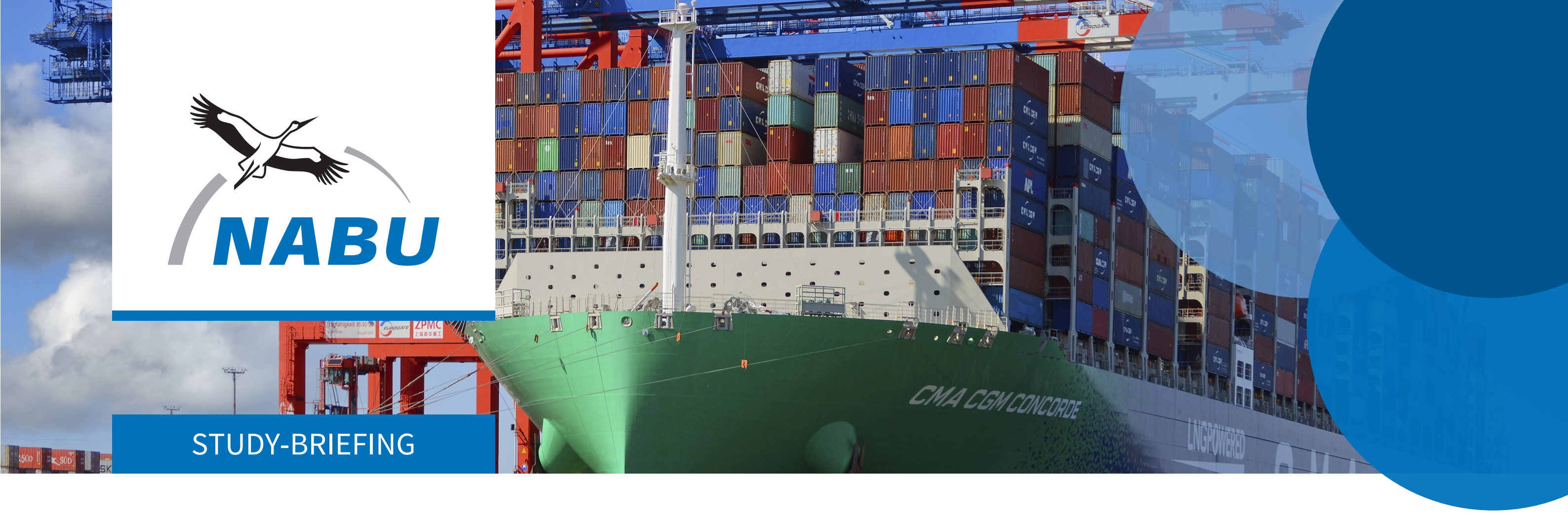
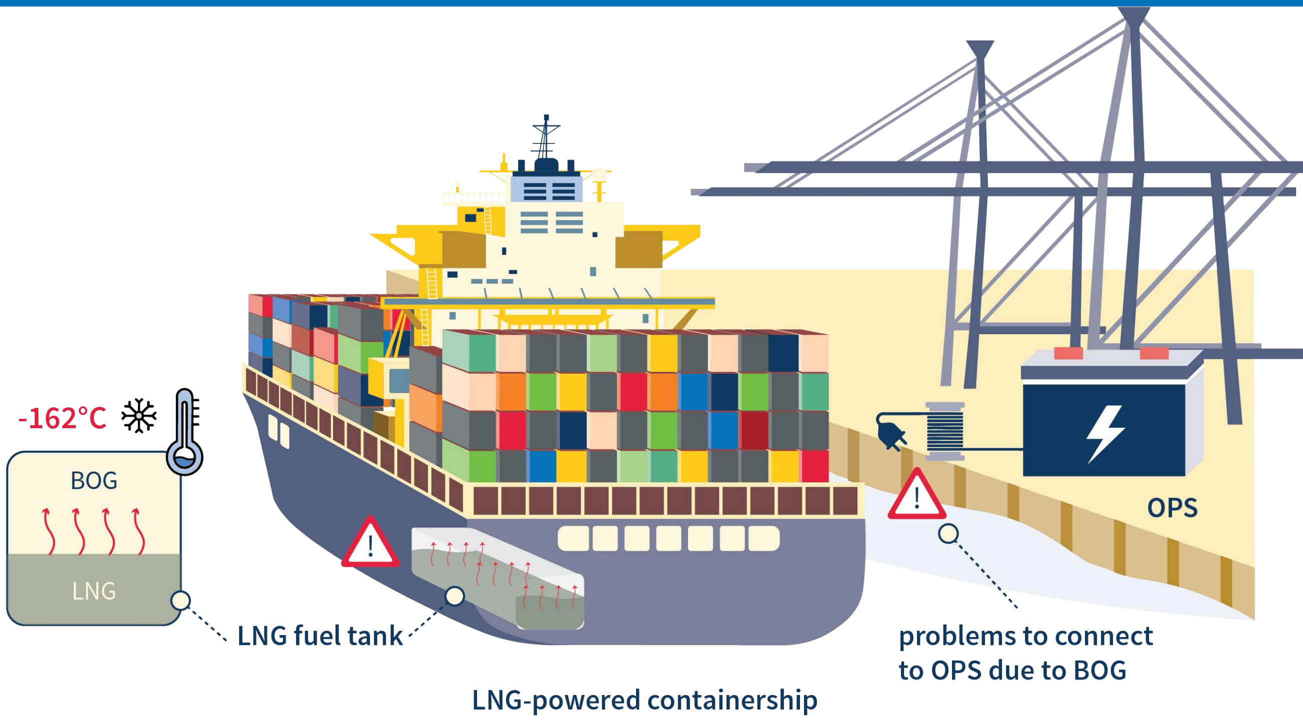


LNG-powered ships: Non-compliant with zero emission in ports?

A new study shows that many LNG-powered (Liquefied Natural Gas) ships are unable to be emission-free while using Onshore Power Supply (OPS) during port stays, even though this emission-reducing solution will be legally required in the EU from 2030 onwards.

The reason lies in the technically complex storage of LNG at low temperatures (-162°C). Unavoidable heat ingress causes part of the LNG to evaporate, forming gaseous methane, known as boil-off gas (BOG), which must be continuously vented and burned to prevent pressure build-up in the tanks. When ships operate on OPS, they can be powered externally, allowing their engines to be switched off. But for LNG ships, they are often the only option to utilize the BOG. As a result, methane emissions may occur which, due to methane's high climate impact, can partially offset the emission-reduction benefits of OPS during port stays.

The study shows that the **technical requirements of LNG-powered ships and current regulations on OPS use are not yet sufficiently aligned** and it identifies both technical and regulatory options for action. This highlights that the energy transition in the maritime sector requires not only ambitious targets, but also solutions that are coherently designed across technologies and regulations.



You will find the detailed infographic on page 5.

Onshore Power Supply as a solution for reducing emissions in ports

Global shipping is currently powered almost entirely by fossil fuels. At the same time, the sector has committed to **becoming climate neutral by 2050**.

One of the most effective measures for reducing climate and air pollutant emissions during port stays is the use of **Onshore Power Supply (OPS)**.

By drawing electricity from the local grid, ships can switch off their engines in ports, significantly reducing GHG emissions and air pollutants such as nitrogen oxides, sulphur oxides and particulate matter. In densely populated port cities in particular, OPS thus makes a key contribution to air pollution control and climate protection.

3% of global greenhouse gas emissions are caused by worldwide shipping.

(EU) Regulations

The enormous leverage for reducing emissions in shipping through the use of OPS is reflected in existing regulations. EU regulations such as FuelEU Maritime and AFIR (Alternative Fuels Infrastructure Regulation) include OPS as a central element of the EU's maritime decarbonisation strategy.

The regulations require large ports and ships to provide and use shore power during port calls from **2030**

Similar regulations on the use of OPS also exist outside the EU, for example in California (USA) and in some Chinese ports.

LNG as a shipping fuel:

Climate risks, BOG formation and conflicting goals in the use of onshore power

To avoid air pollution and demonstrate initial steps towards reducing greenhouse gases, ships powered by LNG have increasingly been put into service in recent years. However, LNG is often mistakenly seen as a lever for decarbonising shipping.

LNG consists almost entirely of methane and is used almost exclusively as a fossil fuel. Methane is a particularly potent greenhouse gas that is around 85 times more harmful to the climate than CO_2 over a period of 20 years. Even though the use of LNG offers advantages over conventional marine fuels in terms of air pollutants such as sulphur and nitrogen oxides, it is fundamentally problematic from a climate perspective.

In order for LNG to be stored on board, it must be liquefied and thus cooled to around **-162°C**

Due to the temperature difference to the ambient temperature, gas inevitably forms in the tank, known as **boil-off gas (BOG)**, which must be removed or utilised to prevent a dangerous increase in pressure in the tanks, which would require emergency venting.

While the use of onshore power in ports can drastically reduce both air pollutant and climate emissions, LNG ships face specific challenges: they are technically designed to continuously utilise fuel in the form of BOG, even during port stays. If shore power is used during a port stay instead of covering the ship's energy requirements by burning the fuel on board, the question arises how to handle BOG that continues to be produced, or how its formation can be limited

Impressum

Text: Raija Koch (NABU), Gestaltung: astridkampowski.com; Bildnachweise: imageBROKER.com/McPHOTO/Klaus Steinkamp, Margeritha Gagliardi

Goal of the study

To investigate this question, NABU commissioned the independent research institute CE Delft to conduct a study, which has now been published (insert link). The study examines the quantity of BOG that is building up in the tanks of LNG-powered container ships during OPS use and possible risks, in particular the danger of unburned methane emissions or inefficient utilization of the BOG. The focus is on container ships, as these, along with passenger ships, will be required to use OPS in major European ports from 2030. The analysis focuses on so-called membrane and Type B tanks, which are most commonly installed in container ships today.

Results of the study

The central conflict of objectives arises from the fact that EU regulations forbid LNG ships to operate their engines while using onshore power from 2030 onwards. This prohibits the most common method to burn BOG on board for energy generation. **Ships with membrane or Type B tanks are particularly affected,** as these tank types have low pressure tolerance and usually do not have systems for reliquefaction or controlled combustion. **Type C tanks,** on the other hand, **can withstand significantly higher pressures and store more BOG** temporarily, which greatly reduces the risk of emergency venting.

The container ships included in the study generally do not have reliquefaction systems, subcooling technology, gas combustion units, or sufficiently large pressure or buffer volumes to store larger quantities of BOG—all measures that could help manage BOG. Some of the ships only have dual-fuel boilers available to burn the BOG generated during onshore power use and thus control the tank pressure.

Dual-fuel boilers can continue to operate independently of shore power if they are needed for heat and/or steam pressure generation on board (e.g., for heating or hot water) and cannot be supplied via the power grid. These boilers can be operated with both BOG and conventional fuel, thus offering a way to utilize excess BOG while the ship is connected to onshore power

However, this often leads to inefficient energy use, as significantly more BOG is burned than is actually required for heating. This prevents the release of unburned methane into the atmosphere, but the excess heat generation produces both CO_2 and methane emissions.

This approach is therefore preferable than simply venting methane, but it remains problematic from a climate perspective. In any case, the LNG ship emits more greenhouse gases than a ship that can use shore power without restrictions.

Some of the ships examined in the study do not have any systems for burning BOG when the engines have to be switched off in onshore power mode. It remains unclear how these ships avoid methane emissions while still complying with their obligation to use OPS. It may be necessary to limit shore power usage times in order to avoid emissions, but this would constitute a violation of the legally prescribed OPS obligation.

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Recommendations of the study

For newbuilds, the study finds that tanks with higher pressure tolerance (C tanks) are increasingly being ordered, reducing the risk of pressure exceedances and unnecessary energy losses in ports. At the same time, it recommends further investigation of the relationship between higher tank design pressure and actual holding time to safely cover longer port stays without causing excess emissions.

For existing container ships with membrane or Type B tanks, which would be very expensive to retrofit, the study recommends systematically sharing experiences on BOG management during the use of OPS in order to avoid unnecessary combustion or direct release into the atmosphere.

Overall, the study confirms the importance of OPS as a key technology for reducing local emissions in ports and as a measure for climate change mitigation. At the same time, it recommends further investigation into how OPS requirements and energy efficiency requirements can be optimally combined to avoid unnecessary energy losses and additional greenhouse gas emissions. For older ships without alternative BOG management options, temporary special rules – such as reduced FuelEU penalties for limited OPS hours – could be justified. However, possible negative effects such as higher emissions, reduced incentives for cleaner sustainable technologies, and distortions of competition must be carefully weighed. The measures would also have to be coordinated with ports and electricity suppliers. LNG ships that are not OPS-compliant must not have any monetary advantages over OPS-compliant ships. Additional costs and disadvantages must be borne by the operator to uphold the polluter pays principle.

In addition, NABU notes that the current regulation does not address inefficient BOG combustion during OPS use. From NABU's point of view, it should be examined whether additional penalties can be introduced for BOG combustion that exceeds the necessary level, e.g., in dual-fuel boilers. Under current EU regulations, OPS is considered emission-free, without taking into account whether emissions continue to be generated on board at the same time, for example through the combustion of BOG. The use of onshore power must lead to a real reduction in greenhouse gas emissions. Neither methane losses nor inefficient BOG combustion should lead to additional climate impacts in the OPS context.

Implications in a broader context: NABU’s perspective

The problem of regulatory compliance for LNG ships is not an isolated technical detail, but symptomatic of the tensions surrounding the maritime energy transition: technologies that reduce air pollutants in the short term can lead to climate risks in the long term.

LNG has been positioned in many places as a bridge technology but is increasingly controversial due to methane emissions along the supply chain. The OPS requirement highlights these contradictions. It shows that air quality targets and climate targets are only compatible if ships are equipped with the appropriate technology. In the long term, alternative fuels such as green ammonia or methanol are expected to gain in importance. The current problem with LNG ships therefore underscores the need to consistently align regulatory paths and infrastructure decisions with zero-emission technologies.

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LNG-powerd ships non-compliant with zero emission in ports

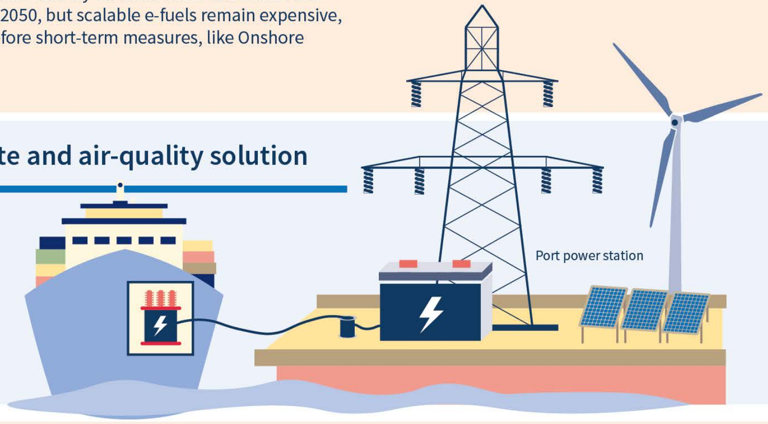
Shipping's fossil fuel problem: a climate challenge

1 International shipping still runs almost entirely on fossil fuels. The sector has committed to climate neutrality by 2050, but scalable e-fuels remain expensive, energy-intensive, and scarce. Therefore short-term measures, like Onshore Power Supply (OPS), are crucial.

3% *of global greenhouse gas emissions are produced by the shipping sector.*

Onshore Power Supply is a climate and air-quality solution

2 OPS allows ships to switch off their engines at berth and draw electricity from the grid, cutting CO_2 and nearly eliminating all local pollutants.

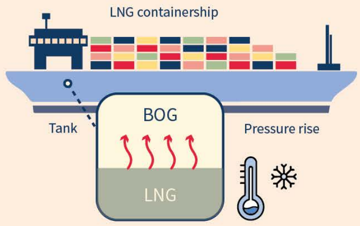


from **2030** *OPS becomes mandatory in EU ports. California and parts of China are also increasingly requiring OPS use.*

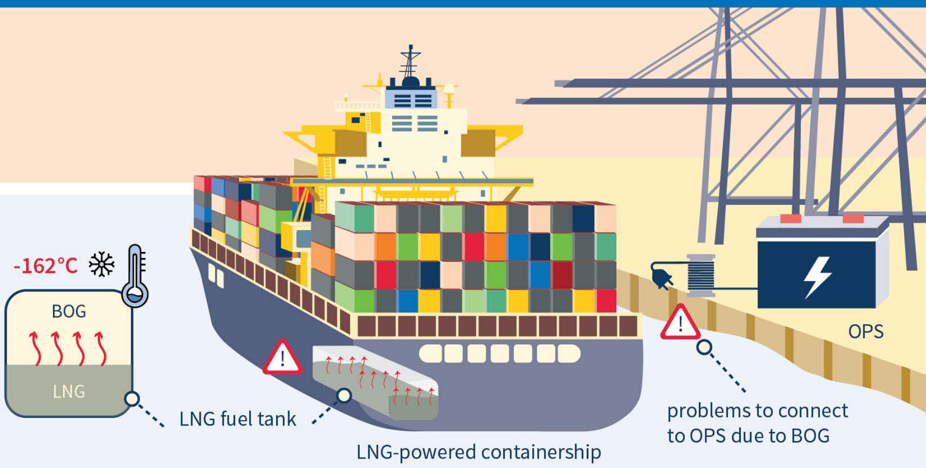
LNG is not a clean solution and is incompatible with OPS

3 LNG is a fossil fuel mainly made of methane, a highly potent greenhouse gas. It must be stored in tanks at -162° to be in a liquid state. This inevitably creates boil-off gas (BOG) that must be managed to avoid tank overpressure. Especially with engines off, e.g. when using OPS, many LNG-powered ships cannot properly manage BOG. As a result, some burn it in dual-fuel boilers, causing inefficient combustion and avoidable CO2 emissions, while others risk venting BOG when connected to OPS.

LNG must be stored in tanks at **–162°C** *This inevitably creates boil-off gas (BOG) that must be managed to avoid tank overpressure.*



LNG-powerd ships non-compliant with zero emission in ports

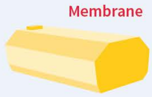


The problem:

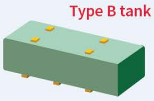
LNG is stored at very low temperatures (-162°C) to be in a liquid state. Due to the large temperature difference from the surrounding environment, methane inevitably evaporates as boil-off gas (BOG) inside the tank. If not continuously consumed, pressure builds up in the tanks, eventually requiring venting. This makes it difficult for LNG ships to switch off their engines and connect to clean Onshore Power Systems (OPS).

Different tanks handle BOG very differently:

Membrane ⚠

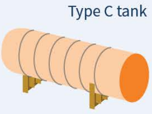


Type B tank ⚠



Membrane and Type B tanks, currently the most common on container ships, have limited pressure tolerance and face problems when connected to OPS, especially without addionall BOG management options.

Type C tank



Type C tanks can withstand higher pressures and temporarily store more BOG, reducing the risk of venting. Increasingly installed in new ships.

Different BOG management options also exist:

Some ships do not have any BOG management options. When the ship is in motion, the BOG is (partly) used in the engines themselves. Some ships have:

Commonly installed on LNG containerships

Dual-fuel boiler ⚠

burns BOG during OPS. This often leads to inefficient, **unnecessary combustion, producing avoidable methane and CO_2 emissions.**

Not installed on LNG containerships

Re-liquefaction plant – returns BOG to liquid LNG

Additional buffer /pressure-holding – extra space to store BOG temporarily

Subcooling / cooling systems – reduces BOG formation

Gas combustion unit – burns BOG in a controlled way

NABU recommendations:

Current EU rules count OPS as a "zero emissions" solution, ignoring continued BOG combustion or methane release. Emissions from LNG ships using OPS must no longer remain hidden. Regulators, port authorities and ship owners should:

1. Consider penalties when:
   - LNG ships can not manage the BOG when connected to OPS
   - excess BOG is burned in dual-fuel boilers during OPS
2. Account for boiler-related emissions even when ships are officially "on OPS."
3. Hold LNG-powered ships accountable for all emissions.