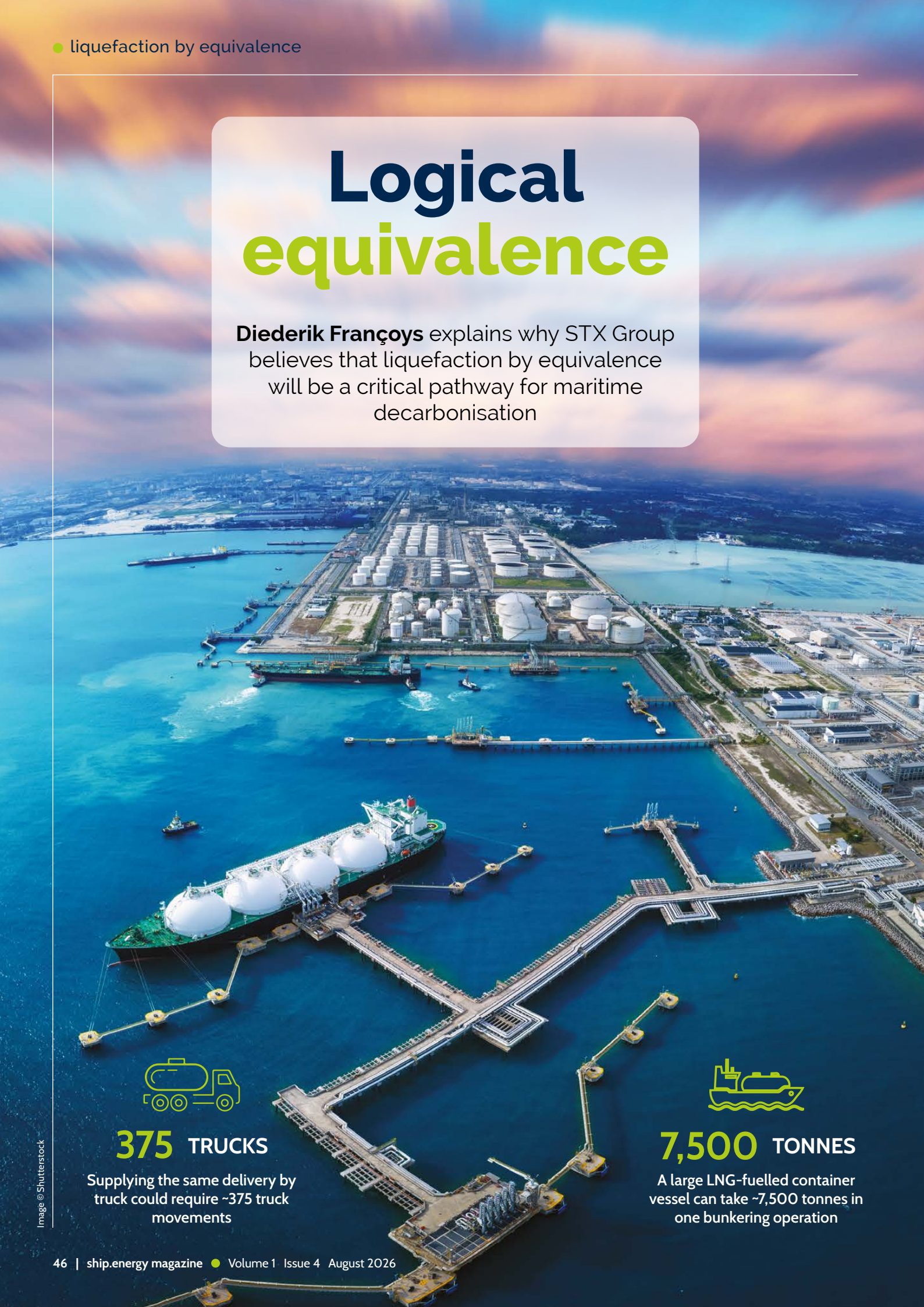
Logical equivalence

Diederik Françoys explains why STX Group believes that liquefaction by equivalence will be a critical pathway for maritime decarbonisation



375 TRUCKS

Supplying the same delivery by truck could require ~375 truck movements

7,500 TONNES

A large LNG-fuelled container vessel can take ~7,500 tonnes in one bunkering operation

Earlier this summer, Eurogas published 'Renewable Shipping Fuel Supply at Risk as EU Proposal Threatens Key Delivery Pathway', a joint statement cosigned by more than 40 companies across the bio-LNG and e-LNG value chain, including shipping companies, infrastructure operators and renewable gas producers. Their message is clear: liquefaction by equivalence is one of the most effective pathways for connecting grid-injected biomethane and e-methane with maritime LNG demand at scale. GHG accounting should follow the certified chain of custody and should not import emissions from a separate fossil LNG supply chain.

DISTINCTION WITH A DIFFERENCE

To understand the debate, we must start by defining 'liquefaction by equivalence' and how it compares to other types of liquefaction. There are three different ways to supply bio-LNG or e-LNG. Onsite/off-grid liquefaction is the pathway with the most direct physical chain between bio/e-methane production and liquified fuel output. There are no intermediate steps. Grid liquefaction uses mass balance to aggregate bio/e-methane injected into the gas grid at different locations and liquefies an equivalent quantity of gas at a central liquefaction facility. Mass balance links certified renewable gas inputs and outputs within a defined system, ensuring that sustainability characteristics are transferred only in volumes corresponding to verified renewable gas production and injection. Liquefaction by equivalence applies the same mass-balance logic across a broader interconnected infrastructure scope, including gas grids and LNG terminals where they are treated as part of the same system. Therefore, the output/extraction point of the mass balance can be where the sustainability credentials are allocated to the LNG going out of the terminal. The delivered LNG can then carry the corresponding certified renewable gas sustainability characteristics.

In other words, liquefaction by equivalence does not claim that the renewable molecule physically travelled to the ship. It uses the same logic as other certified mass-balance systems: renewable gas is injected into an interconnected infrastructure, an equivalent quantity is matched with LNG delivered at a terminal and the chain of custody ensures traceability, volume integrity and no double-counting.

> 'At this stage of the transition, the priority should be to remove unnecessary barriers to investment and enable maritime demand to support additional bio/e-methane production'

A CRITICAL PATHWAY

Liquefaction by equivalence cannot easily be replaced. The biggest reason: scale at the point of delivery. Maritime needs scale – not just annual production meeting annual demand, but also 'drop size': the amount of bio/e-LNG that is delivered in a single bunkering operation. For illustration, a large LNG-fueled container vessel can take ~7,500 tonnes. Such a delivery takes 10-20 hours. If the same delivery had to be supplied by off-grid-produced bio/e-LNG, this would require 375 trucks. Ignoring the challenges of sourcing from multiple bio-LNG plants and the logistical challenges of in-port operations, state-of-the-art truck-to-ship deliveries can manage up to four trucks every two hours. In total, such a bunkering operation could therefore take almost eight days of continuous activity.

This is not a criticism of physical bio-LNG production, which remains essential in specific contexts (e.g., off-grid delivery), but rather illustrates that large-scale maritime bunkering requires delivery infrastructure capable of handling very large volumes in short time windows. Existing LNG terminals and bunkering infrastructure are already designed for this type of operation. And demand for what flows through them is rising fast: shipping companies need bio-LNG today to meet FuelEU Maritime and EU ETS requirements.

A LOGICAL APPROACH

It is therefore logical to ask why larger bio-LNG plants are not being built. The answer is that biomethane production is highly decentralised. Unlike some biofuels, where the feedstock needs to be refined, biomethane often uses feedstocks with very low energy density: difficult to transport far. Extra transport movements increase both costs and emissions. For instance, manure-based biomethane can deliver negative carbon intensity values and is therefore a marine favourite, but the underlying feedstock is bulky and geographically dispersed. By way of illustration, cow manure has a yield of less than 1 tonne bio-LNG per 40 tonnes of manure. This naturally favours decentralised biomethane production. Anaerobic digesters scale poorly, too: larger capacity mostly means more tanks.

Grid liquefaction can also aggregate decentralised biomethane and it will have an important role where dedicated liquefaction capacity is justified. However, requiring the rapid build-out of parallel liquefaction

THE BENEFITS

SCALE TODAY
Use existing LNG infrastructure capable of very large deliveries

COST EFFECTIVE
Avoids premature investment in parallel liquefaction assets

LOWER EMISSIONS
Supports more bio/e-methane into the maritime fuel supply

ROBUST SAFEGUARDS
No double-counting. Emissions from fossil LNG are not assigned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infrastructure before demand is sufficiently mature could increase costs, duplicate existing infrastructure and create stranded-asset risk. Capital directed prematurely into dedicated liquefaction assets may be capital not directed into the most urgent bottleneck: increasing renewable gas production itself.

USING INFRASTRUCTURE WISELY

The main argument against liquefaction by equivalence is that it would drive fossil imports and a fossil lock-in. These are, of course, fair concerns. However, only ~1% of total LNG imports are used for small-scale LNG globally. Bio-LNG is only a fraction of that. So, the main driver for LNG imports is natural gas demand. Importing LNG specifically for bio/e-LNG only happens if someone wants the fossil gas anyway, and if long-distance liquefaction somehow beats local. Once the fossil demand fades, liquefying close to the consumption point becomes the obvious choice.

The policy question is therefore not whether Europe should remain dependent on fossil LNG infrastructure indefinitely. It should not. The question is how to use existing infrastructure efficiently during the transition while renewable gas production, demand and dedicated infrastructure scale together.

A LOGICAL TRANSITION

What should the transition look like? Phased. It would make the most sense to keep using the current infrastructure for as long as the demand for fossil imports remains high. Once the fossil demand starts declining, these LNG import terminals could quite easily be converted to liquefaction plants. The only change needed is adding the liquefaction trains, which can happen relatively quickly. The gas connection, LNG tanks, jetties and loading bays can all stay the same. Why not do that now? In the short term, forcing physical liquefaction at locations that are still primarily importing and regasifying fossil LNG could create inefficient circular energy use: regasifying LNG into the grid while separately liquefying grid gas back into LNG. That would add cost and energy consumption without accelerating renewable gas production.

The advantages of this phased approach: the renewable infrastructure scales up when the fossil demand scales down, allowing investment to follow real demand rather than regulatory distortion. The fossil lock-in concern should be taken seriously but assessed proportionately. LNG terminals exist because of wider fossil gas demand, not because of the comparatively small renewable fuel market. Liquefaction by equivalence does not, in itself, require new fossil LNG demand as it uses existing infrastructure while renewable gas production and dedicated supply chains scale. Also, the EU has long been a net energy importer, importing biofuels at scale and may one day become a net bio-LNG importer.

A REALISTIC VIEW

Shipping has no single decarbonisation pathway. Unlike sectors where electrification is already the dominant end-state, maritime decarbonisation will likely rely on several fuel options. Shipowners are already making investment decisions under significant technological, regulatory, and commercial uncertainty. Increasing sunk costs or narrowing fuel optionality too early is more likely to delay investment than accelerate it.

> ‘Bio/e-methane is among the most cost-effective decarbonisation tools in many different markets’

At this stage of the transition, the priority should be to remove unnecessary barriers to investment and enable maritime demand to support additional bio/e-methane production. Investments in these are highly valuable because these molecules are flexible across multiple end-user markets.

DECARBONISATION THAT WORKS

At STX, we believe bio/e-methane is among the most cost-effective decarbonisation tools in many different markets. It can be deployed from transport markets to utilities and industry. It is a no-regret investment that can be used today to decarbonise shipping and includes external benefits like improved waste management, circularity and rural value creation, when produced under robust sustainability standards. Shipowners tell us that they are willing to invest in biomethane today as long as they don’t have to bear the costs and risks of liquefaction infrastructure. They know that in the worst case, they can rely on trading houses to market these volumes in other markets if it does not turn out to be the most competitive option for them. This flexibility matters for shipping. It reduces downside risk and can unlock investment earlier. This approach ensures shipping companies can invest now, while remaining competitive.

Without premature large-scale dedicated liquefaction investment, the downside risk is reduced as bio/e-methane can still serve other markets, while avoiding unnecessary sunk costs.

A CALL FOR CLARITY

All in all, it is key that liquefaction by equivalence is recognised without unnecessary or disproportionate barriers. Enabling liquefaction by equivalence will increase bio/e-methane investments, while reducing uncertainty for shipping companies. Demand is not hypothetical: bio/e-LNG are among the renewable fuel options available to LNG-fuelled vessels as operators manage increasing compliance targets and reduce lifecycle emissions.

This does not mean weakening environmental integrity. On the contrary, it requires strong mass balance, traceability, certification and safeguards against double-counting. However, it also requires GHG accounting that follows the certified renewable gas chain of custody and does not allocate emissions from a separate physical fossil LNG supply chain to biomethane or e-methane that never entered that chain.

Keeping liquefaction by equivalence open will help connect decentralised renewable gas production with large-scale maritime demand, reduce unnecessary infrastructure duplication, limit stranded-asset risk and give shipowners a credible pathway to invest in renewable fuels today. At this stage of the transition, that is exactly the type of pragmatic, scalable and infrastructure-efficient solution Europe needs.

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