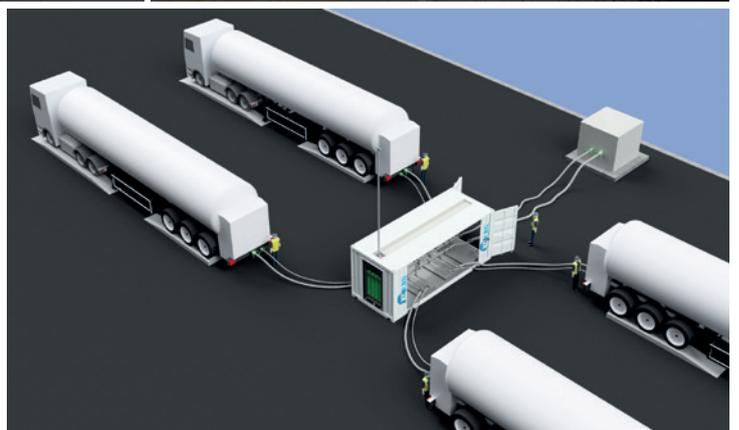
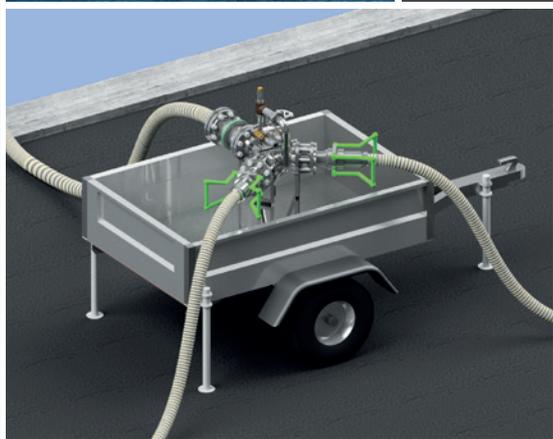
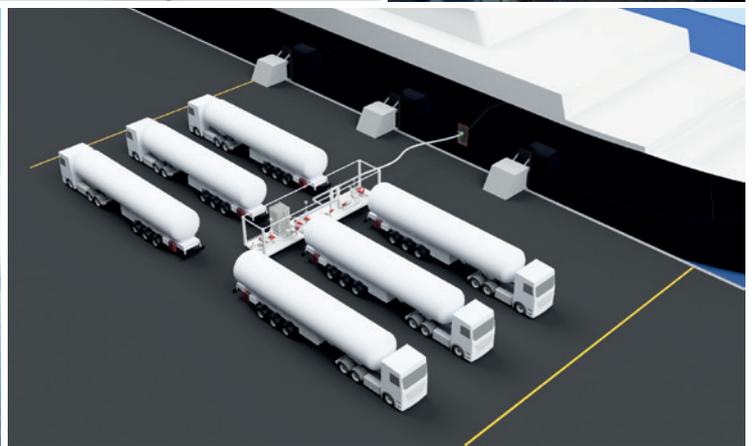
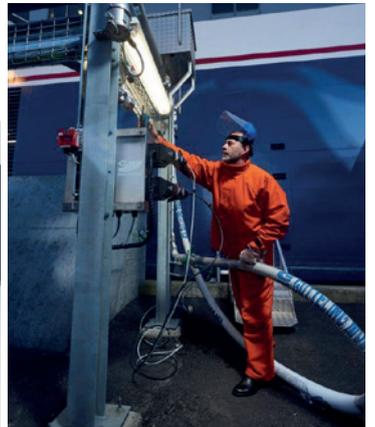
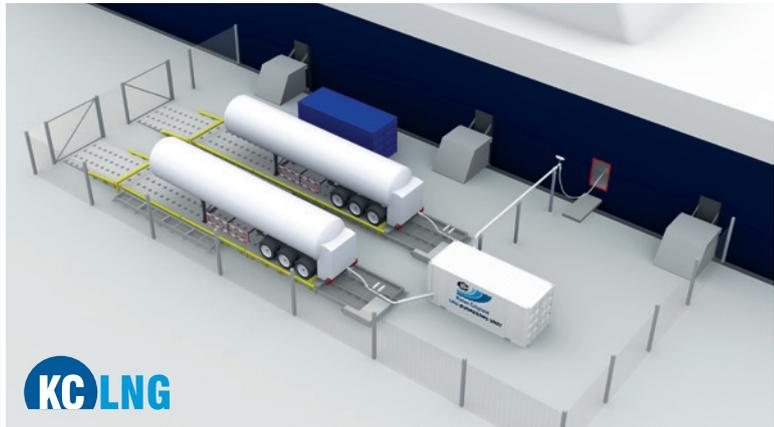


# Small-scale LNG bunkering





***Kosan Crisplant constantly improves and adapts its small-scale LNG bunkering solutions to meet the demands of the ever-changing small-scale market. Our solutions ensure fully automated operations with the aim to limit their impact on the environment.***

For all our LNG solutions, we have our four core principles in mind: zero-emission, scalability, automation and mobility. Together, they form the target we are always aiming at. And separately, they are explained in detail below.

**Zero-emission - choose the sustainable way forward**

As a worldwide operating company, we feel obligated to act to prevent further damage to our environment

and the world we live in. We therefore construct systems and solutions with the lowest possible emission, and it is our goal to avoid any methane slip completely. As a consequence, we have developed a patented system in which no flushing of the pipes with nitrogen takes place. This way, no methane, which is about 25 times more harmful to the environment than carbon dioxide (CO<sub>2</sub>), is emitted.

**Scalability – "grow as you go"**

Kosan Crisplant provides "tailor-made, standard solutions" – all at once. Because our bunkering systems are scalable, it is very easy for customers to increase their supply as the demand rises. Inspired by the Danish LEGO brick system, we invented a system that enables you to "grow as you go" by means of building blocks. With this

system, it is possible to start small and upgrade when needed, thus scaling each element up or down in size to allow various scopes, different LNG supply chains, and numerous end users to benefit from our innovative solutions. By just adding more pumps or trailers, different flows and volumes can be achieved.

**Automation – let the system do the work**

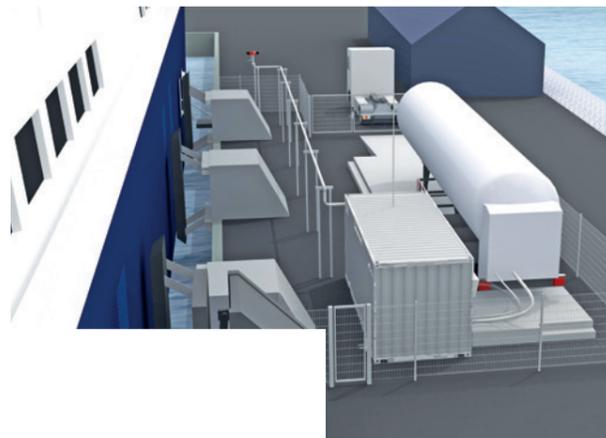
Kosan Crisplant develops complete and fully automatic solutions which make permanent staff superfluous. The solutions come with a comprehensive PLC system installed, which allows us to monitor the entire system. They are equipped with a data collecting system too, enabling us to stay up to date with the performance from a remote location. This will ensure the limitation of human errors.

**Mobility - move and adjust quickly**

The small-scale market is a very dynamic character with vessels sailing one route one day and another the next. This calls for great mobility. By placing most of the technical equipment inside a container, trailer or a skid, the solution can be moved quickly and the sunk costs minimised. It is important to us to stress that regardless how your business develops in future, our solution will be able to adjust along with it, so you do not invest capital in systems that do not fulfil future needs just because they are unknown to us today.

**KC LNG's solutions are indexed by the following specifications:**

	Max bunkering flow
	Scalability: no. of trailers
	Interchangeable during bunkering
	Mobility
	ESD – Emergency shut down
	PBU – Pressure build-up unit
	Zero-emission
	Fully automatic



Case: Pump unit setup

## The Samsøe solution

*The Samsøe solution is a modular, bunkering installation for the Danish Samsøe Ferry. The solution is very lean and light, easy to operate and represents low OPEX and CAPEX. The very cornerstones of the bunkering unit are zero emission of LNG, no permanent staff on shore and a very fast operation.*

- Bunkering directly from tank trailer
- 40-60 m<sup>3</sup>/h bunkering flow
- Bunkering of 10-40 m<sup>3</sup> per bunker operation
- Bunkering operation duration of 15 minutes
- Zero-emission bunkering

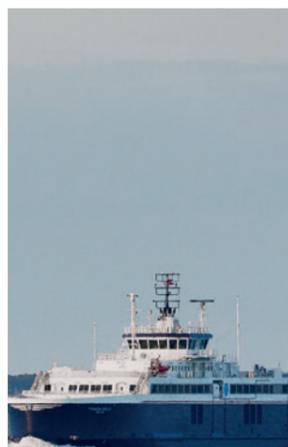
Kosan Crisplant has invented a bunkering solution which is not only fast, but can also be operated by a single operator from the ship. The maximum bunkering duration for the Samsøe Ferry is 15 minutes, which is the amount of time available from the ferry docks till it leaves the Port of Hou.

The plant is fully automatic and requires no permanent staff on shore. Approximately 60 minutes before the ferry arrives at the port, the ferry sends a signal to the control system of the bunkering facility, resulting in a pre-cooling of the pump. This way, we ensure that the system is ready to bunker the ferry without any delays. When the ship docks, the ship operator goes ashore, connects the coupling, and starts the bunkering. When the right amount of LNG is bunkered, the operator will stop the system, disconnect the coupling, and

take off with the ship. Hence, the operation is quick, efficient and allows for a simple operation! Afterwards, the system will take care of the rest.

We designed the system to ensure that any gas left in the pipes after completion of the bunkering procedure is returned to the tank instead of being released into the atmosphere. By means of low pressure in the semi-trailer and thermal expansion in the pipe, we are able to push the gas back into the semi-trailer after each bunker delivery. This renders flushing the pipes with nitrogen superfluous and hence, no methane is emitted into the atmosphere – a gas about 25 times more harmful for the environment than carbon dioxide (CO<sub>2</sub>).

Basically, the idea is to create a boxed system, where the LNG is transported by semi-trailers from a terminal to the port. Rather than establishing a large, permanent tank at the port, we create a supply chain placing the LNG storage on the road and we thereby minimise the CAPEX for the customer. At the time the truck driver parks the semi-trailer at the bunkering unit, it is in fact perceived as a permanent installation. In case of the Samsøe unit, the gas supplier replaces the semi-trailer every fourth day and the ferry consumes between 10-12 m<sup>3</sup> per day.

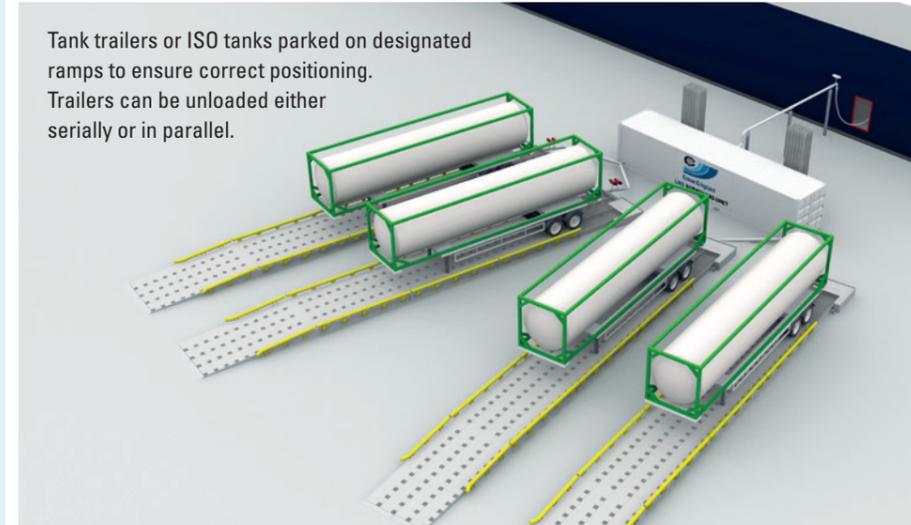
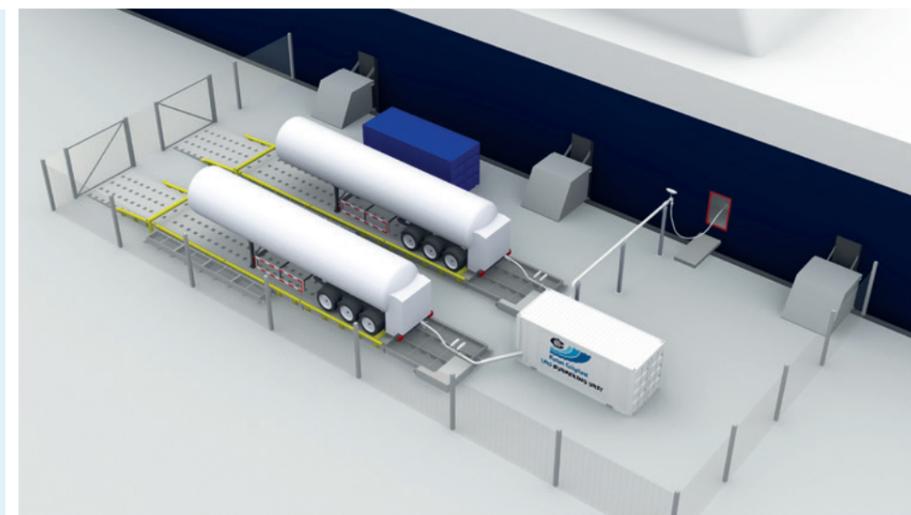


### Dual trailers to ship:

- Bunkering directly from tank trailers
- Two trailers connected to either one or two pumps
- Bunkering flow 40-160 m<sup>3</sup>/h
- Bunkering of 5-100 m<sup>3</sup> per bunker operation
- Zero-emission bunkering

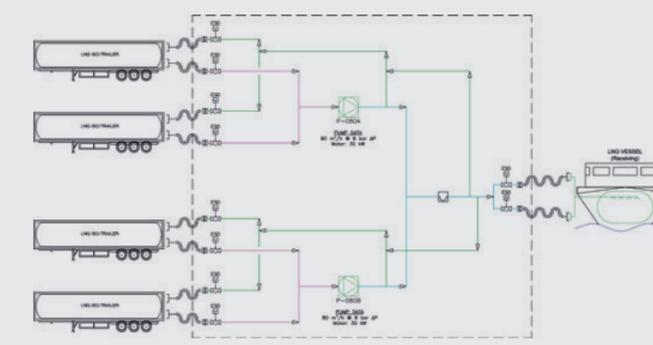
### Four trailers to ship:

- Bunkering directly from tank trailer
- 1-4 trailers connected to two pumps
- Bunkering flow 40-160 m<sup>3</sup>/h
- Bunkering of 5-200 m<sup>3</sup> per bunker operation
- Can be equipped with PBU, Pressure Build-Up Unit, for fast bunkering (Optional)
- Ideal to achieve flexibility on flow and to avoid fixed tank installation
- Zero-emission bunkering



Tank trailers or ISO tanks parked on designated ramps to ensure correct positioning. Trailers can be unloaded either serially or in parallel.

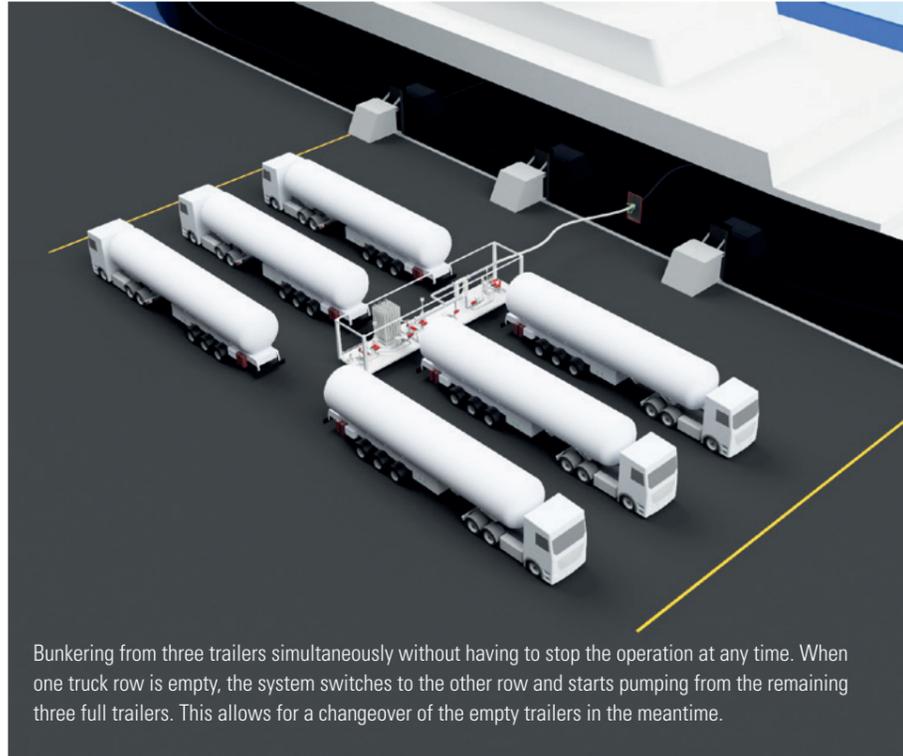
Process Flow Diagram of the multi-trailer solution.



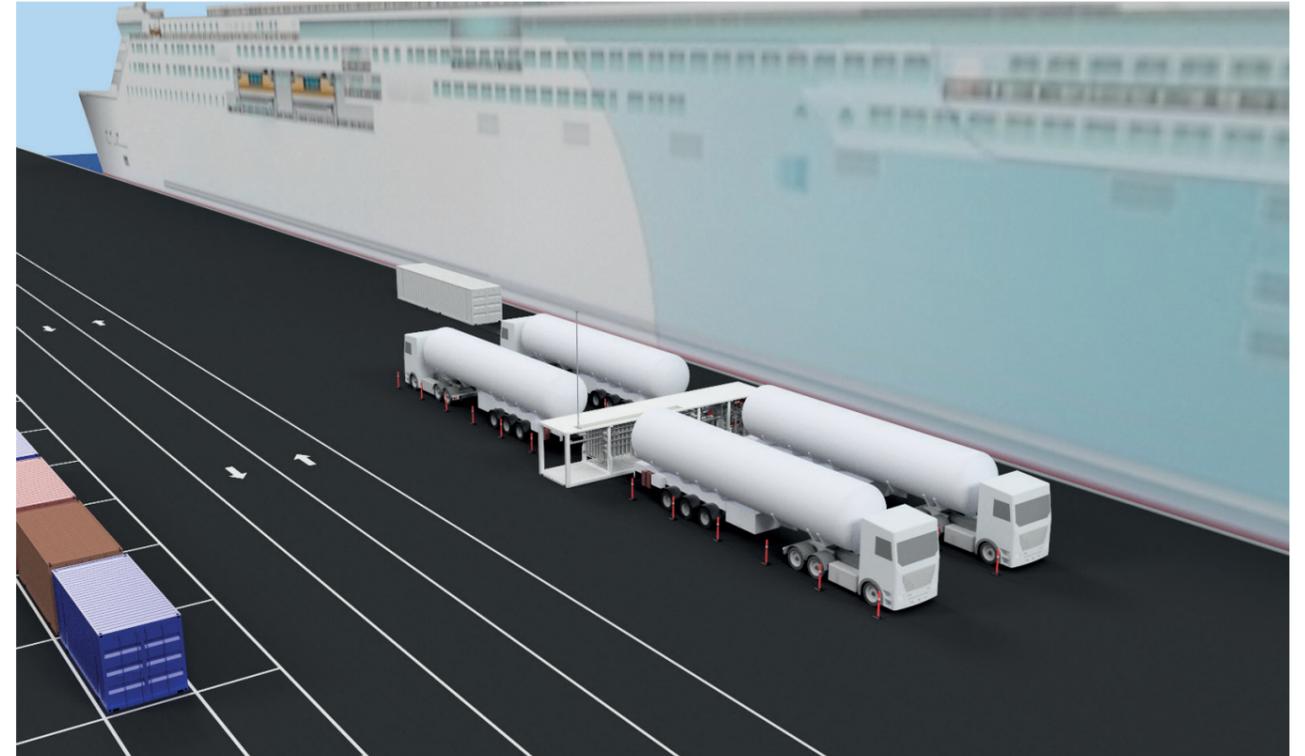
# Movable multiple truck to ship (Movable MTTs)

## Movable multiple truck to ship (Movable MTTs):

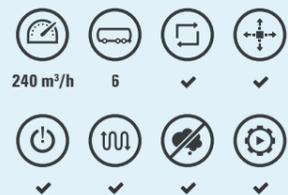
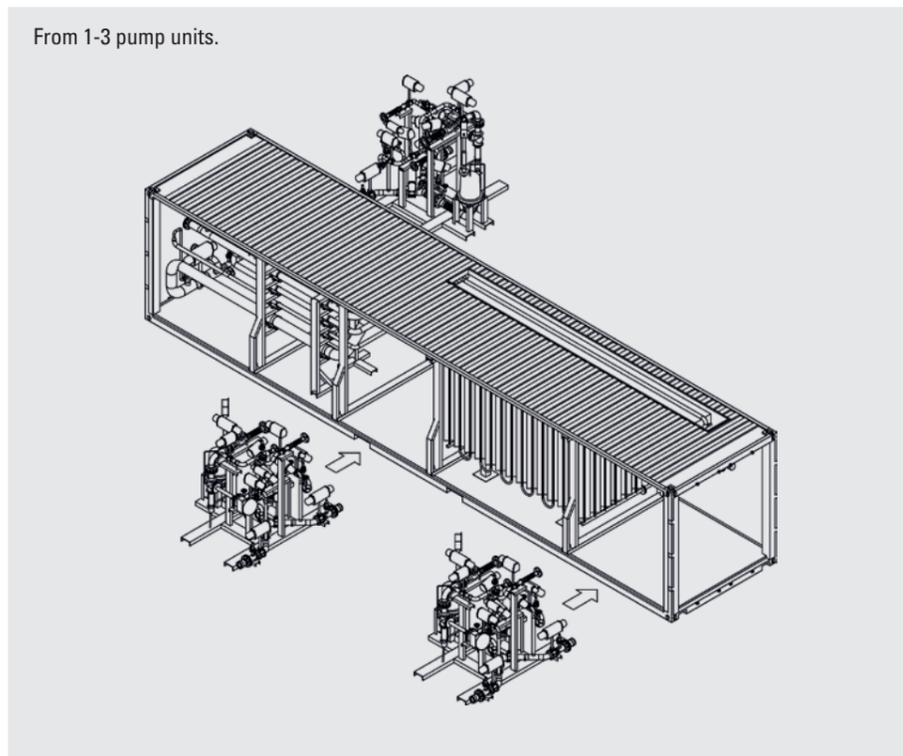
- The entire bunkering installation is movable on a trailer to be used in different bunker locations
- Bunkering directly from tank trailers
- 1-6 trailers connected to the pump unit equipped with up to three pumps
- Total volume for six trailers: 300 m<sup>3</sup>
- Bunkering flow 40-240 m<sup>3</sup>/h
- Can be equipped with PBU for fast bunkering (Optional)



Bunkering from three trailers simultaneously without having to stop the operation at any time. When one truck row is empty, the system switches to the other row and starts pumping from the remaining three full trailers. This allows for a changeover of the empty trailers in the meantime.



From 1-3 pump units.

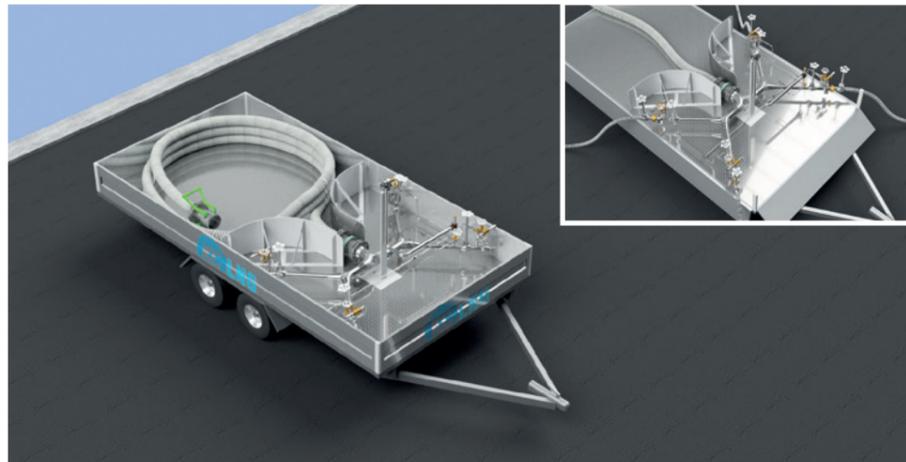
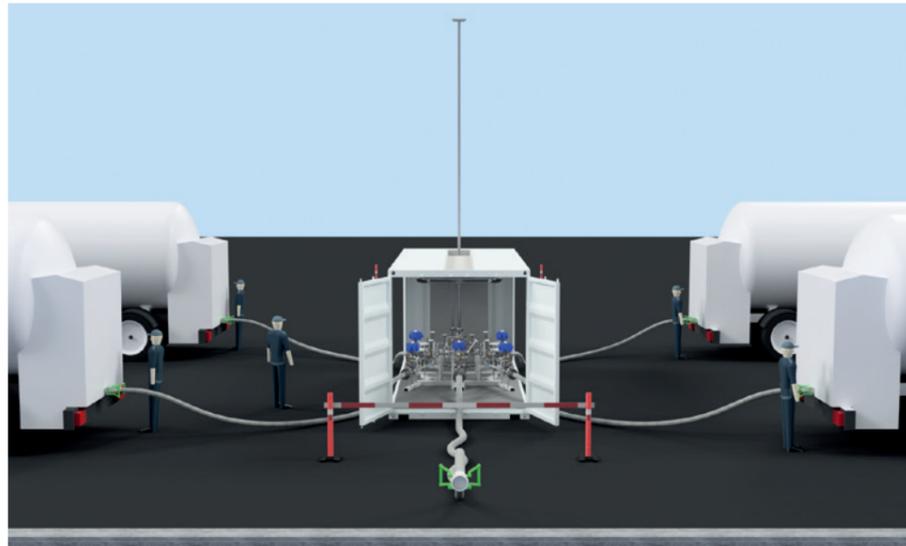
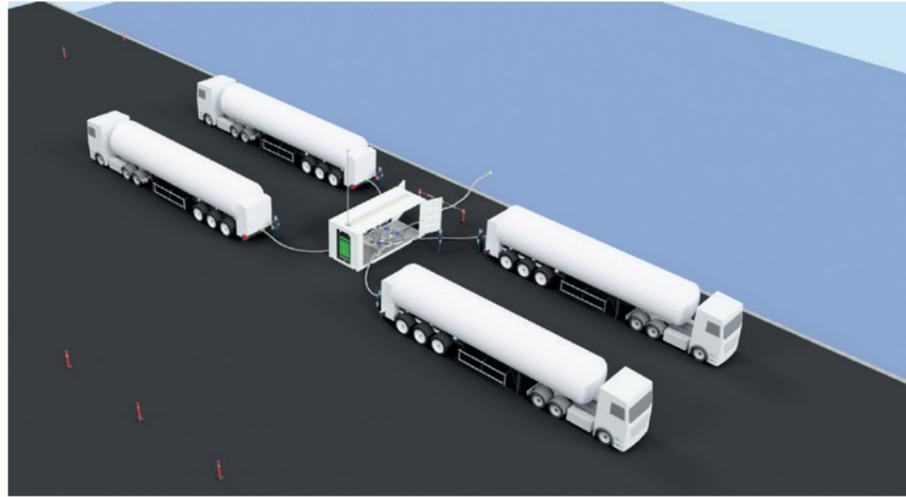


2 pump units.



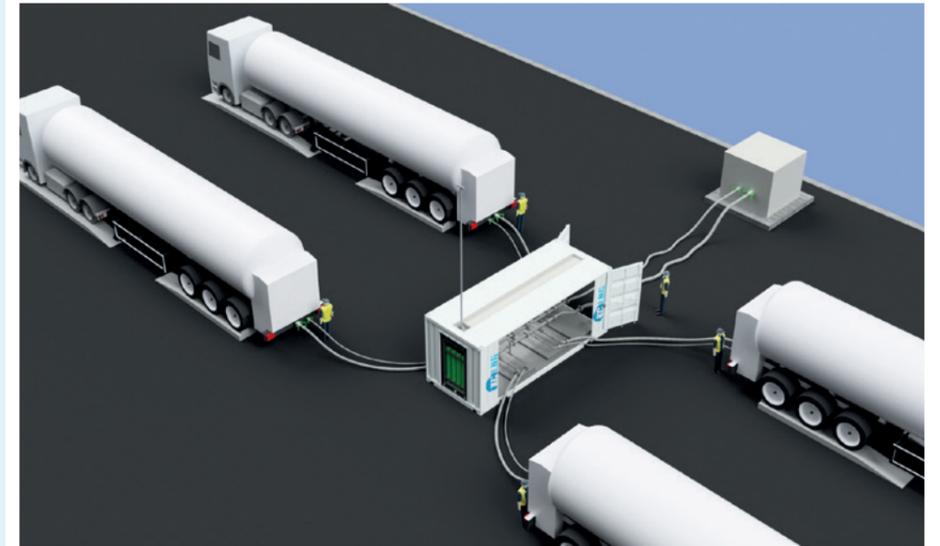
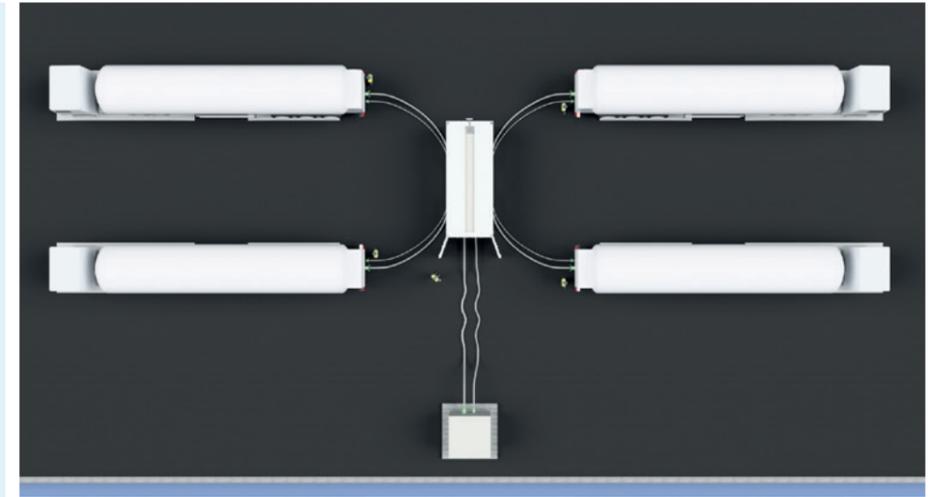
### Bunker manifold:

- Bunkering through the trailers' own pumps
- Bunkering volume per trailer: 45 m<sup>3</sup>
- Total volume for four trailers: 180 m<sup>3</sup>
- Bunkering flow 240 m<sup>3</sup>/h
- Available in a shipping container or trailer version. The trailer is a simplified version and does not feature ESD, Emergency Shut Down.
- ESD (Shipping container version only)



### Ship to multiple truck (STMT):

- Loading directly from ship to two to four tank trailers
- Interchangeable trailers during loading
- Capable of delivering a bunkering flow of 200 m<sup>3</sup>/h
- Total volume for four trailers: 200 m<sup>3</sup>
- Built in modules of 20 feet containers and thereby flexible and moveable
- The system has its own ESD and can be connected to SIGTTO-LINK
- The system can be monitored and controlled to the extent that the customer requires
- Zero emission
- With additional extra systems, a given and required pressure can be maintained on loading LNG from ship to tank trucks





Case: Y-Piece setup

## Double your LNG bunkering capacity with the KC LNG Y-Piece

*Your ship needs a substantial amount of fuel, and filling its tank with LNG takes a lot of precious time. What if there was a way to cut that time down to half – or less? That is the vision that drove us when we designed the KC LNG Y-Piece.*

In fact, it was a request from the Netherlands-based NIJMAN /ZEETANK International Logistic Group that set the whole process in motion in 2018. Their owners wanted a way to improve speed and efficiency when bunkering LNG-fuelled ships, and they approached KC LNG to come up with a solution. We cooperated with NIJMAN/ZEETANK in development and testing, and we ended up with the Y-Piece – a product that has the potential to revolutionise LNG bunkering.

### Scales to your requirements

In the simplest terms, the Y-Piece is an adapter that allows you to connect two tank trailers instead of one, doubling the capacity of your fuelling process. If that isn't enough, the design allows you to add a second Y-Piece and bunker with up to four trailers at once. Now you have cut your bunkering time down to a mere 25% of the original time – a very noticeable difference. For NIJMAN/ZEETANK, a single Y-Piece for each bunkering operation was enough for the time being.

### Tangible results with minimal fuss

NIJMAN/ZEETANK wanted a system that was practical and not too labour intensive. In other words, the reduction in bunkering time should not come at the expense of sharply increased labour or equipment requirements. As a result, the KC LNG Y-Piece is so lightweight that it can be hand-lifted by two crewmembers or transported on a standard trailer. No special equipment is needed.

Another example of the Y-Piece's practical qualities is the fact that it can easily fit any type of tank trailer and is a breeze to connect. The trailers can even be disconnected and changed during the bunkering operation while maintaining constant flow.

Soon after taking the Y-Piece into operation, NIJMAN/ZEETANK International Logistic Group reported great results:

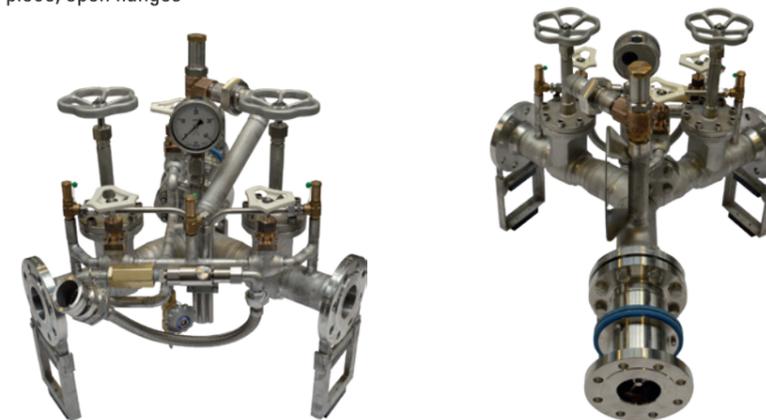
*"KC LNG's Y-Piece has been a game changer for us. It has drastically increased the efficiency of our LNG bunkering process, and it was very easy to install and use. We have already performed several bunker operations and are quickly accustomed to work easily and safely with the new equipment. The professional assistance from KC LNG has only made the experience better."*

*NIJMAN/ZEETANK International Logistic Group*

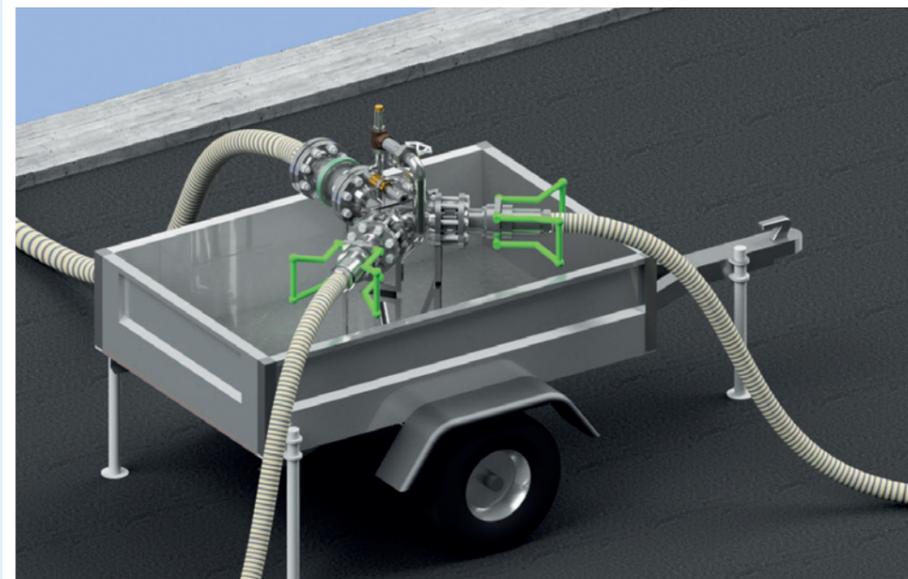
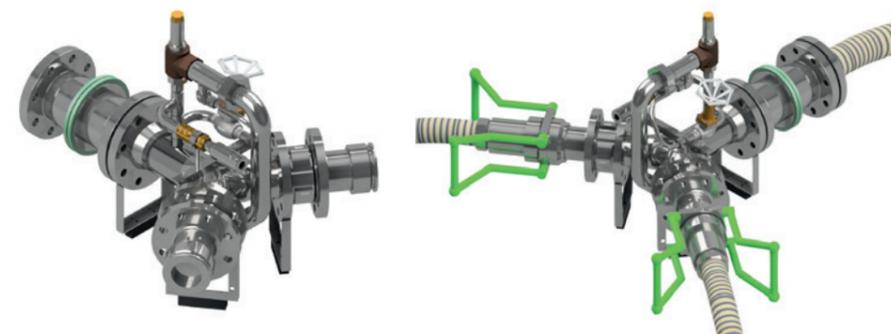
### Y-piece:

- Bunkering directly from two trailers
- Interchangeable trailers during bunkering
- Bunkering flow 40-120 m<sup>3</sup>/h
- According to ISO20519 the total flowrate must not exceed 150 m<sup>3</sup>/h
- If the bunkering flow exceeds 150 m<sup>3</sup>/h, an ERS (Emergency-Release System) system is required
- Total volume of two trailers: 100 m<sup>3</sup>
- Universal solution (enables different trailer designs)
- Fully movable bunkering solution due to the compact and lightweight design
- Y-shaped for optimised flow
- High safety level
- Dry coupling
- Open flanges

Y-piece, open flanges



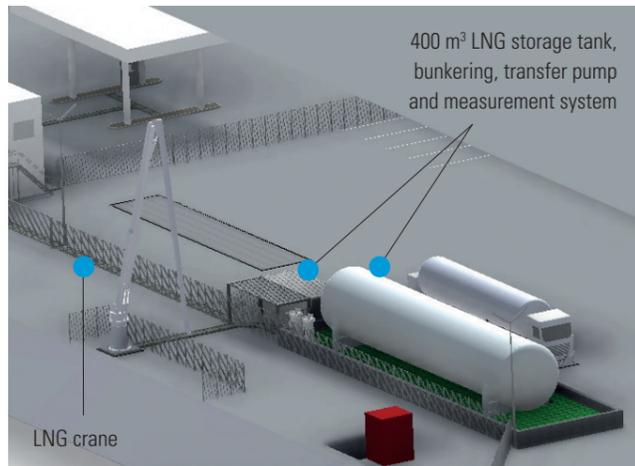
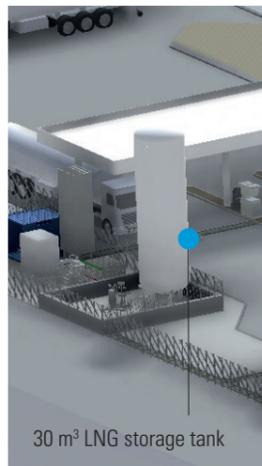
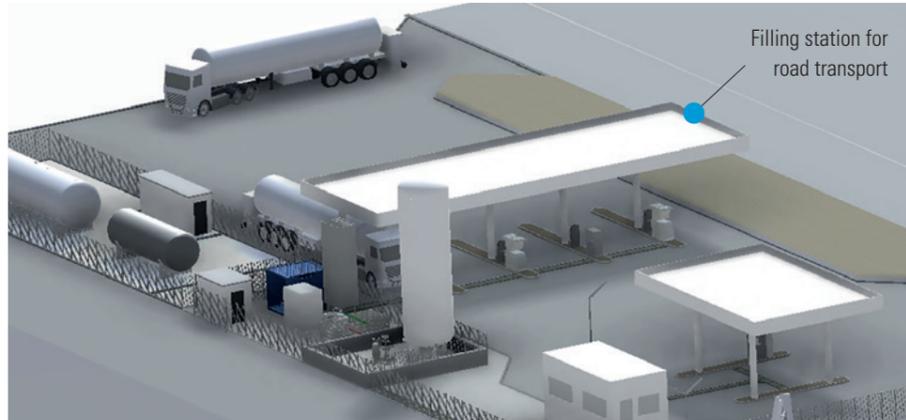
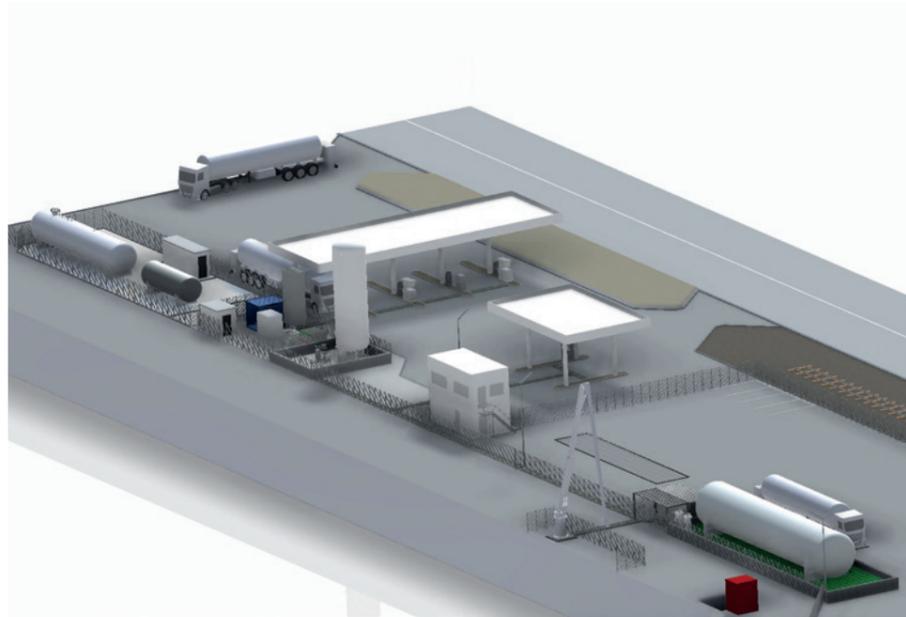
Y-piece, dry coupling



### Multi-fuel station:

A multi-fuel station allows you to service various types of customers ranging from the maritime sector through land transport and industrial customers.

- 400 m<sup>3</sup> and 30 m<sup>3</sup> LNG storage tanks
- LNG transfer pumps
- LNG measurement system
- LNG bunker system on the quay
- LNG and CNG filling station for road transport



160 m <sup>3</sup> /h	1	✓	+
✓	✓	✓	✓

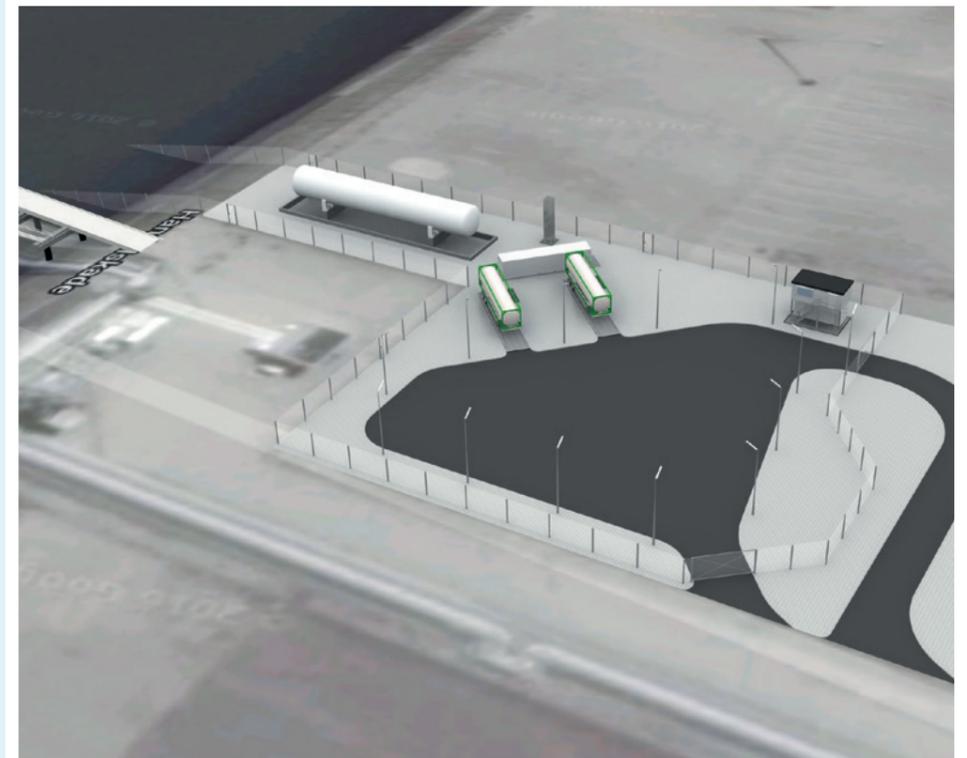
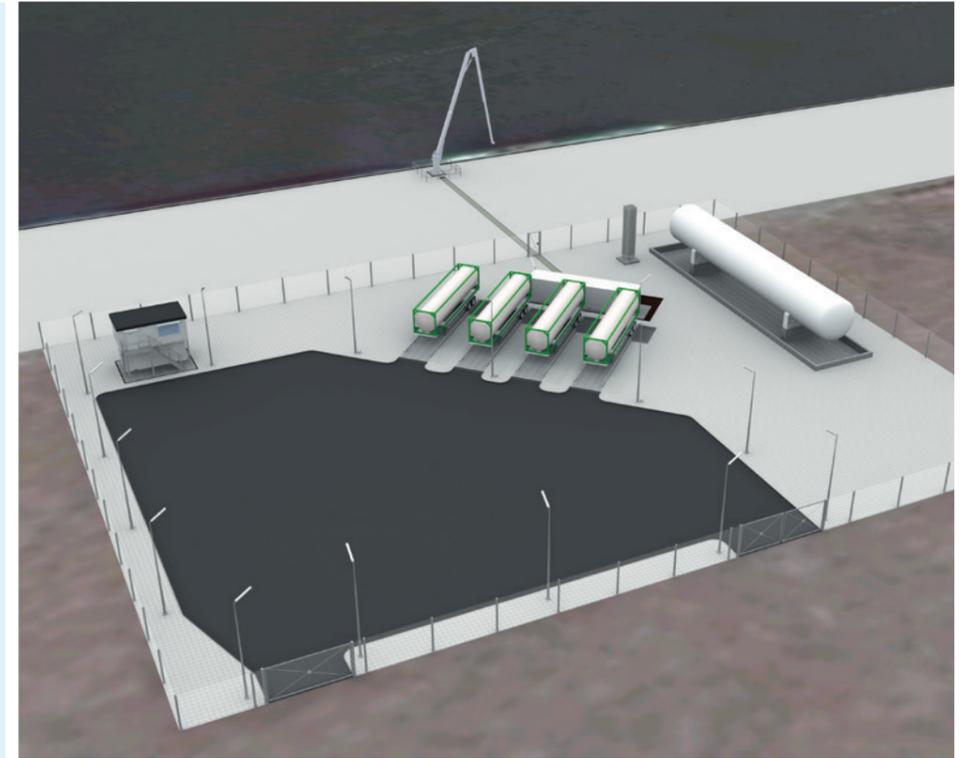
### Stationary storage tank with multiple trailers:

For situations when higher bunkering capacity is required, a fixed installation with an intermediate storage tank and additional trailers will provide the ideal flexibility. This solution will further allow setting up a bunkering installation without having to complete a full environmental impact assessment.

Here, the high-speed, multi-trailer solution is connected to a stationary tank. This way, ships can be bunkered either directly from a trailer or from the stationary tank. The trailer park positions are therefore used either as tank loading points or as bunker tanks. An independent PBU is available to assist the on-board tank trailer PBUs for higher flow. The bunker connection is a crane-assisted bunker hose.

- Bunkering directly from stationary storage tank or tank trailers
- Bunkering flow of 240 m<sup>3</sup>/h with three pumps
- Bunkering of 5-450 m<sup>3</sup> per bunker operation
- Can be equipped with PBU for fast bunkering (Optional)
- Ideal to achieve high flow and avoid EIA (Environmental Impact Assessment)
- Possible to increase capacity and flow rate in phases
- Zero-emission

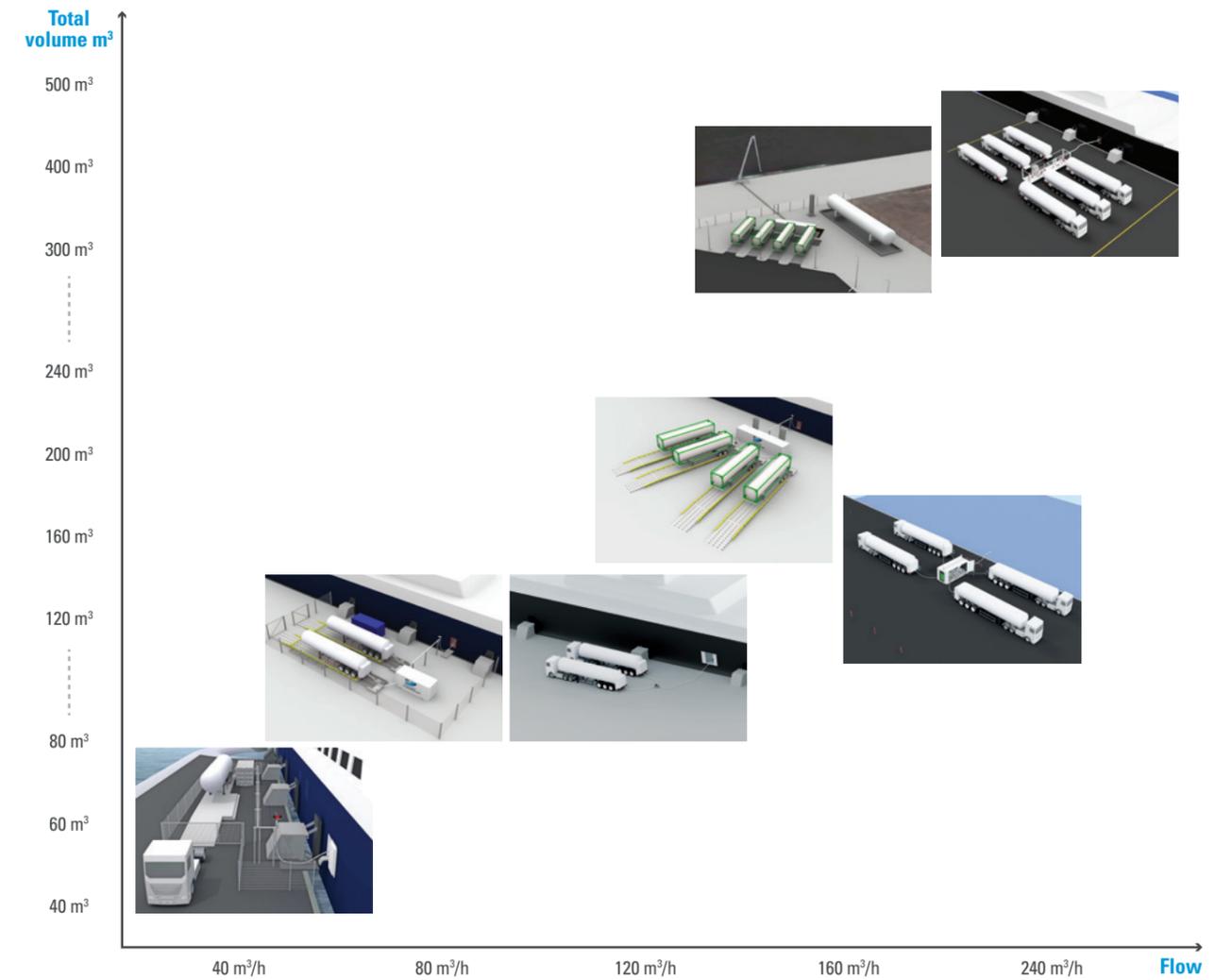
240 m <sup>3</sup> /h	4	✓	+
✓	✓	✓	✓



How many trailers do you want to use for your bunkering operation? Which features should your new system include? These are just a couple of the questions you have to ask yourself when deciding on what solution to go with. In the table below, you can compare KC LNG's different bunkering systems and decide which one best suits your requirements.

	Without pumps			With pumps	
	Y-Piece	Double Y-Piece	Manifold system	Pump unit	MTTS system
Max bunkering flow	120 m <sup>3</sup> /h	150 m <sup>3</sup> /h	240 m <sup>3</sup> /h	120 m <sup>3</sup> /h	240 m <sup>3</sup> /h
Scalability: no. of trailers	2	4	4	2	6
Interchangeable during bunkering	✓	✓	✓	✓	✓
Mobility	✓	✓	✓	—	✓
ESD Emergency shut down	—	—	✓	✓	✓
PBU Pressure build-up unit	—	—	—	✓	✓
Zero-emission	—	—	—	✓	✓
Fully automatic	—	—	—	✓	✓

Depending on the solution you are in the market for, Kosan Crisplant can supply bunkering systems that fit both your present and future demand. Based on the total volume of LNG and the required flow rate, we engineer tailored solutions for you or your clients.



# Small-scale LNG bunkering

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**KC LNG** is Kosan Crisplant's division under MAKEEN Energy dedicated to liquefied natural gas (LNG) solutions. We design, manufacture and deliver liquefaction, bunkering and refuelling solutions, e.g. facilities for both the production and transfer of LNG – a clean and highly cost-efficient fuel. Besides turnkey installations, we can assist you with service offers, after-sales packages, consultancy, engineering and facility management.

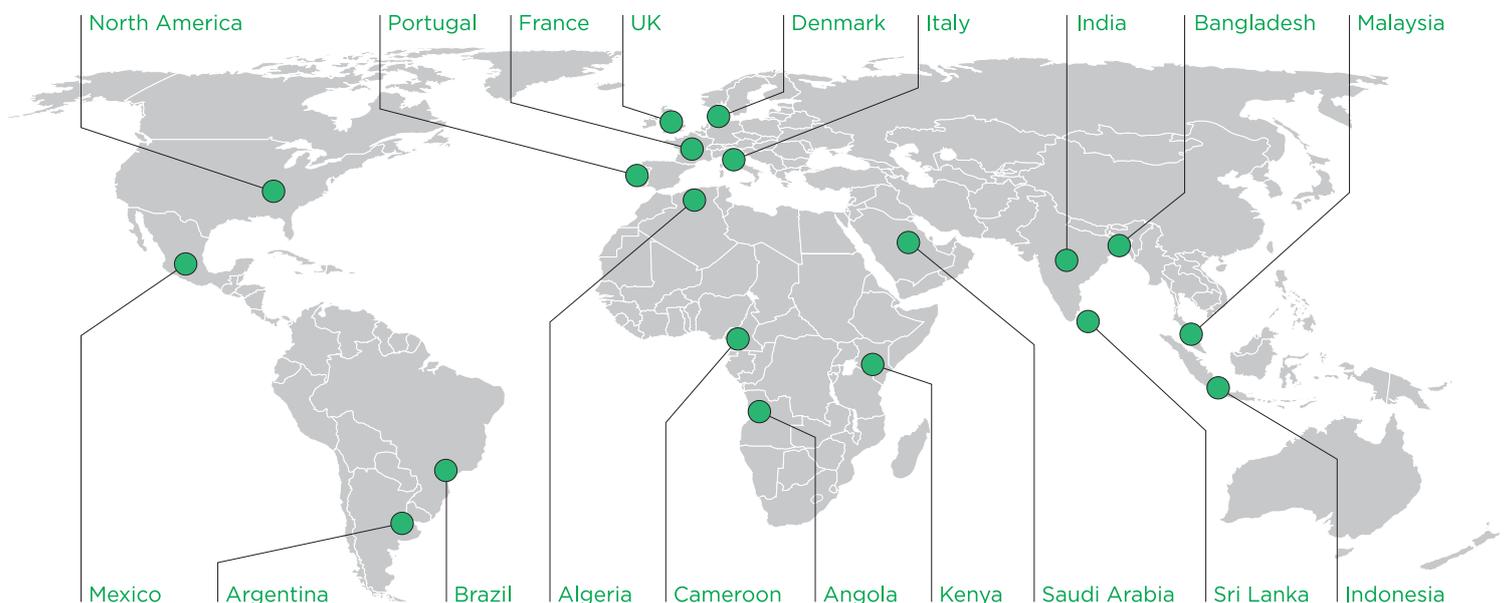
Scalability, zero-emission, automation and mobility are our four core principles which we focus on implementing in every solution. No matter what kind of solution or service we provide, we always make sure to tailor the product exactly to your needs.



**Kosan Crisplant** is a project-oriented corporation that supplies equipment, plants and services for filling and maintenance of LPG cylinders. Since 1951, we have delivered close to 3,000 LPG filling facilities to customers in more than 140 countries all over the world. Always with integrity, reliability and technological excellence.

## MAKEEN ENERGY

**MAKEEN Energy** is a global, market-leading corporation that delivers equipment, solutions and services to the energy industry. We employ approx. 1,000 people across 6 continents and operate in over 140 countries. With our global reach, local presence and decades of experience, we can deliver responsible solutions that make a difference to people and planet.



KC LNG is part of **MAKEEN Energy** – Responsible energy solutions for people and planet