

Global Energy Transfer Solutions Showcase



**A SMARTER APPROACH TO SAFE, EFFICIENT AND
SUSTAINABLE ENERGY TRANSFER SOLUTIONS.**

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An Innovation-Driven Approach to LNG Demand

A Change of Direction at Ship Terminals

Liquefied natural gas (LNG) fueling is becoming an alternative choice for shipping lines seeking to reduce their carbon footprint with immediate impact. Today, CO₂ emissions are around 20% lower, and NO_x and SO_x emissions are almost zero – bringing new market opportunities and driving significant investments in onshore and offshore vessels.

The growth of LNG has led to more orders of LNG-fueled vessels and the bunker vessels required to refuel them. To meet LNG demands, smart solutions and infrastructure are required to enable efficient, safe, cost-effective, and timely LNG transfer operations.

With more than 50 years of experience in the LNG industry, Trelleborg Marine and Infrastructure has played an integral role in shaping the sector and contributed to its growth and development. We invest time in understanding the evolution of LNG, and the requirements it places on the operability and compatibility of LNG infrastructure, creating solutions to meet those specific challenges.

First, with our [Ship-Shore Link \(SSL\) technology](#) for large-scale applications. More recently with LNG fueling applications that require less volume, and our GEN3 SSL/ Universal Safety Link (USL) “Hybrid” system that supports bunker vessels taking LNG from large-scale terminals to refuel ships with smaller packages. Our team continues to explore new technologies to find innovative solutions that meet the LNG industry’s growing needs.

Our collaborative approach allows us to consistently design the most efficient, sustainable, appropriate, and innovative solutions, many of which are currently in use across the globe today. So, whether it’s floating hoses or a move toward pure liquid hydrogen, we innovate accordingly, delivering globally compatible, differentiated, and superior solutions.

The industry’s success in meeting set guidelines and standards can be seen in its outstanding safety record. As recognized thought leaders, we are proud to work hand in hand with industry bodies, such as SIGTTO and SGMF, to develop and improve industry standards and guidelines. This helps ensure LNG transfer systems work effectively across the globe.



Opening the Door to Worldwide Terminals

Japan Terminals LNGC Operator

For optimally safe berthing during LNG transfers, industry guidelines recommend that LNG Carrier (LNGC) mooring arrangements are analyzed using a [Mooring Load Monitoring \(MLM\) system](#). This information is displayed in the shore control room, though best practice also recommends that this data is shown onboard the ship. The [SSL](#) is an ideal carrier of this information, as it connects ship-to-shore during LNG operations.


Some terminals, particularly in Japan, require that MLM information be provided onboard ships. However, without compatible MLM systems installed on ships and shore, data cannot be transmitted, thus preventing compliance with regulations.

Challenge: A major LNGC operator contracted the build of LNGCs at a large yard using non-Trelleborg SSL/MLM systems.

During the commissioning phase of the ships, it became evident that the SSL/MLM equipment supplied was not compatible with the MLM equipment used at most LNG terminals, preventing these ships from operating at these terminals and hindering worldwide compatibility.

Solution: With tight delivery and global compatibility being major concerns, the vessel owner contacted Trelleborg, who agreed to replace the SSL systems onboard the vessels.

Trelleborg completed the delivery, installation and commissioning under extremely tight timescales to ensure that the LNGCs were fully operational once they arrived. SSLs were installed at the next available port visits, avoiding customer delays and minimizing disruption by commissioning the systems during vessel transit. The swap to Trelleborg's SSL systems ensured that vessels would be able to trade freely by successfully displaying MLM data during the berthing process.



Trelleborg delivered a globally compatible SSL system that ensured vessels could trade freely, while optimizing a safe and efficient berthing/LNG transfer operation through the provision of MLM data.

Maintaining Business Continuity Under Global Constraints

Louisiana, Georgia and Texas, USA After-sales & Service

LNG has seen an increase in demand as a more environmentally friendly alternative to reduce carbon emissions and help combat global warming. In addition to being cleaner than coal and oil, LNG allows energy supplies to be diversified.

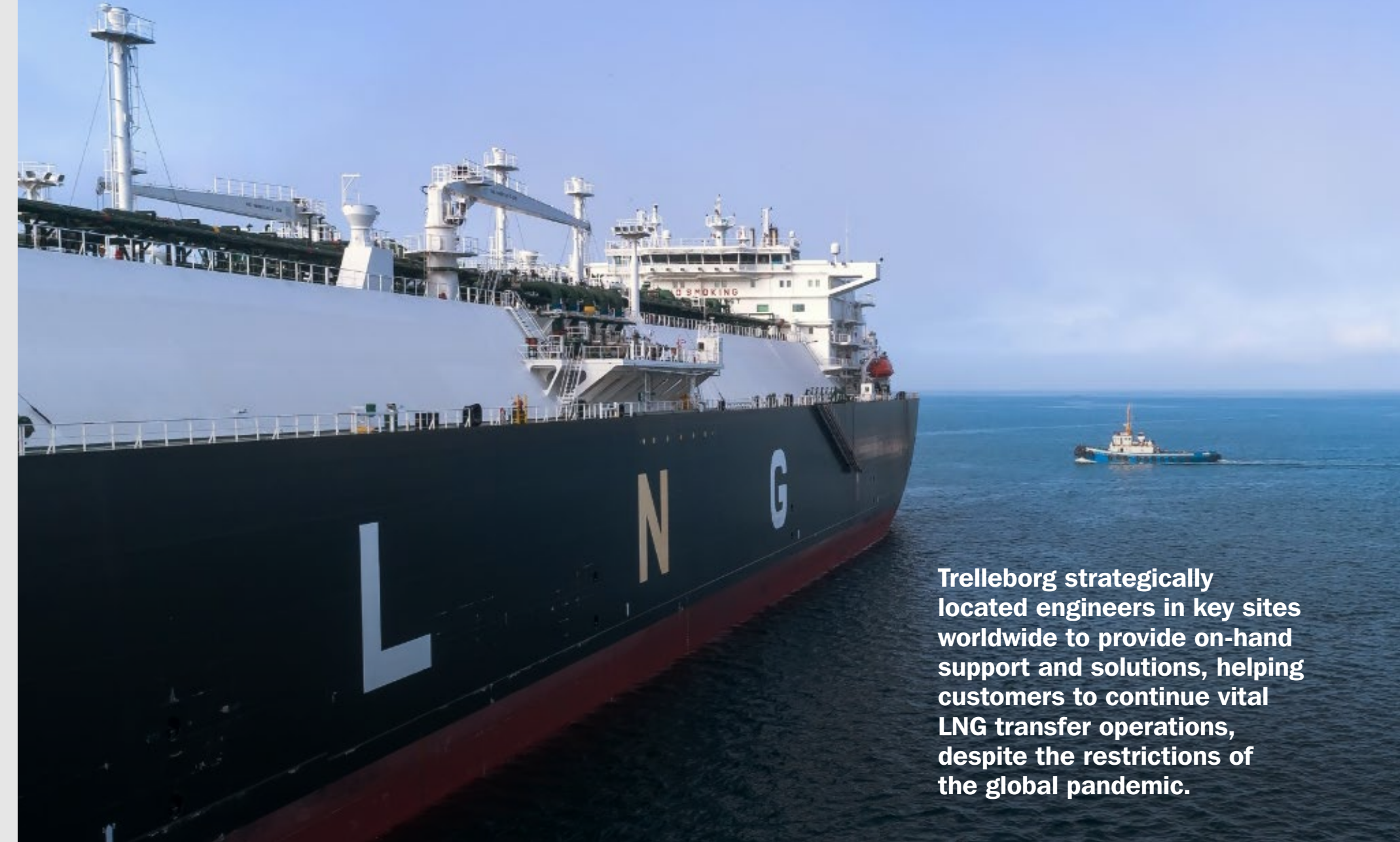
LNGCs are central to supply channels and their ongoing continuous availability for worldwide operations is critical to the supply chain. However, political instabilities and the demand for gas independence have caused a severe impact on both the ability to travel worldwide and the transporting of LNG.

Challenge: With the LNG market growing rapidly, vessels ordered and supplied before and during the Covid-19 pandemic have needed to be commissioned and put into service. Meanwhile, other global political instabilities have caused concern over the flexibility of LNG supply routes.

It is crucial that vessels are not delayed in becoming operational because of these challenges. As a result of recent events, customer requirements for site commissioning and service have also become more urgent with shorter time scales placing more demand on LNG operators.

Solution: As the world's leading supplier of SSL systems, Trelleborg was capable of rising to the challenge. Trelleborg reviewed engineer travel plans with increased use of longer-term secondments to key locations, reducing the impact of quarantine and allowing for work to continue despite restrictions.

Our team of engineers strategically located in key locations across the world allows us to provide excellent service to our customers even in the face of ever-changing restrictions.



Trelleborg strategically located engineers in key sites worldwide to provide on-hand support and solutions, helping customers to continue vital LNG transfer operations, despite the restrictions of the global pandemic.

Service Across the Globe with Remote Installation Capabilities

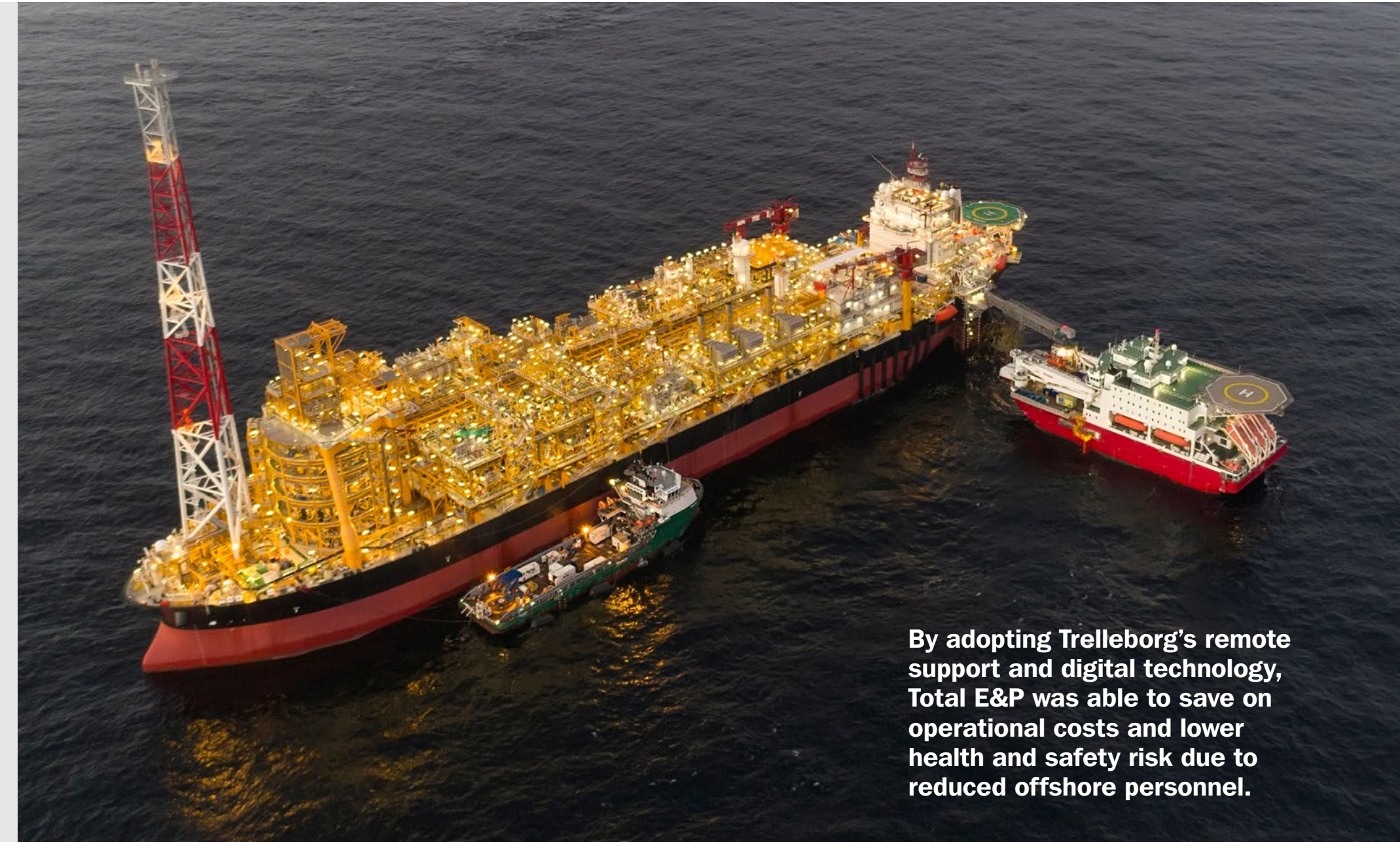
Total E&P, Angola Navigation and Piloting, FPSO

The offshore facilities of Total E&P are often located in remote locations, making it difficult to access them. Yet, work was underway to upgrade the [navigation and piloting systems](#) and buoy monitoring systems for one of Total E&P's operated floating production storage and offloading units (FPSO) in Angola.

Challenge: As part of its plans to upgrade its systems and create more remote operations for its offshore assets, Total E&P required a strategic partner capable of supporting the installation, data integration, software uploading, and commissioning of the equipment. With the COVID-19 pandemic restricting travel and making it unsafe, providing remote assistance became essential.

Solution: The successful installation of Trelleborg's [SafePilot Offshore solution](#) resulted in a new standardization of equipment onboard multiple FPSOs in the Angola area. As a sophisticated navigation and piloting system designed specifically for the oil and gas market, SafePilot Offshore delivers superior situational awareness and visibility with a highly intuitive, easy-to-use touchscreen technology providing pilots with greater control, safety, and accuracy during port approaches and maneuvers. And it optimizes the window of opportunity in this critical environment.

Trelleborg's remote installation capability eliminates the need for field visits. Having successfully installed the remote system in Angola, Trelleborg has since been awarded contracts for upgrading other Total E&P assets, thus strengthening the relationship and proving credibility.



By adopting Trelleborg's remote support and digital technology, Total E&P was able to save on operational costs and lower health and safety risk due to reduced offshore personnel.

Dynamic Positioning in Ship-to-Ship Transfer Operations

Ship-to-Ship Operation

Navigation and Piloting

Ship-to-ship transfer operations can be challenging, whether they are performed offshore or nearshore. Assuring timely and safe operations requires precision alignment of both ships' manifolds in a single attempt, without using tugs to pull off and realign.

The ships' built-in positioning systems are for open water long-haul navigation and cannot provide the adequate overview and precision needed to accurately perform STS maneuvers. However, as offshore LNG fueling becomes more prevalent, safe STS maneuverability is key.

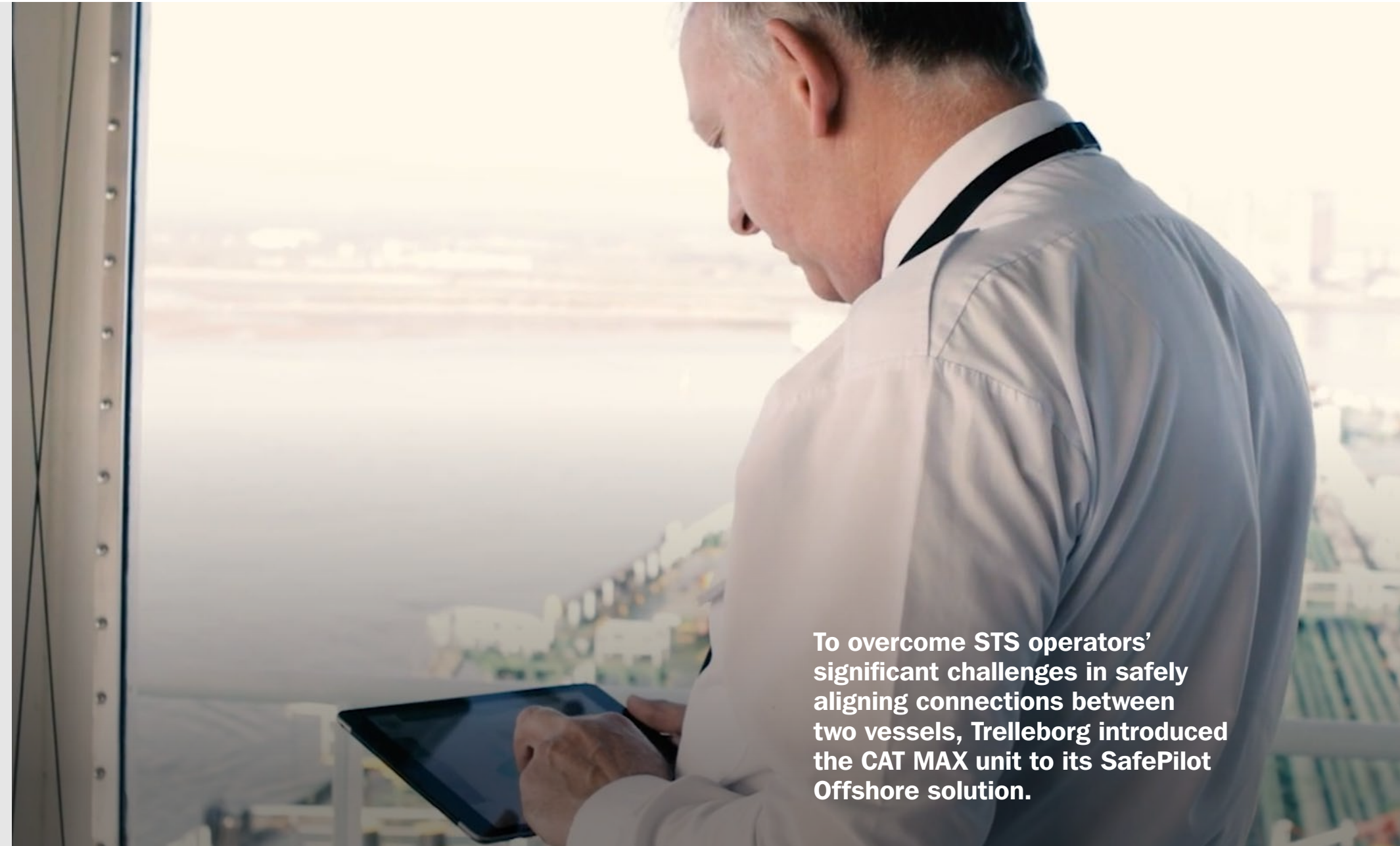
Challenge: A brainstorming session with a major STS operator highlighted the challenge of measuring manifold alignment in real-time for safe maneuvers. Offloading and receiving ships do not have the same equipment, and the equipment does not communicate digitally with each other. Positioning the two vessels dynamically during the operation requires that both vessels have well-coordinated situational awareness.

Solution: Using Trelleborg's SafePilot CAT MAX onboard and offshore positioning unit, our [SafePilot Offshore solution](#) can accurately position a ship on the first attempt. Built-in UHF two-way telemetry connects the systems on the two ships, providing the operations on both with a birds-eye view of the operation.

Now in use all over the world, the solution's iPad display shows the distance to go for manifold alignment, closing distances, and the speed for the two vessels. And, with the display updating every second, STS operators can achieve real-time precision to within 1cm accuracy.



Scan the QR code using your mobile device's camera to watch our Offshore Video.



To overcome STS operators' significant challenges in safely aligning connections between two vessels, Trelleborg introduced the CAT MAX unit to its SafePilot Offshore solution.

Securing a New Energy Hub in Africa

West Africa

Chain Stopper Operations

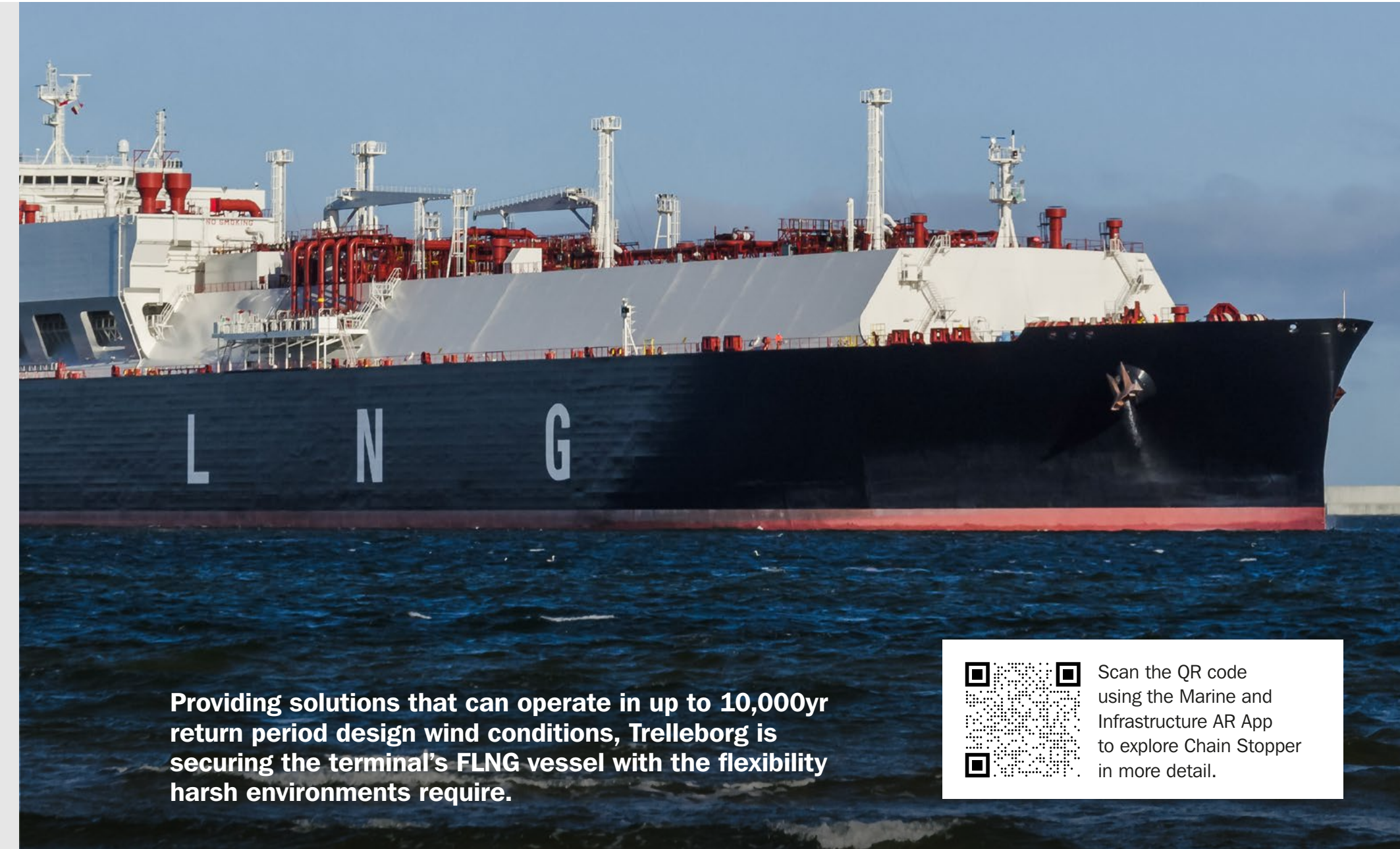
The permanently moored floating liquefied natural gas (FLNG) storage facility in West Africa experiences similar long-period, infra-gravity waves within the harbor, as act upon the LNGC vessels. However, being moored continually in the same location, the FLNG vessel must be more durable.

As a crucial element to the project's success, the FLNG vessel must be moored as rigidly as possible to enable production operations to continue. This would typically involve anchor chain systems – however, that does not enable adjustment to allow for vessel sway, surge motions and tidal or loading draft changes. Unplanned vessel excursions caused by line breakages can cause major safety hazards for personnel and disrupt product transfer operations.

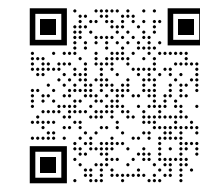
Challenge: The project's FLNG vessel's mooring devices needed to be able to operate in up to 10,000yr return period design wind conditions. This meant keeping the mooring lines in tension would require adjusting the chain portions of the mooring lines link-by-link and then locking them in place while monitoring the mooring loads. This process would need to be repeated as required.

Solution: Early engagement in the project's design phase enabled Trelleborg to provide solutions to the FLNG mooring application challenges. A bespoke adjustable [Chain Stopper](#) device was developed to provide adjustment to chain tension by as little as 200mm using multiple jaws and a safe working load of 250T together with load monitoring. Additional features were developed for units specific to the project to assist in hazardous areas operation compliance, extra dynamic adjustment range, and system redundancy.

The FLNG vessel benefited from a reduction in mooring line loads and vessel movement, an improvement in mooring line safety zones, and sustainable and continuous product transfers.



Providing solutions that can operate in up to 10,000yr return period design wind conditions, Trelleborg is securing the terminal's FLNG vessel with the flexibility harsh environments require.



Scan the QR code using the Marine and Infrastructure AR App to explore Chain Stopper in more detail.

Using Flexibility to Deliver Security

West Africa

Docking & Mooring

Bringing a new energy hub to Africa in the form of an LNG terminal was a great achievement, but it required the construction of an artificial harbor on the West African coast. Being an offshore facility, long-period infra-gravity waves could induce sway and surge motions, unsettling vessels in the harbor and causing high mooring line loads. This can lead to the snapping of lines, endangering mooring crew and transfer operations.

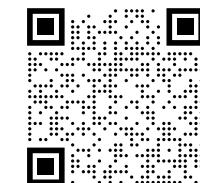
Challenge: Vessels remaining stationary is paramount to allow for the continuous transfer of LNG from the liquefaction vessel through the terminal jetty and onto the LNG ocean-going carrier vessels. To operate in up to 1,000yr return period design wind conditions whilst running passively as often as possible to minimize power demand from the port facility, the solution would need to dampen the vessel's motions through dynamic adjustment of mooring line tensions.

Solution: As part of our jetty-based solution for dampening vessel motions, Trelleborg developed DynaMoor automated dynamic mooring devices that resist natural frequency forces and limit peak mooring line loads.

Trelleborg supplied and installed DynaMoor units that would provide the extra dynamic adjustment range and additional redundancy that the terminal required. This resulted in the reduction of mooring line loads and vessel movement, improved safety in the hazardous mooring line zones, and continuous and sustainable product transfers.

To reduce sway and surge motions in challenging environmental conditions, Trelleborg delivered LNG solutions that provide the tension to put operations at ease.

Powered By
SmartPort®



Scan the QR code using the Marine and Infrastructure AR App to explore DynaMoor in more detail.

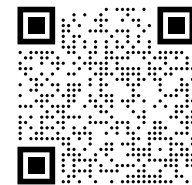
Assuring Compliance with Evolving Safety Standards

PESO Accreditation, India

Hazardous Area Compliance, Global Docking & Mooring Market

Safety is paramount across the oil and gas industry – with a particular focus in the LNG sector. Mismanagement of combustible materials can result in the release of gases or vapors into the environment, which can result in serious injury to personnel or equipment damage.

Regulatory bodies in many countries and regions have established standards and guidelines for equipment used in port operations so that terminal operators are able to ensure the highest safety standards worldwide.



Scan the QR code using the Marine and Infrastructure AR App to explore our Quick Release Hooks in more detail.

Challenge: In India, the Petroleum and Explosives Safety Organization (PESO) sets the requirements for equipment containing electrical systems at new or upgraded LNG facilities. To meet new PESO accreditation requirements, terminals in India now need to meet highly technical local standards for electro-mechanical machinery that operates in hazardous areas.

Solution: For 12 months, Trelleborg worked with its certification agent and key supply chain partners to record technical documentation regarding all electrical systems and enclosures, which needed to be assessed by PESO for suitability for hazardous area operation. Trelleborg's [Quick Release Hook](#) mooring systems are PESO-certified for use in the Indian market, and are fully compliant with Indian laws and regulations that govern the operation of LNG facilities. [Trelleborg's Ship-Shore Link](#) also uses PESO certified equipment.

Trelleborg is the largest PESO-accredited [Docking and Mooring equipment](#) manufacturer, giving customers needing QRHs the confidence that our equipment is certified. With this accreditation, EPCs and terminal owners can avoid unforeseen budget overruns and schedule delays due to compliance issues.



Trelleborg's accreditation means EPCs and terminal owners can move forward without worrying about unforeseen costs.

Ensuring Accurate, Continuous Performance Over Years


The Middle East Gas Service & Maintenance Program

Over 400 [QRHs](#), including class-leading [MLM](#) systems, were supplied to Trelleborg's key client in the Middle East and are currently used on site at various jetty facilities. However, as the installed equipment has progressed through its operational lifecycle, our customer faced the problem of regularly maintaining all of the equipment to ensure safe, accurate, and sustainable mooring operations.

Challenge: Among the most challenging aspect in this project was keeping the 400 QRHs calibrated, certified, and operating within international guidelines. In order to ensure that lines were frequently checked for appropriate tension, and that the vessel remained securely restrained at berth during LNG transfers, accurate MLM systems were necessary.

Solution: Trelleborg developed a new [Load Cell Exchange program](#) to ensure regular calibration of the load monitoring system on each QRH for the customer as part of an extensive tailored service and maintenance program. A set of replacement load cells was developed for operational spares sets at the customer's facilities that allow load cell swap-outs on planned maintenance schedules. Load cells identified for maintenance are returned to Trelleborg for reconditioning and recalibration to be ready for their next deployment.

This ensures that the equipment performs at its best, ensuring operator satisfaction.



Trelleborg is delivering the LNG solutions that keep mooring operations and product transfers continuing safely and sustainably.

Upgrading Links to Adapt to Increasing LNG Demands

The Middle East LNG Terminal

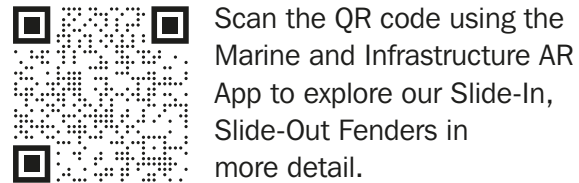
Increasing energy requirements demanded an upgrade of the existing floating storage regasification unit (FSRU) at the LNG terminal. As the FSRU would remain permanently moored at the jetty without any personnel, it needed to be capable of functioning independently. This meant that the terminal had to be equipped with a highly efficient SSL system to ensure that LNG was transferred safely and effectively.

Challenge: The previous FSRU did not have a compatible SSL system, meaning a bespoke FSRU would need to be supplied that could sufficiently integrate with the current SSL at the port. The current SSL also needed upgrading, to move the port from a 'ship FSRU' interface, to a full 'terminal' system, allowing the FSRU to operate efficiently while unmanned.

Solution: Trelleborg provided a bespoke solution that incorporated three separate electrical links – standard SSL communications, jetty platform emergency shutdown (ESD) integration, and jetty QRH signal connections.

This involved replicating the original SSL interface and adapting it to suit the new vessel, along with upgrading the existing SSL to be capable of full ESD, telecoms, and MLM signaling. Any signals not needed by the new arrangement were removed, helping to save costs. Trelleborg also supplied fender systems and docking and mooring equipment.

Upon completion of the project, the existing jetty could continue to function with a new, more efficient FSRU.



Trelleborg delivered a bespoke solution that both upgraded the current SSL and integrated a new system to effectively transfer LNG at the terminal.

Enhanced LNG Hose Transfer Systems

Mediterranean Terminals Ship-to-Ship, LNG

With increased demand for LNG in Europe, Mediterranean terminals have become strategically more important in securing gas import. At the same time, new opportunities for small scale LNG have also risen. The combination of these factors requires LNG hose transfer systems to be as versatile as possible. For example:

- Higher frequency of transfer operations.
- Compatibility with large scale (up to Q-Max) and small scale (bunkering) LNGCs.
- Reloading capacity: from ship to truck.

Challenge: An FSRU had to be equipped with a ship-to-ship (STS) hose transfer system (HTS) capable of being connected to a wide range of large scale LNGCs for LNG import and deliver frequent operations on a weekly basis. The same HTS also needed to connect with small scale LNGCs to reload small quantities of LNG – mainly for the bunkering of ships.

Solution: Trelleborg designed and supplied state-of-the-art [KLaw](#) 10" SIL2 HTS for large and small scale loading and reloading frequent operations.

This innovative system, with diagnostic and monitoring features, requires minimal compatibility adjustments for different sizes of approaching vessels.

A 3" ship-to-jetty system was also supplied for truck loading. This system is unique in the world of the LNG industry and the terminal is the first to perform a complex LNG reloading operation directly from the FSRU vessel to trucks.





Trelleborg is a world leader in marine gas transfer, enabling safe, efficient, and cost-effective operations at every stage of the LNG value chain. From full marine transfer systems to individual component parts, Trelleborg's portfolio is designed to optimize loading and unloading operations to deliver improved productivity, and enhanced safety and asset efficiency in the most demanding of environments.

Powered by innovation and strong customer partnerships, we are committed to playing an active role in supporting the global transition to cleaner energy and supporting you, wherever in the world you may be.

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Trelleborg Marine and Infrastructure

Email: marine_infra@trelleborg.com