An overview of compliance strategy of ship-owners in the SECA area

Baltic Ports Conference 2014

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DNVGL Maritime Advisory, Oslo

4 Sept 2014

ECA Strategy

History:

- Regs behind SECA in Baltic Sea in effect from 19 May 2006 (IMO)
- Regs behind SECA in North Sea in effect from 22 Nov 2007 (IMO)

- Reported penalties: from small to 20kUSD
- <1% of ships tested upon arrival

- Now: Increasing focus, awareness up, but: only 4 months to go! ***Hello…!***

Basically 3 options available:

1 LNG as fuel

2 Scrubbers + HFO

3 Fuel switching:
- Low sulphur fuel
- New solutions

DNVGL involvement:

- *LNG fuel availability, logistics and financials*
- *CMC, Type Approval*
- *Ship Classification*
- *Technology Qualification*
- *Risk assessments*
- *Regulations, procedures, Standards*

…or fleet redeployment, i.e. give up trading in ECAs…

LNG as fuel

50 + 66 ships

+

- Safe, proven, available technology
- ECA compliancy
- Boosting CSR profile
- Expect lower OPEX than Scrubber&HFO

-

- Investment intensive
- Inadequate LNG bunkering grid
- LNG tank steals cargo space
- Limited experience from merchant fleet

?

- LNG fuel prices vs oil
- Price to end-user
- Fleet flexibility
- LNG fuel providers' margins

LNG fuel:

- Newbuilds
- Long Contract periods
- Owner pays the fuel bill
- Fixed routes, much ECA
- Short sea, moving towards Deep sea

66 confirmed LNG fuelled newbuilds – most to DNV GL class (1/2)

Confirmed orderbook

Year	Type of vessel	Owner	Class
2014	Ro-Ro	Norlines	DNV
2014	Ro-Ro	Norlines	DNV
2014	Car/passenger ferry	Society of Quebec	LR
2014	Car/passenger ferry	Society of Quebec	LR
2014	Car/passenger ferry	Society of Quebec	LR
2014	PSV	Harvey Gulf Int.	ABS
2014	PSV	Harvey Gulf Int.	ABS
2014	PSV	Harvey Gulf Int.	ABS
2014	PSV	Harvey Gulf Int.	ABS
2014	Gas carrier	SABIC	BV
2014	Gas carrier	SABIC	BV
2014*	Product tanker	Bergen Tankers	LR
2014	General Cargo	Egil Ulvan Rederi	DNV
2014	General Cargo	Egil Ulvan Rederi	DNV
2014	PSV	Remøy Shipping	DNV
2014	Car/passenger ferry	AG Ems	GL
2014*	Car/passenger ferry	AG Ems	GL
2014	Car/passenger ferry	Samsoe Municipality	DNV
2014	Ro-Ro	Sea-Cargo	DNV
2014	Ro-Ro	Sea-Cargo	DNV
2014	Tug	CNOOC	CCS
2015	Tug	CNOOC	CCS
2015	PSV	Siem Offshore	DNV
2015	PSV	Siem Offshore	DNV
2015	PSV	Simon Møkster	DNV

Year	Type of vessel	Owner	Class
2015	PSV	Harvey Gulf Int.	ABS
2015	PSV	Harvey Gulf Int.	ABS
2015	Tug	NYK	NK
2015	LEG carrier	Evergas	BV
2015	LEG carrier	Evergas	BV
2015	LEG carrier	Evergas	BV
2015	Bulk ship	Erik Thun	LR
2015	Container Ship	Brodosplit	DNV GL
2015	Container Ship	Brodosplit	DNV GL
2015	PSV	Siem Offshore	DNV GL
2015	PSV	Siem Offshore	DNV GL
2015	Container Ship	TOTE Shipholdings	ABS
2016	Container Ship	TOTE Shipholdings	ABS
2016	Icebreaker	Finnish Transport A.	LR
2016	PSV	Siem Offshore	DNV GL
2016	PSV	Siem Offshore	DNV GL
2016	Chemical tanker	Terntank	BV
2016	Chemical tanker	Terntank	BV
2016	Chemical tanker	Terntank	BV
2016*	Ro-Ro	TOTE Shipholdings	ABS
2016*	Ro-Ro	TOTE Shipholdings	ABS
2016	Car carrier	UECC	LR
2016	Car carrier	UECC	LR
2016	Car/passenger ferry	Boreal Transport	DNV GL
2016	Car/passenger ferry	Boreal Transport	DNV GL

Updated 16.07.2014

**** Conversion project***

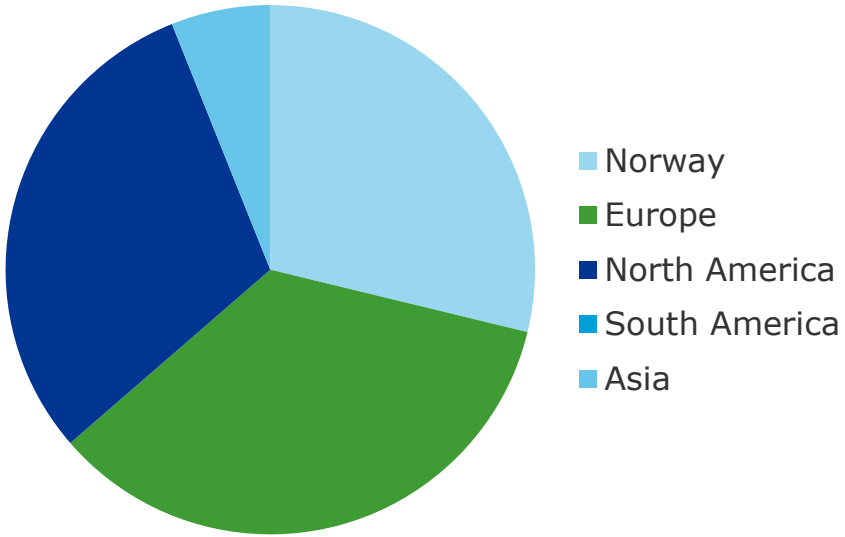
Excluding LNG carriers and inland waterway vessels

66 confirmed LNG fuelled newbuilds – most to DNV GL class (2/2)

Confirmed orderbook

Year	Type of vessel	Owner	Class
2016	Container Ship	GNS/Nordic Hamburg	ABS
2016	Container Ship	GNS/Nordic Hamburg	ABS
2016	Ro-Ro	SeaRoad Holdings	
2017	BC Ferries	BC Ferries	LR
2017	BC Ferries	BC Ferries	LR
2016	Container Ship	Universal Marine	DNV GL
2016	Container Ship	Universal Marine	DNV GL
2017	Container Ship	Universal Marine	DNV GL
2017	Container Ship	Universal Marine	DNV GL
2017	BC Ferries	BC Ferries	LR
2017	Terntank	Terntank	BV
2017	RoPax	Brittany Ferries	BV
2017	Container Ship	Crowley Maritime	DNV GL
2017	Container Ship	Crowley Maritime	DNV GL
2018	Container Ship	Matson Navigation	DNV GL
2018	Container Ship	Matson Navigation	DNV GL

Global development - confirmed orderbook



**** Conversion project***

Updated 16.07.2014

Excluding LNG carriers and inland waterway vessels

Scrubbers + HFO

>120 sold

+

- ECA compliancy
- No new fuel tank, fuel logistics etc
- Easier re-fit and less expensive than LNG fuel retrofit

-

- Sludge reception facilities
- Space requirements, stability
- Large installation/interface onboard
- Fuel penalty, operational costs
- Wash water criteria
- Costs

?

- Performance on all engine loads?
- Performance documentation
- Integration with boilers?
- Corrosion?

SCRUBBER:

- Newbuilds & Retrofits
- Long Charters
- Fixed routes, much ECA
- Deep Sea and Short Sea

Some scrubber references

- Orders: Carnival 20 ships, DFDS 12 ships, NCL, RCCL
- There are now > 20 ships with scrubbers in operation. New orders reported weekly. Some installations:
  - Ferry Pride of Kent (2006) Krystallon (Hamworthy/Wartsila)
  - RoRo Linea Messina (2011) Wartsila
  - Containerships VII (2011) Wartsila Closed loop
  - 8 x NB for Algoma (Great Lakes) 2013, Wartsila
  - RoRo Tamesis, 2012, 28 MW hybrid scrubber Hamworthy/Wartsila
  - RoRo Tarago, 2013, 28 MW hybrid scrubber Hamworthy/Wartsila (Sembawang)
  - ConRo Plyca 28 MW hybrid/PureSOx 2012 (ShipdockNL)
  - RCCL Liberty of the Seas, GreenTech Marine (2012)
  - MV Timbus, Couple Systems, dry scrubber
  - MV Balder, Clean Marine 2012, hybrid scrubber

How does a Scrubber work?

SOx + Sodium hydroxide ⟶ Sodium sulphate solution slurry

(un-combusted fuel ⟶ PAH/soot pollution etc)

Sodium sulphate solution will be concentrated by Centrifuge separator to a sludge, which must be landed as special waste
(in "closed loop" systems) or discharged to sea where allowed ("open loop" systems) – however not allowed in Baltic Sea.
i.e. need special port reception facilities for waste sludge, or acceptance to dump with waste oily sludge. - Added costs!

Description of working principle – Wet scrubber closed loop

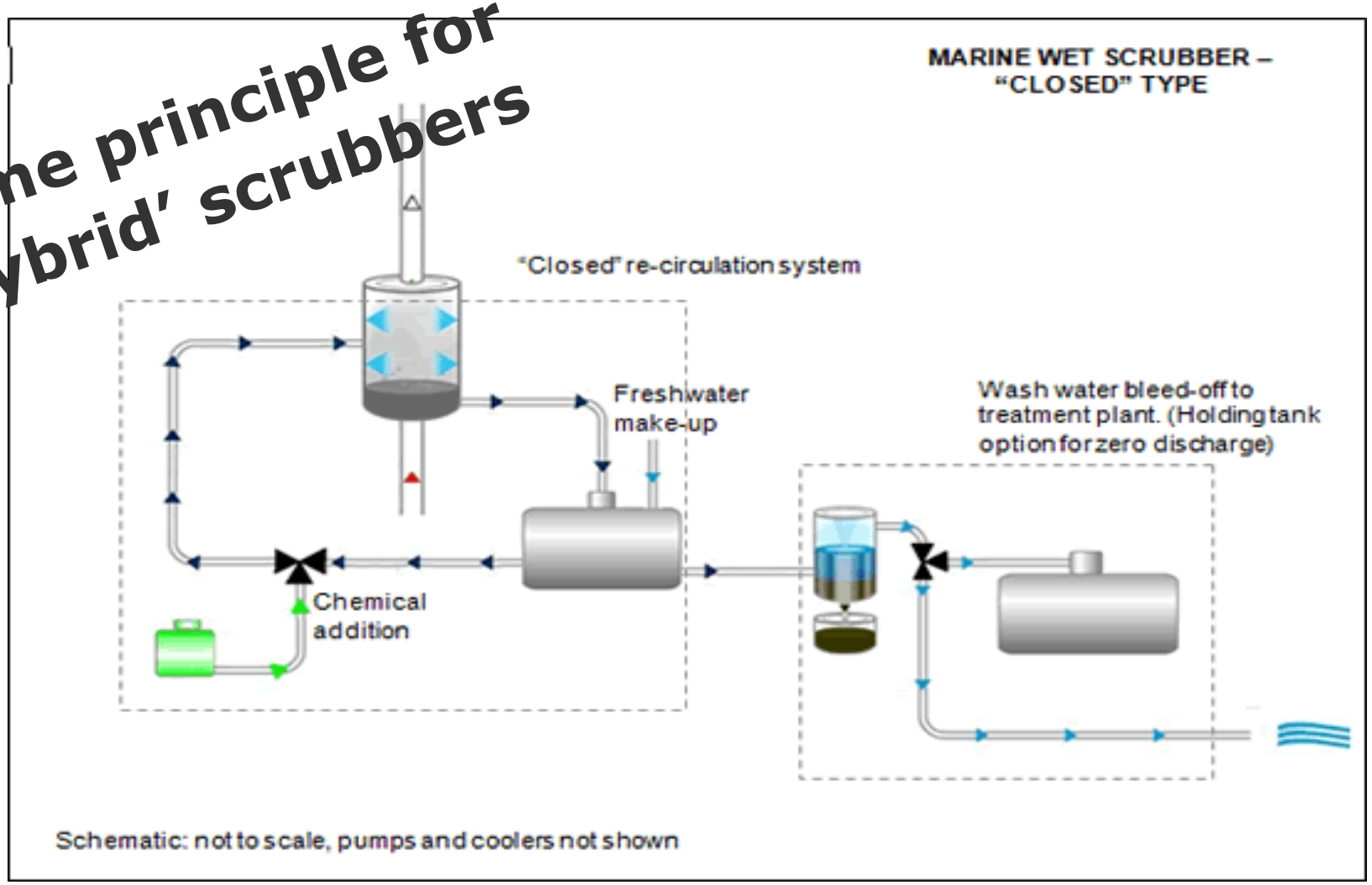


Diagram: Courtesy of Exhaust Gas Cleaning System Association

Switch to conventional low sulphur marine diesel oil

+

- ECA compliancy possible (i.e. SECA)
- Safe and proven, existing network
- Recording regime established
- Familiar fuel for crew
- Low investment

-

- Increased OPEX 30-40%
- Low flashpoint issues
- Fuel switching can cause black out
- No NOx reduction

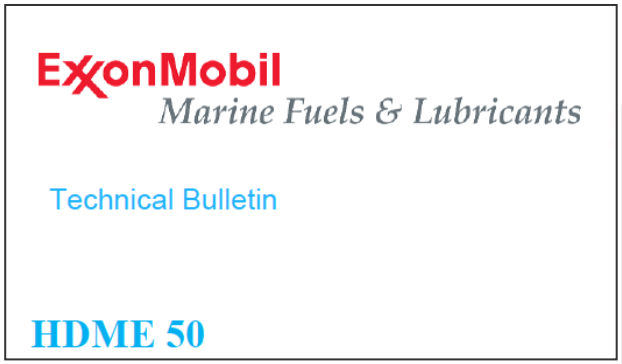
?

- Global availability?
- Price hike?

Fuel switch:

- Newbuilds & Retrofits
- Any contract,
- Anywhere
- Deep Sea and Short Sea
- Excellent for older ships

Brand new fuel: "Hybrid ECO compliant fuels"



Characteristics	DMA ISO 8217	HDME 50 Typicals
Kinematic Viscosity, cSt @ 40°C	6	40 - 75
Density @ 15°C kg/m3	890	895 - 915
CCAI	-	795 - 810
Cetane Index	40	N/A
Sulfur, mass %	1.50	0.1
Flash Point, °C	60	>70
Hydrogen Sulfide, mg/kg	2	< 1
Acid Number, mg KOH/g	0.5	< 0.1
Total Sediment Aged, mass %		0.01
Oxidation Stability, g/m3	25	N/A
Carbon Residue, mass %	0.3	< 0.30
Pour Point, °C	-6	15 - 30
Appearance	C&B	Green/Brown
Water, vol %	-	0.05
Ash, mass %	0.01	< 0.01
Lubricity, microns	520	< 320
Vanadium, mg/kg	-	< 1
Sodium, mg/kg	-	< 1
Al + Si, mg/kg	-	< 0.3
Calcium, mg/kg	-	< 1
Zinc, mg/kg	-	< 1

- Performance over time?
- Stability?
- Mixing with HFO?
- Availability?
- Pricing?
- etc

PolyShield DSOX-15

- New technology (USA, 2013)
- A few installations (Cruise, LPG carriers)
- Washes sulphur out of HFO before the engine
- Successful?

PolyShield TECHNOLOGIES

HOME PRODUCTS COMPANY NEWS

‹ Previous Next ›

Poly Shield Enters Into Agreement with LMS Shipmanagement Inc. for Multiple Installations of the DSOX-15 Fuel Purification System

Case study: Container feeder. LNG or scrubber?

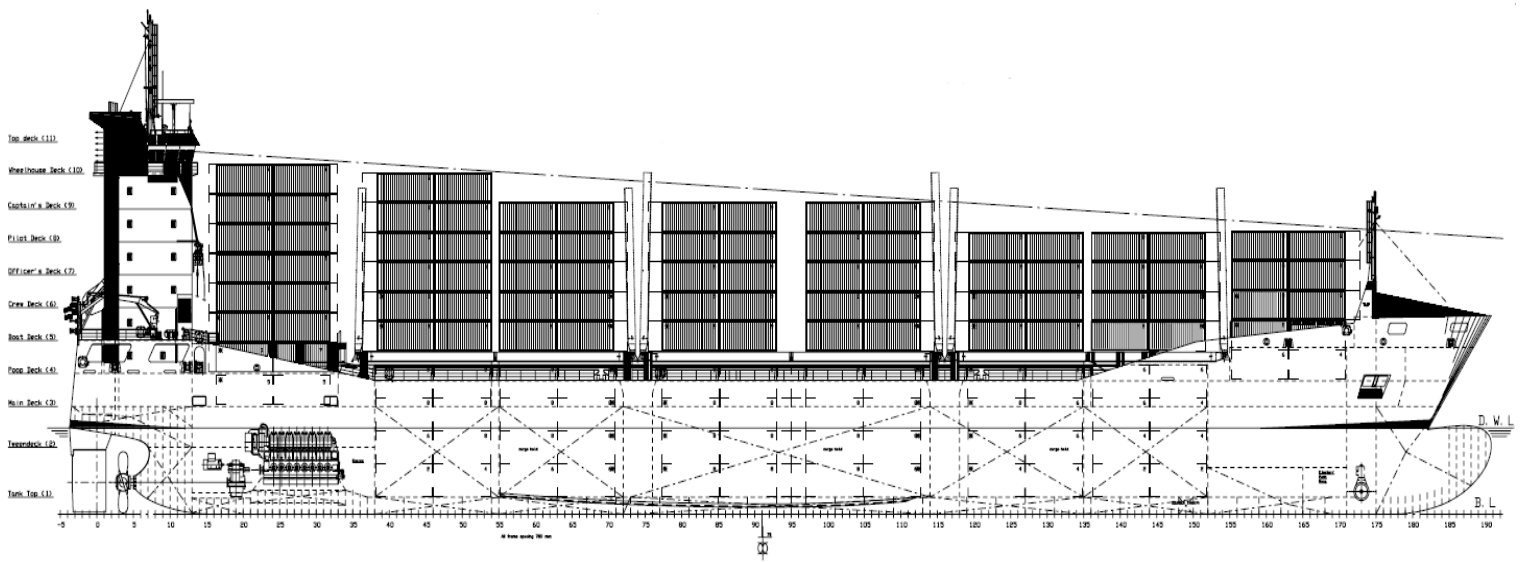
LNG retrofit of a container feeder trading in the Baltic

Case description

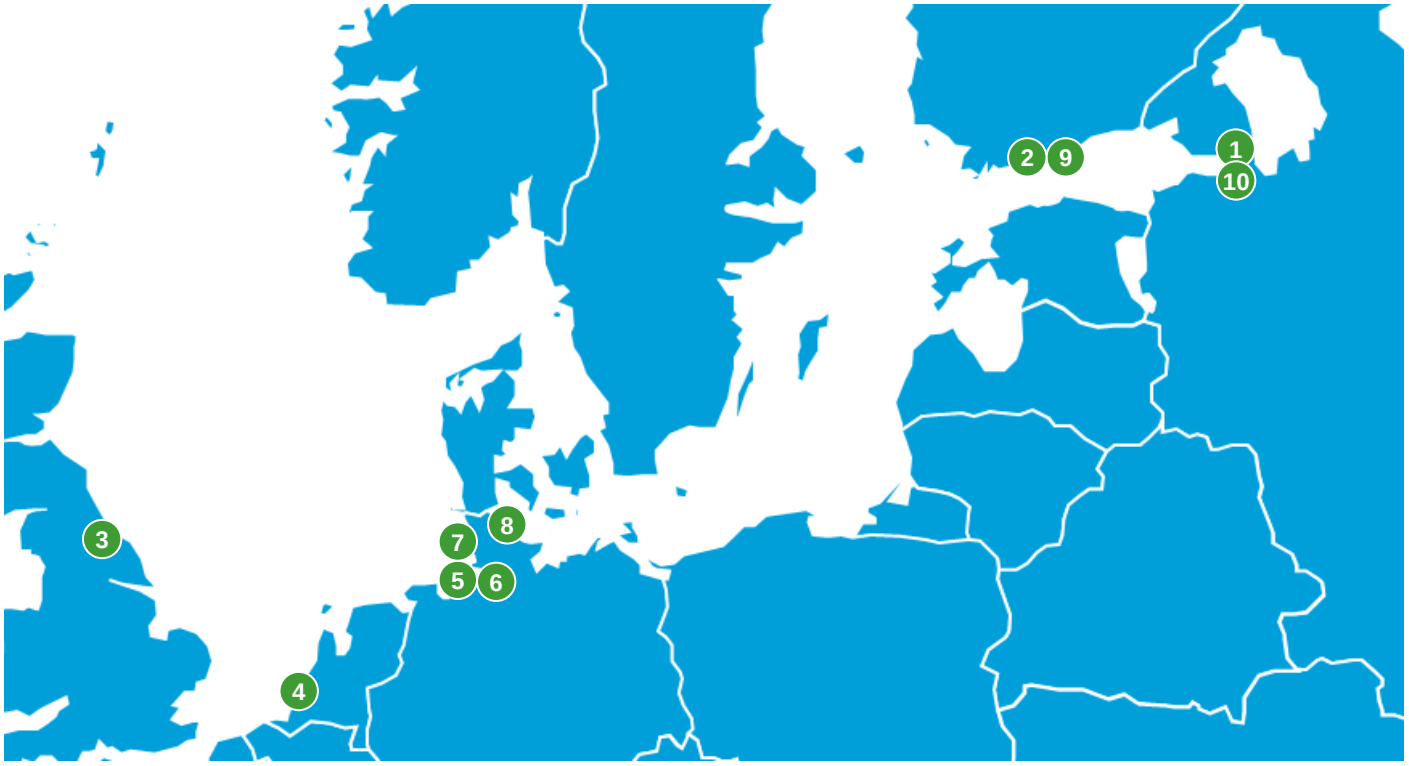
- Conversion of main engine to dual fuel
- Retrofit of LNG system
- 100% LNG operation
- The vessel will bunker twice per roundtrip

Vessel specifics

- Capacity: 1,000 TEU
- Length O.A: 152 m
- Breadth MLD: 24 m



A 14 day roundtrip in the Baltic and North Sea



Nr.	Route
1	St. Petersburg
2	Helsinki
3	Teesport
4	Rotterdam
5	Brunsbüttel
6	Hamburg
7	Brunsbüttel
8	Kiel
9	Helsinki
10	St. Petersburg

Issues to consider

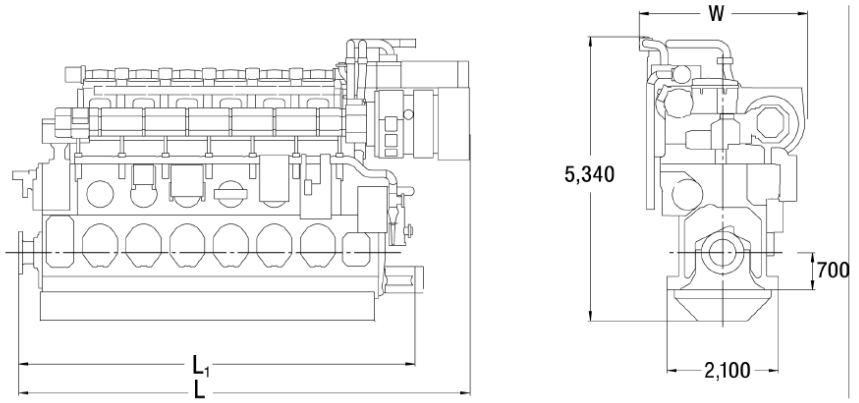
- From 1 January 2015 all vessels operating in designated SOx ECAs need to comply with the 0.1% sulphur regulation

Conversion of main engine to dual fuel engine

Engines

Existing diesel engine: MAN 8L48/60B
Engine size: 9,600 kW
Engine speed: 500 RPM
SFOC@75% load: 190 g/kWh

Converted dual fuel engine: MAN 8L51/60DF
Engine size: 8,000 kW
Engine speed: 500 RPM
SGC@75% load: 151 g/kWh



Source: MAN

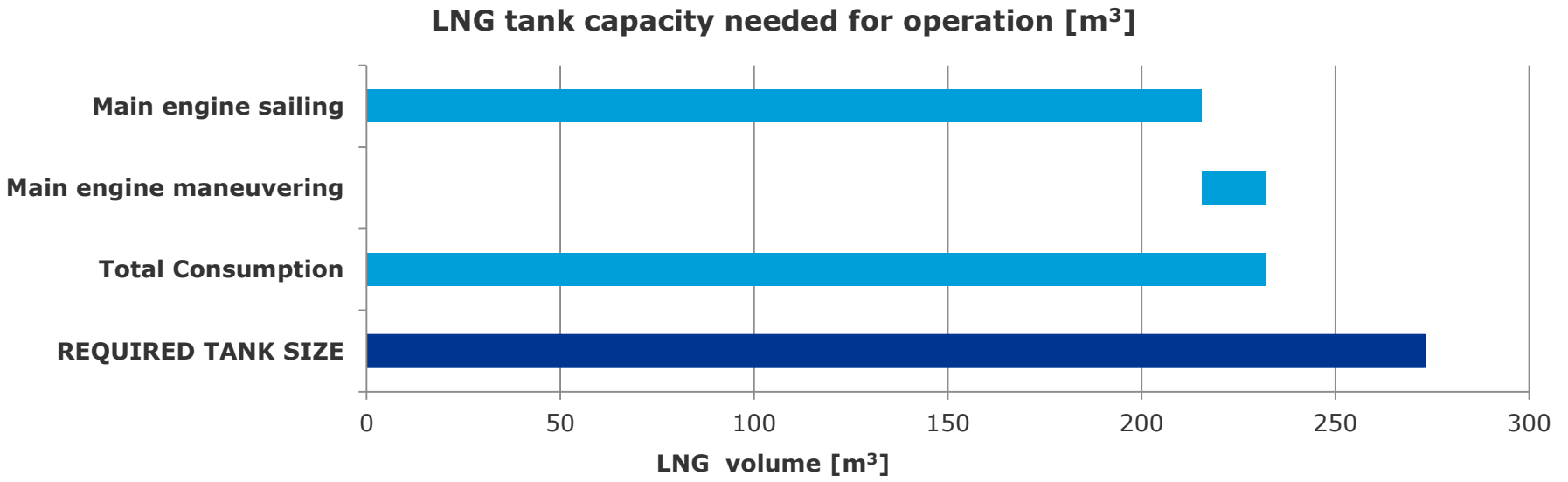
Assumptions and comments

- The main engine will be converted from a diesel engine to a dual fuel engine
- The engine output is significantly reduced

Issues to consider

- Not all diesel engines can be converted to dual fuel
- Cost efficiency of converting auxiliary engines is in general low due to low fuel consumption and high conversion cost
- Future use of vessel in other areas of the world where emission taxes apply

A tank size of 270 m³ is needed if bunkering every week



Assumptions and comments

- Dual fuel only for main engine
- 100% operation on LNG
- Bunkering frequency: Weekly (twice per roundtrip)
- 85% tank utilization
- 5% engine consumption margin added
- 15% safety buffer for propulsion has been added on main engine consumption

Issues to consider

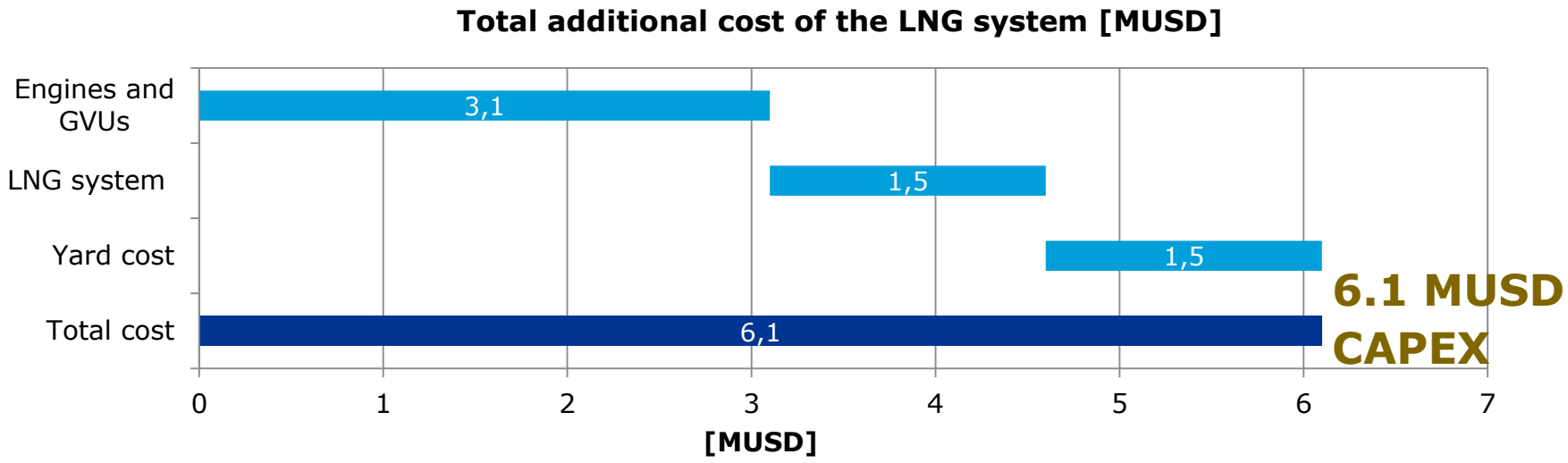
- Flexibility and range on LNG. Changes in sailing plan may cause higher tank size requirements
- LNG availability along the route (existing and future)

Technical conside

Issues to consider

- Special attention must be paid to class requirements for LNG tank location
  - ✓ LNG tank location with respect to existing and future regulations
  - ✓ Tanks on deck will most likely need a full enclosure (steel casing) to withstand the force of a falling container. Containers can be placed on top of and around the steel casing
  - ✓ Tank room must have sufficient space for inspection and cold box
- Installation of double wall vacuum insulated pipes
- Bunker station with valves and connections to shore
- Stability calculations must be performed due to potential impact Removing the HFO tanks and replacing containers with the LNG system could have an high impact on the vertical gravity centre

CAPEX estimate for LNG system



Assumptions and comments

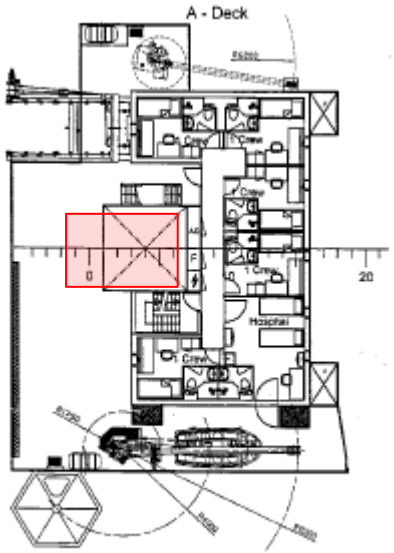
- Estimates based on experience from previous DNV GL projects
- The LNG system price includes the tank, the tank connection spaces, the bunkering station and the automation and interfacing system
- The yard cost assumes a "normal" addition for risk and overhead/profit from the yard, but this may vary significantly with market conditions

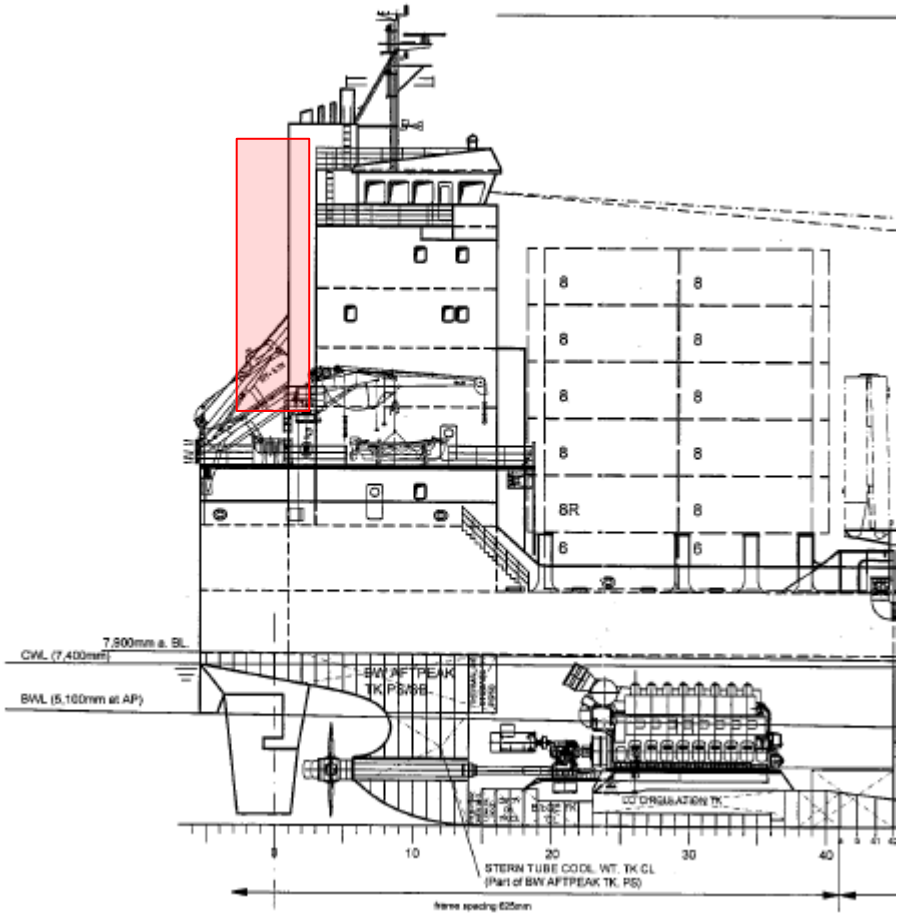
Issues to consider

- For the same LNG volume carried, different tank dimensions can represent high variations in investment costs.

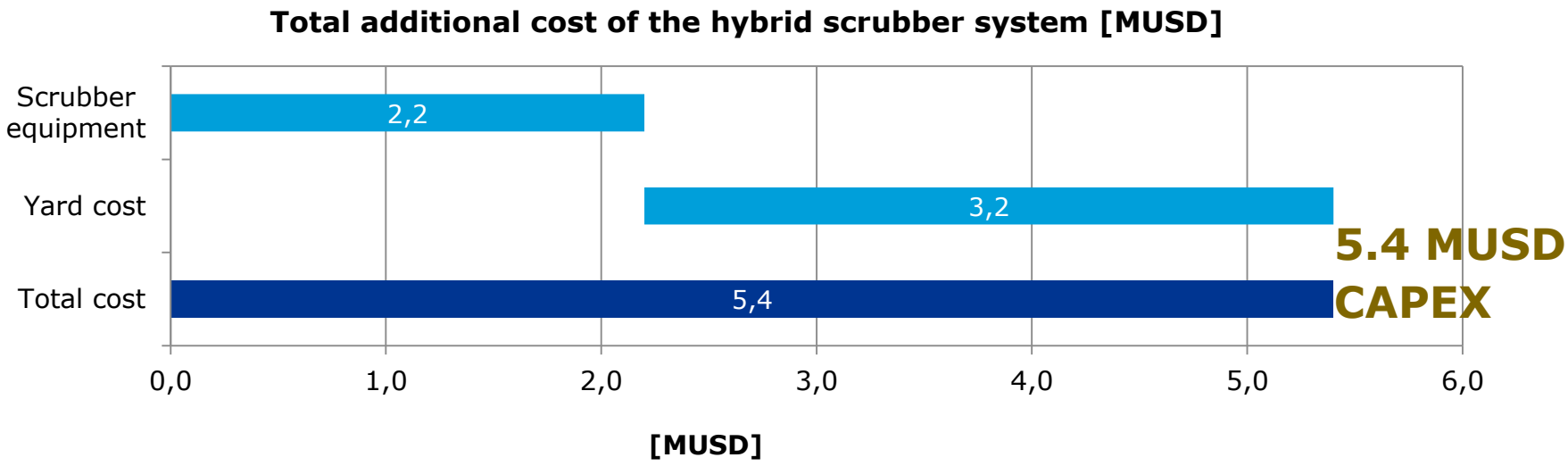
DNVGL Scrubber Assessment (container feeder) : Location of hybrid scrubber system (retrofit)

- Choose and place the optimum scrubber system.
- Preliminary analysis have not revealed any potential design issues (subject to more detailed calculations).
- Extensive piping, pumps and tank arrangements must also be provided.





CAPEX estimate for hybrid scrubber system



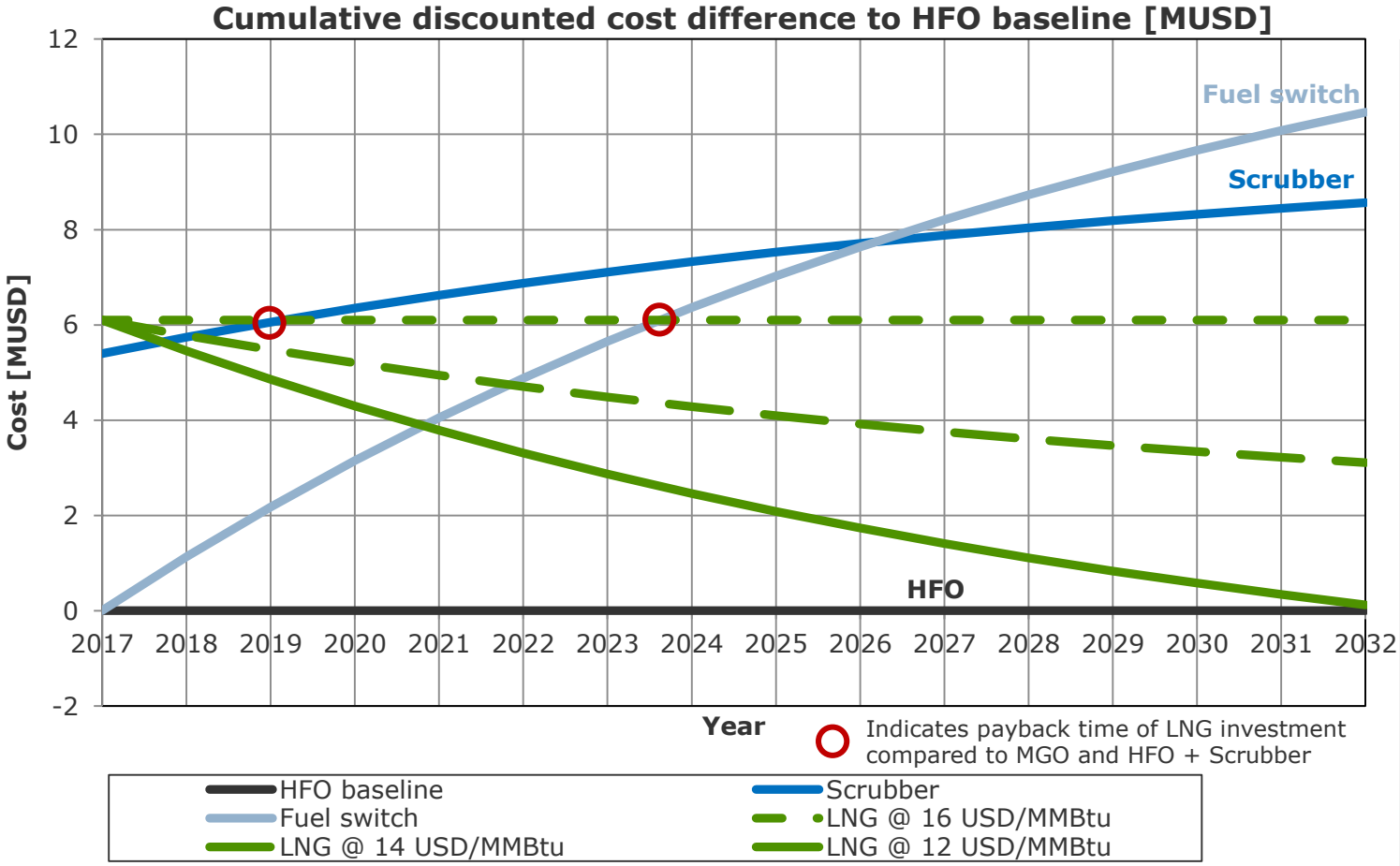
Assumptions and comments

- Hybrid scrubber for cleaning the exhaust of the equivalent diesel fuelled engine
- The cost estimate for the equipment is based on estimations from experience
- Yard cost is a case-to-case specific parameter with high variance

Issues to consider

- Choosing the correct scrubber solution among closed loop, open loop and hybrid scrubber should be investigated in detail. A Technology Qualification process is also recommended to increase the likelihood of a successful installation
- Operational costs of scrubber systems may be significant and need to be accounted for. Costs vary with scrubber type

LNG appears as an attractive alternative for LNG prices around HFO parity



Explanation

Each line represents the additional cumulative costs of the respective configuration compared to baseline (HFO).

LNG has a high investment cost, but depending on the fuel price the operational savings can be significant.

MGO price
930 USD/tonne
23 USD/MMBtu

HFO price
615 USD/tonne
16 USD/MMBtu

The LNG price spread shows which price levels are required for certain payback times. It serves as a good basis for decision making and negotiation with LNG fuel suppliers and system suppliers

Avaliability of novel fuels

Top ten future fuels for shipping

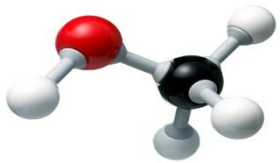
LNG

LPG

CNG

Biogas/biodiesel

Hydrogen



Methanol & DME

HFO

Distillate Fuels

Battery combo

Nuclear

+ Other…

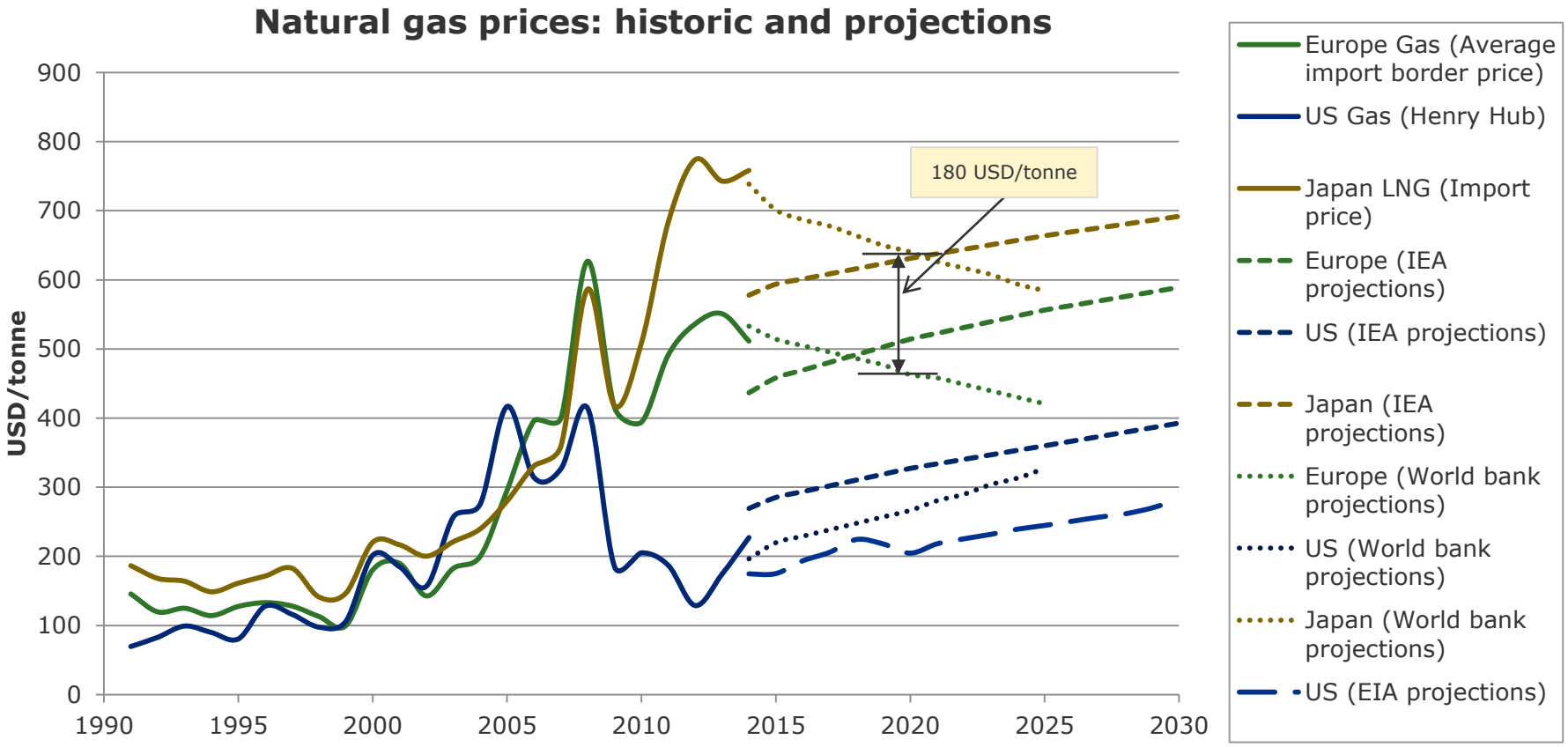
- Only some of these are proven through operation
- Physical & Chemical Characteristics
- Production, Availability & Cost
- Applications & Current Status
- Safety Considerations
- Emissions & Environmental Impact

Map of existing and forecast of LNG bunkering infrastructure in Europe

- **Existing**
- **Planned (*Feasibility study, risk study, proposed locations, pending approval*) Probably in operation from 2015-2020**
- **Proposed (*currently being discussed*)**

IEA and World Bank don't agree on direction, but a good guess is flat pricing in Europe & Asia, and increase in the US

LNG feedstock price + **Distribution cost** = **Suppliers' minimum LNG price**



The Wold Bank estimates that the difference in price between Europe and Japan will remain at around 180 USD/tonne.

How to move forward establishing LNG bunkering?

A. Create predictability for the Maritime and the Gas business

B. Start phase: Subsidies, EU initiative (TEN-T), 'NOx Fund' (Norway) etc …

C. Set up collaboration projects:

- Ports, LNG producers, LNG small scale consumers, infrastructure providers, regulators, financers, design/system suppliers, Class etc
- Example (DNVGL):
  - 2014: USA
  - 2013: Korea, China, Middle East, EU
  - Australia 2012/13: JIP "LNG bunkering infrastructure in Australia"

Australian Government
Australian Maritime Safety Authority

BOC
A Member of The Linde Group

FARSTAD

Ports Australia

Rolls-Royce

SVITZER

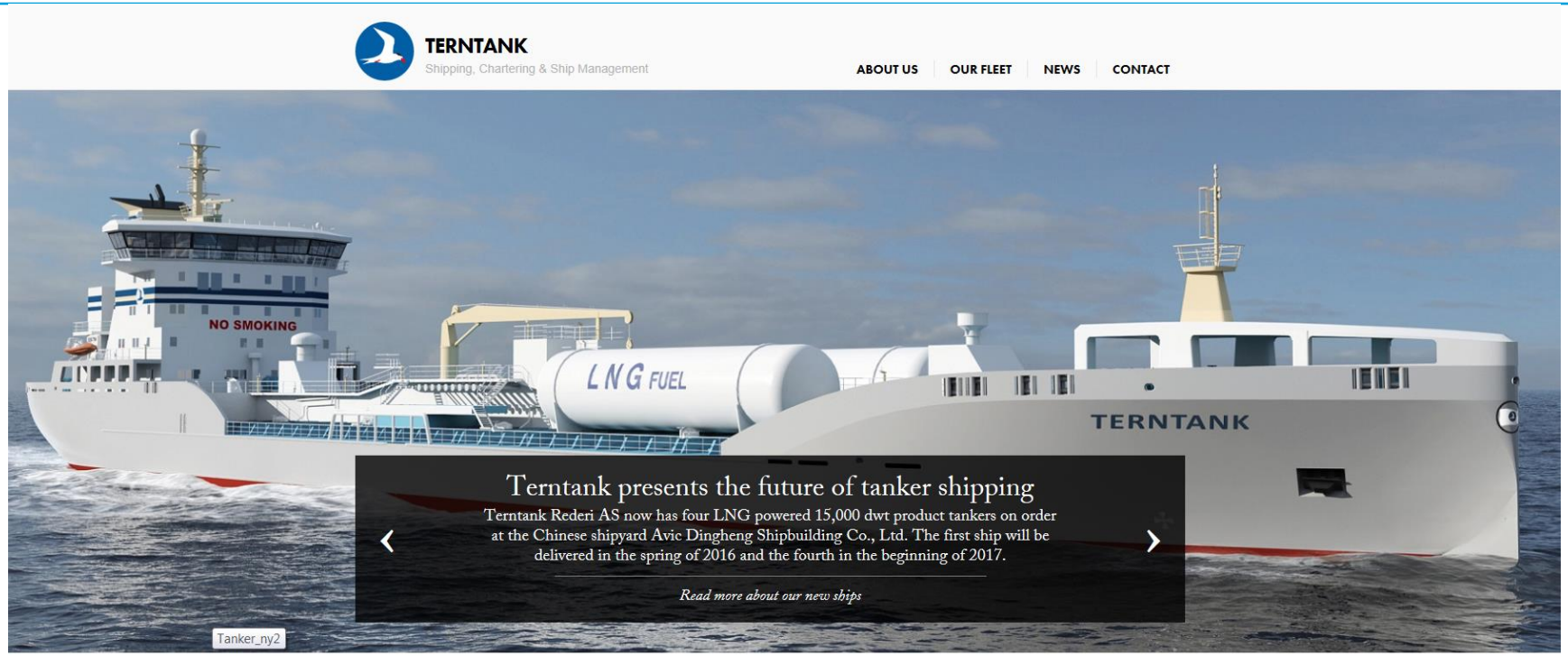
SWIRE PACIFIC

TK

woodside

risk assessment and sketch design

Interesting orders (Sweden)



4 x 15,000 dwt product tankers on order at Avic Dingheng Shipbuilding Co., PRC

Delivery 2016-17

Low-speed, low-pressure dual fuel main engine from Wärtsilä

2 ships have long-term charter by NEOT, North European Oil Trade Oy, Finland

Interesting JIP Project (Sirius Shipping, Sweden)

FUEL FLEXIBILITY

Prepared to operate with:

- DME (dimethyl ether, produces minimal soot and CO)
- RME (rape methyl ester or biodiesel, renewable fuel oil based on rapeseed)
- Heated fuel
- MGO fuel (marine gas oil, low on particulates and sulphur)
- LNG fuel (liquefied natural gas, low on NOx, SOx and PM, reduces CO2)

EXHAUST GAS CO NTROL & PARTICULATE FILTER

Minimises NOx and particulates

OPTIMIZED WASTE HEAT RECOVERY SYSTEM

Recovers exhaust heat from main and auxiliary engines and recycles it to the ship's thermal oil system – reduces fuel consumption

Sirius Shipping Aps
Sirius Chartering
Vald. Anderson Shipagency

Sirius Shipping

JOINT INDUSTRY PROJECT

Plotting the route to safe and clean shipping

author: Anna Lundberg | date: 26 January

DNV·GL

LNG bunkering coming in Hirtshals

Hirtshals Havn
PORT OF HIRTSHALS

English version

HAVNEN | TRANSPORT | FISKERI | OFFSHORE | SERVICE | AKTUELT

AKTUELT

- Nyheder
- Radiospot - Rundt om havnen
- Tilmelding nyheder
- Det sker
- Vejret i Hirtshals Havn
- Skibe i Havnen
- Webcams
- Nyhedsarkiv - 2012
- Nyhedsarkiv - 2011
- Årsberetning

Hirtshals Havn bliver Danmarks første havn med kommercielt LNG-bunkeranlæg

Fjord Line etablerer sammen med Liquiline Danmarks første kommercielle LNG-bunkeranlæg på Hirtshals Havn. Der etableres i første fase et tankanlæg på 400 kubikmeter, som primært skal forsyne Fjord Lines cruisefærger, og som samtidig giver mulighed for forsyning af andre LNG-drevne skibe.

En meget tilfreds bestyrelsesformand ved Hirtshals Havn; Anker Laden-Andersen udtaler:
- Gennem længere tid har vi samarbejdet med Fjord Line omkring mulighederne for etablering bunkerfaciliteter for LNG på Hirtshals Havn, og det er derfor naturligvis glædeligt, at vi nu er nået endnu en milepæl med Fjord Lines indgåelse af aftalen med Liquiline. Med aftalen bliver det første synlig skridt taget med etablering af den første LNG-tank. Endnu mere spændende er dog de fremadrettede strategiske perspektiver, hvor Hirtshals Havn nu har førertrøjen på i forhold til at blive omdrejningspunkt for LNG i den nordlige del af Jylland. Heraf vil også følge muligheden for på sigt at blive cen-trum for udvikling af andre gasaktiviteter.

Quicklinks

- Skibe i havnen
- Vejret på Hirtshals Havn
- Havnens Service
- Webcams
- DMI - Vejrudsigten
- Virksomheder i Hirtshals
- Links

- Phase 1: 400 m3 tank
- Primarily for Fjordline vessels
- Built by Liquiline of Norway

LNG bunkering in Gavle?

SJÖFARTS TIDNINGEN

"Världens sista fyrmastade stål
i originalskick finns i Marieham
på Åland."

Läs Ålandsbloggen

Aktuellt Bloggar Jobb & Karriär Annonsera Prenumerera Om oss

Allt Debatt Ett samtal med Hallå där Kajutan Nybyggen **Nyheter** Personalia Reportage

Gävle hamn på en bild från september 2013. Gävle hamn

Grönt ljus för LNG-terminal i Gävle

Ett viktigt steg har tagits för norska Skangass och deras planer på att bygga en LNG-terminal i Gävle hamn. Detta sedan Länsstyrelsen i Dalarna gett företaget tillstånd att bygga och driva en anläggning i hamnen.

- Skangass of Norway received in Aug '14 permit to build LNG bunkering terminal in Gävle (Sweden)
- 30,000 m3 storage, 500,000 tpa
- Skangass just got a new main shareholder, Gasum of Finland

LNG bunkering in Gothenburg?

- Vopak + Swedgas
- 20,000 m3 tank
- Has got building permit from the county, but some public concerns (?)
- Scheduled opening 2016

SOx emission 'sniffers' – Enforcement is crucial!

explicit

FORCE TECHNOLOGY

UAS Denmark
unmanned aircraft systems

- Emission 'sniffers' being investigated in Denmark and The Netherlands
- Targeting ECA enforcement

PRESSEMEDDELELSE
København, 20. februar 2014

Dansk drone-iværksætter vil fange miljøsyndere til havs

Explicit - en dansk IT-iværksættervirksomhed - vil med støtte fra Miljøstyrelsen udvikle droneteknologi til overvågning af luftforurening fra skibstrafikken. Målet er at fange skibe, der ikke overholder de internationale grænser for svolvudledning. I dag har skibsrøg store menneskelige og økonomiske konsekvenser, men myndighederne savner bedre teknologier til at fange miljøsynderne.

In the US: ECA gives only 18USD added costs to shipping a 20' container

CONCLUSIONS

Conclusions

- ECA poses a true threat for many ship owners if not properly handled
- Ship owners, charterers, cargo owners: cooperate and plan ahead
- Legislators and organizations: Create predictability for business
- Regime for rule enforcement is crucial
- Suppliers, yards and fitters also need predictability
- The majority of the business can cope with ECA and other regulations, but costs but eventually to passed on to end-user

1000 PAX

250 cars

Max 58 kn

40 MW

LNG fuel

DNVGL

Thank you for your attention

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