

**#energy #efficiency #projects #EEXI #CII
#2021 #modern #shipyard #compliance**

13 CLIMATE ACTION



Energy Efficiency
in
vessels and assets

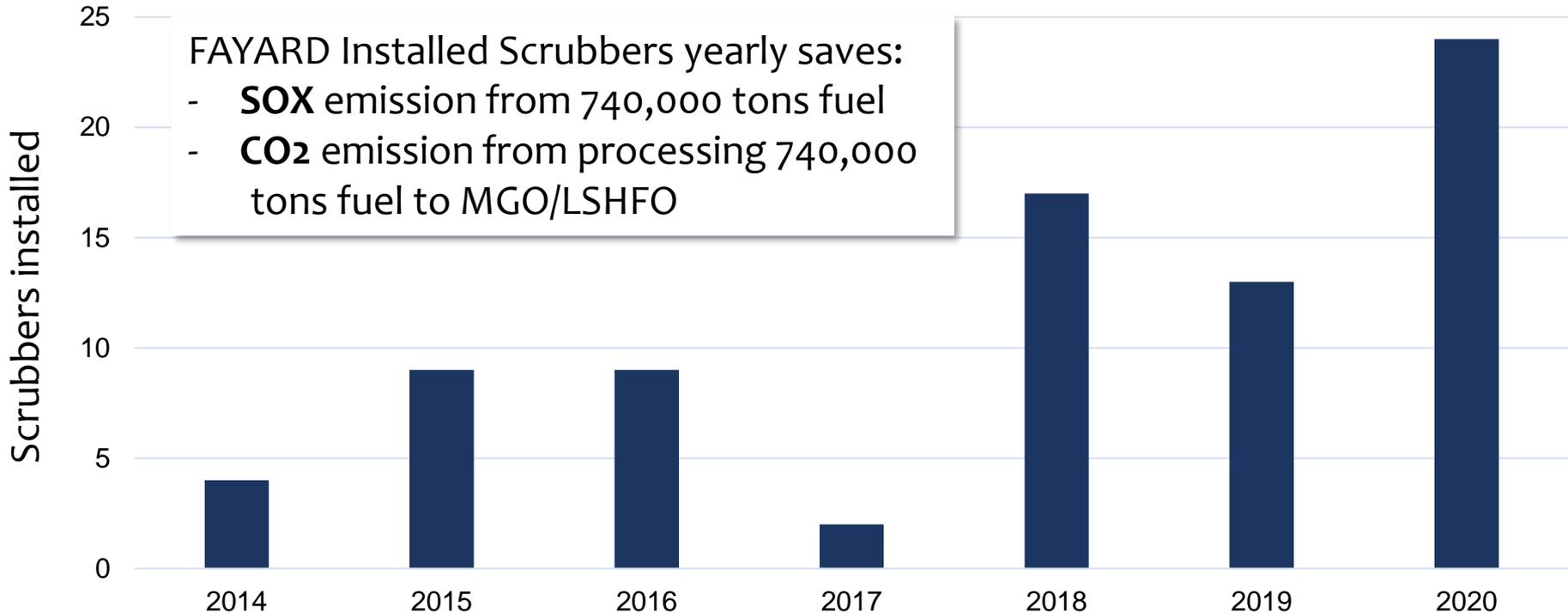
QUALITY
ON-TIME
ALWAYS

The BIG Picture



Emission to Air,

At FAYARD, SOX reducing Scrubbers have been installed for years
 - **What's next?**



This is Next!

Continuously lowering of the Emissions - on the road towards Zero Emissions.

01. January 2023:
Energy Efficiency eXisting Ship Index (EEXI).

$$\text{EEXI} = \frac{\text{Carbon factor} * \text{SFOC} * \text{Engine Power}}{\text{Vessel Capacity (DWT)} * \text{Reference Speed (Vref)}}$$

Carbon Intensity Indicator (CII) 2023 -> 2030 (IMO)

From 2023, the CII requirements will take effect for all Cargo, RoPax and Cruise vessels above 5,000 GT and trading internationally.

The CII measures how efficiently a vessel transports goods or passengers (grams of CO₂ emitted per cargo-carrying capacity and nautical mile).

The vessel is then given an annual rating ranging from A to E, whereby the rating thresholds will become increasingly stringent towards 2030.

While the EEXI is a one-time certification targeting design parameters, the CII addresses the actual emissions in operation.

Actions in vessels:

- Shaft Limitations (SHaPoli)
- Engine Power Limitations (EPL)
- Install Energy Saving Devices (ESD)
- Convert to Low Carbon Fuel
- Increase vessel capacity
- ...

LOWER EMISSION PROJECTS

-

ENERGY
EFFICIENCY
BY ALL MEANS

SELECTED CASE
STORIES



QUALITY
ON-TIME
ALWAYS

**LOWERING
EMISSIONS TO AIR
BY DUAL FUEL
SOLUTION**

Switching to dual fuel solution

FURETANK CARRIED OUT THE LNG CONVERSION OF FURE WEST AT FAYARD A/S.

Regarding the conversion of FURE WEST, Mr. Höglund, CEO of Furetank Rederi AB points out:

“It’s important to us as a company that we continue on the road towards no emissions, since 2011 FURE WEST has been certified as “Green Vessel” according to the CSI and adding to that we now will reduce CO₂, eliminate SO_x and PM and minimize NO_x when converting to LNG”.

Together with the engine maker MAK in Germany, supplier Pon Power in Denmark, Taylor-Wharton which manufactured the tanks and LNG fuel system in Slovakia and the fact that the work was carried out at FAYARD A/S in Munkebo Denmark, the Furetank Rederi AB project LNG CONV stays true to the wish from the Commission, to use European workmanship.

After the LNG conversion at FAYARD A/S, the FURE WEST trades in the Northern European ECA, employed by Furetank Chartering.



The Fure West conversion

Furetank is very satisfied with the performance of Fure West despite some bumps in the road.

In 2012 the engine manufacturer MaK - a part of the Caterpillar Group - had launched its new dual-fuel engine, the 46 DF that is a derivative of its existing 43 C engine with which it shares the same engine block design.

“As a shipping company, we are continually monitoring pending legislation and are always interested in emerging technologies and their impact on our operations. So we decided to apply for EU funding as part of the TEN-T program to ensure that we would be an early adopter, converting our vessels that have engines of this type to LNG fuel”, explains Lars Höglund, CEO of Furetank.

After consultations with MaK it was determined that Fure West was suitable for LNG conversion.

The project commenced under the auspices of the ZVT platform. Several technical challenges had to be resolved before the company was ready to commit to a firm conversion order in November 2014. The conversion process was slated

to be carried out at Fayard in Denmark the following year. The LNG system was to be supplied by Caterpillar.

Renovated engine

The main engine was converted by the manufacturer.

“Basically, everything apart from the engine block and crankshaft were affected by the rebuild. The cylinder diameter was increased from 430 mm to 460 mm which means that new cylinder linings, pistons, heads, exhaust receivers and turbos were needed. The entire control system had to be upgraded with additional sensors increasing the number of gauging points from 50 to around 900”, says Clas Gustafsson, CTO of Furetank.

The installed LNG fuel system included piping, a GUV (Gas Value Unit), the vent-system and the two deck-mounted LNG tanks.

“If something in the system fails, then fuel flow is automatically switched to diesel”, explains Clas Gustafsson.

“As LNG fuelling infrastructure is still in its infancy, we are not able to re-fuel everywhere which means that we have to be able to operate for 30 days at a time to ensure that we can secure continuous LNG propulsion”, Clas Gustafsson points out.

It was a matter of defining the correctly sized LNG tanks so that they would fit on deck without compromising any existing equipment already installed on the vessel. Prior to the LNG installation, the vessel’s stability and hull strength were analysed. The conversion was done without the need to repair the coating in the vessel’s cargo tanks which eliminated the need for any welding.

Delays

Classification and manufacture of the tanks took longer to complete than expected as the supplier was unable to deliver a complete package of components to the yard.

“The yard did a magnificent job, but with an incomplete delivery they were not able to finish work on time so we decided to return the vessel to the yard in April the following year to complete the conversion”, says Lars Höglund.

During this supplementary installation, which was carried out in April/May 2016, everything went according to plan. That is until the first LNG fuelling began. It emerged later that there was a minor but crucial flaw in the design of the LNG tanks.

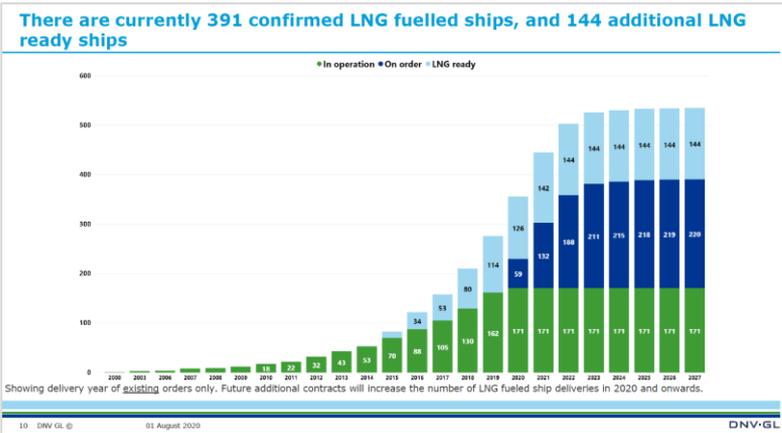
“As an early adopter of innovative technology, you expect these kinds of difficulties”, says Lars Höglund.

Fure West was docked once more at Fayard in the Autumn of 2016 when adjustments were made to her LNG tanks to ensure safe and reliable operation. In October of last year, Fure West was fuelled in Norway and began operations according to plan.

When she was first delivered in 2006 the tanker had a dwt of 15900 tons. Thanks to design margins, the vessel’s deadweight could be increased to 17200 tons.

Pär-Henrik Sjöström

LNG propelled vessels are already here - as well as the LNG carriers



@ FAYARD

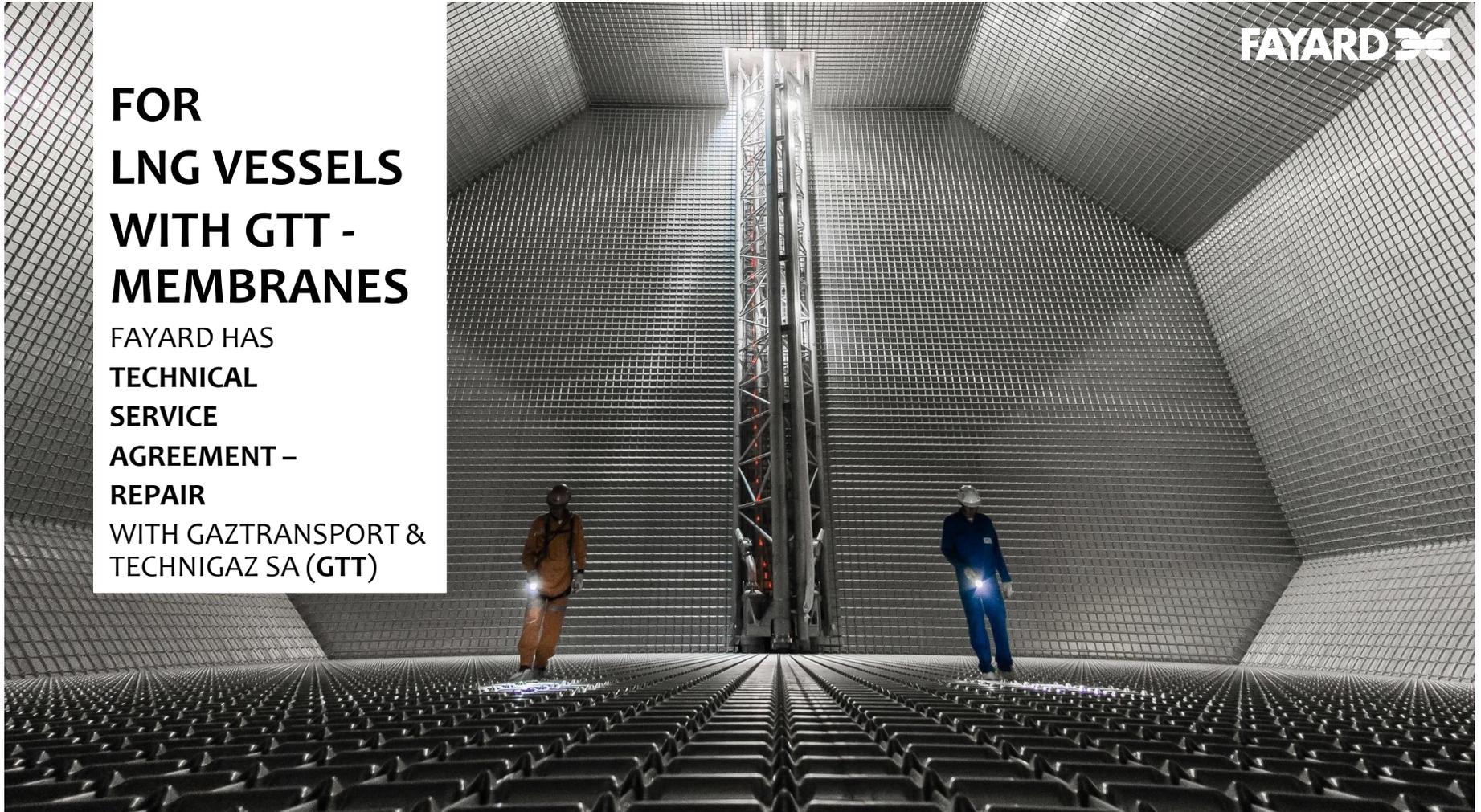
**LNG CARRIERS
SECURING THE
GLOBAL LNG-
INFRASTRUCTURE
ARE SERVICED AT
FAYARD**



FOR LNG VESSELS WITH GTT - MEMBRANES

FAYARD HAS
TECHNICAL
SERVICE
AGREEMENT –
REPAIR

WITH GAZTRANSPORT &
TECHNIGAZ SA (GTT)



**LOWER
NOX- EMISSIONS
BY
SELECTIVE
CATALYTIC
REDUCTION
SYSTEM**





Range of Installation for SCR system

1. SCR Reactors including NOx-reducing catalyst elements.
2. SCR Injection units with mixing element and boss for injector.
3. SCR Mixing pipes.
4. SCR Dosing Units, GMDS, Urea Tank, Urea membrane pump, Urea injector, field sensors, integrated PLC & NOx sensor.
5. SCR Soot blower system.
6. Electrical installation and integration.
7. Pipe work.
8. Foundation structures.
9. Insulation of renewed pipe system.

**LOWERING THE
VOLATILE
ORGANIC
COMPOUND
EMISSIONS**



Today Teekay shuttle tankers uses as supplement to the fuel

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



HYBRID Energy Storage Systems

for reducing emission to air

Selected Case Stories

QUALITY
ON-TIME
ALWAYS



© Scandlines / Claus Lillevang

Hybrid Energy systems

- Vessels are dependent on always having enough power for vessel operation in all terms
- When one single solution is not the right approach, the securing of the propulsion can be achieved combining more state-of-the-art solutions into one Hybrid Energy system
- At FAYARD we have teamed up with Owners in a wide range of system combinations to achieve the most suitable Hybrid Energy systems for specific vessels:
 - Emission hybrids
 - Fuel system hybrids
 - Power generation hybrids
 - Energy Storage Systems
 - And more to come



Electrical – Electrical Propulsion

HYBRID Options

- Diesel - Emission controlled by closed loop Scrubbers
- Diesel – Electrical - Emission controlled by closed loop Scrubbers
- Electrical – Electrical - Zero Emission from the propulsion

Scandlines is the first ferry operator in the world introducing a large scale hybrid system, which can store excess energy in batteries on board.

Scandlines' visions of sustainable ferry services go even further. The ambition of the green strategy is ultimately **zero emission**; that is, a propulsion system for the ferries without any emissions.

A key goal is to optimize the fuel consumption of the two new ships for Rostock-Gedser – and to comply with applicable environmental requirements.

This is done by Scandlines' award-winning hybrid propulsion system and by exhaust gas cleaning solutions (closed loop scrubbers), which reduce the Sulphur emissions by at least 90 percent and thereby comply with the 2020 standards for Sulphur limits.



Battery power a condition for vessel contracts

DOF CARRIED OUT THE HYBRID CONVERSION OF SKANDI MONGSTAD AT FAYARD

DOF's Skandi Mongstad went to FAYARD for conversion early 2018.

The conversion for battery hybrid operation is now required under contracts awarded by Equinor: All vessels to be equipped with hybrid battery operation, and the possibility of shore power connection. This will allow the vessel to reduce fuel consumption while working in dynamic positioning mode.

Equinor says, that with an ambition of being a leader in carbon-efficient oil and gas production, it is focusing on reducing emissions from its logistics activities. The contract requirement will allow to focus on optimizing our operations to continuously improve operation, safety and energy efficiency.

Hybrid propulsion that combines electric drives, diesel generators and batteries can make offshore vessels more fuel efficient, reducing fuel consumption, CO₂ emissions and enhancing the level of redundancy onboard.

Batteries also smooth the load by compensating for peaks and troughs, as well as enhancing safety and reliability by providing back-up in the event of blackouts.

The ability of battery-based Energy Storage Systems to provide peak shaving, power smoothing and power for dynamic positioning operations, features are especially applicable to OSVs.



Plug-in Hybrid

Color Line's "Color Hybrid"

– World Largest plug-in Hybrid Ship in operation from 2019

The ship has full battery operation in and out of the fjord to Sandefjord inner harbor. The ship therefore does not emit emissions to air from harmful environmental gases and the noise is significantly reduced. At 100 m distance to the ship, the noise corresponds to a normal conversation between two people.

Passengers	2000
Crew	100
Cars	500
Batteries (ESS)	5MW equal to app 60min maneuvering at 0-12 knots
Power generation	4 diesel electrical engines & Waste Heat Recovery System
Drives	2 CP propellers (16.8MW Mcr)

Onshore power plants for Shore Connections

The company has been a driving force in the establishment of onshore power plants in Norwegian ports. Oslo in October 2011. Kristiansand in 2014, Larvik in 2016, Sandefjord in 2017 and Kiel 2019

Total annual CO₂ emissions are reduced by about 8 000 tons CO₂. In addition, the local environment is saved for large point emissions of NO_x, SO_x and particulate matter, as well as a significant reduction in noise when the ships are docked.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



Energy Saving Devices (ESD)

**Innovative Solutions &
Incrementally Improvements**

for reducing emission to air by less consumption

**QUALITY
ON-TIME
ALWAYS**

**LOWER
EMISSIONS
OPTIMIZING THE
HULL FRICTION
AND THE
HYDRODYNAMICS**



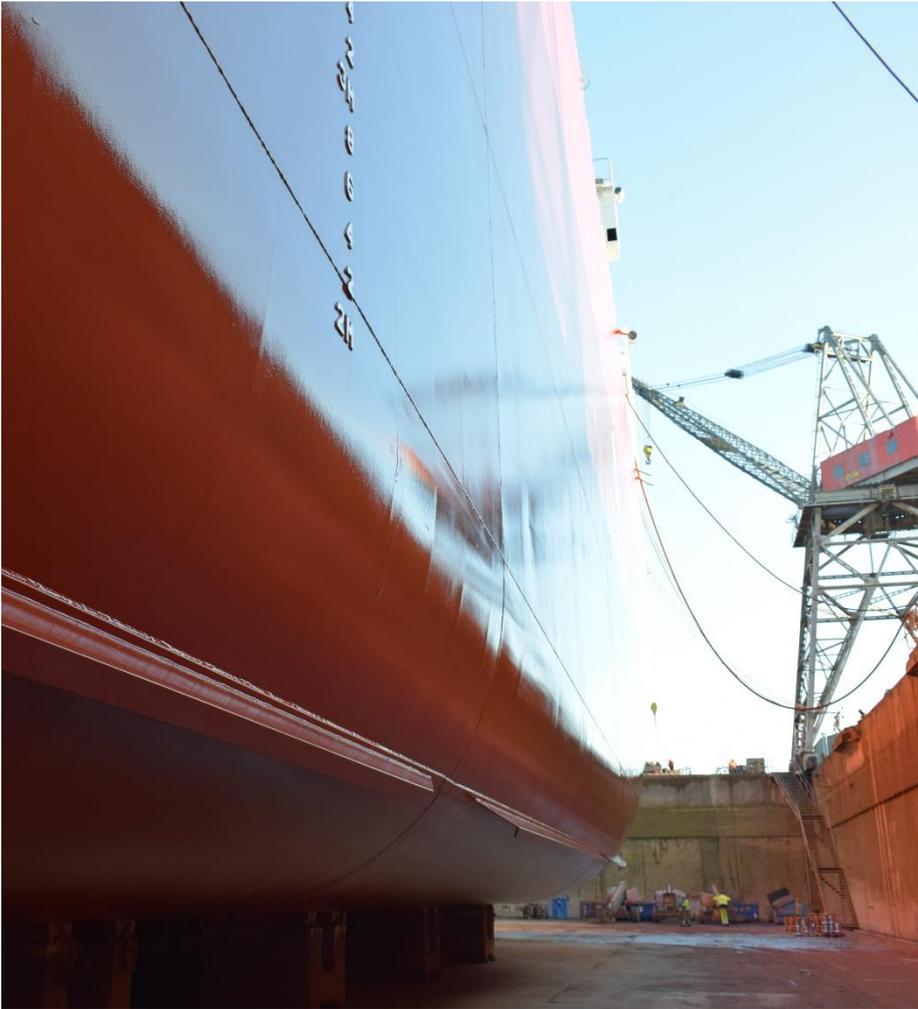
FRWST T BN

T

T

C/D

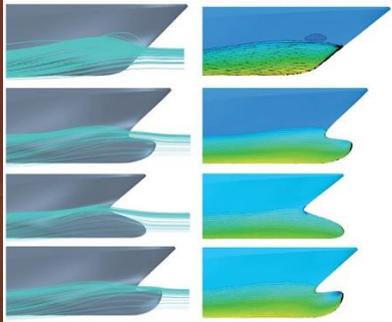
STC



Silicone Antifouling

- Reducing resistance on the hull creates significant savings of fuel
- FAYARD meets the higher applying demands this paint system requires:
 - Special equipment needed, including heated sprayers
 - Special processes needed with high level of documentation and accuracy
- Latests projects are made with Hempadur X7

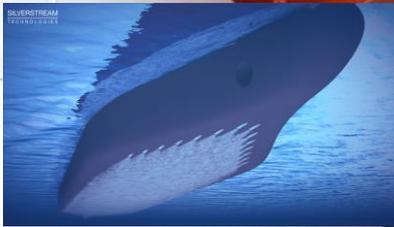
**LOWER
EMISSIONS
BY HYDRO-
DYNAMIC
OPTIMIZATION**



**LOWER
EMISSIONS
BY HYDRO-
DYNAMIC
OPTIMIZATION**



**LOWER
EMISSIONS
BY
AIR
LUBRICATION
SYSTEM**



LOWER EMISSIONS BY CHANGING THE PROPELLERS. THESE SHINY BLADES WILL LOWER THE FUEL CONSUMPTION AND EMISSIONS.



**JUMBOIZATION:
IMPROVING
THE PROFIT-
ABILITY, EEXI &
CII BY
LENGTHENING**



**LOWER
EMISSIONS BY
CONTROLLING OF
CONSUMERS**



Flow Control

- Controlling of e.g. cooling pumps / ventilation fans' speed etc. using e.g. actual monitored temperatures can be a significant contribution to lowering the power consumption onboard and significant savings of fuel.
- Wear and tear is lower.
- FAYARD has installed several solutions for this purpose, all having a short return on investment for the Owner, and at FAYARD, we use flow control ourselves in our Dry Docks for filling and emptying.
- Saving potential is related to specific vessel and its major operational area.
- Roughly the average saving potential is app. 300t CO₂ per vessel per year.

LOWER
EMISSIONS
USING
WIND
ASSISTED
SHIP
PROPULSION





NEW MARITIME COOLING TECHNOLOGY

Patented Cooling Technology, driven by waste heat from the ship's main and auxiliary engines, reduces onboard electricity production, consumption and related emissions.

- Technology: Absorption Cooling
- Refrigerant: WATER
- Savings Potential: 90%+
- Reduces: Fuel consumption and CO₂/NO_x emissions

Scandlines' *Prinsesse Benedicte* has the [COOL4SEA](#) cooling solution in use since 2017.

[COOL4SEA](#)'s patented cooling technology utilizes the ship's waste heat for cooling e.g., the crew quarters, service areas, batteries (ESS) etc.

The cooling system is based on absorption cooling and developed specifically for use on ships.

By recycling the ship's thermal waste energy and utilizing it for heat-driven cooling, the ship's amount of fuel-generated electricity used for cooling can be reduced by over 90%.

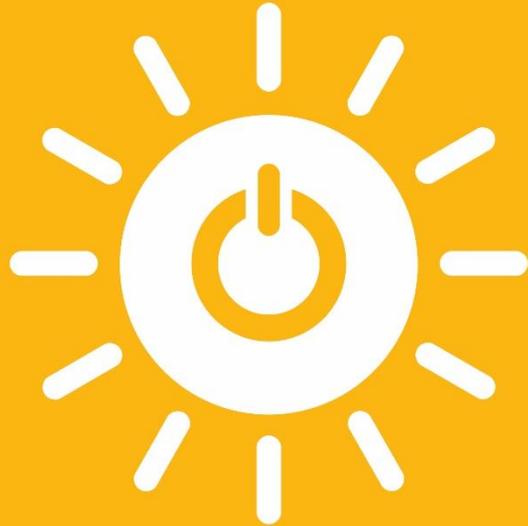
The design has high adaptability, with a flexible construction that can be adapted to the conditions of the individual ship. The system is modular and can be carried on board the ship, through the ship's hatches, and installed while the vessel is in operation or at during a yard stay.

The only essential requirement is simply that the technology's key processes can be connected to three external process circuits.

The choice of materials and the minimal use of moving parts give the system high operating reliability and long operational life.

<h1 style="margin: 0;">FUEL</h1>	<h1 style="margin: 0;">CO₂</h1>	<h1 style="margin: 0;">HFC</h1>	<h1 style="margin: 0;">24/7</h1>
<p>FUEL SAVING</p> <p>COOL4SEA'S COOLING TECHNOLOGY IS DRIVEN BY WASTE HEAT FROM THE SHIP'S MAIN AND AUXILIARY ENGINES. THERE IS NO NEED FOR EXPENSIVE, FUEL-GENERATED ELECTRICITY FOR COOLING.</p>	<p>LESS EMISSIONS</p> <p>A REDUCED ENERGY REQUIREMENT THROUGH ENERGY OPTIMIZATION PROVIDES A LOWER FUEL CONSUMPTION, WHICH RESULTS IN REDUCED EMISSIONS OF CO₂ AND HAZARDOUS PARTICLES.</p>	<p>NO HFC GASES</p> <p>THE COOLING TECHNOLOGY DOES NOT NEED ENVIRONMENTALLY DAMAGING COOLANT GASES, USING ONLY WATER AS A REFRIGERANT, WHICH IS BOTH AN ECONOMIC AND ENVIRONMENTAL BENEFIT.</p>	<p>OPTIMAL OPERATION</p> <p>THE COOLING ARISES AS A RESULT OF A SERIES OF KEY PROCESSES. TO ENSURE HIGH EFFICIENCY, THE PROCESS CHAIN MUST BE OPTIONAL. THEREFORE, OPERATION OF THE COOLING TECHNOLOGY IS REMOTELY MONITORED 24/7.</p>

7 AFFORDABLE AND CLEAN ENERGY



Green shore connection

Reducing emissions to air when in Port, at lay-up and at FAYARD.

“COLD IRONING” made possible by FAYARD

QUALITY
ON-TIME
ALWAYS



Innovative Green Energy

- **Green Energy solution at FAYARD**
FAYARD have 6 mobile shore connecting power supply systems 300A/690V, 500A/440V & 1500A/440V with Vacon AC drives to provide electricity from the national grid to the app 130 vessels and platforms, yearly in doc at FAYARD or in port.
- The solution can supply the required voltage and the required frequency.

The green solution has many advantages:

- Proven Technology – has been in operation since 2009.
- Low exhaust emissions, great flexibility.
- Power, voltage and frequency,
- Lower costs of operation and less noise.
- The Green Energy Shore Connections are incorporated in FAYARD's ISO14001:2015 certification.

How FAYARD handles Energy Efficiency projects

...efficiently!

**QUALITY
ON-TIME
ALWAYS**



FAYARD 

EPIC

QUALITY
ON-TIME
ALWAYS

FAYARD's special focus on adapting to your requirements means that we are able to take on any roles that you would like us to.

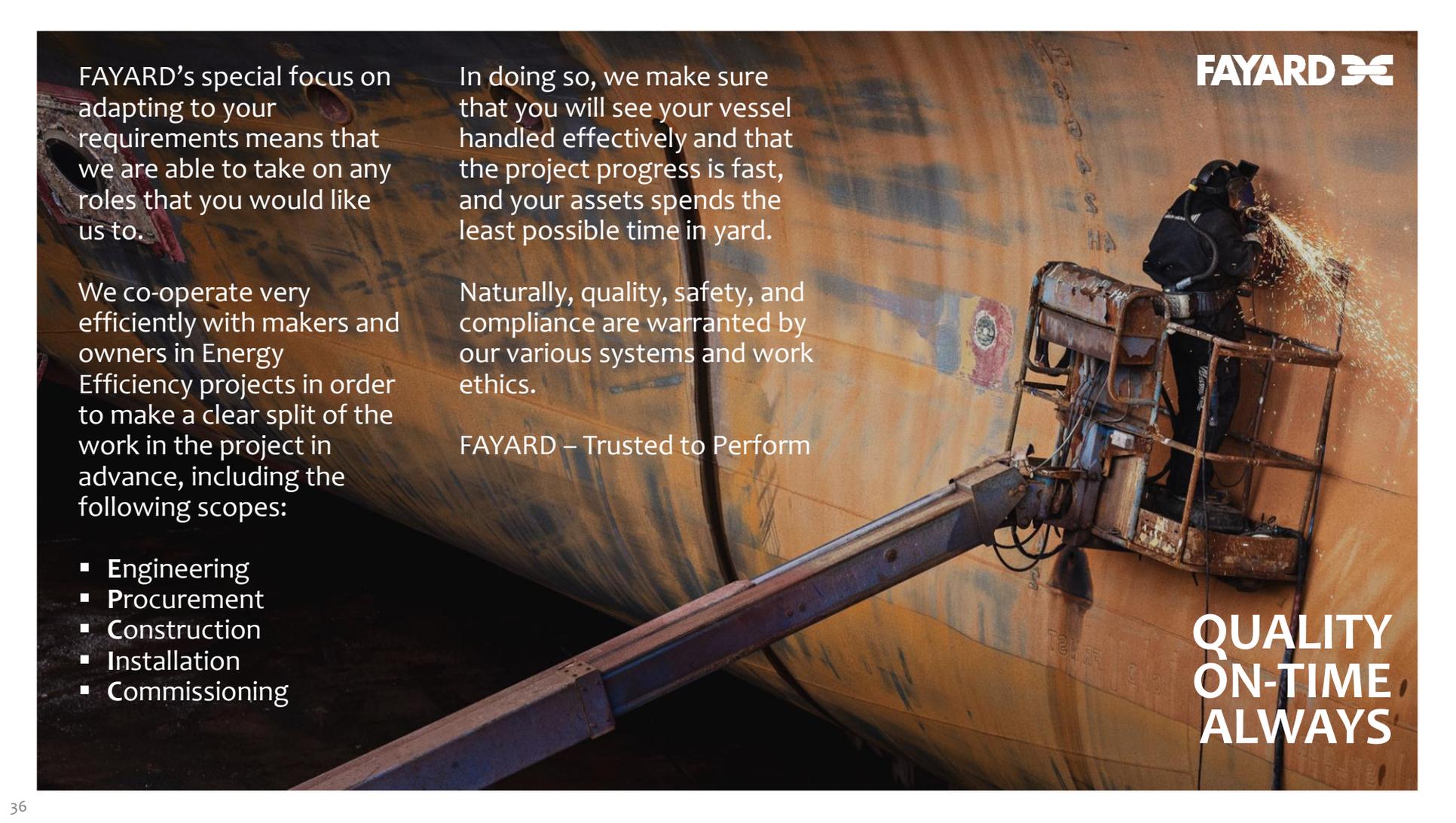
We co-operate very efficiently with makers and owners in Energy Efficiency projects in order to make a clear split of the work in the project in advance, including the following scopes:

- Engineering
- Procurement
- Construction
- Installation
- Commissioning

In doing so, we make sure that you will see your vessel handled effectively and that the project progress is fast, and your assets spends the least possible time in yard.

Naturally, quality, safety, and compliance are warranted by our various systems and work ethics.

FAYARD – Trusted to Perform

A worker in a dark uniform and safety gear is positioned on a scissor lift, working on the exterior of a large, rusted metal vessel. The worker is using a tool that produces a bright, orange spark, likely grinding or welding. The vessel's surface is heavily textured with rust and some blue markings. The background is dark, suggesting an industrial setting.

QUALITY
ON-TIME
ALWAYS

Turnkey Solution or Individual Contracts?

OWNER

System

Installation

Teaming Up

MAKER

FAYARD

Installation: Yard, Alongside or During Voyage?

EPCiC
System

epCIC
Interface Vessel





ENVIRONMENT

Making Global Goals Local Business

- We are fully committed to conducting our activities in an environmentally responsible manner. In our attempt to run a yard that is as environmentally friendly as possible we have amongst others
- Dry Docks are environmentally Closed Loop systems
- Hull Cleaning by Water Jetting as standard
- Shore Power availability reduces vessel emissions
- Tank Washing Water Receive System (Slop)
- Vessels in Inerted condition allowed
- Lower VOC Emission to air than allowed quota
- Waste Management System in operation
- All Chemicals are stores in Secured areas
- Recycling of scrap materials availability
- LED-bulbs where applicable
- EU-approved Ship-recycling facilities



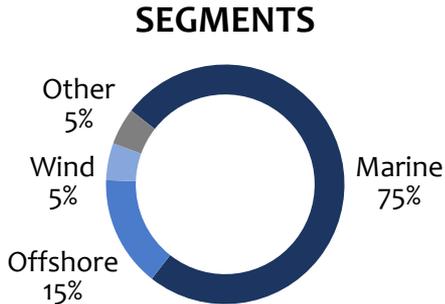
FAYARD IN NUMBERS



AVG. UNITS PER YEAR

130

AVG. DOCK UTILIZATION



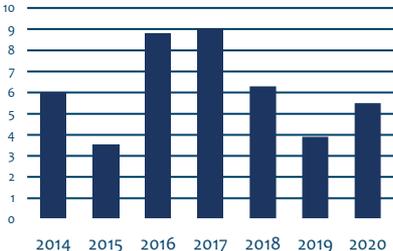
DELIVERED ON-TIME

100%

PART OF TURNOVER FROM RETURNING CUSTOMERS

86%

OSHA TRIR
(the 200,000 hrs benchmark)



AVERAGE WORKING HOURS PER YEAR



DOCK AVAILABILITY

100%

Quality
On time
Always



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