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DIALOGUE

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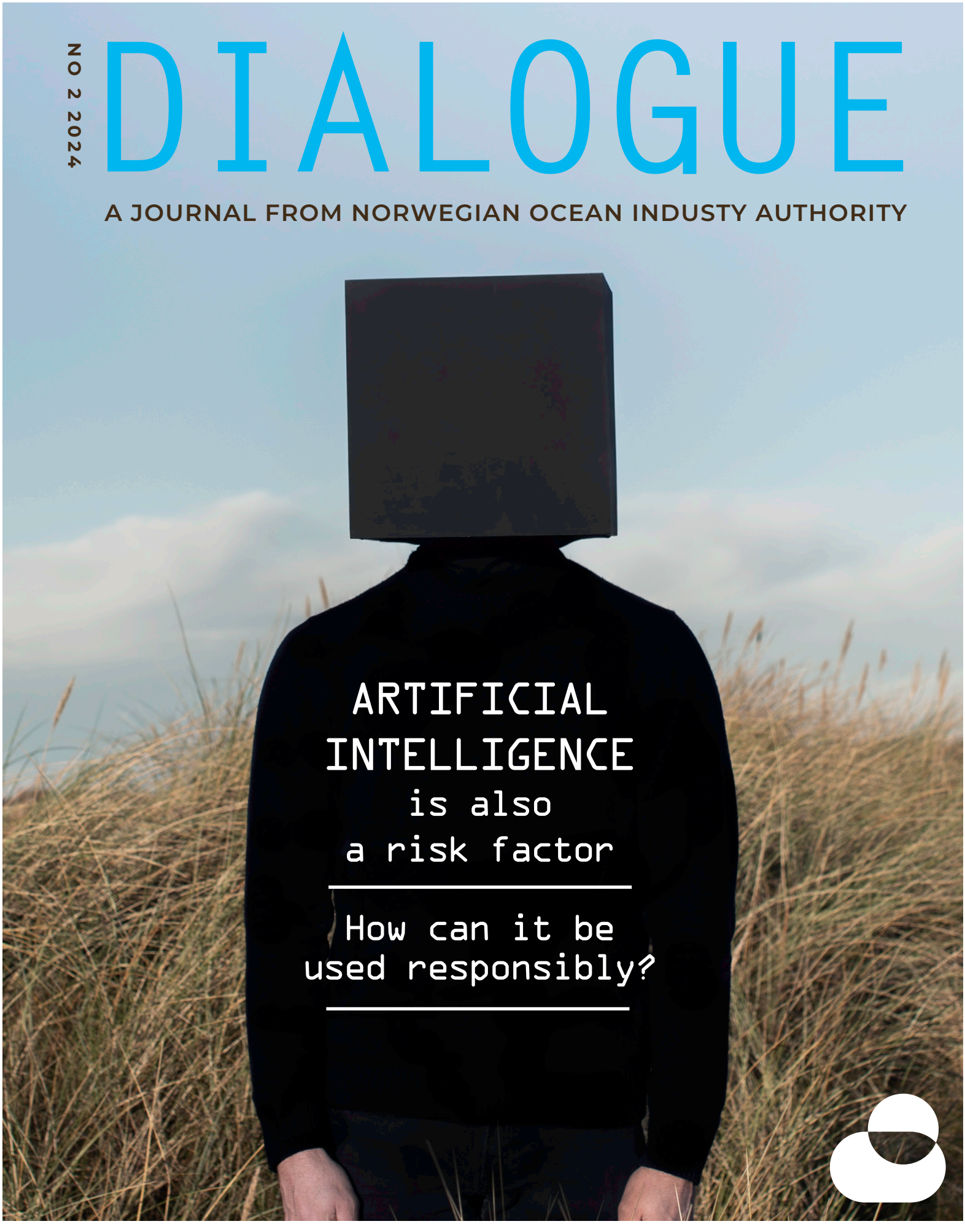


ARTIFICIAL INTELLIGENCE is also a risk factor

How can it be used responsibly?

RIDING THE AI WAVE

Artificial intelligence (AI) is also changing the way the energy sector works. New AI-based systems and solutions can help to improve safety and efficiency. But this innovative technology presents another source of risk.

That raises concerns for us at the Norwegian Ocean Industry Authority (Havtil), as emphasised by our main issue for 2025.

The following pages explain why we have chosen the theme “Artificial intelligence is also a risk factor” as the issue, why we think it should be high on the industry’s agenda and what we expect of the companies.

We have also discussed AI with technologists, managements, employees and researchers both inside and outside the sector. That has illuminated both risks and opportunities, upsides and downsides, and highlighted important views on where our attention should be concentrated as the AI wave washes over us.

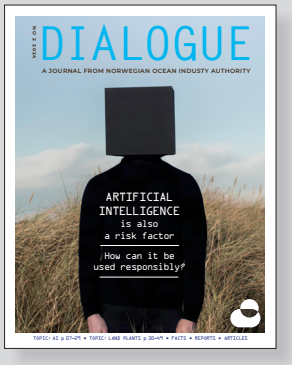
After absorbing the coverage of AI, you can continue to something more prosaic in the shape of Norway’s onshore plants.

These seven facilities vary in age, size, design and function, but play a key role in processing and exporting oil and gas from the Norwegian continental shelf (NCS).

Through facts, articles and interviews, we explain the tasks and functions of the onshore facilities and some of the challenges they face.

This issue also outlines Havtil’s requirements for managing onshore activities and efforts to mitigate risk.

Enjoy!
Øyvind Midttun
Editor



BLACK BOX

The black box metaphor is often used in AI to describe systems or models whose internal processes are hidden from or incomprehensible to users. They can see the inputs and outputs but are unable to understand how the systems reach their decisions.

In a complex neural network, tracing precisely how a model has learned to recognise patterns or take decisions can be difficult. This is what makes it a “black box”.

Such technologies can be problematic because it is important that we not only understand and can explain the crucial underlying decision processes, but are also able to identify errors and vulnerabilities or assess the quality and use of data.

We use our cover photo and the article on Havtil’s main issue to play around with the black box metaphor. We hope the point comes across.

(Cover photo: Elisabeth Kjørmo)

Havtil Norwegian Ocean Industry Authority

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New AI-based systems and solutions could help to improve both safety and efficiency. But this technology also poses risks which must be dealt with.

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ARTIFICIAL INTELLIGENCE is also a risk factor

Artificial intelligence (AI) offers many benefits and improvements, positive solutions and reduced risk, notes Havtil director general Anne Myhrvold. “But it may also be a risk factor in itself. Our main issue for 2025 gives us the opportunity to emphasise this and promote reflection, debate and action in the sector.” ---->

Text: Øyvind Midttun **Photo:** Elisabeth Kjørmo

Myhrvold emphasises the importance of people understanding AI's limitations so that they can intervene and take action when necessary.

"An exaggerated reliance on AI may undermine people's vigilance and lead to poorer decision making. It may also increase vulnerability to cyberattacks." She adds that responsible use of this technology is particularly important in industries with a risk of major accidents.

LIMITATIONS

"Risk can arise from incorrect use of data or errors in the underlying information. This may be distorted or transparency could be lacking – as with black box technology."

Issues Myhrvold identifies include how the systematics are understood and where decisions get taken, and she notes it may be difficult to identify and correct errors unless this is understood.

"With our main issue for 2025, we aim to emphasise the importance of recognising both the positive aspects of AI and the risk factors it presents. The latter mean that the technology also involves a number of challenges."

PERFORMANCE-BASED

"One question is whether our regulations are adapted to developing and utilising AI," Myhrvold observes. "We enforce a technology-neutral, performance- and risk-based regulatory regime for both the petroleum sector and new industries."

In Havtil's view, she says, these regulations are relatively applicable in their present form for ensuring good AI solutions.

"They set out basic requirements for prudent operation and risk management, which is important with a view to integrated and appropriate development and application of AI.

"But we also recognise that they may lack references to good norms and industry standards which can offer useful guidance where AI is concerned.

"We'll therefore be monitoring the industry's work on standards and standardisation, precisely to ensure that AI is covered in a better way." ■

AI has to be viewed in an integrated perspective so that factors related to humans, technology and organisation are taken into account when developing, applying and maintaining solutions.

07 Employees demand genuine participation

Given the growing use of AI in the petroleum sector, vice president Lill-Heidi Bakkerud at Styrke expects the companies to secure expertise, involve their employees in key decision-making processes and ensure genuine participation.

Text: Øyvind Midttun **Photo:** Elisabeth Kjørmo

What do you think of "Artificial intelligence is also a risk factor" as a main issue?
This is highly relevant for raising awareness about what AI really involves and its possible downsides.

How can the industry best balance the benefits of AI against its potential risk?
This is a matter of securing expertise about the nature of AI and where it might lead before adopting it. Decision makers and those involved before green lights are given must have the necessary knowledge. This isn't something you just leave to the IT department.

Norway's performance-based regulatory regime presupposes genuine participation and involvement from those with a broad-based understanding of the possible consequences of decisions. Participation is essential if we're to ensure prudent use of AI in our industry's operations.

What expectations do you have of AI use in the companies, particularly with regard to safety-related operations?
I expect them to take the need for knowledge at every level seriously, and to involve all parties.

What do you see as the most important steps the companies must take to ensure prudent use of AI?
They must stipulate strict conditions based on detailed risk assessments of what AI can be used for, ensure expertise about this in all process stages and involve the operative management. ■

LILL-HEIDI BAKKERUD
VICE PRESIDENT, STYRKE

Styrke (formerly the Norwegian Union of Industry and Energy Workers) has almost 80 000 members in the oil and gas sector, onshore industries, management and technology.

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ELISABET HAUGSBØ
PRESIDENT, TEKNA

Tekna (Norwegian Society of Graduate Technical and Scientific Professionals) organises personnel with higher education in technology and sciences. Its 110 000 members include 13 000 students.

Technology development is organisational development

Tekna president Elisabet Haugsbø emphasises that the right specialist expertise must be in place to ensure a balance between the pros and cons of AI.

Text: Øyvind Midttun **Photo:** Elisabeth Kjørmo

What's your reaction to Havtil's choice of its main issue for 2025?
I believe it's helpful to emphasise that AI also represents a risk factor. That applies to all use of new tools. As with any work involving risk, however, the trick is to balance advantages against disadvantages. To do this effectively, we must ensure that the technical expertise of AI specialists is involved when decisions come to be taken. So I think it's also very useful to talk explicitly about risk with regard to applying AI.

How does the industry strike the ideal balance between the benefits and potential risks of AI?
To assess whether one type of risk is worth taking, we must be well-informed about the tool which may pose (or eliminate) the risk. That's AI in this case.

As I say, it's then a matter of successfully involving appropriate technical expertise in the assessments made. Such involvement should occur early, with good participation from union officials. That's because this is also about carrying your people with you, not only to build new expertise but also to be able to adopt new tools in a safe and effective manner.

What expectations do you have of AI utilisation in the petroleum sector, particularly with regard to safety-related operations?
I expect the industry to succeed once again in following up this technology in a good way. In my experience, this is precisely something it's good at – although expectations may be particularly high for using AI to limit emissions and promote even greater energy efficiency.

What do you see as the most important steps the companies should take to ensure prudent use of AI?
The most important is to recognise that technology development is organisational development. This means that a detailed understanding is needed of the way AI technology actually works when conducting risk assessments. It's also important to involve union officials early in the process, and not least to ensure that employees have the right expertise for using AI tools effectively. ■

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AI can give Norway a competitive edge

Kristine Dahl Steidel, CEO of Microsoft Norway, believes AI has a massive potential for fuelling value creation and enhancing efficiency. She also thinks Norway can lead the way in applying it responsibly.

Text: Øyvind Midttun **Photo:** Elisabeth Kjørmo

Dahl Steidel was one of the speakers at Havtil's top executive conference this autumn, where the authority presented its main issue for 2025 to business leaders. She comments here on the issue and explains why she believes Norway can take the lead on responsible application of AI while striking a balance between risk and opportunity.

What's your response to Havtil choosing "Artificial intelligence is also a risk factor" as its main issue for 2025?

I think this is important and relevant. AI has a massive potential for fuelling value creation and enhancing efficiency – revolutionising the way we work, boosting productivity and creating new opportunities across different industries. It can help to automate routine tasks, for example, analyse large volumes of data quickly and accurately, and enhance customer services through AI assistants and personalised recommendations.

It's also important to be conscious of the risks and challenges which accompany the technology. AI can pose ethical dilemmas linked to data protection and the potential for distortions in the algorithms. Ensuring that AI is developed and implemented prudently, with a focus on transparency, fairness and security, will be crucial. We must also be prepared for the social and economic impacts, such as fluctuations in the labour market and the need for new skills and expertise. By balancing the positive aspects with an awareness of the challenges, we can exploit AI technology's full potential in a sustainable and ethical way.

You've said earlier that you believe Norway is paying too much attention to the risk aspects of AI. What do you mean by that?

When I say that we're focusing too much on the risks, I mean that we often allow ourselves to be influenced by negative scenarios which create fear and uncertainty. These may include worries that AI will take over jobs, cause massive unemployment, or even evolve into a threat to humanity. Although it's important to be aware of →

Balancing the positive aspects of AI with an awareness of its challenges will allow the technology's full potential to be exploited in a sustainable and ethical manner, maintains Microsoft Norge CEO Kristine Dahl Steidel.

"AI has the potential to revolutionise many aspects of our society."

potential risks and challenges, I feel such fears might prevent us from exploiting the enormous benefits and opportunities AI could offer.

This technology has the potential to revolutionise many aspects of our society. It could, for example, enhance health services by analysing medical data faster and more accurately than people can, and thereby yield better diagnoses and treatments.

In the business sector, AI can help to boost productivity and efficiency by automating routine tasks and optimising processes. Where education is concerned, it can be tailored to individual learning needs and offer more customised teaching.

Concentrating too much on the risks means we might miss out on these opportunities. I believe instead that we should adopt a more balanced approach, where we acknowledge and manage risk while actively exploring and investing in AI's positive aspects.

That entails promoting research and development, supporting innovation, and creating a regulatory regime which ensures responsible use of the technology.

Adopting a more optimistic and progressive view of AI will allow us to ensure that Norway becomes a leader in technology and innovation, while also safeguarding our values and societal interests.

How do you view the balance between benefits and risks in adopting AI?

Striking a balance is all about having a realistic understanding of what the technology can do for us. On the one hand, we must be aware of the risks associated with AI, such as data protection issues, security threats and potential job losses. These require thorough assessment and management to ensure that AI is used responsibly.

On the other hand, we must also be open to the major opportunities which the technology offers with regard to value creation and greater efficiency.

It has the potential to revolutionise many industries by automating routine tasks, improving decision-making through data analysis and creating products and services which can enhance the quality of life.

Patient care can be bettered, for example, by analysing medical data and suggesting treatment plans, or customer service might be strengt-hened by offering faster and more specific responses to enquiries.

To achieve this balance, it's important to increase understanding of and knowledge about AI among both executives and employees. That means investing in training and expertise development as well as promoting a culture of innovation and continuous learning.

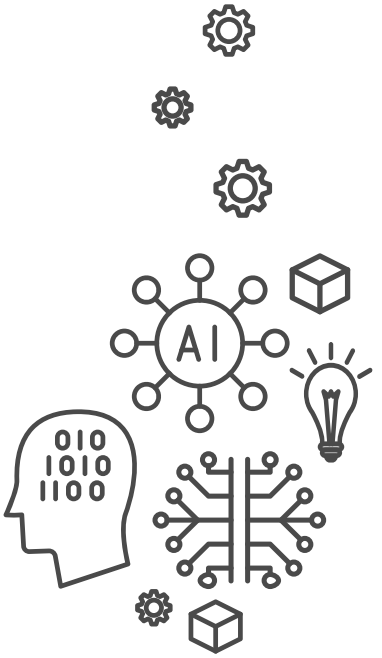
What do you think are the biggest challenges we face with regard to using AI right now?

These challenges include several aspects, and relate to a lack of insight into the technology. Many businesses and individuals still have limited understanding of how AI works and can be applied effectively. This may create false expectations and misunderstandings about what AI can and can't do.

Another aspect is a lack of insight into the way gains can be realised. Although many people are aware of AI's potential, they're often uncertain about how this can be turned into reality.

Addressing this requires a strategic approach, which starts by identifying specific areas where AI can create value, and then implement solutions able to measure and document the potential gains.

This is also about a lack of expertise. People with the knowledge necessary to develop, implement and maintain AI-based systems are in very short supply. That includes technical competence as well as a general understanding of how AI can be integrated into business processes. To meet this challenge, we must invest in training and expertise development, and promote a culture of continuous learning. To exploit the potential of AI fully, we must work to enhance our understanding and knowledge of it. This means offering training



and resources to help both managers and employees to grasp how AI can be used effectively and prudently. We must also promote collaboration between different sectors and professions to ensure that we have the expertise and insight required to realise the benefits of AI.

How can we achieve an optimal interplay between humans, technology and organisation?

Entrenchment in top management is crucial here. This means that senior executives must engage with and actively support the implementation of technological solutions. When they exhibit a clear commitment to technological initiatives, a culture of innovation and continuous improvement is created throughout the organisation.

The technology must be used to support and reinforce the human contribution, which means tools and systems should be designed to enhance the work of employees rather than replace it. Automating routine tasks, for example, frees up time for personnel to focus on more strategic and creative work. That can boost productivity and job satisfaction, while producing better results for the organisation.

A clear understanding of how AI can create value in the organisation is also important. That calls for a strategic approach to identify specific areas where AI offers the greatest possible gain. Mapping and analysing processes makes it possible to identify opportunities for efficiency enhancements and improvements through technological solutions. That can range from enhanced data acquisition and analysis to better communication and collaboration across departments.

How can we best prevent AI solutions making us more vulnerable to external threats and malicious acts?

Trust in our technology partners and the solutions we use is crucial, and we must be proactive in identifying and managing potential vulnerabilities. This means security must become an integral part of the development process, from design to implementation and maintenance. Integrating security measures in all phases of an AI solution's life cycle enables us to reduce the risk of vulnerabilities and to ensure that the technology is used responsibly.

Trust in technology is an important point. What's its significance for using AI? And, from a slightly different perspective, how important is trusting the technology companies?

Trusting technology is essential for exploiting the potential offered by AI. We must be confident that this functions as intended and is used in a responsible manner. It's equally important that we feel assured that the technology companies supplying the solutions observe ethical guidelines. In my view, trust in technology is the crucial factor if we're to adopt and extract the maximum benefit from the new solutions which AI represents. To preserve and reinforce this trust, the technology must be more than just a tool which offers a competitive edge – it must also provide a safe and ethical resource.

A strong culture of trust offers us the freedom to take better decisions, to collaborate openly and effectively, and to dare seize new opportunities. In Norway, we have an inherent belief that decisions are taken with the best interests of society in mind.

Trust means we can dare to take risks and set ambitious goals – like the risk we took as a nation when we knew very little about how important and significant the petroleum industry would become for our economy.

Opportunities for Norwegian success are here again. With an energy sector developing world-class digital value chains and one of the world's most digitalised public sectors, we have a solid foundation for using AI to raise productivity, value creation and prosperity to new heights. ■

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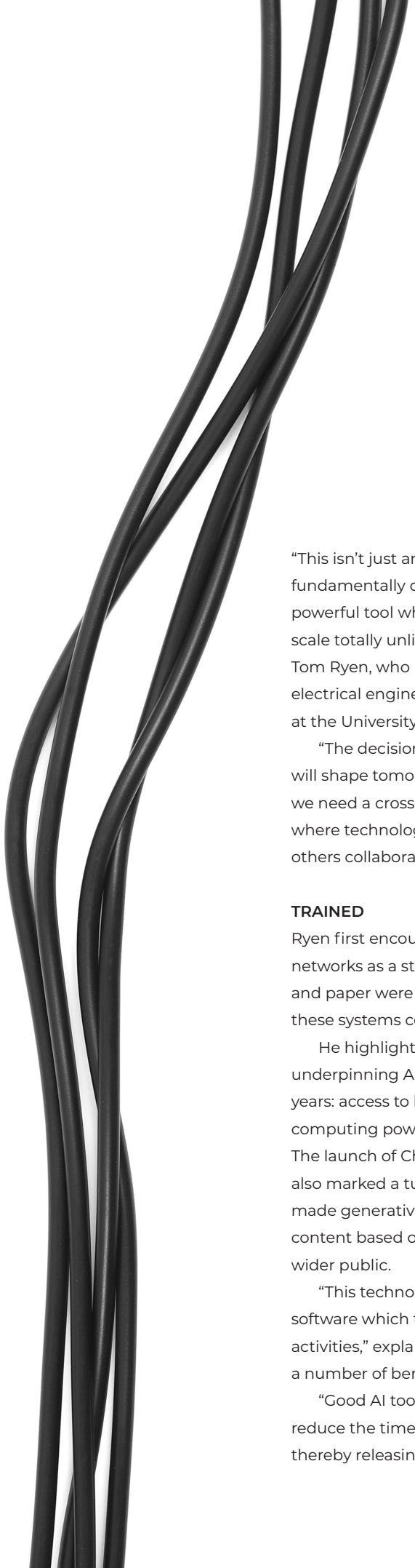
From niche to universal

AI has evolved from a mathematical research field into a technology which is impinging on the whole of society.

Text: Eileen Brundtland **Photo:** Elisabeth Kjørmo

”AI is an extremely powerful tool which can affect society on a scale totally unlike earlier solutions,” says Tom Ryen. He heads the department of electrical engineering and computer science at the University of Stavanger.



"This isn't just another advance – it's fundamentally different, an extremely powerful tool which can affect us on a scale totally unlike earlier solutions" says Tom Ryen, who heads the department of electrical engineering and computer science at the University of Stavanger (UiS).

"The decisions we take about AI today will shape tomorrow's society. That's why we need a cross-disciplinary approach where technologists, social scientists and others collaborate."

TRAINED

Ryen first encountered artificial neural networks as a student in 1998, when pen and paper were utilised to work out how these systems could be trained up.

He highlights three crucial factors underpinning AI development in recent years: access to large datasets, increased computing power and improved algorithms. The launch of ChatGPT in November 2022 also marked a turning point because it made generative AI, which creates new content based on prompts, accessible to a wider public.

"This technology can be defined as software which takes over human activities," explains Ryen, before listing a number of benefits.

"Good AI tools enable us to drastically reduce the time spent on routine tasks, thereby releasing resources for work which creates more value.

"We also see areas where this approach can spot details people might easily overlook. Take radiology – AI can recognise patterns there which even experienced specialists would take a long time to identify.

"It can also replace people in risky conditions. We already see drones taking over power-line inspection from helicopters, and the way subsea technology can replace hazardous diving."

But Ryen also makes it clear that thorough testing and validation of the new technology are important.

"We can't start using a new system immediately just because we've developed it. In the health sector, for example, a lot has to be put in place before AI solutions can be approved and adopted. And the final decisions in critical operations must always be taken by people."

INTEGRATED

AI has evolved from niche research into an integrated part of many technological solutions and societal functions, and calls today for much more than technical expertise. So extensive cross-disciplinary collaboration is needed.

Under Ryen's leadership, the UiS has established the Stavanger AI Lab – a network embracing about 100 researchers from various disciplines.

A number of innovative projects

> "The final decisions in critical operations must be taken by people."

have been launched, from improving search engines and exposing fake news to developing health technologies and behavioural research.

The UiS network is intended to function as an arena for knowledge-sharing and cross-disciplinary collaboration, where various sectors can learn from each other and develop best practice in implementing AI solutions

It is now applying for status as a national centre of AI expertise, with a special emphasis on energy-efficient solutions. That calls for a broad approach and collaboration with both private and public sectors.

"It's all very well being skilled at developing language models, but we also need people familiar with such disciplinary domains as energy, health, education or the maritime sector," explains Ryen.

"And lawyers need to be included to evaluate the legal aspects. We must also invite in experts who can assess whether what we're doing is ethically acceptable."

BALANCED

He underlines the need for a balanced approach to technology, where critical thinking goes hand in hand with practical system understanding.

This requires each developer to get better at questioning sources and taking a more critical view of results from AI systems.

"Spreading false information is a growing concern," Ryen notes. "It's said that fake news travels a hundred times faster via social networks than the true facts.

"We've seen a lot of propaganda and manipulated images, and I'm worried about their consequences for individuals, businesses and our democracy."

He emphasises that this underlines the importance of involving social scientists in discussions on AI. That is not just a technical discussion, but requires value issues and social impacts to be addressed.

NATURAL PART

"We must incorporate source criticism and good judgement into our school curricula to a much greater extent than in the past," says Ryen, who favours giving pupils experience with AI tools under controlled conditions.

"Students must naturally continue to be good at maths and be able to write well, but we also need curricula adapted to the digital world we live in.

"AI isn't a passing trend, but will become an increasingly natural part of our environment. In time, the boundaries between what is and isn't AI will become more diffuse. The right balance needs to be struck between embracing the technology while safeguarding our critical faculties and good judgement." ■

Comprehensive regulation

The EU's Artificial Intelligence Act is a groundbreaking set of regulations covering the use of this technology across Europe.

Passed in December 2023, the Act is designed to ensure the safe, ethical and confidence-inspiring application of AI while promoting innovation and competitiveness within the EU.

It adopts a risk-based approach where requirements for AI systems vary in line with the level of risk they represent, and divides them into four main categories.

1. MINIMAL RISK: most AI systems fall into this category and can apply voluntary ethical guidelines.

2. HIGH RISK: these solutions must meet strict requirements for conformity assessments as well as quality and risk management systems, and be registered in a public EU database.

3. UNACCEPTABLE RISK: such systems – which include social scoring and biometric categorisations based on sensitive personal data – are prohibited.

4. SPECIFIC RISK RELATED TO TRANSPARENCY: applies to systems which can manipulate people, such as chatbots and deep fakes, where users must be clearly told that they are interacting with AI.

Enterprises using AI solutions must prepare for the new requirements by identifying their systems, familiarising themselves with the regulations and making conformity assessments. The AI Act will probably be incorporated into the European Economic Area agreement and thereby also apply to Norwegian companies. ■

Aker BP CEO Karl Johnny Hersvik does not view AI as a threat. He believes it offers entirely new productivity gains as long as people manage to exploit it properly.

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Set to separate winners from losers

CEO Karl Johnny Hersvik at Aker BP is convinced that the pace of implementing AI holds the key to future competitiveness, and that the biggest risk lies in not adopting it.

Text: Eileen Brundtland **Photo:** Aker BP

"Where we're concerned, this has evolved from an interesting technological debate to being a 'make or break' issue for us," the oil company head says.

"We believe AI technology will come to create clear winners and losers in a way we've never seen before, not only in the oil and gas industry but also in other sectors."

Hersvik identifies two key factors driving AI development: its dramatic effect on productivity and the intense pace of change.

"In principle, this technology is accessible to all," he notes. "It's the ability to apply it quickly and effectively which will separate winners from losers."

DIRECT

Hersvik is known for his direct management style and burning interest in technology, which have both followed him from his maths studies and throughout his career in the oil industry.

Nor is he among those who fear the trend.

"AI doesn't represent a threat, but rather something which offers us entirely new productivity gains – as long as we succeed in exploiting it in the right ways."

"It automates and greatly speeds up time-consuming tasks which were previously carried out manually," Hersvik adds, and illustrates this point with a recent example.

"A root cause analysis (RCA) which normally takes months can now be completed in just a few days. We tested this thoroughly with one we'd already done manually and knew the answer to. Running AI agents through the same analysis came up with exactly the same result at a time saving of 97 per cent."

STREAMLINE

This case shows how AI can streamline traditional work. But what do these dramatic gains mean for personnel in the organisation?

According to Hersvik, people will become an increasingly important competitive factor. While machines handle repetitive work, data analyses and complex computations, employees can concentrate on activities which need human intuition and creativity.

"I see this as getting an amazing new tool. The machine frees up time from routine tasks, allowing you to focus on strategic thinking, problem solving, innovation and intuitive assessments.

"That'll require new expertise profiles, where people must develop the ability to interact with technology and understand its opportunities and limitations."

Hersvik highlights three critical areas of expertise, including technology understanding – good insight into what is happening at the sharp end of development.

"In addition come cross-disciplinary translation capabilities, which involve grasping both the technology and the relevant discipline domains.

"The third requirement is management expertise – in other words, executives able to determine strategies, delegate resources and drive change forward."

In Aker BP's experience, he says, the second of these is the most difficult to →

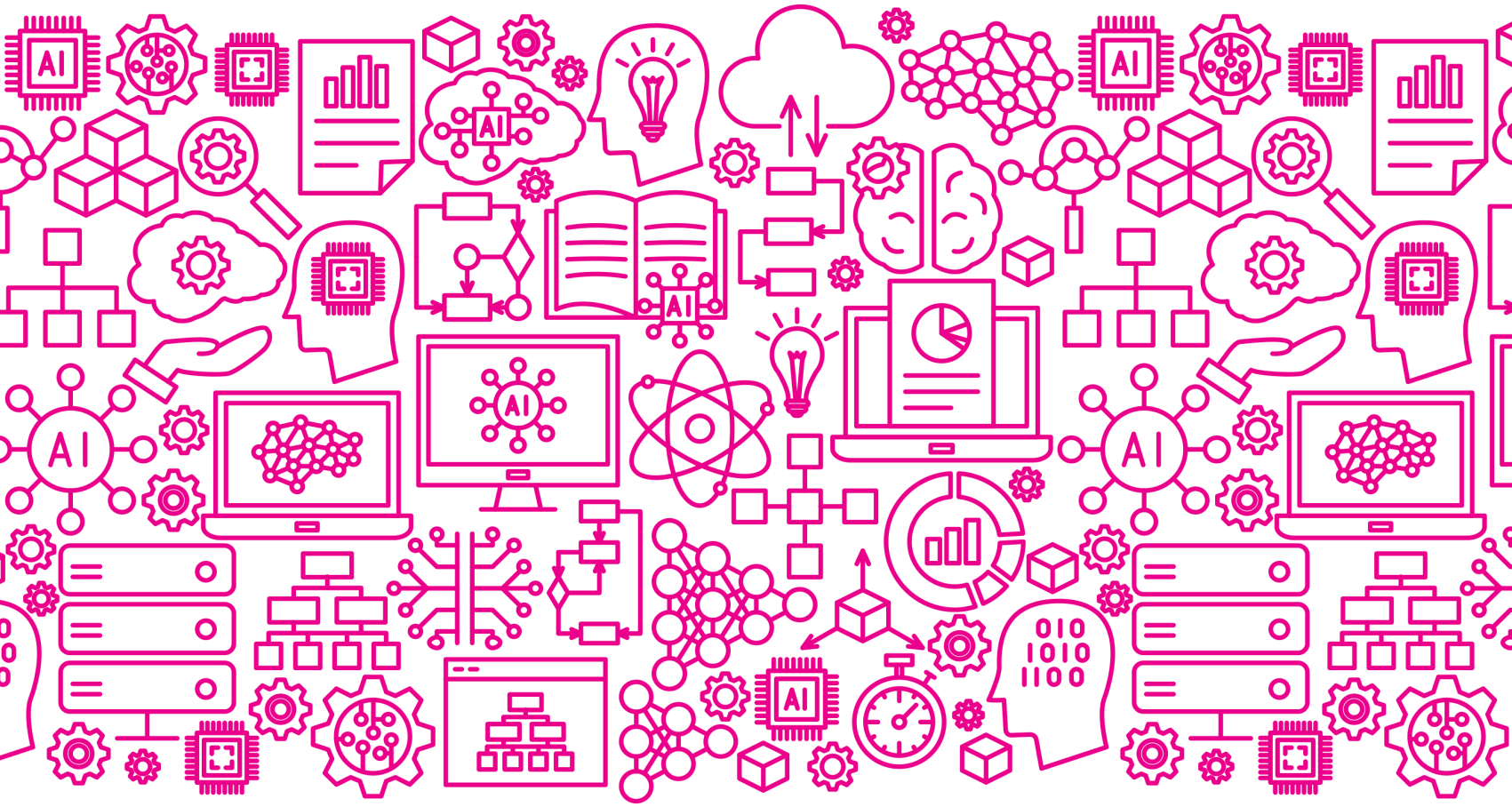


Illustration: Shutterstock

cultivate. It calls for people with a foot in both camps, who understand both the digital and professional domains.

"The oil and gas industry will never become a leader in the actual development of advanced technologies such as language models. Billions of kroner are being poured into researching and developing these. Our strength must instead be the ability to adopt and apply these technologies effectively."

PROCESSES

AI is primarily used today for data extraction and decision support, rather than directly in managing production processes.

"This is a matter of supporting productivity in basic process such as geophysical interpretation, reservoir simulation or RACs. AI can be applied across the entire industry," says Hersvik.

He also believes that the technology can be utilised with safety instrumented systems (SIS) – in connection with barrier monitoring, for example.

Such solutions comprise three main components: sensors to measure condition status, logic solvers which interpret the data, and consequences or measures based on these interpretations.

"Programmers traditionally use a fixed logic for each safety barrier, but an AI agent can handle thousands of such logics automatically," Hersvik explains.

He notes that many people are concerned about false positives – where an AI system mistakenly identifies a negative event as the opposite. But he believes that this risk can be significantly reduced.

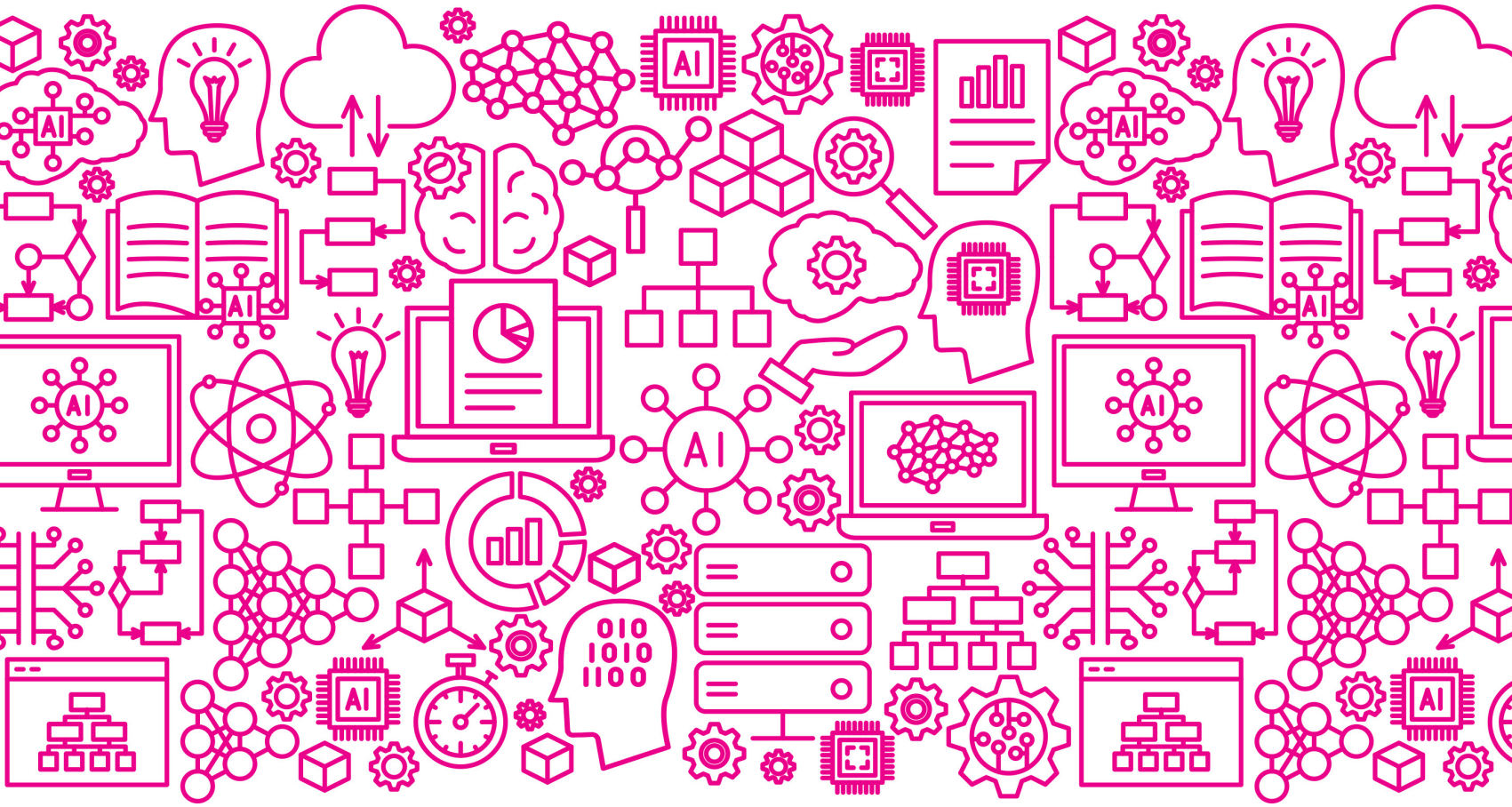
"False positives are a relevant concern if the system is trained using open and uncontrolled datasets. But utilising a high-quality, verified and limited dataset can go a long way towards minimising the problem. That makes it easier to develop reliable safety systems."

Hersvik also emphasises the importance of grasping that industrial data are fundamentally different, so experience cannot be transferred uncritically from general AI solutions to safety systems for industry.

BIGGEST RISK

Hersvik highlights cyber security as the biggest risk when adopting new solutions.

"Information leakage quite clearly poses a threat which needs to be handled," he



acknowledges. “Since cyber security is changing dramatically, it’s very important to have clear guidelines in place to control cyber risk and information leaks.

“We must understand the technological barriers at all times, even though they’ll evolve extremely quickly. This doesn’t mean we can apply AI systems to everything. Industrial data and processes are too complex for that.

“But I’d again emphasise that this isn’t really completely new. It’s a technology like all the others. The process, qualification systems and performance requirements are unchanged. What’s new is the pace of development.”

OPTIMIST

While some are worried their jobs will disappear, Hersvik believes AI will become a new co-worker, collaborating with employees and boosting productivity.

“That’s why I encourage people to be curious and to investigate this technology. We should respond to AI with a positive and forward-looking mindset.”

Hersvik is also conscious of his own role as a chief executive.

“I have a special responsibility both to drive technology development forward and to manage possible risks. Major upheavals must be led from the top. We can’t wait for this to develop organically from the bottom up.

“So I’m devoting a disproportionate amount of my time to understanding the technology and becoming involved in test cases.

“If I’m not on top of this progress, I won’t be in the forefront either of the biggest strategic revolution currently taking place in the world today.”

He points out that companies and employees which successfully utilise AI in their processes will become far more efficient than those who fail to do so. That makes this a key strategic issue for managers in the time to come.

“Be aware of what you’re doing, get involved as a leader, test the technology early and bring the organisation with you,” he says.

“Because this isn’t primarily about technology. It’s about effective utilisation. “I’m incredibly enthusiastic about AI and I really don’t see any great risk in using it. The biggest risk lies in failing to do so.” ■

Five AI paradoxes

Leading US researcher Mica R Endsley is very positive about AI, but admits to having certain reservations. She highlights here some key preconditions for interacting with AI.

Text: Olav Hove

Paradoxes and challenges when automating systems were addressed by British psychologist Lisanne Bainbridge in 1983. The main argument of her article on ironies of automation was that, although the aim is to reduce human error and boost efficiency, it may actually create new problems.

This influential piece is regarded as a pioneering contribution to highlighting problems associated with automating systems.

Endsley, an engineer and former chief scientist with the US Air Force, extends that work to the current wave of AI-based automation and finds the challenges persist.

"My research reveals that many of the problems identified in connection with automation in general are directly applicable to AI," she maintains.

In her 2023 article on the ironies of artificial intelligence, Endsley lists five paradoxes presented by AI.

PARADOX 1

"AI isn't all that intelligent"

First, AI is in practice a machine learning programme good at identifying statistical patterns in the large databases used to train it – but that is as far at it goes. The technology has problems dealing with anything which happens outside these databases.

"AI isn't actually all that intelligent," says Endsley. "There's no common sense and no situational awareness for taking good decisions. All it does is to recognise statistical patterns and act entirely on the basis of these."

PARADOX 2

"People struggle to understand AI"

The second paradox is that people struggle to understand AI. The more advanced a system, the more difficult it is to comprehend.

Endsley notes that AI only does parts of a job, never everything. People need to be involved in monitoring it.

"That's difficult, especially given the 'black box' principle where you don't always understand exactly why the AI is acting as it does."

"And when even programmers don't know why the software behaves as it does, we're left guessing. Research shows that we're not good at this, especially when systems change over time to become better and more highly trained."

PARADOX 3

"We struggle to compensate for AI's limitations"

This is related to the previous paradox.

"Research shows that people monitoring AI systems find it hard to maintain their concentration," Endsley reports. "That's especially true when systems are working well.

"We tend to place far too much trust in the technology. Findings also indicate that people doing nothing other than monitoring AI systems have a tendency to lose their situational awareness."

As AI systems become increasingly advanced and ever more highly trained on a variety of databases, human monitoring becomes even harder. And this leads to paradox four.

PARADOX 4

"The more intelligent AI becomes, the more difficult it is to grasp its faults and limitations"

A number of well-known examples show

"Pay attention to safety - hire people who understand the paradoxes and can secure the ear of management."

that AI can be both biased and racist. Many of these cases are very obvious and easy to spot – as when a generative AI image generator asked to depict a doctor often show a man, for example.

Such biases or systematic errors, which reflect limitations in the datasets the systems are trained on, are not difficult to detect.

"But the more advanced and highly trained a system is, the harder it is to recognise bias – and that can create problems," says Endsley.

The main problem is that people are poor at monitoring and recognising faults in AI, and at assessing the trustworthiness of the advice and assistance they provide.

PARADOX 5

"The more universal AI technology becomes, the more difficult it is to assess its trustworthiness"

To illustrate paradox 5, Endsley cites ChatGPT as an impressive language model where facts are nevertheless often faulty.

"When ChatGPT lacks access to the information requested, we see that it conjures things up – it hallucinates.

"And when such behaviour is integrated into an otherwise well-functioning language model, people struggle to assess how far they can trust it.

"That's because we don't know what its sources are, how the information is put together and whether correct facts are mingled with errors. This becomes even more problematic where safety-critical technologies are concerned."

BOEING

Endsley uses aircraft manufacturer Boeing as an example of a company which failed to understand the risk picture – and had to pay for it.

"For many years, it enjoyed a very good reputation for designing and manufacturing safe aircraft. But cost-cutting over a number of years led to the focus on safety being pushed down the organisation.

"Management talked a lot about focusing on technology and how important it was to be positive to new advances. The human dimension and a grasp of the limits of technology were overlooked.

"This has created a wealth of hidden problems and faults in the company, leading to major accidents (see separate section)." ■

BOEING ACCIDENTS

A Boeing 737 Max aircraft crashed in Indonesia during October 2018, with a similar accident in Ethiopia the following year. In all, 346 people lost their lives.

Investigations attributed both crashes to a new system intended to push the aircraft's nose down automatically if it risked stalling. But pilots lacked adequate training in turning off the system when it activated in error.

Boeing was blamed, hundreds of aircraft were grounded around the world, and the company had to pay USD 2.5 billion in compensation to the families of accident victims.

MICA R ENDSLEY

An American engineer, a former chief scientist with the US Air Force and currently president of SA Technologies, Endsley is best known for her work on situational awareness.

This has had great influence in fields such as aviation, military operations and human-machine interaction. Her theories and research are widely applied to improve safety and efficiency in complex systems.

A concentration on the human dimension in technology development has been a red thread through Endsley's career. She has distinguished herself as a leading researcher in the field of responsible AI.

To hear more from Mica R Endsley, search for 'Havtil' on your preferred podcast platform and listen to the episode on De 5 KI-paradokser *(The five AI paradoxes).*

INTELLIGENCE

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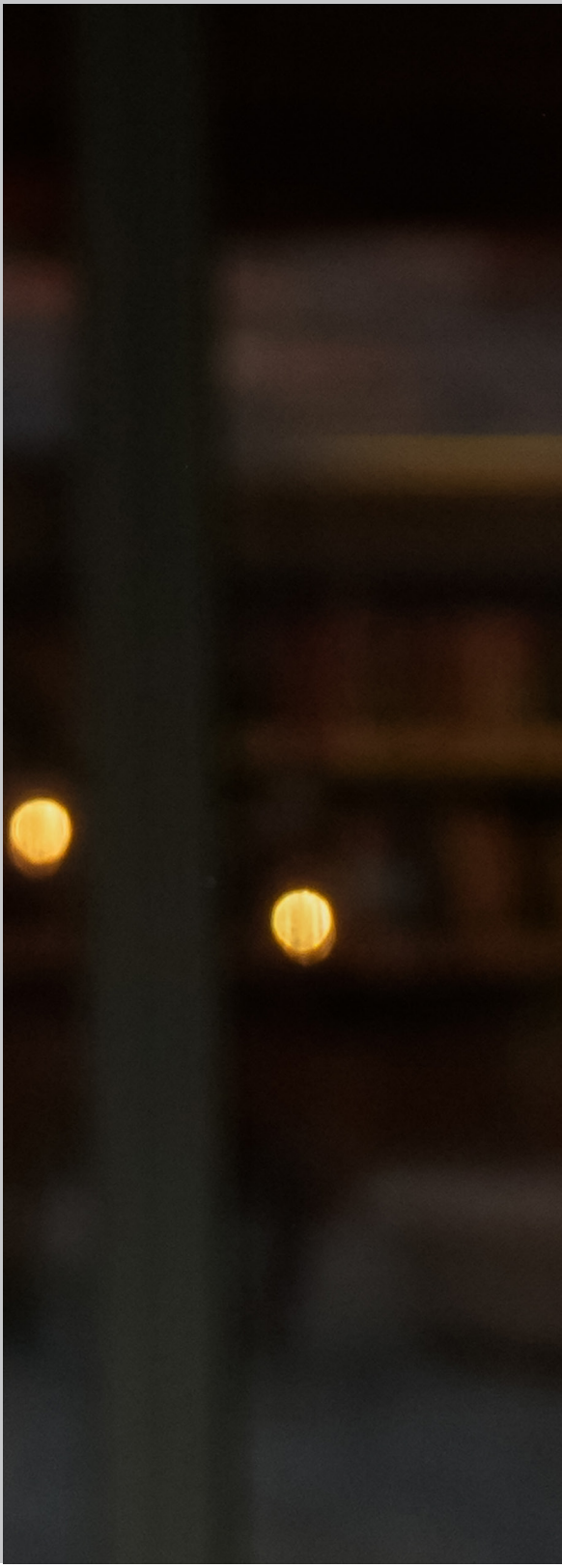


Text: Olav Hove **Photo:** NTB/Beate Oma Dahle

What is actually meant by explainable AI? And how can decisions taken by a technology most people do not fully understand be trusted?

Inga Strümke, an associate professor and researcher in machine learning, explainable AI and AI ethics at the Norwegian University of Science and Technology (NTNU), has responded to three key questions on this issue.

What is meant by explainable AI?
This covers tools created to clarify a model which can't be interpreted by people just like that. These can be used when training a new model or explaining an existing one.

Why is it so important that AI is explainable?
There are several reasons, including a desire to safeguard human autonomy and control (we can't protect our own interests if we don't understand what's going on).

Second, we want to make it possible to discover new knowledge (machine learning models exist which can find answers humans can't come up with).

Finally, we must comply with existing and future regulatory regimes such as the EU's general data protection regulation (GDPR) and AI Act, and the Norwegian Public Administration Act.

How can we trust decisions taken by a technology we don't fully understand?
I believe it's meaningless to talk about trusting or having confidence in mechanical processes. Trust is something you have in players, which machines are still not considered to be. It's like asking whether we should have confidence in a quadratic equation. ■

explained

Trust in technology?
"It's meaningless to talk about trusting or having confidence in mechanical processes," says AI researcher Inga Strümke. "Trust is something you have in players, which machines are still not considered to be."

UNANSWERED QUESTION

What is not only an adequate but also a possible explanation of a machine learning model for us as humans has been extensively explored, but it remains an unanswered question.

The main problem, as I see it, is that it's impossible to explain something complicated in simple terms.

It's like trying to draw a cube in the form of a square. It simply doesn't work, the cube has a whole dimension which the square lacks.

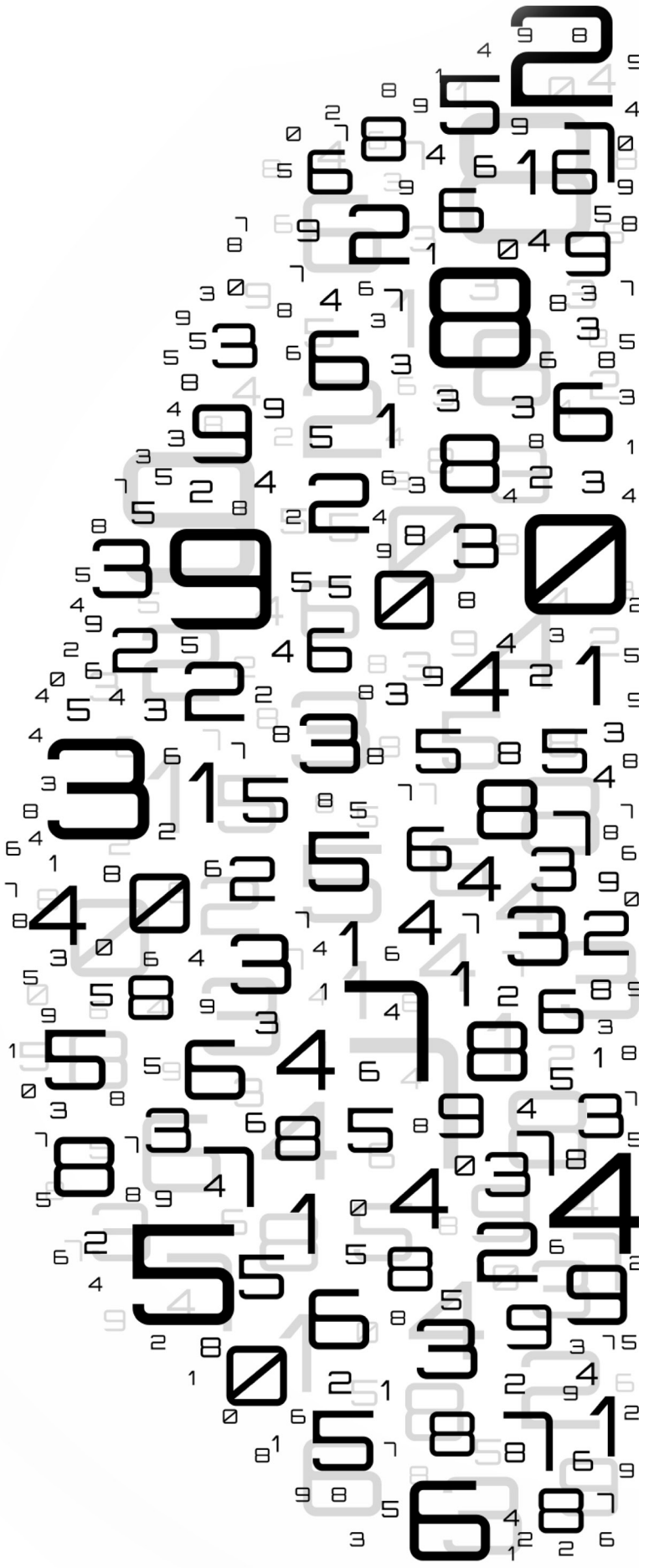
All explanations are necessarily simplifications, and that part of the information which has to be simplified away at the point of explanation must be determined by somebody.

(Inga Strümke: *Maskiner som tenker*, Kagge Forlag, 2023)

AI on the fast track

A new knowledge overview has clarified the fundamental risks posed by developing and applying AI in the petroleum sector, particularly where major accident risk is concerned. It finds that new technologies are being rapidly introduced.

Text: Øyvind Midttun



Conducted for Havtil by DNV, the review has sought to boost knowledge about the risks linked to the development and use of AI in safety-related operations on the NCS.

Its purpose has also been to explore how AI can enhance efficiency and safety while taking account of the unique risks introduced by AI when compared with traditional IT and automation systems.

RAPID

The study reveals a clear expectation that AI will be introduced to the petroleum sector at a fast pace. Such solutions will initially be utilised to generate various kinds of documents and source codes, and used in the short term for advisory applications in such areas as operations optimisation and predictive maintenance.

In the longer term, AI is also expected to be

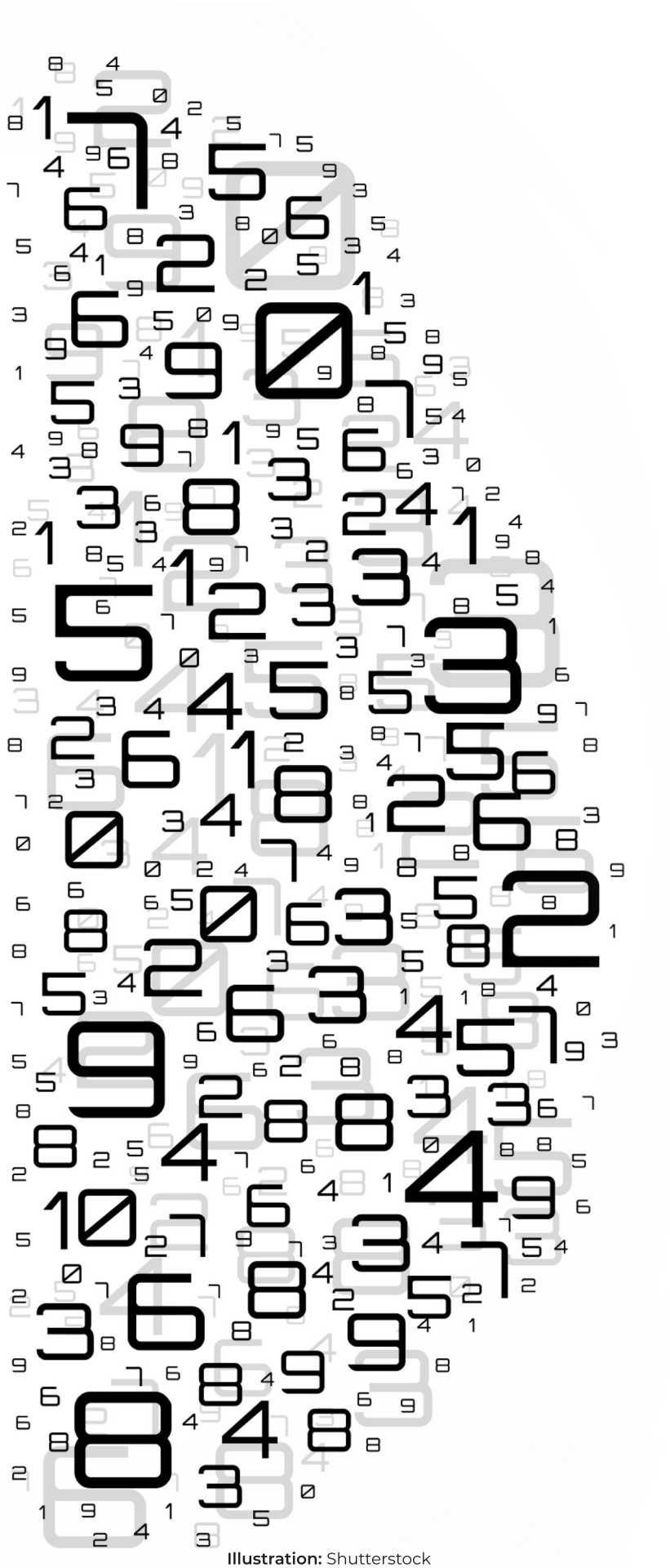


Illustration: Shutterstock

applied in control functions – including with lifting operations and well control. Autonomous AI-based systems will initially be introduced where the damage potential is low, such as subsea vehicles and drones.

UNDERMINE

Published in Norwegian in 2024, the DNV report identifies several risk factors with the potential to undermine operational safety, including:

- inadequate training of algorithms
- poor data quality
- model deterioration over time
- over-adaptation to training data.

AI-based systems will also be vulnerable to software design flaws, hardware defects and deliberate interference such as cyber attacks.

AI is expected to be adopted in various types of systems and operations. Most of these involve a risk that information generated using AI-based systems could result in faulty operational decisions, which may in turn cause accidents.

The report uses “safety-related system” as an umbrella term covering safety, control and monitoring solutions plus applications for advisory purposes as well as planning and condition monitoring.

BARRIERS

The expectation is that personnel and environmental safety will continue to be governed by the barrier philosophy which forms the basis of Havtil’s current regulatory regime.

Underlying this approach is the idea that, no matter how much effort is put into creating safe and robust solutions, errors, hazards and accidents may occur. Barriers should then activate to help manage these circumstances. Were an AI-based application to give a result which means that an operation becomes unsafe, the philosophy is that barriers will prevent this escalating into a hazardous incident.

Such barriers include manual overrides, autonomous control functions and the use of independent safety functions to shut down the process being controlled. In addition come operational restrictions to reduce the risk of an incident if the other barriers prove ineffective. →

INTERACTION

The decision to activate barriers in many types of operations is taken today by people. But the challenge is that undesirable software conditions do not always trigger an alarm.

It is far from certain, for example, that this would happen were an AI algorithm exposed to an operational scenario it has not been trained for.

In such circumstances, barriers will only be activated if personnel are able utilise the total available information to detect that something is wrong.

This underlines the need for AI-human interaction, a human-centred design approach to AI solutions, and the ability to detect unsafe conditions in a way which is independent of the system containing AI.

COMPLEXITY

AI will typically boost both the capability and complexity of a system. Research reveals that the more capable and complex a system, the less a user will be able to understand it and its limitations – and to monitor it reliably.

The challenges posed by human detection of unsafe circumstances mean that the industry should explore opportunities for automated detection of such conditions caused by AI.

LIMITING FACTORS

To ensure that barriers are effective at all times, it must be possible to detect the existence and cause of an unsafe condition. If software has led to this in one way or another, it could only be identified – regardless of cause – if detection mechanisms entirely independent of the same software are in place.

An example of a barrier with an independent detection mechanism is a safety function linked to a safety-critical process which is automatically activated when its own condition measurements indicate this to be necessary.

Increased levels of automation nevertheless mean that independent detection of undesirable conditions and their causes may be difficult in many cases. As a result, the petroleum sector – like many other industries, is moving towards a grey area where critical and complex functions must continuously perform as intended to maintain safety.

The challenges faced here relate particularly to human detection of undesirable conditions, and will often be present regardless of whether AI is in use. But adopting the latter may exacerbate them.

A lack of mechanisms able to detect unsafe conditions, regardless of the system using AI, is expected to set limits to where the technology can safely be introduced.

STANDARDS

The standards referenced in Havtil's regulations for purely safety functions set very strict requirements concerning software development, verification and validation. Incorporating AI into such functions will thereby create a big burden of proof. So DNV believes AI is unlikely to be incorporated in such functions any time soon.

But it nevertheless accepts that AI-based components may be introduced in the longer term – in the form of safety functions activated with this technology as a supplement to human intervention. Where some AI systems are concerned, the results generated will not be deterministic. That means multiple tests using the same input data will not necessarily give the same results.

This may create difficulties in the qualification, validation and maintenance of software containing AI, and may also impose restrictions on where it can be introduced. The industry needs to investigate how that challenge can be met.

UNIVERSAL GUIDELINES

Havtil's regulations refer to a large number of Norwegian and international standards and guidelines. Most players will stick to these rather than having to show that alternative approaches are as good or better. Using a common set of standards and guidelines helps to harmonise the level of safety in the industry.

No standards or guidelines have so far been created with the safe use of AI in the petroleum sector specifically in mind. To keep safety levels harmonised and reduce the burden of proof for each player, it would be desirable for relevant industry participants to join forces on setting guidelines for best practice in the use of the various types of solutions containing AI. Such collaboration should make it easier to meet the requirements in the EU's AI Act. Meanwhile, players wanting to adopt AI must individually clarify and meet the Act's requirements in their own management systems.

Such operationalisation of high-level requirements is normally labour-intensive, but the workload for each organisation could be reduced if the industry collaborates. ■

Read more:
The report Kunnskapsoversikt knyttet til forsvarlig bruk av kunstig intelligens i petroleumssektoren *(Knowledge overview related to the prudent use of AI in the petroleum sector) can be read on and downloaded from the Havtil website at havtil.no.*

MAIN ISSUE 2025

ARTIFICIAL INTELLIGENCE IS ALSO A RISK FACTOR

Where the energy sector is concerned, AI continues to be integrated into ever more technologies – including those used in safety-related operations. AI-based systems represent a key resource and can help to reduce risk. But they may also do the opposite. Industries exposed to major accident risk are particularly vulnerable.

The challenge is to take a broad view and consider AI in an integrated perspective. To ensure the safe and secure use and maintenance of such systems, their development must rest on an interplay between people, technology and organisations. We must also ensure that AI does not make us more vulnerable to external threats and malicious actions.

Responsible use of AI is in the interest of everyone in the industry. Ultimately, responsibility for ensuring this rests with management.

Havtil

All new personnel at Hammerfest LNG must take an initial onboarding programme. “This aims to inculcate awareness and attitudes, understanding risk, the management system and the way we do things,” says Emma Holm Nilsen. She is seen here (left) with Equinor colleague Oscar Laurhammer.

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FAITH IN THE FUTURE

The world's most northerly gas liquefaction plant is running flat out in parallel with Snøhvit Future, a comprehensive and ambitious modification project. That makes big demands on staffing, expertise and risk management. ---->

Text: Øyvind Midttun **Photo:** Elisabeth Kjørmo

THE SNØHVIT FIELD

Identified in 1984, the Snøhvit gas field ranked as the first discovery to be developed in the Norwegian sector of the Barents Sea. A plan for development and operation (PDO) was approved in 2002 and production began in 2007. Equinor is operator.

The development comprises several subsea templates, with the wellstream piped to the Hammerfest LNG liquefaction plant at Melkøya outside Hammerfest in Finnmark county. Liquefied natural gas (LNG) represents the plant's main product and is exported by sea. Water, condensate, CO_2 and mercury are removed from the natural gas in a number of process steps before the gas is cooled to -162°C, temporarily stored in large tanks and loaded onto carriers.

Condensate is also transported away by ship, while CO_2 gets piped back to the field for injection beneath the seabed. Every year, 750 000 tonnes of CO_2 are captured and stored in this way.

"For many people, coming here is like entering a completely different world," says Emma Holm Nilsen at Hammerfest LNG, which stands on the island of Melkøya in Finnmark county.

Responsible for apprentice process operators, she guides confidently around tall concrete tanks and a multitude of pipes and valves. After almost 10 years, she knows her way around – just as well, because things are about to get really busy.

Not only is the processing plant for production from the Snøhvit field operating normally, but major modification work is also under way to provide onshore compression and electrification.

WORKFORCE

In normal operation, the Hammerfest LNG workforce totals about 600 people, including some 350 operators and technicians, 60 graduates, 40 apprentices and 150 contractor personnel.

But Snøhvit Future will mean a sharp increase in supplier and project employees. At peak, 1 200-1 500 people are due to be working at the plant on both normal operations and the project.

"My job includes giving the right introduction to new personnel," says Holm Nilsen. "There have been 70 of them in 2024 alone. Everyone has to undergo an onboarding programme to understand what we do and how we work.

"This introductory package deals with awareness and attitudes, understanding risk, the management system and the way we do things. It quite simply ensures that everyone working here has a basic grasp from the start."

COORDINATION

"Operating normally during major modification work is demanding, but it's a positive challenge," says production vice president Rasmus F Wille at Hammerfest LNG.

"We'll also be conducting an 80-day turnaround in the spring of 2025, the biggest in a long time. A great deal of work thereby has to be planned for, implemented and risk-managed.

"Structured collaboration between the operations and project teams, the operator and suppliers is crucial to success."

"The scale of this activity means increased complexity and risk," observes Fritz H Eilertsen, project manager for the work at Melkøya. "It involves onshore compression and electrification along with a new emergency power system."

Onshore compression is actually quite straightforward, he adds. "We've built a number of compressors in the past and are very familiar with such work.

"The electrification part is more →

Snøhvit Future means a big increase in supplier and project personnel at Hammerfest LNG. At peak, 1 200-1 500 people are due to be working at the plant on both normal operations and the project.

Every five days, or 70 times a year, an LNG carrier leaves the jetty at the gas liquefaction plant on Melkøya outside Hammerfest.

(Photo: Equinor)

complicated technically. A lot of electrical equipment and steam boilers have to be installed. Similar work's been done before, but not on this scale."

PICKING UP

Activity is starting to pick up in the plant area, with construction work under way. The top of one of the four large storage tanks provides a view across to the mainland and work under way on the route for the power line.

Scaffolding, tenting and other preparations for large-scale construction are under way adjacent to the processing plant, where the equipment for compression, power transmission and steam generation will be located.

The project means a stream of newcomers entering the facility, so Holm Nilsen and her colleagues are working hard to onboard them.

Oscar Laurhammer has just arrived in Hammerfest. With his master's degree in hand, he joined Melkøya in the late summer and finds both Snøhvit Future and Hammerfest LNG a perfect fit for a newly qualified electrical engineer.

He is part of a new initiative in operator Equinor's northern region where young new employees rotate into different positions and locations in Hammerfest and at Harstad further south.

The aim is to ensure a stable labour force for the liquefaction facility.

"We hope he stays," says Holm Nilsen, and adds that time is a key factor in wanting to continue living in this Arctic city.

"There's a big difference between being a native and working here. You don't have the same relationship with the place if you're just visiting. What matters is remaining here long enough."

Chief safety delegate Trond Børre Halvorsen at Hammerfest LNG says it takes around three to three and a half years to become an experienced member of the workforce.

"Losing personnel with experience is unfortunate, and it takes a long time to train up replacements," he points out.

ALL TO EUROPE

Annual gas exports from Snøhvit meet the needs of about 6.5 million European households. Every five days, or 70 times a year, a carrier leaves the jetty at Melkøya fully laden with LNG.

Each shipload corresponds to one terawatt hour (TWh) of energy. By comparison, Norway's hydropower output in a normal year is just over 137 TWh.

"Our entire production in 2023 was exported to Europe, probably to compensate for the loss of Russian gas," reports Wille.

"We're proud of our role as an energy supplier."

He notes that Equinor's top management talks a lot about the energy trilemma – how to deliver energy to customers in a sustainable way with low CO_2 emissions and at an affordable price, while also contributing to security of supply.

"Snøhvit Future is perfect for meeting these challenges. It will enable us to cut emissions, increase gas production and contribute to reliable, long-term deliveries."

VARYING RISK

Risk will vary in the different Snøhvit Future phases. The first stage has mostly involved preparing and organising for its implementation, along with construction linked to infrastructure and groundwork. The project is now entering a period of greater hazard associated with hook-up →

SNØHVIT FUTURE

This project aims to increase gas recovery from Snøhvit with onshore compression and converting energy supply from gas-turbine-driven generators at Melkøya to all-electric operation using power from the national grid.

The work is expected to extend Hammerfest LNG's lifetime to 2050 and cut CO_2 emissions from the plant by around 90 per cent or some 850 000 tonnes per annum.

Onshore compression will be completed by 2028, while the shift from gas turbines to full electrical operation will take place in 2030 at the earliest.

Total investment is put at about NOK 13.2 billion.

to electrical systems in a plant operating normally. That calls for good understanding and management of risk based on solid construction know-how.

"We want to keep suppliers and players at Melkøya to a minimum," Wille emphasises. "Our aim is to utilise companies with prior knowledge of the installation and thereby secure efficient logistics, and we've succeeded there. A large proportion of our suppliers are already familiar with the installation.

"Risk varies with the project phase and which stage you're working in. You must always be sure that you actually understand the risk and how to handle it.

"When connecting to substations, electrical systems and the like, we move to a different type of risk related to production stoppages or outages, ignition source control and so on."

An important barrier in managing the risk is the work permit system, where responsibility rests with the operations organisation.

"To manage the risk, we're also building up personnel capacity," Wille reports. "At the same time, we must work at a pace which enables us to keep up and act safely.

"Time's naturally an important factor. And, sure, we'll pursue the projects quickly, but no faster than necessary to ensure safety. That's always a key requirement."

He emphasises that teamwork and psychological safety are essential. "We encourage everyone to let us know if they have any concerns so that we can address these."

CAPACITY

Hammerfest LNG has a major accident potential, and ensuring adequate capacity and expertise is a key demand. Deficiencies in these areas have been highlighted in past Havtil audits and investigations.

A fire broke out in the air intake of a Melkøya turbine in the autumn of 2020. The plant was shut down for more than a year and investigated by Havtil. One nonconformity identified related to resources and staffing – an issue the authorities had followed up and noted in previous audits and investigations.

After this incident, Equinor established a separate unit to work more systematically on expertise and development. Wille believes this has had a positive effect together with other measures, but says competition over able personnel is still fierce.

"Staff turnover has earlier exceeded 10 per cent, but it's now down to around two," he reports. "However, we still face the challenge that it's difficult to compete with jobs offshore.

"This is a matter of pay and working hours, but also access to housing and air fares. Flying south is expensive for families who live here.

"However, we now actually do have quite a few newcomers, and we're also seeing people returning to Hammerfest from offshore life. That's very positive."

INTERESTING

"I think this could reflect the exciting work on offer at an onshore facility – and we're on land," says Wille. "In reality, jobs here are more interesting than those offshore.

"Assignments are more challenging. They're more complex, and you can work both on operations and in various projects."

Local girl Holm Nilsen started her career at Hammerfest LNG in 2015, first as an apprentice process operator and then in operations for several years before becoming manager of the apprentice programme. She combines this with her role in the expertise and development department.

"Where I'm concerned, there's no better place," she says. "I've everything I need here. Activity in the town is so high that it's a struggle to get enough people. Hammerfest is a big place, but in one sense it's also small.

"There aren't enough locals here to meet the demand for labour, so outsiders are needed. As well as skilled workers, there's a demand for graduates – engineers and good managers. And they don't grow on trees." ■

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All-out effort needed on land

Risk levels have moved in a negative direction in recent years at the seven onshore facilities which fall within Havtil's area of responsibility.

Text: Øyvind Midttun

The survey of trends in risk level in the petroleum sector (RNNP) is carried out annually by the authority.

Its measurements also began on land in 2004, when Havtil assumed responsibility for Norway's oil and gas facilities there. The backward trend seen for some time was confirmed by the RNNP results unveiled in 2024.

INCREASED

The survey shows that the number of incidents with a major accident potential on land has risen in recent years, in contrast to the trend on the NCS. That is viewed as a cause for concern.

"Onshore facilities have seen a negative trend for several years," Havtil director general Anne Myhrvold observed when the results were published.

"We saw this continue in 2023, with a marked increase for incidents with major accident potential and a continued reversal in terms of personal injury risk. This isn't good enough."

The RNNP figures revealed a rise in hydrocarbon leaks at onshore facilities over the four years up to and including 2023. These varied in size and potential seriousness. Serious personal injuries were also high in 2023 at a total of 15, while the frequency of such incidents climbed from 1.33 per million working hours in 2022 to 1.42.

FOLLOWING UP

Myhrvold believes that the operators of the land plants should be following up why incidents with an inherent major accident potential have failed to decline for 10 years despite the countermeasures taken. After so much time, improvements are expected. Myhrvold wants the operators to ask themselves several questions, including whether they are addressing these challenges well enough.

"Are they prioritising their resources correctly, working well enough as an industry and with contractors, and taking advantage of potential lessons from gains made offshore – where the trend has been in the opposite direction?

"We also see with concern that the identified need for corrective maintenance is rising both offshore and on land. Inadequate work here can be linked to higher accident risk. It's important that the industry takes this seriously."

CHALLENGES

Norway's seven onshore petroleum plants differ in size and design, and face specific challenges in terms of risk. These differences are reflected in the RNNP figures. Some facilities have many incidents, others few.

The RNNP measures trends in risk levels for the industry as a whole. This means that individual plants and installations are not identified in the survey reports.

Myhrvold nevertheless emphasises that figures for each facility are available to their operators so that they can use them in their own improvement efforts.

"The operators are well aware of which plants show negative trends," she says. "We expect them to use their own figures and resources with RNNP data, and to work actively and purposefully to reverse the trend we've seen in recent years." ■

RNNP figures for 2024 will be presented on 20 March 2025.

Close to the sea, but separate

Text: Olav Hove

Seven onshore plants are responsible for landing and handling petroleum in Norway. What they do and how Havtil monitors them are outlined here.

Havtil has regulatory responsibility for safety, the working environment, emergency preparedness and security in the petroleum industry offshore and on land.

Its authority to develop HSE regulations and ensure that companies operate responsibly was extended to the onshore facilities in 2004.

"Supervising these plants calls for a slightly different type of expertise from that required offshore," says Kjell Arild Anfinsen, Havtil's head of supervision for land. "That's why we have our own supervisory team for onshore facilities."

Although the land plants are directly linked to activities on the NCS, they differ from the offshore installations in several areas.

"First and foremost, they're much larger," explains Anfinsen, who has long experience in his role. "The onshore plants cover relatively large areas compared with the compact offshore facilities, and are also subject to special rules."

SEPARATE

"Many of the regulations are the same offshore and on land, but separate technical and operational provisions apply to the onshore facilities alone," he explains.

In addition come the major accident regulations, which apply to land-based operations producing, using and/or storing toxic, environmentally harmful, inflammable or explosive chemicals.

"The aim of the regulations is to prevent major accidents involving hazardous chemicals and to reduce the impacts such incidents could have," says Anfinsen.

"Although offshore and onshore operations have their differences, which require us to adapt expertise and supervision accordingly, follow-up of both is broadly similar.

"Our supervisory activities will be system-orientated and risk-based, and must supplement rather than replace the industry's own follow-up. Participation by and cooperation between all the parties involved are fundamental."

Annual major-accident audits are synchronised through the coordination group for the major accident regulations (KFS), where Havtil works with other regulatory agencies administering the relevant regulations.

These include the Norwegian Labour Inspection Authority, the Directorate for Civil Protection, the Norwegian Industrial Safety Organisation and the Norwegian Environment Agency.

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1 Hammerfest LNG
2 Tjeldbergodden
3 Nyhamna
4 Mongstad
5 Sture
6 Kollsnes
7 Kårstø

Photo: Equinor/Ole Jørgen Bratland

TJELDBERGODDEN

Kjørsvikbugen, Aure local authority, Møre og Romsdal

OPERATOR: EQUINOR

Tjeldbergodden is located at Kjørsvikbugen in Aure local authority. Three plants were initially established – a reception facility for gas from the Heidrun field, a methanol plant and an air separation unit.

The first two of these currently constitute the main activity at the plant. Gas arriving at Tjeldbergodden through Haltenpipe yields 830 000 tonnes of methanol annually.

NYHAMNA

Gossen, Aukra local authority, Møre og Romsdal

OPERATOR: GASSCO

Nyhamna is located at the northern end of Gossen island in Aukra local authority. This processing plant treats production from the Ormen Lange and Aasta Hansteen fields in the Norwegian Sea, exporting natural gas through the Langeled pipeline to a terminal at Easington in the UK.

Photo: Norske Shell

Photo: Elisabeth Kjørmo

HAMMERFEST LNG

Melkøya, Hammerfest local authority, Finnmark

OPERATOR: EQUINOR

Hammerfest LNG lies on Melkøya, an island in Hammerfest local authority, and is the processing facility for the Snøhvit field in the Barents Sea. Handling gas production alone, its main product is liquefied natural gas (LNG).

The Snøhvit wellstream is transported to the plant for processing and shipping. CO_2 gas is separated from the natural gas and returned to Snøhvit for injection.

Photo: Elisabeth Kjørmo

STURE

Stura, Øygarden local authority, Vestland

OPERATOR: EQUINOR

The Sture oil terminal, located in Øygarden local authority, receives oil and condensate via pipelines from Oseberg A and the Grane field. Crude is exported by ship, while wet gas and liquefied petroleum gases (LPG) are piped via Vestprosess to Mongstad for further processing.

Photo: Equinor/Øyvind Hagen

Photo: Equinor/Woldcam

KOLLSNES

Ona, Øygarden local authority, Vestland

OPERATOR: GASSCO

Kollsnes is located on the west side of Ona island in Øygarden local authority and processes gas. Originally part of the Troll development, it is the landing point for pipelines from the Troll, Fram, Visund and Kvitebjørn fields.

Gas from Kollsnes travels through Statpipe, Zeepipe, Europipe I and Franpipe to continental Europe. The plant is linked to Sture and Mongstad via Vestprosess for the transport of wet gas and condensate.

KÅRSTØ

Kårstø, Tysvær local authority, Rogaland

OPERATOR: GASSCO

Located in Tysvær local authority, Kårstø is responsible for landing and processing natural gas and condensate. It receives input from such fields as Statfjord, Gullfaks, Sleipner, Johan Sverdrup and Åsgard via the Statpipe, Åsgard Transport and Sleipner East condensate pipelines.

Around 30 fields are connected by pipeline to Kårstø, which ranks as the largest facility of its kind in Europe. Wet gas is separated and exported by ship, while dry gas (methane and ethane) travels through the Statpipe system to the Emden terminal in Germany.

Photo: Equinor/Markus Johansson

Photo: Equinor/Øyvind Hagen

MONGSTAD

Lindås, Alver and Austrheim local authorities, Vestland

OPERATOR: EQUINOR

The Mongstad facility is located in Alver and Austrheim local authorities and differs from Norway's other onshore plants in several ways – it is by far the largest, the only refinery and also a big oil terminal.

Crude oil pipelines from Troll B and C, Fram, Johan Sverdrup, Kvitebjørn, Valemon, Gjøa and Vega come ashore here. The plant also receives crude oil via shuttle tanker from such developments as Gullfaks, Statfjord, Draugen, Norne, Åsgard and Heidrun.

Mongstad's oil refinery has an annual capacity of 10 million tonnes of crude, producing mainly petrol, diesel oil, jet fuel and other light petroleum products.

The complex also includes the receiving plant for Vestprosess, a pipeline and processing system for natural gas liquids (NGL) and condensate which connects with the terminals for crude oil at Sture and gas at Kollsnes.

WANT TO KNOW MORE?

Find facts, regulations and audit results for the land plants at havtil.no

TURNING POINT FOR MAINTENANCE

A serious incident in 2016 changed thinking about looking after equipment surfaces at the Mongstad plant.

Text: Olav Hove **Photo:** NTB/Rodrigo Freitas

MONGSTAD: 13.10, 25 OCTOBER 2016
A leaking valve is detected during repairs to a gas pipe at the plant. An operator enters the area and climbs scaffolding, locates the valve and tries to close it. That proves difficult.

HAVTIL'S INVESTIGATION REPORT STATED
"At 13.10.29, operator 1 took the valve key and gave the valve a light rap. He suddenly found the valve and pipe end in his hand, hanging by the key. The gas flow from the one-inch pipe end hit the scaffolding floor half a metre from the fracture site. Those standing nearby describe a 'infernal noise' from the gas flow."

A serious gas leak was now a reality. The operator knew that the gas could ignite spontaneously and escaped to safety. All employees were evacuated and production shut down.

Nobody suffered physical injury in the 2016 Mongstad incident, although this was probably down to luck. The incident nevertheless triggered hectic activity at Mongstad – and at Havtil.

"In this case, the potential for a fatal

Havtil's far-reaching investigation of the 2016 gas leak at Mongstad identified many learning points.

accident had been so great that we quickly decided to investigate," says Kjell Arild Anfinsen, supervisor for onshore facilities at the authority.

He remembers the incident well for several reasons, including the potential consequences and what the accident and subsequent investigation revealed.

Havtil's investigation was detailed and identified many learning points, not least a lack of recent surface maintenance. Anfinsen believes the incident was a turning point for thinking about the latter activity.

STORM

At Mongstad itself, maintenance manager Kjartan Storsæt was in the heart of the storm. He has worked in many roles at the facility since joining it as an apprentice in 1992, and knows both the plant and the business well. And, not least, he knows the people.

"An incident like this unavoidably affects you personally," Storsæt says. "The operator concerned could have died. Having employees faced so closely with risk affects me and the whole organisation."

A major rehabilitation project was under way at Mongstad when the accident occurred, and Equinor had already worked to identify corrosion under insulation (CUI). The incident and investigations by Havtil and Equinor made it clear that change was needed.

"Where Mongstad was concerned, the accident was an eye-opener with regard to shortcomings in barriers and surface maintenance," says Storsæt.

Many and far-reaching measures were taken, he adds. "We initiated a two-phase process, starting with immediate action and followed up through a longer-term process."

INADEQUATE

Investigations by both Havtil and the operator concluded that surface →

Havtil conducts audits at the Mongstad plant (above) two-three times a year, with at least one concentrated specifically on hydrocarbon leaks and major accidents. These are system audits, scrutinising management systems and maintenance programmes and examining the company's own follow-up.

Photo: NTB/Marit Hommedal

maintenance at the facility had been inadequate over time, which permitted the pipe end to fracture and cause the leak.

"So putting a crystal-clear safety-first stamp on the entire organisation was important," says Storsæt. "A key aim in the first phase was to get across that people should shut down as soon as they feel unsafe – and actually do it.

"You have to accept the consequences of any uncertainty and close down the plant when necessary. And we've stuck to that."

The next step was to create a risk-based long-term plan for surface maintenance at the plant. Such a programme already existed but was stepped up sharply as a direct consequence of the 2016 incident.

By 2018, the surface maintenance programme at Mongstad was three times bigger than for the entire NCS, and Storsæt reports that it has been escalated even further – by a factor of about six-seven from before the incident.

But an average of 300 insulation, scaffolding and surface treatment (ISS) personnel working every day on the maintenance programme since 2016 have yet to cover the whole plant.

That reflects the sheer quantity of piping at Mongstad – actually over 2 000 kilometres or more than four times the distance between Bergen and Oslo by car.

And just like the road network around Mongstad, not all these pipes are straight. They contain every kind of bend.

This piping geometry has made the work challenging and time-consuming. That's why new technology for detecting weaknesses and corrosion has also been important.

TOOLS

"We've launched a dedicated technology programme to develop new detection tools," reports. Storsæt. He says a solution called Open Vision, which allows the surface condition of pipes to be inspected without removing insulation, is currently being qualified.

"When that's in place, we'll save time and

resources and be able to check previously rehabilitated systems without having to strip off perfectly good insulation and paint."

He will soon have such data for the entire plant. Despite the extra commitment launched after the 2016 incident, about 10 per cent of the facility remains to be inspected. And with new technology soon in place, the remainder is set to proceed much more quickly.

Anfinsen emphasises the importance of maintenance management for onshore facilities. "The plant itself has no defined design life – that applies to the equipment ."

One nonconformity identified in Havtil's investigation report concerned incident response. Since no risk assessment was carried out before personnel entered the area, known weaknesses had not been addressed and the risk of removing insulation from pipes and inspecting them was underestimated.

NOT WITHOUT FRICTION

Although the incident and the subsequent investigations triggered many improvement processes, Storsæt acknowledges that the process has not been friction-free.

"The problems revealed by the incident can't be solved overnight. This process has enjoyed many victories, but also setbacks, challenges and serious occurrences."

In his view, he now leads a maintenance programme and an organisation which are more robust and competent in dealing with setbacks and problems. But he admits that an investigation can take it out of one.

"The exposure is intensive. It's demanding to be responsible and under scrutiny by the regulator and your own employer while still having to run day-to-day processes at the plant."

AUDITS

Havtil has been closely monitoring developments since the 2016 incident. Audits are carried out at Mongstad two or three times a year, with at least one concentrated specifically on hydrocarbon leaks and major accidents.

"Our attention is focused on scrutinising management systems and maintenance programmes and on examining the company's own follow-up," says Anfinsen.

"We conduct system audits, including verification of documentation and equipment to measure compliance with regulatory requirements. In our view, that's the most sensible approach."

The same applies to the implementation of new technology. As a regulator, Havtil does not recommend one technical solution in preference to another.

"We observe that new technology is being developed and we follow up its implementation," says Morten Langøy in Havtil's structural integrity discipline.

"A lot is happening in technological terms, including the development of sensors for detection and moisture measurement in pipes. We monitor this work but don't stipulate specific guidelines.

"We stay at the system level. Responsibility for taking care of safety rests with the companies."

TOOL

Langøy headed Havtil's investigation of the 2016 Mongstad incident, and points out that such enquiries are an important tool for the authority – not least in looking more closely at causal chains. The aim is to contribute to learning lessons and preventing similar incidents recurring.

"This investigation and subsequent follow-up have had a positive effect," says Langøy. "A number of measures implemented since 2016 have improved safety at the plant."

Storsæt emphasises the importance of building mutual confidence over time.

"Interaction with the regulators has been characterised by continuity," he says. "Many people have occupied the same roles for a long time. In this way, we've built up the necessary trust.

"The regulatory authorities have shown understanding that changes in such a big organisation don't take immediate effect. That's been important." ■

WANT TO KNOW MORE?

Havtil's investigation report on the Mongstad incident can be found at havtil.no/en/supervision/investigation-reports

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INTEGRATING SAFETY AND SECURITY

The presence of drones and Home Guard soldiers must not distract attention from safety work at a land plant, says Gassco CEO Frode Leversund. “We need to strike a balance.”

Text: Øyvind Midttun **Photo:** Elisabeth Kjørmo

Gassco and Frode Leversund play key roles where gas deliveries from the NCS are concerned. Their responsibility has acquired growing significance for security policy in recent years.

From its head office at Bygnes north of Stavanger, state-owned Gassco controls Norway's entire gas exports. This huge responsibility has become even more significant following the Russian invasion of Ukraine in 2022.

The attention paid to security of supply, gas infrastructure and the company's role peaked when the Nord Stream 1 and 2 pipelines in the Baltic Sea were sabotaged in September 2022.

As top man at the Norwegian gas guarantor, Leversund accepts that deliveries of this commodity to Europe have acquired a security-policy dimension today. But he is quick to emphasise that regularity has always been high.

"Norway's reputation is as a reliable supplier, and regularity has been consistently above 99 per cent – effectively 100 per cent. The events in the Baltic focused massive attention on anything which could create uncertainty about deliveries. But we see, of course, that we've delivered extremely well and stably throughout this period."

SECURITY

Public concern over the security of critical gas infrastructure and deliveries from Norway is much lower today than it was. But that does not mean they are less important – the country currently meets 30 per cent of Europe's gas needs.

Nor does reduced attention mean a decline in the threat level – quite the contrary.

In 2023, Gassco was brought within the scope of Norway's National Security Act, and gas transport to Europe was designated a fundamental national function (GNF). Responsibility for →

"We must be vigilant and not naive."

supervising compliance with the Act in the petroleum sector rests with Havtil.

Where the gas transport company is concerned, one result of this has been greater responsibility for safeguarding assets and closer collaboration with the government on emergency preparedness.

"Security is nothing new to us, we've worked on it a lot," says Leversund. "The Act imposes even stricter requirements on us. We're now looking at what this means in such areas as vulnerability analysis and risk assessment.

"The new requirements will probably entail some changes, such as improved information management and the introduction of different levels of security clearance."

INTEGRATED

"We must be vigilant and not naive," says Leversund, who is prepared for today's high threat level and the big demand for Norwegian gas to continue.

The question is then what consequences a strong concentration on security will have for traditional safety work related to the working environment and major accident risk.

Frode Leversund emphasises that this must be managed in an integrated way.

"Responsibility for both safety and security rests with the line organisation, while the staff functions are responsible for security as a discipline. I don't think integrated responsibility here poses a big challenge. It's well understood.

"However, it could be challenging if the adoption of security measures distracts attention from safety work. An example is raising the security level and stationing Home Guard soldiers at a large gas plant.

"Such scenarios must be handled in a good way and through close collaboration between the operator, the plant manager and the authorities.

"We mustn't allow drones and Home Guard soldiers to distract attention from safety work at a plant. It must be possible to strike a balance between both."

REORGANISATION

The decision to create Gassco was taken in 2001 as part of a big reorganisation of Norway's oil and gas sector in response to the partial privatisation of Statoil (now Equinor) and the EU's gas market directive.

Ensuring neutral treatment of all parties involved in gas transport was thereby necessary, and the Storting (parliament) achieved this by establishing an independent state-owned company,

From 1 January 2002, Gassco assumed operator responsibility for all gas transport from the NCS. It took over Statoil's control centre at Bygnes as well as the pipeline network and terminals on land.

In addition, it became responsible for the two big central gas processing plants at Kårstø north of Stavanger and Kollsnes in Vestland county. Operatorship of the Nyhamna plant in Møre og Romsdal followed later.

LIMITED

Despite its major responsibilities, the new company was limited in size. Storting proposition no 36 (2000-2001) stated that

"the new company will concentrate its activities on system operation, licence administration and overall supervision of the whole transport infrastructure on the NCS".

That is still the position. As operator, Gassco uses others as technical service providers (TSPs) at its major onshore facilities – Equinor at Kårstø and Kollsnes, and Norske Shell at Nyhamna.

The company itself has just under 400 employees. Two-thirds of them work at Bygnes and the rest at the gas terminals. Without the TSPs, this number would be much higher.

"Including suppliers, and depending on the level of activity, some 4 000 full-time equivalents (FTEs) are worked annually to operate gas infrastructure on the NCS," Leversund reports.

He identifies several benefits of the TSP model, along with the requirements posed for the operator's "see-to-it" duty towards suppliers. The latter is an important principle in assigning accountability for plant safety.

"Such a model supplements our own capabilities by giving us access to resources and technical expertise at Equinor and Shell," Leversund points out.

"Our operator role means that we must have sufficient expertise in the various disciplines to exercise our see-to-it responsibility for the TSPs."

Even if Gassco does not have a big technical organisation of its own, Leversund points out, it must know enough to understand the issues as well as being able to challenge and ask the right questions. "Kårstø, Kollsnes and Nyhamna are big gas plants which play a hugely important role in the whole Norwegian gas machine," he says.

"So it's important for us to ensure that we're given priority by the TSPs, and that these have sufficient resources, staffing and expertise. That's naturally regulated by contracts, but we can't just sit back and expect everything to go smoothly."

ROLES

"It's important to distinguish between an operator and a TSP," Leversund adds. "We have different roles, and these must be recognised and understood.

He was at Statoil when the TSP model was adopted, and recalls much discussion about the boundary between the two sides – there was talk of "a line in the sand", who was responsible for what, and how detailed operator control of a TSP should be.

"We had the same discussion with Shell a few years later, but by then the model was well known," Leversund says. "The interfaces and our follow-up had been clarified.

"I think the allocation of responsibilities between Gassco as operator and Equinor and Shell as TSPs creates a best-practice discussion.

"An operator who challenges in a balanced way and works on best practice across organisational boundaries provides a form of benchmarking. In addition come the infrastructure owners, who also have a see-to-it role.

"So, in a way, you're well challenged at many levels. This strengthens our HSE work by making us perhaps even more vigilant." ■

WHAT IS THE SEE-TO-IT DUTY?

An operator has a special duty to ensure that the enterprise as a whole is conducted in a responsible manner and in line with regulations. It must see to it that everyone doing work on its behalf complies with the requirements of the HSE regime.

This "see-to-it" or oversight duty is a general, all-embracing responsibility which comes on top of a company's general obligation to comply with the regulations.

The operator's management system must specify how this duty is to be discharged.

It is not confined to the operator, but also applies to the other licensees in a production licence.

The latter must make provision for the operator to do its job, and ensure that work complies with regulatory requirements. Licensees also have a responsibility to take action if nonconformities with the regulations are identified.

ABOUT GASSCO

Gassco assumed operator responsibility for all gas transport from the NCS on 1 January 2002 as part of a major reorganisation of the Norwegian oil and gas sector.

It is a state-owned limited company, with the Minister of Petroleum and Energy serving as its general meeting.

Gassco operates the three large Kårstø, Kollsnes and Nyhamna land plants as well as the pipeline network – almost 9 000 kilometres long – which transports gas from the NCS to Europe.

New name, same goal

On 1 January 2024, the former Petroleum Safety Authority (PSA) became the Norwegian Ocean Industry Authority (Havtil). The new name reflects the expansion in our area of responsibility.

WE EXERCISE REGULATORY SUPERVISION TODAY FOR THE FOLLOWING:

- oil and gas activities on the NCS, at seven onshore petroleum plants on land and for associated pipeline systems
- activities linked to renewable energy production offshore
- operations related to carbon transport and storage on the NCS
- activities linked to recovering seabed minerals
- enforcement of Norway's National Security Act in the petroleum sector.

In spite of the expanded responsibility and new name, Havtil's goal remains the same – to safeguard the life and health of everyone subject to its supervisory regime.

Havtil Norwegian Ocean Industry Authority

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