

# Environmental compliance strategies under the light of changes in the oil market

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# CHEAP OIL

AN OPPORTUNITY?

WILL IT LAST?

MANY BET ON FUEL PRICE RECOVERY!

CERTAINLY THE PRICES WILL CONTINUE TO FLUCTUATE!



## ECA's are influencing all major shipping routes

- § Combined **SOx and NOx ECA**  
This is the only designated NOx ECA so far
- § 200 miles from the coast
- § Max. 1000 ppm S in fuel or after cleaning
- § All new US flagged as well as foreign flagged ships built after 1.1.2016 have to comply with IMO Tier III NOx limit
- US flagged ships have some additional requirements stipulated by EPA

### **SOx ECA only (existing)**

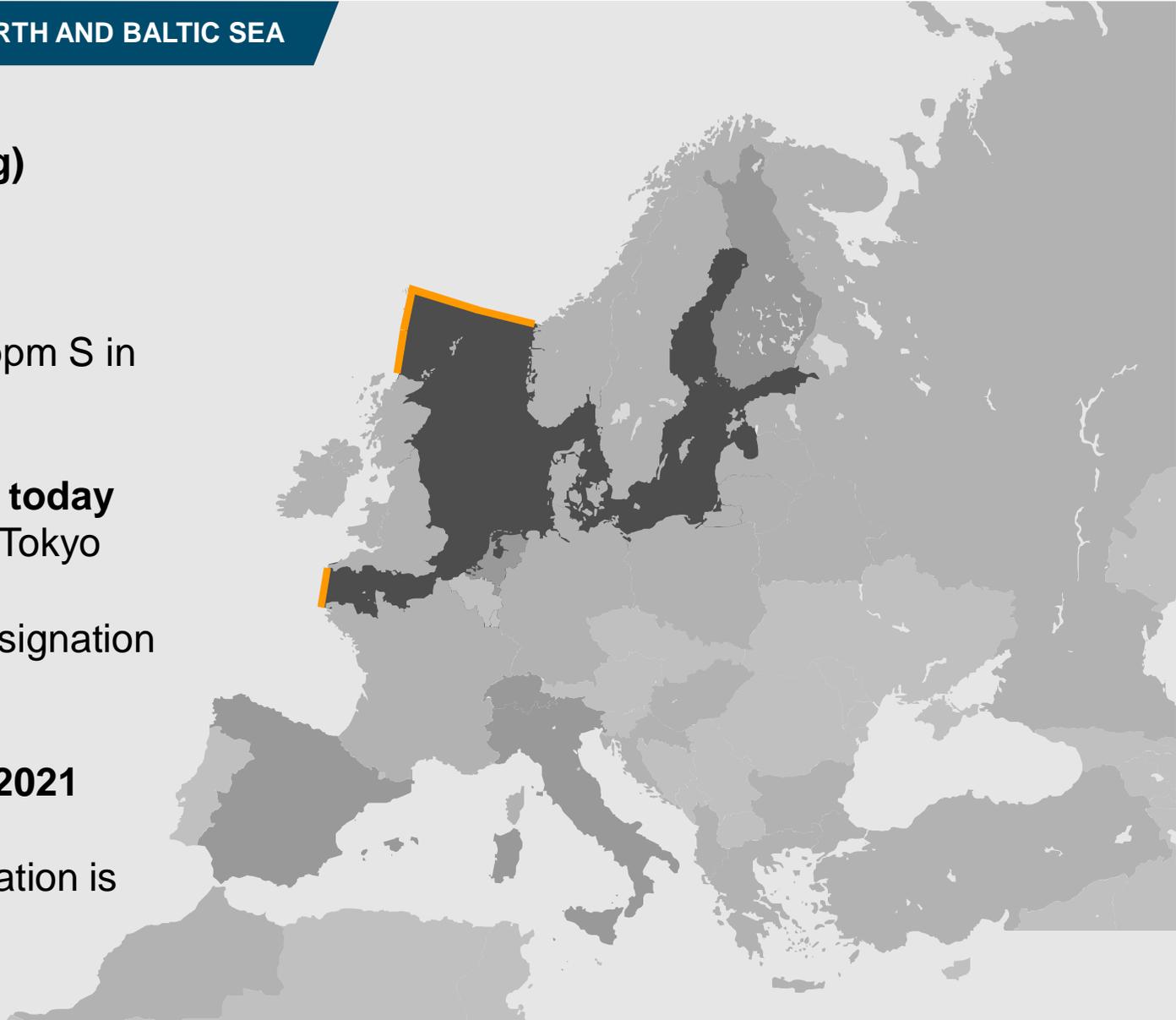
- § Baltic Sea
- § North Sea
- § English Channel
- § Currently max. 1000 ppm S in fuel or aftercleaning

### **Non-existing NOx ECA today**

- § Baltic and North Sea, Tokyo Bay, Hong Kong, etc
- § No applications for designation submitted to IMO

### **Expected NOx ECA in 2021**

- § Baltic and North Sea
- § Application for designation is submitted to IMO



## COMPLIANCY WITH EMISSIONS IS STILL STANDING

### HFO

Scrubber + IMO Tier III NOx compliant engine

- SCR
- EGR
- Water
- 2-stage TC

### MGO

Low Sulphur fuel + IMO Tier III NOx compliant engine

- SCR
- EGR
- Water
- 2-stage TC

### GAS

Gas as fuel in ECA area, HFO outside ECA area (DF engine)

### Sulphur free fuels

As fuel in ECA area, HFO outside ECA area (DF engine)

## ASPECTS TO BE TAKEN INTO ACCOUNT IN TECHNOLOGY CHOICE

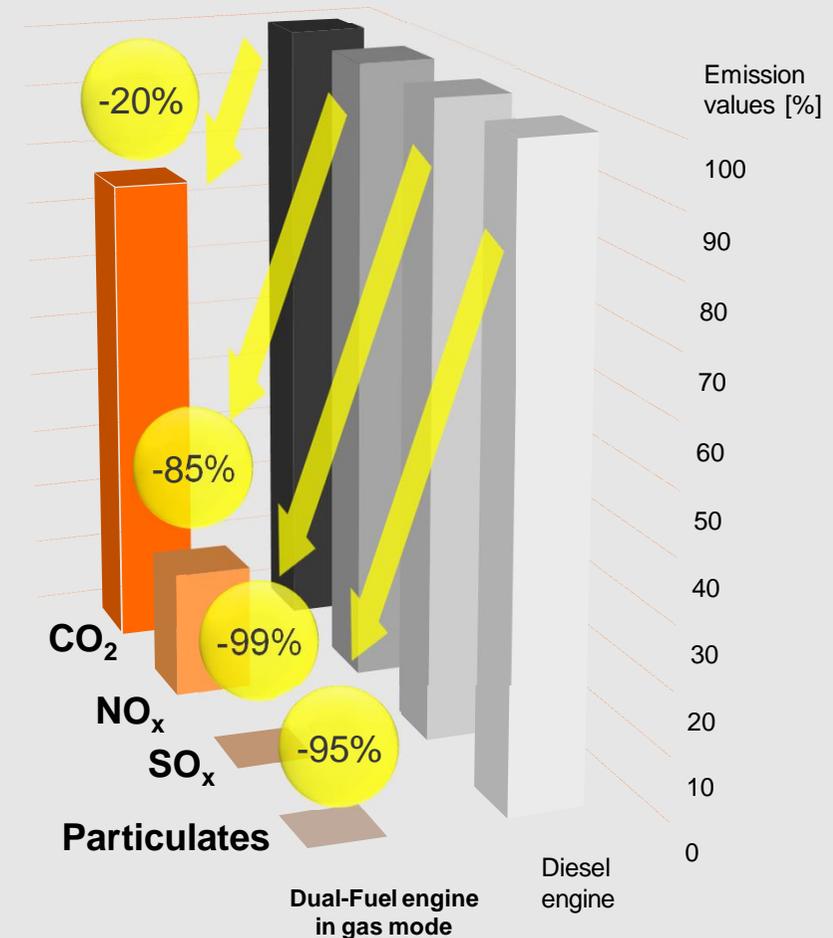
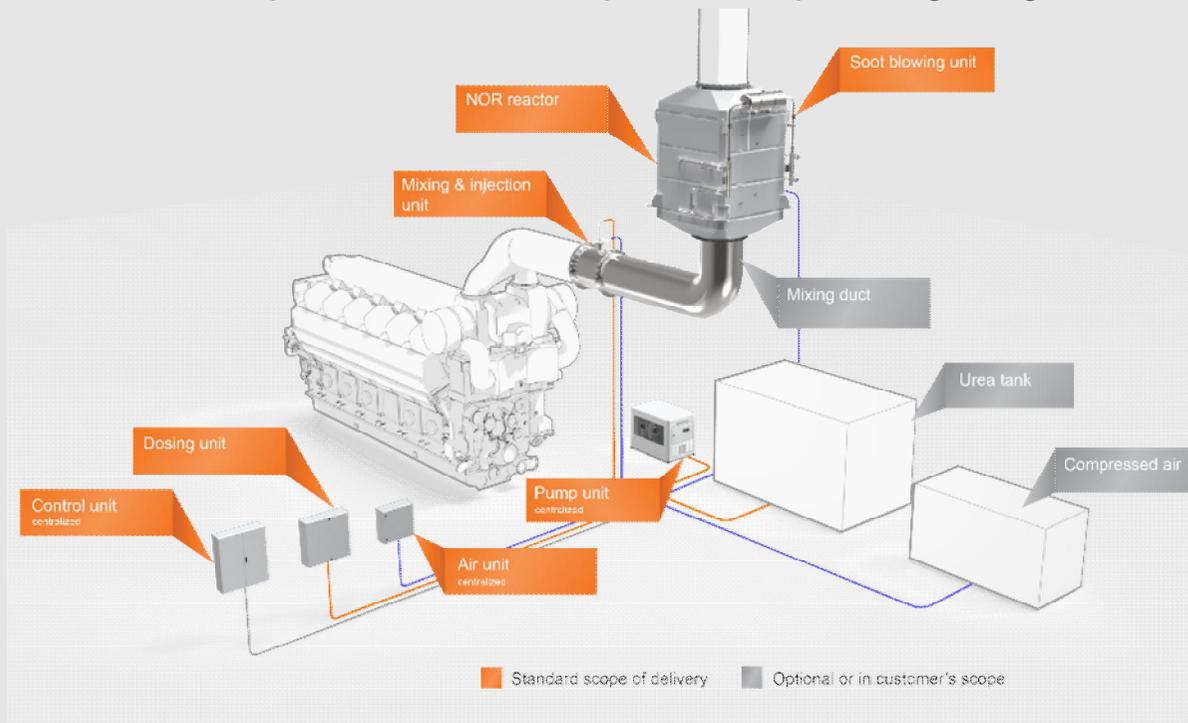
- Investment cost vs. operating cost
- Installation issues
- Flexibility of technology (operational, fuel choice, installation)
- Reliability and maintenance needs

### The dual fuel technology provides significant reductions in emissions

- IMO Tier III level NO<sub>x</sub> in GAS mode and in DIESEL with SCR
- IMO Tier II NO<sub>x</sub> in DIESEL without SCR

### Full range of SCR products optimised for Wärtsilä engines

- Meeting IMO Tier III requirements
- Fuel dependent SCR temperature operating range



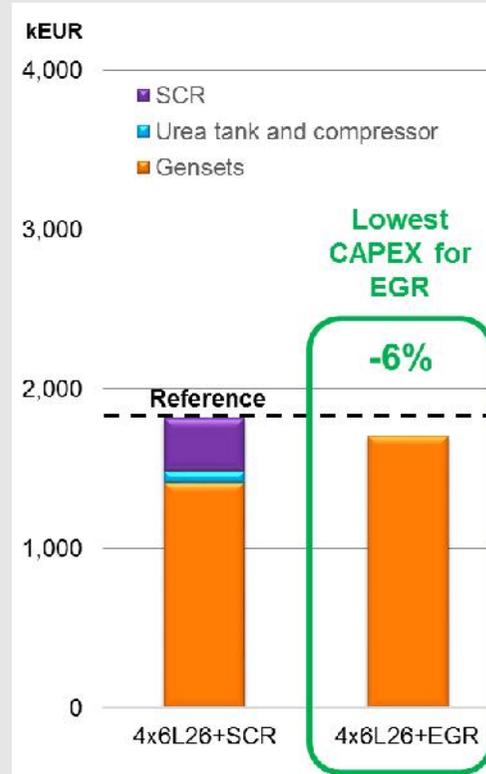
## SCR VS DRY EGR - PSV APPLICATION CASE



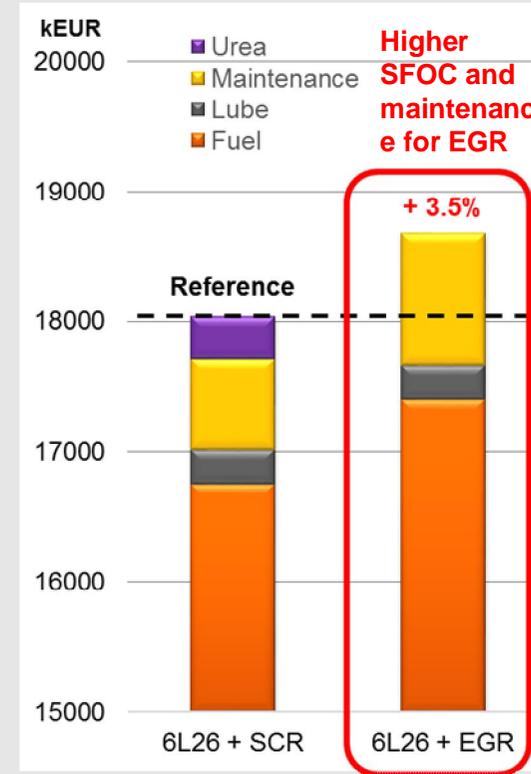
- § 5500 DWT PSV
- § Electric propulsion, 60Hz
- § Fuel type is MGO, sulphur 0,1%
- § ECA 100%
- § Operating profile, 6000h/year
- § 4x 6L26, 1950 kW @ 900 rpm

- § **IMO Tier III NOx level**
- § **Overall good efficiency vs Tier II set-up**
- § **Smoke emission lower than 0.3 FSN**
- § **No or very limited compromise in max achievable output**

### Investment cost



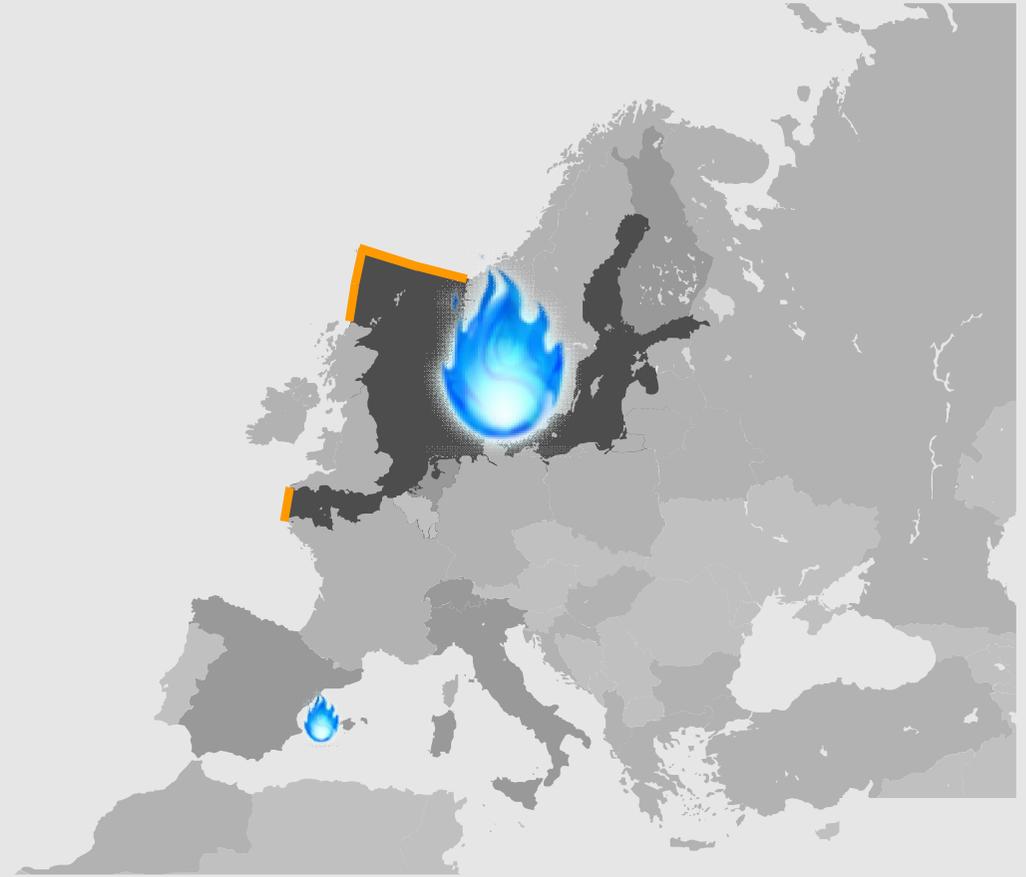
### 10 years operational cost



MGO price 566 EUR/ton  
 Lube oil price 2300 EUR/ton  
 Urea price 171 EUR/ton

## REGIONAL LNG UTILIZATION VS. EMISSION RESTRICTIONS

LNG propulsion has increased in world regions where ECA areas have been established



# >1,500 engines à >16,000,000 running hours

## MERCHANT

LNG Carrier	204 vessels
LPG Carrier	11 vessels
Tankers	14 vessels
Containers	4 vessels
Bulk Carrier	3 vessels
Car Carrier	2 vessels



881 engines

## CRUISE & FERRY

CruiseFerry	1 vessel
ROPAX	3 vessels
Ferries	12 vessels



66 engines

## OFFSHORE

Platform	2 vessels
FSO	2 vessels
FPSO	6 vessels
Jack-up Rig	1 vessel
OSV	24 vessels



132 engines

## DF CONVERSION

FPSO	4 vessels
Chemical tanker	1 vessel
RORO	2 vessels
Ferries	3 vessels
IWW	1 vessel



36 engines

## SPECIALS

Hopper Dredger	1 vessel
Tugs	6 vessels
Navy	1 vessel
Icebreaker	1 vessel
IWW	16 vessels
Guide ship	1 vessel
Cable Layer	1 vessel



46 engines

## DF POWER PLANT

Plants	82
Output	5031 MW
Online since	1997



376 engines

# WE BELIEVE IN FUEL FLEXIBILITY

## LNG



OWNER - Viking line AB

DF engines

## ETHANE



OWNER - Evergas

DF engines

## METHANOL



OWNER - Stena line

DF engines - conversion

## LPG



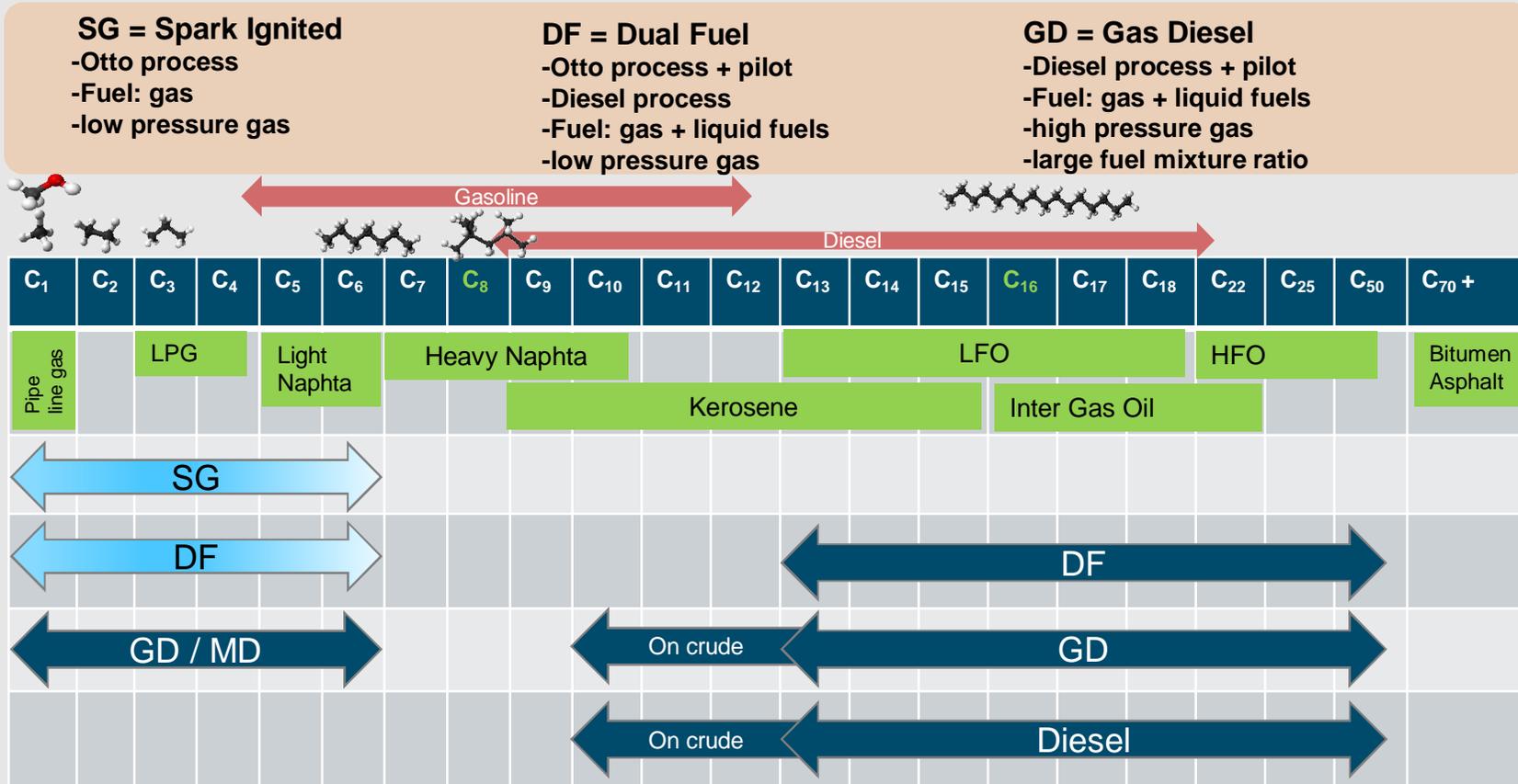
POWER PLANT - El Salvador & Honduras

SG engines

## MORE TO COME?

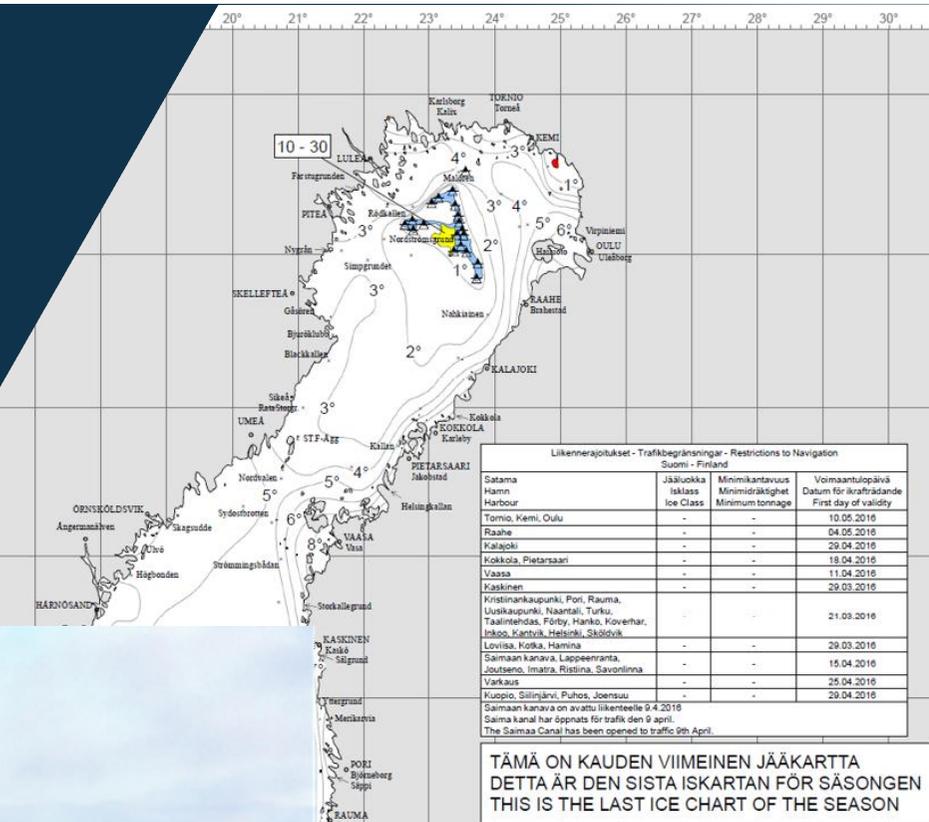


# FUELS IN WÄRTSILÄ ENGINES



# World's first LNG-fuelled multi fuel icebreaker "Polaris"

- The arctic areas are environmentally very sensitive to both airborne emissions and fuel spills. Operating in the arctic climate puts high demands on the equipment since the range of the ambient temperature is very wide.
- Ice-breaking vessels have traditionally been powered by diesel engines, but the advantages of the gas powered reciprocating engines have made gas an alternative also for the high demands of this application.





## Wärtsilä 34DF - Upgrade

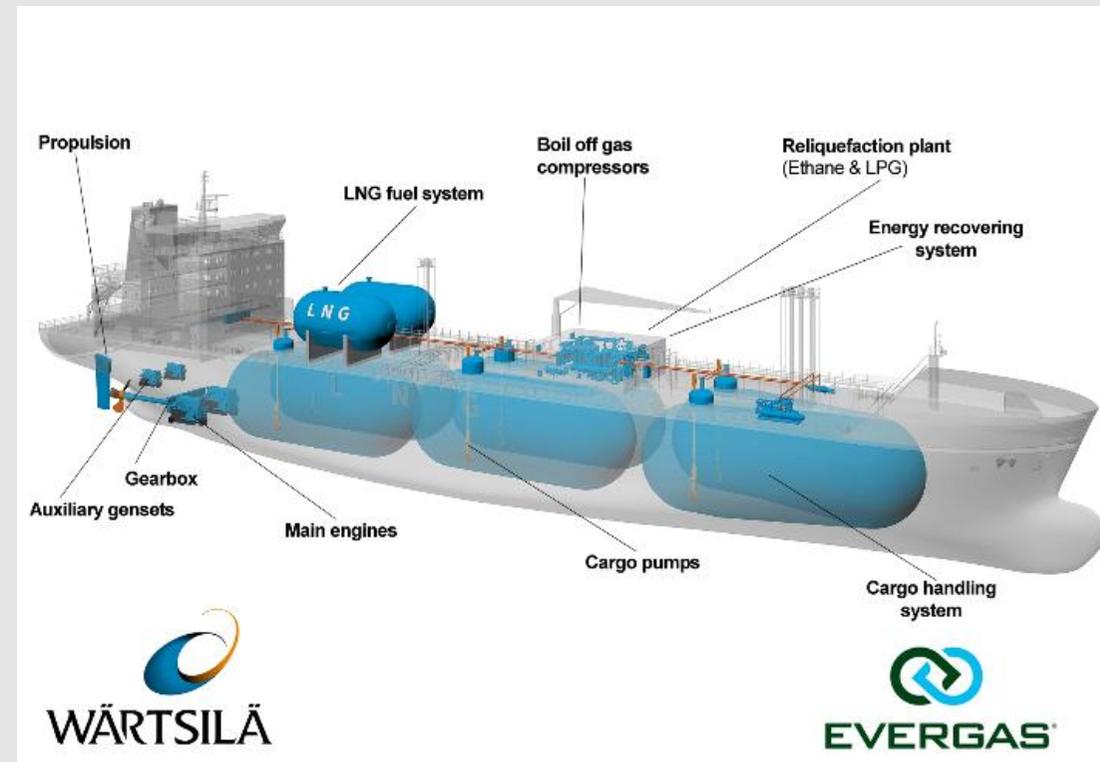
- Upgraded version of W34DF launched in 2014
- Power output increased by 10% to 500kW/cyl
- 1,5% unit efficiency improvement in both diesel and gas mode
- Greatly improved load-taking capability
- Ø Performance improvements enabled by increased firing pressure combined with latest generation single-stage turbocharging

## Wärtsilä 20DF - Upgrade

- Upgraded version of Wärtsilä 20DF launched in 2014
- 10% increase in cylinder output
- Ø Performance improvements enabled by improved gas admission, combustion optimization and variable valve control



- 8 x 27,500 CBM Multi-gas carriers
- World's largest Ethane multi-gas carriers currently in operation
- Broad scope of Wärtsilä supply including engines, propulsion, fuel system, gas handling & storage, service CBM agreement
- 15-year charter agreement with INEOS to transport US Ethane to Europe
- Initially ordered to use LNG as fuel - later development made to enable ethane fuel burning capability



## Two power plants with Wärtsilä® 34LPG engines sold so far

### Installation: Tonalli

- Location: El Salvador
- Engines: 2 × Wärtsilä® 20V34LPG
- Output: 14.4 MW
- In service

### Installation: RECO

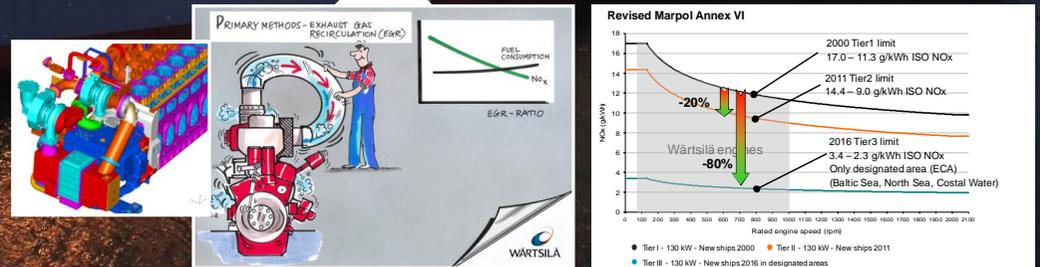
- Location: Honduras
- Engines: 4 × Wärtsilä® 20V34LPG
- Output: 28 MW
- Under construction



# Choice of Tier III technologies – ship owners' viewpoints

Emission reduction technologies are there for fulfilling upcoming regulations

- à But how will the customers accept the solutions?
- à How are users making decisions regarding what technology to use?
- à How to bridge the gap between customer needs and OEM development?



- **Objective** – Investigate how ship owners make the choice of engine technology to fulfil future emission legislations
- **Means** – Case studies and interviews
  - Offshore Supply Vessels, drill ships
    - CAPEX most important due to direct influence on charter rate à EGR
    - LNG attractive at prices 20% below MGO for payback times <6 years
  - Ro-Pax
    - OPEX most important à HFO + SCR + scrubber + 2-stage TC a winning concept
    - LNG attractive at prices <1.35\*HFO
- Any new technology needs to be easy to use and training to be provided by the OEM!
- LNG – preferred technology for short-haul shipping and the best option for new-builds!
- HFO + SCR + scrubber – preferred still a long time for ocean shipping!

**Conclusion is that investment in fuel and operational flexibility is needed**

## Diesel engines: 740 kW to 20 MW



## Dual-fuel engines: 960 kW to 18,3 MW



## Auxiliary generating sets: 455 kW to 4,5 MW



**Viking Grace - the largest passenger ferry operating on LNG entered service in January 2013. Reached a milestone with 1000<sup>th</sup> LNG bunkering operation in August 2016**



**> 70% of Power Plants' deliveries GAS/DF based**

## Wärtsilä 31 – Market Launch - 2015

- We are passionate about supporting our customers with what they need, through optimised lifecycle value and best-in-class operational efficiency, environmental excellence and fuel flexibility.



**Safe & reliable operation**

**Environmental excellence**

**Fuel flexibility**

**Integrated solution**

**Operating flexibility**

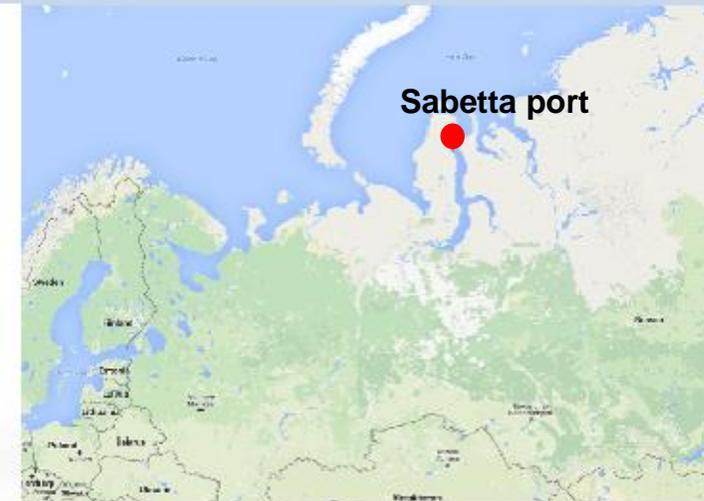
**Innovative product**



**Reduced total cost of ownership**

## First **Wärtsilä 31** pilot engine project

- The first customer installation with Wärtsilä 31
  - § State-of-the-art icebreaker Aker ARC 124
  - § Built at PJSC Vyborg Shipyard on behalf of FSUE Atomflot
- Three 8-cylinder Wärtsilä 31 diesel engines, ExW Oct 2016
- The icebreaker will serve the Yamal LNG project in Sabetta, located north-east of the Yamal peninsular in Russia



# PRODUCT LIFECYCLE SERVICES



## NEW BUILDING

Commissioning and training



## WARRANTY PERIOD

Warranty handling



## SERVICE PERIOD

Parts, services, maintenance support



## UNEXPECTED EVENTS

Trouble shooting and support



## UPGRADES

Lifetime extensions, modernisations, environmental compliance



Gas is the future –  
but don't forget HFO  
quite yet...

...and the **battery** market starts  
being particularly active with  
potential for reducing emissions  
and increase efficiency



THANK YOU!



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