

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO

BioMSAR™

MSAR®

Jason Miles – CEO
quadrisefuels.com

4TH

OCTOBER 19
GREENTECH IN SHIPPING
VIRTUAL FORUM

AGENDA

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO

1

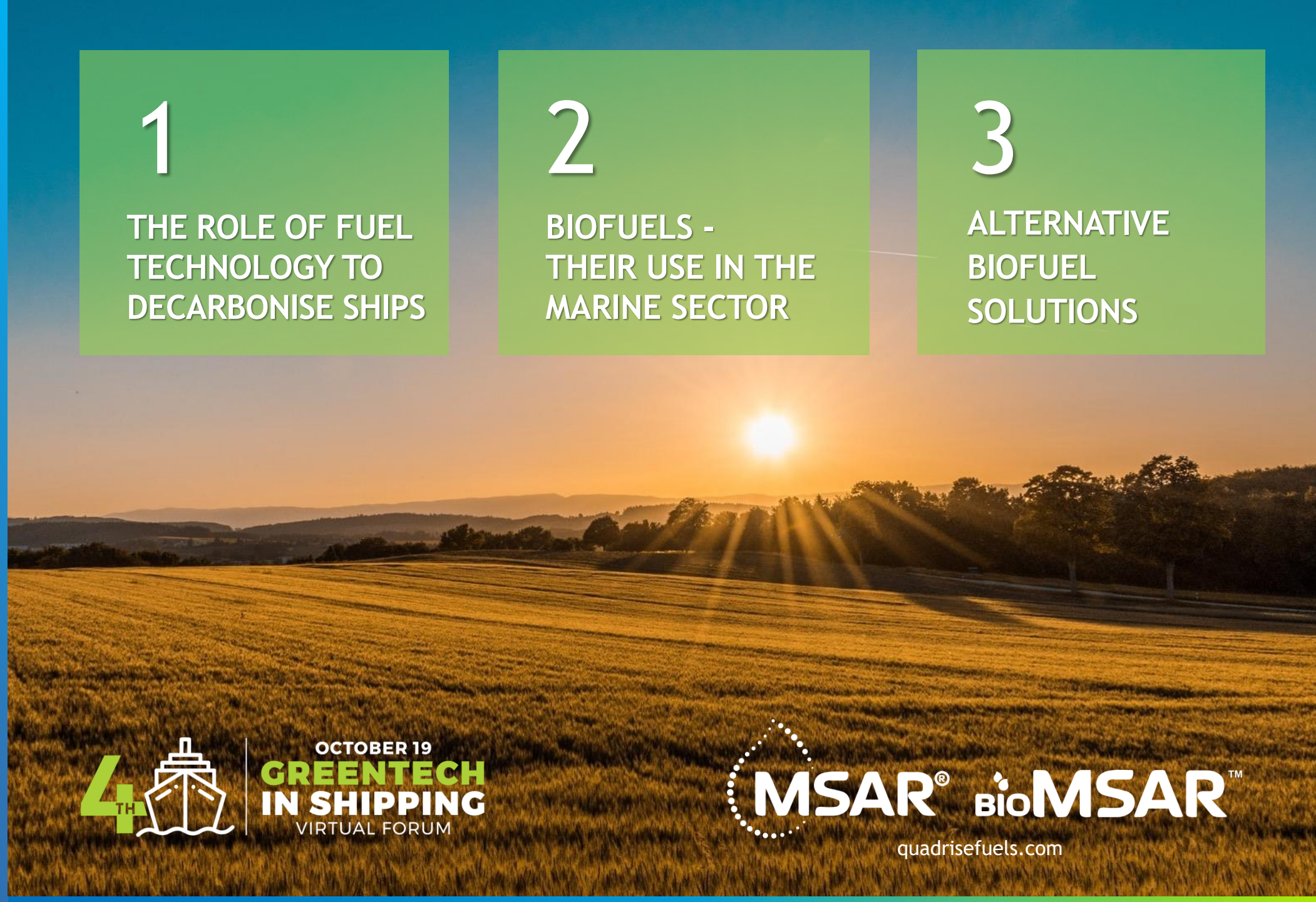
THE ROLE OF FUEL TECHNOLOGY TO DECARBONISE SHIPS

2

BIOFUELS - THEIR USE IN THE MARINE SECTOR

3

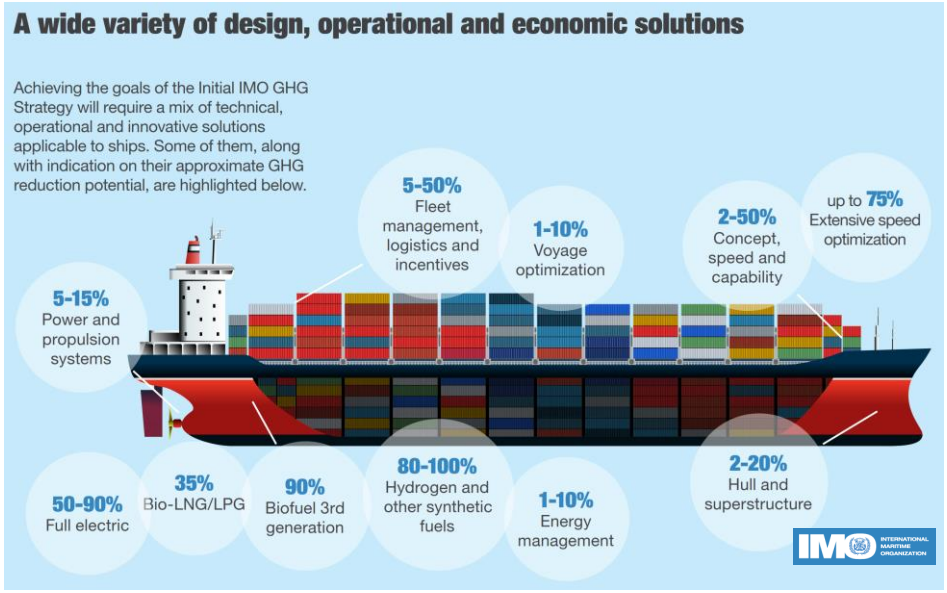
ALTERNATIVE BIOFUEL SOLUTIONS



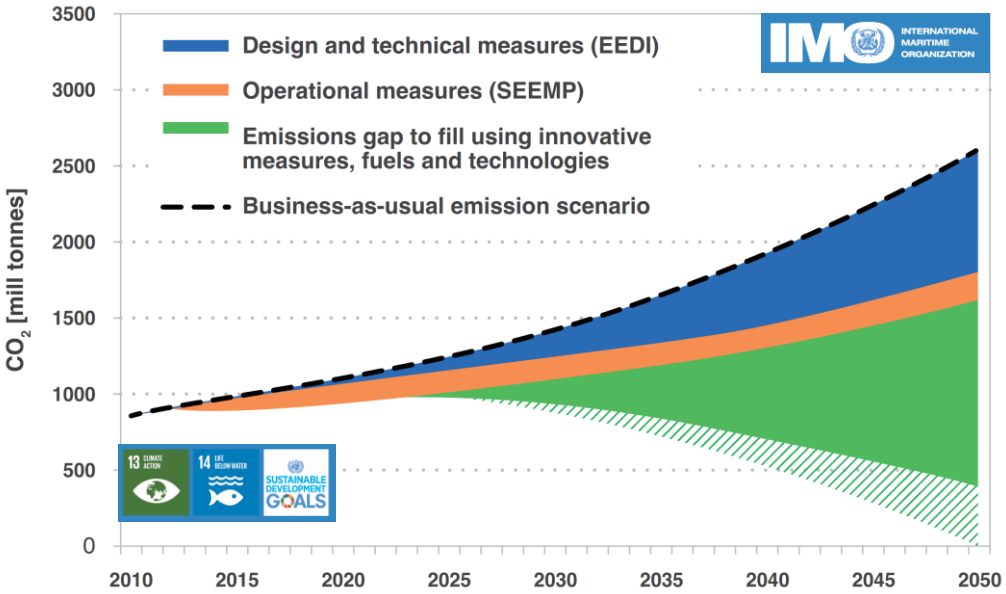
THE RACE TO NET-ZERO

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO

Options today? there are many!



Is the rate of change fast enough?



COURTESY OF THE INTERNATIONAL MARITIME ORGANISATION : IMO ACTION TO REDUCE GREENHOUSE GAS EMISSIONS FROM INTERNATIONAL SHIPPING

What can be done today to help transition quickly, without incurring significant costs or fleet changes?

We are focusing today on:

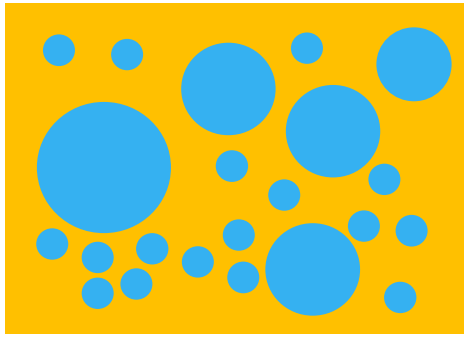
1. **Improving energy efficiency**
2. **Lowering emissions**

Using disruptive technology…

THE RACE TO NET-ZERO

A CRASH COURSE IN EMULSIONS!

Water-in-oil Emulsions

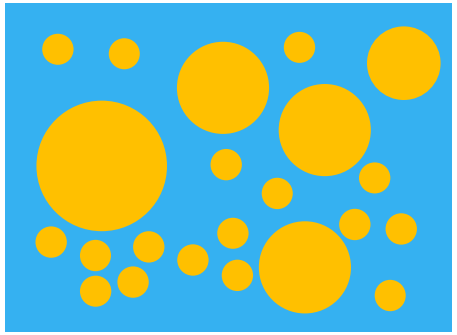








Oil-in-water Emulsions









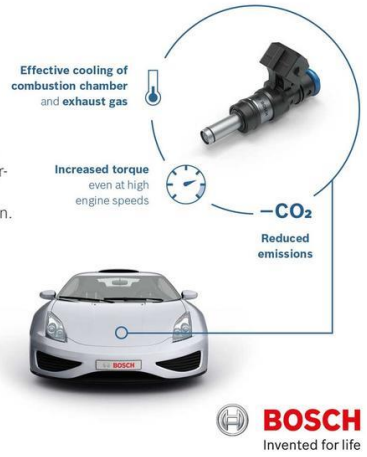
For engines: Water helps combustion & emissions

Water power that leaves turbochargers in its wake

Water, not gasoline – Water injection is based on a simple principle: the engine cannot be allowed to overheat. So before the fuel is ignited, a fine water mist is injected into the intake manifold to cool things down.

up to **13 %**

lower fuel consumption
even with rapid acceleration or on long highway journeys



5 LITRES OF WATER FOR 500 HORSES.

8% greater performance. 8% less consumption.

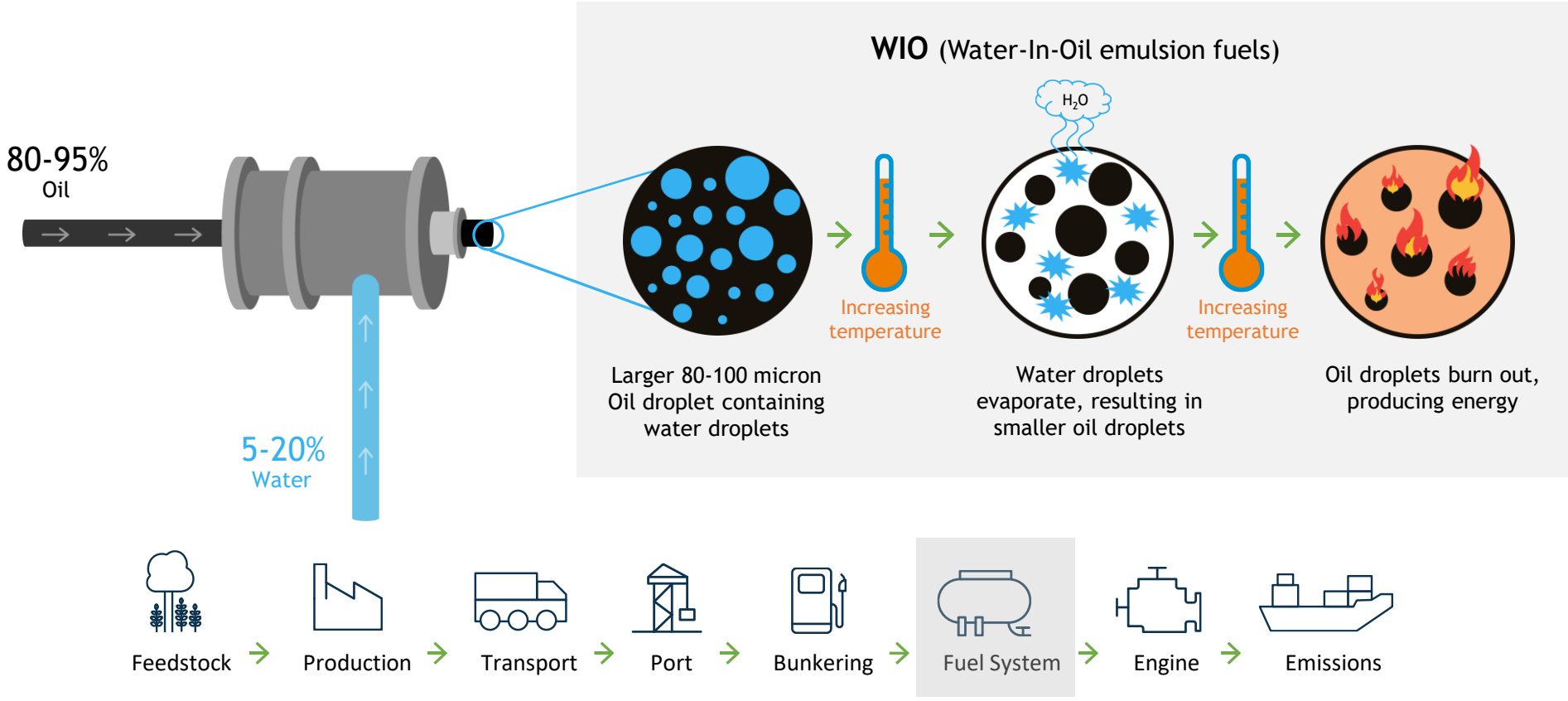


IMPROVING ENERGY EFFICIENCY

WIO technology is deployed at the point of use, to improve the combustion of conventional fuels

Water-In-Oil Emulsion Fuel Technology

- Conventional emulsion systems add water to marine fuels to produce Water-in-Oil emulsions
- This reduces NOx (each % of water added reduces NOx by a % typically)
- Also improves combustion and reduces Black Carbon due to secondary fuel atomisation
- Potential for higher engine efficiency in some cases
- Implemented by installing an emulsion system on the vessel

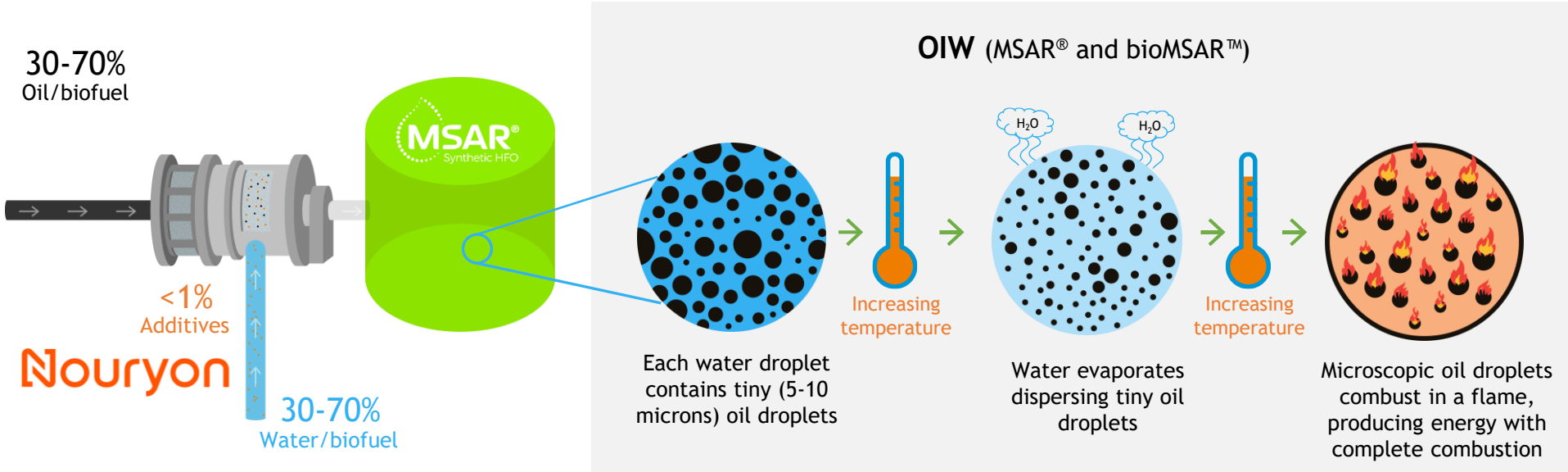


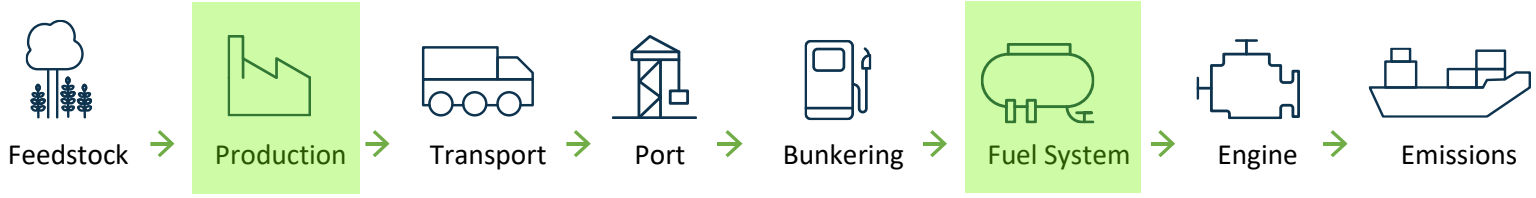
Oil-In-Water Emulsion Fuel Technology

IMPROVING ENERGY EFFICIENCY

OIW technology is deployed at fuel production, to reduce fuel costs and emissions

- Uses lowest value fuel components at the refinery or fuel terminal for blending
- Improves blending stability, and water lowers viscosity and NOx by 20-30% typically
- Complete combustion from micron-sized fuel droplets, reducing Black Carbon substantially
- Improves engine efficiency, lowering energy consumption to achieve CO2 savings of up to 6-9%
- New fuel flexibility is provided by installing a separate emulsion fuel booster unit on the vessel





Diesel & Marine Experience

- Quadrise have >60 million tons of emulsion experience
- 150,000 reliable running hours on 4-stroke Wartsila engines for base-load power generation
- Comprehensive 2-stroke marine MSAR® programme with Maersk, on MAN and Wärtsilä engines, resulting in:
  - Trials on MAN D&T, Mitsui & Wärtsilä test engines
  - Proof of concept tests at sea on Maersk Bogor and Seago Istanbul vessels
  - Operational trial on Seago Istanbul (~1500 hours)
  - Interim LONO obtained on Wärtsilä Flex 96
- Further operational experience and full LONO in planning phase under JDA with MSC Shipmanagement











Maersk Bogor 43,000 DWT (MAN B&W 7K80ME-C9)



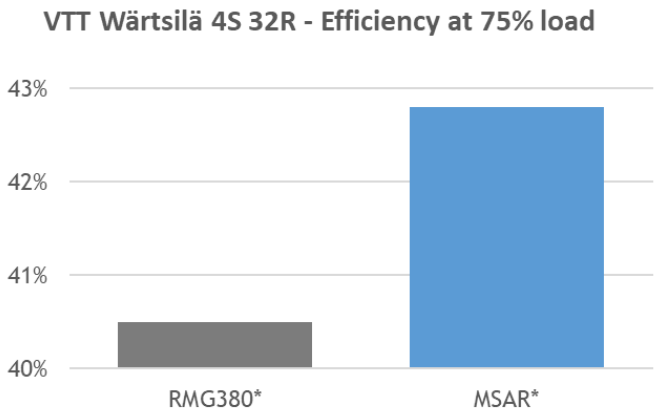


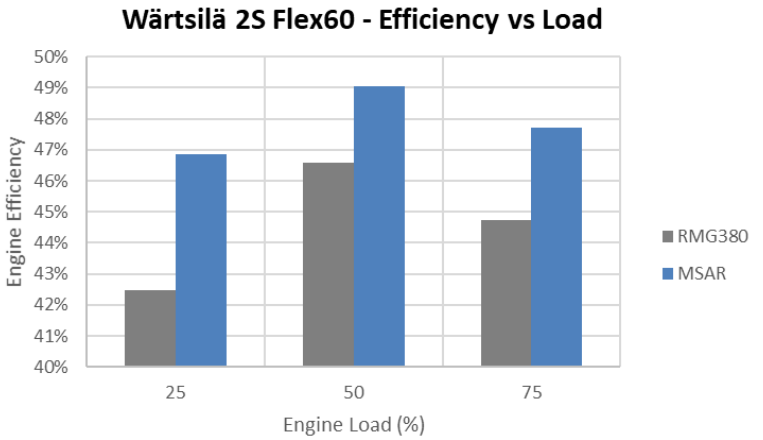
Seago Istanbul 54,000 DWT (Wärtsilä 12 RT-Flex 96 C-B)

Niels H Bruus
Maersk Line A/S:

"…during the MSAR® trial programme Maersk has enjoyed a close and professional collaboration with our technology partner QFI … resulting in a smooth operation during which the MSAR® fuel has performed well."

Energy efficiency benefits of up to 6-9% (4S/2S)…





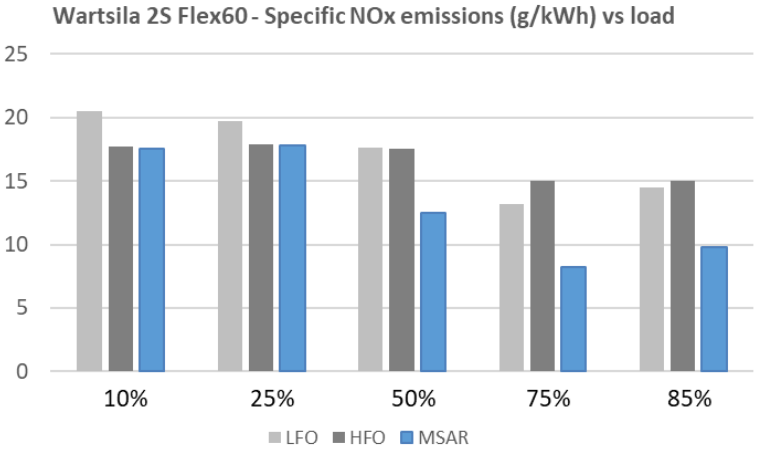
Result in 5-9% lower CO_2 & GHG emissions well-to-wake.

IMPROVING ENERGY EFFICIENCY

LOWERING EMISSIONS

AT LOWER FUEL COST





Plus… reduced smoke (black carbon) & NOx emissions.

BIOFUELS

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO

Marine biofuel options

Data summarised from ICCT Working Paper Sep 2020
Legend: ✓ Good; - Average; ✕ Poor

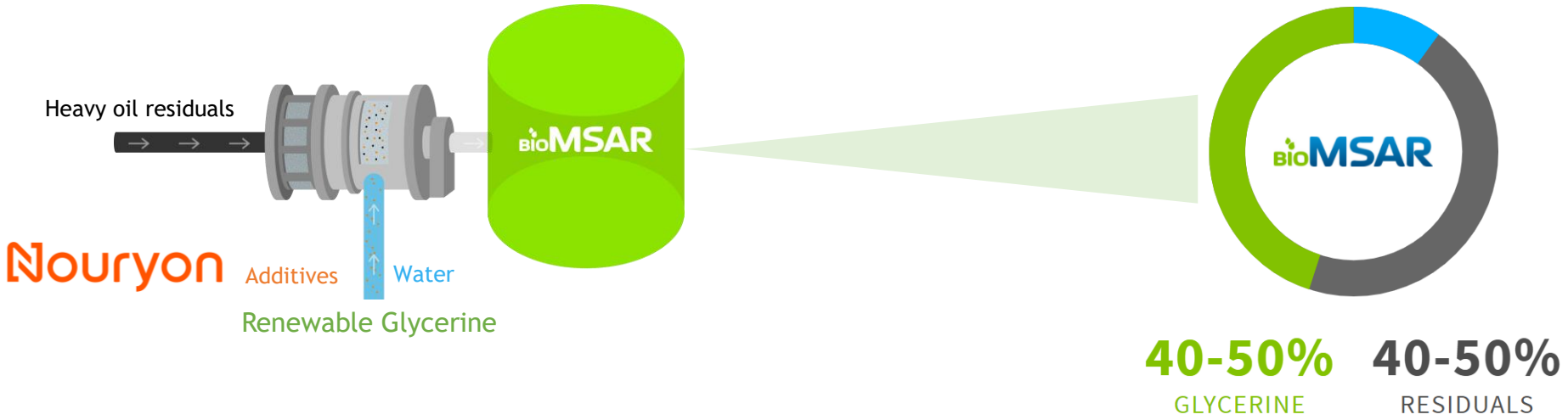
Fuel	Supply	Compatibility	Cost	Interest
FAME biodiesel	Veg oils, UCO, tallow	✓	✓	-
Hydrotreated renewable diesel	Veg oils, UCO, tallow	✓	-	✓
FT diesel	Lignocellulosic biomass, natural gas	-	✕	✓
DME	Lignocellulosic biomass, natural gas	-	✕	✓
Methanol	Lignocellulosic biomass, natural gas	-	-	✓

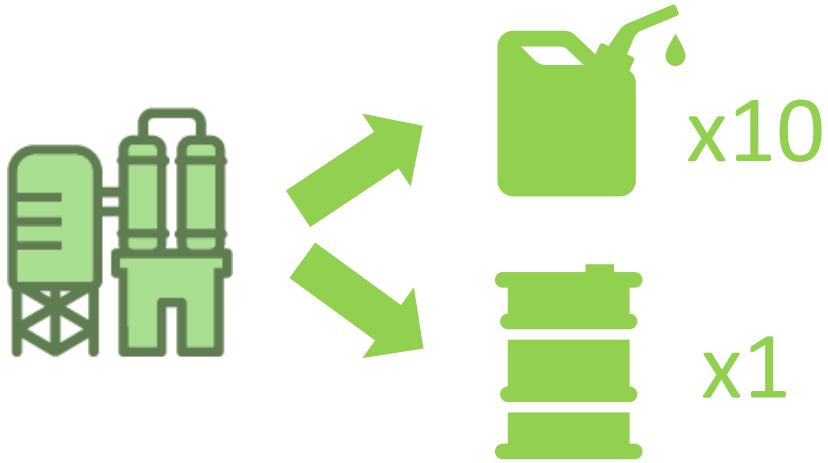
Is there also a role for disruptive biofuel solutions tailored for shipping?

BioMSAR	Biodiesel, fatty acids, ??	✓	✓	MSC

Commercialising a new biofuel for marine users

Launched at the end of last year, bioMSAR™ combines the benefits of MSAR® fuel & technology to blend renewable fuels (both oil and water based).





>4m tpa of glycerine today, mostly as a by-product of biofuel & fatty acid & alcohol production

e.g. 1 barrel of crude Glycerine is produced for every 10 barrels of biodiesel…
This can be refined for fuel applications!

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bioMSAR™

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Glycerine experience in diesel engines

- Glycerine has already been utilised in diesel generators to power Formula-E race cars and VW's record-breaking Pike's Peak ID R.

- Good potential as a marine transition fuel as not an obvious option for aviation or road transportation:

Glycerine benefits:

- ✓ Non-toxic
- ✓ Non-flammable
- ✓ Good lubricity
- ✓ Bio-degradable
- ✓ Low g/MJ CO_2
- ✓ No methane slip

- Based on 40% glycerine, CO_2 emission reductions are 25% well-to-wake or tank-to-wake.

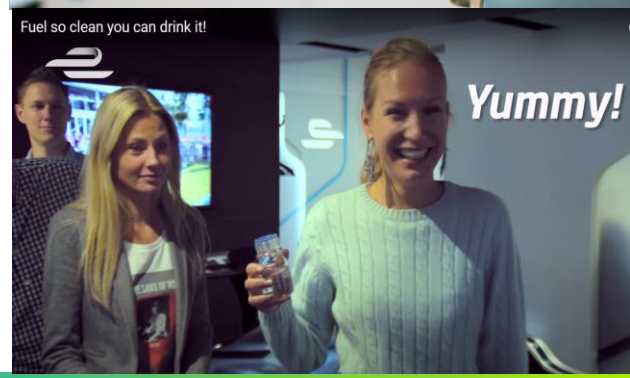
- Glycerine content can be tailored to user requirements.

- In **bioMSAR™** it can be used in existing marine diesel engines, with only minor modifications to the fuel handling system (same tanks, but separate fuel booster).









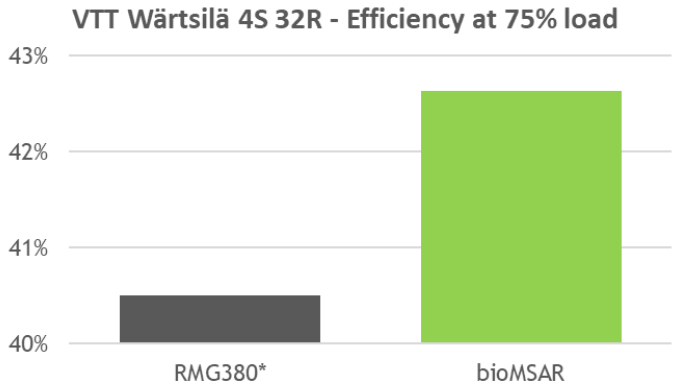
bioMSAR™

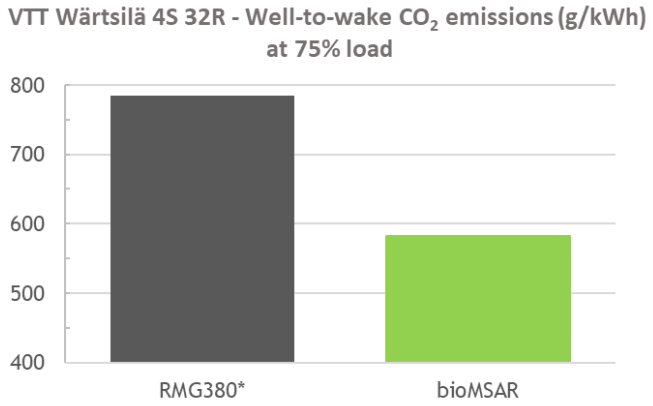
IMPROVING ENERGY EFFICIENCY

LOWERING EMISSIONS

TRANSITION TO NET ZERO

Energy efficiency benefits of up to 7%

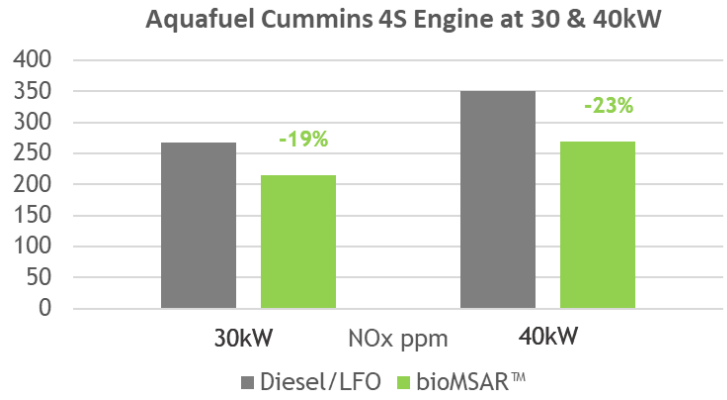




Over 20% lower CO_2 & GHG emissions well-to-wake

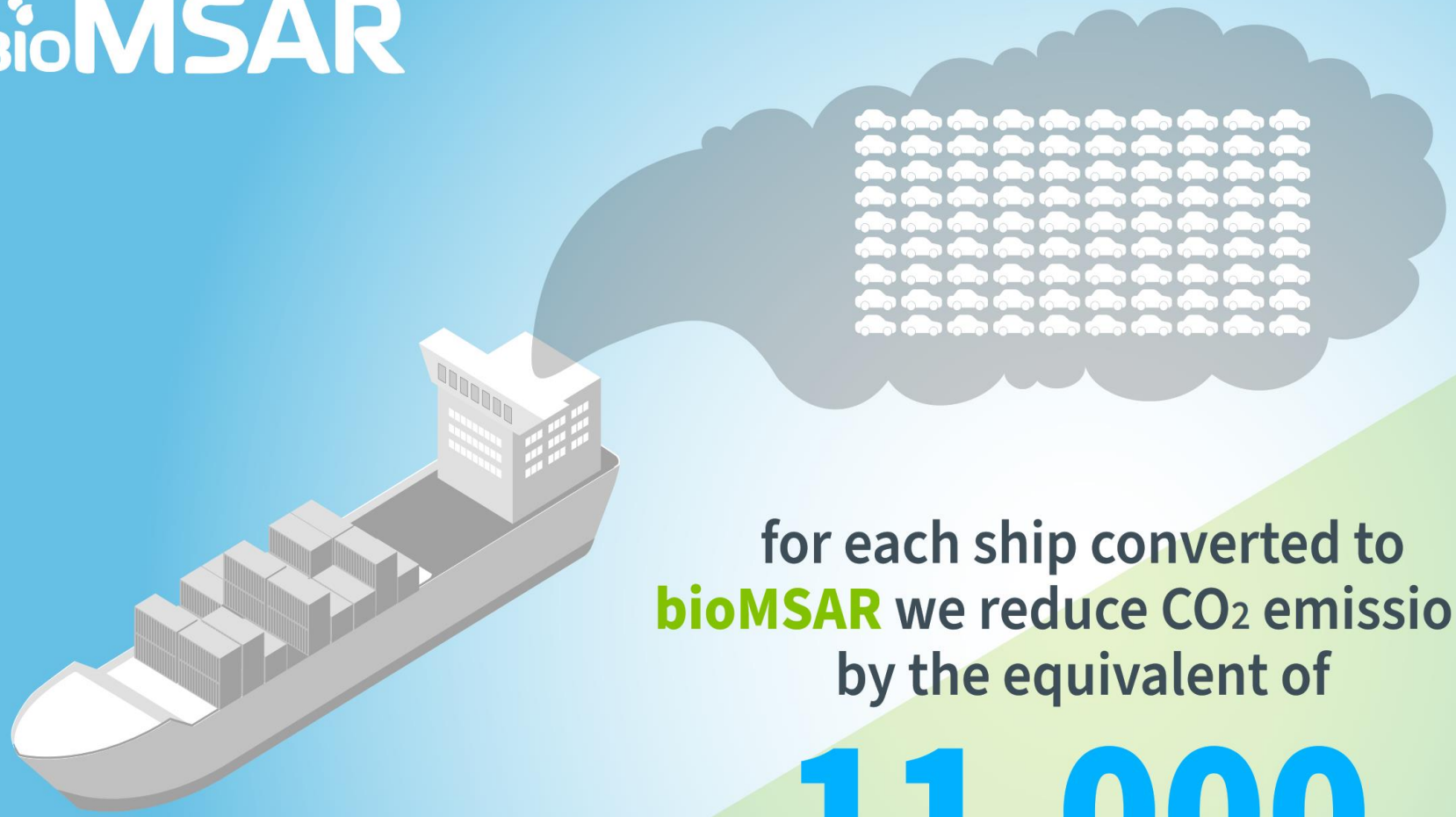


Wärtsilä Vasa 4R32 LN DF E



Low NOx and smoke emissions, reducing black carbon

BioMSAR



for each ship converted to
bioMSAR we reduce CO_2 emissions
by the equivalent of

11,000

PETROL CARS



CLEANER FUEL
CLEANER PLANET

bioMSAR™

SUMMARY & NEXT STEPS

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO

- bioMSAR™ successfully tested on 4S Wärtsilä & high-speed diesels
- Recent bioMSAR™ testing confirmed;
  - ✓ Engine performance was very similar to MSAR® & other fuels
  - ✓ High engine efficiency of up to 7%, as seen with MSAR®
  - ✓ Lower CO_2 emissions per kWh calculated (WTW or TTW)
  - ✓ Overall NOx emissions were similar to MSAR®
  - ✓ Low smoke, THC and CO with bioMSAR™
- As with MSAR®, which was successfully tested on ME and Flex engines, bioMSAR™ also needs to be tested on a 2S engine
- Further options to expand global supply of glycerine being studied
- **New opportunities to incorporate other renewable fuels into the oil or water phases of the fuel using MSAR® blending technology to enhance the stability of marine transition fuels**



BioMSAR™

UK CHAMBER of SHIPPING

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO



Quadrise Fuels International plc

Q&A

INNOVATIVE MARINE FUEL SOLUTIONS TO RAPIDLY TRANSITION TO NET ZERO

ANY QUESTIONS?



MSAR® BioMSAR™

quadrisefuels.com