FAYARD

NAVIGATING A ROUTE TO NET ZERO

Energy efficiency first - then new zero-carbon fuels

#energy #efficiency #projects

#EEXI

#CII

#2024 #modern #shipyard

#RealAction

QUALITY
ON-TIME
ALWAYS

For Your Inspiration,
please find here a collection of
Energy Saving Initiatives

www.fayard.dk

Climate change is one of the biggest sustainability challenges of our time.

At FAYARD we have a strong focus on supporting customers regarding the CII and the EEXI improvements, and in optimizing the ships in operations by incremental retrofits.
We are thrilled to work together and to help our customers become more efficient while reducing the vessels' environmental footprint.

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The BIG Picture

EEDI, EEXI, CII, SEEMP III is Now!

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

Energy **E**fficiency e**X**isting ship **I**ndex (**EEXI**)
for vessels above 400GT trading internationally.

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

Carbon **I**ntensity **I**ndicator (**CII**) **2023 -> 2030** (IMO)
The **CII** requirements is in force for **all** Cargo, RoPax and Cruise vessels above 5,000 GT and trading internationally. The Carbon Intensity Indicator (CII) is a measure of how efficiently a ship can transport goods or passengers and is given in grams of CO_2 emitted per cargo-carrying capacity and nautical mile, based on reported IMO DCS data.

$$\textbf{CII} = \frac{\text{Annual Fuel Consumption} * CO_2\ \text{Factor} * \text{Correction Factors}}{\text{Annual Distance Travelled} * \text{DWT or GT}}$$

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

IMO's target for **2026** is a **11% reduction** of vessels' CO_2 emission

Actions:
- Shaft Limitations
- Engine Power Limitations
- Install Energy Saving Devices
- Convert to Low Carbon Fuel
- Increase vessel capacity
- …

FAYARD

Energy Saving Devices (ESD)

Innovative Solutions & Incrementally Improvements

for reducing emission to air by less consumption

Find the right solution to stay compliant and efficient.

Our examples on the following pages are

- available to all
- have low OPEX
- fast to implement

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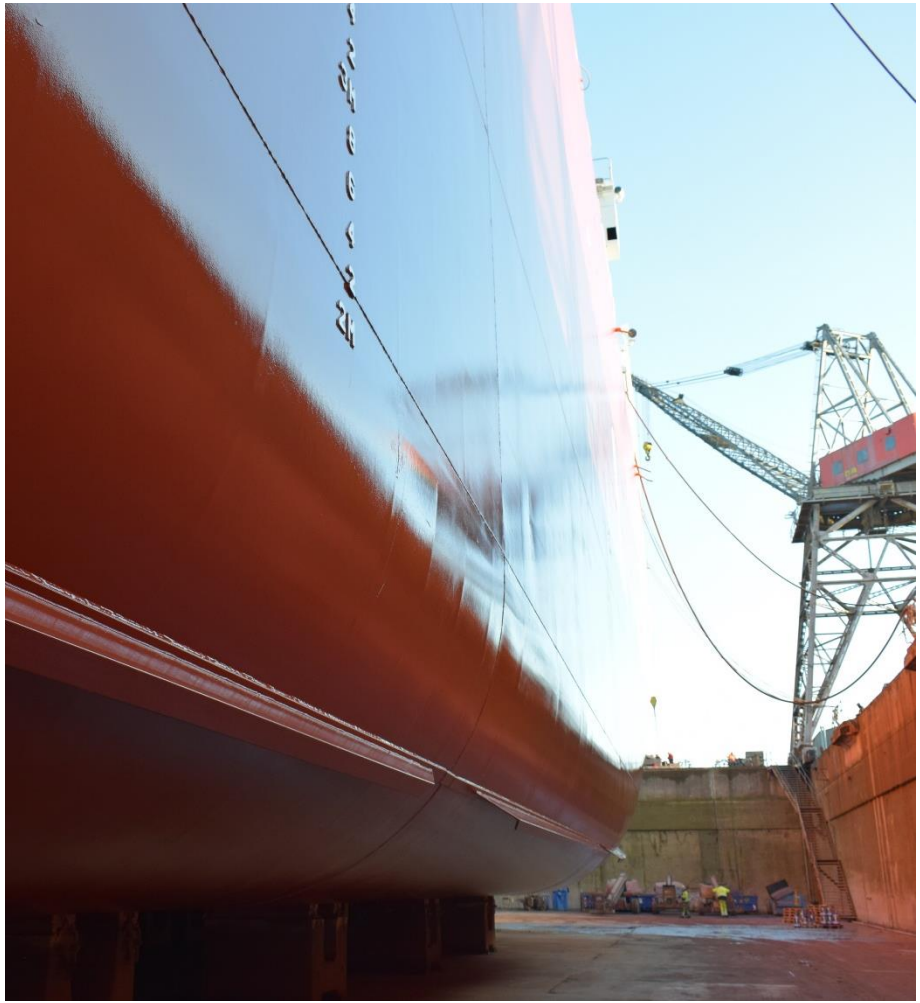
REDUCE EMISSIONS OPTIMIZING THE HULL FRICTION AND THE HYDRODYNAMICS



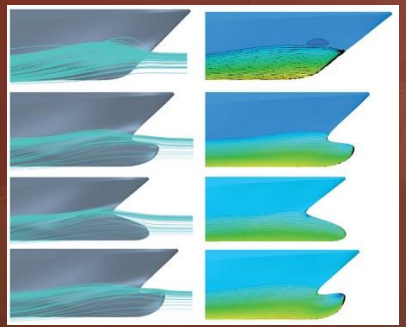
Silicone Antifouling

- 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 & X8

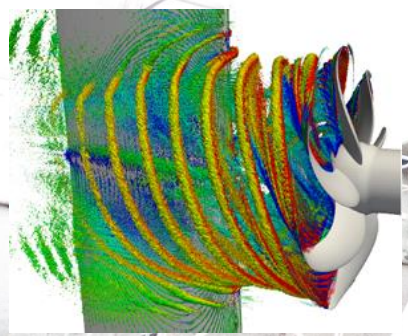
Clean Hull = Less Emission

FACILITIES AVAILABLE FOR APPLYING SILICONE-ANTIFOULING THROUGHOUT THE YEAR

REDUCE EMISSIONS BY HYDRO-DYNAMIC OPTIMIZATION



REDUCE EMISSIONS BY HYDRO-DYNAMIC OPTIMIZATION



REDUCING EMISSIONS BY CHANGING THE PROPELLERS.
THE RIGHT, AND CLEAN, PROPELLERS CAN LOWER THE ANNUAL FUEL CONSUMPTION BY THOUSANDS OF TONNES FUEL.

REDUCE EMISSIONS BY

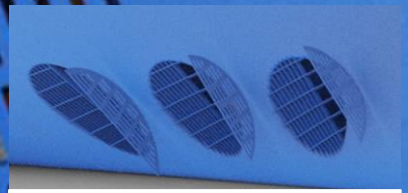
CHANGING THE PROPELLERS. THESE SHINY BLADES WILL LOWER THE FUEL CONSUMPTION AND EMISSIONS.

REDUCE EMISSIONS BY AIR LUBRICATION SYSTEM

REDUCE EMISSIONS BY HYDRO-DYNAMIC OPTIMIZATION: *ELOGRIDS*

Reduces fuel consumption about 2 %, which leads to about 0.5 t of fuel saved per day equal to app. 1 .5 t less CO_2 emissions per day per ferry.
Viking Line / ELOMATIC

REDUCE EMISSIONS BY SUPPRESSING THRUSTER TUNNEL DRAG. ONE EXAMPLE:



DNV AND FINCANTIERI ARE DEVELOPING A HYDRODYNAMICALLY EFFECTIVE SOLUTION NOW AVAILABLE FOR THE MARKET.

FINCANTIERI'S PATENT-PENDING SOLUTION CONSISTS OF A SPECIALLY DESIGNED GRID AND A HINGED, SLOTTED DEFLECTOR COVERING THE FORWARD PORTION OF THE TUNNEL.

Link: Suppressing thruster tunnel drag to conserve energy (dnv.com)

REDUCING OVERALL EMISSIONS BY COMBINED UPGRADES:

INCREASED CONTAINER CAPACITY & CHANGE OF PROPELLER

VESSEL'S OVERALL EMISSIONS REDUCED: INCREASED CONTAINER CAPACITY & EVEN MORE EFFICIENT PROPELLER

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

REDUCE EMISSIONS BY RECOVERY OF HEAT IN THE EXHAUST

From waste heat to added value
Retrofitting the onboard boiler solution with boiler technology that recovers waste heat from the main and auxiliary engines offers an emission reduction potential.
Potential is reductions up to 14% on energy use and carbon emissions
(Source: Alfa Laval)

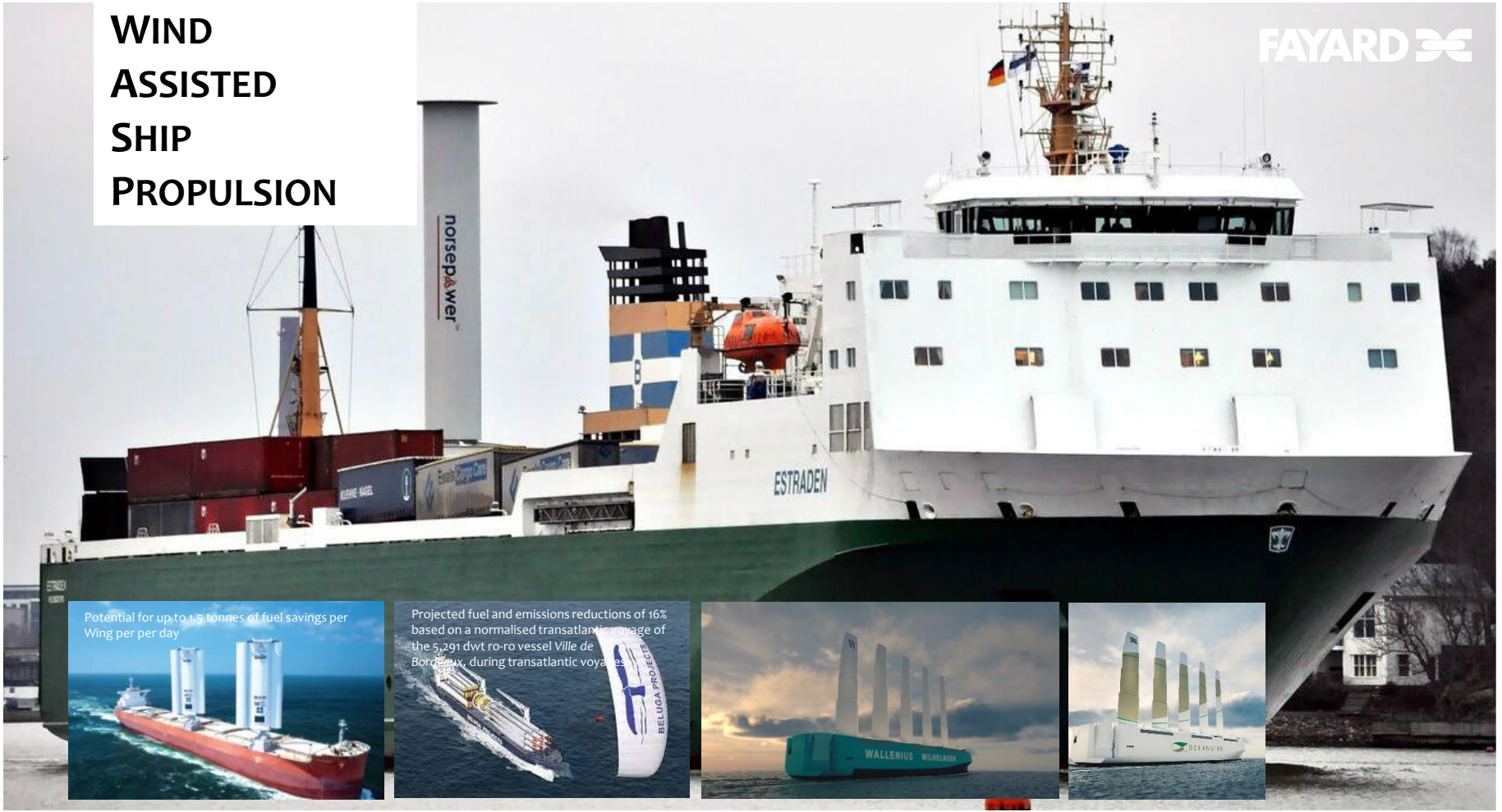
Control of rotating equipment

- Controlling of e.g. cooling pumps / ventilation fans' speed etc. using e.g. actual monitored temperatures, pressure, torque, volume or ...
- Actual demand operation versus on/off approach
- Less Fuel consumption causes less GHG.
- Less Wear and tear.
- Less noise onboard.
- 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 CO_2 per vessel per year.

LED Lights

- Replacing the lights onboard with low energy consumers as e.g., LED lamps not reduces the power consumption reflecting lower GHG emissions
- LED lamps also reflect lower heat generation and by such reduces the HVAC requirement.
- Relevant for especially Cruise, Ferries, PCTC vehichles carriers, RoRo vessels etc.

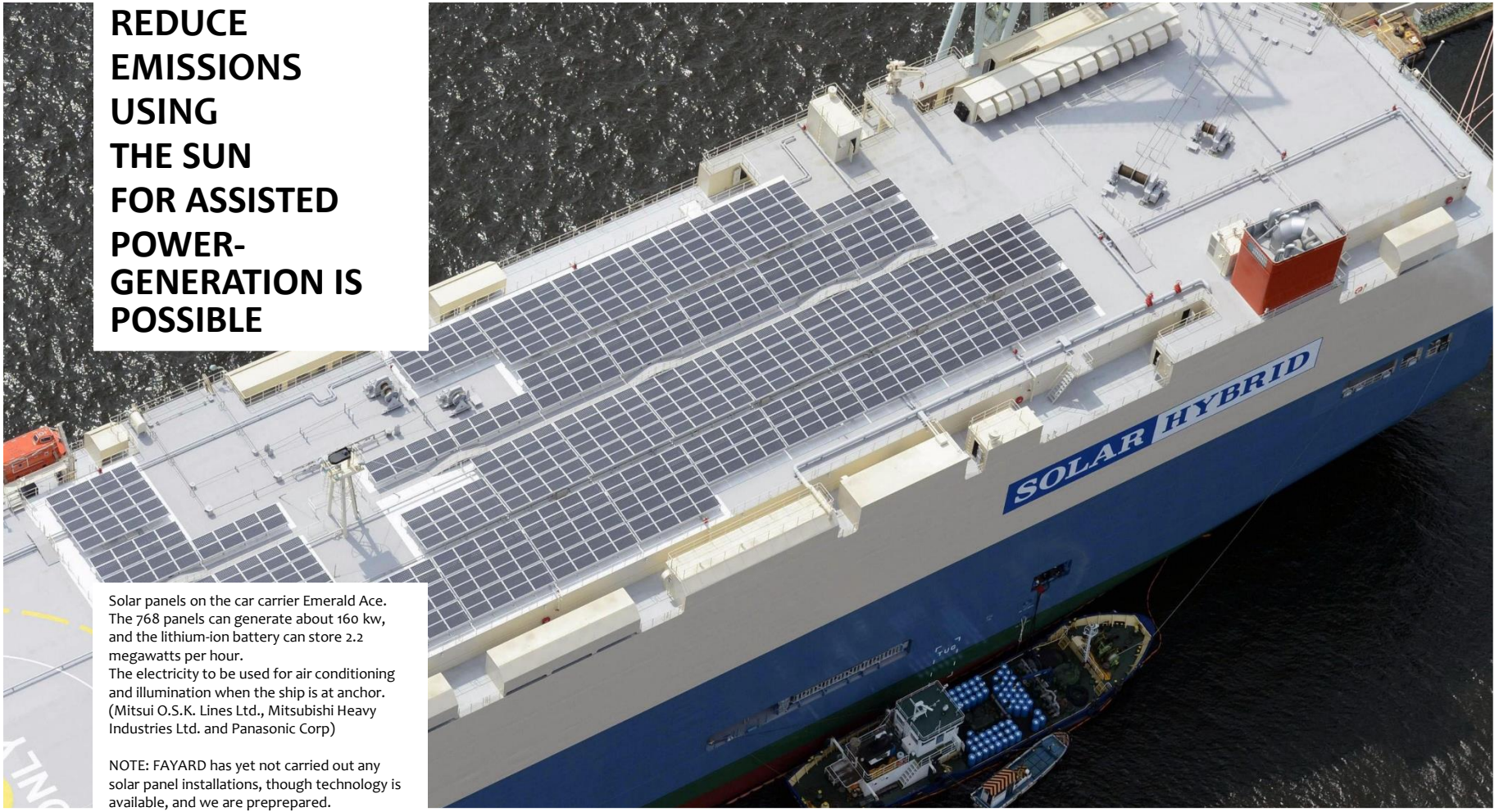
WIND ASSISTED SHIP PROPULSION



Potential for up to 1.5 tonnes of fuel savings per Wing per per day

Projected fuel and emissions reductions of 16% based on a normalised transatlantic voyage of the 5,291 dwt ro-ro vessel *Ville de Bordeaux*, during transatlantic voyages

REDUCE EMISSIONS USING THE SUN FOR ASSISTED POWER-GENERATION IS POSSIBLE



Solar panels on the car carrier Emerald Ace. The 768 panels can generate about 160 kw, and the lithium-ion battery can store 2.2 megawatts per hour.
The electricity to be used for air conditioning and illumination when the ship is at anchor. (Mitsui O.S.K. Lines Ltd., Mitsubishi Heavy Industries Ltd. and Panasonic Corp)

NOTE: FAYARD has yet not carried out any solar panel installations, though technology is available, and we are preprepared.

FAYARD

HYBRID
Energy Storage Systems

for reducing emission to air

Selected Case Stories

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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

Parallel Hybrid Transmission

- The Northern Offshore Service's Bunkering Tanker is dependent on always having enough power for vessel operation in all terms
- Also, the vessels are required to be compliant to various port restrictions for emission as well as a Owner driven dedication to lowering the overall fleet footprint.
- At FAYARD we have installed Northern Offshore Services' newest hybrid solution:
  Parallel Hybrid Transmission (PHT). The PHT-solution consists amongst others of:
  - Esco Power PHT module installed between the diesel engine and the gearbox
  - Esco Power Hybrid Electrical Solution Package (HESP). HESP consisting of efficient electric motors and generators, electronic control and command system, control levers, screens, and software to benefit from various operation;
    propulsion modes: diesel – electric – automatic and additional modes as: generator–back up–cross feed.
  - ZEM Battery system
  - ZEM Charging system
  - Step up/down transformer

Hybrid Energy systems

- The Northern Offshore Service Vessels are dependent on always having enough power for vessel operation in all terms
- Also, the vessels are required to be compliant to various port restrictions for emission
- At FAYARD we have assisted Northern Offshore Services for upgrading the vessels to HYBRID operation, Diesel and/or Electrical propulsion made possible.
- 4 x Volvo Penta D13-700 DST (Tier 3) engines
- 4 x Volvo Penta IPS900 Q2 props
- ESS made ready for to allow charging by shore power for emission free sailing

Plug-in Hybrid

Color Line's "Color Hybrid"
– World Largest plug-in Hybrid Ship in operation from 2019

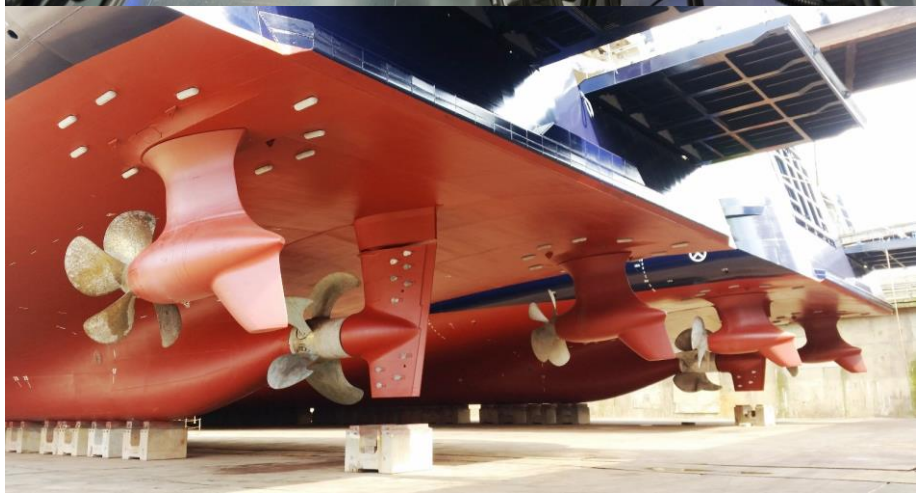
The ship has full battery operation in and out of the fjord to Sandefjord inner harbor. The ship therefore does not emit emissions to air from harmful environmental gases and
the noise is significantly reduced. At 100 m distance to the ship, the noise corresponds to a normal conversation between two 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 CO_2 emissions are reduced by about 8 000 tons CO_2. In addition, the local environment is saved for large point emissions of NOx, SOx and particulate matter, as well as a significant reduction in noise when the ships are docked.



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, CO_2 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.

SHORE TO SHIP POWER

Alternative Marine Power (AMP):

FAYARD's SHORE CONNECTIONs

Reducing emissions to air when in Port, at lay-up and when at FAYARD.
In 2022 59.3% of the electrical power in Denmark was generated from the Wind and the Sun.

AMP made possible by FAYARD's solution

QUALITY
ON-TIME
ALWAYS

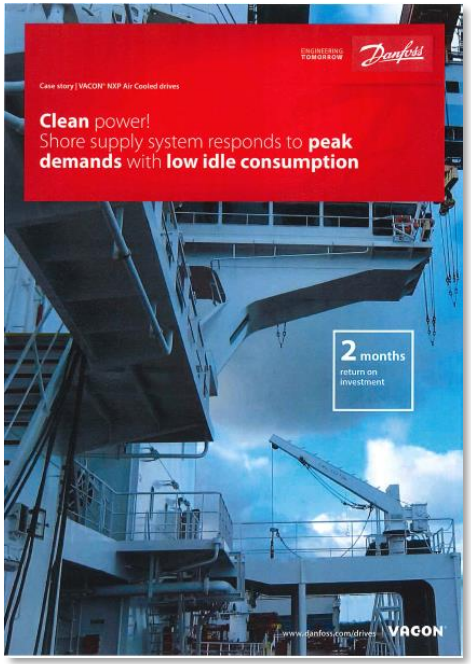
ALTERNATIVE MARINE POWER (AMP):

LOWER THE VESSEL'S EMISSION USING SHORE TO SHIP POWER WHEN IN PORT.

Innovative SHORE TO SHIP POWER – AMP

Most vessels have shore connecting equipment allowing power supply from ashore when in port or yard.
For the onshore supply of power to the vessel, FAYARD and Danfoss have developed the **"Clean Power"** shore supply system.
At FAYARD we naturally use the solution having 10 systems in use
2022: 59.3% of Provided electricity was generated in Denmark from the Wind and the Sun.

We sell, rent, lease the solution to Ports and Owners in need for the right Shore to Ship interface between the domestic onshore power grit and the vessel.



Solving the shore supply challenge
When in dock, ships rely on shore power supply. The load on a ship is not stable, and is characterized by many peaks, presenting a major efficiency challenge. Supplying enough power to meet these peak demands, while simultaneously ensuring low baseline power consumption, is a difficult balance to achieve. Normally it requires a large reserve supply.

The solution for FAYARD A/S shipyard in Denmark was to convert from a diesel-generator based to an electric shore supply system using VACON® NXP Air Cooled drives.

Before: Costly to run
FAYARD A/S is a modern repair yard with four dry docks up to 415 m in length and 90 m breadth. Here all types of maritime vessels can be repaired, maintained and upgraded.

Before 2010, when ships were in dock the electrical shore power supply was supplied by rotating converters. This equipment converted the 50 Hz shore power to the 60 Hz grid on board the ship. Unfortunately they were costly to run, since the rotating converters typically had a stand-by consumption of 1000 kWh per day due to mechanical and electrical losses.

For larger ships, the power was supplied by portable diesel generator sets which were leased for each project. The diesel gensets typically consumed 800 litres of fuel per day. Efficiency was also very poor since the generators ran at extremely low loads most of the time.

Pilot
FAYARD has an installed base of 25 large VACON® AC drives on site. Therefore the electrical supervisor, Jesper Gravesen, is very familiar with these drives. He has experienced only very few failures, and any malfunctions have been promptly solved by the service team.
Therefore Jesper Gravesen did not hesitate to contact the experts in VACON® drives to find an alternative to the rotating converters and the diesel gensets. Together with the application engineering team he built a pilot system comprising:

- A VACON® NXC Air Cooled drive to convert the 50 Hz shore power to 60 Hz
- A sine-wave filter to create a near sinusoidal waveform
- A separation transformer to eliminate common mode noise and create an IT grid as required on board the vessels

The results clearly demonstrated that the operating costs of the pilot system were far lower than for the existing systems. Therefore it was easy for FAYARD to decide to invest in two full-scale shore power systems.

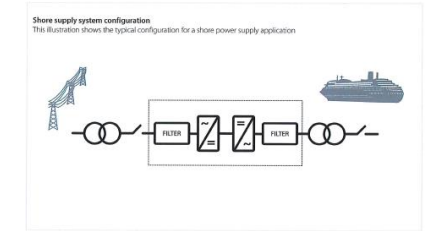
After: High-efficiency electric systems
In 2010, FAYARD Shipyard installed two portable shore power systems, each with a maximum power of 500 A at 440 V, or 300 A at 690 V.

Two VACON® NXC systems were built into two 20-foot (6.1 m) containers. These containers are easy to position on the deck of a ship, or at the quay side, depending on the vessel and the type of project.

For vessels with large power consumption, the two systems can operate in parallel, on board the same vessel. Alternatively, they can be used as stand-alone systems for two different vessels.

Payback in two months
The energy savings are impressive. The standby losses per system are reduced to less than 50 kWh per day, and efficiency is typically above 90% with an average load profile.

2 | Danfoss Drives · DKDD.PC.932.A1.02



The payback period was calculated to be less than two months, based on:

- Reduced energy cost. The fuel cost for each diesel generator was approximately 43k € for a 40-day project
- Elimination of leasing cost for diesel generators
- Maintenance of the generators no longer being required

Due to the good experience with the first two shore power systems, FAYARD built another system in 2013. The total shore power capacity is now 1500 A at 440 V.
In spite of the turbulent business conditions in the marine and offshore industry, FAYARD has been operating at 75–80% capacity over recent years. The shore power systems run for 180 days per year on average.

Reduced emissions and acoustic noise
As an extra benefit, the working environment at the shipyard has improved, with better air quality and reduced noise. FAYARD is in the process of implementing an ISO 14001 environmental certificate and it is very important for the yard to validate the green company profile. These documented reductions in emissions and acoustic noise provide the much-needed proof.

Innovative SHORE to SHIP POWER

- **Green Energy solution at FAYARD**
  FAYARD has 10 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 dock or alongside at FAYARD.
- The Shore to Ship 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, noise and GHG-emissions.

- The Green Energy Shore Connections are incorporated in FAYARD's ISO14001:2015 certification.

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THE ESTABLIHING OF FUTURE FOSSILFREE POWER REQUIRES SIGNIFICANT MARITME INVOLMENT

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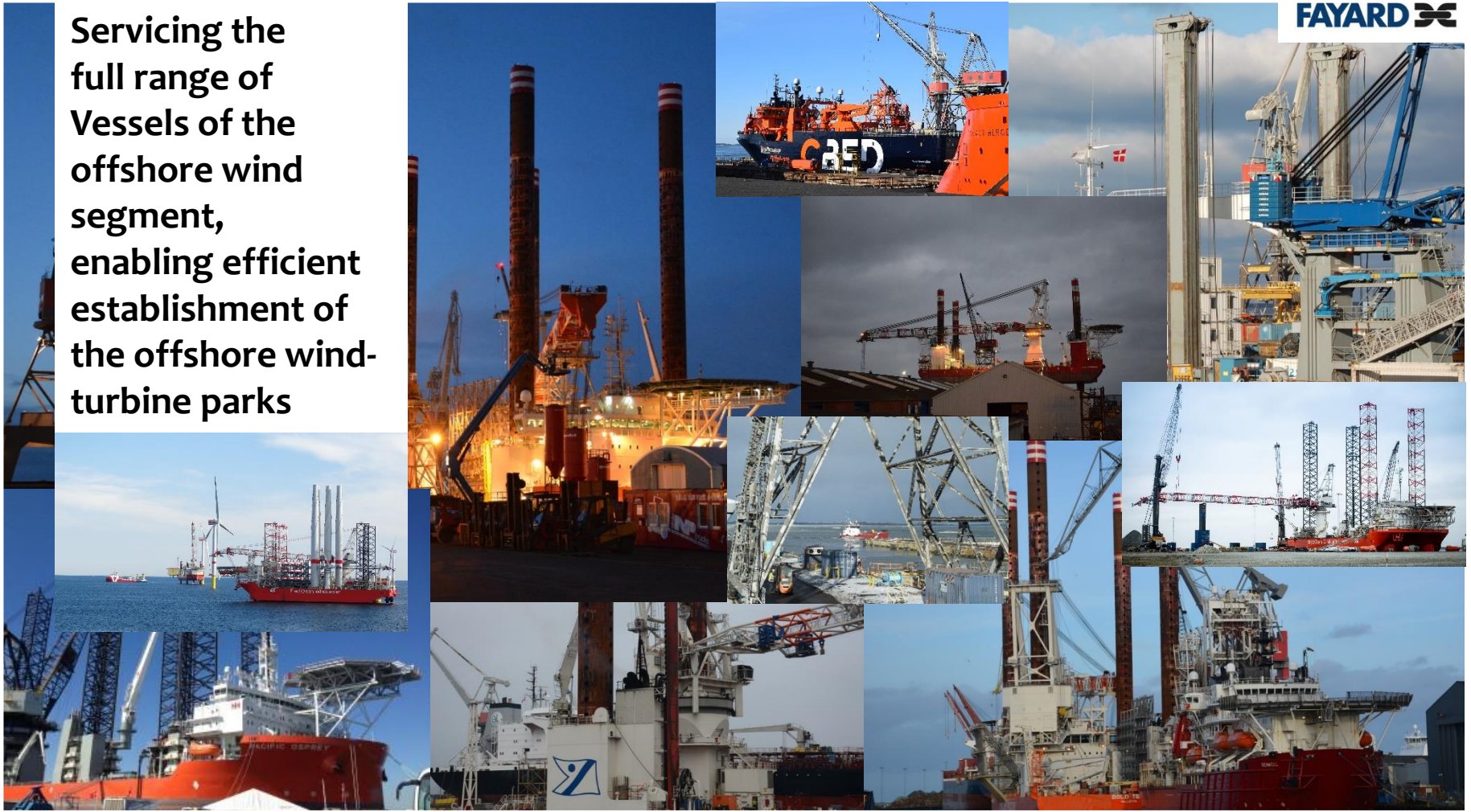
Servicing the full range of Vessels of the offshore wind segment, enabling efficient establishment of the offshore wind-turbine parks



FAYARD

Emission to Air reductions
NEXT is NOx-Limitation

#NOx
#SCR Catalysator
#DPF Particle filters

Selected Case Stories

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LOWERING GHG NOX-EMISSIONS BY

SELECTIVE
CATALYTIC
REDUCTION
SYSTEM

Urea tank with dosing unit and control system

Injector spools

SCR Unit no. 3 of 3

LOWERING GHG NOX-EMISSIONS BY

SELECTIVE
CATALYTIC
REDUCTION
SYSTEM

FAYARD

FUTURE FUELS

for reducing emission to air

Selected Case Stories

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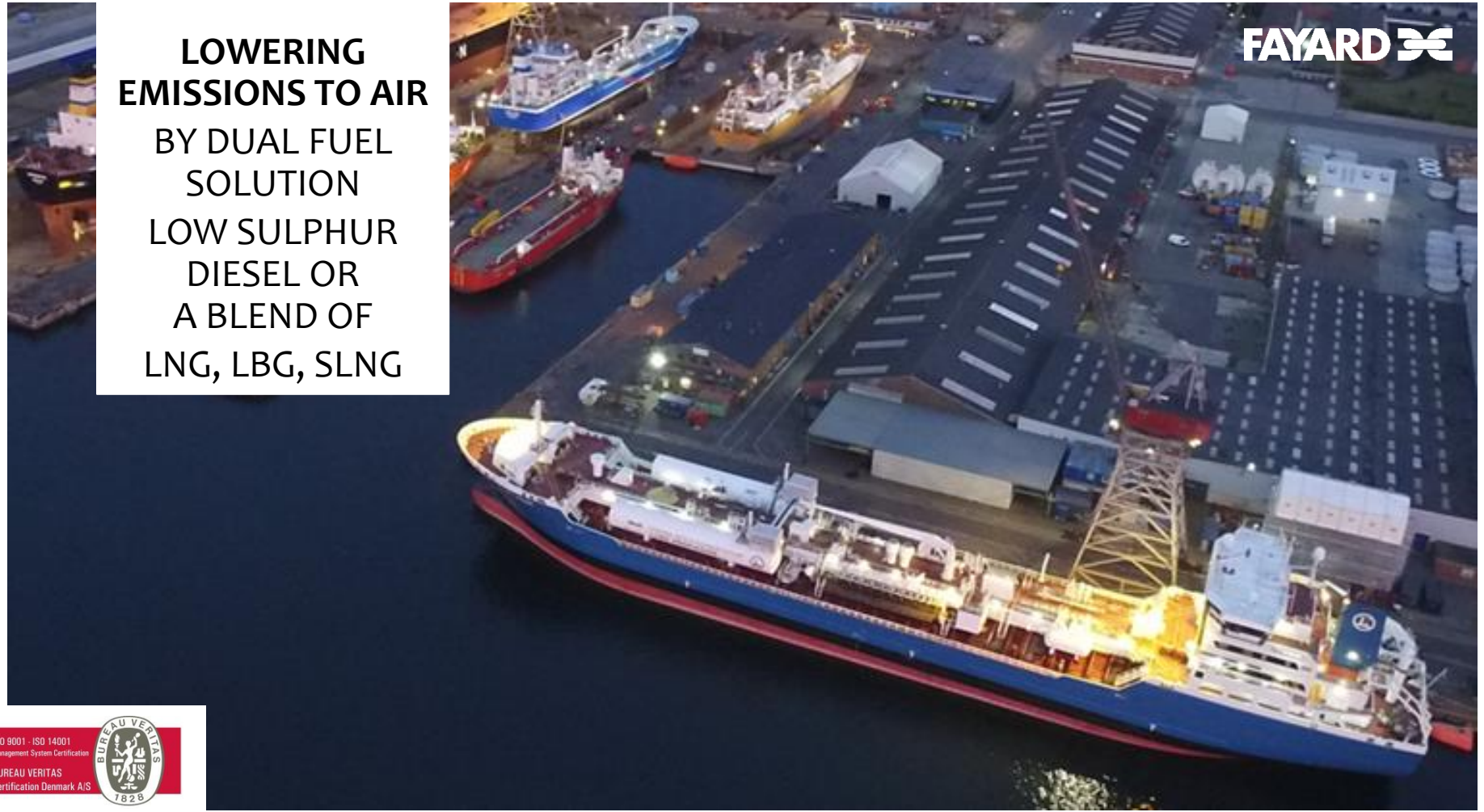
FAYARD
LOWER EMISSION PROJECTS
UPGRADING TO DUAL FUEL PROPULSION
LEADING INTO A CLEANER FUTURE
BY LNG PROPULSION
MAK
Co-financed by the European Union
QUALITY
ON-TIME
ALWAYS



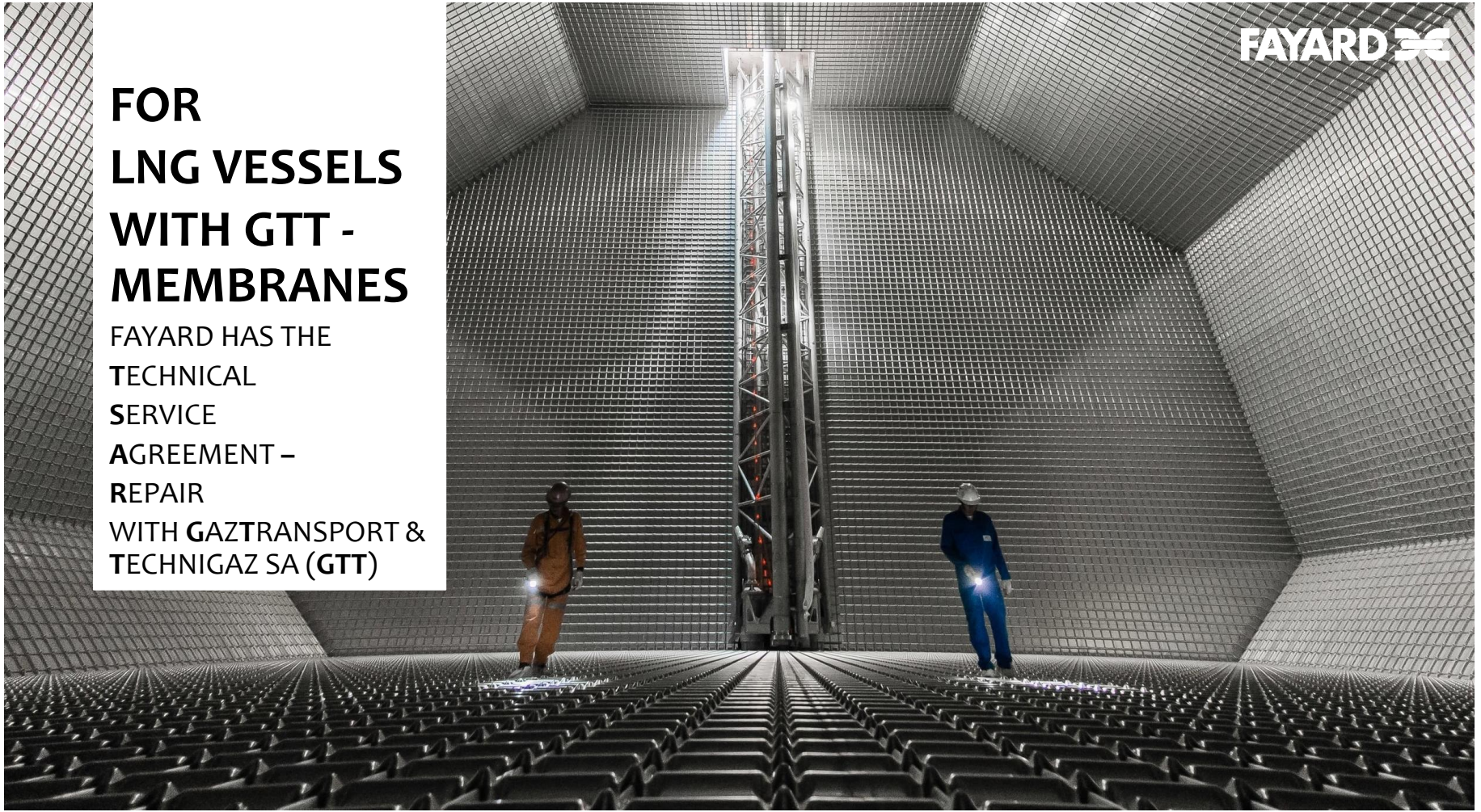
LOWERING EMISSIONS TO AIR

BY DUAL FUEL SOLUTION

LOW SULPHUR DIESEL OR A BLEND OF LNG, LBG, SLNG

ISO 9001 - ISO 14001
Management System Certification
BUREAU VERITAS
Certification Denmark A/S

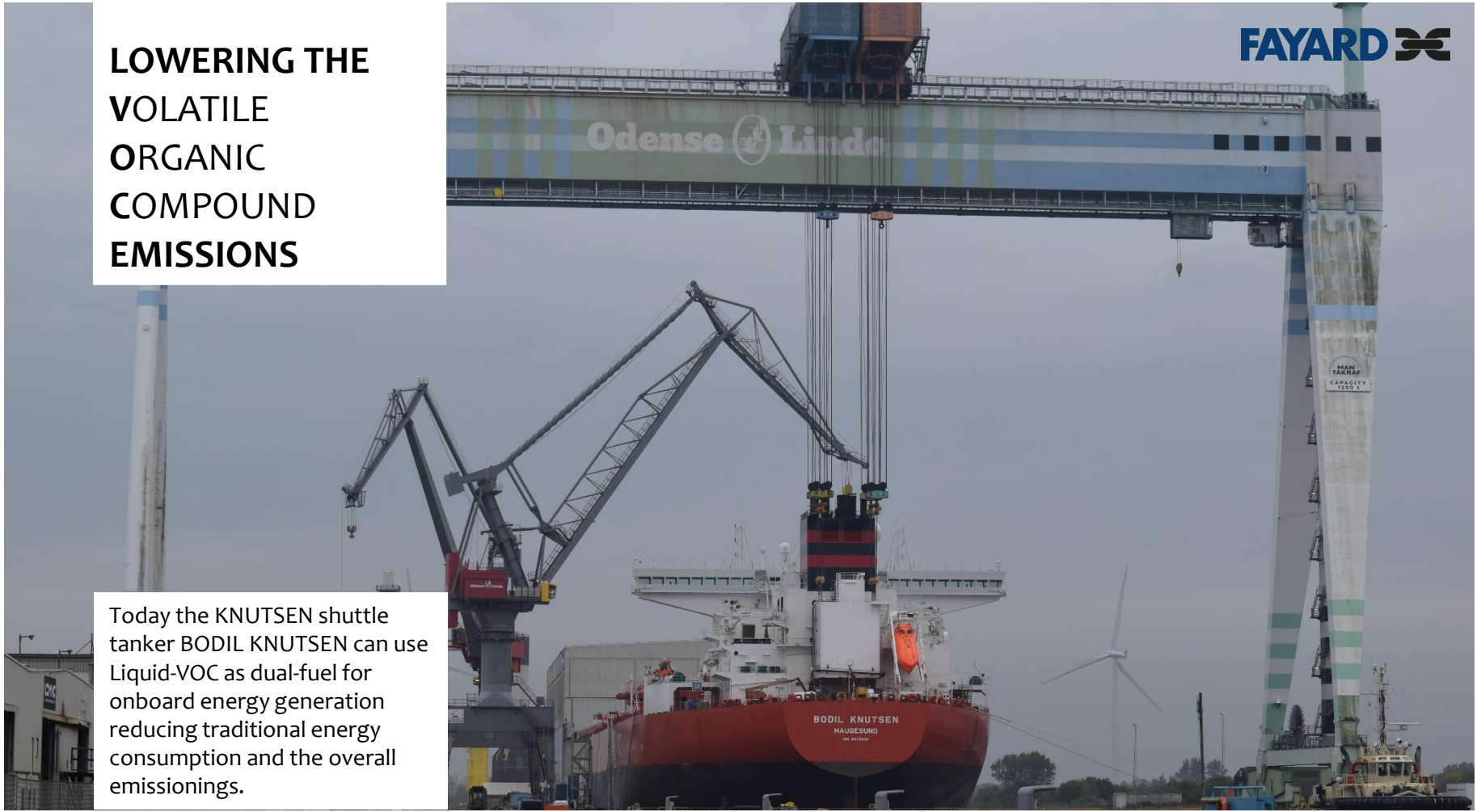
LNG CARRIERS, SECURING THE GLOBAL LNG-INFRASTRUCTURE, ARE ALSO SERVICED AT FAYARD



FOR LNG VESSELS WITH GTT - MEMBRANES

FAYARD HAS THE **T**ECHNICAL **S**ERVICE **A**GREEMENT – **R**EPAIR WITH **G**AZ**T**RANSPORT & **T**ECHNIGAZ SA (**GTT**)

LOWERING THE VOLATILE **O**RGANIC **C**OMPOUND **EMISSIONS**



Today the KNUTSEN shuttle tanker BODIL KNUTSEN can use Liquid-VOC as dual-fuel for onboard energy generation reducing traditional energy consumption and the overall emissionings.

How FAYARD handles Energy Efficiency Projects

… efficiently!

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Making Global Goals Local Business

FAYARD

Improvements Implemented

- We are fully committed to conducting our activities in an environ-mentally 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

MANAGEMENT SYSTEM

Certified to the ISO 9001, 14001 & 45001 standards by Bureau Veritas

SDG ACCELERATOR

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:

- **E**ngineering
- **P**rocurement
- **C**onstruction
- **I**nstallation
- **C**ommissioning

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.

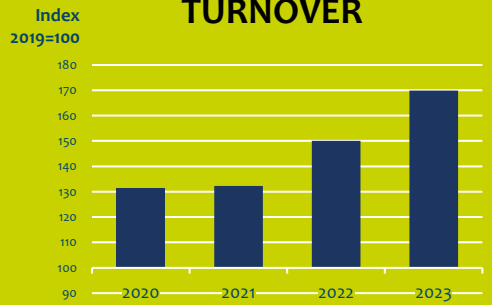
FAYARD – Trusted to Perform

FAYARD

QUALITY ON-TIME ALWAYS

THE NUMBERS

TURNOVER

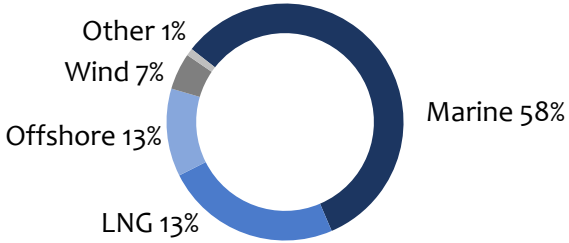


VESSELS PER YEAR (avg.)

121

2023 DOCK UTILIZATION

SEGMENTS



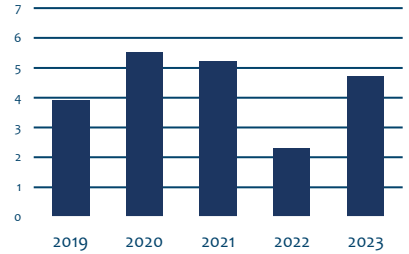
DELIVERED ON-TIME

100%

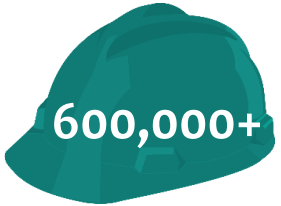
PART OF TURNOVER FROM RETURNING CUSTOMERS

87%

OSHA TRIR (the 200,000 hrs benchmark)



AVERAGE WORKING HOURS PER YEAR



DOCK AVAILABILITY

Meets requested service slot

98%

Quality - On time - Always

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