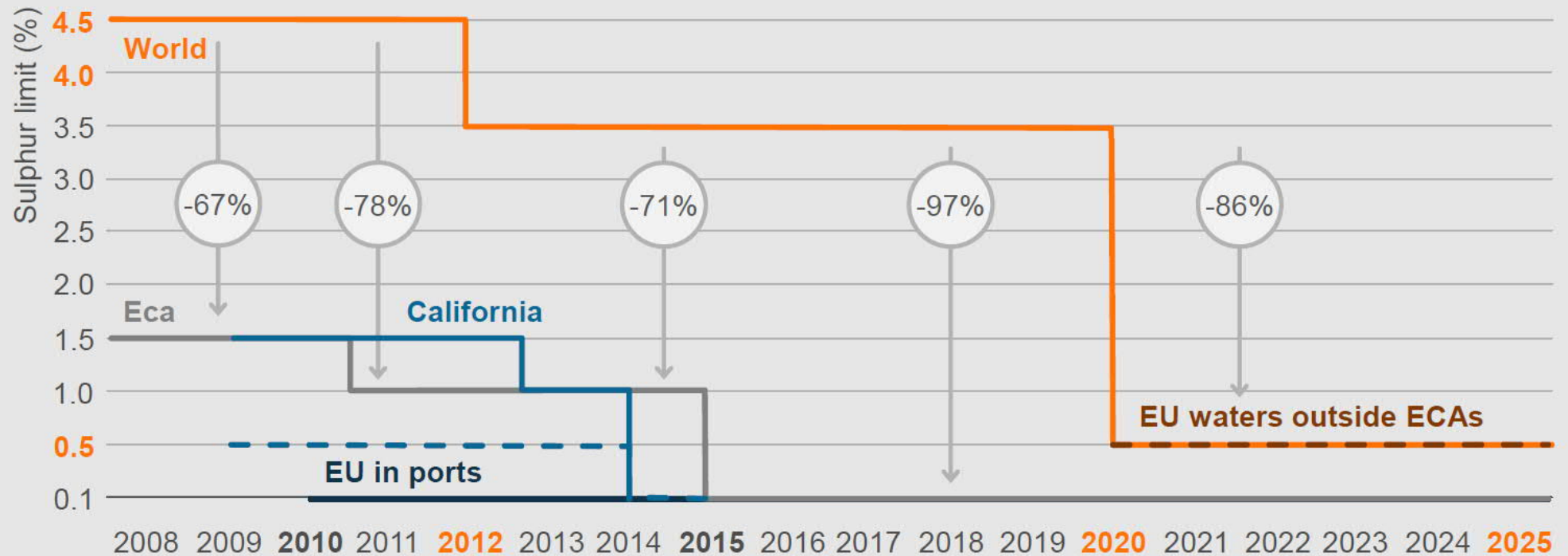


MARPOL 2020 Compliance and Beyond :OEM Perspective

Sachin Kulkarni
Head-Marine Sales (South Asia)
Wartsila India

Stepwise sulphur reductions & 2020 Global Marine Fuel Sulphur Cap



LEGISLATION SETS MILESTONES

2020

2030

2050

0.5%
SO_x

40%
GHG

50%
GHG

Emissions from engines can be divided in two categories

Category 1: Local emissions:
health & environment related

- Mainly NO_x, SO_x and particulates
- Contribute to deterioration of human health, loss of wellbeing, early death
- Also impact the environment on short term
- Impact is very much on location of emission.

Category 2: GHG emissions:
climate related

- Mainly CO₂ and CH₄ (methane)
- Contribute to global warming / climate change, however CH₄ is 28 times more potent as CO₂.
- Low to no impact on human health or environment on immediate terms
- Impact is not dependent on location of emission, as climate change is a global problem

CATEGORY 1 LOCAL EMISSIONS

Main health and environment related local emissions from engines



SULPHUR DIOXIDE (SO₂)



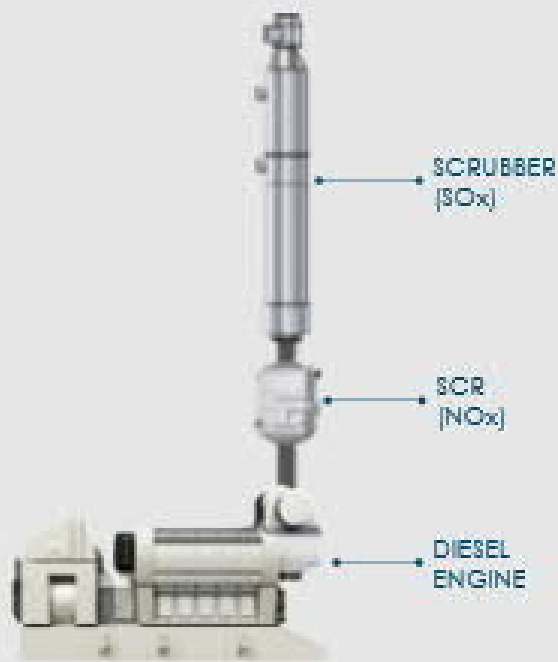
NITROGEN OXIDES (NO_x)



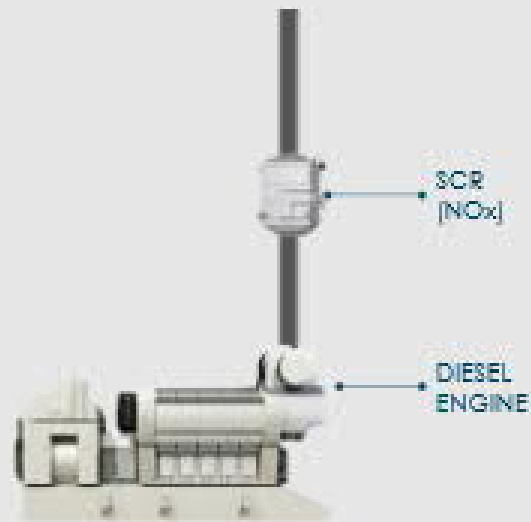
PARTICULATE MATTER (PM)

IMO global sulphur limit IMO tier III For NO_x

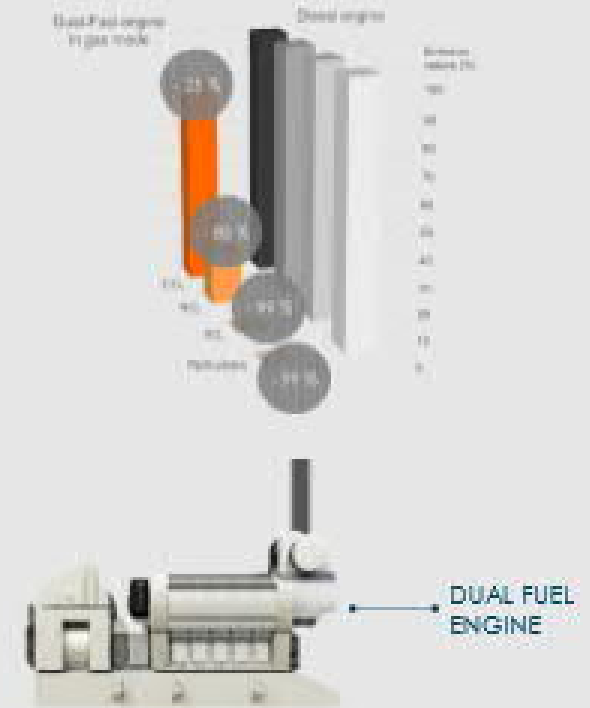
High sulfur fuel
(S > 0,1%)



Low sulfur fuel
(S < 0,1%)



LNG



OPERATIONAL GUIDELINES / TRAINING

- Selection of lubricants (for ordering)
 - HFO engines starting to alternate between HFO and LSHFO or LFO can typically continue with the same lubricating oil as before.
 - HFO engines starting to operate continuously on LSHFO can often start using lubricating oil with lower BN typically 30 or 40.
 - HFO engines starting to operate continuously on LFO should start using lubricating oil with lower BN typically 10 – 20.
- Minimum LFO viscosity when ordering
 - The minimum viscosity of the fuel supplied to diesel engines is in the range 1,8...3,0 cSt.
- Maximum LFO temperature –before injection pump 45 deg C.
- HFO/LSHFO switch-over procedures
- HFO/LFO switch-over procedures
- Onboard fuel compatibility tests
- Cylinder oil feed rate (2-stroke)
- Analysis of piston underside drain oil (2-stroke)
- Flash point and viscosity analysis of lube oil (4-stroke)

DIESEL ENGINES

- Anti-Polishing Rings (2-stroke)
- Tribopack (2-stroke)
- Exhaust valves (4-stroke)
- Check of fuel rack adjustment for increased pump wear
- ME speed governor
- Start fuel limiter
- Load increase rate (2-stroke)

SYSTEMS

- HFO settling tanks
- HFO service tanks
- HFO bunker tanks
- LFO tanks
- HFO separators
- LFO separators
- HFO/LFO blending unit
- LFO cooler
- Fuel return line to LFO service tank
- HFO/LFO switch-over arrangements
- Cylinder oil storage / daily service tanks (2-stroke)
- Fuel filter differential pressure monitoring

CATEGORY 2: GREENHOUSE GAS (GHG) EMISSIONS



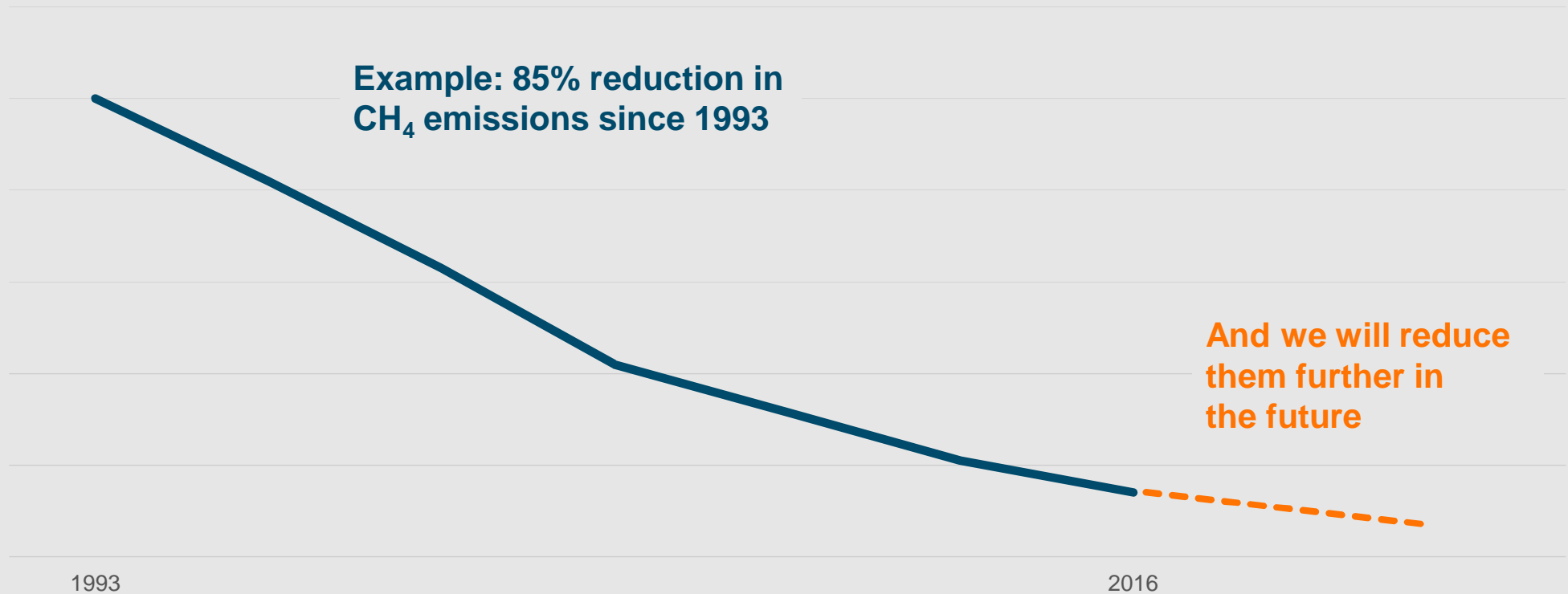
**Emission of greenhouse gases cause
a warming and changing of climate**

GHG EMISSIONS IN WÄRTSILÄ ENGINES

EMISSIONS AND
WÄRTSILÄ ENGINES

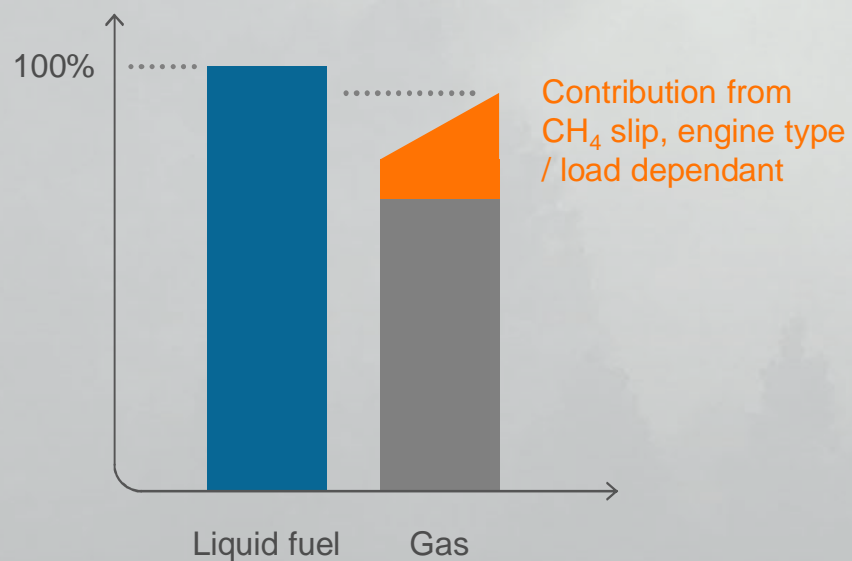
GHG emissions from Wärtsilä engines have been decreasing for decades

Wärtsilä gas engines now outperform Wärtsilä diesel engines by 12-30%

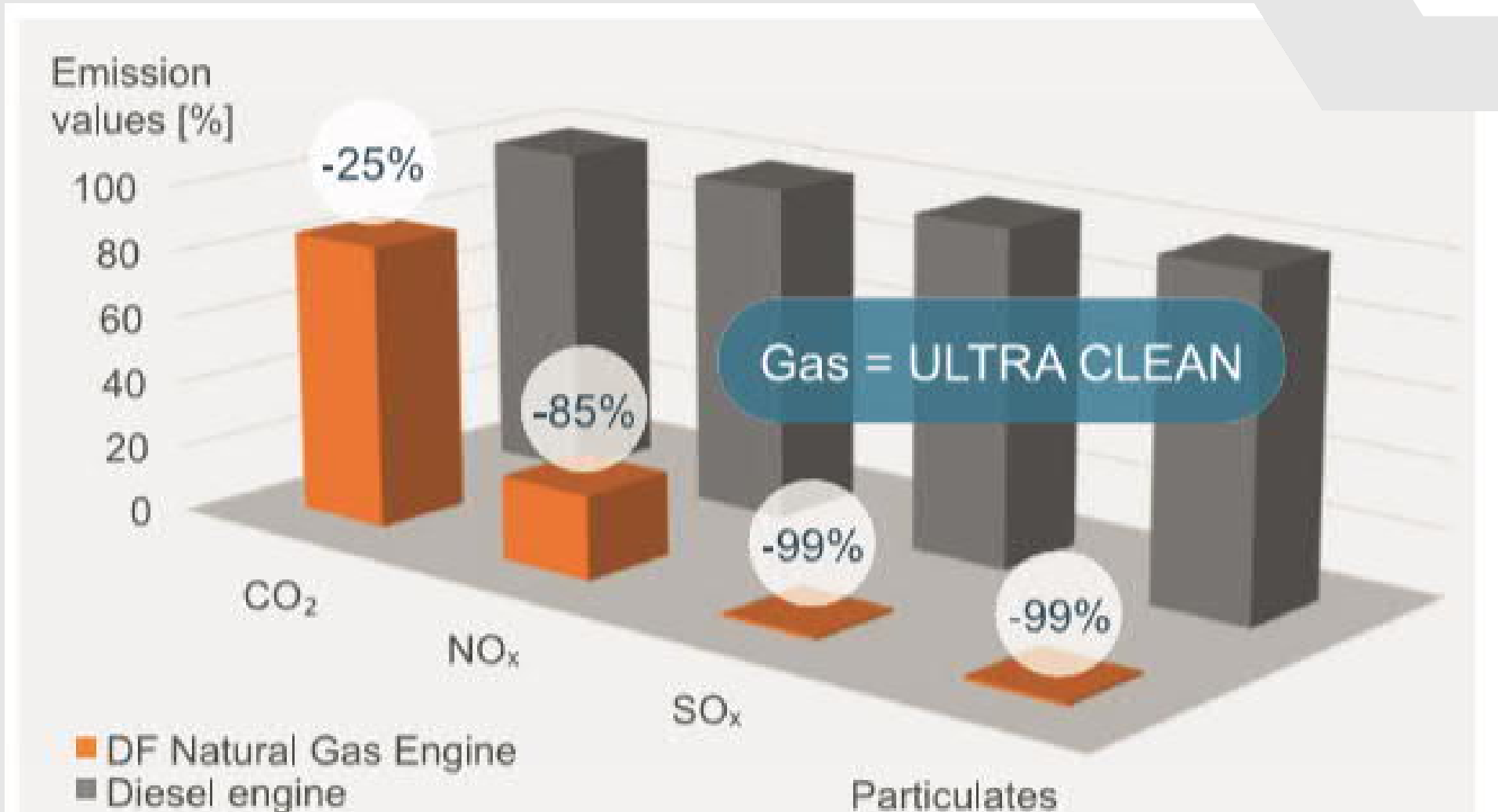


Diesel and gas engines produce greenhouse gases...

Indexed GHG emissions as CO₂ equivalents



...but gas engines compare favorably to diesel engines!



EMISSION REDUCTION TECHNOLOGIES

EMISSIONS AND
WÄRTSILÄ ENGINES

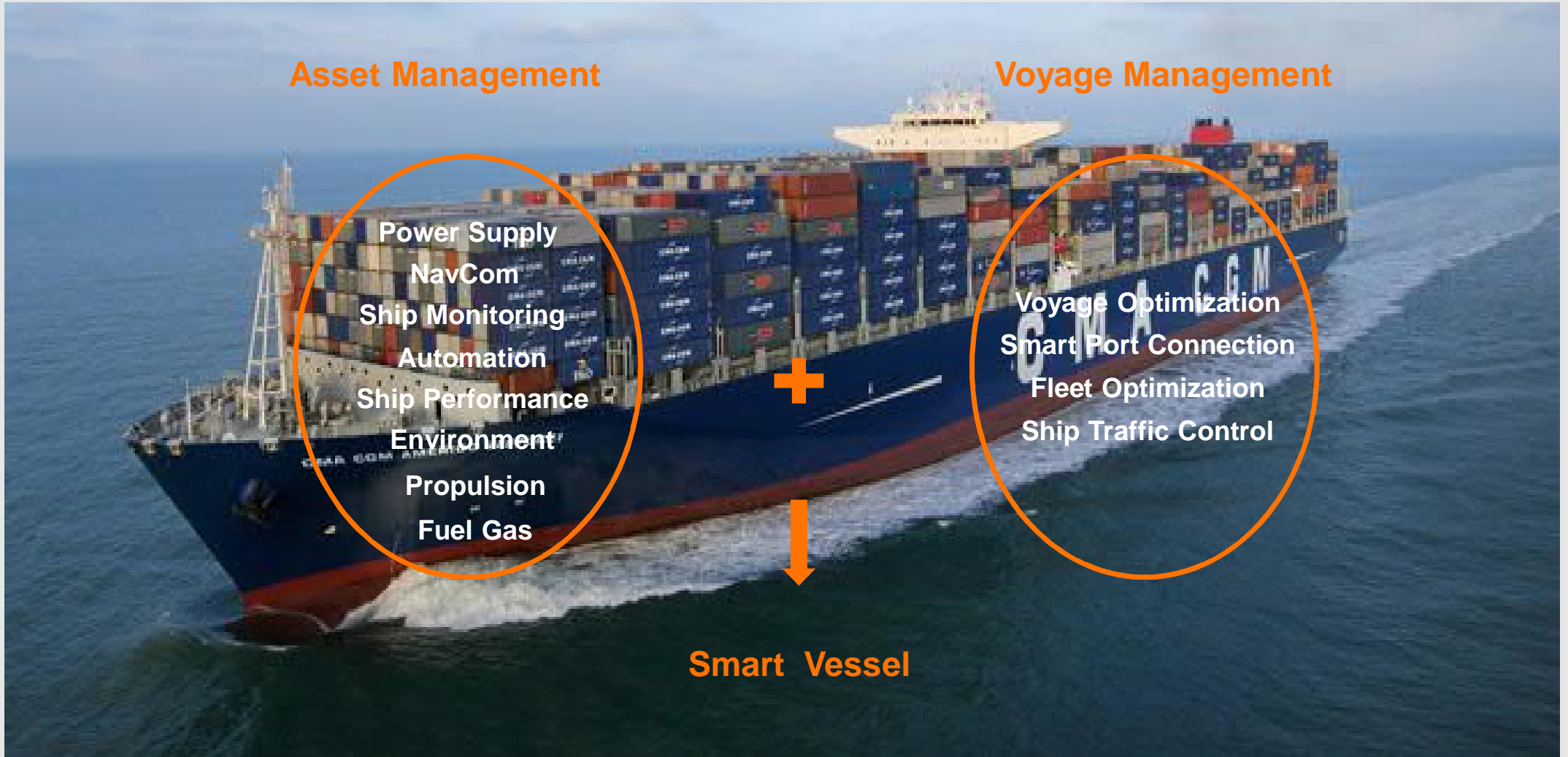
Many options exist to reduce GHG emissions

Engine efficiency improvements, leading to lower engine CO₂ emissions

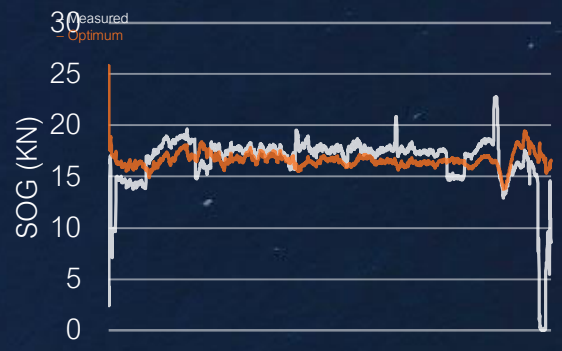
Fuel de-carbonization, utilizing fuels with a lower carbon content such as LNG or biofuels

Lowering non-CO₂ emissions. Prime example is CH₄ emitted from gas engines.

Connecting the entire ecosystem, improving efficiencies and performance by connecting the ships with ecosystem

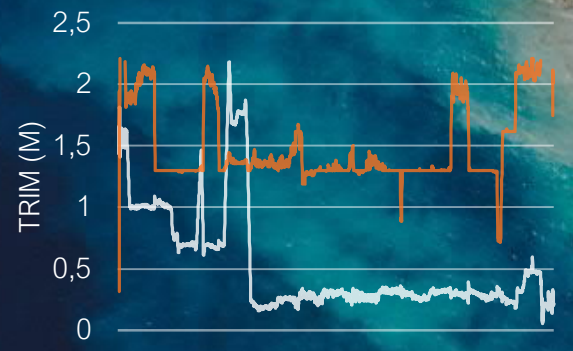


OUR VOYAGE



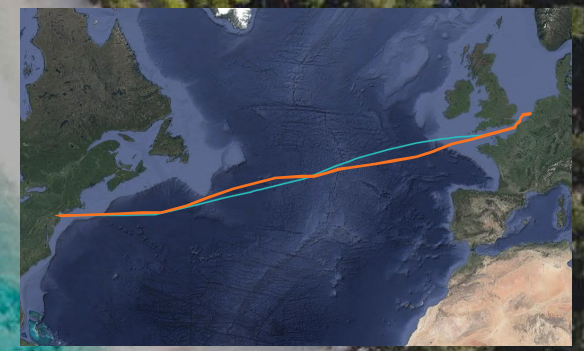
SPEED & POWER PLANT

-7.1%



TRIM

-2.1%



ROUTE

-2.7%

OUR VOYAGE

12.1% energy saved


340 T
CO2

Annual 9 200 t


110 T
FUEL

Annual 2 930 t


53 000 €

Annual 1 430 000 €

ENHANCED SAFETY & EFFICIENCY ACROSS THE WHOLE VALUE CHAIN

AIR

safest route
up to 5-7% fuel savings



AID

automatic anomaly
detection
dangerous situation
prevention



AIM

15-20 min trajectory prediction
reduced risks of collisions
reduced risks of human errors
safety in congested areas



FUTURE OUTLOOK

EMISSIONS AND WÄRTSILÄ ENGINES



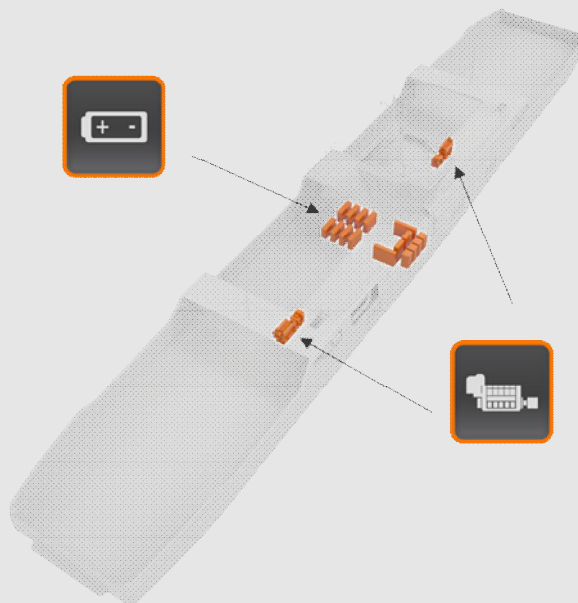
Fuel choice for environmental regulation compliance?



Batteries are coming and are here to stay

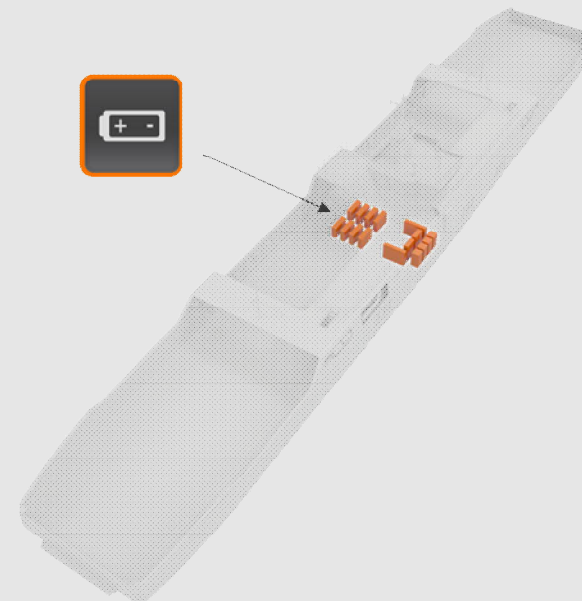
HYBRID (+ PLUG-IN HYBRID)

Batteries combined with engine to optimize performance in specific conditions (e.g. DP)



ALL-ELECTRIC

Batteries used as the only power source all the time during operations (short routes only)



Wärtsilä Hybrid

- Hybrid solution is a combination on traditional generating sets with batteries
- Peak load shaving: picking up top transitional loads allowing to decrease the total installed power





Taking power from the shore

Increasing pressures on ship operators and port authorities to minimize the impact of air pollution and noise emissions by way of meeting strict environmental regulations are now a worldwide concern.

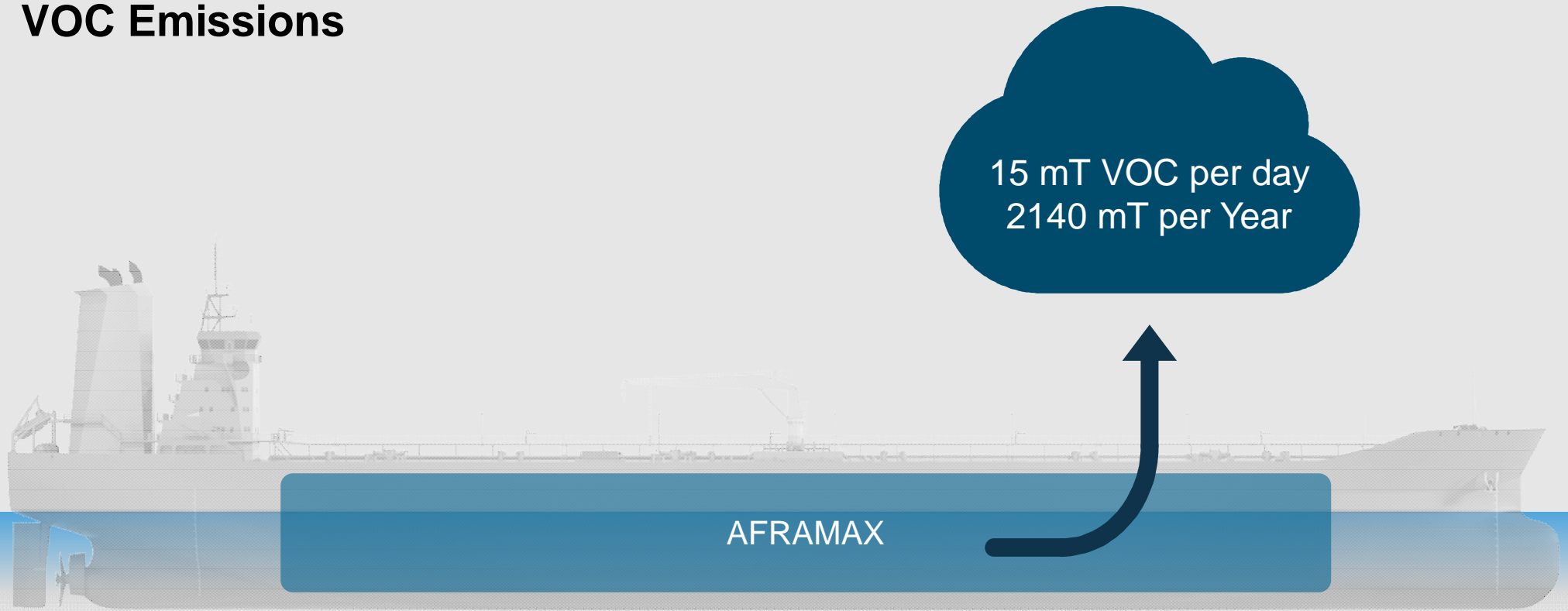
Providing electricity to ships from the shore is a smart way of complying with port emission requirements, and our Shore Connection is the simplest and most cost effective way to do it.



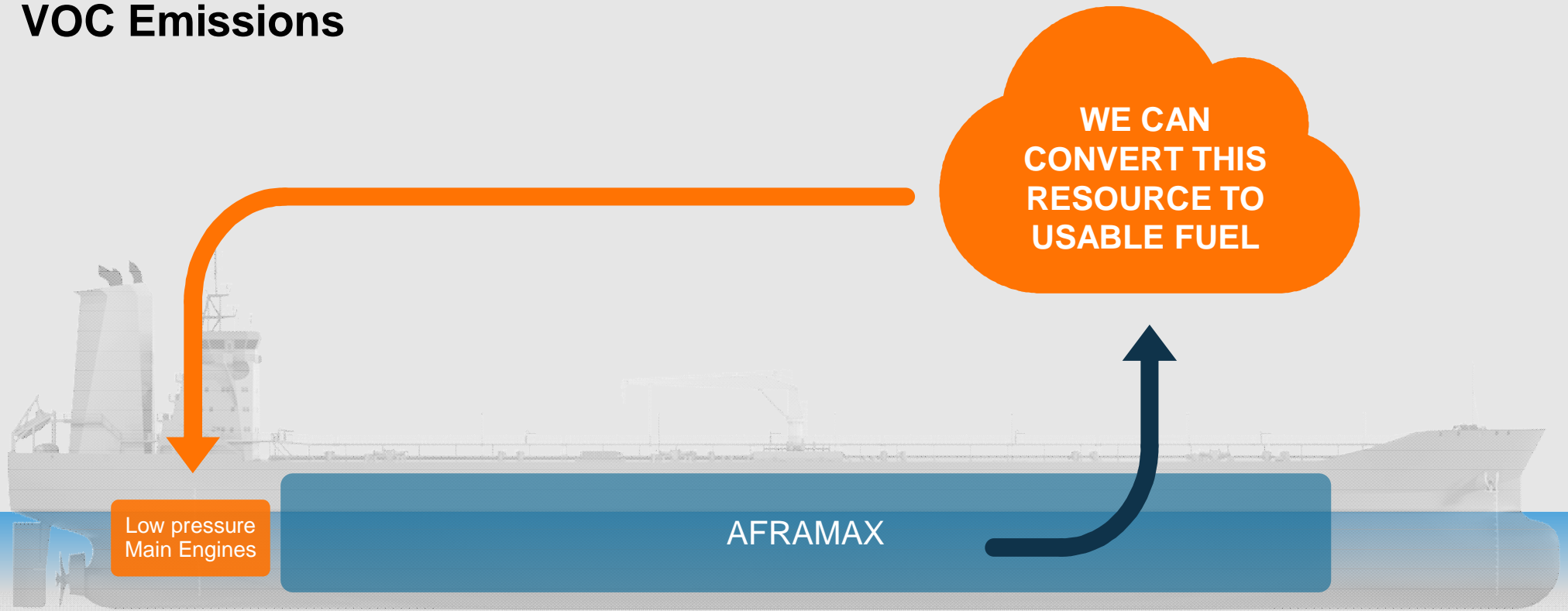


VER™ Voyage emission recovery

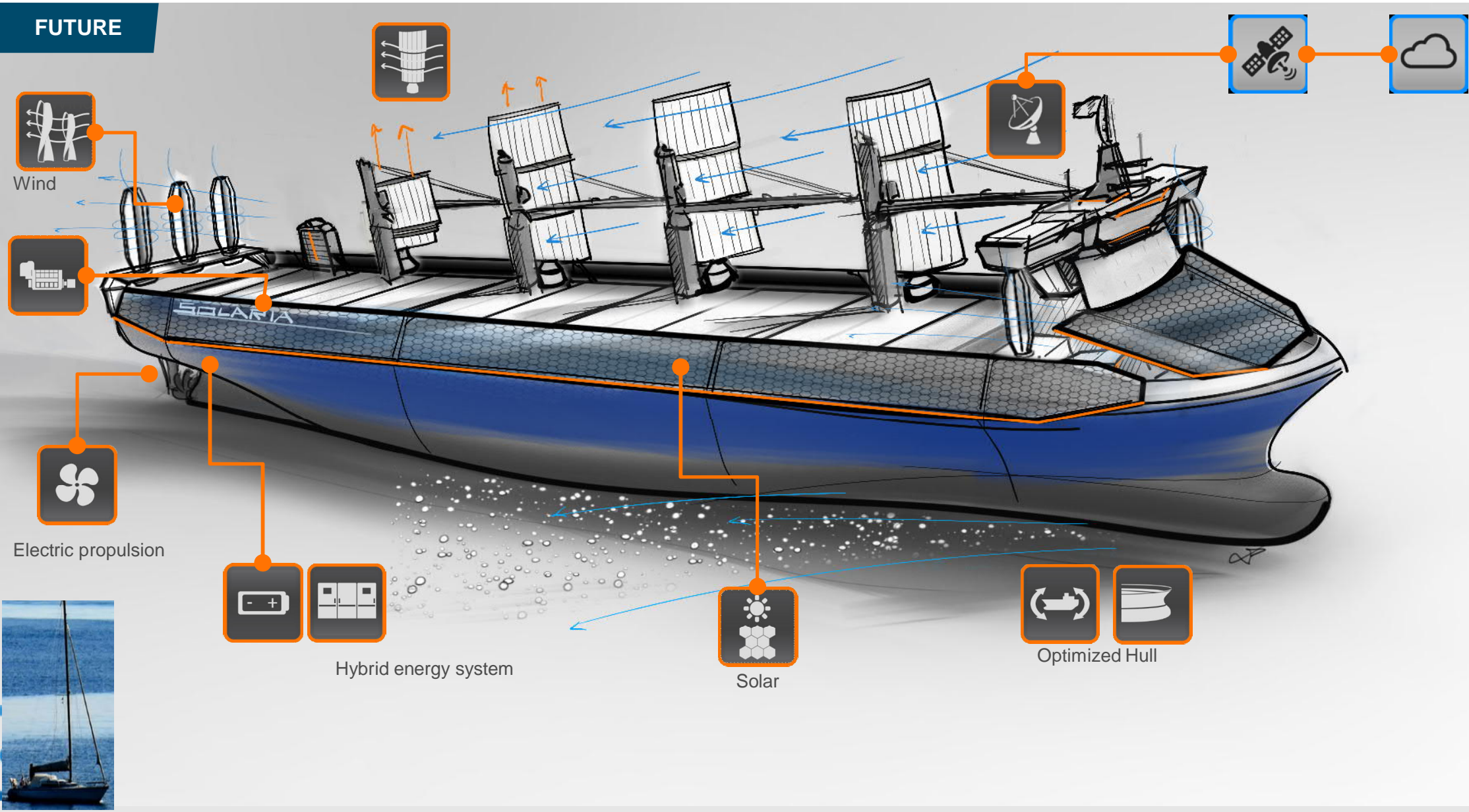
VOC Emissions



VOC Emissions



FUTURE



DON'T FORGET! POWER GENERATION & TRANSPORT ALSO HAVE A HUGE POSITIVE IMPACT!



Power generation and transport has lifted billions of people out of poverty, and continues to do so!

**Power is great, as long as it is produced with great care.
Let's build a sustainable society together!**



THANK YOU



WÄRTSILÄ