



**FUELSAVE**

GREEN  
TECHNOLOGY

# OPEX & EMISSION REDUCTION FOR A SUSTAINABLE & VIABLE CLEAN-FUEL TRANSITION FOR MARITIME VESSELS.



Save energy.



Save money.



Save the planet.



**MARINE**

GREEN  
TECHNOLOGY



# FUELSAVE - MISSION

**WE HELP OPERATORS OF COMBUSTION ENGINES**

(MARITIME ASSETS / POWER PLANTS / MINING / TRAINS , ETC)

**TO BECOME MORE PROFITABLE  
WHILE REDUCING THEIR EMISSIONS**

(FOR A SUSTAINABLE & ECONOMICALLY VIABLE CLEAN FUEL TRANSITION)

## PRINCIPLES

- CUSTOMER SATISFACTION FIRST
- ROI WITHIN THE WARRANTY PERIOD
- „NO CURE NO PAY“ MENTALITY

*Chosen by leading Accelerators of the world:*



*3 Seals of excellence from the EU  
+ 2 times funded by the EU*



"This project was funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 806083"



# FIELD-PROVEN FOR 2,5 YEARS



DETAILING I.E. THE MEASUREMENT SERIES IN HAMBURG:  
GROSS COST SAVINGS OF FUEL = 25,01% GROSS

- 0,60% E-POWER
- 7,60% METHANOL
- 0,70% COMPRESSED PRESS. AIR / FRESH WATER

NET COST SAVINGS = 16,11% NET

MV ANNETTE  
EU's LARGEST HEAVY LIFT CRANE SHIP



## OVER 16 % NET COST SAVINGS

IN FUEL CONSUMPTION ALONE

## OVER 20% NET OPEX SAVINGS TOTAL



# FIELD-PROVEN WITH 3rd PARTY VALIDATIONS



DURING THE FIELD TEST, INSPECTIONS BY CBH AND DNV-GL HAVE BEEN PERFORMED ON THE ENGINE AND FS MARINE+ UNIT INSTALLED ON THE MV ANNETTE VESSEL.

## 1000 HOURS INSPECTION REPORT

AFTER THE FIRST 1000 HOURS OF OPERATION OF FS MARINE+ ON THE MV ANNETTE, CBH INSPECTED THE ENGINES TO CONFIRM THE POSITIVE EFFECTS OF THE SOLUTIONS.



*Cleaner Combustion → Less Soot → Cylinder Heads "Like New"*

WITH THE PERFORMED INSPECTION, IT HAS BEEN VERIFIED THAT THE ENGINE HAS NOT SUFFERED ANY NEGATIVE EFFECT.

FURTHERMORE, IT HAS BEEN NOTICED:

- LESS SOOT AND DEPOSITS ON ALL THE COMBUSTION PROCESS ENGAGED COMPONENTS.
- VISIBLY LESS EMISSIONS FROM THE EXHAUST SYSTEM.
- THE LUBE OIL HAS TRIPLED ITS LIFETIME.



## DNV-GL SECOND APPROVAL

ON MAY 20<sup>TH</sup> 2017, DNV-GL CONTROLLED THE ENGINE AFTER THAT FS MARINE+ HAS BEEN INSTALLED ON THE VESSEL FOR MORE THAN ONE YEAR WITH A TOTAL ONBOARD RUNNING TIME OF 4000-5000 HOURS DURING WHICH ANY PROBLEM HAS BEEN RECORDED.

DURING THE INSPECTION, BOTH THE ENGINE AND THE HYDROGEN GENERATOR DEVICE HAS BEEN INVESTIGATED AND THE OUTCOMES OF THE CONTROL HAS BEEN FULLY POSITIVE:

- THE OPERATED SHIP ENGINE WAS DISMANTLED AND INSPECTED WITHOUT ANY NEGATIVE FINDINGS.
- THE FS MARINE+ UNIT WAS TESTED AND INSPECTED WITH FULL SATISFACTORY RESULT.



*From left to right: Connecting Bearing, Cylinder Head, Piston Head*



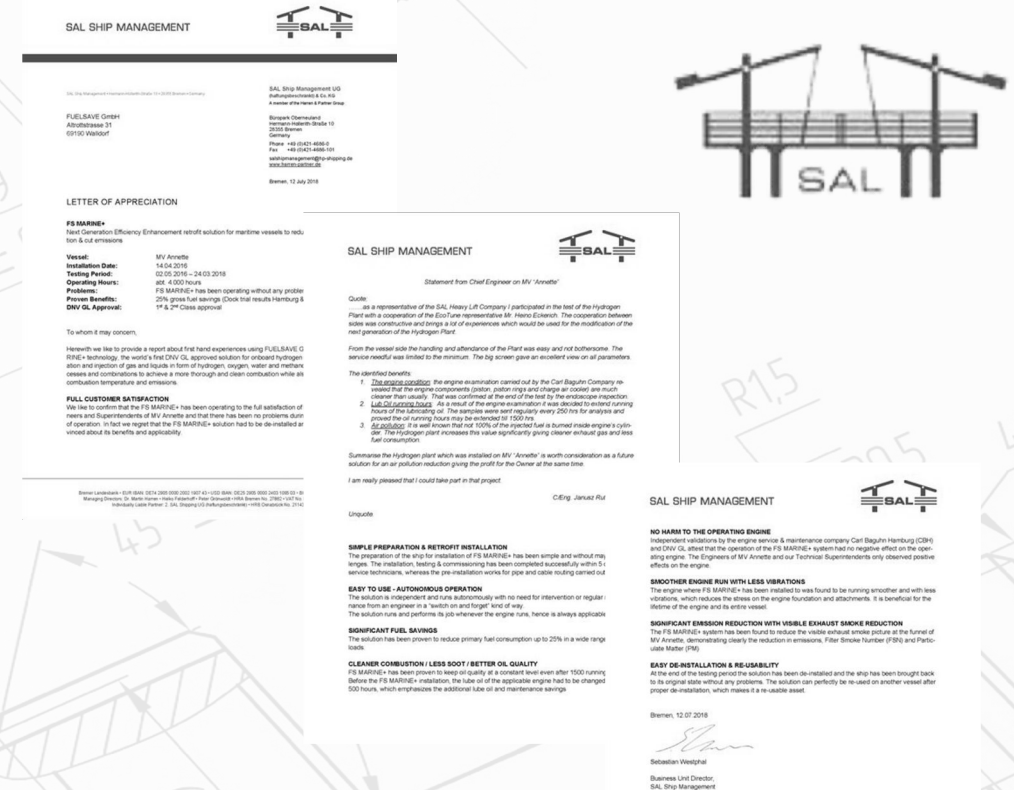
# APPRAISED BY INDUSTRY & CUSTOMERS

**CBH** CARL  
BAGUHN  
HAMBURG

CBH ARE ONE OF THE MOST RESPECTED AND OLDEST ( OVER 100 YEARS) ENGINE SERVICE COMPANIES & SPECIALISTS IN GERMANY + ENGINE SERVICE COMPANY OF SAL HEAVY LIFT

FOLLOWING THE FS MARINE+ INSTALLATION ABOARD THE SAL HEAVY LIFT SHIP MV ANNETTE, **CBH MANAGING DIRECTOR CARSTEN KÖRBE LIN SAYS:**

“IT IS A MATTER OF FACT. WE HAVE BEEN MAINTAINING THE OWNER’S AUX ENGINES FOR SOME YEARS. THEY RUN ON MDO, HAVE ALWAYS BEEN WELL MAINTAINED AND OPERATED UNDER NORMAL CONDITIONS. BUT **SINCE WE INSTALLED THE FUELSAVE SYSTEM, THE ENGINE HAS BECOME MUCH CLEANER. THERE IS NO VISIBLE SOOT AND ENGINE RUNNING IS MUCH SMOOTHER, WITH REDUCED LEVELS OF NOISE AND VIBRATION. THE IMPROVEMENT IS ASTONISHING. THIS IS SOMETHING VERY SPECIAL.**”



CUSTOMER **100% SATISFIED** +  
CUSTOMER SIGNED CONTRACT FOR 6 SHIPS



# HOW WE ACHIEVE THAT



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WITH **DYNAMIC & LOAD-BASED** **INJECTION** OF

**HYDROGEN**

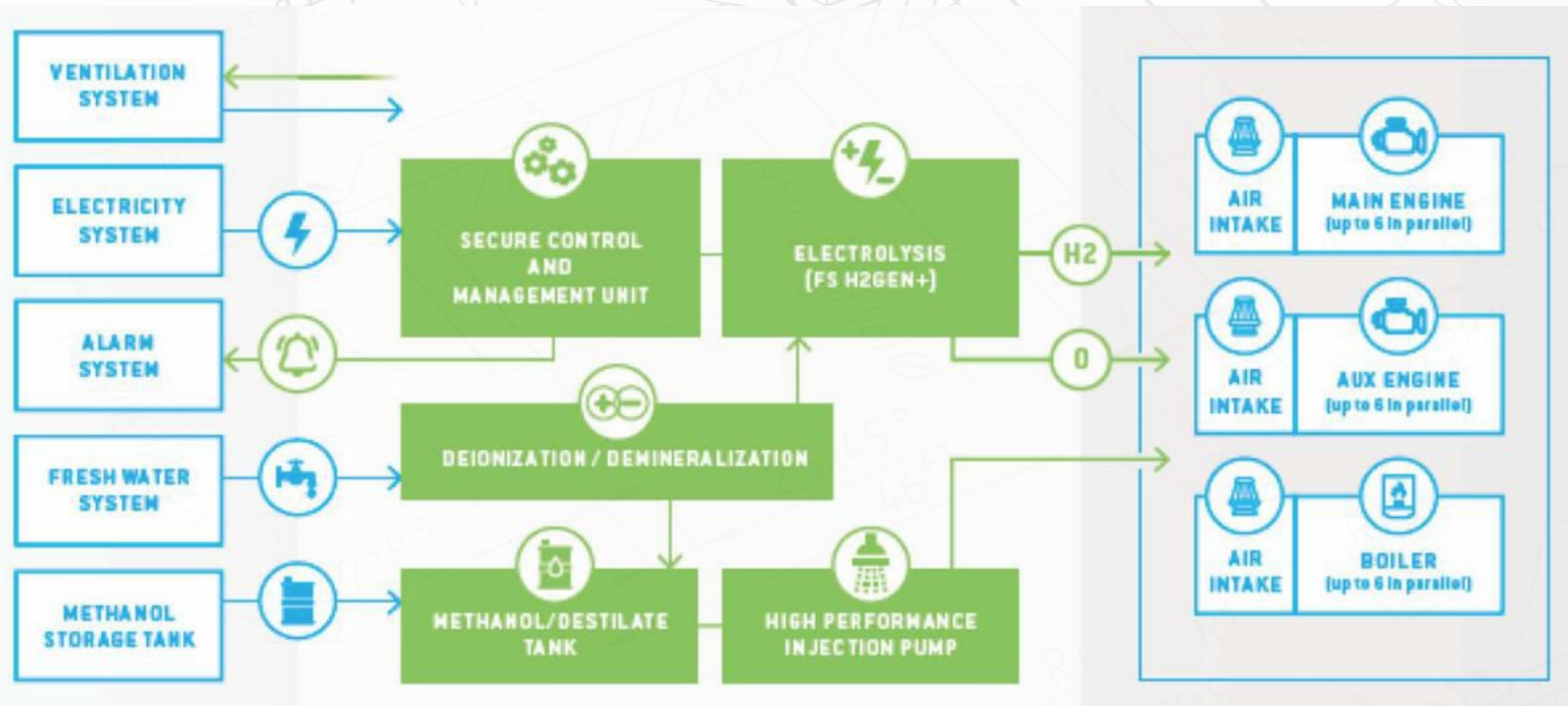
**OXYGEN**

**METHANOL  
& WATER**

**IN THE **AIR INTAKE** IN THE **RIGHT WAY****



# SCHEMA & FLOW DIAGRAM



## OPERATING EXPENSES (OPEX)

### CONSUMABLES

- ✓ METHANOL (BASE COMMODITY)
- ✓ WATER (TECHNICAL WATER IS SUFFICIENT)
- ✓ ELECTRICAL POWER
- ✓ COMPRESSED AIR

### OPERATIONS

- ✓ SYSTEM WILL BE INTEGRATED INTO CONTROL ROOM AND NEEDS VERY LOW LEVEL OF ATTENTION;
- ✓ NO EXTRA PERSONNEL REQUIRED

### MAINTENANCE

- ✓ ONGOING (PREDICTIVE) MAINTENANCE AND SERVICE THROUGH LOCAL REPRESENTATIVE AS PART OF A LONG-TERM SERVICE AGREEMENT



# HIGHLIGHTS

GUARANTEED

**10%**

NET OPEX  
SAVINGS

AVERAGE  
ROI

**<3YEARS**

## KEY ENABLER FOR **EMISSION REDUCTION** & **COST SAVING / EFFICIENCY ENHANCEMENT STRATEGIES**

- ✓ MATURE TECHNOLOGY – **FIELD & LAB PROVEN | PATENTED | AWARDED**
- ✓ APPLICABLE FOR 4 STROKE ENGINES and VARIOUS FUEL TYPES
- ✓ FAIL SAVE
  - NO RISK OF PLANT OUTAGE
  - NO NEGATIVE IMPACT ON OPERATION

UP TO **25%**  
PRIMARY FUEL  
REDUCTION

UP TO **50%**  
MAINTENANCE  
COST REDUCTION

UP TO **33%**  
LUBE OIL  
REDUCTION

UP TO **15%**  
CO<sub>2</sub>  
REDUCTION

UP TO **40%**  
PM  
REDUCTION

UP TO **20%**  
SO<sub>x</sub>  
REDUCTION

UP TO **80%**  
NO<sub>x</sub>  
REDUCTION

UP TO **33%**  
BLACK CARBON  
REDUCTION



# SOLUTION / UNIQUE BENEFITS

Thanks to the right mix injected into the engines and boiler, the pollutants emissions problem is addressed at its root making the **combustion process cleaner**. Through this, several benefits are achieved spanning from **pollutants' emissions reduction** to **economic benefits for the shipping companies**.

## KEY ENABLER FOR CO<sub>2</sub> AND CO<sub>2</sub>-e REDUCTION STRATEGIES + EMISSION TRADING ( EU-ETS)

CA. **8-15%**

**CO<sub>2</sub>  
REDUCTION**

CA. **40%**

**PM  
REDUCTION**

CA. **10-20%**

**SO<sub>x</sub>  
REDUCTION**

CA. **33%**

**BLACK CARBON  
REDUCTION**

CA. **30-80%**

**NO<sub>x</sub>  
REDUCTION**

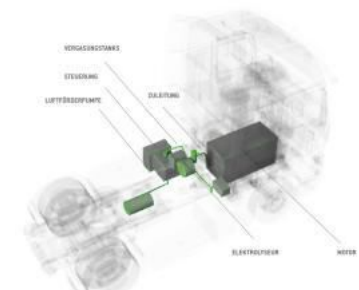
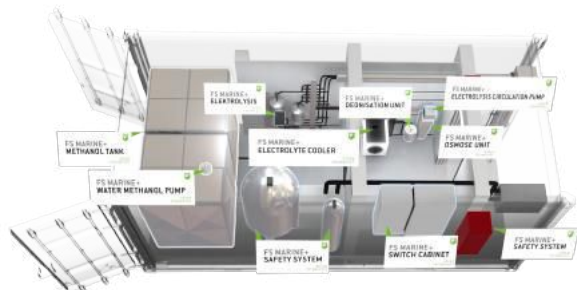
## OTHER SAVINGS?

- ✓ UP TO 50% REDUCED MAINTENANCE
- ✓ UP TO 33% REDUCED LUBE OIL
- ✓ EMISSION TAX SAVINGS (EU- ETS)
- ✓ REDUCED AIR INTAKE COOLING
- ✓ LESS TURBOCHARGER MAINTENANCE & CLEANING
- ✓ FURTHER OPEX SAVINGS WITH SCRUBBER / SCR COMBINATION



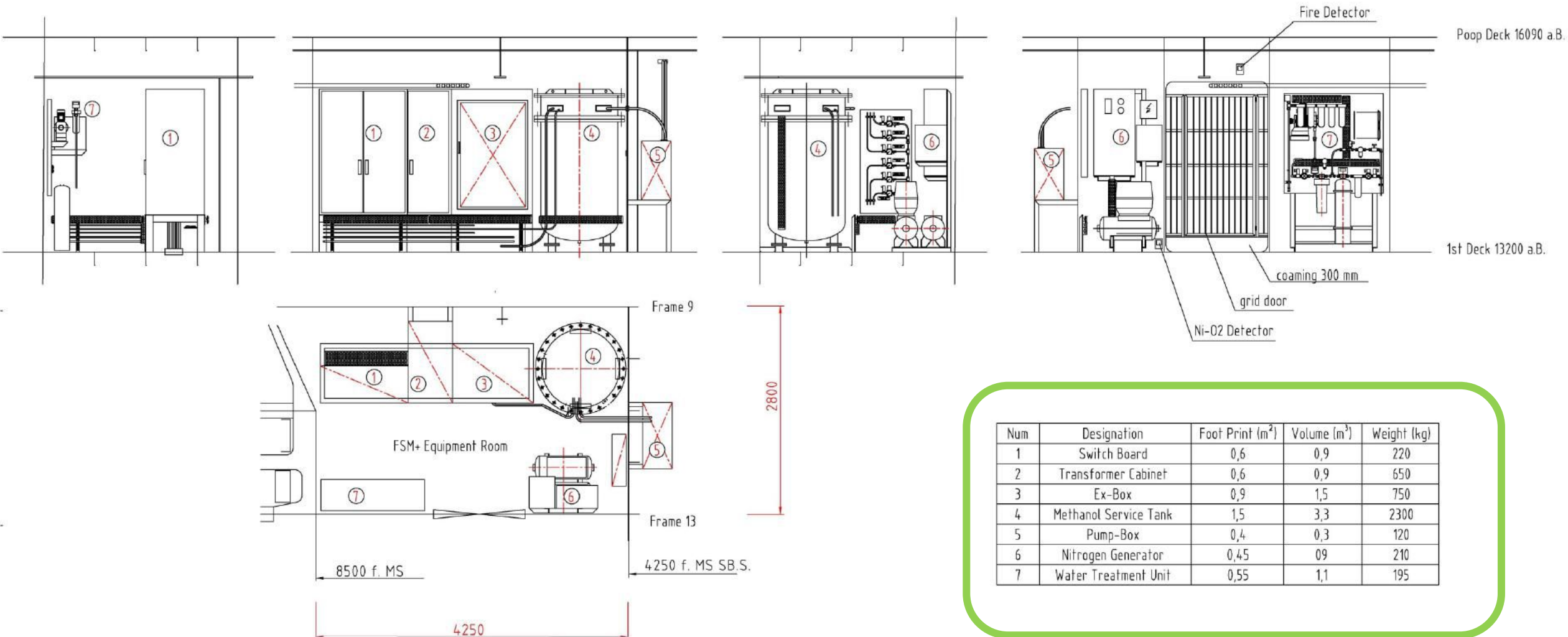
# MODULAR & SCALABLE – RETROFIT SOLUTION

MODULAR SYSTEM EASY TO RETROFIT & SCALE FROM **100 kW to 100 MW+**





# MODULAR OVERVIEW & FOOTPRINT





# LAB-PROVEN LEADING LAB IN EUROPE

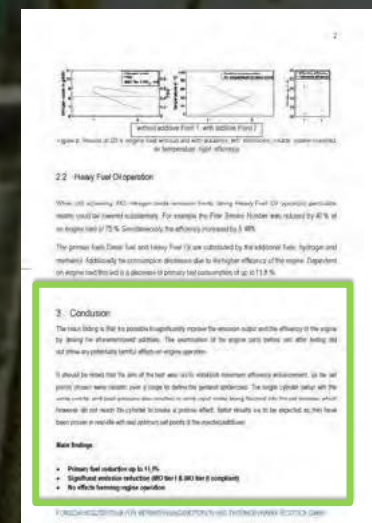


- 1) REDUCTION IN FUEL CONSUMPTION
- 2) REDUCTION IN EMISSIONS  
(IMO TIER II+ COMPLIANT)
- 3) NO HARM TO THE OPERATING ENGINE

MAK



**BOSCH**  
Invented for life





# PRODUCT FS MARINE+

4 STROKE | 2 STROKE



WORLD'S 1<sup>ST</sup>  
SOLUTION  
OF SUCH TECHNOLOGY



1<sup>ST</sup> MOVER /  
UNIQUE & PATENTED  
IN 40 COUNTRIES



FUNDED BY THE EU  
HIGHEST EVALUATION  
SCORE BY EC  
TOP SME OF EU

VOTED BY INDUSTRY "SOLUTION OF THE FUTURE"  
AND WON IN Q1 2020 THE NEPTUNE AWARDS.

AWARDED "BEST CLEAN TECH COMPANY"  
BOSTON MIT / MICROSOFT NERD CENTER" END OF 2018.



# 1<sup>st</sup> PROJECT – INCLUDING LARGEST 4 STROKE

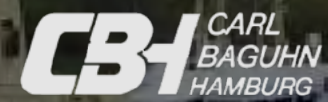


1<sup>ST</sup> CONTRACT SIGNED

+5 M EURO

6 SHIPS (93 MW)

GO LIVE  
END OF  
Q2 2021!!



ecoTune MARINE

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**2<sup>nd</sup> PROJECT — INCLUDING WORLDS 1<sup>ST</sup> METHANOL REROFIT TANK STORAGE CONTAINER**

**2<sup>nd</sup> CONTRACT SIGNED**

**4 ENGINES @ 2 ENGINE ROOMS  
[over 16 MW  
combined engine power]**

**2 METHANOL STORAGE TANKS**

**GO LIVE  
Q4 2021!!**

**Van Oord**

**Marine ingenuity**



**MAK**



**BUREAU  
VERITAS**

# LATEST PROJECT – WEST HERCULES DRILLSHIP

LATEST CONTRACT SIGNED

6 ENGINES @ 3 ENGINE ROOMS  
(48 MW combined engine power)

1 METHANOL STORAGE TANK  
CONTAINER

GO LIVE Q1 2022!!

# Seadrill<sup>★</sup>

HYUNDAI

HIMSEN



ABS<sup>®</sup>



# OUTPERFORMING ALTERNATIVE OPTIONS

FS MARINE+

**10 %**

FUEL SAVINGS

**27.000**

mt

HFO on MAIN

**3.000**

mt

MDO on AUX

WIND ROTOR

**-374.438 tons**  
**Co2-e!**

OVER

**400 %**

**HIGHER EMISSION REDUCTION**  
**PER VESSEL**

**-87.814 tons**  
**CO2-e!**

CO2:	9.866 TONS	
NOX:	838 TONS	[GWP 298]
BC:	35,9 TONS	[GWP 3200]

CO2:	8.912 TONS	
NOX:	156 TONS	[GWP 298]
BC:	10,1 TONS	[GWP 3200]



**ROI ~ 3 YEARS**

without Emission tax savings or  
Carbon Offsetting schemes or  
fleet rollout


**-28.296 tons CO2-e!**

PER SUPPLY VESSEL PER YEAR!

**CO2: 1.052 TONS**

**NOX: 58 TONS** [GWP 298]

**BC: 3 TONS** [GWP 3200]



# ROI ~ 2,7 YEARS

without Emission tax savings or  
Carbon Offsetting schemes or  
fleet rollout

## -54.429 tons CO2-e!

PER JACKUP RIG PER YEAR!

CO2:	1.989 TONS	
NOX:	121 TONS	[GWP 298]
BC:	5 TONS	[GWP 3200]



# ROI ~ 2,3 YEARS

without Emission tax savings or  
Carbon Offsetting schemes or  
fleet rollout

## -115.146 tons CO2-e!

PER RIG PER YEAR!

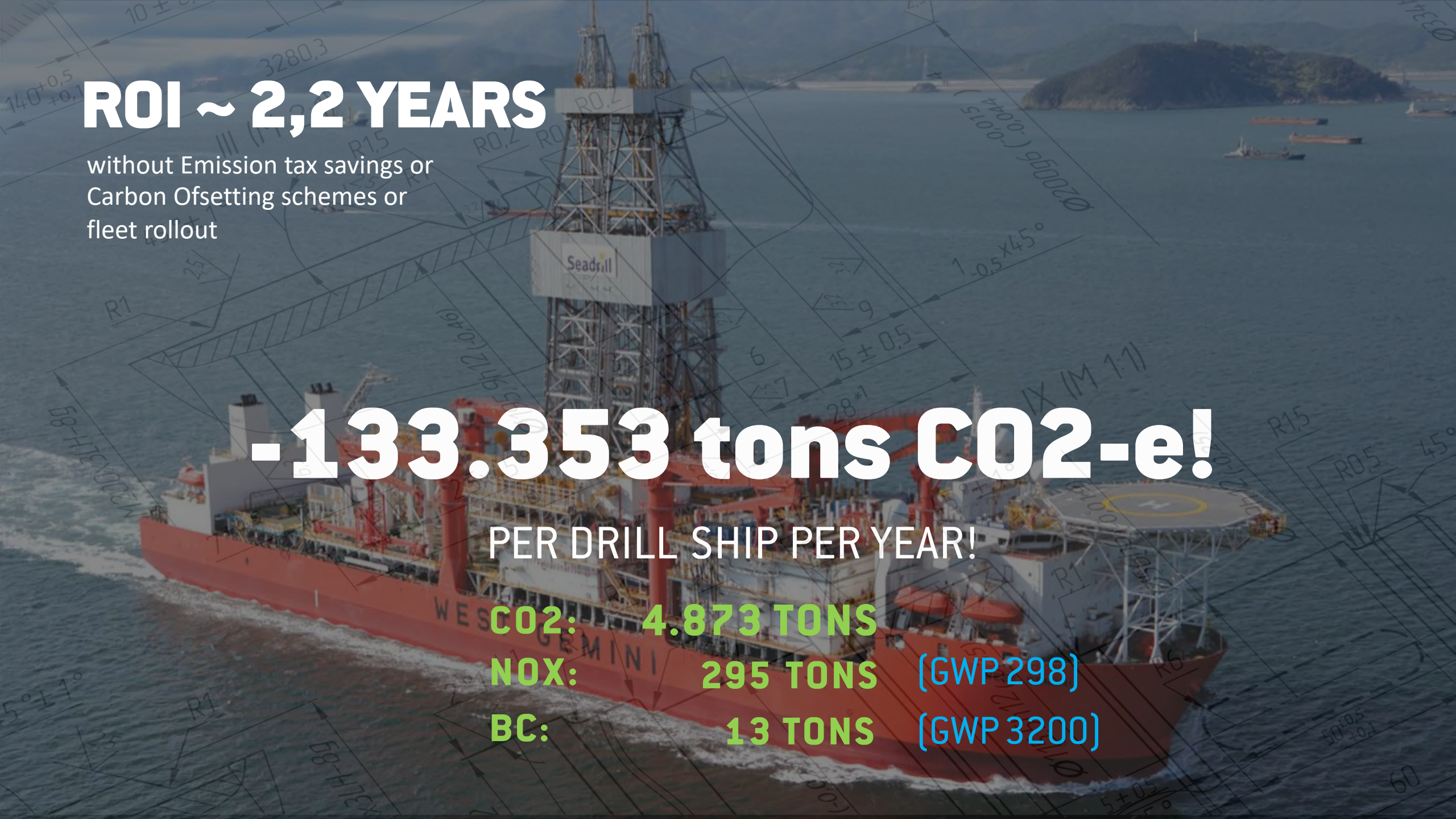
**CO2: 4.208 TONS**

**NOX: 231 TONS**

**BC: 9 TONS**

[GWP 298]

[GWP 3200]



**ROI ~ 2,2 YEARS**

without Emission tax savings or  
Carbon Offsetting schemes or  
fleet rollout

**-133.353 tons CO2-e!**

PER DRILL SHIP PER YEAR!

<b>CO2:</b>	<b>4.873 TONS</b>	
<b>NOX:</b>	<b>295 TONS</b>	<b>[GWP 298]</b>
<b>BC:</b>	<b>13 TONS</b>	<b>[GWP 3200]</b>



# ROI ~ 1,9 YEARS

without Emission tax savings or  
Carbon Offsetting schemes or  
fleet rollout

## -265.342 tons CO2-e!

PER CRUISE SHIP PER YEAR!

CO2: 7.208 TONS

NOX: 593 TONS [GWP 298]

BC: 25 TONS [GWP 3200]



# ROI ~ 1,5 YEARS

without Emission tax savings or  
Carbon Offsetting schemes or  
fleet rollout

## -442.401 tons CO2-e!

PER CONTAINER VESSEL PER YEAR!

**CO2: 12.438 TONS**

**NOX: 958 TONS** [GWP 298]

**BC: 45,2 TONS** [GWP 3200]



# REAL-TIME CONSUMPTION RECORDING



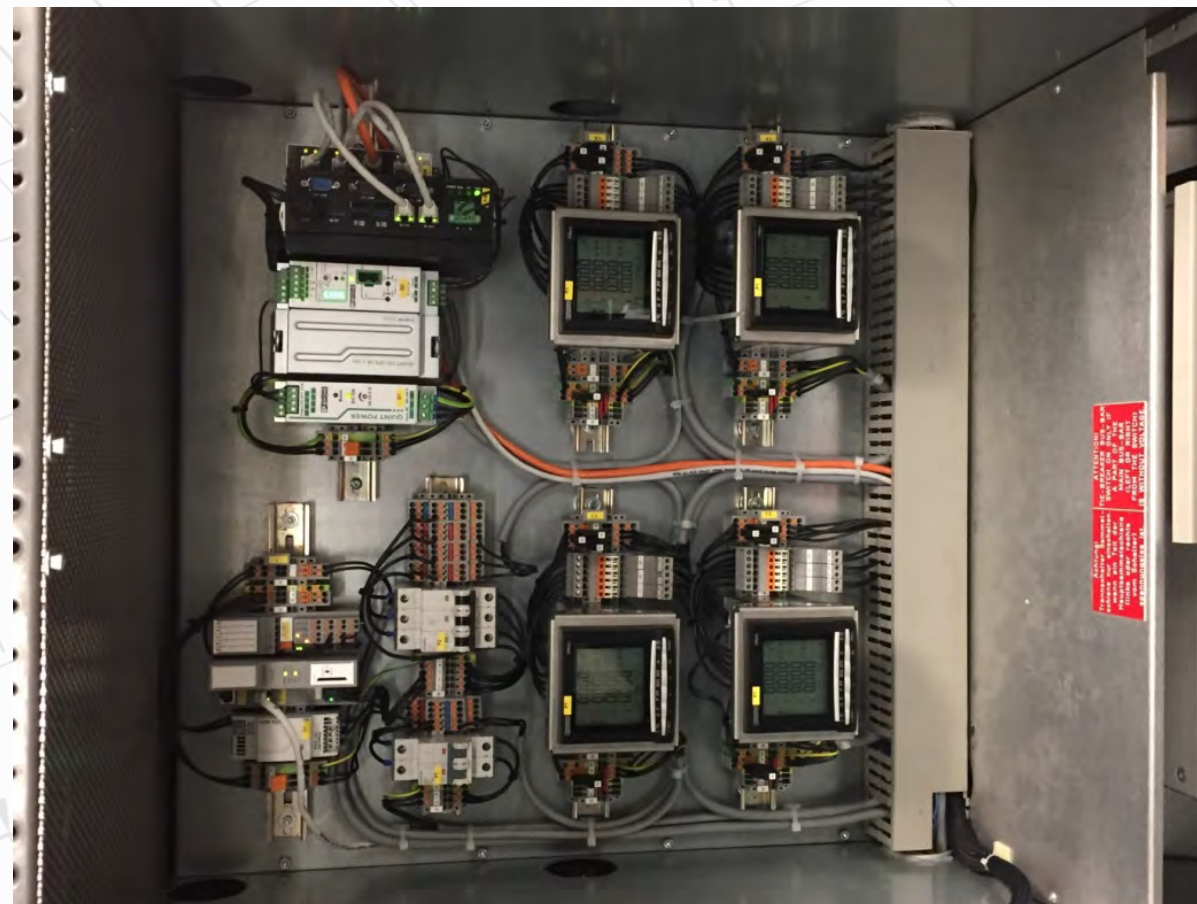
FUEL OIL CONSUMPTION RECORDING  
COR-NET CORIOLIS MASS FLOW METER



SPM-NET SHAFT POWER METER



ENGINE LOAD RECORDING  
CONTROL & MANAGEMENT LOGIC / SPS

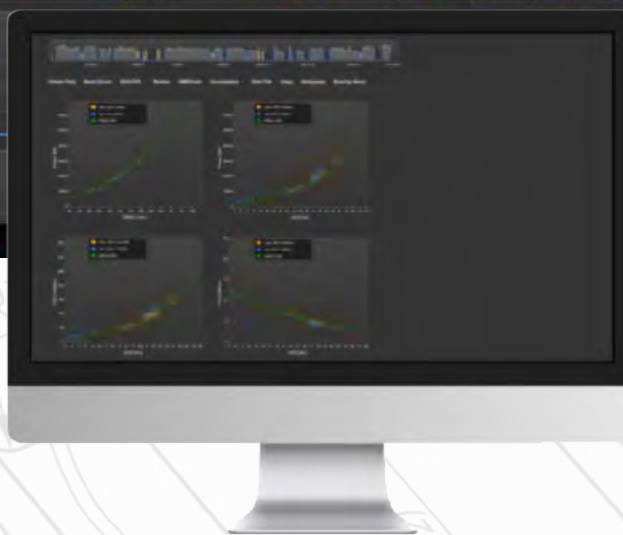
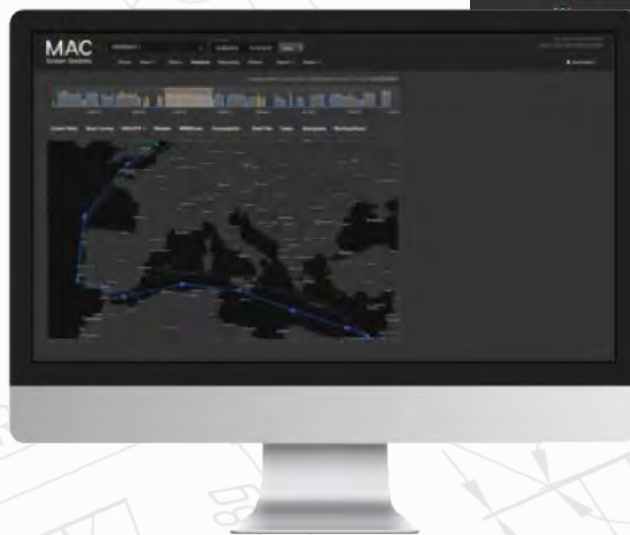
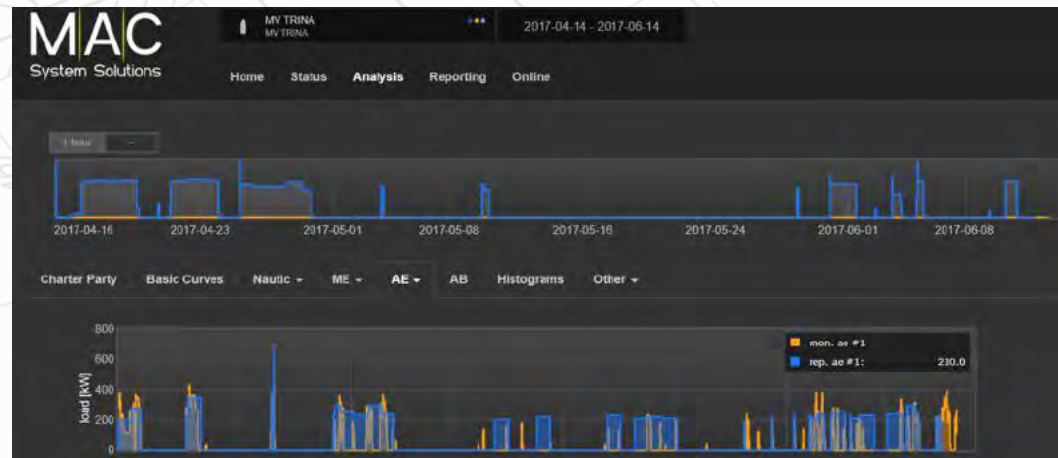




# REAL-TIME PERFORMANCE MONITORING



MAC SYSTEM SOLUTIONS – CERTIFIED END-TO-END MONITORING



OFFICIAL DNV GL PARTNER FOR PERFORMANCE MONITORING



# IMO 2020 / TOWARDS NET ZERO !

## 4 BASIC CHOICES TODAY (IMO 2020)

- USE **MDO / MGO** (DISTILLATE)
- USE **NEW COMPLIANT FUELS**
- INSTALL **SCRUBBER**  
(USE WITH HFO)
- SWITCH TO **LNG**

## ISSUES + **FSM**+ BENEFITS

### HIGHER FUEL PRICES & HIGHER OPEX

→ BETTER BUSINESS CASE & ROI + EMISSION REDUCTION

### UNCERTAINTIES IN PERFORMANCE (i.e. VLSFO & BC)

→ PROVIDES FLEXIBILITY IN ADJUSTING FOR NEW FUELS IN THE FUTURE TO OPTIMIZE COMBUSTION

### INCREASE CO2 EMISSIONS

#### SYNERGIES WITH A SCRUBBER

→ BETTER BUSINESS CASE & ROI WITH FS MARINE+  
→ REAL CO2 & NOX REDUCTION + PM REDUCTION

### INCREASE GHG EMISSIONS

→ MITIGATE THE METHANE SLIP  
→ OPTIMIZE PM (LEAN COMBUSTION)  
→ ACHIEVE OPEX SAVINGS

## 3 BASIC CHOICES TOMORROW (TOWARDS NET ZERO)

### CARBON OFFSETTING & EMISSION TRADING

(EU – ETS)

- GOOD INITIATIVES & COMPLEMENTARY  
→ BUT JUST TREATING SYMPTOMS

### CARBON CAPTURE / STORAGE / UTILIZATION

(CCSU)

- GOOD INITIATIVES & COMPLEMENTARY  
→ BUT JUST TREATING SYMPTOMS

### CLEAN FUELS / BIO FUELS / (GREEN) E-FUELS (RENEWABLES)

- WILL MAKE SOME EMISSION REDUCTION TECHNOLOGIES OBSOLETE  
BUT **WILL MAKE COST SAVINGS EVEN MORE IMPORTANT**  
DUE TO HIGHER COSTS OF CLEAN FUELS.

## CLEAN RENEWABLE CIRCULAR FUELS (INCLUDING DROP-IN CLEANFUELS) & OPTIMIZED COMBUSTION & EFFICIENCY

DIRECTLY ADDRESSING THE ROOT OF THE PROBLEM IN RETROFITS - TODAY





# BUSINESS MODEL

AS PART OF THE GO-TO-MARKET (GTM) AND GROWTH STRATEGY, A VERSATILE BUSINESS MODEL HAS BEEN DEVELOPED EMBRACING VARIOUS TYPOLOGIES OF TRANSACTIONS FOR INCREASING TOP-LINE REVENUE.



**B2C**

**BUY /**  
**DIRECT SALES**



**B2B**

**LEASE /**  
**EAAS**



**LICENSING /**  
**CONTRACTING**



# WHAT'S NEXT FOR R&D?

## BOOTSTRAPPED – NOW OPENING FOR INVESTORS



LARGEST 4 STROKE  
SINGLE ROW ENGINE  
IN THE MARKET

PROJECT DELIVERY  
ACCEPTANCE &  
DISSEMINATION

--> ROLLOUTS



2 STROKE  
TESTBENCH & PILOT

LATEST DUAL FUEL ENGINE  
TEST WITH LIQUID  
VLSFO / HFO / MDO &  
GASEOUS FUELS  
(LNG / SNG)



R&D ACTIVITIES

- A. METHANE SLIP  
REDUCTION FOR LNG
- B. IMO TIER 3 COMPLIANCE  
WITHOUT SCR / DPF
- C. AMMONIA ICE  
OPTIMIZATION

- ✓ SUSTAINABLE CLEAN FUEL TRANSITION.
- ✓ REDUCE OPEX & INCREASE PROFITS.
- ✓ CO2 & CO2-e REDUCTION. TODAY!

THANK YOU VERY MUCH !

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