

PureSOx

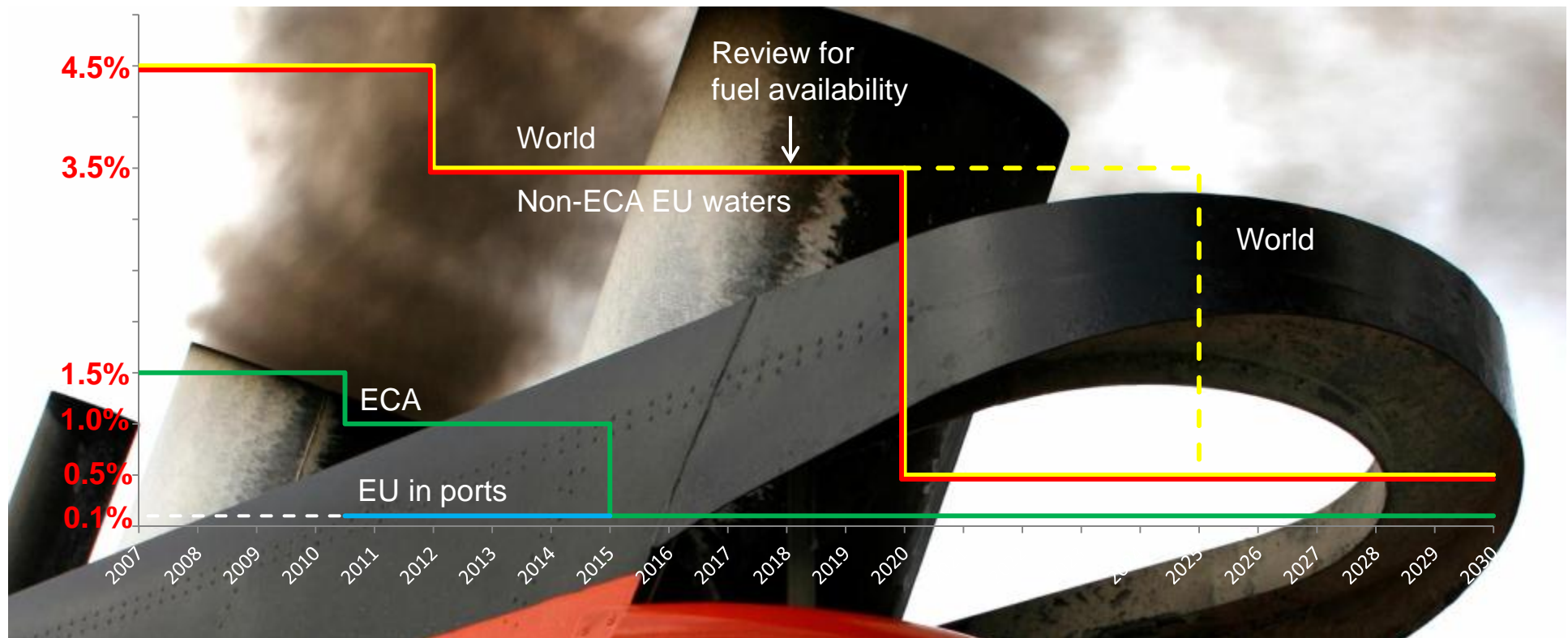
The proven route to competitive ECA compliance

Current Status and Issues of
SOx Scrubber Technology



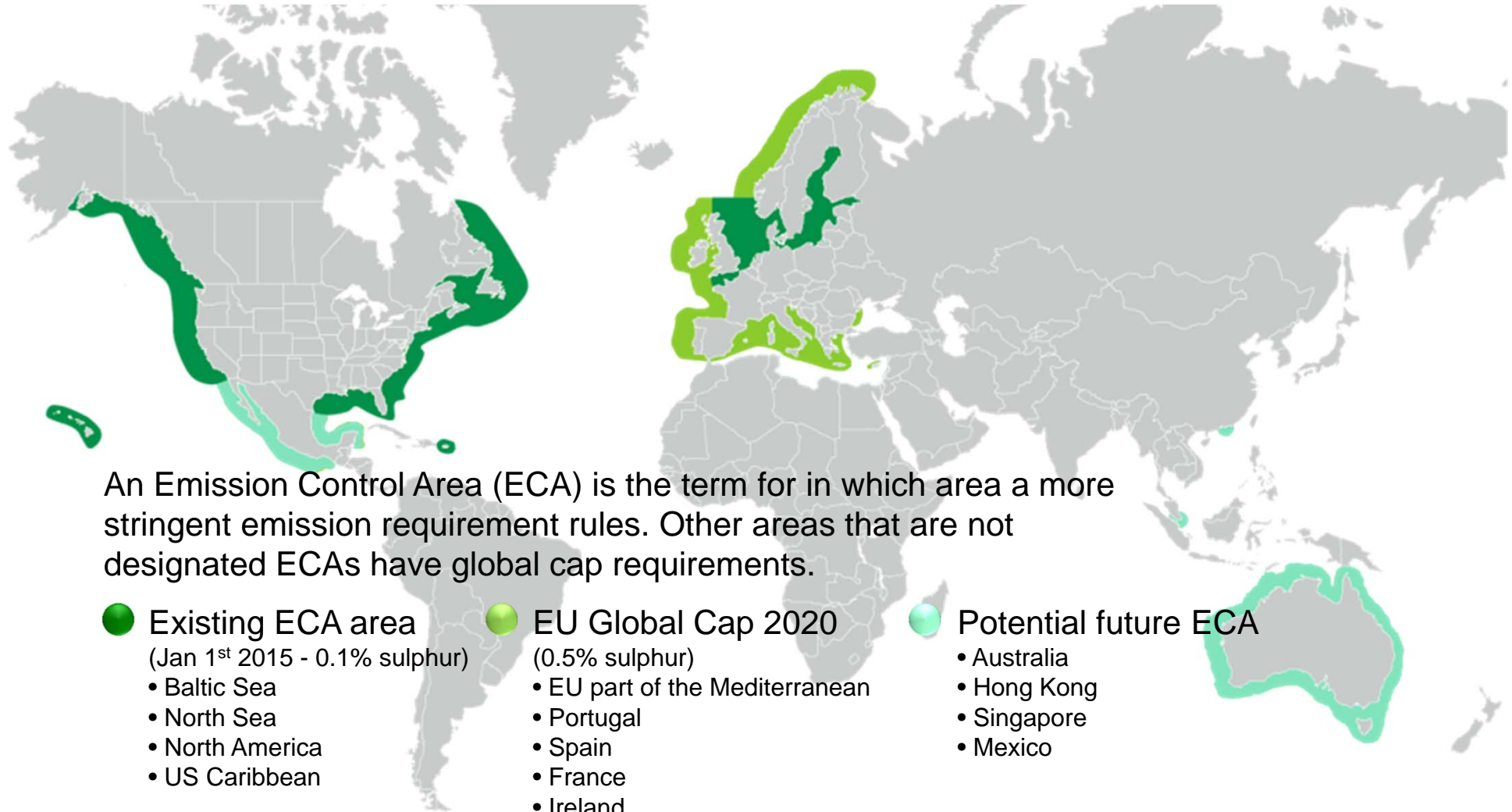
SO₂ legislation

SO₂ reduction schedule



* ECA – Emission Control Area

Sulphur emission control



An Emission Control Area (ECA) is the term for in which area a more stringent emission requirement rules. Other areas that are not designated ECAs have global cap requirements.

- Existing ECA area
(Jan 1st 2015 - 0.1% sulphur)
 - Baltic Sea
 - North Sea
 - North America
 - US Caribbean

- EU Global Cap 2020
(0.5% sulphur)
 - EU part of the Mediterranean
 - Portugal
 - Spain
 - France
 - Ireland
 - UK non-ECA
 - Norway

- Potential future ECA
 - Australia
 - Hong Kong
 - Singapore
 - Mexico

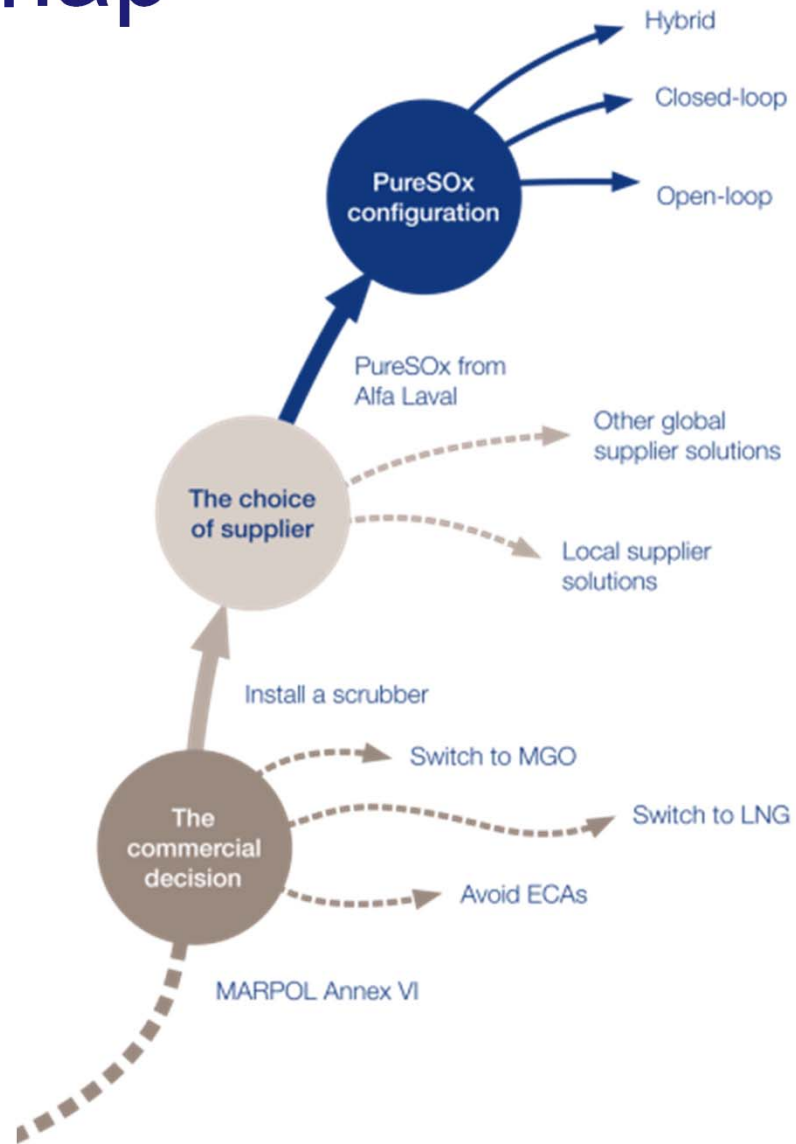
MEPC.184(59)

Emission limits according to the Guidelines

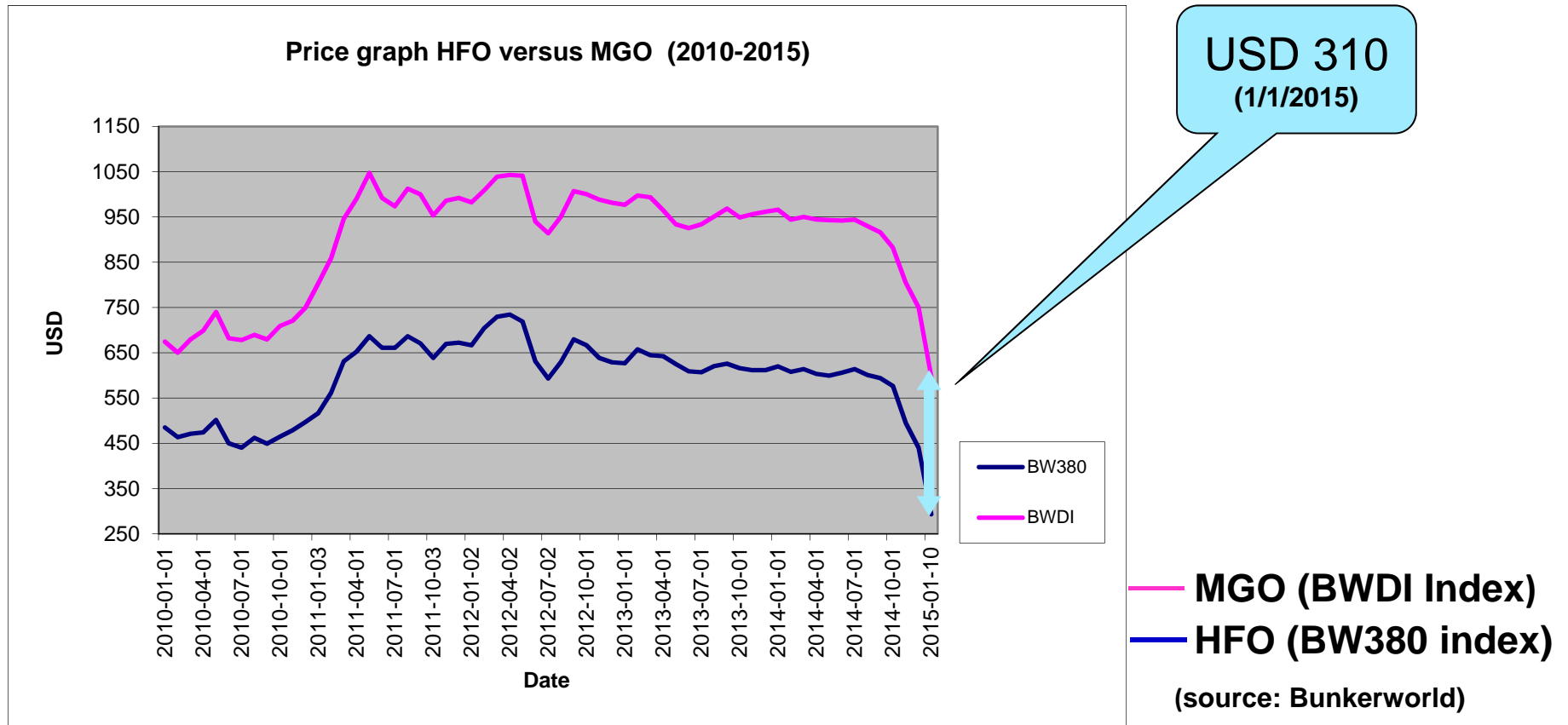
- SO_x (ECA)
 - Before 2015: 43 ppm SO₂/% CO₂
 - After 2015: 4.3 ppm SO₂/% CO₂
- Turbidity: 25 FNU or NTU above inlet
- PAH: 50 µg/L above inlet (water flow depend.)
- pH:
 - Inlet vs. outlet: ΔpH 2
 - Ref. outlet pH: pH 6.5 at 4 m from discharge

Solutions

Decision map



Fuel price development



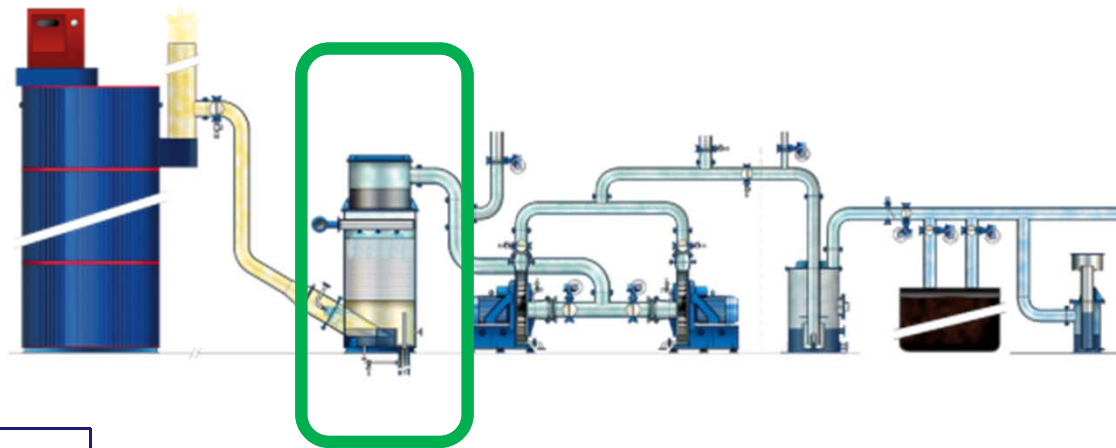
PureSOx

The proven route to
competitive ECA compliance

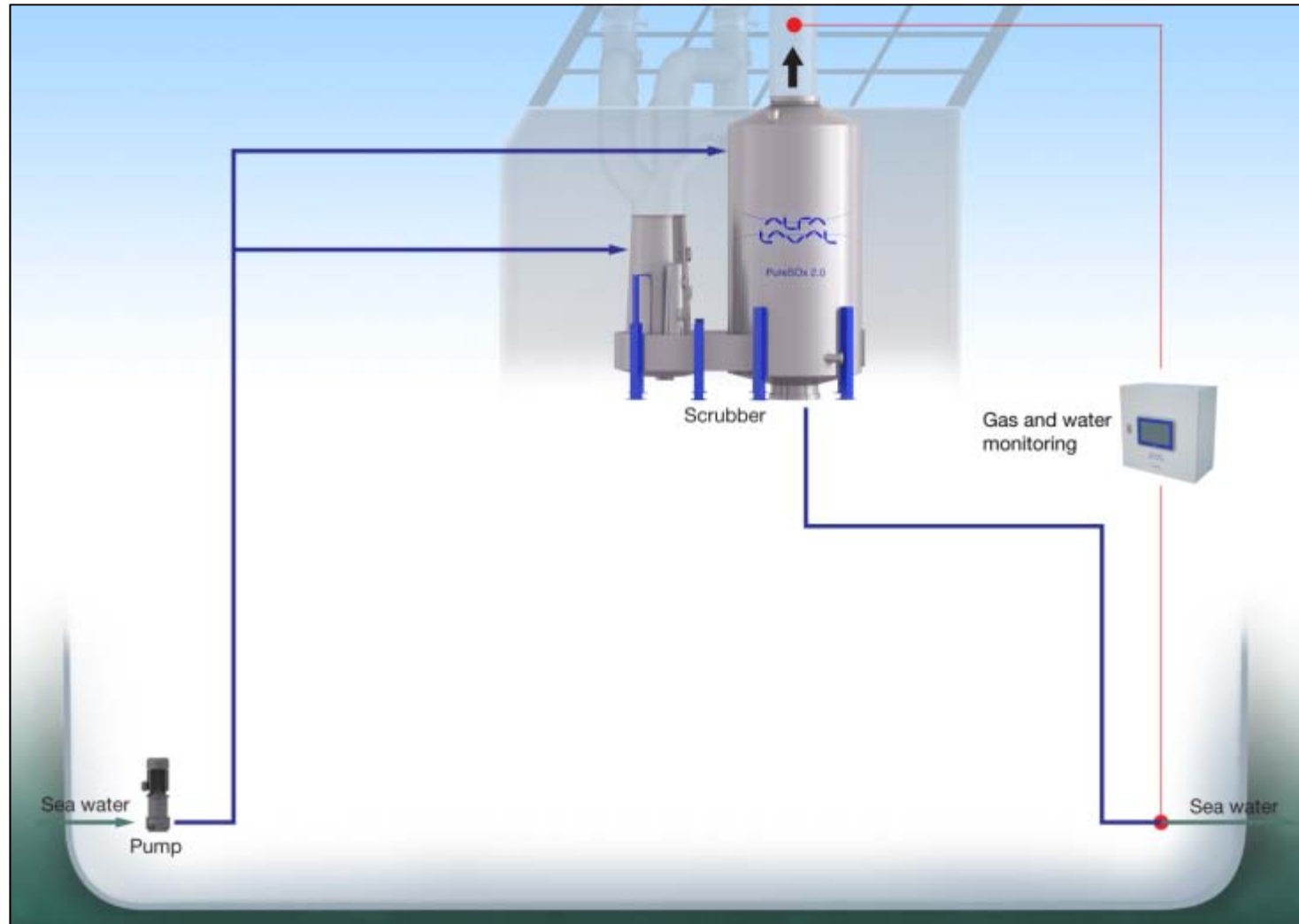


History of PureSO_x

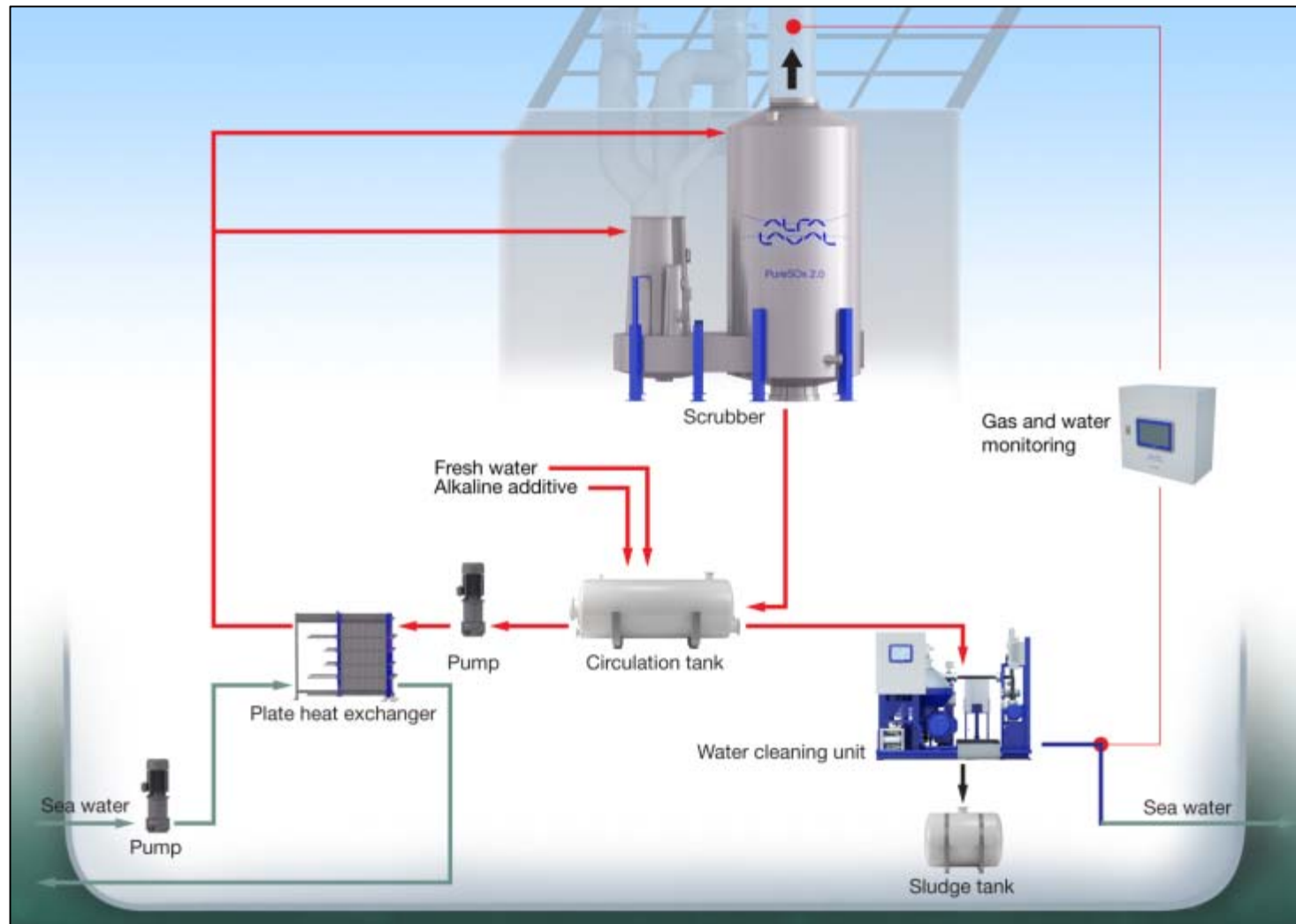
- ~1000 Flue gas systems sold
- ~3000 Combustion systems sold with scrubber section
- Tested on 1 MW MAN diesel engine in 2008/2009



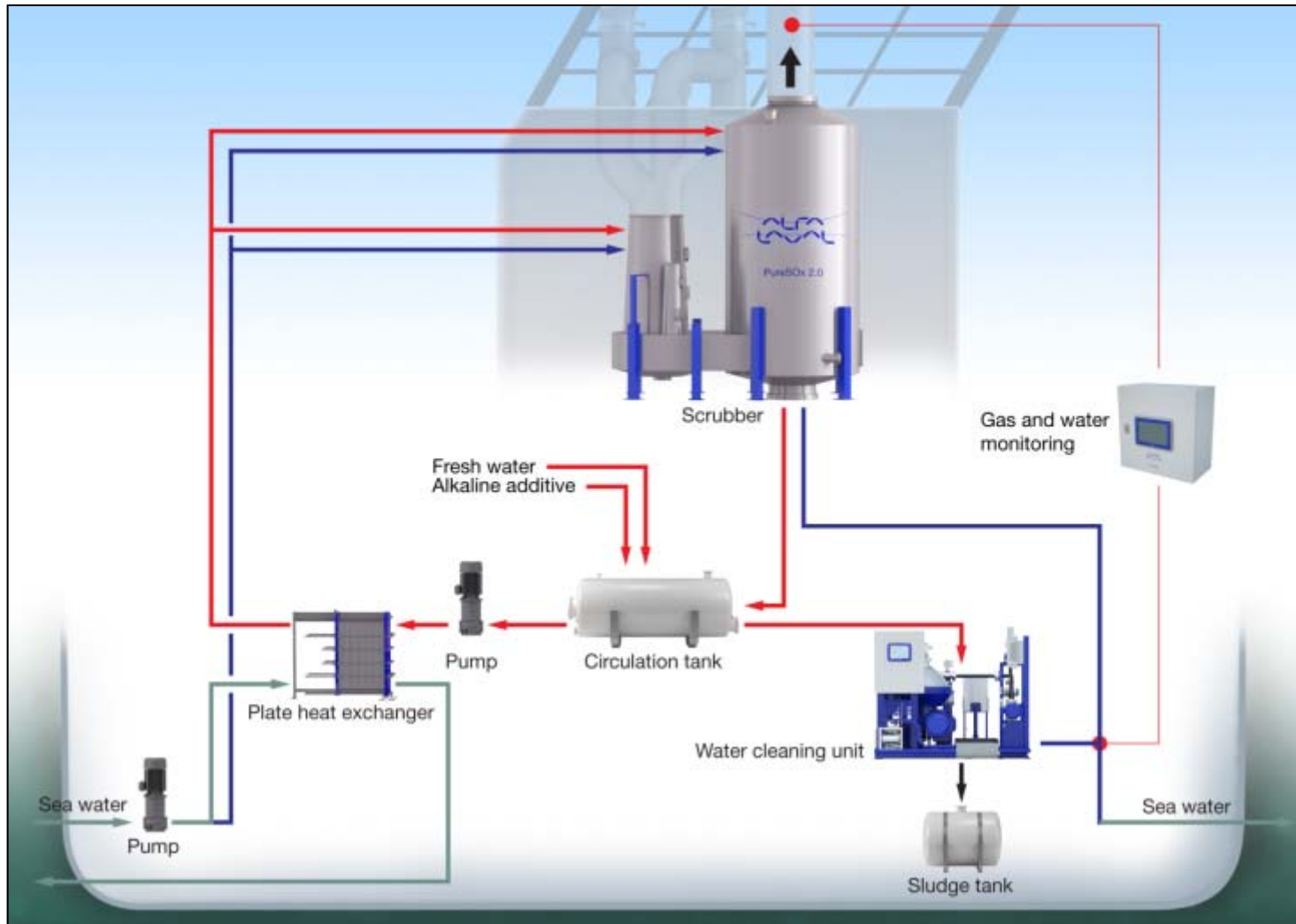
Open-loop mode



Closed-loop mode



Hybrid mode



Multiple inlet systems

Combine main engines and auxiliary engines in one scrubber

- Less space required
- Less weight
- Lower investment costs



PureSOx 2.0

PureSOx 2.0

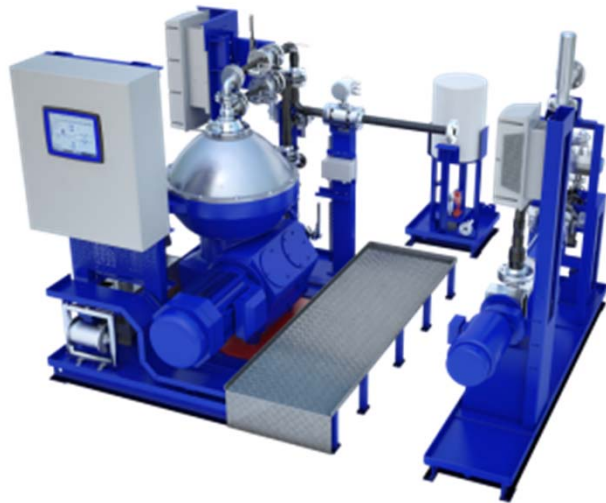
More compact design



- 15% reduced diameter of the absorber
 - Suitable for wider range of vessel sizes,
 - Reduces the likelihood that cargo or passenger space will be affected.
- Control system downsized by 50%
 - For small vessels in particular.

PureSOx 2.0

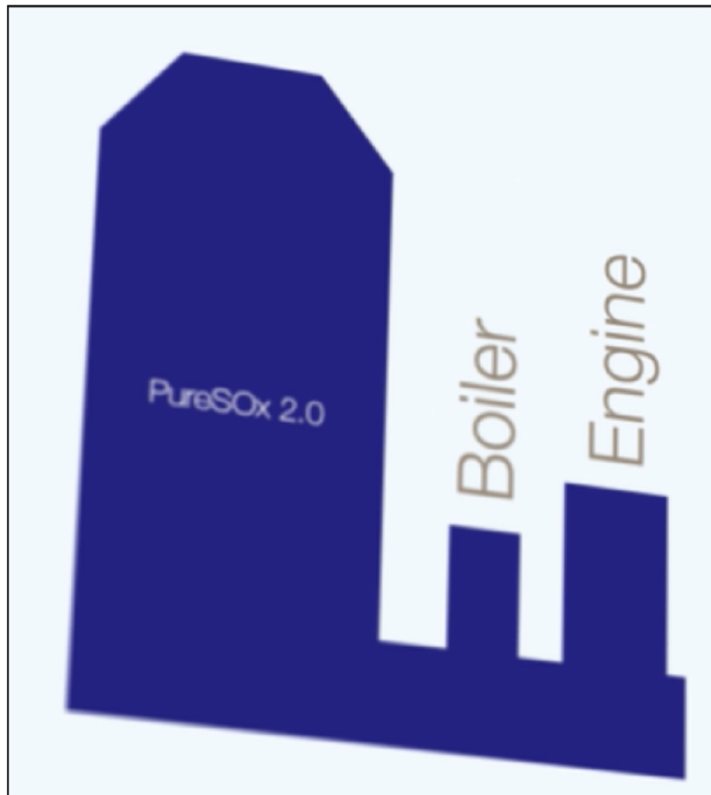
Water cleaning unit



- Redesigned to be split into three sections.
 - easier to get on board and
 - independent placement of the individual skids.
- MEPC wash water criteria are met
- Based on Alfa Laval core technology
- Small footprint of 6 m²
- Not influenced by ships operation
- Global service by Alfa Laval

PureSOx 2.0

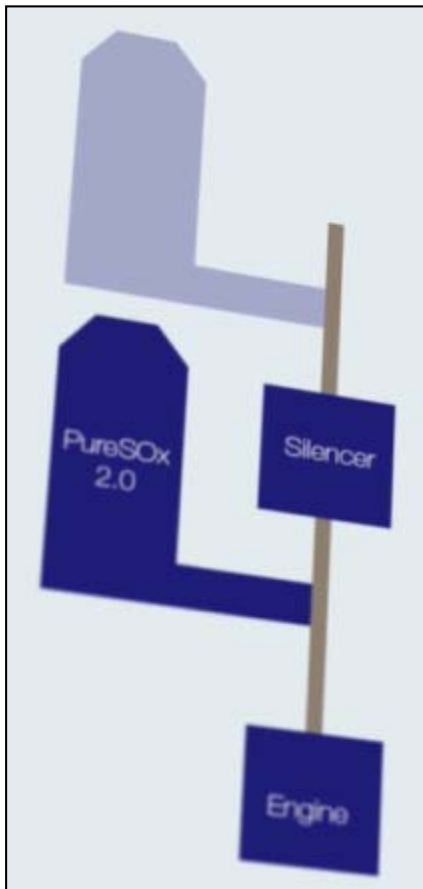
Boiler combination



- One scrubber cleans both engine and boiler exhaust gas, eliminating the need for an additional scrubber or running the boiler on MGO.
 - Lower TCO
 - Less space required
 - Less weight

PureSOx 2.0

Noise attenuation



- Scrubber attenuates noise
- Retrofit: Place the scrubber before the silencer
 - Reduced back pressure
- Newbuilds: Lower scrubber placement
 - Positive on vessel stability

PureSOx 2.0

Powder dosing



- Powder dosing as an alternative for caustic soda
 - Safe handling
 - Lower costs for consumables
- Mixed with circulation water before entering closed-loop circuit

References

References

- 63 vessels (excl 2 pilots)
 - 52 Retrofit projects
 - 11 New builds
- 70 PureSO_x systems (excl 2 Hybrid pilots)
 - 39 Hybrid systems
 - 8 Closed loop systems
 - 23 Open loop systems



Pilot project

Ficaria Seaways (DFDS)



Technical data

- Retrofit installation: 2009 at MWB AG
- Engines: 2-stroke MAN 9L60
- Total output: 21 MW
- No of scrubbers: 1
- System type: Hybrid, single inlet
- Classification: Lloyd's Register

PureSOx for Ficaria Seaways

18,000 hours in operation

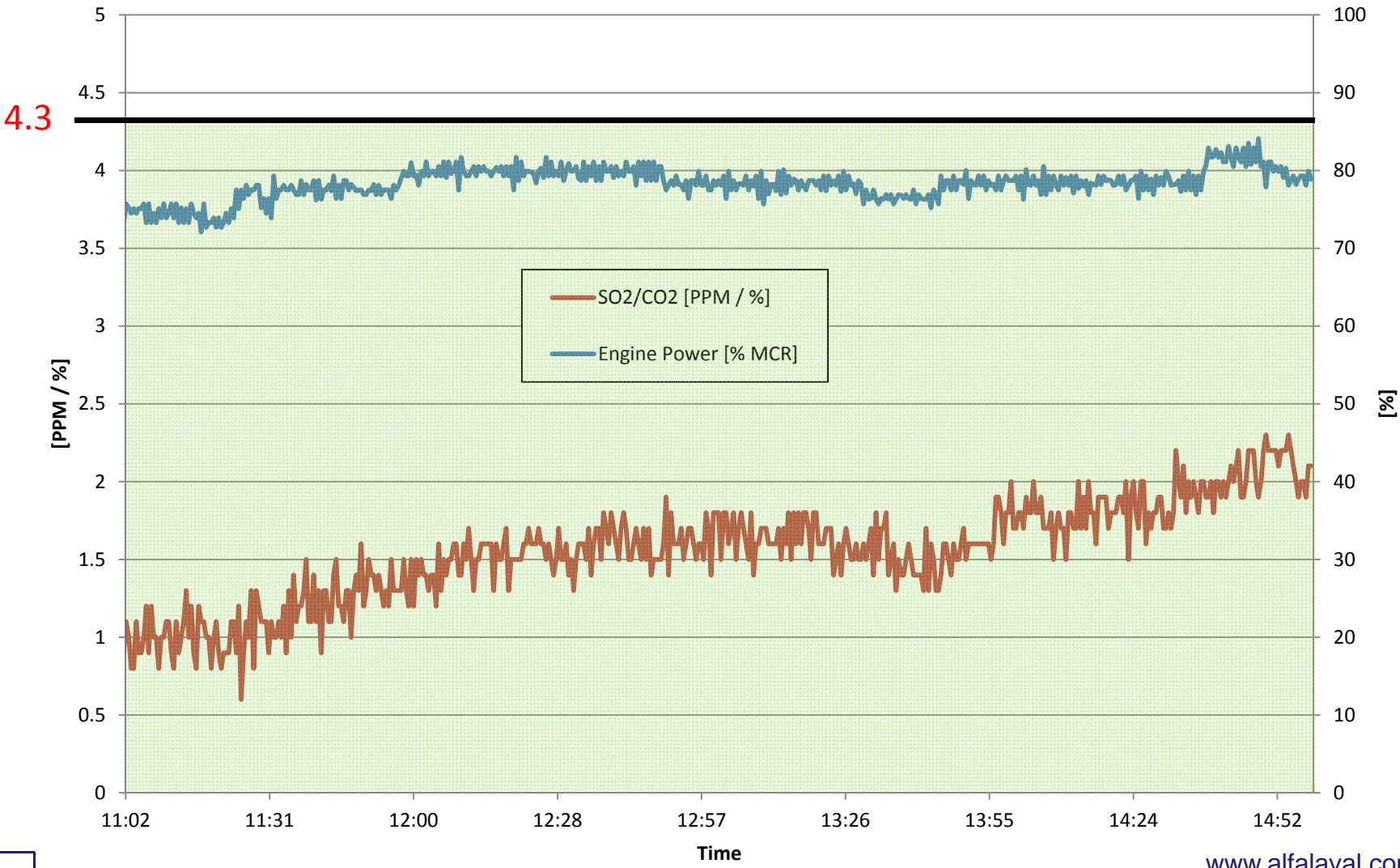


Technical data:

- System type Hybrid
- Ship owner DFDS Seaways
- Engine 1 ME
- Total Power output 21 MW
- Height 10.5 Meters
- Length 8.2 Meters
- Diameter 4.6 Meters
- Weight empty 24T
- Weight with water 32T
- Exhaust gas 192,000 Kg/h
- Material SS alloys

Open loop operation results

Open Loop Operation March 2014



Pilot project

M/V Plyca (Spliethoff)



Technical data

- Retrofit installation: 2012 at Shipdock
- Engines: 2x ME 4-stroke Wärtsilä 12V46C / 2x AE Wärtsilä 8L20
- Total output: 2x 12.6 MW / 2x 1,36 MW
- No of scrubbers: 1
- System type: Hybrid, multiple inlet
- Classification: Lloyd's Register

PureSOx for Plyca

15,000 hours in operation



Technical data:

- System type Hybrid
- Ship owner Spliethoff
- Innovation 2 ME + 2 AE
- Total Power output 28 MW
- Height 9.3 Meters
- Length 8.5 Meters
- Diameter 4.7 Meters
- Exhaust gas 216,000 Kg/h
- Weight 154 tons (complete system)
- Material SS alloys

Newbuild project

2 Cruise vessels (Fincantieri)



Technical data

- Vessel delivery: 2015/2016 at Fincantieri
- Engines: 2x 4-stroke MAN 12V32/44CR / 2x MAN 9L32/44CR
- Total output: 23,5 MW / 23,5 MW
- No of scrubbers: 2 / 2
- System type: Closed-loop, multiple inlet
- Classification: Lloyd's Register



In consortium with MAN Diesel & Turbo

www.alfalaval.com

Retrofit project

2 RoRo vessels (Finnlines)



Technical data

- Retrofit installation: 2014 at BLRT Talinn, Estonia
- Names: Finnkraft / Finnhawk
- Engines: 4-stroke MAN 12V48
- Total output: 12,6 MW
- No of scrubbers: 1
- System type: Open-loop, single inlet
- Classification: RINA

Retrofit project

2 RoRo vessels (Finnlines)



Technical data

- Retrofit installation: Q4 2014 / Q1 2015 at BLRT Turku, Finland
- Names: Finnmill / Finnpulp
- Engines: 2x 4-stroke MAN 9L48
- Total output: 18,9 MW
- No of scrubbers: 1
- System type: Open-loop, multiple inlet
- Classification: RINA

Retrofit project

Cruise: Freedom Class (RCCL)






Technical data

- Retrofit installation: Q2 - Q3 2015 during operation
- Names: Liberty of the Seas / Independence of the Seas / Freedom of the Seas
- Engines: 3x 4-stroke Wärtsilä 12V46
- Total output: 37,8 MW
- No of scrubbers: 1
- System type: Hybrid, multiple inlet
- Classification: DNV-GL

Case Studies

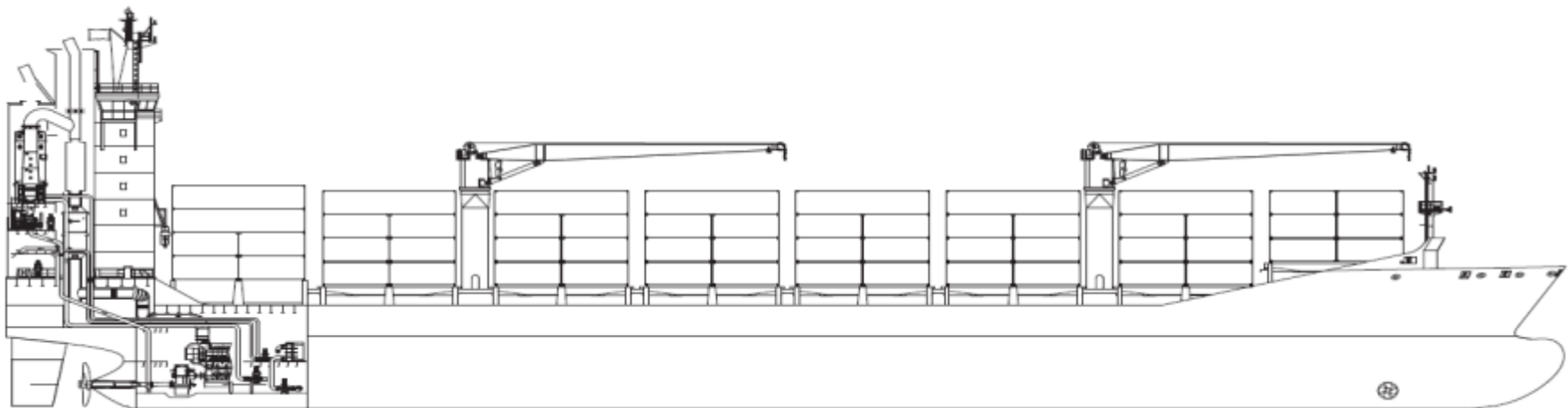
Breakeven for several ship types

	Ship type	Typical engine	Operating profile (hours/y)	% of operation in ECA	Break even in Years
	Container 800 TEU	8.4 MW	Sea: 5,000 Port: 3,760	100%	2.0
	Tanker Aframax	16 MW	Sea: 6,560 Port: 2,200	60%	3.1
	Ferry/ RoRo	28 MW	Sea: 6,200 Port: 2,560	100%	1.2

- * All above cases are retrofit
- * Price difference MGO/HFO: 300 USD/t

Case 1: Container feeder

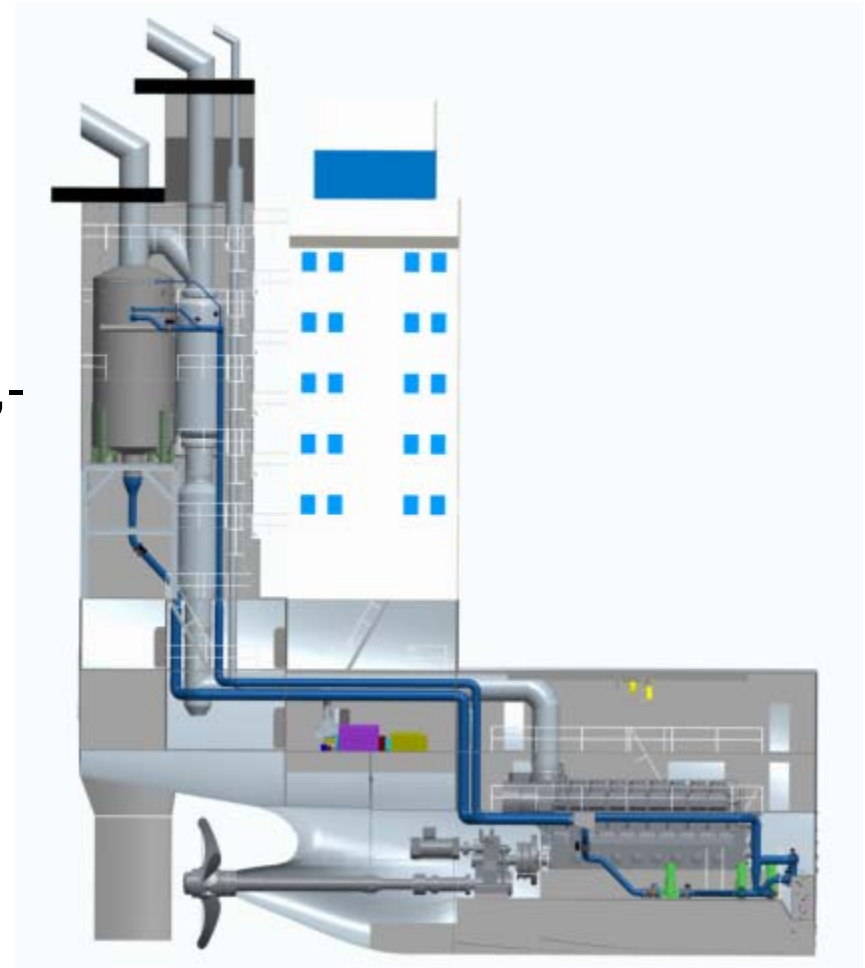
- Vessel details:
- 800 TEU
- 8 MW Engine
- Fuel consumption 5800 tonne
- Operates in Baltic sea / North Sea
- 5.000 hours at sea
- 3.760 hours in port



Case 1: Container feeder

- PureSO_x details
- Hybrid system
- Single inlet
- Operational cost PureSO_x € 3.300.000,-
- Operational cost MGO € 4.500.000,-

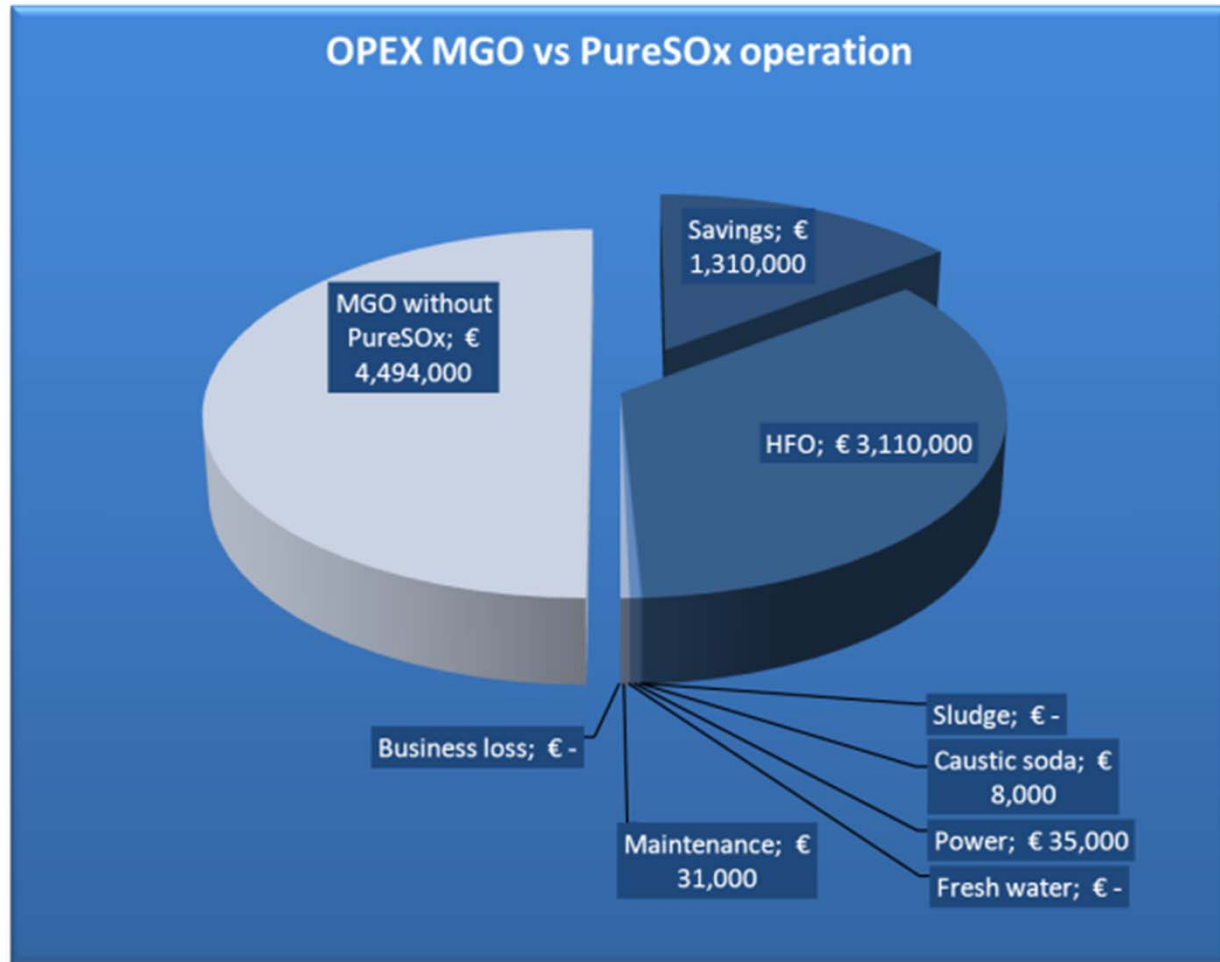
- Payback time 2 years



Case 1: Container feeder

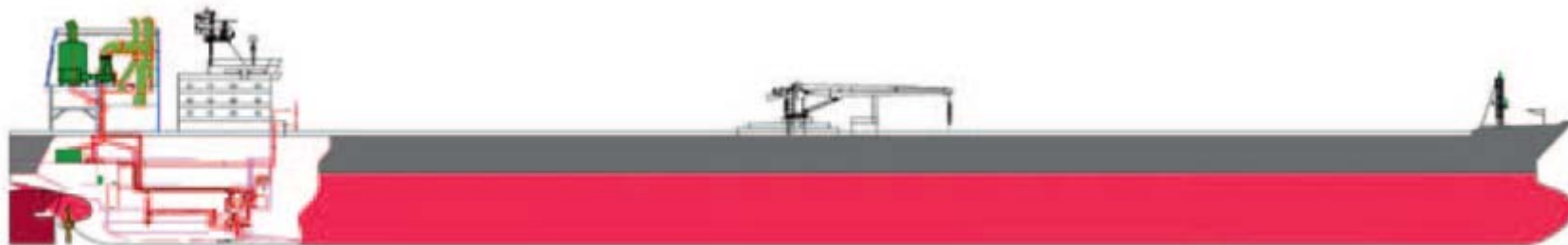
PureSO_x details

- Hybrid system
- Single inlet
- Investment PureSO_x
 - € 1.190.000,-
- Investment installation
 - € 1.190.000,-
- Payback time 2 years



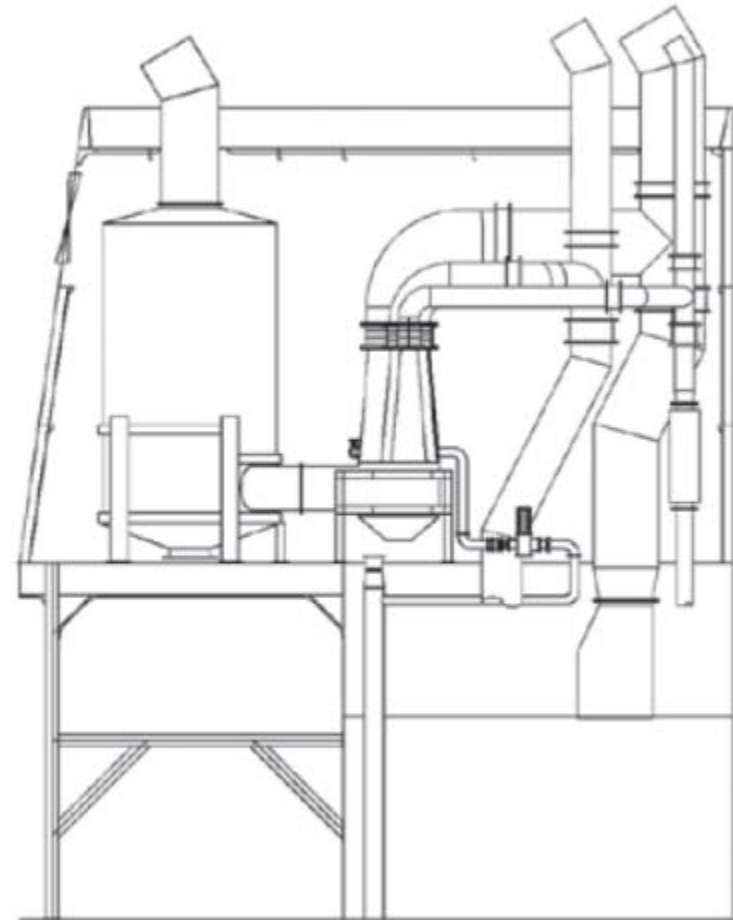
Case 2: Aframax tanker

- Vessel details:
- 14 MW Main engine
- 3 Auxiliary engines of 0.85 MW
- Fuel consumption 6700 tonne
- Operates in world wide, 60% in ECA
- 6.560 hours at sea
- 2.200 hours in port



Case 2: Aframax tanker

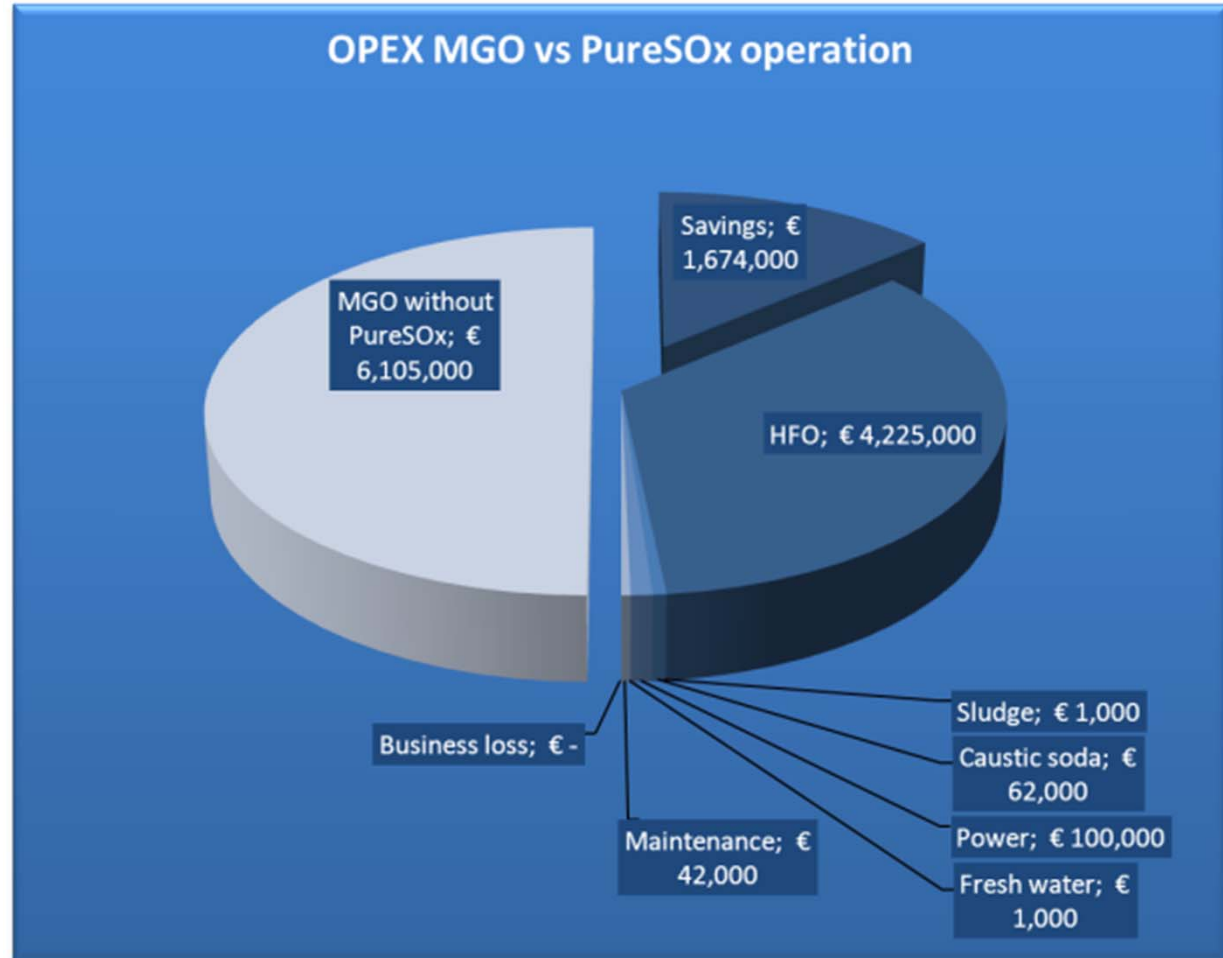
- PureSO_x details
- Hybrid system
- Multiple inlet
- Operational cost PureSO_x € 4.500.000,-
- Operational cost MGO € 6.100.000,
- Payback time 3 years



Case 2: Aframax tanker

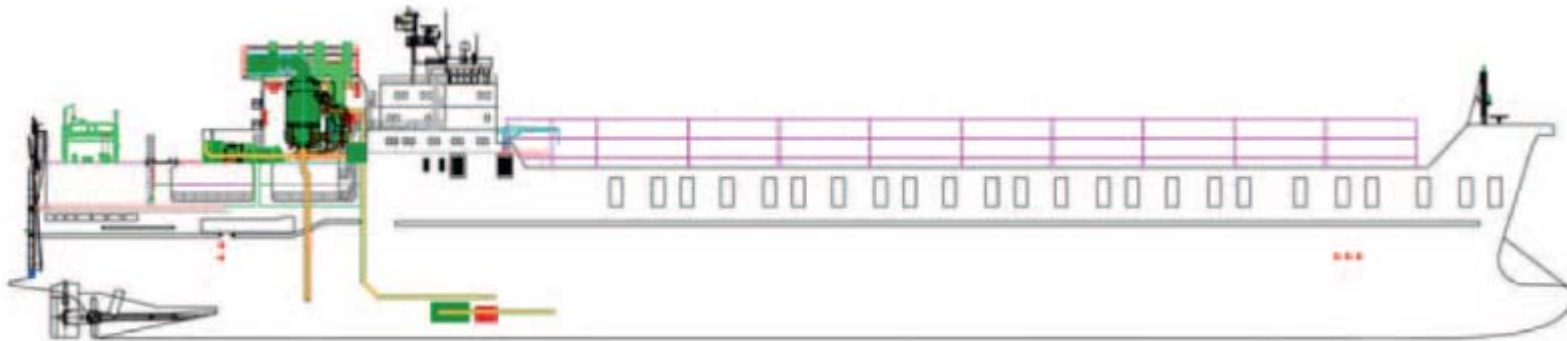
PureSO_x details

- Hybrid system
- Multiple inlet
- Investment PureSO_x
 - € 2.260.000,-
- Investment installation
 - € 2.260.000,-
- Payback time 3 years



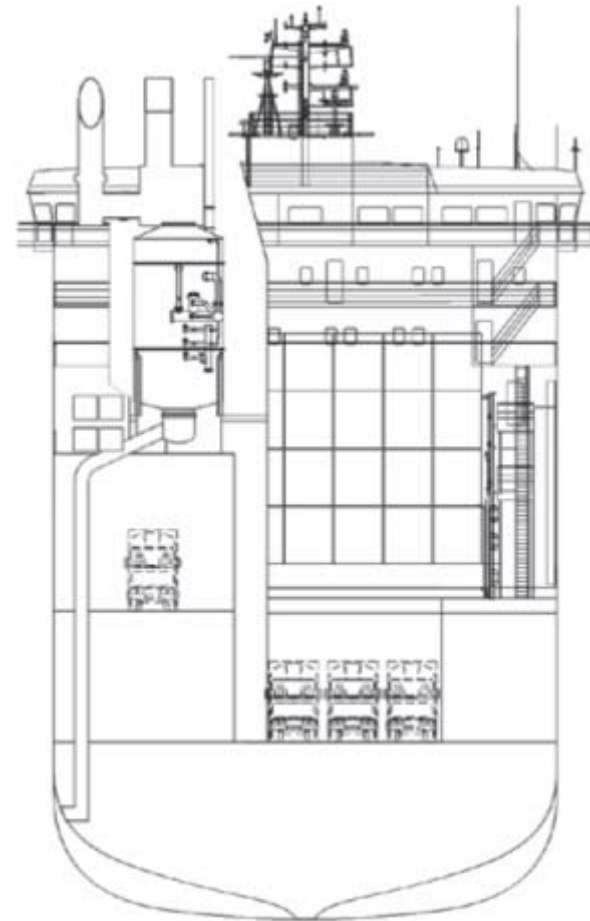
Case 3: Ro-Ro ferry

- Vessel details:
- 4 Main engines of 6 MW
- 2 Auxiliary engines of 1.5 MW
- Fuel consumption 18200 tonne
- Operates in Baltic sea / North Sea
- 6.200 hours at sea
- 2.560 hours in port



Case 3: Ro-Ro ferry

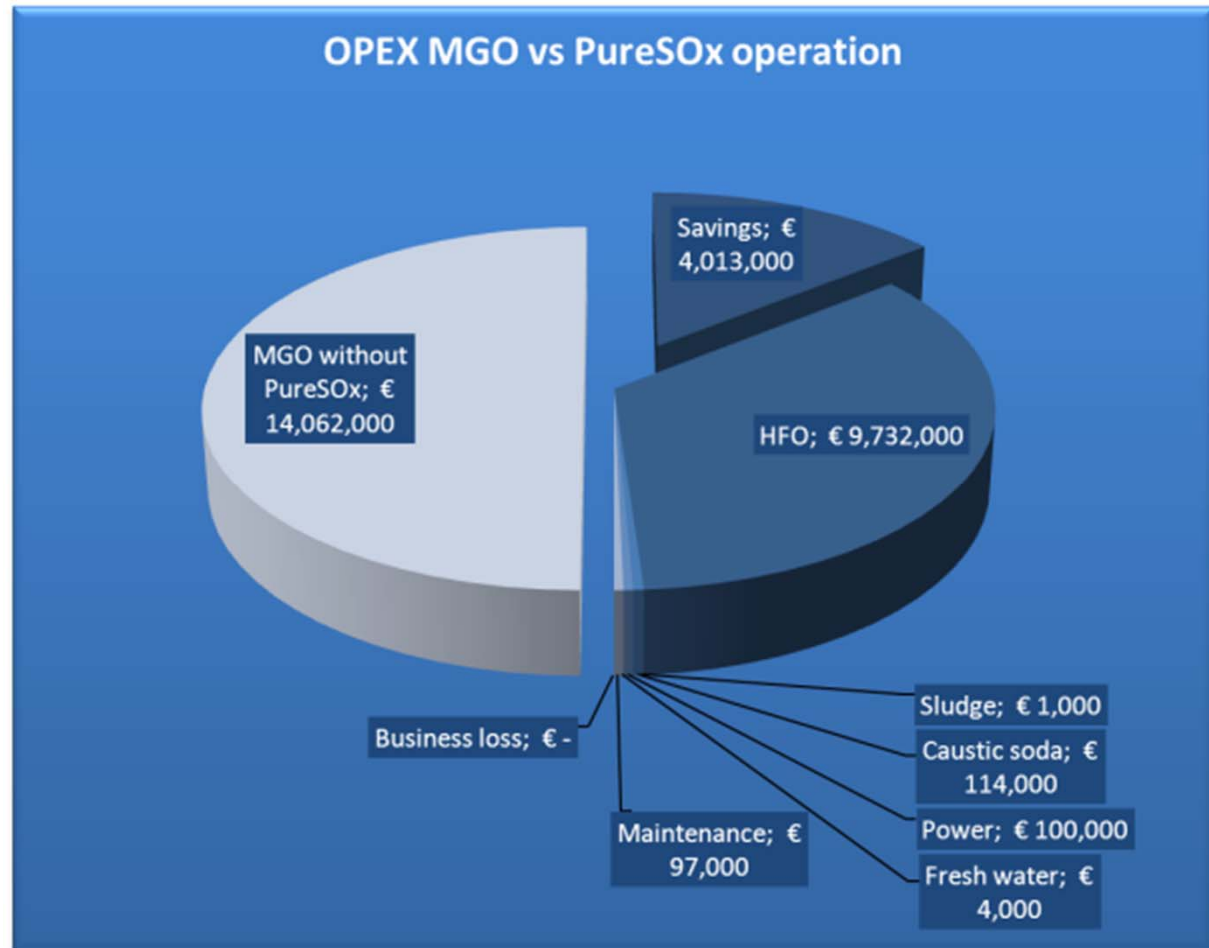
- PureSO_x details
- Hybrid system
- Multiple inlet
- Operational cost PureSO_x € 10.000.000,-
- Operational cost MGO € 14.000.000,
- Payback time 1 year



Case 3: Ro-Ro ferry

PureSO_x details

- Hybrid system
- Multiple inlet
- Investment PureSO_x
 - € 2.800.000,-
- Investment installation
 - € 1.700.000,-
- Payback time 1 year



Trends in EGC market



Oil prices go down
Stable difference MGO-HFO ->
No impact on EGC business case expected



LNG expected to have 10-20% market share
newbuild in 2030



EGC gets increasingly perceived as **proven solution**



Increased number (10-15) of **EGC competitors**

Thank you

Contact us at PureSOx@alfalaval.com