Offshore Norge's input to the EU Commission on LDAR minimum detection limits for methane in implementing act

16th May 2025

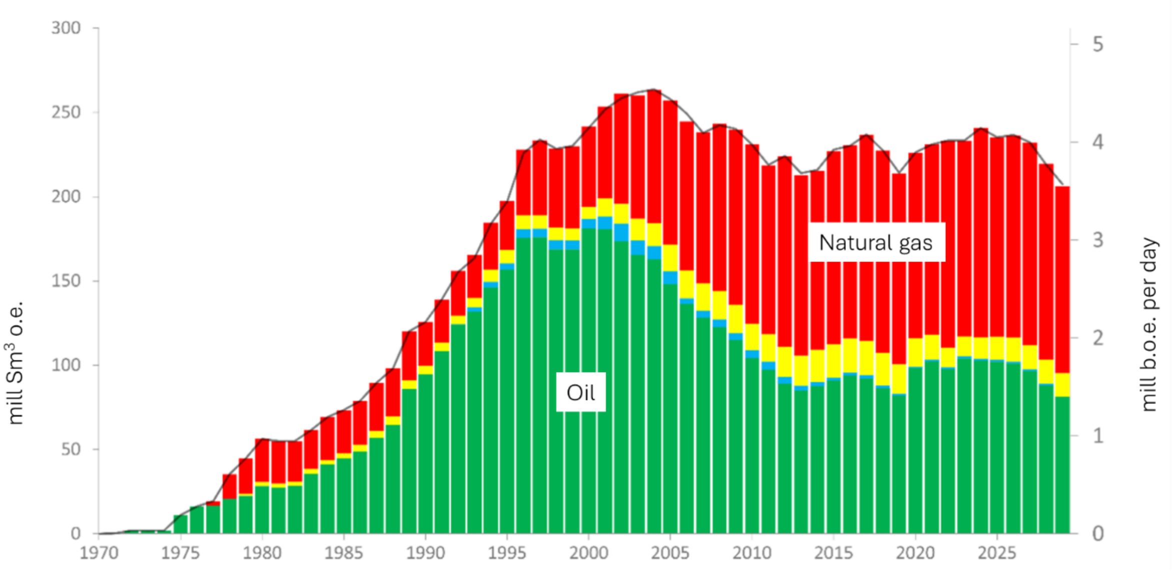
Offshore Norge is an industry organization for companies with activities related to the Norwegian continental shelf. Detecting methane leakage is an integrated part of the operations at oil and gas offshore installations and onshore gas processing facilities in Norway, both for safety and climate reasons. Current leak detection and repair procedures have been developed in cooperation with the Norwegian authorities and are considered as best practice for the offshore installations and gas processing facilities in Norway.

This document describes the current practice in Norway and gives our recommendations to the EU Commission on the implementing act for LDAR minimum detection limits (MDLs). In general, Offshore Norge recommends that the EU methane regulation is not implemented in Norway. Implementing the EU methane regulation would lead to marginal additional reductions in the methane emissions from our oil and gas operations, and in some cases even a net increase in the emissions.

For further details on minimum detection limits for methane, Offshore Norge refers to the input from IOGP and relevant studies carried out by Carbon Limits[1] and Sintef[2] for Offshore Norge.

Oil and gas production at the Norwegian continental shelf

Natural gas production at the Norwegian continental shelf (NCS) was 126 mill. Sm3 oe (bcm) in 2024. The figure below shows historic production and prognosis until 2029[3].



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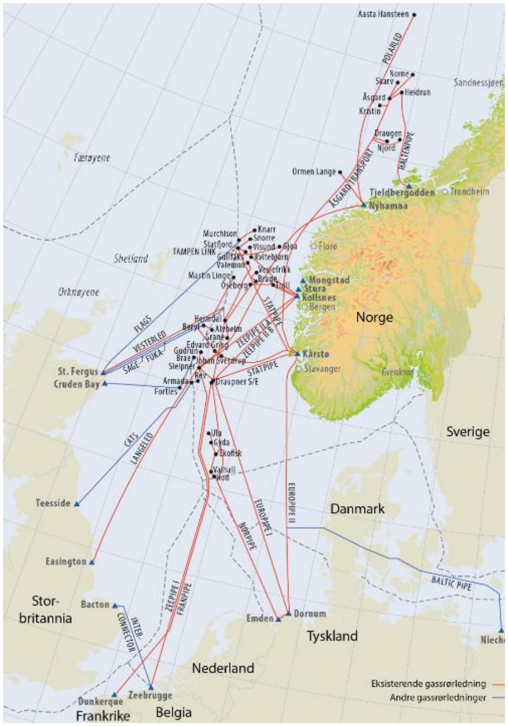
[1] Offshore Methane Detection and Quantification Technologies; Overview of Subsea Methane Emissions Detection and Quantification Technologies; Carbon Footprint of Subsea Leak Detection and Repair
[2] Fate of Dissolved Methane from Ocean Floor Seeps
[3] Source: sokkeldirektoratets-aarsrapport-2024.pdf

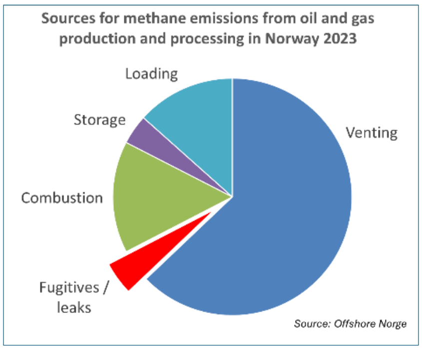
The oil and gas at the NCS are produced at 94 fields[4], however not all of them have a separate installation. Rich gas from the fields is sent through pipelines to three onshore gas-processing facilities: Kårstø, Kollsnes and Nyhamna. At the onshore gas processing facilities, the rich gas is separated into liquid products and natural gas. The liquid products are shipped to customers worldwide, while the natural gas is compressed and transported by subsea pipelines to gas terminals in Europe. The transportation network comprises nearly 9000 km of pipelines and is operated by Gassco, which is a fully state-owned company. The main markets for the piped natural gas from Norway are Germany, the UK, France, and Belgium.



LNG is only produced at the Equinor-operated LNG plant at Hammerfest north in Norway. LNG produced at the Hammerfest plant represents about 5% of the yearly natural gas export from Norway.

Methane emissions from oil and gas production in Norway

Methane emissions from oil and gas production in Norway is reported for each field and facility on a yearly basis. Total methane emissions[5] from oil and gas production and processing in Norway were in 2023[6] 11579 tonnes, which represents about 3%[7] of the total GHG emissions. The figure to the right shows the sources for methane emissions at the Norwegian offshore installations and onshore gas facilities in 2023. Emissions from leaks contributed to about 5% of the total emissions, i.e. about 500 tonnes methane.



Upstream methane intensity for oil and gas production at the Norwegian continental shelf was in 2023 0.02%[8]. IEA states in their Global Methane Tracker 2025 that Norway has the lowest emissions intensity of any country. And further, if all countries managed to match Norway's emission intensity, global methane emissions from oil and gas operations would fall by more than 90%. IEA points to a ban non-emergency flaring and imposed a tax on natural gas venting and flaring as some of the reasons for Norway's low emission level.

[4] At the start of 2025 (source: Norsk Petroleum)
[5] Methane emissions direct to air
[6] 2024 data will be published June 2025
[7] Global warning potential over 100 years
[8] Total methane intensity from upstream oil and gas production divided by total volume gas sold

Leak detection at onshore gas processing facilities in Norway

The requirement for an LDAR program and monitoring of leakages (diffuse emissions) are anchored in the company's management system, based on requirements and regulations from the Norwegian authorities and Best Available Technology (BAT). The facility's LDAR program is conducted on *a yearly basis*. Components installed on hydrocarbon systems are inspected with an Optical Gas Imaging (OGI) camera. Minimum detection limit (MDL) for the OGI cameras used is typically 0.4 g/h (specified from supplier, not independently verified). Leaks that are identified from the OGI survey are measured at 1 cm and 10 cm distance using a catalytic sensor for all sources; where access is available and can be performed safely. MDL for the catalytic sensors used are typically 500 ppm (specified from supplier, not independently verified).

All measured results, no matter the size of the leak, are reported in the management system for follow-up and repair according to specified criteria. All reported leaks are risk-assessed based on health, safety and environmental impact, and ranked according to priority. Mitigating measures are implemented as soon as practically possible after a leak is identified to stop or limit the leak. In some cases, depending on the size of the leak, this may lead to a partly shutdown for repair. Identified leaks that cannot be repaired immediately are monitored with *regular field inspections* as part of the maintenance program to check if an escalation of the leak occurs and urgent actions must be taken.

Searching for possible leaks is a high priority for the companies and is *integrated into the ordinary operational routines* in addition to the defined LDAR program. The regular daily operational inspection rounds are carried out for the entire facility to detect any faults and deficiencies, including leaks.

In addition to the yearly internal leak detections, leak detections *by third parties* are conducted at the Kårstø gas processing onshore facility *every three years*. The third-party campaign conducted at Kårstø in 2022 was using an Optical Gas Imaging camera with a specified MDL of 0.4 g/h (specified from supplier, not independently verified) in combination with best practice High Flow Sampler (HFS). From the *survey of 230 000 potential leak points*, the use of OGI camera revealed 75 leaks. By using the HFS for quantification, it was determined that *61 of the 75 leaks* had an average emission rate *above 1 g/h*. Data from surveys carried out at Kårstø in 2020 and 2024, see appendix A, show the ability of both the equipment and personnel to detect small leaks, and that leaks are repaired within short time.

The onshore gas processing facilities in Norway have based their LDAR program on the use of OGI technology. The reason is that third-party specialists have extensive experience using OGI technologies and that these technologies provide opportunities for multi-use. OGI has also good accuracy and efficiency.

When comparing the provided MDLs for the current catalytic equipment in use, these are not qualified according to the MDLs proposed by the EU Commission. This is unfortunate as this equipment has proven to be effective in identifying leaks during the daily operation of a gas processing plant. As this device is small, technicians could be equipped with these kinds of devices into their daily equipment loadout and allow for leak detection as part of the daily operational activities. However, the use of handheld catalytic sensors close to the component is often limited due to accessibility to the component.

Leak detection at offshore installations topside

The requirement for LDAR and monitoring of leakages (diffuse emissions) are anchored in governing documentation and operational routines. In a similar manner to onshore facilities, leaks at offshore installations are measured at 1 cm and 10 cm where access is available and can be performed safely.

The equipment used for measuring and quantifying leaks is very similar to the equipment used at the onshore gas processing facilities, which means OGI cameras for identification and catalytic sensors for measurement with similar MDLs as for the equipment used onshore. For offshore campaigns, user-friendliness and agility in execution are of high priority when it comes to the choice of detection equipment and methods due to the limitations on bed capacity and personnel on-board.

The process layout and environmental conditions offshore need to be considered and acknowledged when implementing MDLs. The implementing act must allow for a combination of technologies for use in varying weather conditions and distances.

There are many examples of gas leaks being detected with stationary detection systems several decks above/below the leak. Such leaks often originate from leak points that cannot be directly accessed by handheld close contact detection devices. To overcome these challenges a combination of technologies is essential. The use of OGI technology or other long-range technologies for detection in combination with sniffers are proven to be effective.

Leak detection subsea

Safe and effective management of pipeline systems is of great importance for the operators and is crucial for ensuring the safe and efficient transportation of resources while minimizing environmental impact. This involves a comprehensive approach to barrier management, which is categorized into preventive and consequence-reducing barriers. Preventive barriers focus on proactive measures to detect and mitigate potential issues, such as internal and external corrosion, structural impacts, and third-party activities. On the other hand, consequence-reducing barriers, including pipeline monitoring and emergency preparedness, are in place and essential for managing incidents. By integrating these two layers of management, operators enhance the safety and reliability of subsea components and pipeline systems, ultimately protecting both the environment and public interests.

To get good coverage in detecting subsea leaks, *several techniques are used* based on assessment of BAT and ALARP[9] principles. The technologies and systems currently in use are mass balance, satellite radars, OSD radars, underwater inspections, and observations. See Appendix B for a description of the technologies. The different techniques cover detection of hydrocarbons on the sea surface, in the water column, local sensors on infrastructure, and process monitoring combined with inspections. The sensitivity of the different techniques varies dependent on the process conditions, water depth, and weather. It is the sum of all techniques used that define the leak detection system of a subsea field or installation, with the goal to detect all leaks before they become an environmental or safety risk/threat.

[9] As Low As Reasonably Practicable

Leak monitoring for subsea components and pipelines vary depending on the type of material, temperature and pressure specifications. Current practices for inspection, pipeline integrity management, and leak detection are based on experiences gathered over a long time in the industry and relevant regulations and requirements. The frequency of inspection and the choice of leak detection system is a result of *a risk-based assessment* that emphasizes HSE, effective barrier management, and the effect of the current pipeline integrity program.

The primary pipeline leak detection system for the export pipelines is the *mass balance system*. Advantages of the mass balance system are that it covers the entire pipeline section by combining input data from several online monitoring systems and instruments connected to the pipeline. The mass balance system is continuous, not dependent on external conditions, and allows for online monitoring, analysis and automatic alert/alarm functions 24/7. Results from the mass balance system in combination with data from real-time process conditions allow a trained engineer to determine confirmed leaks and initiate the necessary actions.

In combination with the mass balance system, there are several other leak detection systems in operation. Examples of such systems are *satellite radars* detecting fluid on the surface, *external pipeline inspections conducted using ROVs* and *"intelligent pigging operations"* which are a part of the rigorous pipeline integrity management program. For detecting small leaks, the ROV inspections are the most relied upon method; however, this is highly dependent on the external conditions, both above and below sea level. The technology mounted on the ROVs for detecting and quantifying leaks relies on sound, vibration, visual inspection, or sniffing to detect leaks. The ROV inspections have *a frequency of 2-6 years* for the export pipelines. If leaks are detected, the inspection frequency is evaluated and if needed adjusted.

All identified leaks from subsea components are quantified and monitored with a set frequency. For pipeline ruptures and leaks of a larger scale, operators in cooperation with relevant emergency responders will take immediate action. Due to the nature of a subsea pipeline grid, potential leak points are often placed at the subsea connection points. In some cases, this calls for cross-company collaboration to coordinate shutdown frequencies and repair of the leak.

To be able to quantify the leak, the need for an ROV and vessel is required. A test container to encapsulate a given amount of leaking gas can be mounted on the ROV. Good visibility is needed to ensure the entire stream of gas bubbles is captured. The capsule is then sent for analysis. This measurement is not representative of the emissions to air, which must be calculated based on the results of the lab test and modelling work.

Due to the high climate impact of conducting subsea surveys with vessels, the *best practice is to combine the leak detection survey with the pipeline integrity inspection campaign*. With today's regulations and requirements pipeline integrity and leak monitoring are conducted without compromising safe operations. The MDLs proposed by the EU Commission may challenge this, and uncertainties with regards to third-party vendor capacity are expected.

The feedback from subsea technology experts is that the current maturity level of subsea detection technologies is not sufficient to comply with the MDL of 3.4 g/h proposed by the EU Commission.

Offshore Norge's recommendations regarding LDAR minimum detection limits

1. **The implementing act must not limit the use of different technologies.**
   - An unnecessary low minimum detection threshold will limit the choice of detection technologies.
   - There is a risk of appropriate technologies being excluded if the MDLs are based on vendor claims and only expressed in ppm or g/h. Units like ppm-m should be considered.

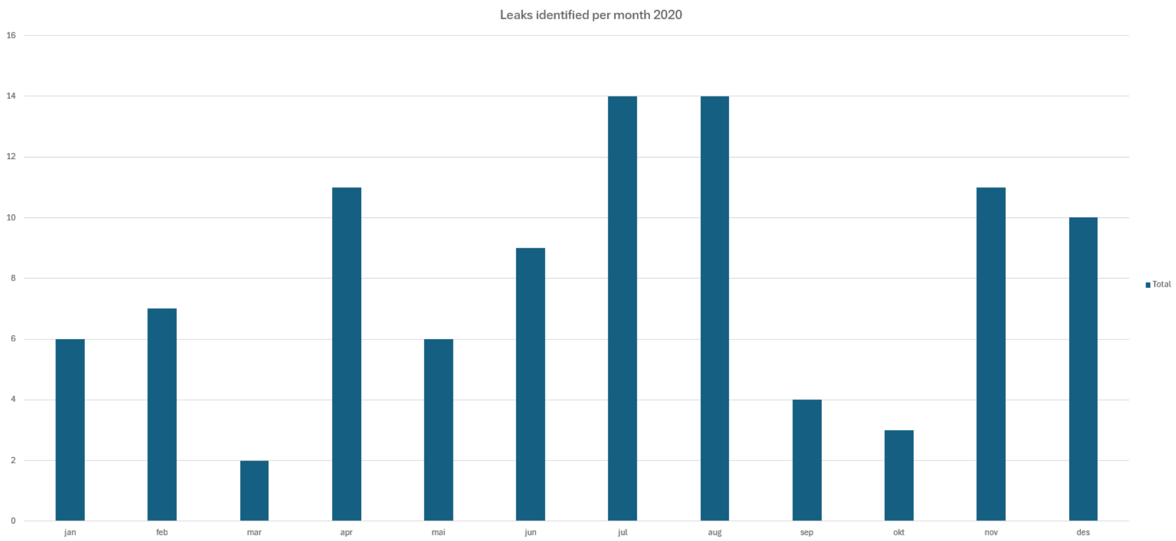
2. **The implementing act must not hinder the use of a combination of detection and quantification technologies.**
   - MDLs for different detection technologies will vary depending on the physical location, distance from source, weather conditions and operational conditions.
   - Some technologies are more robust for use in the field, safer to use, easier to deploy, and would therefore perform better and be more suitable.

3. **The MDLs must recognize the effect of real-life conditions.**
   - Vendor claimed MDLs are often set at ideal conditions and not representative at actual operating conditions.

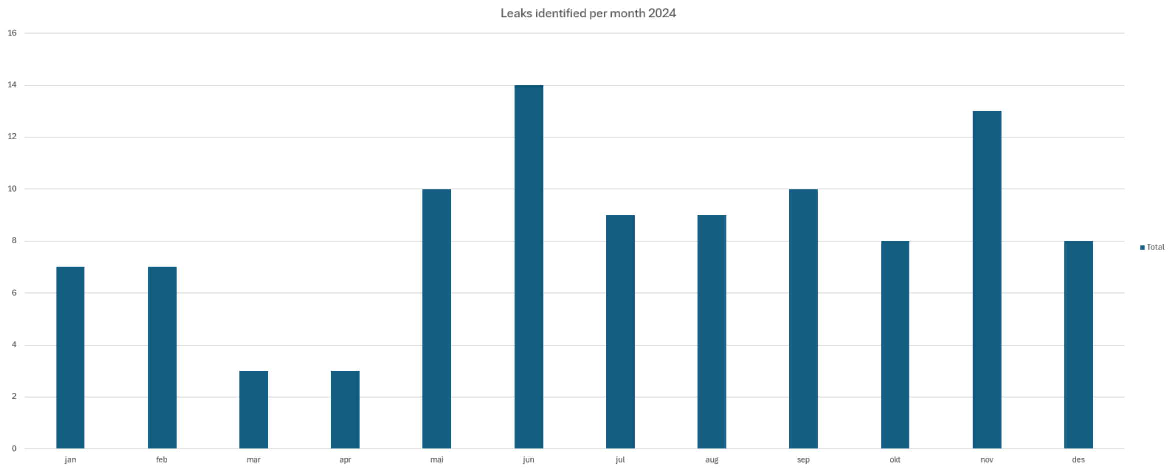
4. **The implementing act must support technological development.**
   - New techniques for leak detection are constantly monitored, evaluated, and tested to find detection methods that are more sensitive and have good reliability.
   - New technologies are evolving with a big potential.
   - Defining specific MDLs in an implementing act will significantly limit the incentive for testing, innovation and development of new technology.

Appendix A – Detection data from the Kårstø onshore gas processing facility

The graph below shows the number of identified leaks per month from 2020 gathered from the Kårstø onshore gas processing plant. As seen below a total of 97 leaks of varying sizes were identified. This comes as a result of surveying over 230 000 potential leak points. The scheduled LDAR program for the year 2020 was performed on different sections of the plant between May and August. Nevertheless, the graph clearly shows continuous reporting and identification of leaks throughout the year. Showing a clear priority in identifying leaks in combination with safe operations.



Data from 2024 from the same plant in the figure below shows a total of 101 leaks identified of varying sizes identified using the same approach as in 2020. The scheduled LDAR program for the year 2024 was performed in the period May to October. Data clearly shows continuous reporting yet again.



Every leak gets assigned an individual ID number for follow up. Comparing leak IDs for 2020 against leak ID's from 2024 shows no duplicates. Meaning all leaks identified in 2020 have been repaired before conducting the 2024 campaign. Repairs are conducted as soon as practically possible. Considering the intricate and technical process of the onshore facilities, and their respective position in the value chain, this is considered a good result. The figures above indicate that small leaks of this magnitude do not remain at such a level for long.

Appendix B – Techniques for detection of subsea leaks

Techniques used for subsea leak detection at the Norwegian continental shelf include:

- **Satellite pictures** are taken and evaluated daily giving a detection time of approximately 24-28 hours between each picture. If the weather is too rough or too still, detection is very difficult. Also, the leak must be large enough to reach the sea surface and make a thick enough oil film to calm the sea for detection. Satellite detects oil leaks from all subsea installations.
- **Local sensors** on templates can be passive acoustic, sniffer, and/or active acoustic technology. These sensors have a good sensitivity but limited range only detecting leaks in or near the template. Detection with the local sensors is normally done in minutes (if the leak is large enough to give an effect on the technique) but are also dependent on the level of background noise for passive acoustic and background level of methane for sniffer technology. Active acoustic sensors have better detection of gas in the water column than oil, since good detection is dependent on the density difference of the sea and the leaking medium. Oil leaks without gas are harder to detect.
- **Process monitoring** can include mass balance systems and pressure surveillance. Typically, mass balance systems are installed for export pipelines and pressure low limits for production flowlines, but mass balance systems are also used on flowlines from wells to platform. Pressure alarms require the system pressure to be higher than the ambient seabed pressure and are normally set to detect full ruptures and initiate automatic shutdown. Mass balance systems are the best method to monitor pipelines for small to medium and large leaks giving alarm in minutes to hours depending on the leak size. The sensitivity of a mass balance system is dependent on the technique used, sensors available and the accuracy of the instruments. Process monitoring is also done by the operators of the fields and is expected to detect leaks that give unexpected process changes or reduction in produced volumes.
- **Visual inspection by ROV** is probably the most sensitive method for detecting small leaks and is done yearly for infield and templates but less frequently for long pipelines 2-6 years.
- **Single/Multi Beam Echo Sounder (SBES/MBES) sensors** are acoustic sensors installed on surface vessels that allow the mapping of the seabed.

In sum the techniques used are set up to detect leaks of different sizes and give warnings or alarms as quickly as possible, meeting the risk tolerance criteria set for oil and gas leaks per field. Detection of small leaks on templates with continuous detection and short alarm time, i.e. minutes. Detection of small to medium leaks on pipelines with continuous detection, minutes to hours. Detection of very small leaks during yearly visual inspections. Satellite covering the whole NCS detecting leaks that reach the sea surface. Pressure low limit alarms is the only technique that shuts down production, all other techniques give an alarm that must be evaluated by an operator.

The smallest leak sizes to be detected by subsea sensors are down to 0.05 kg/s, with possible better sensitivity with ROV. New techniques for leak detection are constantly monitored, evaluated, and tested to find detection methods that are more sensitive and have good reliability.