to survive strikes me as a very very odd thing to do – also from a climate perspective."

Lambert finds the climate debate is coming up with the wrong solutions, and feels that



**Blunt message.** Philip Lambert wants tax to function as an incentive for increasing value creation even further – including in Norway. "When future generations look back at the NCS, they'll ask how it proved impossible to reap more than 50 per cent of the oil and gas in place," he says.

"This is a huge area of sea and you got a result over the disputed zone with the Russians. This area and that close to it could have a massive hydrocarbon potential."

He likes to regard the government and its agencies as trustees for huge assets and the companies as fund managers for handling this wealth.

In his view, the fund managers were not structured in 1999 to optimise the value. Statoil had to be strengthened as well as several

find these fish', and I want my billion dollars from Great-Aunt Gwendoline to be unleashed there."

Asked whether the trustees (governments) should both invest and tax less in the exploration phase, Lambert prefers to stress the burden of the petroleum industry's battered reputation on future development – its weakened position in the public arena means that few dare to enter the debate.

The future rests on petroleum, he says. "The greens would have us believe that we can shun the oil and gas industry. But they can provide only five million boe of the 250 the world needs every day from wind and solar, at a cost of USD 150-250 a barrel."

Lambert believes the problem is that the industry has allowed itself to be pushed increasingly into a "embarrassment corner", instead of fighting for what it represents and contributes. The

oil companies as such. "It's simply a matter of economics."

Norway relies on its oil and gas revenues. Without investment, tax receipts from this source will ultimately plunge. If taxes are too high, people will disinvest. That is what Lambert now fears.

"There has to be a debate in the industry. In certain countries, the tax rate is 90 per cent. That's too high in today's circumstances."

He notes that such rates were set when the industry was in a different phase and a lot of the fields were incredibly profitable.

Companies in many areas are into the second or third development phases, which tend to involve much more complexity, deeper water, greater distance from land and thicker ice – so costs just go up.

"And the world is still using

"When future generations look back at the NCS, they'll ask how it proved impossible to reap more than 50 per cent of the oil and gas in place. I think that'll be a justified question.

"The issue today is therefore how to create a tax regime which encourages that recovery rate to move up to 60 per cent or more in complex fields. Norway has led the way on reserve recovery. Does the government want that to continue?"

But he does not think tax is the biggest mistake being made by Norway at present. "Before you have a tax debate, you should have an open discussion about what the oil and gas industry stands for.

"If you stick with the belief that what we're doing is wrong, you're never going to secure support for reducing taxes for our

many who say they are concerned with temperature change are much more interested in the idea of renewables or in hitting the oil and gas industry.

"If you're really interested in carbon reduction, it's very simple. You'd just go hell for leather to replace coal from the market place with gas.

"That can be done quickly, realistically and without crippling the poorest members of our community with persistently high energy costs."

The petroleum industry is very important in global terms. And it is important for Norway. Lambert is astonished people have forgotten "that this amazing industry has created huge wealth for Norway – without destroying the environment".

What he calls the misperceptions about the industry

“Tax is getting in the way of investment and decent margins.”

“ Nothing has transformed people’s lives more than access to affordable energy. ”

are not special to Norway, and points to UN secretary-general Ban Ki-moon, whose main job is reducing world poverty.

“He’s recommended disinvestment in fossil fuels, without any distinction between gas and coal. That’s incredibly dangerous from a man in his position, because he’s nothing to put in its place

collaborating over joint tasks on a daily basis.

They think and speak globally. “But I’m not sure that we talk well enough across genders, because there still aren’t enough women in the industry.”

A natural question to ask Lambert is whether the world is trapped in a form of Catch 22 –

London 50 years ago, we would have been covered with soot and probably unable to see each other through a “peasouper” fog. “We displaced coal with gas in this city and look what happened.”

A lot of pills are prescribed for creating a cleaner world. Lambert admits that many are



**In a better light.** Philip Lambert wants greater recognition from governments and the general public of the contribution made by the petroleum companies in securing the 150 million daily barrels of oil and gas on which the world depends.

except mass impoverishment.

“I heard a left-wing commentator say recently that the energy industry, not the medical profession, has had the greatest impact on reducing infant mortality globally. Nothing has transformed people’s lives more than access to affordable energy.”

Lambert considers Statoil to one of the best industrial companies world-wide, regardless of sector. “It stands for high levels of ethics and environmental protection as well as value creation – and now also internationally.”

He says that Statoil and other oil companies contribute positively in a number of areas which are seldom mentioned. Their workforce is multinational, with people from all over the world

producing and consuming the energy needed to maintain prosperity but then polluting more than the planet can cope with, or cutting energy supplies.

“I’d very much challenge that thinking,” he responds. “The term ‘pollution’ is one which needs a genuine debate. Talking about ‘fossil fuel’ is like lumping all vegetables together. Again, we need to distinguish between gas and coal.”

“In China today, more than 600 million people can’t breathe properly. That’s never happened before in human existence. It’s nothing to do with carbon dioxide, but with sulphur dioxide and nitrogen oxides. And gas doesn’t produce them.”

He points out that if we had been sitting on a bench in

well intentioned, but the challenge is to get them also to function economically.

“We’ve got to find a pill that works. We have one in our industry, and it’s called gas. The ultra greens don’t want it because it doesn’t cure the world fully. If I were a patient offered the choice between getting mostly better or becoming worse, I’d have taken the first option.”

He urges the political system in Norway to start recovering its pride in the industry, and particularly in Statoil. “Once that recognition is established, the necessary measures to ensure that oil and gas can continue giving a good return would follow.”



**Hunting for solutions.**

“About 95 per cent of the brainwaves you get are no good,” says Martin Landrø, winner of the NPD’s IOR prize for 2014. “So you must be able to celebrate that something’s gone right when you come up with a solution. It doesn’t happen often, after all.”

# Man in the money

The fourth dimension in 4D seismic is *time*, and Professor Martin Landrø has devoted his since 1986 to improving such surveys. This work has won him much acclaim – including the 2014 IOR prize from the NPD.

| Bjørn Rasen and Monica Larsen (photos)

Tens of billions of kroner in added value have been generated on the NCS by 4D seismic surveying, and a good deal of the honour for these revenues must go to Landrø.

"[He] has undoubtedly been a leader in this development," NPD director general Bente Nyland said when the IOR award was presented at the ONS exhibition in August.

She added that the professor of applied geophysics in the department of petroleum engineering and applied geophysics at the Norwegian University of Science and Technology (NTNU) was one of the pioneers behind the use of 4D seismic on Gullfaks.

Landrø recalls that he was contacted by Statoil, operator of the North Sea field, while working on 4D with the Sintef research foundation, and took over as project manager.

"Considerable scepticism existed in the company, but the management was willing to make a commitment. BP, a Statoil research partner, was also eager to try out the technology."

Seismic surveyor Schlumberger Geoco was the project partner, and the other Gullfaks licensees were

positive. "I told them it wasn't certain this would work. They appreciated that the risk is high, but took the chance. That was the backdrop."

This was moreover the last project which formed part of Statoil's strategic alliance with BP.

### Offshore

Landrø emphasises that 4D was not his idea. "We were very well aware of what was being done on land in the USA, but this was offshore in wind and weather – and in 1995."

The method had been studied in America during the 1980s by starting a fire in the reservoir to achieve rapid development. One of the first papers was published 1987.

Two strong arguments against 4D existed in the North Sea, Landrø notes. One was that achieving a rapid spread of burning was not easy on Gullfaks because cold water was injected.

In addition came the doubts about the method and how big an impact it might have. "We thought the effect would be small", Landrø

admits.

The idea was to find how far a reservoir could be quantified with 4D, which proved to work very well in sandstone reservoirs. It is now used on most NCS fields above a certain size.

"Laying cables on the seabed is the ultimate answer," explains Landrø. "Permanent monitoring represents the best and most expensive solution."

"It's found today on four Norwegian fields, more than the rest of the world put together. We're now in a time of transition over costs, and this is the Rolls Royce version. But we can do it with a Volkswagen model, too."

The biggest expense is not the equipment as such, but the need to bury the hardware required on a permanent basis in trenches on the seabed.

### Breakthrough

Although the method is now used off Brazil and Angola as well as in the Gulf of Mexico, Landrø says the really big breakthrough will be

to extend it to carbonate rocks. These are found widely in the Middle East.

The other advance he is waiting for involves combining 4D seismic with electromagnetic (EM) surveys. "I've always said it ought to be possible."

"Somebody will overcome the challenge of repeatable EM surveying. I'm certain it'll come – this fits hand-in-glove with 4D seismic. But EM is still in its infancy."

While seismic surveying is based on sound/pressure waves, EM uses seabed receivers to pick up electromagnetic pulses. Generated by the mother ship, these make it possible to distinguish between hydrocarbons, water and rock in the sub-surface.

### Eager

Although the IOR prize is awarded for work done a while ago, Landrø is eager to make further progress. Thinking up solutions is not a job for depressives, he says.

"I seldom get ideas sitting at my desk. So I always have a notepad in my pocket should something occur to me – while I'm out walking, for example."

"About 95 per cent of the brainwaves you get are no good. So you must be able to celebrate that something's gone right when you come up with a solution. It doesn't happen often, after all."

And ideas are developed through interaction, with the oil companies as the main partner. Landrø also draws on discussions with his students, which has proved fruitful.

If he has a vision for the work ahead, it is to develop the method so that results can be achieved for resources difficult to squeeze out of the reservoir.

"While 4D seismic surveys detect mobile oil, they could also play a role in recovering immobile oil in combination with injecting chemicals. But the industry is in a cost-saving phase, and isn't pursuing such projects now."

“ I seldom get ideas sitting at my desk. So I always have a notepad in my pocket. ”





**Suitable field.**

A complex reservoir makes Gullfaks very suitable for 4D seismic.  
(Photo: Harald Pettersen/Statoil)

# Big pay-off from 4D

NOK 6 billion in extra revenue was the return from just over a decade of four-dimensional seismic surveys on Gullfaks. Operator Statoil believes that further advances with this technology could yield at least as much again over the next 15 years.

| Astri Sivertsen



“Being able to cancel wells on the basis of new 4D information is very valuable.”

Half of all the oil produced from the North Sea field between adopting 4D in the late 1990s and 2008 can be attributed to the 4D survey technique, reports Tor Vegar Mårdalen in Statoil.

These big additional earnings derive specifically from 19 wells which are unlikely to have been placed where they actually were without the contribution of 4D data.

Although such surveys are primarily used to plan where new wells should be drilled, they also make it possible to avoid bad well positioning and to save on drilling costs.

“Being able to cancel wells on the basis of new 4D information is very valuable,” affirms Mårdalen, who is responsible for geophysical work on Gullfaks.

Given that a well on the NCS can easily cost several hundred million kroner to drill, it is easy to understand that such savings quickly add up.

The first three-dimensional seismic survey on Gullfaks was shot in 1985, before the discovery even had a name or production had begun.

Following a successful 4D pilot in 1995, survey ships have crossed the field at regular intervals after 1996. Since 2001, too, hydrophones and geophones have been installed on the seabed to collect other types of seismic data than can be picked up by streamers on the surface.

All this has generated huge volumes of information – Mårdalen estimates 2 000-2 500 seismic volumes each covering the whole main field – which are in constant use.

Right now, for example, the geophysicists are engaged in reprocessing the 1985 data. That was acquired before the arrival of GPS, and using other criteria for placing and registering shot points, vessel location and

streamer position.

“But technological progress is making data quality ever better in terms of both navigation and seismic shooting,” Mårdalen explains. “New noise removal methods and algorithms have been developed, revitalising old data.”

### Behind

Norway was not the first to adopt 4D technology. The country was 10-15 years behind the USA, where the method had been used on land for many years.

Martin Landrø, winner of the NPD's IOR prize for 2014 (see separate article), worked at Statoil's research centre in Trondheim from 1996 to 1998 and headed the team involved in the early 4D phase on Gullfaks.

Three of the other scientists in the group moreover came from BP, which had experience of using this technology on Britain's Magnus field 160 kilometres north-east of Shetland.

A few 4D surveys had been conducted on the NCS for well 2/14-14, which leaked 20 000 barrels of oil per day for almost year before operator Saga Petroleum managed to halt the blowout just before Christmas 1989.

Norsk Hydro had also carried out some tests on the Oseberg field in the North Sea, but Landrø says that Gullfaks was the first on the NCS where the method was adopted on a large scale.

One reason for choosing this field is that its sub-surface geology is complex. “If the reservoir were a single big tank, 4D surveys would have had less point,” explains Landrø.

“We knew that the potential was substantial. Extensive faulting on Gullfaks provides many opportunities for concealing reserves.”

By comparison, adopting



#### Gullfaks A.

The drilling crew at work on the platform. Improved well positioning has yielded substantial revenues. (Photo: Harald Pettersen/Statoil)

“ Before, you had to make a case for acquiring this type of data. Now it’s almost the opposite – you have to justify *not* doing this. ”

4D technology at a later date on Statfjord added much less value than on Gullfaks precisely because this field is a big “tank”.

Nevertheless, Landrø observes that Statfjord’s eastern flank is a little more complex. “The more complicated a reservoir, the more use there is for such technologies as 4D.”

Another key reason for adopting the method was that it gives a strong seismic reflection (echo) from the top of a reservoir where oil exists, and a much weaker one for water.

In other words, a strong indication existed that the seismic surveys could detect the difference between oil- and water-filled reservoirs.

This was precisely what the geoscientists working on Gullfaks were looking for – the ability to see where oil had been replaced in the formations by water.

Mårdalen adds that sub-surface conditions on Gullfaks provide very good 4D images – including a reservoir temperature of 78°C, ideal for maximum contrast between oil and water.

“When you replace oil with water, you get very clear images – a strong 4D signal,” he explains. That was a crucial factor in launching the project in the 1990s.

“The hydrocarbon zones lit up on our first-amplitude map – which shows the acoustic contrast between two rock strata in the sub-surface – for the Brent formation in Gullfaks,” he says. “We saw that the potential was massive.”

### Standard tool

Collaboration between the operations team and the Trondheim research centre is highlighted by

Per Digranes as a key reason for the great success of the Gullfaks development.

Now head of one of Statoil’s geophysical units, he had experience of 4D surveys from Norsk Hydro before becoming involved with the Statoil project in 1997.

Three of the scientists from the Trondheim centre were at the Gullfaks office in Bergen two-three days a week during 1997-99, for instance.

And cooperation between the various disciplines involved was very good. Geologists, geophysicists, reservoir engineers and production engineers worked closely together throughout.

“This type of seismic survey was in its infancy at the time, and we had to come up with reasons why it should be adopted,” Digranes notes.

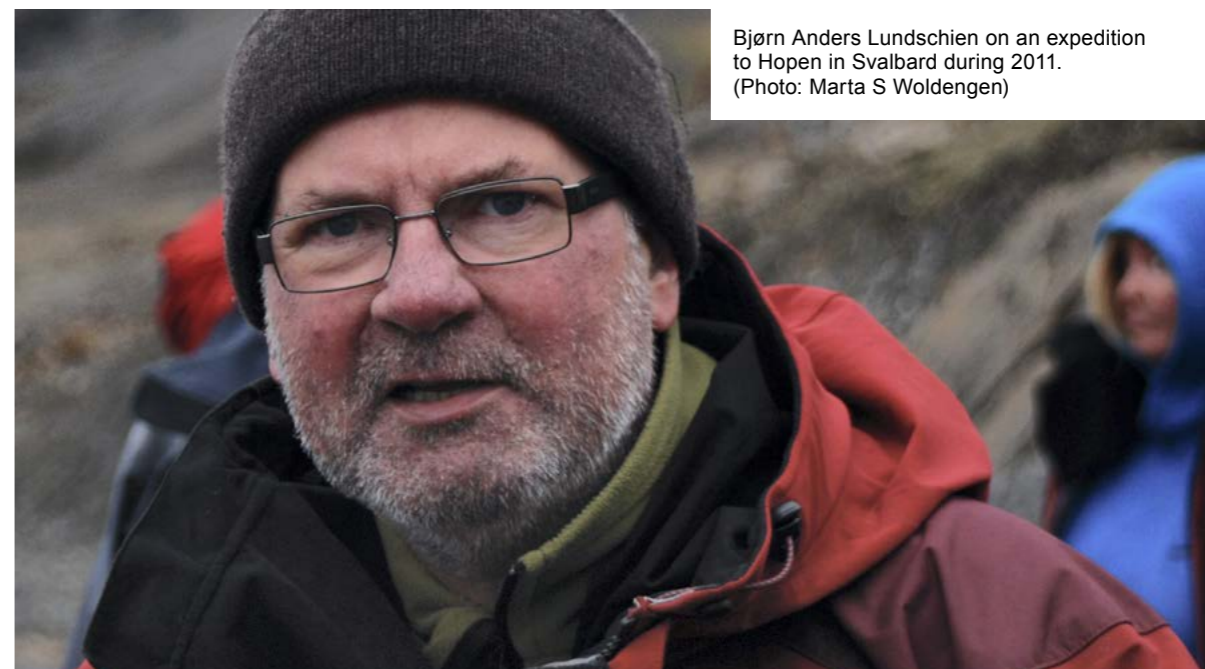
The project team made some simple value calculations which showed the return from positioning wells more accurately and with greater confidence by using 4D data.

“That was important in arguing why the method should be utilised,” he says. “When you can show the impact on the bottom line, it’s much easier to get a go-ahead.”

Reservoir management on roughly 20 Statoil-operated fields currently uses 4D seismic data. Digranes says this figure can vary, because some fields are close to depletion while new ones get added.

Assessing the use of 4D seismic surveys is now mandatory for all new developments. “What we achieved on Gullfaks has converted 4D from a research project to a standard tool,” he observes.

“Before, you had to make a case for acquiring this type of data. Now it’s almost the opposite – you have to justify *not* doing this.”



Bjørn Anders Lundschieen on an expedition to Hopen in Svalbard during 2011. (Photo: Marta S Woldengen)



Geologists studying mudstones and sandstones deposited during the Triassic on Hopen in 2011. (Photo: Terje Solbakk)

## Atlantis theory sunk

| Astri Sivertsen

A collection of articles being published by the NPD throws new light on earlier theories about the geology of Svalbard and the northern Barents Sea.

According to a venerable hypothesis, sand and shale deposited around the Arctic archipelago derive from an earlier microcontinent – a kind of sunken Atlantis called Crockerland.

But studies by the NPD have exploded that view, reports geologist and project coordinator Bjørn Anders Lundschieen.

“Nothing suggests that such a land mass ever existed.”

Scientific drilling by the directorate off Kong Karls Land in 2005 was expected to determine the Permian-Triassic boundary, which dates back about 250 million years.

But it proved to be the Middle-Upper Triassic boundary from roughly 229 million years ago. “Being out by some 20 million years means there’s something wrong with the model,” says Lundschieen.

Instead of coming from the north, the sand found around the

islands originated to the south-east – all the way from highlands and mountain chains in Russia’s Ural region.

The NPD has staged a number of expeditions to and around Svalbard since 2005, collecting and analysing data together with Norwegian, Russian, Polish and British research institutes.

*NPD Bulletin no 11*, due to be published shortly, contains 10 scientific articles which discuss various aspects of the information acquired through the field work.

# ROCK SHOT



## Dug deep

| Terje Solbakk (text and photo)

Fjords are often viewed as a uniquely Norwegian phenomenon – and Norway has given them their name. But geology finds them wherever glaciers have been at work – in Argentina, the Himalayas and New Zealand, for example.

They are the product of

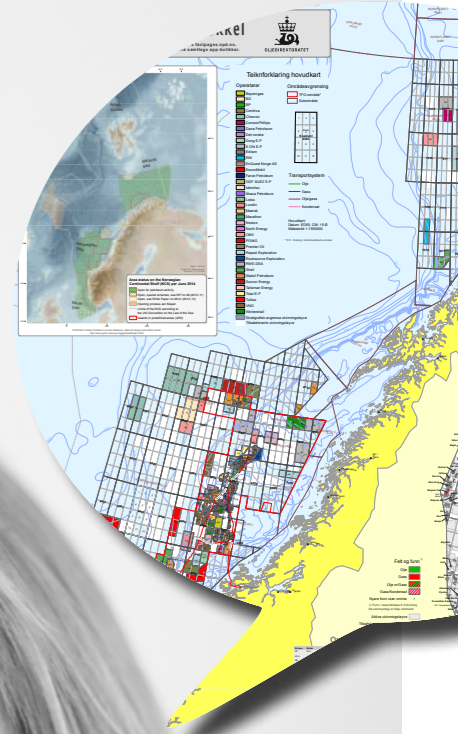
glacial erosion. When ice masses flow down narrow valleys under the force of gravity, they become thicker and dig deeper.

As the valley widens, the glacier thins out and can no longer cut down so far. The result when the ice ultimately withdraws is a deep trench with a shallower threshold, and this

trough fills with water – fresh or salt.

Pictured here is Vestisen, part of the Svartisen glacier in the northern county of Nordland. In front of it lies Nord Fjord, which varies in depth from more than 150 metres to 50 metres at the threshold.

# Updated data source



A new version of the NPD's digital FactMaps portal was launched this summer. Astrid Espe, who has participated in this development, wants it to be a tool for everyone.

| Bente Bergøy and Emile Ashley (photos)





Managing and communicating data on the NCS is one of our most important jobs. The new Fact products have better functionality and are more tailored to user requirements.

Bente Nyland, director general, NPD



**Oriented.** Astrid Espe is more than averagely interested in maps.

Along with the NPD's FactPages, the revised facility provides access to virtually everything worth knowing about petroleum activities on the NCS.

Information on discoveries, fields, operators, licensees, wells, production licences, pipelines and seismic surveys is updated on a daily basis.

"FactMaps is nothing new – we've had it for about a decade," says Espe. "But a lot's happened on the technology side, and we realised it was starting to lag behind. So we've launched a new version, while also updating FactPages."

Users get a better layout in both portals. And linking FactPages to the standard version of FactMaps provides more opportunities for search

and analysis in the latter.

Figures for 2013 show that the two facilities jointly received about 20 000 individual hits per day, which means that someone was accessing data through them every five seconds on average.

"In the future, we envisage merging FactMaps and FactPages into a single solution," says Espe.

The new map portal is available in two versions – standard (HTML5) and advanced (Silverlight). Those who have downloaded the Oil Facts app (see page 40) will be familiar with the first of these, which is designed to work on all digital platforms.

"Users who want more functionality should go for the advanced option," Espe explains. "This allows you to filter data, for example, and to add third-party

information or map services.

"But the data content of the two versions is the same. It's also possible to use and process the FactMaps content as a service in your own solutions."

Both portals are important and useful for specialists in the oil industry, not least in connection with licensing rounds. But the user spectrum extends much more widely, and includes government agencies, environmental organisations, students, financial analysts and journalists.

"The diversity is greater than you might think," says Espe, who is keen to receive comments and suggestions from those who benefit from the service.

"We launched the new FactMaps this summer, without any particular fanfare. Fortunately,

most of the feedback has been positive."

She has been interested in maps since childhood, when she and her brother lay on the deck of a boat with an atlas apiece and explored everything from population figures in distant countries to the depth of the Hornindals lake.

"Since one of the atlases was older than other, we saw how the changes occurred in the world – and in the way it was presented, too," she recalls.

But it took a few years before she realised that this was the route she would be taking – towards the coast with a map in her hand.

"I encountered geographical information systems (GIS) for the first time in the geography department at the University of

Bergen," Espe explains.

These computerised solutions are used to register, model, store, retrieve, manipulate, analyse and present geographically referenced data.

"The switch from the old paper atlas to digital data and GIS wasn't that big a leap," Espe observes. She has been working at the NPD on maps and communicating facts via the web since 2010.

"Our new version of FactMaps has made it much easier for users to study petroleum activities on the NCS, and I've learnt an incredible amount about GIS and system development along the way."

Working with maps can cover a lot of ground, and her interest in this field means she participates in various national hydro-

graphic collaborations – including Barentswatch.

"It's not always that easy, but it's inspiring and fun," she says, "And no day is the same. It's not least interesting and educational to see how people elsewhere work with maps and how our map data is used in various contexts."

GIS and digital map data provide endless opportunities for comparing and communicating such information. But paper maps still have their place, at least in the NPD.

"Our NCS map – put simply, FactMaps in poster format – is still very popular," Espe reports. "The 17 000 copies we printed for ONS in Stavanger during August all went, so we're waiting for a new delivery from the printer."



**Grand master.** Garry Kasparov (right) was a prestigious visitor to Bård Vegar Solhjell's book launch

# Game plan for education

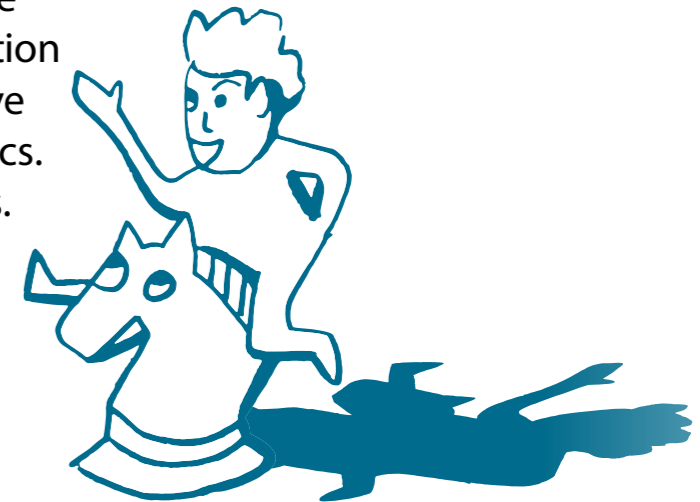


“ All youngsters benefit from chess, and not only the super-intelligent. ”

**Smarter.** Chess can act like an enzyme, a catalyst, to boost the level of educational attainment in Norway, maintains Jøran Aulin-Jansson. (Photo: Astri Sivertsen)

Many people regard chess as a miracle cure for poor memory and concentration difficulties, and a quick way to improve learning of languages and mathematics. But few have taken the consequences.

| Astri Sivertsen and Johnny Syversen (photos)



A clutch of politicians and chess enthusiasts gathered in an Oslo bar on a wet October evening to celebrate the launch of a new book entitled *Sjakk – ei kjærleikshistorie* (Chess – a love story).

Author Bård Vegar Solhjell, deputy leader of the Socialist Left Party, stood at an improvised lectern by the counter to explain why he has written it and why he likes the game.

He was followed by Abid Raja, another member of the Storting (parliament) and fellow player, and Silje Bjerke, Norway's woman chess champion.

Most of the audience appeared to know each other. The mood was convivial and the sound level high. Until a sudden silence fell. Garry Kasparov had entered the room.

Handed a microphone, the compact and energetic man regarded by many as the world's best-ever chess player gave Solhjell an unexpected boost.

"I love this title," he said with reference to the book. "It's not unusual for politicians or business people to talk about chess. And this is a passionate promotion of the game."

Now 51, Kasparov retired as a professional chess player almost a decade ago after a career which included being world champion from 1985 to 2000.

He has since been a prime mover in teaching children the game he himself learnt from his

mother at the age of five in the former Soviet Union.

From his new home town of New York, his Kasparov Chess Foundation has acquired spin-offs worldwide. Asked why he wants children to play, his answer is simple: "To make them smarter."

He backs this claim with research assembled by his foundation, which shows that chess helps youngsters to concentrate and improves their memory.

It also aids them in structuring their thoughts when having to take decisions. Through play – which chess is, after all – they acquire the ability to recognise patterns and apply formulas to different tasks. And they see that something done in one place has consequences in another.

"Kids who've had a little bit of chess training do much better in the general curriculum," Kasparov contends.

He wants poor and underprivileged children, who cannot count on help with their homework, to learn the game. It gives them fundamental skills for mastering maths and reading.

Moreover, he claims, truancy decreases when pupils are allowed to play chess at school.



## Ability

"The perfect age to learn chess is six-eight," Kasparov says. "All the studies show that, by the age of nine, the mind is already closed."

He supports this contention by pointing to research on the ability to learn foreign languages in childhood.

"Education still helps, but everything you do before the age of nine is like hardware. After that, it's only software."

He emphasises that all youngsters benefit from chess, and not only the super-intelligent. That view is supported by Jøran Aulin-Jansson, president of the Norwegian Chess Federation.

Responsible for Kasparov's presence this evening, he is himself a very capable player but protests vehemently at the notion that chess is only for the academically gifted.

"Definitely not! I probably have Norway's worst university qualifying exam – and spent seven years trying to pass it."

However, he is convinced that chess has given him a better memory and improved his ability to think ahead. And the game also develops intuition, he says.

"[Norwegian chess prodigy] Magnus Carlsen can sit and think about a move for 30 minutes," Aulin-Jansson observes. "But all

“Chess is an enzyme, a catalyst, which could help to boost the level of educational attainment in Norway.”



he's doing is checking his intuition. He probably thought out his actual move in 10 seconds."

Chess takes 30 minutes to learn and a lifetime to master, he adds. Like Kasparov, he is eager to see the game adopted in schools – but then with proper teaching, which makes it more a subject of study than a leisure pursuit.

"You won't get a job on the basis of your marks at chess," he says, "But if it helps you to understand maths and languages better and to absorb learning much more effectively, I don't know of any other activity with all these positive spin-offs."

"Chess is an enzyme, a catalyst, which could help to boost the level of educational attainment in Norway."



## Teacher

Torbjørn Ringdal Hansen, Carlsen's very first chess teacher, has just begun a new job at Tiurleiken School in Oslo's Romsås district.

After four years as a full-time chess instructor, the child welfare specialist decided to return to the education system as a counsellor.

But he devotes 30 per cent of his time to teaching chess to children aged six to 13. Almost half the pupils attend the lessons, which take place during breaks and after school hours.

"Chess gives you a feeling of mastery," Hansen explains. "Players experience small victories all the time."

The game has always been popular in the various child welfare institutions where he has worked, including with children who have big behavioural problems.

Even sufferers from attention deficit hyperactivity disorder (ADHD) become absorbed in it, he explains, and can thereby manage to sit still and concentrate.

"The kids learn the consequences of their actions, and how to look and plan ahead. These skills are transferrable to everything in life."

For his part, Solhjell believes that chess has taught him to think strategically – a useful accomplishment for a politician. He also agrees that the game improves concentration and memory.

The fact that chess is a purely mental activity fascinates him. "There's no chance involved. If you lose, you know where the problem lay."

Armenia, where Kasparov's mother came from, introduced chess as an obligatory subject for the first and second years of primary school in 2010.

Several Russian republics and Indian states have subsequently done the same, and roughly a dozen countries now possess various programmes for chess in their schools.

Studies in the UK, the USA

and Germany have measured progress in learning languages and maths by chess-playing pupils compared with those who are not taught the game.

Many of these investigations have identified a strong relationship between learning chess at school and problem-solving abilities in general and mathematical skills in particular.

But Solhjell, a former education minister, admits that the research is of varying quality. So he thinks it is too easy simply to advocate introducing chess to the school curriculum in Norway.

He would prefer to try it out first, and has therefore advocated a Storting hearing to establish the relationship between chess and learning.

This could lead to a trial, with some local authorities and schools testing chess as part of the curriculum for a few years. Comparing the results with control groups who do not learn chess would permit a systematic evaluation.



## Teaching trials

Jone Haarr, chief education officer for Gjesdal local authority near Stavanger, has not studied the issue scientifically, but is convinced that chess has a positive impact on school performance.



He points to a study at a primary school in the German city of Trier, where one maths lesson a week was replaced by chess teaching and play for years one-four in 2003-07.

The outcome was compared with classes in similar schools which had normal teaching, and the results were surprising.

Maths performance in nationwide tests by year-four pupils at the "chess schools" was twice the national average. Reading and language comprehension were 2.5 and three times better respectively.

The Gjesdal, Time, Sandnes and Stavanger local authorities in south-west Norway have offered chess lessons to year five pupils for the past two academic years.

Combining school contests with competition at a high level under the Norway Chess umbrella, they have noted a doubling in interest from one year to the next.

Harr calls the game a "concentration sport", and is pleased as an educator to be involved in promoting attentiveness and strategic thinking among children.

"It's OK in Norway to be good at sport, singing and dancing," he observes. "Ability in maths or chess has somehow lacked the same status."

"But Magnus Carlsen's success has widened interest in chess – previously seen as a game for nerds and special enthusiasts – far more than we could have hoped for."



**Welcoming.** Silje Bjerke wants to encourage more girls to feel at home in the chess community.

## Getting girls involved

**Cultural factors mean that chess has tended to be male-dominated. But there is no reason why this should persist.**

Silje Bjerke, who is on the national team and has been Norwegian champion 11 times, is one of the very few women playing high-level chess in Norway.

Only five per cent of the 3 000 or so members of the Norwegian Chess Federation are female, compared with 20 per cent of just under 4 000 participants in its youth wing.

Only six active women players are to be found in the over-45 age group, says Bjerke. The 32-year-old estimates that she plays against men and boys 90-95 per cent of the time.

Many girls become involved with chess at school or in after-school clubs, but often drop the game when they reach puberty. Bjerke attributes this to cultural factors and a masculine image.

"It's less accepted for girls to devote a lot of time to playing chess," she says. "Being interested in the game as a teenager isn't seen as cool or feminine."

"Women also encounter a number of prejudices and stereotypes in the chess community. It's common to hear such put-downs as 'you play like a girl!'"

While teenage lads go to tournaments with their friends, many girls find themselves relatively alone among all the boys. When they also meet a lot of internal prejudice, opting for another activity becomes an easy decision, Bjerke observes.

She believes it is important to create a more appropriate social environment if girls are to be persuaded to continue playing in their teens.

Oslo accordingly has a separate girl's chess club, which meets every week, so that members can make friends to travel to tournaments with.

Chess is generally more popular than it used to be, and Bjerke says that both parents and children are more ambitious. But she has not seen any particular change among the girls.

"It would have been very interesting to see what would have happened if we also got a female Magnus Carlsen," she says.

# Turning the tide for drilling

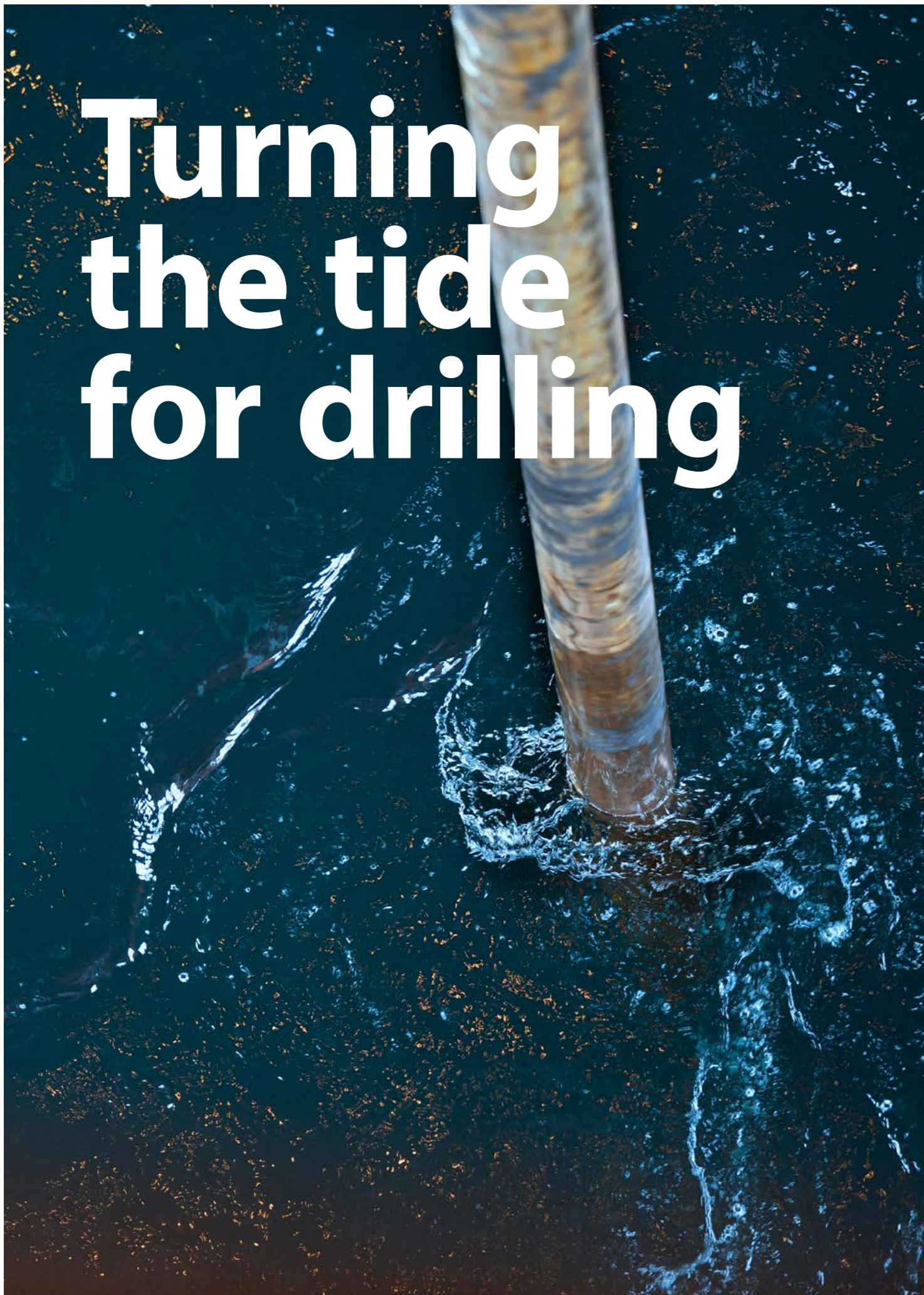


Photo: Harald Pettersen/Statoil

The cost of new production wells has multiplied several times over during recent years, putting big volumes in mature fields under threat. But extensive efficiency programmes and new technology could reverse this trend.

| Alf Inge Molde

Many people are concerned about cost developments on the NCS. Their high level not only affects new developments but could also have major consequences for improving recovery from mature fields. That applies particularly to the most important measure in this context – more production wells.

Drilling these accounts for 30-50 per cent of spending over a field's commercial life, and the bill has risen dramatically in recent years. The average price for a production well drilled from a mobile rig has more than doubled since 2002.

Most of the easy drilling targets have been taken. The bulk of projects awaiting sanction on producing fields involve relatively small volumes compared with new field developments. Many contain less than 2.5 million standard cubic metres of oil equivalent (scm oe) or 16 million barrels.

The NPD has also registered that the operators have had problems delivering the promised wells.

In addition to a dramatic rise in costs, the statistics show that

drilling efficiency has declined on a number of fields. Fewer wells are drilled per year from fixed rigs, at a higher price.

The present slump in oil prices from just over USD 100 to around USD 80 per barrel makes the overall picture for production on the NCS look even more serious.



**Halving and doubling.** "Our attention has been concentrated for many years on getting out the volumes, without thinking too much about costs," says Roy Ruså, vice president for technology at Petoro. His goal is to halve well costs and double the pace of drilling from fixed installations. (Photo: Emile Ashley/Petoro)

## Underestimated

"Wells don't just happen," says Roy Ruså, vice president for technology at Petoro, which manages the state's direct financial interest (SDFI) in Norway's petroleum sector. "We've underestimated both time and costs."

Like the NPD, he has devoted most of his time over the past few years to convincing licensees on the NCS to invest more in new production wells on the mature fields.

That is because, despite the many sophisticated methods available to improve recovery, none equal the importance of drilling additional wells.

But progress has been slow – and the clock is ticking. By Petoro's own calculation, drilling a producer from a fixed installation currently costs four times more than 10 years ago.

Rigs which previously managed three wells a year now do just over one, at an average price of more than NOK 600 million. The cost for mobile units has tripled over the same period.

"If we maintain our present





Photo: Harald Pettersen/Statoil

pace, we won't be finished with drilling the wells we need before 2060 or 2070," says Ruså. "The installations will then have been standing for 75-80 years."

He estimates that 1 000 wells are needed on Norway's mature offshore fields. "If the recovery target is going to be raised from 50 to 60 per cent, the drilling rate must double."

### Inefficiency

The current position is the result of creeping inefficiency, says Ruså. "Our attention has been concentrated for many years on getting out the volumes, without thinking too much about costs."

Although efficiency has occupied a key place, it has been confined to avoiding faults – in other words, downtime. Great attention has been paid, particularly in recent years, to creating fault-free processes, where everything carries equal weight.

This has been a self-reinforcing process, says Ruså. Ever more detailed requirements are individually well-founded, but less positive collectively.

To find out whether everything really was better before, Petoro has compared the time it took to drill the same type of wells from the seabed to the top of the reservoir on the same field 20 years ago with the present position.

This comparison reveals that 23 of 25 sub-operations take longer now than they did in the 1990s. In the worst case, the increase was 316 per cent.

Ruså believes that ambitious goals are required: "Well costs must be halved on fixed and floating facilities, and the drilling pace on fixed installations has to be doubled."

Petoro's comparison shows that this is a realistic target. If it could be done two decades ago, newer technology and longer experience must also make it possible today, says Ruså. That requires the industry to work more efficiently.

### Complex

Jan Krokeide, manager for drilling at the Norwegian Oil and Gas Association, points out that modern wells are far more complex than those drilled 10, 20 or 30 years ago.

The first horizontal well drilled on Troll in 1989 was 502 metres long, and groundbreaking. "We now drill such wells for kilometres," Krokeide says.

At the same time, drillers must avoid old well paths and often encounter unexpected pressure regimes because reservoirs are injected with water and chemicals or affected by geological shifts. Plans must then be modified, boosting costs.

Installations are also aging, and old wells must be plugged to make room for more. A new requirement this year is that temporarily abandoned exploration wells have to be permanently plugged within two years.

Where producers are concerned, too, hydrocarbon-bearing zones must be plugged and abandoned within three years if the well is not to be continuously monitored. Such an operation can take as long as the original drilling job – and ties up the same rig.

### Drivers

"The regulations provide a number of cost drivers," Krokeide observes. "In addition, the companies can have their own internal interpretations and requirements."

"Since things must be as safe as possible, procedures have a general tendency to become more extensive than is strictly necessary."

Norwegian Oil and Gas runs three networks intended to contribute to experience transfer – the Drilling Managers, Well Integrity, and Plug and Abandonment Forums.

These aim to get the companies to share success stories and challenges, explains Krokeide. "The culture for such sharing has become significantly better."

"The government must also follow up the work it's initiated itself. In recent years, we've had the Åm committee, the Reiten committee and the rig report. These have all established the facts and made recommendations. What's happened to them?"



**Simple.** The age of world records is over. Geir Tungesvik, senior vice president for drilling and well at Statoil, wants to work safely, simply and cheaply to improve recovery from the mature fields. (Photo: Harald Pettersen/Statoil)

### Concerned

Geir Tungesvik, senior vice president for drilling and well at Statoil, says he has been concerned about developments for a long time.

The company has a recovery factor of 50 per cent, compared with an industry average of 35 per cent, and recently set a target of reaching 60 per cent – providing it can be done profitably.

While the oil price has tripled over a decade, Statoil's own statistics show that costs have risen four- and five-fold without any sign of a slowdown.

Tungesvik has been telling everyone for the past two years that this could not continue, but the rest of the world thought everything would just go on rising.

He says that getting down the cost of drilling and down-hole activities would mean more wells and thereby improved recovery. If the negative trend continues, more oil will stay in the ground. It is that simple.

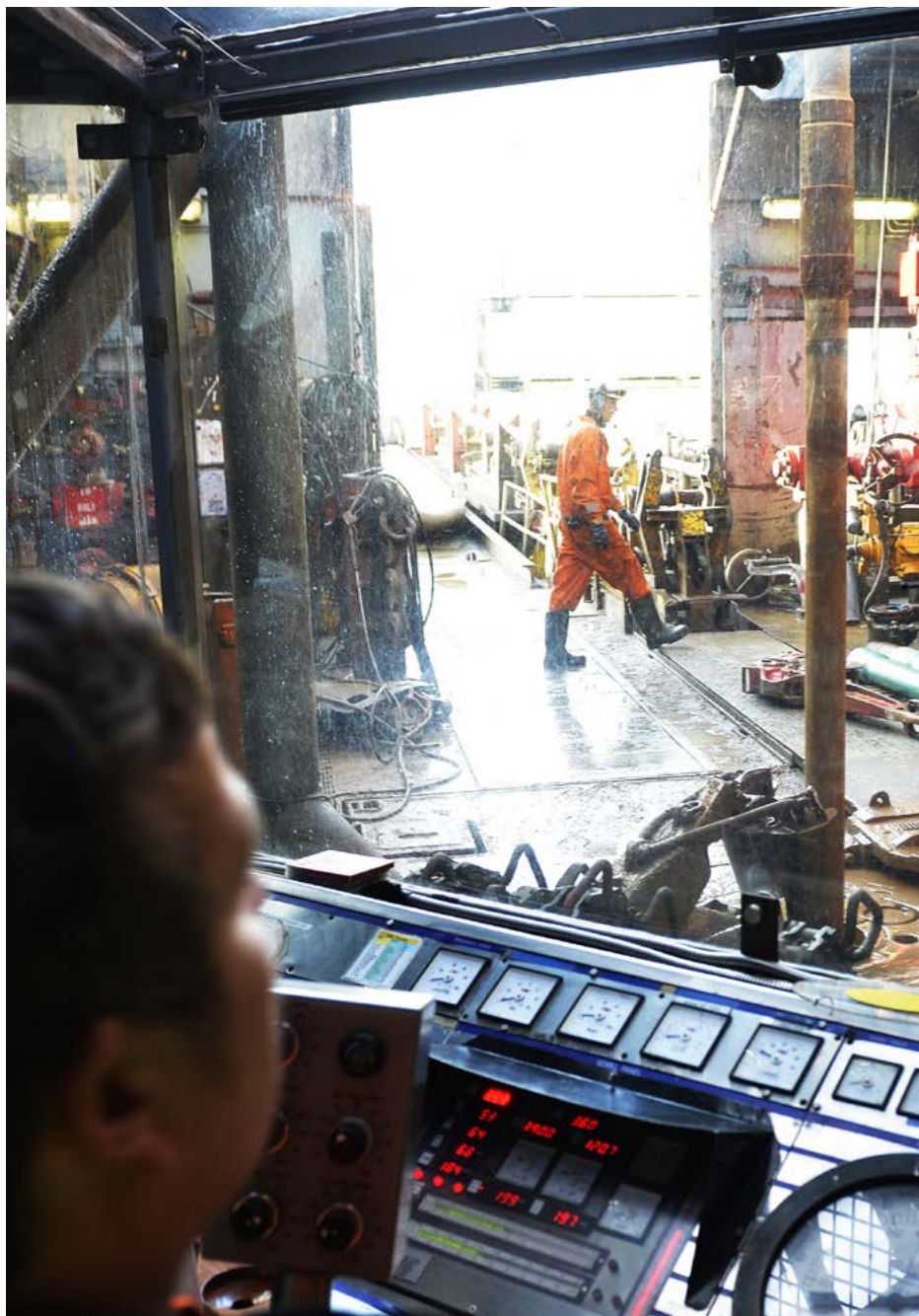


Photo: Harald Pettersen/Statoil

## Regulation not to blame

Nobody has been able to identify which special Norwegian rules might push up offshore costs, with the exception of a few well-known requirements for personnel rest and restitution.

Based on a comparison with UK regulations, this conclusion appears in the latest annual *Safety – status and signals* publication from the Petroleum Safety Authority Norway (PSA).

“Norway’s offshore regulations are constantly being challenged in cost/benefit terms,” the article notes. “Since the present rules came into force in 2001, however, nobody has been able to identify which of them might make operations more expensive.

“Nor has it been possible to demonstrate that any significant difference exists between the regulations and those in the UK – which Norway often compares itself with, for natural reasons.”

Possible differences between the NCS and the UK continental shelf are often attributable to differences in enforcement and practice, observes Anne Vatten, the PSA’s director of legal and regulatory affairs.

“We’ve asked the industry on several occasions since 2002 to provide specific examples of cost-enhancing requirements which haven’t already been identified. We haven’t received any response so far.”

The mantra for Statoil’s technical efficiency programme (Step) is finding best practice, simplifying and working more intelligently. A 15 per cent improvement is the target for this year, and 25 per cent in 2015.

### Targets

So far, for example, Statoil has needed perhaps three targets to justify a new well. Encompassing all these has resulted in very advanced designs, which take a long time to complete and carry a high risk of failure.

Tungesvik’s answer is to drill to one target, then implement sidetracks to each of the others. Cheaper, more intelligent and simpler. The age of setting world records is past.

“We’ve seen that it’s straightforward to drill a horizontal section 1 500 metres long through a reservoir. Beyond that, the failure rate is high.

“We might get more out of the reservoir if we drill for 1 700 metres. And if we’re going to do that, we might as well continue to 2 000.”

But what happens if the well collapses and the work has to start all over again? Must a well be 1 700 metres long or nothing, or would 1 500 be good enough. Does it have to be so complex?

“People were very satisfied when they finally managed to deliver the complicated well, even though it perhaps cost more than planned,” says Tungesvik. “We must find the right balance between investment and present value.”

### Change

The last crisis to hit the oil industry was in 1998, when prices dropped dramatically. Everyone understood that change was needed, with simplification and increased efficiency as the recipe.

Tungesvik wants to recreate that position now. But health, safety and environmental (HSE) standards must be maintained.

Operations are much safer than they were in 2000.

“Working efficiently also means working safely,” he says. That calls for good plans where everyone is familiar with the job, the procedure and the equipment, and understands the risk.

Tungesvik is concerned to turn every stone, including contract forms: “The supplies industry has been challenged to come up with alternative forms of cooperation to get down costs.”

That involves standardisation of equipment and solutions, and Statoil is also keen to test new ways for operators and contractors to collaborate.

“My goal is to get down costs and drill as much as possible,” says Tungesvik. “Those who order special and difficult wells are now told that they’re too expensive. It’s no longer acceptable.”

### Technology

Planning and execution are one factor. Another is technology, notes Sigmund Stokka, head of the Drilling and Well Centre for Improved Recovery (DrillWell).

This Stavanger-based body is one of the country’s Centres for Research-Based Innovation (SFI), financed by the Research Council of Norway and the industry.

Together with the International Research Institute of Stavanger (Iris), Sintef Petroleum, the Norwegian University of Science and Technology (NTNU) and the University of Stavanger, Stokka seeks new technical solutions to improve NCS recovery.

“Although drilling operations are very similar to the way they were 50 years ago, much technological development has occurred,” he says.

The bit has improved, new methods mean the reservoir can be hit more accurately, well control and integrity are enhanced and more specialised equipment can be obtained.

Although the technology is available or just around the corner, however, the industry suffers from inertia. “This is a conservative business,” Stokka observes.

People are afraid of making mistakes. When each well must justify new technology, it is often easier to opt for something known than to take a risk. Some companies run campaigns, which is positive – but not enough.

### Reduce

A report just issued indicates that technical innovation could reduce annual drilling costs on the NCS by NOK 20 billion or 20 per cent within a few years.

This finding comes from OG21, Norway’s national technology strategy for the petroleum industry, which is mandated by the Ministry of Petroleum and Energy.

It represents a collaboration between oil companies, universities, research institutes, suppliers and government agencies.

Work on the report, with Stokka as one of the contributors, has been headed by Dag Breivik, drilling manager for Norway at oil company OMV.

“The challenge isn’t day rates and that sort of thing, but delivering wells at all,” says Breivik. “It takes too long.”

OG21 identifies five technologies with a particular potential to enhance drilling efficiency and save money, including steerable liner drilling.

The others are managed pressure drilling, expandable casing and well equipment, high-speed

downhole communication during drilling, and automated and autonomous systems.

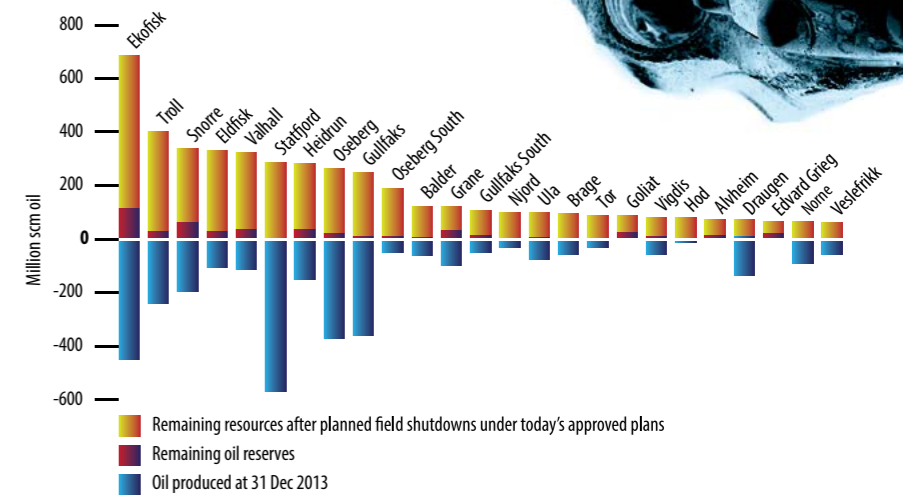
Many of these solutions are already on the market and tested, but the companies have failed for various reasons to exploit their potential. Other technologies will soon be available, too.

### Execution

Drilling a well costs NOK 5-10 million per day. Cutting execution time by 10 days would accordingly save NOK 50-100 million per operation, Breivik observes.

“It’s important to stress that none of the technologies cited will necessarily achieve that alone. But combining several would have a big impact and give the industry more tools.”

The OG21 report also emphasises that the government has a clear role in supporting



Resource overview for Norway’s 25 largest oil fields – potential for improved recovery

technology development and piloting, while companies must eliminate requirements which lock in old solutions.

Breivik invites oil companies, rig owners and suppliers to sit down to a collective discussion on the improvement potential and the way obstacles can be removed.

He is well aware that a lot of commitment and collaboration is needed to get everyone concerned to understand what the new technologies involve and what they could mean.

Risk is also balanced against short-term gain, he observes. "But this isn't something you win at the level of the individual well. It must become part of the standard."

### Game-changer

Industry veteran Mads Grinrød notes that simplification and efficiency can be pursued to a point where nothing more is to be gained. "Then you need a new technology, a game-changer."

Retiring in 2007 after 35 years with Statoil, the company's former head of drilling and well shares worries about the number of wells being drilled on the NCS.

He is now working with the continuous motion rig (CMR), a new concept which – put simply – comprises a fully automated unit with two systems which take it in turn to rotate the bit.

Allowing new drill string to be made up while continuing to drill ahead, this solution offers many advantages over existing technology.

At present, drilling has to stop during tripping, and for 10-15 minutes every 30 metres to extend the string. Circulating mud continuously avoids these halts and cuts pressure variations.

Drilling with nobody on the drill floor also provides an HSE benefit and saving in itself. Analyses show total cost cuts of 20-25 per cent compared with existing technology.

"These are conservative figures," Grinrød emphasises. "We believe the potential is even greater."

### Full-scale

The CMR concept has been developed by West Drilling Products, which is now planning a full-scale rig alongside the Ullrigg test facility at Ullandhaug in Stavanger.

Financed by West Group, Statoil, ConocoPhillips, Shell, the Research Council and Innovation Norway, the aim is to have everything in place during the first half of next year.

Asked when he will be ready to deliver a finished product, Grinrød says this can be done in late 2016 if he gets in an order now.

But he is keen to see how the system works. There is no assurance that the equipment will function immediately in the way it does in simulations.

But the biggest challenge is to find an oil company willing to take the first step and to devote the necessary time and money to bring a new solution into operation.

Grinrød is well aware of the industry's conservatism, and says it used to be better at trying new things. The NCS was known precisely for that.

After 2000 in particular, however, the industry has become more wedded to proven technology. Everything is more bureaucratic, and nobody wants to accept risk.

But the answer to the sharp rise in costs on the NCS will be to implement new solutions. A commitment is required, and must be made swiftly.



**New ideas.** Mads Grinrød retired as Statoil's head of drilling and well in 2007, after 35 years with the company. Simplification and efficiency can be pursued to a point where nothing more is to be gained, he says. His present job involves the continuous motion rig (CMR), a completely new concept for fully automated drilling which cuts costs and risk. (Photo: Emile Ashley)

# An alternative approach

**No best practice.** Erik Sverre Jenssen, Lundin Norway's COO, does not believe in best practice. "We must constantly get better, or we've lost." (Photo: Trym Bergsmo/Lundin Norway)

## Lundin aims to keep costs down and the pace of drilling up when the Brynhild, Edvard Grieg and Johan Sverdrup fields are to be brought on stream.

"Our approach has been a bit different to that taken by others," says Erik Sverre Jenssen, chief operating officer at Lundin Norway in Lysaker outside Oslo.

Not everyone is able to start from scratch. But that was what this aggressive exploration enterprise did when it was founded in 2004.

It concentrated on hiring a limited number of experienced staff, made heavy use of consultants and contractors, and developed a minimum of management systems.

That provides flexibility and rapid decision processes. "I'm not concerned about passing one milestone before starting on the next," says drilling manager Johan Bysveen.

He wants to work on several phases simultaneously, and prefers to bring together the drilling team, review the risks and take it from there. Things can quickly get over-elaborate, he observes.

### Five rigs

With 43 exploration wells drilled over seven years, Lundin has had five rigs in operation this year and plans to spud 11 wells as operator with five units in 2015.

These rigs will also be drilling one and a half production wells on the Brynhild subsea

development and three-four on Edvard Grieg.

The company's exploration experience will be used to sink producers safely, quickly and cheaply – not least on the giant Johan Sverdrup development, where 80 wells are planned up to 2026.

"Maintaining sufficient focus on efficiency and the use of new technology is incredibly important," observes Harald Mortensen, who is responsible for Johan Sverdrup.

This field's reservoir extends very widely and offers a few challenges. Mortensen says that the licensees are now trawling the industry for technology projects to support.

Much is happening on many fronts, including automation, drilling fluids and more exact metering technology. New ways of treating drill cuttings are another priority area.

Lundin also notes the importance of dry wellheads and Xmas trees, which make maintenance and improved recovery measures much easier than with subsea solutions.

"We have clear views about this on Johan Sverdrup," explains Mortensen, and adds that experience transfer is particularly important on this field – both at operator Statoil and through active exchanges with other licensees.

Lundin itself is using wired pipe on Edvard Grieg, where a signal cable is integrated in the drill string to replace transmission through the mud.

This allows an almost unlimited amount of data to be conveyed directly from the bit to the surface, making efficient control much easier and quicker.

"Although it's well-known, the technology hasn't been much used in Norway," reports Jenssen. "We're completely committed to it."

### Research

Lundin spends NOK 100-200 million annually on research and development. While much of this was devoted earlier to geology-related work, budgets for drilling are increasing.

One of the technologies sponsored by the company, being developed at Stavanger-based Fishbones, involves drilling boreholes 20-30 centimetres in diameter.

Equipment is then run down with a couple of hundred little drill bits, which emerge individually from the string to produce a lot of small holes.

This makes it much easier to achieve flow from tight rocks in the reservoir, and could potentially permit far more effective – and thereby fewer – production wells.

"Multilateral wells have made a big contribution, and Fishbones is taking them a step further," explains Mortensen. "We're also sponsoring a lot of other projects, but we don't want to say too much about some of them."

Bysveen is hoping that the drilling department will be left a little alone on new fields such as Johan Sverdrup, without too much involvement from other parts of the company. That can quickly become a case of too many cooks.

He also hopes that the industry will make a proper collective effort, where all competent partners are genuinely brought in – including the drilling contractors.

"Today's drilling industry is highly competent," Bysveen observes. "That wasn't the case 30 years ago, but the oil companies still have a tendency to believe they know it all."

Although the industry has been pursuing experience transfer for several decades, he still has to see a perfect example of this working. Lundin is now studying a new computer system which makes it easy to access information.

"We've also been indoctrinated with the idea that best practice doesn't exist," adds Jenssen. "We must constantly get better, or we've lost."



**Local adaptation.** Takoradi in Ghana, one of the new oil nations in the International Upstream Forum. Participants can learn from work done elsewhere, and adapt it to their own national conditions. (Photo: Emanuel Baah)

# Fruitful collaboration

## Comment

Bente Nyland, director general, NPD

An important lesson to be drawn from the latest meeting of the International Upstream Forum (IUF) is that everyone concerned – operators, the industry and the government – needs to do their homework even better before new projects are launched. That applies as much to a licensing round as a field development.

Forty leading representatives from 13 nations attended the sixth IUF in Stavanger earlier this autumn, with the NPD as the host.

This forum allows national regulators responsible for resource management to share experience in order to strengthen collaboration with and follow-up of the industry.

Although the forum is basically a multilateral collaboration, it also provides the basis for bilateral conversations – which reinforces Norway's influence in international cooperation. And, not least, it builds relationships.

Participants this year included experienced producer countries such as the USA, Canada, Australia, the UK, Mexico, Brazil, Nigeria, Ireland and Denmark.

Newer oil nations such as Ghana, Israel and Iceland also attended.

### Learn

Forum participants have different histories, cultures and backgrounds. But they can all learn from the work done by others, adapted to their own national conditions. Not reinventing the wheel in each oil and gas nation must be of general interest.

Norway also applies experience from the IUF in the Oil for Development programme run by the Norwegian Agency for Development Cooperation (Norad), where the NPD, the Petroleum Safety Authority Norway and Petrad are important players.

I had the pleasure of opening this year's forum. It is always interesting to hear about developments elsewhere in terms of new discoveries, developments and regulatory changes. This proved a fruitful two-day event, where experience and views were exchanged.

One of the relevant issues discussed is how governments

can become better at following up the companies in the exploration phase, with particular emphasis on deep seas and Arctic waters.

### Management

The question is how risk management can be conducted during the exploration phase. New resources are often located today a long way from established infrastructure and in smaller discoveries, and the cost of recovering them has risen sharply.

A number of challenges need to be overcome. How, for example, are we to ensure good resource management and determine that operational risk is being handled well? Oil and gas nations such as Canada, the USA, the UK and Norway have common interests here – and much to learn from each other.

Countries such as Brazil, Nigeria and Mexico are in a phase characterised by extensive restructuring of their administrations, and want to draw on the experience of others.

Norway can learn a lot from its big neighbours to the west,

particularly for activity in deep Arctic waters. Examples include different methods of data acquisition and risk management for offshore operations.

The companies often cooperate closely with the supplies sector, but collaboration between government and industry has not been equally good at the international level.

While regulators and operators must maintain a healthy distance, openness and predictability are in everyone's interests. We have been successful with this in Norway, and a number of other nations are accordingly interested in learning from us.

### Overview

Government in Norway collects information from the companies and maintains an overview of activities. This equips us to produce good analyses of the NCS and to follow up plans and operations by the companies in a positive way.

We are also a pioneering nation in making data available, so that the companies have the best possible information when they seek new production licences or face drilling decisions.

Instead of acquiring data, the players can devote their energies

to interpreting it. This is cost-effective. Everybody is served by minimising the number of dry wells drilled and avoiding the waste of money which occurs when existing information is inaccessible.

A US debate on how risk can be better managed when new licences are awarded has followed the 2010 Macondo accident in the Gulf of Mexico. The Americans have drawn in this work on experience and practice from other nations.

### Financial

Another subject discussed at the IUF meeting was managing financial risk in major offshore oil and gas projects. Costs have greatly exceeded original estimates in far too many of these, whether they involve developments or clearing up fields which have ceased production.

That is an issue which concerns all the producer nations, reinforced by the rising level of costs in the petroleum sector.

The NPD produced a report last year about lessons learnt from developments in recent years. A key conclusion was that better work needs to be done in the early phase of a project to avoid cost overruns.

This subject is closely allied to national management of revenues from the oil and gas industry. Norway has much to contribute on how such income contributes to building good social welfare.

### Recovery

Norway also plays a key role in the third topic on the IUF agenda – improved recovery from offshore fields, and strengthening follow-up of reservoirs and developments on mature producers.

Experience shows that regulators like the NPD must be a driving force in ensuring measures which require investment to improve recovery from mature fields.

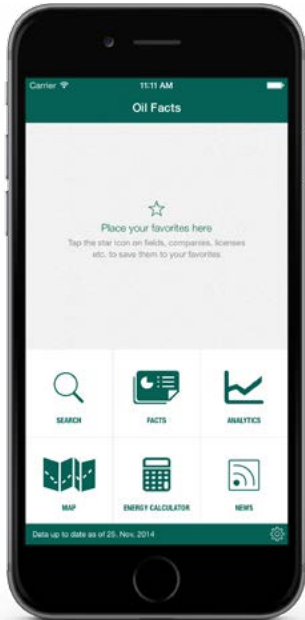
Such work begins as early as the development planning phase, which should take account of later measures to maximise recovery of the commercial resources in a field – even though margins are lower in its final years.

That subject also interacts with the environmental and climate debate because energy is needed to get out the final producible resources in the fields.

This is unlikely to be the last time that such considerations are illuminated and debated in the IUF and other arenas.

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## Knowledge on tap

An updated version of the iPhone app from the NPD and the Ministry of Petroleum and Energy can be found in the App Store by searching for Oil Facts.

Available free of charge in iPhone, Android and WindowsPhone variants, this tool is based on data from the NPD's FactPages and FactMaps.

It provides information on fields, production licences, companies, production and active exploration wells, as well as news from the ministry and the NPD.

The map function presents fields and active exploration wells, all linked to relevant background information. Users also have a dedicated search function.

An analysis section makes it possible to filter and sort data, which can then be stored as personal favourites to simplify later updating. Graphs can also be generated here.

The app is available in Norwegian and English versions.



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